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SCIENCE AND THE PRESS

THE Conference on Science and the Citizen which was arranged last March by the Division for the Social and International Relations of Science of the British Association (NATURE, April 3, p. 382) was, as Mr. J. G. Crowther observed, the first in Great Britain to be devoted entirely to the consideration of the means which can be used to increase the public understanding and appreciation of science and the methods of improving them. The Press can exert a most powerful influence in this matter, and appropriately a whole session of the Conference was devoted to a discussion on science and the Press. Unless effective relations can be established in that field, the general appreciation, not only of the powers but also of the limitations of scientific research, which Sir John Anderson stressed as vital for the effective contribution of organized Government research, industrial research organizations and academic and private research institutions to the solution of post-war problems, can scarcely be achieved.

The subject was frankly and fully discussed at the Conference. It was recognized that as regards the human element there have been faults on both sides. While it would be unfair to expect the scientific community to accept the whole responsibility for the failure of science to exert upon the public mind the influence that it should, scientific workers appear much more disposed than formerly to admit their own shortcomings in the task of dispelling public ignorance of science. It is recognized that the task of exposition is vital and that it calls for qualities of mind no less deserving of respect and reward than those of the investigator whose results in some recondite but important field have to be interpreted to the lay mind.

We may leave on one side the admitted weakness of many scientific workers in interpreting their own results, their tendency to keep to themselves, their shyness and technical jargon—these are matters which will undoubtedly be corrected from within, partly as the effect of a wider and more cultural education as a basis for scientific study is felt, partly through the efforts made by scientific men themselves to counteract the effects of excessive specialization now that the danger is recognized, and partly by the pressure of professional opinion awakened to the importance of closer and fuller contact with the world at large if men of science are to play a fitting part in its shaping. What we may fairly look for as one result of the Conference is a more generous attitude to the scientific expositor himself, for he has rarely received from his confreres the honour that is his due. Nevertheless, as Mr. J. G. Crowther pointed out, until it is possible to make a reasonable income from reporting science, very few good men are likely to become what the Americans call 'science writers'. However, it is at least as important that such expositors should be sure of the appreciation and support of their professional colleagues in the world of science.

The ultimate factor on the personal side of this question is the long-range one of education. The difficulties arise as much from the neglect of cultural and human elements in the training of the man of science himself, and from specialization at an over-early age making him a half-educated man, as from the failure to include in the education of every citizen such a broad training in the method and outlook of science as will fit him or her to live intelligently in a world in which scientific factors have so profound an influence. They will not disappear entirely until these educational defects have been rectified and come to fruition in the following generation, and this factor must be kept in mind in considering what form of organization should be adopted to improve the immediate position and to serve the needs of adult education in this respect.

There can be no question that, as Mr. H. Brewer has pointed out in a recent letter (NATURE, May 8, p. 534), a large measure of responsibility for the present position lies on the shoulders of scientific workers themselves through their neglect of organization to that end. The work which Science Service has been doing in the United States since 1921 has no parallel in Great Britain, and the Institution for the Popularization of Science which now conducts Science Service is even further ahead. It is not sufficient to blame the Press for its failure to appoint science editors or scientific correspondents, when on the side of the scientific worker arrangements for the presentation or interpretation of scientific and technical advance are so defective and poorly organized. The neglect of scientific workers to organize on rational lines their own publications within the fields of a particular science even in these days of paper shortage is a further illustration of this failure.

One of the most significant features in the present situation is the great opportunity which the War has opened up for the wider presentation of scientific and technical knowledge to the many who, in the Forces or in their war-work, have become engaged in scientific and technical operations. Mr. Crowther did well to remind us of the field that is here open for increasing the efficiency of war production, and his suggestion that the Minister of Production should, like the Ministers of Food and Fuel, secure space in the daily Press and run a series of scientific and technical articles on the innumerable fascinating non-secret processes used in the field of production deserves to be explored. To assist the worker to understand what he is doing is a sound method of improving production or maintaining it under stress, and is a prime reason for greater attention to science in the Press. It is equally important that there should be a widespread appreciation of the implications of scientific advance in such fields as nutrition, health, agriculture, fuel, the use of the land, forestry, and the like, so that reconstruction may be formulated and judged on impartial and practical lines. That is a further urgent reason for attention to this question; the problem of the social relations of science, with its claims for wider and fuller consideration, is an additional reason.

Mr. Henry Martin, of the Press Association, in his paper at the Conference, urged with some force that it is for science to take the first step towards a *rapprochement* with the Press, and he referred to the encouraging results which have already attended some early steps in this field. There was immediate response to the articles issued on behalf of the Central Council for Health Education, and to the work of the British Council. The Press conferences held during the War at regular intervals by the chief medical officer of the Ministry of Health are a further instance of wise co-operation with the Press, and Mr. Martin spoke with warm approval of the Press Bureau of the Ministry of Information. What science needs, he suggested, is a Press Bureau for the collection, collation and dissemination of scientific information, with offices in or near Fleet Street. Such a bureau should have international ramifications and contacts in the foreign capitals so as to permit of interchange of information and rapid and frequent consultation. Each bureau would, as in London, be responsible for organizing the collection of science news in its own territory.

Such a Bureau would require a director, together with an editor or a news editor and a small staff of men with both journalistic and scientific qualifications—men with a practical knowledge of newspaper needs and technique, and with a catholic interest in, and knowledge of, science, combined with a capacity for assimilating material in the raw and turning it into simple language for publication in the daily Press. Such a combination of qualities is by no means easy to find, and the question of personnel is likely to be a real difficulty in launching any such scheme. Mr. Martin is right none the less to stress the importance of such qualifications, and particularly in the selection of the director, who besides being well known to, and *persona grata* with, scientific men, must possess first-class organizing ability.

The brief sketch of the activities of the director and of the Bureau which Mr. Martin outlined shows how much might be done, not only to put the relations of science and the Press on a firm footing of understanding and mutual confidence, but also to open up an even richer field than at present in the magazines and periodicals. An essentially similar scheme was outlined by Mr. Ritchie Calder in his plea for an Institute of Scientific Information. He recalled that, at its Dundee meeting in September 1939, the council of the British Association had on its agenda the discussion of a scheme for the establishment of an organization in Great Britain linked up with similar agencies in Europe and the United States to ensure a regular, accurate and up-to-date service of news for the Press, films and radio, on scientific developments.

Mr. Calder did not go into the same detail as Mr. Martin in his proposals, but he stressed, like him, the importance of very careful selection of staff and of establishing links with panels of experts in all branches of science. Upon such personal relations and contacts the success of any such Institute or Bureau must very largely depend, and it is the more important therefore that Mr. Martin's advice to proceed slowly should be heeded. Time will be required for the discovery of staff and for the establishment of the essential relations and organization, which itself may be a matter for experiment, just as the technique of communication itself merits research, as Mr. Crowther pointed out.

What must be recognized is that these tasks cannot be left to the casual observation or investigation of busy men who are primarily engaged on other work. Exposition and interpretation must be a full-time primary occupation with appropriate status and financial recognition. Furthermore, it is essential that the organization of any form of Press bureau for science should not be undertaken without consideration of scientific and technical publications as a whole.

Granted the wider interest that the War has awakened in science, it may well be held that both Mr. Calder and Mr. Martin are unduly optimistic as to the effect of the War on the mental attitude of the average reader. There is at least this much in Mr. Wells's view that the practicability of using the newspaper to-day as a vehicle of instruction may be open to challenge. Admittedly it is difficult to view some newspapers as other than purveyors of amusement and sensation, but that is not true of all. Are we even to assume that the popular newspaper must always be limited by the deficiencies in ideas and education of the readers for whom it caters, and to exclude the possibility of even any slow advance in this respect?

To adopt that position seems uncomfortably like an admission that the War will be fought in vain, and no world order established worthy of the effort and sacrifice made. Short of such a defeatist attitude, we must utilize the Press as one means of consistent interpretation and exposition to the public of at least the social significance of scientific and technical advances as they are made. We should neglect no means by which the task of making every citizen aware of the place of science in the modern world may be discharged more effectively.

The charge of complacency is easily levelled against both the scientific worker and against the Press. What is required is constructive criticism, goodwill and readiness to co-operate. In this matter of publication, scientific workers have clearly to set their own house in order, and one result of closer attention to that would be more first-class exposition in textbooks and articles in the magazines and periodicals, the elimination of useless jargon and of the grosser overlapping of publication, particularly of abstracting.

It may well be hoped that the Conference will stimulate further consideration of the problem by the professional associations of scientific workers and of journalists themselves. The hope of progress lies largely in the collaboration of such professional bodies on both sides. Some of the opportunities were clearly displayed at the Conference—opportunities which it requires no fresh organization to seize. Organization may enlarge those opportunities, but no new technique will be needed: it can be done only by trained minds devoted as implicitly and sincerely to the exposition of the results of scientific discovery and their application as those devoted to the acquisition of fresh facts and discoveries.

To repeat what was written in these columns many years ago: "The imagination of mankind will only be fully touched by the achievements of science and man roused to a wider application of scientific method, when innumerable artists of science, great and small, in utter fidelity to truth—to science as to life—have made plain its mysteries in words understood of all". That task rests finally on the shoulders of the expositor. Deriving his authority from his power of comprehending his subject, assessing values, and understanding his public, his scientific training must be supplemented by his ability to interpret facts and values in language understood by the common people. In proportion as he displays the same qualities of mind and unswerving loyalty to truth which his fellow men of science show in the laboratory investigations, the task of exposition will stand out before all in its true greatness, as compared with that of propaganda with which it is too often confounded.

AUTHORITARIANISM VERSUS INDIVIDUALITY

The Fear of Freedom

By Dr. Erich Fromm. (International Library of Sociology and Social Reconstruction.) Pp. xi+257. (London: Kegan Paul and Co., Ltd., 1942.) 15*s*. net.

THAT our world stands in flames and that no one can say with any hope of finality what in fact is happening to us are facts which are present in everyone's mind. Most of the attempts to explain the situation from recent economic and sociological causes are patently insufficient, and Dr. Fromm is wise enough to present his excellent survey with a clear eye on its necessary limitations. His analysis of the individualistic character-structure of modern man, shown in relief against the contained collectivity of the Middle Ages, is an excellent example of the value of the historical method to psychological understanding. The fundamental premises of the Gothic mind were self-evident and unquestioned. Men marched in step with their time. Their fate was laid down and contained in their community. From the Reformation onward this containing envelope was ruptured and the individual began to emerge into a world which no longer shielded him from the deep-rooted sense of his own impotence and powerlessness over and against dangers and forces he could not control. Instead of being integrated and enclosed he felt exposed and alone, and this was projected into the idea of a hostile deity whose arbitrary nature demanded indefinite and intense placatory effort. The Calvinistic conception of God and the world were the inevitable result of this ejection of medieval man from his contained paradise.

Dr. Fromm has excluded the study of myths from his field. It is a pity. Because the evolution of conscious man from the instinctual paradise of Nature, in which primordial unconsciousness enclosed him in a timeless garden, is surely the continuous archetype of every new step towards individual consciousness. But when we ask ourselves what is that force which time and again in history has prised man away from his containing background, and driven him forward upon this age-long experiment of individuation, can we, in fact, answer it in the terms given by the title of this book? Is it, in fact, the fear of freedom which is at bottom responsible for the authoritarian character-structure of the neurotic modern man? If we take the whole evolutionary story, we observe the fact that before he begins his ascent primitive man can only integrate his psyche outside himself in his tribal container. The moral principle operates not within the individual soul but through tribal law and taboo, and the amazing complexity of primitive systems of kinship manifest the compelling force of social integration. The social man, therefore, precedes the individual man. He is the evolutionary plinth upon which individuality eventually must stand.

From our experience of individual development we know that at every fresh stage in consciousness there is a tendency to recoil or regress back to an earlier condition. Evolution is never a constant forward movement. The stepping backwards into the security of the past is like the pull of psychical inertia, in opposition to which individual consciousness eventually declares itself. The totalitarian mentality of the present time shows all the characters of just such a regressive movement to an archaic pre-Christian model. On the other hand, as Dr. Fromm clearly sees, the individualistic trend of post-Reformation psychology can be leading only to a new conception of individuality, in other words to man in the fullest expression of his whole nature. But just because the author conceives this individual experiment in terms of freedom, he gives to man's capacity for free and spontaneous expression the whole meaning of deliverance. As he has left it, the problem of individuation is simply a matter of developing the capacity to be oneself in place of the artificial personality which is a more or less mechanical response to collective assumptions and expectations.

Everyone can agree that this problem of the original spontaneous human being versus the authoritarian civilized artefact is the main issue of our time. But what Dr. Fromm has omitted from his survey is the undeniable fact that the self-discipline required to bring about an order of freedom within is not to be attained by the mere cultivation of spontaneity. The way of individuation is no new experiment. Various methods of spiritual development have, in fact, been practised in the West as well as in the East. But the goal of wholeness or completeness has never yet been attained without a religious devotion and rigorous self-discipline. Surely the reason why the authoritarian hypothesis is so readily accepted by mankind in general is simply because the way of individuation is infinitely more exacting and difficult. To be completely oneself in the sense of living one's life with absolute security and integrity is indeed the heroic path. This freedom is realizable only on a higher level of responsibility.

It would seem, therefore, that no one is capable of developing his fullest gifts and powers unless he knows in his heart that his creative task is acceptable to the God he serves. Only when a man feels that the fullest expression of individual life and consciousness lies near the heart of God's purpose can he give his complete devotion to it and submit to the discipline it involves. For individuation also involves the social task as an integral aspect of being. In his historical chapters Dr. Fromm has emphasized the fact that the authoritarian conception of God must be related to man's sense of insecurity and helplessness, and that this authoritarian character will inevitably persist so long as men project absolute value into some external condition, as for example, the State, the Mikado or even an absolute Deity. If this hypothesis is correct, that the regressive authoritarian mentality is invariably dependent upon some non-human absolute, it would surely follow that man can achieve wholeness only by accepting an evolutionary relativity both in his conception of God and of the ideals by which he navigates his own life. But to omit these ultimate issues altogether as outside the scientific field is surely to ignore the very centre around which a total integration is even conceivable.

Although the work suffers from this serious omission, the author's analytical conclusions seem to me incontrovertible and of considerable importance. It is a genuine contribution, particularly in regard to the right understanding of the sociological factors which operate so powerfully in human psychology.

H. G. BAYNES.

PROBLEMS OF GEOMORPHOLOGY

Geomorphology

Systematic and Regional. By Prof. O. D. von Engeln. Pp. xxii+655. (New York: The Macmillan Company, 1942.) 4.50 dollars.

THE recent revival of interest in geomorphology is reflected in the appearance of a number of text-books in the past five years. The most recent, by the professor of geology at Cornell University, is to be welcomed particularly because it is intended for more advanced students. The author assumes that the reader has already completed an elementary course of geology, and that he is acquainted with the nature and operation of geological processes. By omitting much of this introductory matter, Prof. von Engeln has been able to devote much more than the customary space to the discussion of wider concepts.

Short chapters are devoted to 'first order relief' (the forms of the earth as a whole, of the ocean basins and of the continents), the relief of the ocean bottoms (graphically illustrated by some simple diagrams) and geomorphic units. Much of the rest of the volume deals with the relief of the continents, and the treatment given is unusual and stimulating. Like most American geomorphologists, Prof. von Engeln believes that the terminology and concepts of W. M. Davis afford a most convenient basis for the description and discussion of many relief features; but he is not content to ignore other approaches to the problem, and devotes considerable space to consideration of the views of Walther Penck.

The teaching of W. M. Davis gave great prominence to the concept of the 'cycle of erosion'. He emphasized the fact that many landscapes can be regarded as having been developed by the dissection of an uplifted region, the stages of dissection being those of youth, maturity and old age. He held that long-continued erosion would lead to reduction in altitude and to the formation of a low-lying plain, a peneplain. In the frequent re-statement of these views, perhaps an undue emphasis in some cases has been laid on the comparative rapidity of the uplift which initiates the cycle, and on the long-continued stability of the land during its degradation. The recognition of erosion surfaces is held to be of primary importance in the interpretation of topography: as Prof. von Engeln points out, "the uplifted, more or less dissected, peneplain surface is a marker of the same kind, but of even greater significance, to the geomorphologist that the stratification plane is to the stratigrapher".

The concept of the 'geomorphic cycle' has been criticized, particularly on account of the long-continued stability necessary to permit of the complete peneplanation of a large area, but it has afforded a framework for much fruitful discussion of relief. It is therefore particularly fitting that Prof. von Engeln should devote an early chapter to a very interesting discussion of the peneplain concept. In this and a later chapter he considers the views of Penck in some detail: Chapter 13 (the Walther Penck geomorphic system) probably gives the fullest summary of Penck's opinions which has appeared in English. Penck believed that the Davis cycle of erosion applies only in the special case of rapid uplift followed by prolonged *stillstand*, and that varying rates of uplift are of primary significance in the development of types of relief. In particular, he considered that in certain cases very slow upheaval controlled the development of land forms; for example, in a newly emerged land rising very slowly and continuously he suggested that degradation would level the area as rapidly as it rose, so that there would be no increase in the amount of relief. Such a featureless plain or *primärrumpf* would truncate structures, and would have many of the characteristics ascribed to a peneplain as defined by Davis, but it would not have resulted from the degradation of a previously elevated tract. Such a *primärrumpf* might be raised later by an acceleration in the rate of uplift. Probably a great variety of land forms would result from differences in the ratio of rate of uplift to degradation.

