NATURE

No. 3951 SATURDAY, JULY 21, 1945 Vol. 156

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
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Telephone : Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

SCIENCE AND NATIONAL DEFENCE*

IMPORTANT as it is that there should be worked out as speedily as possible an adequate national defence policy embodying all the lessons and experience of the last five years, no such policy can be formulated in isolation. It should be ensured of the support of all political parties in Britain, and it must also be related to the policies of other members of the British Commonwealth and of the United Nations. That much was clearly recognized in the debates in the House of Lords, in Lord Vansittart's plea for a permanent Inter-Allied Committee of Scientists to examine and control the use of any scientific discovery or invention considered dangerous to the safety of mankind, in Lord Strabolgi's proposal for pooling knowledge of scientific discoveries and inventions, in Lord Cherwell's reply, and in Lord Brabazon's plea for an international committee with full powers of investigation anywhere in the world. What is encouraging, however, is the evidence of the extent to which these problems are already occupying the minds of others of the United Nations, and notably in the United States.

The parallel in thought between the report of the Select Committee on National Expenditure and the address of the Hon. Robert P. Patterson, U.S. Under-Secretary for War, on "Science and Industry in National Security" (see *Nature*, **154**, 785 ; 1944) is unmistakable. A recommendation for the establishment within the National Academy of Sciences of a Research Board for National Security has already come from the Committee on Post-War Research, as was stated by the U.S. Secretaries of War and the Navy on February 12, 1945, in which these facts are recognized. Further, Dr. J. B. Conant has lent the weight of his authority to a proposal for the establishment of an international civilian technical inspectorate in which a tradition might be built up anchoring professional loyalties to an association of nations. Dr. Vannebar Bush in his recent report as president of the Carnegie Institution of Washington touches briefly on this same question of defence and its relation to scientific research, and the imperative necessity of continuing attention to the possible military applications of expanding science. Different aspects of the problem are also discussed in an able article, "Science and Foreign Policy", by the American expert, Mr. G. Fielding Elliot, in *Foreign Affairs* of April last, from which Lord Vansittart quoted, and in the study, "The Control of Germany and Japan", by H. G. Moulton and L. Marlio, which the Brookings Institution of Washington published last year.

Mr. Elliot raises the fundamental question whether the discoveries of science must not now become the common property of all for the use of all, and whether we can afford any longer to tolerate private research for military purposes, or commercial processes serving those purposes. The robot-bomb, the rocket and the jet-propelled plane demonstrated the dangers which must be guarded against, and no international organization for world security will be adequate

* *Continued from* p. 31.

which does not possess the ability to deal with such dangers at the source.

Mr. Elliot urges that the foundation of successful partnership in international affairs, as elsewhere, is good faith and mutual confidence; and he suggests therefore that the first step to security is the exchange of full information regarding the armed forces. Already we have seen that modern warfare involves the mobilization of all national resources, and that science has introduced into warfare a succession of new weapons of steadily increasing range, speed and destructiveness. Nevertheless, Mr. Elliot believes—and the trend of Lord Cherwell's speech would seem to indicate his concurrence—that if the results of the labours of all scientific men in the peace-loving States were pooled, the chance of sudden surprise would be greatly reduced, since science in different countries generally advances on parallel lines.

Mr. Elliot does not ignore the difficulties that may have to be overcome in securing the complete and continuous interchange of information on the progress of scientific research among the United Nations. He puts a question mark against the attitude of the U.S.S.R., though here the appointment of Prof. Eric Ashby as scientific attaché at the Australian Legation in Moscow may mark the beginning of some closer contact between that country and the Western nations. The matter is so important that it is all the more unfortunate that the Government should have considered it necessary on any ground to refuse exit permits to British men of science who had accepted invitations to attend the two hundred and twentieth anniversary celebrations of the Soviet Academy of Sciences.

