AERONAUTICS AT THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

By G. JACKSON

THE Committee on Education and Research in Aeronautics, appointed by Lord Weir of Eastwood in October 1918 to consider what steps should be taken to organize education and research in aeronautics after the First World War, reported in March 1919 to the Secretary of State for Air, the Right Hon. Winston S. Churchill: "Education and research are clearly very closely interrelated. The education with which we have chiefly concerned ourselves is that suitable for Aeronautical Engineers and Constructors, that is to say, post-graduate work for which the students will be fitted by a previous undergraduate course of either mechanical or general engineering training at one of the Universities or Technical Colleges. We have not dealt with the training of pilots or of mechanics. The course we contemplate will comprise a special study of the following matters: Aerodynamics—the laws of motion of bodies moving in the air, illustrated by experiments and researches in wind channels; the principles of design and construction; engines and the methods of propulsion of aircraft; the investigation of instruments used in flight, with problems in Meteorology and Navigation. The engineer must also gain the practical knowledge acquired only in the workshop and must have experience of the full scale researches necessary to test and verify his theoretical conclusions. Such a course might eventually involve one or more centres of theoretical instruction with experimental aerodromes and laboratories where the full scale problems may be worked out, but as the number of persons likely to require this higher post-graduate education will not be great, we consider that it will be wise for the present to concentrate the work in one central institution with which the experimental aerodromes should be closely connected. Such a central institution we find in the Imperial College of Science and Technology at which the Professorship lately founded by Sir Basil Zaharoff, G.B.E., is to be held. Turning now to Research: this is the means by which advance in Aeronautics is possible and it is required by all interested in the progress of the subject; by the State whether for the purpose of defence or to enable it to lay down the rules necessary for the safety of aircraft when used for civil purposes; by the Professor whose aim is to increase knowledge, and by the Industry in order that they may maintain the superiority which British aircraft has already achieved. Research is difficult, its requirements are costly, and the men who can undertake it are few. To establish separate research laboratories and aerodromes for each of these special interests is for the moment out of the question; here again combination is called for; combination too with the agencies concerned in education".

By the end of 1919 the chairman of the Committee, Sir Richard Glazebrook, had been appointed Zaharoff professor of aviation. The new Department of Aeronautics received its first students in 1920, five students attending regularly courses in engineering and aerodynamics given at 1 Lowther Gardens, and in meteorology and navigation at the rooms of the Meteorological Office and in the Air Ministry Laboratory of the Physics Department of the College. The following year there were ten full-time students, four of whom were research students, and a full-time teaching staff of four, namely, the director of the Department, the professor of aerodynamics (Prof. L. Bairstow), the professor of meteorology (Sir Napier Shaw) and the lecturer in design (Mr. F. T. Hill). Now, in 1957, the Department is just completing its thirty-seventh year with thirty-nine final-year undergraduates, twenty postgraduate and research students, a teaching staff of ten, and for the first time with premises of its own. After moving first to the buildings of the Royal College of Science and then to the City and Guilds College, the Department now occupies the western half of the new Roderic Hill building, opened by the Chancellor of the University of London, H.M. Queen Elizabeth the Queen Mother, on May 28.

The major increase in the number of students passing through the Department has taken place since the end of the Second World War. Prof. (now Sir Leonard) Bairstow, who succeeded Sir Richard Glazebrook as Zaharoff professor in 1923, had retired in 1945, and the present Department represents the fulfilment of plans launched by Prof. (now Sir Arnold) Hall and continued since 1952 by the present head of the Department, Prof. H. B. Squire, for the expansion, re-equipment and rehousing of the Department to meet the new requirements of the second generation of aeronautical engineers. As foreseen in 1918, the