In the present volume it is not suggested that the ideas of Davis and Penck are mutually exclusive. It is clear that both lines of approach are legitimate and may be useful. The two systems differ in the interpretations of slope forms, and if the attention here paid to Penck's views leads to a closer study of slopes and their development it will have been amply justified.

On the whole, the conclusions of British geomorphologists have been in line with Davis's concept of the cycle of erosion, and intermittent uplift with successive periods of comparative *stillstand* has been held to explain the origin of the features observed. In general, these views have been supported by much recent work on the gradient curve of rivers; Prof. von Engeln makes little comment on this method of investigation. In Britain there is much opportunity for such detailed studies, but it is not surprising that many American workers are more attracted to wider problems.

There is an interesting chapter on factors of rock strength, while later chapters deal with the history of the folded Appalachians, desert and glacial geomorphic cycles, coasts, coral shore lines, karst topography and land forms resulting from volcanicity. It is no criticism of a work such as this to suggest that many workers will find statements with which they may not wholly agree. For example, the usual definition of superimposed drainage would scarcely cover the case illustrated in Fig. 114; the diagram showing Willis's interpretation of rift valley structure (Fig. 227) also is misleading owing to the geological shading adopted.

It remains only to add that the volume is illustrated in the lavish manner to which we have become accustomed in American works of this type, and that a wide range of references to classical and current literature is given. By supplying such a thoughtful account of many aspects of geomorphology the author has placed teachers of geology and geography in his debt. It is a volume which may be warmly recommended for the reading of more advanced students.

A. E. TRUEMAN.

THE POLYNESIANS

Polynesians—Explorers of the Pacific

By J. E. Weckler, Jr. (War Background Studies, No. 6: Publication 3701.) Pp. iv+77+20 plates. (Washington, D.C.: Smithsonian Institution, 1943.)

THE exploits of the early Polynesians in discovering and populating, at one time or another, every habitable island in the Pacific mark them as the most daring deep-sea voyagers the world has ever known. In spite of having tools made of stone or shell only, they fashioned large double-keeled ships which they stocked, like arks, with food-plants and animals, and then transported themselves and their women into the unknown. True, there are islands at intervals along the route which they almost certainly took from the eastern end of Asia to the nearer islands of Polynesia, but even these voyages entailed a week or two at sea, while islands like Hawaii and New Zealand took longer to reach. There is some controversy as to whether these emigrants travelled through Micronesia or Melanesia, the inhabitants of both showing certain cultural affinities with the Polynesians, but the author considers that evidence points rather to the northern route, with what one might call a backwash to the marginal islands of Melanesia from Samoa.

After discussing his reasons for assuming the Micronesian route, the author describes the ships used by the ancient Polynesians as compared with their present-day canoes, and again emphasizes their skill and courage in facing the unknown. Their navigation was aided by a knowledge of the stars and an extensive study of the weather, in the forecasting of which they were, and still are, adepts. The colonizing of the new lands presented increasing difficulties as they forged farther afield, for not only was the terrain different, coral atolls replacing the fertile volcanic islands, but also the supplies of food plants they brought with them must have been running short and there was no food for their animals. Colonization in these circumstances was no mean task, and although they eventually reached the more fertile lands of Polynesia proper, they might not have been able to profit much at first from them owing to the lack of plant and animal stock. Whatever their route or methods, however, the fact stands out that these intrepid people established themselves throughout the Pacific islands as far even as Easter Island. It is also possible that they reached South America, while their own traditions indicate that they penetrated into the Antarctic.

Following this introduction, the author treats of Polynesian ways of life first in pre-European times and then in the difficult transition days of early contact with their conflicting cultures, and finally in the present day. In a short appendix there is a brief account of each of the principal island groups, and the paper is illustrated by a map and excellent photographs, and accompanied by a bibliography.

K. RISHBETH.

Fuel Testing

Laboratory Methods in Fuel Technology. By Dr. Godfrey W. Himus. Second edition. Pp. xvi+288. (London: Leonard Hill, Ltd., 1942.) 21*s.*

INDUSTRY in general has not given adequate attention in the past to thrift in the use of fuel. In Great Britain coal has been abundant, good and relatively cheap. Fuel has usually been a minor item in cost of production. War conditions have brought a change measured by the scarcity and cost of fuel. Moreover, it is unlikely that pre-war conditions will ever return. Present conditions have caught many with plant inadequate to handle lower-grade fuels and operated by staffs lacking in technical knowledge to cope with new difficulties. One result has been the issue by the Ministry of Fuel and Power of much literature in pamphlet form full of practical advice on most of the problems facing the operational staffs of fuel consumers. Last year the British Standards Institution issued two new specifications on (*a*) "The Sampling of Coal and Coke", No. 1017, 1942, and (*b*) "The Analysis and Testing of Coal and Coke", No. 1016, 1942. These collect and codify what has previously been scattered in several specifications, representing the combined experience of many years. They give the general impression of an increase in the elaboration and refinement which is necessary in research and critical work. Anyone familiar with the conditions under which coal is bought, sampled and handled in ordinary industrial practice will doubt whether all this refinement is necessary. The book by G. W. Himus is a timely production, for not only does it incorporate the essentials of the British Standards Institution specifications, but also it goes much further, with chapters on liquid and gaseous fuels, technical pyrometry and other matters of interest to the fuel technologist. It is the most recent and comprehensive work of its kind available to those chemists and engineers who are compelled by circumstance to interest themselves in industrial fuel economy, and of these to-day there are many.

H. J. H.

How Aeroplanes Fly

By W. O. Manning. (Oxford Air Training Manuals.) Pp. 64. (London: Oxford University Press, 1942.) 2*s.* net.

THIS volume is yet another added to the spate of publications dealing with the several branches of aeronautical sciences from the semi-popular outlook. It is not easy to see exactly what type of reader the author envisaged when writing this. It is not the ordinary popular descriptive book, as it does not link up with aircraft by giving photographs of appropriate machines, but on the other hand its technical aspect is so elementary that it can scarcely appeal to anyone with any pretence to the elements of aeronautical knowledge.

The text is well written, very lucid, and largely free from those inaccuracies that many authors commit when endeavouring to present an abstruse subject in simple language. It presents the theory of flight in chapters on the atmosphere, sustenation of the wings, control and stability of the aircraft, propulsion by the airscrew, choice of engines, and types of aircraft for different purposes. There are a few cases where attempts at simplification have resulted in a statement that seems unnecessarily vague for a scientific work. For example, it is stated that in certain engines the water jacket is "no thicker than a piece of tin". How thick is a piece of tin? Anyhow, the material to which the author is apparently referring is tinned sheet steel. Also the word "fuselage" is used constantly instead of "body". This practice was officially discouraged some time ago, and the more general word "body" is always used in Air Ministry correspondence to-day. The author surely sometimes underestimates the intelligence of his reader when he says that "60 miles an hour is 88 feet per second", and goes on to add that "30 miles an hour is 44 feet per second".

Altogether this is a pleasant, readable book for a beginner who will necessarily not read it too critically.

Steels for the User

By R. T. Rolfe. Second edition, revised and enlarged. Pp. xi+356+42 plates. (London: Chapman and Hall, Ltd., 1942.) 25*s.* net.

THAT this book has been found of practical value by users of steel is shown by the fact of a second edition being called for after three years. The author is particularly concerned with plain carbon steels; and although alloy steels are discussed when necessary, he is at pains to show that by suitable heat treatment the simple carbon steels may be given a wider range of usefulness than is sometimes supposed. The value of the book is essentially practical, and many examples of applications in service, and also of service failures, are discussed in detail. Some of the minor applications of steel which have a metallurgical interest of their own, such as needles and instrument pivots, usually neglected in text-books, are included.

The new edition contains much new matter, especially on heat treatment, welds, and fatigue testing. The short theoretical section is less satisfactory, the iron-carbon diagram on p. 35 being quite out of date, but this is not likely to mislead the user for whom the work is intended, and whose requirements are not met by the standard text-books. The presentation throughout is clear, and the numerous illustrations are representative and well reproduced.

Bibliography of the Literature relating to Constitutional Diagrams of Alloys

Compiled by Dr. J. L. Haughton. (Monograph and Report Series, No. 2.) Pp. iv+163. (London: Institute of Metals, 1942.) 3*s.* 6*d.*

THIS compilation gives, in systematic order, references to papers dealing with the constitution of metallic alloy systems. It does not include physical properties unless they have been used as a means of determining constitution. It represents the result of many years of careful card-indexing and should save investigators a great deal of trouble in searching the literature. The first 125 pages cover the binary systems, but another 34 pages are needed for the ternary alloys, a larger number than might perhaps have been expected. More complex systems have been very little investigated. The book is published at a low price by the Institute of Metals, and the author has in most instances added the page of the abstract to be found in the *Journal* of the Institute, for the convenience of readers who have it at hand. Besides metallurgists, chemists interested in phase equilibria will find the publication of value.

ORGANIZATION OF AMERICAN SCIENTISTS FOR THE WAR*

By Dr. KARL T. COMPTON
President of the Massachusetts Institute of Technology

IN America we have two principal scientific societies which are broadly representative of all the fields of science and which are rather parallel to the Royal Society of London and the British Association for the Advancement of Science. Dr. Frank B. Jewett, president of the National Academy of Sciences, has asked me to deliver his personal message to the president of the Royal Society of London, Sir Henry Dale, and in addition he requested me to express the admiration which is felt by the members of the National Academy of Sciences for the magnificent manner in which the scientific men of Great Britain have thrown the whole weight of their energies and abilities to master the innumerable technical problems arising in this War. He wanted me to assure you that in so far as we can do likewise, we in America are making a sincere effort to handle our similar problems and co-operatively to supplement the great work which you are doing.

Dr. Isaiah Bowman, who was elected president of the American Association for the Advancement of Science last month, also gave me a message of greeting to British men of science from which I quote as follows: "Now that the war has advanced to the stage at which we begin to talk of post-war plans, we feel more than ever the need for collaboration between Great Britain and the United States. While there is no such thing as an Anglo-American bloc in world politics, there is such a thing as close comradeship in the fight for principles. This comradeship we feel whenever we deal with the leaders of Britain and whatever the field of interest. I venture to predict that, whatever difficulties may arise, we shall find that comradeship and agreement upon principles will ever mark our future relations. This belief is based upon our widely recognized common responsibility for the peace and safety of mankind in the years after the War. If England is being changed by the War, the United States is changing just as rapidly. Once our President was able to report on 'the state of the Union', as our constitution provides, almost without touching on foreign affairs. Two world wars have changed both the tenor and the scope of such messages. The state of the Union now includes the state of the world. This conception of the state of the Union lays new obligations upon us all. The scientist can no longer report on the state of the sciences. He must report on the impact of science upon society. He must make use of the qualities of mind that science fosters in dealing rationally with the terrible waste in vital resources that war imposes upon the human species. We may hope that the day will soon come when every mature man and woman will feel himself responsible for the state of the Union and act responsibly in that sector of our common life committed to his care, no matter how small the sector may be, no matter how humble . . . no matter where one starts in estimating future problems and future responsibilities, one ends by recognizing the special bond between America and Britain, by acknowledging the rich inheritance that has been responsible for so many strong elements in American life, and by elevating the comradeship that we both feel and need."

* Substance of the Pilgrim Trust Lecture delivered under the auspices of the Royal Society of London on May 20.

Peace-time Organization of Scientific Men in the United States

The scientific and engineering work in the United States may be discussed under three categories: first, the agencies of the Federal Government, exclusive of the Armed Services; second, the agencies within the Armed Services; and third, the non-governmental agencies.

Federal Bureaux. The scientific services of the Federal Government in peace-time are spread through about forty federal bureaux, of which eighteen can be called primarily scientific. Their operations involve only about half of one per cent of the total peace-time Federal budget, but their work is, of course, absolutely essential to the national welfare in agriculture, manufacture, commerce, health and safety. The personnel of all these bureaux operates under the Civil Service.

From the point of view of size of personnel and budget, the scientific services under the Department of Agriculture stand first in the list. Probably these scientific establishments, however, are not so well known generally as those of some of the other departments because their research work is quite largely spread through a great number of agricultural experimental stations distributed throughout the various States of the union and operated co-operatively between the Federal Government and the States. Most of the bureaux in Washington are primarily of an administrative character, but there are several which also conduct centralized research, as, for example, the Bureau of Chemistry and Soils and the Food and Drug Administration. Until recently, the U.S. Weather Bureau operated under the Department of Agriculture, but a few years ago it was transferred to the Department of Commerce, largely because the requirements of air transportation had taken the lead in demanding more accurate and refined methods of weather forecasting than those which had served reasonably well in the past to provide for the needs of agriculture.

Some of the more important of these governmental scientific bureaux are well known; for example, the National Bureau of Standards under the Department of Commerce, the Geological Survey, the Bureau of Mines, and the Bureau of Mineral Statistics and Economics under the Department of the Interior, and the National Institute of Health under the U.S. Public Health Service.

Of particular interest because of its unique character is the National Advisory Committee for Aeronautics, which was established during the War of 1914–18 and which operates three great research establishments. Until recently, the work of the NACA was centred in the aerodynamical research programme at Langley Field, Virginia. Several years ago there was added another aerodynamical research establishment named the Ames Laboratory at Moffett Field, in California, and quite recently still another large research and development establishment for aircraft engines in Cleveland, Ohio. Also, under the NACA, there are currently some eighty research projects being carried on at universities under contract. This obviates unnecessary duplication of facilities in a government laboratory and maintains a group of university scientific workers and engineers in close contact with the problems of aeronautical research.

The administration of this organization is also unique among our Federal scientific agencies in that its controlling body is a committee which serves without salary and has been composed of men of such high character and distinction as to render it completely free from political influence. This committee is provided with representation from the most interested branches of the Army, Navy and Governmental Departments, but the chairman and the majority control reside in a body of citizen scientists appointed by the President who, in practice, has followed the recommendations of the chairman in appointments to fill vacancies. The present chairman of the NACA is Prof. J. C. Hunsaker, head of the Departments of Mechanical and Aeronautical Engineering at the Massachusetts Institute of Technology, and incidentally, while a very young man, the designer of the first American aeroplane to fly the Atlantic.

Army. Turning now to the United States Armed Services, I can best describe their research and development work as principally a co-operative effort between the services themselves and American industrial companies, with occasional participation from the research laboratories of the technological and educational institutions.

Each branch of the Army contains a technical division under which operate laboratories or arsenals in which a certain amount of research and development work is carried on, the activities of which consist for the most part of testing and proving new war materials or equipment. Thus the technical staffs in the various branches of the Army and Navy have the threefold duty of planning and co-ordinating an extensive programme of research and development carried on in the industrial laboratories, of organizing and conducting research programmes in their own establishments, and of carrying on the extensive operations of proving and testing which result in the acceptance of new devices and the drafting of specifications for production orders.

Among the principal Army establishments in which such work is centred, I would mention particularly those falling under the Ordnance Department, the Signal Corps, the Chemical Warfare Service, and the Army Air Forces. The Ordnance Department operates a great proving ground at Aberdeen, at which is centred most of the proving and testing of ordnance and research on ballistics for arms of all types. In addition it operates five principal arsenals. The Watertown Arsenal is concerned principally with the manufacture of mounts for large-calibre guns and is the principal centre for research and technical service in the field of metallurgy. The Picatinny Arsenal is devoted to the testing of explosives and the design and operation of pilot plants as guides to the industrial producers. The Rock Island Arsenal carries on research and development in the field of oils and lubricants. The Frankford Arsenal supplements the Aberdeen proving ground as a testing and a development centre for small arms. The Tank Arsenal in Detroit is the centre for the design and testing of tanks.

In the Signal Corps the technical division is divided into three principal branches: the Ground Signal Branch, the Electronics Branch and the Aircraft Radio Branch. The research, development and testing work carried on under the Signal Corps is divided principally between the signal laboratories at Fort Monmouth, Camp Evans, Camp Coles, Eatontown and Toms River. The Signal Corps also maintains a large co-operative establishment working with the Army Air Forces at its principal centre, Wright Field.

Until quite recently the research and development work of the Chemical Warfare Service was centred in its great Edgewood Arsenal. As the threat of war came closer, however, a few years ago, and since a very large portion of the facilities at the Edgewood Arsenal are taken up by production, the Chemical Warfare Service established a subsidiary research laboratory and took over for this purpose the newly erected Chemical Engineering Laboratory of the Massachusetts Institute of Technology.

Despite the great expansion of the Army Air Forces, this service has continued to concentrate its research, development and testing activities at its huge establishment at Wright Field in Ohio. There are, of course, other centres at which extended service testing goes on, or at which new equipment is installed in aircraft, but Wright Field remains the headquarters for the research and development work of the Army Air Forces.

The co-ordination among all these various technical services of the Army is maintained by two types of agency. Within each branch of the Army is a board which has general supervision over technical matters within that branch. Examples are the Coast Artillery Board and the Army Engineers Board. When a project has been approved by one of these boards it is next discussed by the appropriate technical committee, composed of members of this branch of the service, and other branches which may be concerned with the project. If this technical committee also approves the project, it goes as a recommendation to the general staff which presumably issues the appropriate directive.