Mr. Elliot points out clearly all that is involved in such interchange—freedom of communication, travel, the Press, radio, and academic and scientific interchange—and if such a policy is the soundest from the point of view of national defence, it is the policy also which is most stimulating to creative thought and fundamental research. Such objectives are widely recognized as claiming the steady support of all scientific workers, but to attain them much more will be required than the maintenance of the machinery for Anglo-American collaboration and exchange of scientific and technical information set up during the War, or even the relaxation of the censorship. Much will depend on the readiness with which the U.S.S.R. abandons her 'Chinese wall', and clear thinking will be required to deal with the problems which arise out of the relation between scientific research prompted by commercial competition and military affairs, patent law and the like. Mr. Elliot notes that we must be prepared to find that the solution may involve much loss of individual freedom and some curtailment of the search for commercial or military advantage.

Only some of the problems that arise in the technical control of Germany and Japan are indicated very briefly by Mr. Elliot. Those problems are closely analysed in a recent book* by Dr. H. G. Moulton and Dr. L. Marlio, who, considering first the lessons of the Treaty of Versailles, suggest that measures for economic control must be based on two guiding principles: first, the economic devices must not be permitted to throttle the economic life of the country on which they are imposed; and secondly, the measures selected must be administratively feasible and relatively easy to enforce. On these grounds they regard, for example, the complete destruction of the chemical industry of Germany as impracticable; the only strategically key industry which holds sufficient possibilities of effective control to merit favourable consideration is the electric-power industry.

Drs. Moulton and Marlio reject the idea of permanent military occupation as well as of economic controls, and propose that reliance should be placed upon a system of detection and coercion by punitive measures if infringements are discovered. For this purpose they propose the creation of a Rearmament Detection and Prevention Board comprised chiefly of military officials, and in the nature of an extension of the war-time Combined Staff Organization. The Board would be the executive agency for the general policies and procedures regarding military controls determined by the governments at its establishment, but it should possess the power of independent action within the field so defined. It should be empowered to maintain within key industrial areas sufficient supervisors to detect evasions of the disarmament provisions, to direct the attention of the German or Japanese Government to any evasions discovered and to apply the necessary coercive measures if such warning is not promptly heeded.

There may be some grounds for doubt as to whether we can wisely rely on a system of detection and coercion alone; Drs. Moulton and Marlio are not altogether convincing in their demonstration of the impracticability of economic control, and their two principles can be stretched too far; but that some measure of inspection must be worked out and systematically applied is scarcely open to challenge. Any such system will almost certainly function more effectively when the free interchange of scientific and technical information and exchange of personnel is carefully fostered; and for this reason the development of the British Central Scientific Office in Washington, the American Scientific Office in London, the Anglo-Soviet Science Collaboration Committee and the Scientific Co-operation Office of the British Council in China into something of an international science co-operation service, as suggested by Dr. J. Needham (*Nature*, **154**, 657; 1944), may be a measure of the first importance from the point of view of defence.

It is for men of science to stress the importance of this aspect of the matter at the present time. Mr. Lyttleton, in the House of Commons on June 13, admitted that the free flow of scientific information in an industry is absolutely necessary. The free flow of scientific and technical data in a nation and between nations is equally essential to world security, and to encourage, as Sir Arrol Moir suggested in the *Engineer* of June 2, the fullest possible inventiveness in time of peace.

Rapid progress in this matter, as Mr. Elliot observes, can scarcely be expected, but scientific

* The Control of Germany and Japan. By Harold G. Moulton and Louis Marlio. Pp. xi+116. (Washington, D.C.: Brookings Institution; London: Faber and Faber, Ltd., 1944.) 10*s*. net.

workers should miss no opportunity of educating both public opinion and Government as to its importance. A system of scientific attachés could do much to stimulate the free flow and interchange of information and of men and women, and to avoid incidents like that in connexion with the Soviet Academy of Sciences, which tend to jeopardize good relations. But while endeavouring to secure a wider understanding of the contribution of science to national defence and the conditions in which that contribution can be made most effectively, they should lend the full weight of their influence as citizens to secure urgent attention to the formulation of defence policy on lines above the turmoil of party politics, and to stimulate the clear thinking required. They could help in emphasizing certain principles which an adequate defence policy must embody : the retention of an adequate Combined Staffs Organization, not only of the different armed services but at least between Britain, the United States and the U.S.S.R. ; the determination of the peace strength of the armed forces in accordance with the possible rate of development of full war potential, the strength of the other principal Powers and our geographical strength, and in appropriate relation with our foreign policy, so that strength which can only be changed very slowly is in accord with policy, so far as that can be set by looking well ahead.