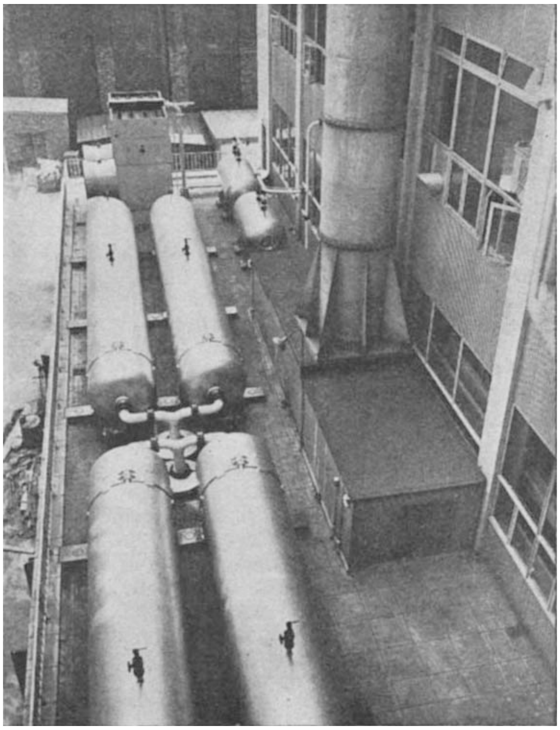

Fig. 1. Air storage vessels for supersonic tunnels

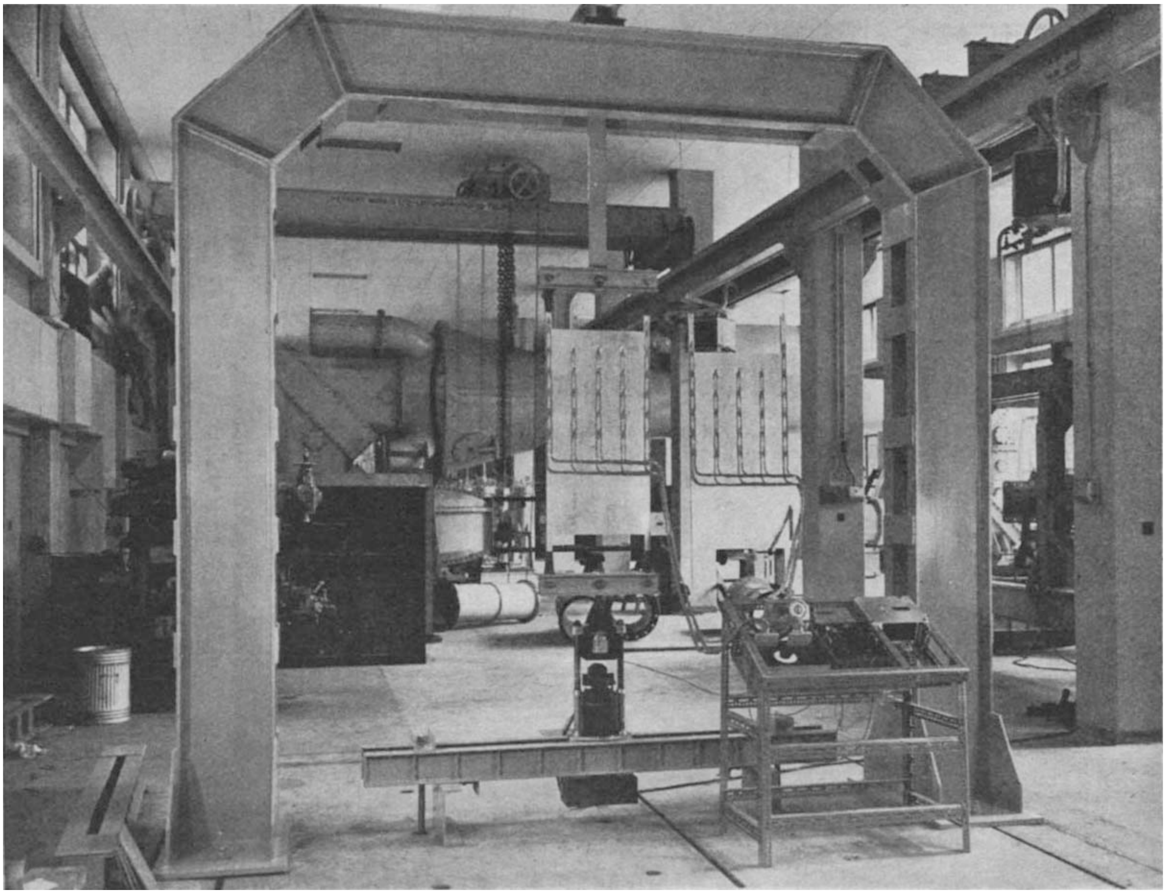

Fig. 2. Experiment on the diffusion of load into a stressed skin panel. In background, 1 ft. × 1 ft. supersonic tunnel

number of students of aeronautical engineering is now sufficient to support departments of aeronautics in many colleges and universities. The organization and aims of the Aeronautics Department at the Imperial College are still accurately described by the intentions of the 1918 Committee, except in so far as meteorology has been separated from aeronautics, the responsibility for aircraft navigation has largely been transferred to electrical engineers, and the teaching of aeronautical subjects has been extended into the undergraduate syllabus.

Aeronautics now has three main subdivisions—aerodynamics, aeronautical structures and propulsion. The first two are dealt with by the staff of the Department and propulsion is taught by the Mechanical Engineering Department. Aerodynamics and aeronautical structures are the main activities of the Department, the importance of the latter having been recognized by the creation in 1955 of a chair in aeronautical structures, held since its inception by Prof. J. H. Argyris. Since 1945 the principal tasks in these two fields of activity have been to design and install experimental apparatus for study and research and to establish up-to-date courses for both undergraduates and postgraduates.

Forty-five undergraduates enter the Imperial College each year for a three-year course of study in aeronautical engineering, leading to the B.Sc.(Eng.) degree. In their first year these students take a common course with other students of engineering in the City and Guilds College. In the second year about one-third of their time, and in the third year all their time, is spent in the Aeronautics Department, studying specifically aeronautical engineering subjects. Postgraduate students may spend one year in studying in the Department for the diploma of the Imperial College (D.I.C.) or may work for the M.Sc. or Ph.D. degrees of the University of London. The current expansion of the Imperial College is unlikely to see any great increase in the number of undergraduates, but the number of postgraduate students may increase to forty in the next three years.