Mention should be made also of the Army Medical Corps, within which a significant amount of research is conducted under the general supervision of the Surgeon-General of the Army.

Navy. The Naval Observatory and the Hydrographic Office, which are under the Chief of Naval Operations, have obvious functions in research and development work. The Marine Corps does some research, but naturally depends to a large extent on the Army and the various bureaux of the Navy. All the bureaux of the Navy Department, Ships, Ordnance, Aeronautics, Naval Personnel, Supplies and Accounts, Medicine and Surgery, Yards and Docks, do research and development work, though naturally the material bureaux conduct the greatest volume.

All research work of the Navy Department is tied together through the office of the Co-ordinator of Research and Development, which office also arranges co-ordination with the Army, with other Government Departments, and with the numerous civilian agencies which I will mention later.

Under the Bureau of Ships, the Naval Research Laboratory near Washington is a centre for all matters of fundamental research including radio, electronics, chemical warfare defence, etc. The David W. Taylor Model Basin, also near Washington, is the primary station for research and development of ship structures, propeller and hull design. The Naval Boiler and Turbine Laboratory at Philadelphia is concerned with all matters of boiler research, testing and design including fuel, composition, quality and nature of boiler fuels, ceramics, etc., and also for research, test and development of main propulsion turbines. The U.S. Naval Engineering Experiment Station at Annapolis, Md., is assigned all problems of research, test and development of mechanical equipment in ships other than main propulsion, and it also has a well-equipped Diesel engine laboratory. The principal metallurgical laboratory for the Bureau of Ships is also located at the Engineering Experiment Station. In New York there is located the Materials Test Laboratory which handles all matters of research, test and development of electrical materials and equipment, acoustical equipment, optical and navigational material and equipment, plastics and allied materials. There are Rubber and Paint Laboratories at Mare Island, California, and an inspection test laboratory in Pittsburgh, Pa., where line production methods for chemical analyses are set up which permit a capacity of about 5,000 chemical analyses a week with a minimum of personnel and equipment. In addition to the above, each Navy yard is equipped with an industrial laboratory to serve the purposes of the yards. It has been found possible to place specialized problems in some of these laboratories, such as the development of chain and rope in the Boston Navy Yard. The assignment and progress, as well as general administration of all research, development and test work, is carried out by the Bureau of Ships in Washington in order most fully and effectively to co-ordinate all work and to collect, apply and distribute the results.

Under the Bureau of Ordnance there are the Dahlgren Proving Ground, the Naval Gun Factory at Washington, the research department of which includes the Naval Ordnance Laboratory, the Naval Powder Factory near Washington and the Newport Torpedo Station. In addition there are establishments devoted to mines, counter-mines, nets and the like.

Under the Bureau of Aeronautics there is the Naval Aircraft Factory in Philadelphia, the Cedar Point Flight Testing Field near Washington, and the Aircraft Armament Laboratory and Testing Field at Hampton Roads.

Research in medicine and surgery is directed by the Research Division of the Bureau of Medicine and Surgery, using many facilities but largely those of the U.S. Naval Medical Research Institute at Bethesda, near Washington, and the Medical Research Laboratories at Pensacola and New London.

Civilian Agencies. I pass now to the non-governmental scientific organizations in the United States, most of the members of which are attached to the staffs of some 600 colleges, universities and engineering schools, some 2,000 industrial research laboratories and other specialized research institutes. Do not be alarmed when I begin by saying that these comprise well over one hundred nationally recognized scientific and engineering societies, exclusive of the social sciences. Of these, only a few are general in scope in the sense that they cover broadly the entire field of science. Largest of these is the American Association for the Advancement of Science, a close parallel to the British Association, with a direct membership of about 24,000 and an indirect aggregate membership of about a million through the 187 associated and affiliated societies. Of a more exclusive character and without the affiliated and associated societies are the American Philosophical Society and the American Academy of Arts and Sciences.

Unique among the scientific organizations of the United States is the National Academy of Sciences. In March 1863, during a crisis of our Civil War, Congress established the National Academy of Sciences, and President Lincoln signed the Act of incorporation. This Act specified that "the Academy shall, whenever called upon by any department of the governments, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be made from appropriations which may be made for the purpose". There was also the provision in the charter that, except for the actual expenses of these activities, neither the Academy nor any member of the Academy is entitled to receive any compensation whatsoever for such services. Although the membership is legally limited to 450, the actual membership in the Academy has never exceeded its present enrolment of 350.

Outside its services in war-times, perhaps the most noteworthy public service by the Academy was its geological and engineering investigation of the slides which at one time threatened to prevent the successful consummation of the Panama Canal. However, the utilization of the Academy by the Government has been rather 'spotty'. Under some administrations the Academy has been used rather extensively and in other administrations has been more or less forgotten by the Government. In this respect I believe that the Royal Society has had a more consistent role of usefulness.

One inevitable characteristic of this type of organization, in which membership is considered to be the highest scientific honour of the country, is that membership, like scientific recognition, is likely to come to a man after he has passed the peak of activity in his scientific career. For this reason the Academy has been able to perform an excellent function of the 'scientific elder statesmen' variety. It has zealously kept itself free from all types of political influence. Its ideals have been unselfish service, integrity and scientific competence. Frequently, however, probably in the great majority of cases, when a very active research programme has to be undertaken, many of the personnel best adapted for the particular job are not found within the membership of the Academy.

During the War of 1914–18 in Europe, but before the United States had become a participant, President Wilson by executive order requested the National Academy of Sciences to establish the National Research Council as a measure of national preparedness. This organization operated so usefully during the war that in April 1919 the National Research Council was perpetuated by the National Academy of Sciences at the express request of President Wilson.

This National Research Council is organized into nine permanent divisions covering the various fields of scientific research and of scientific administration. These divisions are composed of appointed members and also of representatives from many of the scientific and engineering societies and branches of the Government. Because of this wide representation the National Research Council is a most effective agency for finding just the right persons to do any specific scientific job.

During the present War the National Academy and the National Research Council have been called upon to perform many important services, some of an advisory character and some involving the placing of contracts for research and development work in various laboratories.

Among the nearly two hundred committees operating under the National Research Council, the following are typical of those concerned with the War: aviation medicine, war metallurgy, passive protection against bombing, war use of research facilities, tin smelting and reclamation, clothing, shock and transfusions, treatment of gas casualties, war-time diet, and selection and training of service personnel.

War-time Scientific Organization

IN spite of the apparently complete peace-time organization which I have just described, it has always been our experience, in the time of great emergency, that it appears advisable to establish temporary new agencies to deal particularly with the emergency.

I have frequently tried to analyse the reasons for the establishment of special scientific agencies during times of crisis. They are, I think, varied and rather fundamental. One of them is that every great crisis involves conditions so different from the normal situation that the types of organizations which can survive and operate during peace-time are not adequate to meet the emergency. It may be, for example, that the emergency calls for exercise of very extensive administrative functions, such as the supervision of research projects and the disbursement of large governmental funds to a far greater extent than in peace-time. Hence a peace-time body of scientific men organized primarily to exercise advisory functions may not be organized in a manner suited to prompt and efficient executive action. Another reason is the impossibility of always maintaining in the administrative positions of peace-time agencies the personnel who would be most effective for handling important projects in a war emergency. Men who have the proper capabilities are frequently too busy and too active in other directions to be willing to hold positions in a peace-time organization which is relatively inactive. Consequently when the emergency comes, the only alternatives may be to change the leadership in the existing organizations, a difficult if not impossible process, or to set up new temporary agencies to deal with the emergency.

Whatever the reasons may be, this present war emergency has run true to form and has resulted in the establishment of a group of special agencies of temporary character which I shall proceed now to describe. It is these agencies which are carrying the principal burden of the scientific research and development work related to the War, in the United States.

The National Roster of Scientific and Specialized Personnel was established early in July 1940, when President Roosevelt approved a project for making available in one central office an index of all American citizens who have special scientific or professional skill. Headed by President Leonard Carmichael of Tufts College, this agency operates under the War Man-power Commission under the Office for Emergency Management of the executive office of the President. As a result of information secured from questionnaires sent to all members of all scientific and professional organizations in the United States, and supplemented by other information, an elaborate punch-card system has been set up in which practically every person in the country with specialized training or skill is listed with reference to his or her major professional fields and with the addition of a great deal of supplementary information regarding special interests, languages read or spoken, foreign countries travelled in, previous experience in the Armed Services or in industry, etc.

There are altogether fifty-nine special fields listed in the Roster, falling under the general categories of administration and management, agricultural and biological sciences, engineering and related fields, humanities, medical sciences and related fields, physical sciences, and social sciences. At the present time the total number of persons in this Roster is about 600,000, including, as of last October, 71,511 chemists, 7,297 mathematicians, 10,080 physicists or astronomers, 4,559 radio engineers, 14,729 electrical engineers, only 408 professional philosophers, and the smallest entry in the list is 142 spelæologists.

The Roster was originally conceived to serve governmental agencies which might request information on scientific personnel. More recently, as serious man-power shortages have developed both in industry and in education, and as the Armed Services have become more and more concerned over the most effective use of all scientifically trained personnel, the Roster has been used to an increasing degree in connexion with placement work and to give the supply and shortage data on professional groups. Up to the middle of last month the National Roster had certified more than 140,000 names of specialists to various agencies engaged in the war programme in the United States.

Office of Scientific Research and Development (OSRD). Most important of the scientific agencies established specially to deal with problems of this War is the Office of Scientific Research and Development, the director of which is Dr. Vannevar Bush, president of the Carnegie Institution of Washington. It was created by executive order of the President in June 1941 and under it operate the National Defense Research Committee, which had been established just a year earlier, and also the more recently established Committee on Medical Research. The OSRD is directed to co-ordinate, and where necessary supplement, the scientific research and development work relating to the War among civilian agencies as well as those of the Government, including the Armed Services. To facilitate this co-ordination the advisory council to the director of the OSRD includes high ranking representatives from the War and Navy Departments, the chairmen of the National Advisory Committee for Aeronautics, the National Defense Research Committee and the Committee on Medical Research and, by invitation, the president of the National Academy of Sciences and the director of the newly established Office of Production Research and Development of the War Production Board.

The principal research and development activities of the OSRD are carried on under contracts with appropriate research institutions, these contracts being financed out of an annual Congressional appropriation. At the present time these contracts involve expenditures at the rate of about 100,000,000 dollars a year, and there are currently active about 1,400 contracts with about 200 industrial laboratories and 100 educational or special research institutions. About 6,000 scientific workers and engineers of professional grade are engaged on these contracts, with the assistance of a considerably larger number of technicians of various types.

To facilitate interchange of information between the OSRD and our British colleagues, an OSRD Liaison Office was established with offices in Washington and London, now headed by Dr. Caryl P. Haskins and Mr. Bennett Archambault, respectively. These, in co-operation with the similar liaison services of Great Britain, Canada and, less extensively, Australia and South Africa, have served well to knit together our joint scientific efforts.

The National Defense Research Committee (NDRC) operates to recommend to the director of the OSRD research and development contracts in the field of instrumentalities, devices and mechanisms of warfare. Under the chairmanship of President James B. Conant, of Harvard University, this committee is composed of four civilian men of science, plus one representative each from the Army and Navy, and the Commissioner of Patents. Feeding into it come the recommendations from nineteen divisions, most of which are subdivided into several sections. These divisions and sections are each built around a specific functional concept such as fire control or sub-surface warfare or explosives. However, there are two divisions which are in the nature of 'catch-alls'; for example, the Division of Physics and the Division of Chemistry can be defined as handling everything in these respective fields which does not fall into any one of the more sharply defined divisions.

In addition to the nineteen divisions of the NDRC there are two panels concerned respectively with applied mathematics and engineering. The difference between a division and a panel is suggested by the fact that the Fire Control Division, for example, is concerned with the development of fire control instruments, whereas the Applied Mathematics Panel is not concerned with the development of applied mathematics as such, but rather with the use of mathematics to aid in accomplishing the objectives of the various divisions. For this reason the applied mathematics panel includes membership on each divisional committee in which applied mathematics is likely to be important. The Engineering Panel serves all the divisions to expedite the transition from the stage of research and development to the stage of quantity production under Army or Navy contract.

Intimate contact between the NDRC and its divisions on one hand, and the Armed Services on the other, is maintained at several levels by an extensive organization of Army and Navy liaison officers, who have proved invaluable as channels for acquainting the NDRC with the needs and desires of the Armed Services for new equipment, and for making arrangements for demonstrations and service tests.

Proposals for research or development projects come to the NDRC from a wide variety of sources—requests or suggestions from the Army or Navy, proposals from industrial or academic research laboratories, promising inventions transmitted to the NDRC from the National Inventors' Council, or in many cases projects originating within the NDRC committees themselves. However, the NDRC has complete freedom in making its decisions on the projects which it recommends to the director of the OSRD and the priority attached to these projects, and the director of the OSRD has complete freedom in his own judgment to authorize the recommended contracts.

For reasons of security no person serves as a member of any NDRC committee unless he has been 'cleared' by the Army and Navy Intelligence Offices, after investigation. Similarly, all personnel of the contractors working on the research and development projects are 'cleared' by these intelligence offices to whatever degree is deemed advisable in virtue of the degree of secrecy attached to the project.

The Committee on Medical Research (*CMR*), under the chairmanship of Dr. A. Newton Richards, of the Medical School of the University of Pennsylvania, is in every respect parallel to the National Defense Research Committee in its organization and methods of operation. It deals exclusively with problems of war medicine such as shock, immunization or protection against types of diseases characteristic of the present theatres of war, etc. Though considerably younger and smaller than NDRC in both personnel and budget, it already has a record of substantial accomplishment.

Joint Committee on New Weapons and Equipment (JNW). The organizations described thus far have proved effective in organizing and administering research projects and in maintaining close relationships and exchange of information with the Armed Services and our British allies. In respect to the Armed Services, however, these relationships are primarily at the research and development level, and for a time lacked one very important element necessary to make the work fully effective in the War. This missing element was an intimate relationship between the research and development agencies and the highest command of the Army and Navy, who have the responsibility of planning the military or naval operations in which newly developed weapons might be used effectively or for which new devices should be developed.

In order to fill this gap, the U.S. Joint Chiefs of Staff in May 1942 established the Joint Committee on New Weapons and Equipment, composed of Dr. Bush, director of OSRD, as chairman, the Assistant Chief of Staff G4 of the Army (now Brigadier-General Moses), and the Chief of the Readiness Division of the Navy (now Rear-Admiral De Laney). JNW is charged by the Chiefs of Staff with correlating the research programme of Army, Navy and civilian agencies. It acts through subordinate bodies, of which the special mission in which I am presently engaged in England is an example.

Through JNW any new weapon the potentialities of which appear to be unusually significant is brought directly to the attention of the High Command for their consideration in the planning of future operations. Conversely, JNW offers a direct channel through which the High Command can pass down to the research scientists a request for development of any particular instrumentality which could be particularly effective in connexion with some contemplated operation. This type of liaison between the scientific workers and the High Command is new in the United States. Its possibilities are still being explored and developed, but it can be said definitely that it has already demonstrated its possibilities of great value in the War. It is a move in a desirable direction in which Great Britain has gone farther than the United States.

National Inventors' Council. War is a great stimulus to invention, not only in the research laboratories of a country, but also on the part of great numbers of its citizens, some of whom are technically competent and most of whom are uninformed but sincere in their desire to be helpful. Any actively operating research organization like the OSRD or the Naval Research Laboratory could be quickly bogged down under the deluge of ideas and inventions induced from all sources by the War. It is very important for purposes of morale that these inventors and would-be inventors be sympathetically handled. It is also important that their ideas be expertly examined to make sure that ideas really worth while are not brushed aside, even though experience has shown that perhaps only one in one hundred thousand is new and significant. To give such sympathetic and expert consideration and to screen the interesting suggestions out of the great mass, the National Inventors' Council was established in June 1940, in close association with the U.S. Patent Office in the Department of Commerce, under the chairmanship of Dr. Charles F. Kettering, vice-president in charge of research for the General Motors Corporation. All suggested inventions relating to the War from any source and submitted to any agency or person in the Government are channelled through this National Inventors' Council (unless they happen to come initially to an appropriate agency which is immediately interested in pursuing the matter). They pass through the hands of an expert staff of examiners who select those inventions which appear to have merit and bring them to the attention of the appropriate agency.

Office of Production Research and Development of the War Production Board. Until recently, the organized war research efforts in the United States failed to include the very important category of research aimed at the development of substitute materials in fields where shortages exist, or of improved methods of production and manufacture. It was apparently assumed that the commercial interest of the production companies would lead them automatically to take care of this situation. However, under the pressure of war production orders, limitations of man-power and materials, and financial regulations, the normal peace-time incentives to such research and development work by companies proved inadequate to meet the needs of the situation. Consequently, last September, there was established in the War Production Board an Office of Production Research and Development under the directorship of Dr. Harvey N. Davis, president of the Stevens Institute of Technology. This agency is still in the process of organization to operate somewhat along the lines of the Office of Scientific Research and Development, but with primary responsibility for materials and method of production rather than devices and instrumentalities of warfare. It is regrettable that we did not have the foresight to establish this much needed agency at a much earlier date, but it has already begun its operations and we hope that it may be enabled to play an important role during the balance of the War.