These are some of the principles emerging from the experience of the last twenty-five years ; and the Select Committee's recent report provides scientific workers with admirable material for their task of education. That there should be so much evidence on both sides of the Atlantic that the same conclusions are being reached provides ground for the hope that there will this time be thrashed out a national policy for defence which is in harmony with our commitments and our foreign policy, in which the various elements are in balance one with another and appropriate use is made of all the nation's resources of materials, man-power and intellect. No defence policy, no system for the control of Germany or Japan, will be effective which does not provide for attracting men of the highest ability into the armed services and the scientific and technical services of the United Nations, for the adequate prosecution of research and encouragement of inventive ability, and for the fullest and widest possible dissemination of scientific and technical information. Closer co-ordination is essential between the departments and other agencies or institutions within Great Britain and with such organizations as the National Academy of Sciences, the National Research Council, and the Office of Scientific Research and Development in the United States, possibly through a Central Scientific and Technical Board as suggested at the recent Conference of the Association of Scientific Workers. The free exchange of knowledge across national boundaries, upon which creative thought has always largely depended, and which now may well provide one of the strongest safeguards against those dangers of which the robot-plane and the long-range rocket have given so dire a warning, is still one of the fundamentals of a free society.

CHEMICAL ANALYSIS AND STRUCTURAL DIAGNOSIS BY INFRA-RED ABSORPTION

Infrared Spectroscopy

Industrial Applications and Bibliography. By R. Bowling Barnes, Robert C. Gore, Urner Liddel and Van Zandt Williams. Pp. vi+236. (New York : Reinhold Publishing Corporation, 1944.) 2.25 dollars.

THAT modern wars lead to scientific development is a commonplace more vividly borne out in the present War than in any other. Now that the silences may be broken, applications of physical techniques become evident which may be equally important in times of peace. Infra-red spectroscopy has been transformed during recent years from a delicate and exacting technique into a more easily controllable robust tool, which will be of great value in the future for both pure and applied science. Some indications of this have been shown by discussions such as that recently organized by the Faraday Society.

The limitations of secrecy imposed in different lands have varied, and still delay publication of many developments. Dr. Barnes and his colleagues, well known for their past work in the infra-red, and now members of the research laboratory of a leading industrial firm in America, have given us one of the first manuals for workers in this field, and particularly for those who will use infra-red absorption as an analytical technique. The first part of their book is a reprint of a lengthy paper published recently in *Industrial and Engineering Chemistry*, in which the theoretical and experimental principles of infra-red measurements were described, and a range of the spectrum of each of a very large number of molecules was shown graphically for purposes of reference. To this the authors have now added a detailed and excellent bibliography of the subject, which should be valuable to specialists and non-specialists alike.

Infra-red absorption can be applied to the qualitative and quantitative analysis of mixtures of substances, but it can also be used for diagnostic purposes as well. The vibration frequencies of a molecule, which correspond with absorption bands in the near infra-red, are determined in magnitude by the masses of the atomic nuclei and the forces between them, that is, the strengths of the bonds. It follows that molecules with different nuclear configurations will have a different set of vibrational modes, and since all molecules other than a pair of optical enantiomorphs differ in nuclear configuration, the infra-red spectrum can be regarded as a fingerprint of the molecule. Indeed, it is probable that this vibrational spectrum is the most characteristic physical property of a molecule yet measured. In order to analyse a mixture of substances it will simply be necessary to know the spectra of the pure components present. Unless special interactions occur, the spectrum of the mixture is got by simply superposing those of the individual components with the appropriate intensities, and the key bands can therefore be used for either qualitative or quantitative estimation of the individual components.

In spite of this individualistic character of the infra-red spectrum, some linkages or small nuclear skeletons give rise to vibrational frequencies which are not much affected by the remainder of the molecule. In some cases the reason for this is obvious.