The Department is housed on four floors and has three lecture rooms, a library, a drawing office and a well-equipped workshop, where much of the equipment of the Department is made. The laboratories are on a scale which, although modest by the standards of contemporary aeronautical establishments, certainly justifies the observation of 1918 that the requirements of research are costly. The supersonic wind tunnel now nearing completion has a working section one foot square and will, with its associated equipment, have cost more than £50,000. There are five wind tunnels, all designed in the Department and all built since the War. The working section sizes of the three low-speed general-purpose tunnels are 5 ft. × 4 ft., 3 ft. × 2 ft. (both rectangular) and 20 in. × 20 in. (octagonal), the latter being intended mainly for elementary student experiments. All three are of the closed working section, closed-return type which is now standard. The top speed of all these tunnels is about 200 ft./sec. Several research and students' experiments in low-speed aerodynamics are made each with its own air supply from a blower taking from 1 to 5 h.p.—an arrangement much more economical and in many cases more convenient than using a wind tunnel.

The supersonic tunnels have working sections 1 ft. × 1 ft. and 8 in. × 2¾ in. Both have a maximum Mach number of two and both are of the induction type, supplied from a series of air vessels with a total capacity of 2,420 cubic feet. This source also supplies air to other small pieces of apparatus for experiments in high-speed flow. The storage pressure is up to 1,000 lb./in.^{2}, provided by compressors requiring altogether 517 h.p. The larger supersonic tunnel is designed to be run at stagnation pressures up to 3 atmospheres in order to extend the Reynolds number range. Higher Mach numbers will later be obtained by a relatively simple modification into a semi-blowdown tunnel. A small hypersonic tunnel is at present being designed.

The aeronautical structures laboratories contain a series of test frames based on two reinforced concrete slabs 3 ft. thick, built into the ground floor; a universal fatigue testing machine of 60 tons capacity taking specimens up to 6 ft. in length; a machine for compression tests on stiffened panels; a testing machine of 4 tons capacity for determining strength and stiffness properties of materials and small structural elements; apparatus for the determination of elastic moduli of sheet materials at high and low temperature and apparatus for the investigation of structural effects due to kinetic heating.

The Department has also a small hydrodynamics laboratory and an electronic analogue computer.

Current research work in the Department includes various studies of the effects of rotation in fluid motion, theoretical work on transonic and hypersonic flows, the flow in regions of recirculation (cavity flows), vortex flow near slender wings and bodies, the use of analogue computers in investigating aircraft stability problems, the theory and application of matrix methods in structural analysis in conjunction with electronic digital computers, the analysis of buckling modes of stiffened and sandwich panels, the calculation and measurement of vibration frequencies and modal shapes of thick plates and the investigation of thermal stresses and distortions in structures.

"The engineer must also gain the practical knowledge acquired only in the workshop and must have experience of the full scale researches necessary to test and verify his theoretical conclusions." All engineering undergraduates of the College receive instruction in manufacturing processes; aeronautics students also participate in a course in flight testing at the College of Aeronautics, Cranfield, and fly in gliders from the Lasham Gliding Centre, and some fly with the University Air Squadron. In large measure, however, the practical side of aeronautical education, equal in importance with academic training, is the province of the aircraft industry where nowadays undergraduate and postgraduate apprenticeships link up closely with university courses.

SOME BIOCHEMICAL PROBLEMS OF CANCER CHEMOTHERAPY

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THE conviction that cancer is fundamentally a group of closely related metabolic diseases has often been expressed. If this rather widely accepted concept be regarded as correct, it follows that there must be important biochemical differences between neoplastic cells and their normal counterparts. Accordingly, in suitable circumstances, these postulated differences might be exploited selectively to the disadvantage of malignant growth. That the fundamental biochemical lesion or lesions of neoplasia and of autonomous cancer cells have not been discovered, despite the efforts already made, reflects the inadequacy of our knowledge of the multitudinous inter-related chemical reactions concerned with the maintenance of life, with the reproduction and differentiation of cells, and with such special functions as invasiveness (or the absence of it). Nevertheless, metabolic knowledge has advanced so rapidly during the past decade or two that no justification can be found for the assumption by biochemical investigators of a defeatist attitude toward the cancer problem. On the contrary, the metabolic problems of normal and abnormal growth appear to deserve even more intensive study, not only for wholly adequate reasons of inherent scientific curiosity, but also because of the need for information that might help to combat the rapidly mounting death-rate from various forms of malignancy. In view of the concept that increased knowledge of the biochemical differences between normal cells, tumour cells, and highly malignant cells can be regarded as a possible key to cancer control, too few scientists appear willing to risk the possible frustrations attendant upon so formidable a problem.

Recognizing the need for fresh approaches to cancer chemotherapy and for improvement in and expansion of research in this area, various agencies have joined in the establishment of a new Cancer Chemotherapy National Service Center housed at the National Institutes of Health of the U.S. Public Health Service in Bethesda, Maryland. These agencies include the