Engineering, Science and Management War Training Programme. Though not directly concerned with scientific research, a review of the scientific war agencies in the United States would not be complete without at least a brief reference to the efforts to increase the supply of technically trained personnel to meet the increasing demand for such personnel in every field of war activity. In October 1940 a special engineering training programme was organized under the U.S. Office of Education and financed by Congressional appropriation. Later, this programme was extended to include also training in science and industrial management. It operates at both the collegiate and the technical school levels and its magnitude may be appreciated by the fact that, even in its first year of operation, it put through its specialized courses approximately ten times as many students as graduated in that year from the regularly established engineering colleges. Most, but not all, of the work was carried on in night schools, and the whole programme has been decidedly helpful in relieving the technical man-power shortage.

Army and Navy Technical Training Programme. At the present time the Army and Navy are jointly establishing a very extensive programme for the training of their own younger personnel in such fields as aeronautical engineering, naval architecture, electronics, communications, automotive engineering, etc., through contractual arrangements with several hundred of the nation's colleges and universities. Under these programmes it is anticipated that approximately 250,000 selected young men in uniform will be detailed for this training at educational institutions during the coming year, the duration of such training to vary from field to field and individual to individual, in accordance with the needs of the situation and the performance of the individual. These special collegiate programmes are intended to supplement, at the higher level, the very much larger technical training programmes which the Army and Navy are conducting in their own establishments.

Conclusion

I conclude this factual, over-long, but I hope usefully informative address on a note of faith and optimism which I am sure is shared by the allied men of science on both sides of the Atlantic. Each of us concerned with some phase of the war effort is aware of some very significant new applications of scientific research in the War. For most of us, this knowledge is largely restricted to the special fields in which we ourselves have been working. Of necessity, the general public knows only in a vague way about some of these things and nothing at all about most of them.

When victory has been won, and the whole story of these scientific accomplishments can be told, it will indeed be a thrillingly interesting recital. Out of it all will come, not only its important contribution to victory, but also a number of exceedingly significant results of permanent peace-time value. It is already evident that many of these war-time developments will have very useful peace-time applications, the contributions of which to our standards of living and general prosperity and comfort will help to compensate for the ravages wrought by the War. Scientific men will have a renewed faith in the worthwhileness of their work, and will continue their intellectual and practical endeavours with the increased power that has come from the experience of 'team-work' on war problems. The general public, and especially the governmental and industrial leaders, will have greater appreciation of the value of science and scientific workers, both pure and applied; and this should result in permanently increased support of scientific research in the universities, industries and governmental agencies. These, I trust, will be some of the long-term gains to which we may look forward as the result of the temporary concentration upon practical problems of survival and victory which the War has forced upon us.

With these words of optimism, I close with the hope that the next American Pilgrim Trust lecturer may not feel obliged to discuss the War, but will be able to treat of some interesting aspect of the progress of science in accord with the original conception of Sir William Bragg and as a happy feature in the post-war forward march of science.

SCIENCE AS A HUMANITY

By Prof. W. G. de BURGH, F.B.A.

THE session on "Science as a Humanity" held during the recent British Association Conference on "Science and the Citizen" is of good augury, for it is a further testimony to the fact, evident of late in many quarters, that the old rivalry of science and the humanities is a back number, and is rapidly ceasing to cast a cloud over the future of our national education. There has always been something unnatural about the controversy ; for, as Prof. J. L. Myres reminds us in his opening address as well as Dr. Waddington at the close, both the parties share a common parentage in the epoch of the Renaissance, inheriting therefrom an identity of aim and interest that is belied by their artificial severance. We can picture how Copernicus, Kepler and even Harvey would have recoiled from the suggestion that the study of classical antiquity was irrelevant, not to say inimical, to that of the sciences of Nature. If later generations have emphasized the contrast, to the detriment both of science and the humanities, the responsibility lies chiefly with a philosopher, Immanuel Kant. For Kant, science meant Newtonian physics ; man's moral personality and the entire realm of ethical and religious value were excluded from the knowledge of speculative reason and regarded as objects of practical faith. No wonder that such limitation of the scope of science provoked a protest, of which Wilhelm Dilthey was the leading champion in Germany, to the effect that over and above the sciences of Nature were the sciences of spirit (*Geisteswissenschaften*) which were none the less deserving of the name of sciences, though their objects and methods were poles asunder from those of mathematical physics.

Science is an ambiguous term and both Prof. Myres and Dr. Waddington see the necessity of clearly understanding what we mean by it. Kant's use is far too narrow, for it would scarcely include biology, to say nothing of psychology or anthropology. On the other hand, to take it as the equivalent of the German *Wissenschaft* is far too wide ; if every inquiry that employs an elaborate technique is a science, then not only are history and archæology sciences, but also all the departmental researches of the pundits of the British Museum, and the higher criticism of the Old and New Testament, deserve that title ; and what branch of knowledge is then left over for the humanities ? Dr. Waddington, though he endorses Prof. Myres's inclusion both of the "interactions of individuals, which are incommensurable qualitatively, and of value" within the scope of science, dissents from the view, sometimes put forward by scientific advocates of the wider interpretation, that science can be stretched to cover "all the achievements of logical or rational thought". Science, for him as for Prof. Myres, is the product of the wedlock of reason and experiment, and the empirical, if not always the experimental, factor is an essential constituent of its meaning. That, he claims justly, is the hall-mark of Greek culture, "a culture of quick-witted, subtle Individualists interested on the one hand in deep speculative generalisations, and on the other in highly practical matters of an empirical nature". What is distinctive of the humanities, he tells us, is that they are grounded on "feeling applied to the individual". This definition may be accepted, provided always that the term "feeling" is not taken to exclude the possibility of a knowledge of the individual such as is achieved through history, through literature and the arts, and through personal relationships between man and man and possibly—though this is a larger question—between man and God, a knowledge which is none the less rational in that it is closely integrated with emotional and volitional activity. That this personal knowledge can function even within the strictly scientific fold, for the untold enrichment of the conceptual thinking that properly characterizes science, will scarcely be disputed by those who appreciate the intimate contacts with birds and other animals enjoyed by such lovers of Nature as W. H. Hudson or the late Lord Grey of Fallodon. A wide field for reflection is here thrown open, very relevant to the topic of the cultural value of science, by the co-operation of the personal and impersonal methods of inquiry.

Among those who took part in this conference, Dr. R. V. Southwell is the one who seems to appreciate this most clearly. He points out that what is requisite for the training of the citizen's personality cannot be restricted to the technique of the laboratory, or even to "acquaintance with scientific thought". This indeed is necessary, but it is not sufficient. Science calls for supplementation by the humanities. "No less needed", he says in a highly instructive passage, "is the thinking that reveals itself as wisdom in the affairs of life itself. The humanists claim that it is developed by their studies, and I think I have noticed in many of them a suppleness (if the word will serve) which men of science too often lack. Here then is a case for 'the humanities' in a balanced education, and in my belief they are an essential part : though I am by no means satisfied with the way in which they are studied under our examination system, and can perceive, I think, the danger of a teaching so completely based upon authority. Too often, dislike of the premature conclusion leads to a shunning of decisions in a world where decisions are imperative. But what is still wanting, science, I believe, can give : realization that hard problems require hard thinking, and that the effort must be made." This is excellently said, and carries a lesson both for the scientist and the humanist. It may be that Dr. Southwell exaggerates the deference to authority in current humanistic teaching, and glozes with natural partiality over the excessive conservatism that has often prejudiced original advance in science. But the ready response that his *eirenicon* will evoke in humanist quarters may be gauged by a reference to the Provost of Kings' presidential address at the recent meeting of the Classical Association at Cambridge. He will have none of the familiar party slogans : "I am for the Classics", "I am for Religion", "I am for Science", and appeals to the temper of Erasmus, typical of the great days of Humanism, and still prevalent in English education in the seventeenth century. "Would Harvey of Caius," he asks, "who discovered the circulation of the blood, have done better in his science if he had been sent to an expensive, well-taught, well-laboratoried secondary school and had sat at school for his M.B. ?"

Of course, there are difficulties in the way of realizing the union of the scientific spirit with that of humanism in a concrete educational programme. Are arts subjects to be added to science courses, and science subjects to courses in arts ? Or is science to be taught culturally so as itself to be a humanity in its own right ? Both lines of approach should be tried, after the true scientific method, experimentally. Only the other day, the late Prof. Muirhead, then the doyen among English philosophers, publishing his reminiscences as an octogenarian, recalled the arts curriculum at Glasgow in the seventies of last century, which still kept alive its fidelity to the medieval tradition. He gives as his reasoned opinion, formed after experience of the Oxford system and that of the new English universities and of several of the great American universities, both State and other, that, "for breadth of training and as a preparation either for business life, for the professions, or for further specialized study, there is nothing which, on the whole, has proved better than this old Quadrivium of Classics, Mathematics, Philosophy and Physics, all softened and humanized by a halo of English literature". Then there is the further problem of finding teachers of science able and willing to bring home its cultural significance to students without experience of a laboratory. The tradition that the training of highly specialized researchers alone is the concern of the teacher of science is so strongly rooted that the cultural value of science has almost vanished from the picture. The arts student in our universities has no opportunity of learning the bearings on human life of the mysteries that are being enacted within the precincts of the laboratory. There is serious need for lecturers to mediate between the specialist and the public, possessed of the gift for expounding, like Huxley in his generation, or Bertrand Russell, in his "A.B.C. of Atoms", the leading currents of contemporary scientific thought in language intelligible to the thinking public.

All the speakers at this Conference, except perhaps Prof. Le Gros Clark, who confines his remarks to the teaching of biology and its applications to the education of the citizen, recognize that it is the task of science to throw light on the problem of moral value. Dr. Waddington, as we should expect from his recent volume on "Science and Ethics", which has deservedly arrested the interest of the public, believes that evolutionary science offers the key to its solution. That "man himself is, after all, a member of the animal world" is, of course, a truism of which we do not need the biologist to assure us; it was well known to antiquity, and there is a mass of contemporary evidence to bring home to us how close the ape and the tiger lie to the surface of human nature. But man is not merely an animal; he is a thinking animal, an animal with a moral consciousness, capable of extending his outlook both in thought and action beyond the bourne of time and space.

In my contribution to Dr. Waddington's book, I ventured to question whether the appeal to evolution could justify the absolute claim of moral obligation. Dr. Waddington's suggestion, reiterated at this Conference, that "the highest duty of man should be to carry forward the main stream of evolution" seems to make larger drafts upon the future than is warranted by our knowledge of the course of evolution. Does that knowledge really bear out Prof. Myres's contention that, despite the tragic antithesis of the ethical and cosmic processes, "good must win"? Prof. Myres adds the proviso, "if all good men work together in the cause of good". Can evolutionary science enlighten us, as Dr. Waddington believes it can, as to the nature of what is good? The menace of entropy is surely enough to give us pause. Even if we restrict our view to the facts of recorded history, what evidence do we find of uniform advance in human morals? Does it not look to-day as if the human race were moving rapidly and of deliberate purpose down the slope that leads to self-destruction?

Dr. Waddington closes his address with some pertinent remarks on the trend towards socialism, characteristic of the modern cultural outlook, and suggests that science, by emphasizing man's essentially social nature, may play a "by no means negligible part in bringing the new society to birth". He holds that as in the humanism of the Renaissance, a purely this-worldly individualism, which found appropriate embodiment in art, superseded the other-worldly sociality of the Middle Ages; so a this-worldly sociality is destined to replace the individualism of the capitalist epoch that is now in process of disintegration, with science as its fitting medium of expression. Science will thus replace art, as art replaced religion, as the predominant human interest.

But is this picture of the dialectical process true to fact? Has interest in art shown any tendency to decline, for example, in Soviet Russia? And what about religion? "En mon temps on avait Dieu", said the old French marquis in the play; and it sometimes looks as though even in Russia they had him still. It is at all events matter for argument whether theism cannot offer a more promising solution of the problem of value than the optimism which pins its faith to the evolutionary process. But this is a view which, I fear, would scarcely find favour among those who collaborated in this Conference.

OBITUARIES

Dr. Henry Forster Morley

THE death of Henry Forster Morley occurred on April 3, 1943, in his eighty-eighth year. He was well known to chemists and other scientific men, both in Great Britain and abroad. Over a long period of time Morley and his wife, who died only a few weeks before him, were frequent visitors at scientific gatherings and until recently they customarily attended the conversaziones and evening meetings of the Royal Institution.

Forster Morley, born on October 23, 1855, was the eldest son of the late Prof. Henry Morley, sometime professor of English literature at University College, London. He was educated at University College School, University College, London, and proceeded to the Universities of Paris, Berlin and Bonn. He was assistant professor of chemistry at University College, London, in the time of Williamson's professorship. He also held the posts of professor of chemistry at Queen's College, London, and lecturer in chemistry at Charing Cross Hospital. He acted as examiner in chemistry to the Universities of London, Oxford, to the Conjoint Board, the Society of Apothecaries and elsewhere.

In addition to his original publications in chemistry, Forster Morley prepared, in 1899, in conjunction with Patterson Muir, a revised edition of "Watt's Dictionary of Chemistry", a work which still continues to serve useful purposes. The text-book of organic chemistry he published in 1884 has lasting merit, inasmuch as in dealing with the practical relationship, properties and preparation of organic substances it arouses the student's interest in these aspects before his attention is concentrated on the theoretical framework of organic chemistry. It is a remarkable fact that this text-book is still in use. He also acted as director of the central bureau concerned with the preparation of the International Catalogue of Scientific Literature published by the Royal Society. The first annual issue of this great work under his directorship was published in 1903 and annual issues followed up to the fifteenth, dealing with the year 1915, after which the work was suspended owing to the War of 1914–18. After peace came, there were great difficulties in the way of resuming the work, and in 1922 it was decided not to continue it further.

Morley's earliest scientific publication appears to have been a paper on the Groves gas battery published in 1878. Another paper published in 1878 was one with L. Claisen describing the preparation of phenylglyoxylic acid and its ethyl ester by the interaction of ethyl oxalyl chloride and mercury diphenyl. In 1879 he investigated, with C. Wurster, the methylation of *m*-phenylene diamine and obtained the tetramethyl derivative. He also examined the action of nitric acid on the new compound. In the same year he studied the action of nitrous acid on diphenylethylene diamine and diphenyldiethylene diamine, obtaining the nitrosamines, from the second of which he prepared diphenyl diethylene tetramine.

In 1880 some work on bases allied to choline was published. The interaction of monochlorhydrin with mono- or dimethylamine was found to give methyl diox-ethylene diamine and the corresponding dimethyl compound. The action of propylene and *iso*-propylene chlorhydrins with trimethylamine gave the trimethyl hydroxy propylamine chloride and the corresponding *iso* compound. By the interaction of chlorhydrin with mono- and dimethylamines he obtained the mono- and dimethyldioxy ethylene amines.

In 1882 the action of an aromatic amine (*p*-toluidine) and propylene oxide was tried, and oxypropyl *p*-toluidine was isolated as a crystalline solid. In 1885 he worked with A. G. Green on the constitution of the propylene chlorhydrin obtained from glycerin. It was shown to be mainly $CH_3CH\ OH\ CH_2Cl$, but an admixture of the isomer was not excluded. The action of zinc ethide on the benzoyl derivative of the chlorhydrin was investigated and found to follow a somewhat unexpected course, giving rise to a member of a new series of compounds which were named 'ketates'. In the course of this work propiophenone was prepared for the first time in solid form. In the same year, in conjunction with W. J. Saint, he prepared and investigated ethyl thioxalate. Two years later he wrote some criticism of H. E. Armstrong's views on substitution in the benzene nucleus. In 1891 he published, in conjunction with E. Hari, an account of the *p*- and *iso*-propyl *p*-toluidines.

Morley did not entirely retire until he was eighty-four, when he resigned from his last examinership on his wife's persuasion—although he was asked to continue for a further year.

A man of happy disposition and simple tastes, he loved to welcome his friends to his house at Hampstead or to his quiet home and garden in Midhurst, the peace of which was rudely disturbed by enemy action a few weeks before his death. He himself fortunately escaped injury.

FRANCIS H. CARR.

Prof. A. A. Boon

THE death occurred in Edinburgh on April 1 of Prof. Alfred Archibald Boon, emeritus professor of chemistry in the Heriot-Watt College. He was seventy-six years of age, unmarried, and had been in failing health for some years.

Born in India, where his father was in the Indian Medical Service, Boon graduated B.A. at the University of Madras, then went to the University of Edinburgh to study chemistry under Crum Brown and natural philosophy under Tait, whose lectures appealed to him very much. He graduated B.Sc. in 1898, then took the D.Sc. degree in 1905, his researches being in the field of organic chemistry. Boon was always keenly interested in the medical and pharmacological aspects of chemistry.

For some years Boon was on the staff of one of the training colleges in Edinburgh and was also a part-time member of the chemistry staff of the Heriot-Watt College. On two occasions, he conducted courses for teachers in Dublin on the invitation of the Board of Agriculture and Technical Instruction for Ireland. He soon became a full-time member of the staff of the Heriot-Watt College as lecturer in organic chemistry and, on the death of Prof. John Gibson, became acting head of the Chemistry Department in 1913. In 1919, he was appointed professor of chemistry, a post which he held until his retirement in 1931 with the title of emeritus professor.

