NON-DESTRUCTIVE TESTING OF MATERIALS

THE summer meeting of the Non-Destructive Testing Group of the Institute of Physics was held this year in the University of Bristol during July 11–14, and the programme of the meeting was presented under the title of "Some New Aspects of Non-Destructive Testing". Dr. S. G. Hooker, director and chief engineer of Bristol Aero-Engines, Ltd., was the guest speaker at the introductory session, which was held during the evening of July 11. Dr. Hooker reviewed the many important problems of inspection which confront the aircraft manufacturer, and he showed that, in fulfilling the requirements of modern engineering development, existing inspection techniques are far from adequate. He made a plea for physicists to put every effort into the task of providing scientific information of a kind which will not only enable better use to be made of existing techniques but which will also make possible the development of new, and more suitable, inspection methods. By invitation of the Bristol Aeroplane Co., Ltd., a visit to the production plants of the Company, during the afternoon of July 13, formed a part of the programme of the meeting. Dr. Hooker said that the tour of his Company's works had been so arranged as to give emphasis to inspection procedure, and he hoped that the visit would add stimulus to the work with which the Non-Destructive Testing Group is concerned.

This was the first summer meeting of the Institute of Physics which has been devoted to what the Non-Destructive Testing Group decided to call "new aspects of non-destructive testing". The words "new aspects" were included in the title because, until now, it seems to have been the custom to regard non-destructive testing as concerned only with the detection of defects in engineering materials and components. This, of course, is not the case. The detection of defects forms but a part, albeit an important part, of the field covered by non-destructive testing, and a major aim of the meeting was that of directing the attention of physicists to the fact that the whole of physics is involved, in one way or another, in the scientific background of industrial inspection. If progress in the technology of inspection is to be maintained, considerable attention must be devoted to this background, and the right kind of scientific information must be made available to the technologists who fulfil the very important functions of developing inspection techniques and of putting these techniques into practice.

The interests of the Group are not confined to the application of physics in industry. During the past two years the application of physics in medical diagnosis has formed part of the Group's activities, and an evening discourse on "Physical Problems in Medical Diagnosis" was given, on July 12, by Prof. C. B. Allsopp (Department of Physics, Guy's Hospital Medical School, London). Prof. Allsopp showed, by referring to the work of his own Department, how this important application of the physics of non-destructive testing is put to good use by research workers in medical schools, and he aroused the interest of his audience by demonstrating the fact that an exchange of information between physicists engaged on industrial problems and physicists engaged on medical problems can be of mutual value. This was the first time an evening discourse had been included in the programme of a summer meeting of the Non-Destructive Testing Group, and Prof. Allsopp's lecture made it an outstanding event of the meeting.

In almost all the uses to which materials are put, their mechanical strength and mechanical behaviour are important factors—usually the most important factors—to be considered. Nearly all mechanical tests involve the destruction of the material under examination, so that if the mechanical behaviour of the actual material which goes into service is to be determined with the certainty required nowadays, then, in addition to the mechanical tests which are at present used, there is a need for a system of non-destructive testing which will provide an assessment of mechanical behaviour. The establishment of such a system presents a formidable problem; but present beliefs are that much success can be achieved by studying the influence of variations in the constitution and structure of materials on their mechanical and physical properties. If the changes brought about in these two types of property can be related empirically, then it will be possible to use those physical properties, which can be measured non-destructively, as a basis for the development of tests which will detect non-uniformity in the quality of complete batches of materials and will assess the significance of non-uniformity in terms of mechanical strength and mechanical behaviour.

Both Prof. W. Sucksmith (University of Sheffield) in his paper on magnetic properties and the structure of metals, and Dr. D. E. Thomas (Aluminium Laboratories, Ltd.) in his paper on the relationship between electrical resistivity and the mechanical properties of aluminium alloys, sounded a severe note of caution in this respect. Although magnetic and electromagnetic non-destructive testing instruments are already in use in industry for detecting non-uniformity in the quality of materials and components, Prof. Sucksmith and Dr. Thomas showed that indiscriminate use of any method of testing based on the detection of variations in either magnetic or electrical properties cannot, at this stage in our knowledge, be regarded as constituting a reliable inspection technique.

On the question of the assessment of the mechanical behaviour of materials the detection of fatigue in metals was chosen for discussion, and a complete session of the programme was devoted to it.

Dr. R. H. Hanstock (High Duty Alloys, Ltd.) described the fatigue process in metals and showed that the structural changes responsible for the formation of a fissure are highly localized. Physical properties, such as damping capacity, which provide a measure of the energy dissipated during a stress cycle, are an obvious choice for the detection of the onset of fatigue failure; but Dr. Hanstock produced evidence from his own work which showed that, whereas it is sometimes possible to obtain a rough estimate of the fatigue life of a material from initial values of hysteresis loss, in general, because of the localized nature of fatigue failure, insufficient change occurs in the overall energy dissipated per stress cycle for detection to be possible by existing methods of measurement.