Boon was a very able teacher and took great care in the supervision and administration of his Department, which developed greatly under his direction, among the developments being courses in paper-making, brewing, and pharmacy. The interests of his Department and of his students came first; he never seemed to forget a student. The heavy administrative and teaching work he had to bear gave him little opportunities for research, to which, however, he made contributions. In all his teaching he always stressed the great importance of fundamental principles.

During the War of 1914–18, he undertook investigations for the Services, particularly for the Admiralty, such as the systematic examination of oils collected from the surface of the North Sea whenever a German submarine was destroyed, the first of these being at Fidra in the Firth of Forth.

On several occasions, Boon served on the Council of the Institute of Chemistry, he was for many years a member of the Board of Examiners in Scotland of the Pharmaceutical Society of Great Britain, and served on several committees dealing with the training of pharmacists.

A man of deep religious convictions, Boon was a hater of injustice, was very conscientious, fair-minded, and helpful to any who sought his aid or advice. A cricketer and a swimmer in his younger days, he took up golf in later years and enjoyed his holiday in North Berwick; he became an able player, as many of his friends found. To those who knew him he was a true friend.

F. J. WILSON.

WE regret to announce the following deaths:

Sir Thomas Middleton, K.C.I.E., K.B.E., C.B., F.R.S., chairman of the Agricultural Research Council since 1938, on May 14, aged seventy-nine.

Sir Arthur Newsholme, K.C.B., sometime principal medical officer under the Local Government Board, on May 17, aged eighty-six.

NEWS AND VIEWS

Chair of Biochemistry in the University of Cambridge

PROF. A. C. CHIBNALL, whose appointment to succeed Sir Frederick Gowland Hopkins as professor of biochemistry in the University of Cambridge has recently been announced, has for some time been recognized as one of the most distinguished biochemists in Great Britain. Since the time when, following upon a period of study with the late T. B. Osborne in Newhaven and some years of work at University College, London, Prof. Chibnall succeeded the late S. B. Schryver at the Imperial College, he and his pupils have maintained a steady output of work on problems of plant biochemistry. His earlier work was chiefly concerned with lipoid constituents of plants; this subject had formerly been in great confusion, and Chibnall, with the aid of his own highly developed chemical technique reinforced by valuable collaboration in X-ray analysis from Dr. S. H. Piper, was the first to bring it into order. Later he devoted more attention to proteins and other nitrogenous constituents of plants in relation to problems of nitrogen metabolism; this work formed the subject of his Silliman lectures and of the monograph which he based on them. More recently Chibnall has become interested in fundamental problems of protein structure, to which he has made important contributions, adopting the analytical approach and constantly insisting on the precision of technique which has been characteristic of all his work. Prof. Chibnall therefore leaves the important school of plant biochemistry, which he has built up at the Imperial College, with a wide experience behind him and well fitted to take charge of the most distinguished biochemical laboratory in Great Britain.

Chair of Chemistry in University College, Bangor

UNDER the late Prof. Kennedy Orton, the Department of Chemistry of the University College of North Wales, Bangor, became one of the first of those modern schools of research which are concerned with the elucidation of the nature and mechanism of the reactions of organic chemistry. It therefore seems appropriate that Dr. Edward David Hughes, one of Prof. Orton's many distinguished pupils, should follow Prof. J. L. Simonsen in Prof. Orton's chair. After graduating in Bangor with first class honours in chemistry in 1927, Dr. Hughes commenced, under the leadership of his professor and of Dr. H. B. Watson, then on the College staff at Bangor, his first researches in the general field to which he has contributed so considerably. For this work he was awarded the Ph.D. degree and a studentship of the University of Wales in 1930. In that year he proceeded to University College, London, and there, first as a research student under Prof. C. K. Ingold, than as a research fellow, and finally as a member of the College staff, he continued the work which brought him in rapid succession the highest research degrees of the University of London, the British Ramsay Fellowship, and, in 1936, the Meldola Medal of the Institute of Chemistry (awarded for the most distinguished chemical work carried out under the age of thirty). Dr. Hughes is author or joint author of more than seventy papers published in British and American scientific journals. His most noted work relates to the establishment of ionization (or 'heterolysis') as controlling phase in a large class of substitution and elimination reactions of saturated molecules and ions, the discovery of the rules governing the spatial orientation of substitution (including a demonstration, by the use of radio-halogens, of the invariability of Walden inversion in bimolecular substitution), and the elucidation of circumstances which control the appearance of steric hindrance in substitution processes.

Chair of Physics at University College, Dundee

MR. G. D. PRESTON, whose appointment to the Harris chair of physics at University College, Dundee, has recently been announced, is best known for his applications of physical methods to metallurgical problems. After leaving Cambridge, he joined the staff of the National Physical Laboratory, working first in the Physics Department and later in the Department of Metallurgy. His chief interest has lain in X-ray crystallography and more particularly in its applications to metallurgy. In collaboration with Prof. E. A. Owen, he was one of the pioneers in the investigation by X-ray methods of alloy systems, and succeeded in determining the structure of various alloys and alloy systems. In addition to his work in the X-ray field, he has also applied the method of electron diffraction successfully to problems of metallurgy and to the study of corrosion. He was one of the first in Great Britain to construct and use the electron microscope. Mr. Preston's more recent work has been concerned with the age-hardening of alloys. During these investigations he found the diffuse X-ray reflexions which have been the subject of so much experiment and discussion of late. His work has thrown much light on their nature and origin. His researches have been notable for the fact that they have been carried out almost entirely with apparatus designed and constructed in his own laboratory, and much ingenuity has been shown in producing equipment essentially simple, but eminently suited for the task in hand. It is to be hoped that in his new sphere Mr. Preston will have ample opportunities for further research.

Royal Society: New Foreign Members

AT a meeting of the Royal Society on May 20, the following were elected foreign members:

Dr. Bernardo Albert Houssay, professor of physiology in the University of Buenos Ayres. He is distinguished for his researches on endocrine glands and is a leader of an important centre of biological research.

Dr. Victor Moritz Goldschmidt, professor of mineralogy and geology in the University of Oslo since 1936. He was formerly professor of mineralogy and petrology in the Universities of Oslo (1914–29) and Göttingen (1929–36). He has made fundamental contributions to petrology on the genesis of the crystalline schists in progressive metamorphism, while his researches have laid the foundation of the science of crystal chemistry. In geology, using chiefly the methods of analysis of quantitative optical and X-ray spectroscopy, he has determined the principles that govern the minor elements in the earth's crust and meteorites.

Royal Society of Arts: Albert Gold Medal

THE Albert Gold Medal for 1943 of the Royal Society of Arts has been awarded to Sir John Russell, director of the Rothamsted Experimental Station. The Medal, which was struck in 1864 to commemorate the presidency of the Society held by Prince Albert during 1843–61, is awarded "for distinguished merit in promoting Arts, Manufactures and Commerce". Fifty years ago the Medal was awarded to Sir John Bennet Lawes and John Henry Gilbert "for their joint services to scientific agriculture, and notably for the researches which, throughout a period of fifty years, have been carried on by them at the Experimental Farm, Rothamsted".

Prof. K. A. Timiriazev, For.Mem.R.S. (1843–1920)

THE centenary of the birth of Prof. K. A. Timiriazev will be celebrated on June 3 at the Timiriazev Agricultural Academy, where the jubilee session will be held. Timiriazev, one of the foremost men of science of his day, was an honorary and active member of more than forty academies of science and universities. In 1911 he was elected foreign member of the Royal Society. His scientific researches were confined almost solely to the photosynthetic activity of the green leaf; the application of scientific achievement to practical life was closely bound up with his experimental work. He blazed a new path in the field of application of plant physiology to agriculture, in the field of science teaching, and in the field of the popularization of science. In 1908, Timiriazev wrote: "In the world-wide struggle between that part of mankind which looks ahead and that part which is fatally destined to gaze retrospectively, the following words will be inscribed on the banner of the first: Science and Democracy—*in hoc signo vinces!*" Science and democracy—this idea served also as a guide to action for Timiriazev; to him it denoted an organic bond between theory and practice, science actively serving mankind, and plant physiology at the service of agriculture. Timiriazev was a confirmed opponent of all narrow specialization, of the man of science shutting himself up in his laboratory so that there ceases to be a common language between the man of science and the community, and even between one scientific worker and another. But though specialization can be a serious evil it is essential for the development of modern science. With a very wide circle of interests, in his own research Timiriazev limited himself to one field, indeed to one problem. To explain the working of photosynthesis, the effect of solar energy on plants, was his life-work. The problem of photosynthesis was very clearly linked up for Timiriazev with general biology and his world outlook. He held that "the task of the physiologist is not to describe, but to explain and direct nature, his role must not be that of an observer but that of an active experimenter".

Copernicus Commemoration

BUT for the War, Poland would have commemorated the four hundredth anniversary of the death of Copernicus on May 24, 1543, and the publication of "De Revolutionibus Orbium Coelestium", by an international gathering of astronomers and others interested in the pursuit of natural science. In Great Britain the occasion was marked by a meeting on May 24 at the Royal Institution; the meeting was arranged by the Copernicus Quatercentenary Celebration Committee, a mixed body of distinguished Poles and fellows of the Royal Society, and was attended by the President of Poland and members of the Polish Government in London. The meeting was opened by a short address by Sir Henry Dale, president of the Royal Society, who stressed the significance of Copernicus' contribution to thought, and read a message he had broadcast to a parallel meeting which was being held in New York. Prof. Stanisław Kot, Polish Minister of Information, then delivered an address on Copernicus, surveying the history of Poland during the Middle Ages in order to show the relation of Copernicus to movements of his times, and drawing a picture of university life at Cracow. He remarked that, before the War, books used and annotated by Copernicus were treasured among Polish historical possessions—their fate is unknown.

Prof. Kot was followed by Dr. H. Spencer Jones, Astronomer Royal, who recounted the main facts of the life of Copernicus and dealt in some detail with the significance of the heliocentric theory. Count Edward Raczyński, Polish Ambassador to Great Britain, expressed his country's gratitude for the way in which the Royal Society had assisted in carrying through the limited commemoration which had been possible. The meeting closed with a recorded message from Prof. Harlow Shapley, director of Harvard Observatory, in response to Sir Henry Dale's broadcast address. He spoke from New York, where a commemorative meeting was held in the Carnegie Hall, and mentioned that, in addition to other similar meetings, planetaria in the United States are showing special programmes during May. By such means, Poles in exile and scientific men of the other members of the United Nations joined in commemorating the work of Copernicus as one of the great natural philosophers of all time.

The Science Library, South Kensington

IN this War, Mr. Roosevelt has said, books are weapons, and perhaps it has needed an emergency like the present to prove the value of scientific and technical libraries to many who have not hitherto given them much thought, or seen the necessity for their active development and encouragement, if a country is to play a worthy part in the world's activities. Certain it is that to-day Government Departments in Great Britain directly concerned with the war effort—especially new offices without established information centres of their own—are increasingly relying on them for much information needed for the successful prosecution of their work. The Science Library at South Kensington, as one of the largest of these libraries, with its wealth of periodical literature and its well-known bibliographical service, is one of those most able to assist the State and firms working for the Government. Its loan department, which deals with many thousands of volumes a year, is a great asset to Great Britain at any time but never more so than at present, and its possession of much scientific literature from the smaller countries of Europe must be a source of the greatest value to the Allied Governments in London, cut off, for the moment, from their own resources. It cannot be divulged what particular services libraries like the Science Library have rendered to Great Britain and its Allies during the War, but these may well be found to be not unworthy of a chapter in the final history. They will show the need for a better understanding of their potentialities, not only in war-time but also in peace, and for a greater consideration for their permanent upkeep at real efficiency level. For the present, it may be stated that in official circles the services of the Science Library are much appreciated, and they are regarded as indispensable for the conduct of the War.

American Library in Great Britain

THE U.S. Office of War Information announces the formal opening of the American Library, which has been operating for several months as a special reference library at the American Embassy, 1 Grosvenor Square. The Library is designed for American, British and other United Nations officials, agencies, for research institutions, associations, business, and for the Press. As Mr. Winant said: "This operation represents trust in the free mind and a desire that our Allies be informed on our way of thinking in the United States". The director of the Library, Dr. Richard H. Heindel, said: "By force of war circumstances this might be called a 'utility' or 'austerity' library. We have not consumed vital shipping space. Many of the American books and periodicals are not easily available elsewhere. The experience gained in the library will help us when the time comes to rebuild the libraries and intellectual life of the continent". The American Library Association, the Library of Congress, learned societies and many other American associations, and their opposite numbers in Great Britain, have been consulted constantly in building up this modest but potentially important centre and cultural focus.

The Linnean Society of London

AT the anniversary meeting of the Linnean Society held on May 24, Mr. A. D. Cotton, keeper of the Herbarium in the Royal Botanic Gardens, Kew, was elected president in succession to Dr. E. S. Russell. Dr. Russell addressed the meeting on "The Stereotypy of Instinctive Behaviour". In a review of the activities of the Society, the retiring President directed attention to the revision of the by-laws, just completed; to concession in the amount to be paid by fellows of sixty-five and more who wish to compound; to the fruitful work of the Crustacea Committee and the Marine Algæ Committee; to grants-in-aid towards the cost of publication; to work done by a sub-committee appointed to prepare a plan for rearranging the Library; to the great need for more shelving for the books; to the gratifying progress made towards completing a photographic record of the Linnean collections and manuscripts; and to the Society's excellent relations with other societies and scientific bodies.

The first fruit of the work of the Sectional Committees, being a key to the British harvestmen or Opiliones by Mr. T. H. Savory, is ready for the printer, as the first of a series of Linnean Society Fauna Synopses. The Marine Algæ Committee's attention has been chiefly directed to collecting data on the ecology of the Fucaceæ.

The Society has created within itself a new class of members, namely associates, who must be less than thirty years of age and for a yearly subscription of one pound will be admitted to meetings, to the use of the Library and will receive the *Proceedings*. It is thought that there may be many biologists, such as advanced students, whose means do not permit them to apply for fellowship, but to whom membership of the Linnean Society offers advantages, contacts that can ripen into friendships and inspiration.

Message from Chinese Men of Science

PROF. TSENG CHAO-LUN, head of the Department of Chemistry of the National Southwest Associated University, Kunming, China, has sent the following open letter to British scientific men:

"While the introduction of modern science into China dates back to eighty years ago, the real beginnings of scientific research in China came after 1919. On May 4 of that year, students in Peiping (then still called Peking) demonstrated against Japanese agression, and from that incident was evolved the so-called 'May 4th Movement', so important in the cultural as well as the political history of modern China. That movement, which quickly spread all over China, not only rallied the country to the standards of democracy but also promoted the natural sciences as factors in the modernization of China. With this impetus, scientific education and scientific research developed at a rate never dreamed of before. The progress made between 1929 and 1937 was particularly rapid, and constant encouragement was received from scientific workers in the United States and in Europe. Since the outbreak of the Sino-Japanese War in 1937, scientific institutions and scientific men in China have suffered tremendously through the deliberate efforts of the Japanese to destroy Chinese culture. But here in the hinterland of Free China, Chinese men of science have been labouring hard for the last five years in the interest of China and of science.

"Chinese scientific workers owe much to Great Britain for their training. For both democratic ideals and scientific accomplishment, we have always looked to Great Britain for guidance. Now, under the banner of the United Nations, Britain and China are fighting shoulder to shoulder to save democracy for the world; a new era of co-operation between the British and Chinese peoples has begun. Early this year we had the honour of welcoming a cultural mission from the British Council. One of its members is Dr. Joseph Needham, who is now doing most valuable work in our country, and who brought with him a large number of scientific books so much needed by us. Recently, Chinese science students in Britain, with the help of the British Ministry of Information, the British Broadcasting Corporation, the British Council, and other organizations, have started a scheme for sending us science news, which includes a weekly broadcast summary of the principal contents of each week's issue of NATURE; recent valuable scientific publications and microfilm copies are being sent, and scientific books are being collected with the view of establishing an adequate Science Library in China. Many British men of science are helping in these efforts. We shall never forget such things, and we hope they will develop into a bigger scheme of co-operation between the scientific men of Great Britain and China".

Chance, Freewill and Necessity

THE twenty-seventh Guthrie Lecture of the Physical Society was delivered on May 18 by Prof. E. T. Whittaker, who took as his subject "Chance, Freewill, and Necessity in the Scientific Conception of the Universe". The lecture was devoted to a study of the association which has been held to exist between the philosophical theory of determinism on one hand, and the scientific view of the world on the other. When a coin is tossed, we say that whether it comes down heads or tails is a matter of 'chance'. This does not mean that there is any real indetermination in the occurrence; but merely that we cannot make a confident prediction, because we do not know the precise velocities of translation and rotation which were communicated to the coin by the thumb of the operator, or the exact mass and figure of the coin, or the density and resistance of the air. If these, and the other relevant data which are unknown to us, are called the 'hidden parameters', then an imaginary person to whom the values of the hidden parameters were correctly known would be able, by aid of the laws of dynamics, to calculate mathematically all the circumstances of the flight and to determine whether the coin would fall heads or tails.

Phenomena of this kind, which are in reality deterministic, although we cannot foretell their outcome because of our lack of information regarding hidden parameters, may be called 'crypto-deterministic'. Wherever the notion of 'chance' occurs in classical physics, it has the crypto-deterministic sense. It is otherwise in the newer atomic physics. The alpha-particles emitted by a small quantity of radium salt may be observed by means of the scintillations they produce on a fluorescent screen, and these scintillations appear at irregular intervals—it is impossible to predict the instant when any particular radium atom will explode. By a quantum-mechanical examination, Prof. Whittaker showed that this phenomenon cannot be crypto-deterministic, but involves a true indetermination. Thus the world is not a closed deterministic system but experiences a continual succession of intrusions or fresh creations. The relation of this to certain ideas in Greek philosophy was discussed, and its bearing on the formulation of the law of causality and on the problem of freewill.

English Scientific Film Association

AN English Scientific Film Association was formed on May 15, at a meeting representative of science and films, convened by the Scientific Films Committee of the Association of Scientific Workers. Mr. Arthur Elton was in the chair. He stated that the new association would be independent and self-governing. An Interim Planning Committee was appointed to frame the constitution and to propose conditions of membership. Contact has already been made with the equivalent Scottish association. The acting secretary is Mr. M. Michaelis, 51 Fitzjohn's Avenue, London, N.W.3. The main aims of the new Association are: to promote the national and international use of the scientific film in order to achieve the widest possible understanding and appreciation of scientific methods and outlook, especially in relation to social progress; and to collect, collate and distribute information on the scientific film, including possibly the formation of a reference library of books and the publication of a journal and pamphlets. The Association will publish comprehensive lists of scientific films graded according to scientific merit. It hopes to establish relations with Government departments, public bodies and other organizations which are in a position to make, use or circulate scientific films. A representative panel of scientific workers, to advise producers of films of all types on scientific matters in connexion with their films and to maintain close contact with the film industry, will be compiled.

The Work of Copernicus

PROF HERBERT DINGLE writes: "Might I correct a small error, for which I am partly responsible, in the report of my address on Copernicus printed in NATURE of May 22? Luther did not 'predict' that Copernicus would overturn astronomy. His words were: 'Der Narr will die ganze Kunst Astronomiae umkehren'; that is, 'The fool *wishes to* overturn the whole science of astronomy'. There is no reason to suppose that Luther thought he would succeed.

Comet Whipple-Fedtke

THIS comet is fading rapidly and on April 13 its magnitude was 8·5. An ephemeris is given for June.

	R.A.	Dec.	ρ	r
June 1·0d.	13h. 12·4m.	+21·1°	1·456	2·097
5	13 15·7	19·6	·523	·137
9	13 19·0	18·2	·593	·177
13	13 22·4	16·7	·664	·218
17	13 26·0	15·4	·738	·258
21	13 29·6	14·1	·813	·299
25	13 33·4	12·8	·891	·340
29	13 37·3	11·5	·969	·381

The Night Sky in June

NEW moon occurs on June 2d. 22h. 33m. U.T. and full moon on June 18d. 05h. 14m. The following conjunctions with the moon will take place: June 1d. 19h., Mercury 1° N.; June 6d. 14h., Jupiter 2° N.; June 7d. 00h., Venus 4° N.; June 26d. 05m., Mars 3° N.; June 30d. 19h., Saturn 3° N.; June 30d. 21h., Mercury 3° N. Occultations are very few during the month and only one is worth noticing: June 16d. 1h. 26·0m., γ Lib. (D). Mercury is stationary on June 4 and attains its greatest elongation west on June 18, and on this date rises at 3h. Venus attains its greatest elongation east on June 28 and sets then at 22h. 40m. Mars is moving northward into the constellation of Pisces and rises at 1h. about the middle of the month but cannot be observed very conveniently. Jupiter sets at 22h. 20m. in the middle of the month and can be seen for only a comparatively short period after sunset. Saturn is in superior conjunction with the sun on June 7 and cannot be observed. Summer Solstice is on June 22d. 07h.

Announcements

THE King has been pleased to command that the Institute of Chemistry shall henceforth be known as "The Royal Institute of Chemistry of Great Britain and Ireland".

THE thirteenth Thomas Young Oration will be delivered before the Physical Society by Prof. F. C. Bartlett on June 4 at 5 p.m., in the lecture theatre of the Science Museum, South Kensington. Prof. Bartlett will speak on "Some Current Problems in Visual Functions and Visual Perception".

THE British Coal Utilization Research Association is arranging an open conference on "The Ultra-fine Structure of Coals and Cokes, with Special Reference to the Application of Modern Physical Methods", to be held at the Royal Institution during June 24–25. Forms of applications to attend, which are issued free of charge, can be obtained from the Conference Secretary, B.C.U.R.A., Rickett Street, West Brompton, London, S.W.6, to whom they should be returned by June 4.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Morphine-like Properties of Diphenylethylamine and Related Compounds

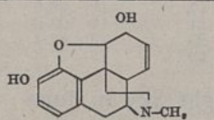
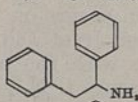
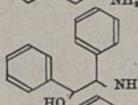
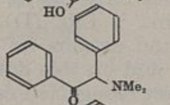
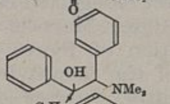
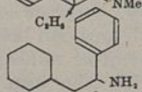
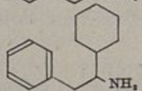
THE synthesis of relatively simple stilbene derivatives (stilbœstrol, hexœstrol, etc.) possessing all the physiological properties of the complex naturally-occurring steroid œstrogens[1] has suggested that simple analogues might be prepared to imitate the effects of other complex therapeutically active compounds containing the phenanthrene nucleus. Such a compound is morphine.

A widespread search for a substance possessing the narcotic effects of morphine without its disadvantageous accessory actions has been carried out under the auspices of the American National Committee on Drug Addiction. The substances tested have been mainly morphine derivatives or synthetic phenanthrene or carbazole analogues[2].

We have attempted to find much simpler compounds with morphine-like activity, and this preliminary note reports the results obtained with compounds of the diphenylethylamine series. These substances bear somewhat the same structural resemblance to morphine as do the synthetic œstrogenic analogues to the naturally occurring œstrogens.

In our preliminary tests we have assessed the capacity of the synthetic compounds to: (*a*) depress the righting reflex in rats[3]; (*b*) raise the blood-sugar concentration in rabbits[4]; and (*c*) produce dilatation of the pupil and other effects in cats. Toxicity has in some cases been determined in mice. The substances we have tested possess these activities in varying degrees, and the results obtained with six of the substances which are briefly tabulated below are representative of the larger series which will be published in detail elsewhere.

All the substances have been injected as aqueous solutions of their hydrochlorides. Depression of the righting reflex has been determined after intra-peritoneal injection into at least eight rats. The starved rabbits were injected subcutaneously and blood-sugar determinations were made at hourly intervals for 3 hours after the injection; two or more rabbits were used in each test unless the dose was fatal. Rises in blood-sugar level of less than 20 per cent are not regarded as significant. One or two cats were injected intramuscularly and the figures in the table indicate the number of cats injected and the number of positive responses. The difficulties of supply have so far prevented us using a larger number of animals, which is particularly unfortunate in the case of the cats, in which we find considerable individual variations in response to both morphine and the synthetic compounds. In rabbits and cats that have been used for more than one test there has been a lapse of 7 days or more between successive tests.

		Animal used:	Mice	Rats	Rabbits	Cats		
		Activity tested:	L.D. 50 (mgm./kgm.)	% depression of righting reflex	% max. inc. in blood sugar	Pupil dilatation	Emesis	Hyper-excitability
Substance	Formula	Dose (mgm./kgm.)						
Morphine		2		—	6	2/2	1/2	0/2
		5	360	5	15	2/2	1/2	2/2
		10		55	48	2/2	0/2	2/2
		20		55	121	2/2	0/2	2/2c
*M*3 *αβ*-Diphenylethylamine		10		—	—	1/2	0/2	2/2
		20	410	—	13	1/2	0/2	2/2
		50		15	72	1/1	0/1	1/1
		100		85	204+	—	—	—
*M*4 *β*-Hydroxy-*αβ*-diphenylethylamine		20		—	3	0/2	0/2	2/2
		50	—	—	19	2/2	0/2	2/2
		100		0	16	—	—	—
*M*7 Dimethylaminobenzyl-phenyl-ketone		5		—	—	1/2	0/2	0/2
		10	120	—	—	1/3	1/3	0/3
		20		—	—	—	—	—
		50		50	20+	—	—	—
*M*9 *β*-Hydroxy-*αβ*-diphenyl-*n*-butyl-dimethylamine		20		—	—	1/2	0/2	2/2c
		50	—	43+	17	—	—	—
		100		—	212+	—	—	—
*M*16 *α*-Phenyl-*β*-*cyclo*hexylethylamine		10		—	55	0/1	1/1	1/1
		20	275	0	52	0/2	1/2	1/2
		50		86+	173+	—	—	—
*M*18 *α*-*cyclo*Hexyl-*β*-phenylethylamine		20	—	21	13	0/2	0/2	1/2
		50		70	103+	0/1	1/1	1/1c

c = Convulsions occurred at this dose level. + = One or more animals were killed with this dose.

We have unfortunately not been able to find a satisfactory quantitative test of the analgesic power of morphine or the synthetic compounds in either man or experimental animals. Since this is obviously the crucial test we have conducted rough clinical trials of some of our compounds. *M*3, 4 and 7 have been administered to patients with intractable pain due to pressure symptoms in inoperable cancer. These patients were already under treatment with morphine, and it has been found that all three compounds given orally in doses of 50–400 mgm. every 4 hr. relieved their pain. While these results are by no means quantitative, *M*4 appears to be the most effective, which indicates that the analgesic activity is not related to the capacity to raise the blood sugar.

It is readily admitted that the clinical and experimental data do not justify any claim that these diphenylethylamine compounds can replace morphine. We feel, however, that the results are sufficiently encouraging to warrant publication and the hope that further exploration of the series may yield compounds of much greater activity.

We are grateful to Dr. D. Ranger for clinical trial of the compounds and to Mr. I. A. Hepple for technical assistance.

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[1] Dodds, E. C., Golberg, L., Lawson, W., and Robinson, R., *Proc., Roy. Soc.*, B, **127**, 140 (1939).

[2] Small, L. F., Eddy, N. B., Mosettig, E., and Himmelsbach, C. K., U.S. Public Health Service, Suppl. No. 138, Public Health Reports (1938). National Research Council: Report of Committee on Drug Addiction 1929–1941. Collected reprints 1930–1941.

[3] Eddy, N. B., and Howes, H. A., *J. Pharmacol. Exp. Therap.*, **53**, 430 (1935).

[4] Ross, E. L., *J. Biol. Chem.*, **34**, 335 (1918).

A New Method of Nuclear Methylation of Aromatic Amines and Phenolic Substances

HYDRAZOBENZENE, when heated to high temperatures, decomposes with formation of aniline and azobenzene[1], and it is likely that this reaction starts with the cleavage of an NH–NH linkage forming free radicals, which become stabilized by disproportionation involving undissociated hydrazobenzene :

$$C_6H_5\text{–}NH\text{–}NH\text{–}C_6H_5 \rightarrow 2\,C_6H_5\text{–}NH\text{–}$$
$$2\,C_6H_5\text{–}NH\text{–} + C_6H_5\text{–}NH\text{–}NH\text{–}C_6H_5 = 2\,C_6H_5\text{–}NH_2 + C_6H_5\text{–}N{=}N\text{–}C_6H_5.$$

Hydrocarbons possessing aliphatic C–C linkages also decompose at high temperatures, starting with a cleavage of such a link and formation of radicals, which become stabilized by disproportionation with other undissociated hydrocarbons, thus forming saturated hydrocarbons of smaller carbon content in addition to unsaturated hydrocarbons[2].

$$R\text{–}CH_2\text{–}CH_2\text{–}R \rightarrow 2\,R\text{–}CH_2\text{–}$$
$$2\,R\text{–}CH_2\text{–} + R\text{–}CH_2\text{–}CH_2\text{–}R = 2\,R\text{–}CH_3 + R\text{–}CH{=}CH\text{–}R.$$

Aniline reacts in presence of mineral acids with formaldehyde forming anhydro-4-amino-benzylalcohol, which is a polymer and should possess a ring or long-chain structure of two or more molecules (I or II). In the latter case, the free valencies of the terminal atoms should be saturated by a water (or aniline) molecule.

$$\text{(I)}\quad \begin{array}{ccc} (HN\text{–}C_6H_4\text{–}CH_2)_n \\ | \qquad\quad | \\ H_2C\text{–}C_6H_4\text{–}NH \end{array}$$

$$\text{(II)}\quad H_2N\text{–}(C_6H_4\text{–}CH_2\text{–}NH)_n\text{–}C_6H_4\text{–}CH_2OH.$$

We considered that since this substance contains CH_2–NH linkages which are intermediate between NH–NH and CH_2–CH_2 linkages, they might behave similarly, and form when heated to high temperature in the first place radicals of the type III, $n = 0, 1, 2 \ldots$, which in turn would undergo disproportionation with formation of para-toluidine (IV, $n = 0$) or substances (IV, $n = 1, 2 \ldots$), from which para-toluidine could be easily formed during the heating. In this case, some part of the material would be expected to serve as source of hydrogen.

$$\text{(III)}\quad \text{—}HN\text{—}\ (C_6H_4\text{–}CH_2\text{–}NH)_n\text{–}C_6H_4\text{–}CH_2\text{–} \rightarrow$$

$$\text{(IV)}\quad H_2N\text{–}(C_6H_4\text{–}CH_2\text{–}NH)_n\text{–}C_6H_4CH_3 \rightarrow \text{–}HN\text{–}(C_6H_4\text{–}CH_2\text{–}NH)_{n-1}\text{–}C_6H_4\text{–}CH_2\text{–} + CH_3\text{–}C_6H_4\text{–}NH_2.$$

Indeed, anhydro-4-amino-benzylalcohol, when heated to a temperature above 300° or simply dry distilled, decomposes with formation of a mixture of almost equal parts of aniline and para-toluidine (total yield, 20 per cent) in addition to small amounts of other products. We have found that the unexpected formation of aniline is due to a side-reaction, namely, the formation of condensation products containing methylene linkages connecting the aromatic groups such as *pp'*-diamino-diphenylmethane and the complicated aniline-formaldehyde resins. These are known to be formed in acidic conditions, and decompose according to our experiments mainly with formation of aniline.

We have, therefore, carried out the distillation in presence of alkaline materials such as calcium hydroxide or sodium carbonate, hoping that under such conditions the side-reaction would be inhibited. We obtained almost pure para-toluidine (yield, 35–40 per cent), the amount of aniline being negligible.

Other anhydro-4-amino-arylalcohols behave similarly[3]. Varying amounts of *pp'*-diamino-diarylmethanes are also obtained. This method is in many cases (*m*-xylidine, *o*-4-xylidine) much superior to any existing methods. The residues of the distillations consist of resinous material which has obviously served as source of hydrogen, but does not lend itself to an investigation.

A more detailed paper will be published elsewhere[3].

Having found that anhydro-4-amino-arylalcohols undergo at high temperatures decomposition with formation of nuclear methylated aromatic amines, we thought it possible that anhydro-2 or 4-hydroxyaryl-alcohols of the general type I or II (cf. above), which possess oxygen atoms in place of the NH groups of the anhydro-aminoaryl-alcohols, would undergo a similar reaction with the initial formation of radicals and subsequent disproportionation and formation of nuclear methylated phenols ; some part of the material would again serve as source of hydrogen.

A study of the literature indicated that the isolation of anhydro-hydroxy-arylalcohols would meet with great difficulties, since *o*- and *p*-hydroxy-arylalcohols, HO–Ar–CH_2OH, known to be the first reaction products between phenols and formaldehyde in the presence of alkaline catalysts, possess a great tendency in absence or presence of both alkalis and acids to form polyphenolic substances containing methylene linkages between the different phenolic groups, such as the crystalline dihydroxy-diarylmethanes and the more complicated high molecular phenol-formaldehyde resins. The problem of finding conditions, under which anhydro-2- or 4-hydroxy-arylalcohols would be formed, and, in addition, would be sufficiently resistant to the formation of the condensed phenol-formaldehyde products mentioned, at the required high temperature (in excess of 250°), could therefore be expected to be rather complicated.

2.6-Dihydroxymethyl-4-methyl-phenol, $HO-C_6H_3(CH_2OH)_2CH_3$, was chosen as subject of a detailed investigation. Preliminary experiments showed that, dry distilled, this substance decomposes with the formation of small amounts of 2.4-dimethyl-phenol and 2.4.6-trimethyl-phenol, the two theoretically possible methylated phenols, in addition to a considerable amount of *p*-cresol. The formation of *p*-cresol is due to the intermediate formation of phenol-formaldehyde condensation products consisting of two or more aromatic groups connected by methylene linkages, which, as already shown by Megson[4], and confirmed by us, decompose with formation of the original phenols in addition to traces of methylated phenols (generally less than 2 per cent). This is completely analogous to the formation of aniline from anhydro-4-amino-benzyl-alcohol owing to the intermediate formation of aniline-formaldehyde resins.