Dr. N. Thompson (University of Bristol), reading a paper on structural changes and energy dissipation

during fatigue, prepared by him and Dr. N. J. Wadsworth, described the work carried out at the H. H. Wills Physical Laboratory in which simultaneous observations were made of the metallographic changes visible on the surface, and of the changes in energy dissipation which take place during the fatiguing of copper, nickel and cadmium. From the results of this work Dr. Thompson showed that there is no direct connexion between the changes in energy dissipation and the progress towards fatigue failure.

The development of non-destructive inspection methods for non-metallic materials presents a difficult but, nevertheless, intensely interesting field of investigation for physicists. As in the case of metals, the promise of improved techniques is most likely to be found from studies made of the effects of structure on physical properties. Dr. P. T. Barrett (Terylene Council, Imperial Chemical Industries, Ltd.) reviewed the work which has been carried out on the development of tests for plastic fibres. In his paper on the testing of fibres and their molecular structure, he described the methods of physical measurement which provide information about the structure of fibres, and he discussed the mechanical properties of fibres in terms of their molecular structure.

It is one of the aims of the Non-Destructive Testing Group to encourage discussion on research investigations which have not necessarily been embarked upon for the purposes of non-destructive testing, but which are likely to produce results of use in the development of new non-destructive testing methods. In this connexion, four papers were presented at the meeting. Three of these described work in progress at the Atomic Energy Research Establishment, Harwell, and the fourth work which has been carried out at the National Physical Laboratory, Teddington.

Dr. L. E. Drain's paper on the principles and applications of nuclear magnetic resonance made an impressive contribution to the aims of the meeting. He enumerated twelve applications to which the measurements involved in his work could be put, and six of these applications were of direct use for the purposes of non-destructive testing. Mr. W. A. Runciman read a paper on optical fluorescence in non-destructive testing, in which he described the phenomenon of optical fluorescence and showed that, in addition to its use for detecting surface defects, it can be applied to problems of chemical and microscopic examination of materials. Mr. S. F. Pugh, in his paper on the effects of penetrating radiations on materials, reviewed present knowledge on radiation damage and indicated how the results of work in progress on this subject are likely to provide information on the structure of materials. Finally, Mr. M. F. Markham (National Physical Laboratory) gave a paper on the measurement of elastic constants by the ultrasonic pulse method. In this Mr. Markham described the propagation of stress pulses in æolotropic media, and the information he provided is not only of value from the point of view of establishing new techniques for the measurement of elastic constants, but also its application to the technology of ultrasonic inspection is of considerable importance.

The attendance at this meeting was one of the largest which the Non-Destructive Testing Group has had at its summer meetings, and it is the hope of the Group that the enthusiasm shown throughout the whole programme by those present is indicative of the fact that in the future there will be ample support given to the Group in its task of disseminating information on the physics of non-destructive testing.

E. G. STANFORD

PLANT BREEDERS' CONFERENCE AT CAMBRIDGE

WHEN the first conference of plant breeders was called by the Agricultural Research Council in 1947, forty workers met at the Plant Breeding Institute, Cambridge, then a research institute of the School of Agriculture, to discuss their common problems and to learn something of the work in progress there. In the intervening years the conference met annually until 1950 and biennially since then, inspecting work and discussing mutual problems; the meetings have been held at the John Innes Horticultural Institution, first at Merton and later at Bayfordbury, at the Welsh and Scottish Plant Breeding Stations, and at the station at Loughgall of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland. With the seventh meeting held on July 4 and 5 at the Plant Breeding Institute, Cambridge, the initial cycle has been completed. The expansion of effort in plant breeding is indicated by the increase in the number of participants to 105 at this meeting, and by the fact that since the first meeting the four main plant breeding centres in Great Britain have been transferred to new stations to provide facilities adequate for the expansion that has occurred.

During the morning sessions, members of the staff of the Plant Breeding Institute gave short talks, which were followed by informal discussions. The afternoons were divided between tours of the field-plots and glasshouses, designed mainly to provide an indication of the scope of the work, and laboratory demonstrations and informal discussions between specialists to allow them to fill in the details of particular interest.

R. Riley gave an outline of the work on alien chromosome addition with reference to wheat breeding. Here the object has been to introduce new genes for particular desirable characters from primitive related species into wheat. From the results so far obtained in the production of new synthetic amphidiploids, the introduction of complete genotypes appears to bring in too many undesirable characters with the good. The work discussed concerns the addition to hexaploid wheat of single pairs of chromosomes from rye; new plants with the addition to wheat of six of the seven rye chromosomes, both as disomics and as monosomics, were shown, as well as some in which only a part of a rye chromosome had been added. Initially the new forms tend to revert to the euploid condition, but it seems likely that balance may eventually be achieved.

K. F. Thompson discussed sporophytic incompatibility with special reference to the possibility of using a set of clones to produce commercial quantities of double-cross seed of uniform types of marrow stem kale. The interpretation of the data so far accumulated is complicated by the range of partial compatibility shown in some crosses, and by the finding that in other members of the family the degree of compatibility varies, probably with environmental differences.