Attempts to heat 2.6-dihydroxymethyl-4-methyl-phenol in presence of alkaline materials of different strength in the hope of finding conditions which would inhibit the undesired condensation proved to be successful. The amount of methylated phenols varies in presence of different alkaline materials. We have found that alkalis of medium strength such as the hydroxides or oxides of the alkaline earths or the borates of the alkali metals give the best results; yields as high as 25–30 per cent of 2.4.6-trimethyl-phenol, in addition to some 2.4-dimethyl-phenol, are obtained. The corresponding salts of 2.6-dihydroxy-methyl-4-methyl-phenol behave similarly.

The reaction discussed is characteristic for all 2- or 4-hydroxymethyl-phenols and other substances able to form at high temperatures anhydro-2- or 4-hydroxymethyl-phenols; for example, 2- or 4-aminomethyl-phenols, $R_2N-CH_2-Ar-OH$[5].

The bearing of these results on the theory of the formation and structure of phenol-formaldehyde resins and the possibility of making the above results the basis of an economic process for the preparation of nuclear methylated phenols, especially 2.4.6-trimethylphenol, 2.3.5-trimethylphenol, 2.3.5.6-tetramethylphenol, 2.3.4.6-tetramethylphenol, will be discussed in a more detailed paper to be published elsewhere[5].

We thank the Calico Printers' Association, Ltd., Manchester, for permission to publish this letter.

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April 13.

[1] Hofmann, *Proc. Roy. Soc.*, **12**, 576 (1863).
[2] cf. Rice and Rice, "The Aliphatic Free Radicals" (Baltimore, 1935), pp. 91, 142.
[3] cf. in the meantime, Burawoy, *B. Pat.*, 539,747.
[4] *Trans. Far. Soc.*, **32**, 336 (1935).
[5] cf. Burawoy, *B. Pat.*, 545,382.

Theory of Large Elastic Deformations

WHEN rubber is subjected to a large elastic deformation, which may be assumed to take place without change of volume, it ceases to be isotropic, and the attempt to relate the stresses and strains in different directions may be a matter of some difficulty. However, if the assumption is made that Hooke's law is obeyed in simple shear in any isotropic plane, it is possible, as Mooney has shown[1], to deduce certain relations which represent the elastic behaviour under the most general type of homogeneous deformation. If such a deformation is defined by the three principal strains, λ_1, λ_2 and λ_3 (where λ_i is the ratio of final to initial length along the i-strain axis), the expression for the work of deformation W is

$$W = \frac{G}{4}\sum_{i=1}^{3}\left(\lambda_i - \frac{1}{\lambda_i}\right)^2 + \frac{H}{4}\sum_{i=1}^{3}\left(\lambda^2 - \frac{1}{\lambda_i^2}\right) \qquad (1).$$

This equation, which rests on an argument of a most general character, leaves two constants G and H to be determined by the specific properties of the material. The constant G may be identified with the ordinary modulus of rigidity, but the physical significance of H is not easy to grasp. The ratio H/G is related to the difference of behaviour under different types of deformation, and is termed by Mooney the "coefficient of asymmetry".

Approaching the subject from a different angle, Wall[2] has recently derived stress-strain relations for an idealized network of molecules, on the basis of the kinetic theory of elasticity. He finds a linear stress-strain relation in shear, and by comparing his equation for elongation with that given by the more general theory of Mooney (equation 1) he is able to relate the constants G and H to a single molecular parameter. The result is

$$G = H = NkT,$$

where N is the effective number of molecules per c.c., k is Boltzmann's constant and T the absolute temperature. Combining this result with equation (1) leads to the simpler form

$$W = \frac{G}{2}(\lambda_1^2 + \lambda_2^2 + \lambda_3^2 - 3) \qquad (2)$$

for the strain energy in the most general type of homogeneous deformation. It follows, therefore, that the description of rubber-like elasticity does not necessarily require the use of two independent physical constants. Whether in fact the behaviour of a given rubber can be satisfactorily represented in terms of a single physical constant is, of course, a matter for experimental investigation.

Our unpublished experiments show that Wall's relations do in fact represent the behaviour of vulcanized rubber in elongation, compression and shear with reasonable accuracy up to moderately large deformations.

If Wall's theory is assumed, then having once used it to derive the simplified form (2) of Mooney's equation, one may proceed to apply this equation to any problem involving the more complex types of deformation of rubber, without further reference to the molecular theory.

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[1] *J. Appl. Phys.*, **11**, 582 (1940).
[2] *J. Chem. Phys.*, **10**, 485 (1942).

An Application of the Principles of Allometry to the Study of English Senonian Echinocorys

THE following notes summarize the results of an investigation which was curtailed by the War, but which, though incomplete, has introduced some important conceptions. They concern the size and proportion changes in the Senonian sea urchin Echinocorys[1].

APPROXIMATE VALUES OF GROWTH COEFFICIENTS IN SELECTED GROUPS OF ECHINOCORYS

Zone	Subdivision	Locality	Coeffts. of relative height b	Coeffts. of relative height a	Coefft. of relative breadth	
M. cortestudinarium			0·21	1·35	0·87	
M. coranguinum		Northfleet	0·30	1·20	0·83	
Marsupites	*Uintacrinus depressula*		0·27	1·25	0·79	Southern England
O. pillula			0·12	1·45	0·83	
Base, *B. mucronata*		Shawford	0·53	1·10	0·84	
Base, *B. mucronata*		Bramford	0·40	1·15	0·86	
B. mucronata		Harford	0·33	1·20	0·85	
B. mucronata		Catton	0·32	1·20	0·83	East Anglia
Ostrea lunata	Sponge beds	Trimingham	0·51	1·05	0·82	
Ostrea lunata	Grey chalk	Trimingham	0·35	1·15	0·85	
Ostrea lunata	White chalk with *O. lunata*	Trimingham	0·20	1·30	0·87	
Holaster planus			0·68	1·05	0·88	
M. cortestudinarium			0·64	1·05	0·89	Yorkshire
Marsupites			0·08	1·50	0·79	
Actinocamax quadratus			0·38	1·15	0·88	

The material was examined in groups, each one from a given horizon and locality, and in each group, breadth and height respectively were plotted against length on a logarithmic grid as described by J. S. Huxley[2].

It was found that breadth was isometric[3] relatively to length, that is, it could be represented by the formula

$$B = b' \times L,$$

where b', in the material examined, varied between approximately 0·8 and 0·9.

Height, on the other hand, was represented by the simple allometry formula

$$H = b \times L^{a},$$

where the coefficient α was greater than unity, that is, height was positively allometric relatively to length, and the coefficient b was smaller than unity, so that the ratio H/L tended to be less than 1.

On the whole, a large value for the coefficient b was accompanied by a small value for the coefficient α, and vice versa. The relationship between the two coefficients is expressed by a formula of the same type as Huxley's simple allometry formula, since the values, if plotted double-logarithmically, form approximately a linear figure.

There is some possibility that the changes in size and proportions can be correlated with changes in environment, that is, depth of water in the Chalk sea, in which case, an increase in size correlated with change of environment appears to give rise in many cases to a *decrease* in relative height, whereas a size increase in the ordinary course of the individual's growth gives rise to an *increase*.

A few sea urchins contemporary with Echinocorys were examined along similar lines, and although the material was scanty there was a suggestion that the coefficient α may be identical in contemporary irregular sea urchins from a given locality. The matter needs further investigation, but its effects on certain taxonomic questions may well be important.

The results are fully described in a thesis accepted by the University of London for the degree of doctor of philosophy, a copy of which thesis is in the University library.

JOHN F. HAYWARD.
29 Mount Echo Drive,
Chingford, Essex.

[1] See Hayward, J. F., *Naturalist* (1941), for references.
[2] Huxley, J. S., "Problems of Relative Growth" (London, 1932).
[3] Needham, J., and Lerner, I. M., "Terminology of Relative Growth Rates", NATURE, **146**, 618 (1940).

Expediting Visual Adaptation to Darkness

THE problem of expediting artificially the adaptation of the eye to darkness is of considerable theoretical, and of no less practical importance, as, for example, in the case of night flying under war conditions. It has long been established that the period of adaptation when passing into complete darkness from a brilliantly lighted room is 45–50 minutes, and from a dully lighted room 25–30 minutes.

Proceeding from the theory of trophic adaptation of L. A. Orbeli, who demonstrated that the sense organs are innervated by the vegetative nervous system, I formulated the hypothesis that the process of adaptation to darkness is likewise influenced and controlled by the vegetative nervous system. The influence of this system on the visual apparatus (retina, conducting channels and brain centres) may be modified by exciting other sense organs by stimuli adequate to the latter. In 1937 I experimented in expediting adaptation to darkness by exciting the organ of taste (with sugar), the effect of which was to shorten considerably the period of adaptation[1].

Several months ago we experimented in expediting adaptation by means of light muscular exercise, during which the part of a weak exciter of the central nervous system and the visual organ is played by the nerve impulses imparted by the muscles and cartilages as they changed their length and thickness during muscular exercise.

Experiments made on ten subjects with the help of the adaptometer revealed that it was possible in this way to reduce the period of adaptation from 25–45 minutes to 5–6 minutes. Moreover, it was ascertained that usually sensitivity is roughly 20–30 per cent higher after such exercises than after remaining 45 minutes in darkness in a state of rest.

In another series of experiments we measured contrast sensitivity. The experimenter measured the time that elapsed from the moment the subject passed into darkness to the moment he could distinguish a black silhouette against a dark-grey background. Ten to fifteen experiments on eight subjects led us to conclude that this period is reduced to one half or one third under the influence of light muscular exercise.

What is the physiological mechanism of this influence? We believe that we have here a sensory vegetative reflex, as a result of which the functional state of the retina and, in particular, its absolute and contrast sensitivity, are changed. There are grounds for believing that in such cases the vegetative nervous system also affects the periphery (retina) and the visual centres of the cortex and subcortex of the hemispheres. That it is possible to influence the brain through the vegetative nervous system was demonstrated several years ago by A. V. Tonkikh and E. A. Asratyan in Orbeli's laboratory. A. V. Tonkikh showed this in particular in relation to the spinal cord, and E. A. Asratyan in relation to the cortex of the cerebral hemispheres.

KRIKOR KEKCHEYEV.

Soviet Scientists' Anti-Fascist Committee,
Moscow. March 19.

[1] *Bull. Exp. Biol. Med.* (1937).

Science or Pseudo-Science

RECENT discussions on the teaching of science recorded in NATURE indicate a wide diversity of opinion and a lack of co-ordinated and constructive suggestion. There is the disconcerting prevalence of self-denunciation among the ranks of science teachers themselves—the admission of 'over-specialization', a predilection to use the term 'humanities' with awe, and a *persuasion* that a smattering of the facts of all the sciences, pure and applied, is better than a training in scientific procedure. There is also a hankering after the deliberate training of character in the classroom, for example, by 'humanizing' scientific instruction. Smiles on "Character" pricks this bubble in his first few pages. In brief, there are many who contend that unscientific science (that is, science taught and interpreted in the same way as the humanities as factual knowledge) is more desirable than the science advocated by Armstrong, Huxley and Perry.

The teaching of science cannot be discussed in isolation, but only in relation to the whole of education, much of which is out of school. Those who clamour (I think rightly) for the historical method of teaching science should insist that the historian should teach it. History as now taught is political history. The humanities specialize in inhumanity—instruction in the accumulated evil, intrigue, and strife of the ages. Surely, the time has come when the subject-matter of history should be more stimulating and elevating—the history of the progress of mankind (of art, science, industry). General science should be taught by the historian, *not* by the science master. In the earliest stages English, arithmetic and nature study, if liberally interpreted, provide a complete educational background. Later, nature study gives place to history (including general science and geography).

The Fisher Report (1919) on "The Teaching of English in England" gives an impartial, well-balanced, and searching review of present difficulties in education. Nowhere has the solution of these difficulties been indicated so clearly and convincingly as in this report. Quoting from it:

"Hitherto literature has, even more than science, suffered in the public mind both misunderstanding and degradation. Science has too often been regarded as a kind of skilled labour, a mere handling of materials for profit. Literature has first been confused with the science of language, and then valued for its commercial uses, from the writing of business letters up to the production of saleable books. The word art has been reserved for the more highly coloured or the less seriously valued examples of the latter. We must repeat that a much higher view must be taken of both science and art, and that this view is the only one consistent with a true theory of education. Commercial enterprise may have a legitimate and desirable object in view, but that object cannot claim to be the satisfaction of any of the three great natural affections of the human spirit—the love of truth, the love of beauty, and the love of righteousness."

If English language and literature is made the root and stem of the tree of British education, science can contribute by providing concrete experience for literary and artistic expression. Science is an integration of experience and not of fact. If general science consists of encyclopædic factual knowledge, it is not science, and it cannot be taught as science should be taught. Even special science as now taught in schools is far too much a matter of memory and far too little a matter of experience and scientific development and procedure. The 'specialization' of school science to-day is humanistic specialization—an insistence on much fact and little method. At the university, the student is too often 'lectured into a degree'—the natural consequence of early training.

The humanistic specialization of science arises out of an examination system which is almost exclusively a test of factual knowledge and sheer memory. Science syllabuses should be drastically curtailed so that school science deals with fundamentals so exhaustively as to become part and parcel of the student's mental equipment. His knowledge of science should be similar to his knowledge of running and eating. A written examination is quite inadequate and far too precarious as an educational assessment. Full-time visiting examiners (and advisers) are necessary to assess the work and progress of the pupil and to furnish a detailed record of it.

The primary aim of education should be to create a love of books, a passion for reading, and a desire for knowledge. The pupil must be trained to search for knowledge and to find it. He then educates himself throughout life and stimulates others to do the same. The beginner must not be forcibly fed with classical literature—he must be encouraged to read books that interest him. Any attempt to coerce him is both stupid and dangerous. Post-war houses should be provided with every facility for home education—cupboards, shelving, desks and the equipment for private libraries, studies and laboratories. Education must lead to self-education throughout life. Breadth of vision far transcending anything previously known in education is unlikely but extremely desirable. Small classes, trained and reasonably paid teachers are absolutely essential reforms; also, facilities for adult education—social centres of mental and bodily culture—institutions quite different from a school—halls of leisure). C. W. HANSEL.

Bedford School, Bedford.
April 23.

PHOSPHORUS METABOLISM IN MOULDS

By DR. T. MANN
(Senior Beit Memorial Research Fellow),
Molteno Institute, University of Cambridge

ONE of the characteristic features of anaerobic carbohydrate metabolism in animal- and yeast-cells is the active participation of a number of well-defined phosphorylated intermediates. Comparatively little, however, is known about the nature and function of phosphorus compounds formed in the course of the aerobic metabolism of living cells. The study of the aerobic phosphorylations is made difficult by the circumstance that even under aerobic conditions fermentation may still occur and account for some of the changes observed in the phosphorus metabolism. In this respect, many mould fungi, especially the species of Aspergillus and Penicillium, occupy a somewhat unique position inasmuch as their carbohydrate metabolism is predominantly aerobic. *Aspergillus niger*, for example, will oxidize sugar very efficiently in the presence of oxygen to non-volatile organic acids such as gluconic, citric and oxalic acid, whereas anaerobically it will scarcely ferment sugar at all.

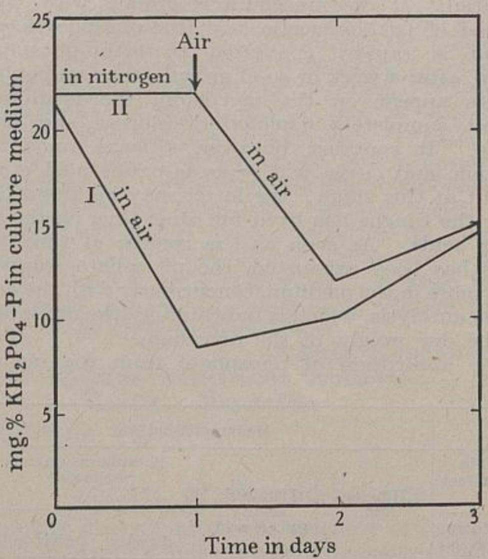
Hitherto, the biochemical investigations of the carbohydrate metabolism in moulds have been chiefly concerned with the many aspects of the formation of the organic acids. These investigations received recently a new stimulus by the discovery that the enzymic oxidation of carbohydrate in moulds appears to be linked with the formation and function of anti-bacterial substances (penicillin A or notatin[1] and penicillin B[2]). Up to the present, however, the metabolism of the acid-producing mould fungi has not been extensively studied with regard to the occurrence and role of phosphorus compounds, although it has been known for some time that inorganic phosphate added to the culture media enhances both the mycelial growth and the formation of acids, and also that moulds are capable of transforming the phosphate into an acid-soluble 'organic' form[3,4].

The experiment recorded in the accompanying table was carried out with *Aspergillus niger* v. *Tiegh* (Nat. Coll. 594) sown on medium composed of 10 per cent glucose, 0·2 per cent potassium phosphate (K_2HPO_4), 0·5 per cent sodium nitrate and 0·1 per cent magnesium sulphate ($MgSO_4.7H_2O$), and grown at 30°. A thin mycelium usually appears 24 hours after sowing and the production of gluconic and citric acid soon follows. At the same time, the absorption of phosphate from the medium begins to be noticeable. The growing mycelium converts a large proportion of the absorbed phosphate into a new compound which can be extracted from the mycelium by means of cold trichloroacetic acid. When hydrolysed for 7 minutes with hydrochloric acid (1*N*) in boiling water, the phosphorus compound present in the extract breaks down completely to inorganic ortho-phosphate. Thus it behaves like a typical 'easily acid-hydrolysable phosphorus compound'. The use of trichloroacetic acid for extraction is essential. If the mycelium is ground with water instead of trichloroacetic acid, the phosphorus compound is rapidly converted to ortho-phosphate. When, after a week or so of growth, the first conidiophores appear on the mycelium, the medium is almost completely depleted of glucose and phosphate. It contains, however, a large amount of gluconic and citric acid whereas oxalic acid is still absent at this stage; the latter may be found later after the fungus has lived for some time on the two other acids. As soon as the reserve of these two acids has been exhausted, the phosphate reappears once more in the medium, concurrently with the onset of the autolysis, which is indicated by the diminution of the dry weight of the mycelium.

Aspergillus niger culture		Mycelium			Medium (50 ml.)			
Age	Characteristics	Dry weight (gm.)	Phosphorus (mgm.) in the trichloroacetic extract estimated		Glucose (gm.)	Titratable acidity (ml. *N* acid)	Phosphorus (mgm.) estimated	
			directly	after 7 min. hydrolysis			directly	after ashing
1st day					5·0		17·8	17·8
2 days	Thin continuous mycelium	0·506	0·4	1·6		3·2		
3 days	White strong mycelium	1·056	1·5	5	1·1	15·0	10·5	10·5
5 days	First conidiophores	1·340	1·5	9	0·05	18·0	5·0	5·0
9 days	Mycelium covered with conidiophores	1·728	1·1	12·3	0	5·5	0	0
2 weeks	Autolysis	0·932	2·6	4·8	0	0·3	8·0	9·6

The absorption of phosphate from the medium and the formation of the easily hydrolysable phosphorus compound was found to occur only in the presence of oxygen. Iodoacetate (0·001 *N*), azide (0·001 *N*) and fluoride (0·005 *N*) had a strong inhibitory effect on the respiration and on the acid production of the fungus, and at the same time they brought the phosphorus metabolism to a standstill. They also accelerated the breakdown of the phosphorus compound already existing in the mycelium. These processes could best be studied on mycelia grown directly in the cups of the Barcroft differential manometers. In order to demonstrate the effect of oxygen on the phosphate metabolism, it was found convenient to grow mycelia for several days on media deficient in phosphate (0·01–0·02 per cent instead of 0·2 per cent K_2HPO_4) but otherwise composed as described above. If these mycelia were then transferred to 0·1 per cent phosphate (KH_2PO_4), they quickly utilized the inorganic phosphate and built up from it the easily hydrolysable phosphorus compound provided that oxygen was available (curve I). Otherwise, that is, anaerobically, there was no change in the content of phosphate in the medium (curve II). With the onset of autolysis even in the presence of oxygen, the phosphate uptake declined rapidly. When similar experiments were carried out with pyrophosphate and also with sugar-phosphoric esters, it was found that these were first broken down by the mycelium, and the ortho-phosphate derived from them was built up into the easily hydrolysable compound.

To obtain more definite information with regard to the chemical nature of the new phosphorus compound, several 9-day-old mycelia (dry weight, 20 gm.) were extracted with trichloroacetic acid, the extract treated with an equal volume of alcohol, and filtered. On addition of sodium hydroxide to the clear filtrate, there appeared at *p*H 5–6 a precipitate, which after drying yielded 700 mgm. of a white powder. This crude preparation was free from ortho-



phosphate but contained 15 per cent easily hydrolysable phosphorus; the curve of acid-hydrolysis closely followed that of pyrophosphoric acid, but the rate of dialysis was slower than that of pyrophosphate proper. At this stage the preparation contained some organically bound nitrogen as well as some carbohydrate which showed reducing property after hydrolysis. However, on further purification by means of precipitations with lead, silver and barium, the phosphorus compound was obtained nitrogen- and carbohydrate-free, but it still contained some organic matter, the ratio C : P not being lower than 1 : 4. From an alkaline solution of a purified preparation (28 per cent P) crystalline sodium pyrophosphate was obtained, but it did not account for the entire easily hydrolysable phosphorus. Presumably, the isolated substance may contain more than one easily hydrolysable polyphosphoric acid. This assumption is further strengthened by the behaviour towards barium nitrate, by means of which two distinct fractions have been obtained, one precipitated at *p*H 2, and the other at *p*H 5. Both these fractions yielded ortho-phosphate after 7 minutes hydrolysis but the analysis of the fraction precipitated at *p*H 2 showed a ratio Ba : P = 1 : 2 as required for a tetraphosphoric acid. In its behaviour towards barium nitrate the mould phosphorus compound resembles the polyphosphoric acid complex which has been shown to occur in yeast[5].

It is too early to say what may be the actual size of the polyphosphoric acid molecule in the mycelium itself. The occurrence of large molecules is made probable by the fact that if the mycelium was ground rapidly with acetone and dried, it retained a high proportion of the easily hydrolysable phosphorus. On the other hand, there is the possibility that the polyphosphate exists in the mycelium in combination with an organic substance and that this complex, though not sensitive to the acetone treatment, is affected by the acid extraction. Finally, it should be mentioned that the formation of polyphosphate is by no means restricted to *Aspergillus niger*. Various moulds, among them *Penicillium notatum* Westling (Fleming), were found to be capable of performing a similar synthesis, the most striking feature of which was its aerobic character.

[1] Coulthard *et. al.*, NATURE, **150**, 634 (1942).
[2] Robert *et. al.*, *J. Biol. Chem.*, **147**, 47 (1943).
[3] Vorbrodt, *Bull. Int. Acad. Pol.*, 1099 (1926).
[4] Michel-Durand, *Bull. Soc. Chim. Biol.*, **20**, 399 (1938).
[5] Umschweif and Gibaylo, *Acta Biol. Exp.*, **11**, 6, 124 (1937).

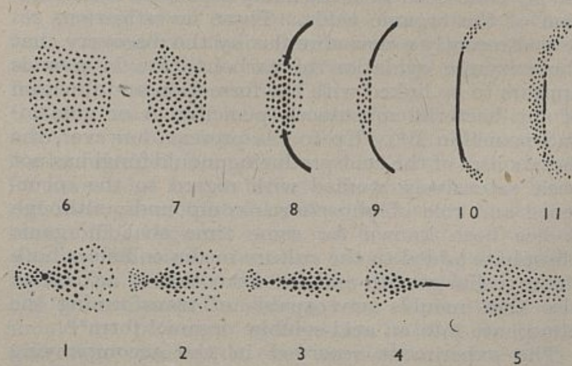
CONICAL REFRACTION

By SIDNEY MELMORE
Yorkshire Museum

ATTENTION was recently directed[1] to a connexion between the phenomenon of conical refraction and the focal lines in biaxial crystals described by Sorby: some additional observations have since been made regarding the behaviour of these focal lines.

When light travels along the acute bisectrix, two pairs of focal lines appear, one overlying the other. To avoid unnecessary complications, it is desirable to employ an analyser to quench one pair of lines; attention can then be directed to the remaining pair. These lines are straight; one coincides with the trace of the optic axial plane (xz) and will be referred to for brevity as the line A; the other is perpendicular to it and will be called the line B; each line lies in a plane perpendicular to the axis of the microscope.

Let the crystal be rotated about 5°–6° away from the acute bisectrix about an axis perpendicular to the optic axial plane: rack up the microscope and then begin to focus slowly downward. The first thing to come into view is a minute spot of light which, as the microscope is lowered, moves along the trace of the optic axial plane. This point of light is clearly



a cross-section of the focal line A now running at an acute angle to the axis of the microscope. Continuing to focus downward, two small brushes appear about the point (Fig. 1) and thereafter the successive appearances are as shown in the accompanying figures. The brushes develop into a cusp, after which we pass through an ill-defined region out of which the second focal line B emerges. This line is no longer straight but crescent-shaped and does not lie wholly in one plane, for the horns of the crescent come into focus a little before the centre.

From serial drawings of this kind it is possible to construct a thread model showing the course of the rays from one focal line to the other. A small perspective representation of it would serve no useful purpose, but the model can easily be made by anyone interested, as follows. On a base-board draw the curved focal line B; drill seventeen holes in it, $a, b, c \dots i \dots o, p, q$, at equal intervals apart, the hole i being at the vertex of the curve. Next, on a narrow strip of wood draw a straight line parallel to its length and drill nine holes 1, 2, 3 . . . 7, 8, 9, at equal intervals along the line. Fix this rod at a convenient height above the baseboard so that it lies over the axis of the curve, the end 1 being inclined downward over the concave side. The holes are now to be joined by threads according to the following scheme :

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	8	7	6	5	4	3	2	1

in which the holes in the same column are to be joined. (If the joins to the points in the latter half of the last line are omitted, a better view can be had of the threads in the interior of the model.) Cross-sections of this model by imaginary horizontal planes will be found to reproduce the appearances seen under the microscope.

But to return to the observations themselves. On rotating the crystal into positions such that the refracted rays approach nearer and nearer to the optic axis, and making observations in depth at each position, it is seen that the focal line A (represented by successive positions of the faint spot of light) continues to turn over, until, when the optic axis is reached, it is parallel to the axis of the microscope. We then see that the light giving rise to the Hamiltonian conical refraction does not proceed from a point (as most descriptions of the phenomenon lead one to suppose) but emanates from a focal line : the bright central spot is this focal line seen end on.

Sir George Stokes supplied the mathematical theory underlying the effects observed by Sorby, and after considering the case of rays in the xz-plane he concludes : "The extravagant changes of apparent index in the immediate neighbourhood of the wave- and ray-axes could probably not well be followed by the microscope, on account of the necessity of working with pencils of finite angular aperture, which would make the phenomena of focusing blend themselves with those of conical refraction"[2]. Observation shows that this is true ; and that it is also true far away from the neighbourhood of the optic axes ; so that it is impossible to draw any but an arbitrary distinction between the Hamiltonian conical refraction in the neighbourhood of the optic axes and that taking place elsewhere in the optic axial plane.

After determining refractive indexes of aragonite to five places of decimals by the prism method, Glazebrook formed the opinion that it is "most probable that Fresnel's theory is only true as a first approximation", and "we may assert that in a central section of the wave-surface inclined at a small angle to the plane of the optic axes, there is a considerable difference between Fresnel's theory and experiment : that the differences between the two are most marked in the neighbourhood of the optic axes, and amount there to 0·0005 about"[3].

It is in this region near the optic axial plane that Sorby's method also indicates departures from Fresnel's wave-surface, for as Stokes noted : "Mr. Sorby's method is remarkable for this, that it brings out into prominence variations of refraction with change of direction, though the absolute refractions which are involved may be nearly the same"[2]. Unfortunately, these differences cannot be determined quantitatively beyond three places of decimals by this method, even when the focal line lies wholly in one plane.

Rays travelling in the yz-plane also form curved focal lines.

The problem of deducing the form of the wave-surface from the shape of the focal lines is evidently a formidable one, for even Stokes, owing to the mathematical difficulties involved, did not deal with such a line throughout its whole length, but only with one point in it, namely its point of intersection with a principal section of the wave-surface.

[1] Melmore, S., Nature, **150**, 382 (1942).
[2] Stokes, G. G., *Proc. Roy. Soc.*, **26**, 386 (1878).
[3] Glazebrook, R. T., *Phil. Trans. Roy. Soc.*, **170**, 287 (1879).

A NEW ELECTRICAL FREQUENCY DIVIDER

ONE of the common characteristics of all non-linear electrical devices, such as vacuum tub s, is the generation of harmonic frequencies in which, with a pure sine wave input, the output contains a series of multiples of the input frequency. For more than a decade, piezo-electric oscillators have been used as sources of reference frequencies because of their high stability. Since it is desirable to operate these oscillators at a frequency higher than those of the standards—usually at 100 kc.—a sub-multiple generator, or frequency divider, is required to secure the desired lower frequencies.

The most successful frequency dividing circuit is the regenerative frequency divider, the basic form of which is described in an article by F. R. Stan el (*Bell Lab. Rec.*, 21, No. 4 ; Dec. 1942). It consists of a modulator, an output circuit tuned to the sub-multiple frequency to be produced, and a harmonic generator. The action of the circuit is easy to understand. Assume, for example, that the input frequency is 100 kc., and that the output is 20 kc. Part of the output is fed back to the harmonic generator, where its fourth harmonic, 80 kc., will be selected by a tuned circuit. This 80 kc. current and the 100 kc. input will result in a difference frequency of 20 kc. in the output of the modulator, and in a number of other frequencies as well. The 20 kc. output frequency is selected by the tuned circuit. To start the oscillators, a 20 kc. component must be present in the circuit. In some regenerative frequency dividers this is supplied by a pulse applied from a starting circuit, but in more recent circuits the starting circuit has been omitted and dependence is placed upon the transient voltages normally present in the circuit for this starting pulse.

In general, when the nth sub-multiple frequency is desired, the harmonic generator is tuned to the $(n-1)$th harmonic. When the output frequency is to be half the input frequency, $(n-1)$ is equal to 1, and no harmonic generator is required. Part of the output is fed back directly to the modulator.

The regenerative frequency generator cannot operate without an input frequency. Should the input frequency fail, the output drops to zero, and thus off-frequency operation does not occur. In addition, the output current of the generator is a relatively pure sine wave, and additional 'clean-up' filters are not required as they are with the multivibrator when a sine wave is desired. A pentagrid-mixer tube is used for the modulator and a pentode for the harmonic generator. With a modulator tube having two shielded input grids, it is possible to eliminate the balanced modulators and transformers required for earlier regenerative frequency dividers. With the increased modulator gain obtained, not only is it possible to eliminate the starting circuit, but also frequency division as great as 10 to 1 is obtainable in one stage.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, May 29

FREE GERMAN INSTITUTE OF SCIENCE AND LEARNING (at 16 Buckland Crescent, London, N.W.3), at 5 p.m.—Capt. Helmer Dahl: "Norwegian Universities and Schools—Past, Present and Future".

Monday, May 31

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. F. A. Secrett: "Horticulture in Peace and War".

Friday, June 4

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. F. C. Bartlett, F.R.S.: "Some Current Problems in Visual Functions and Visual Perception" (13th Thomas Young Oration).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Arthur Bryant: "Our Sea Tradition".

Saturday, June 5

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4 p.m.—Prof. J. Yule Bogue: "Applied Photography"; Miss K. C. Clark: "Indirect Radiography as applied to Medical Work"; Dr. L. Mullins: "Miscellaneous Applications of Industrial Radiography"; Mr. C. D. Reyersbach: "Sub-Standard Kine-Photomicrography"; Mr. H. M. Ross: "The Photography of Photo-Elastic Stress Patterns".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ENGINEERING SUBJECTS in the Durham Road Senior Technical and Commercial Institute—The Director of Education, Education Office, Prince Consort Road South, Gateshead (June 3)

RESIDENT LECTURER IN SCIENCE, able to take Gardening—The Principal, Diocesan Training College, Fishponds, Bristol (June 5).

LECTURER TO TEACH ELECTRICAL ENGINEERING SUBJECTS in the Municipal Technical College—The Director of Education, Education Offices, Nelson Square, Bolton (June 5).

PHARMACIST at the County Hospital, Pembury, Tunbridge Wells—The County Medical Officer, County Hall, Maidstone (June 7).

PRINCIPAL of the South-East Essex Technical College, Dagenham—The Chief Education Officer, County Offices, Chelmsford (June 12).

PSYCHIATRIC SOCIAL WORKER to work with the Psychiatrist and Educational Psychologist in the Child Guidance Clinic—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (June 21).

CITY BACTERIOLOGIST—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (June 30).

CHIEF TECHNICAL ASSISTANT, SENIOR TECHNICAL ASSISTANT, and TECHNICAL ASSISTANT I, FOR ENGINEERS experienced in the use of Woodworking Machine Tools or Production Managers experienced in Planning the Production of Machined Woodwork—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Ref. C.1068), Alexandra House, Kingsway, London, W.C.2.

BIOLOGY TEACHER (part-time) to assist in Botany and Zoology—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 9: Salmon and Sea Trout of the Waterville (Currane) River. By Arthur E. J. Went and T. Sankey Barker. Pp. 83–102. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. 6*d*. [124

Report of the Rugby School Natural History Society for the Year 1942. (Seventy-sixth Issue.) Pp. 22. (Rugby: George Over, Ltd.) [124

University of London: University College. Annual Report, February 1942—February 1943. Pp. 64. (London: Taylor and Francis, Ltd.) [124

British Records Association. Memorandum No. 7: Modern Records, What may we Destroy? Pp. 6. (London: British Records Association, c/o Public Record Office.) [134

Report of the Committee on Post-War Agricultural Education in England and Wales. (Cmd. 6433.) Pp. 92. (London: H.M. Stationery Office.) 1*s*. 6*d*. net. [134

The Pre-Nursing Course: Synopsis of Regulations, Suggestions for Syllabuses, Equipment and Books: together with further Recommendations of the Association of Women Science Teachers. Pp. 20. (London: John Murray.) 9*d*. [154

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Other Countries

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