

that is done the problem of reduced capacity due to extremes of environmental conditions, hot climates, or due to disabilities or age, is not quite so acute because the load on the individuals working under those conditions or on the aged or disabled worker is still below their level of output.

What is the maximum capacity of the body for exercise? One approach has attempted to work out an endurance or tolerance limit, usually about 50 per cent of maximum capacity. When a person starts to work, physiological changes occur in the body, and these changes increase until a balance is struck between the energy he is putting out and his external work. He will go on using the same amount of energy for the same amount of external work, although not many people work at a steady rate. The endurance limit can be increased by training the individual to become physically fitter by acclimatization. One way to push the endurance limit up is to bring the load down, thereby reducing the effort to gain a given output. This endurance-level will fall with age, with certain disabilities and under extremes of temperature, and the safety level will become less and less.

This endurance limit is the maximum level at which a man can be expected to work over a period of time. During a long period of work, the energy output remains constant initially; but as time passes it is necessary to put out more energy because the efficiency of the muscles doing the job is becoming less and more muscles have to be used to produce the same result; more muscles demand more energy and the safety margin of effort becomes reduced. Provided this safety margin is not exceeded, the operator is paying as he goes; that is, he is getting sufficient oxygen to allow the energy for the muscles he is using. If this level of effort is exceeded, he no longer gets enough oxygen for his energy requirements. This condition can be maintained for a time; but the longer it goes on the bigger becomes the physiological debt. Another aspect of this is the use of rest pauses. In Great Britain it is usual to have a break in which the operators probably sit down. In Sweden, if work of a very cramped nature, such as sewing, tabulating or assembly, is being undertaken, they sometimes have Swedish drill, which is rather like organized ballet.

There is no one physiological method which will give an overall picture of man at work in all circumstances. If it is desired to use physiological methods for different measurements, the methods to be used for particular situations must be very carefully chosen, the results carefully integrated and finally interpreted with the utmost caution. The main difficulty at the present time is that these methods are mainly designed to investigate man working under extreme conditions, and these situations are very rare in industry.

The experimental approach is the one which will produce the best results, involving as it does formal scientific methods under controlled conditions. The first thing to do is to find out exactly what the problem is and then determine the main factors within that problem. One way of dealing with it is for research people to go out into industry with the industrialist to examine the problem and see if it really warrants research or if it can be dealt with by some other means. What is necessary is encouragement from industry itself, not so much on *ad hoc* problems, but for establishment of a long-term policy.

PROBLEMS OF AIRCRAFT NOISE

IN reply to a question in the House of Commons on June 28, regarding progress in research by the Ministry of Supply into the silencing of aircraft engines, Mr. Duncan Sandys stated that work in this field is also being carried out by the Ministry of Transport and Civil Aviation and by universities and aircraft firms on their own initiative. In a detailed statement circulated in the Official Report, expenditure by the Ministry of Supply on this problem in the current year is given as £100,000 compared with £40,000 last year, and the Ministry of Transport and Civil Aviation is also expected to spend about £20,000.

The problem of reducing aircraft noise is being tackled from several angles. The main effort has been concentrated on jet engines. An extensive programme being carried out by a leading firm of engine makers, under contract by the Ministry of Supply, includes a detailed analysis of the noise of a jet engine operated with various alternative types of nozzle on an open-air test bed. The nozzles which are being tested include toothed, corrugated, convergent-divergent and fish-tail types. Promising results have been obtained from toothed and corrugated nozzles, and further studies are being made to decide the optimum shapes for these types. A special study of the by-pass engines in relation to the noise problem is being carried out, with the object of determining the relationship between noise, jet velocity and temperature. The effect on noise of injecting water into the jet stream is also being investigated.

Two other engine companies are working under Ministry of Supply contract on silencers for piston engines used in helicopters. The Ministry of Transport and Civil Aviation is experimenting with the construction of a brick baffle-wall at London Airport. This wall is shaped to accommodate the forward part of a large civil aircraft, with the object of reducing noise in certain directions when the engines are being run on the ground. Results are not yet entirely satisfactory, but the investigation is being continued. The Ministry of Supply has placed a contract for the design of two types of mobile ground mufflers, one suitable for single-engine aircraft and the other for multiple-engine aircraft. Experiments by a firm of aircraft manufacturers with portable screens, which are placed around the aircraft while the engine is being run up, showed some reduction of noise, and further screens are on order. A firm of consulting engineers is advising four other aircraft manufacturers on the use of specially designed pens for muffling the sound of aircraft the engines of which have to undergo running tests on the ground. Another firm, on its own initiative, is building a pair of mobile ground mufflers to its own design.

Tests being carried out by the College of Aeronautics, Cranfield, under Ministry of Supply contract, include the following: the measurement of thrust and noise-levels of engines with nozzles fitted with noise-reduction devices of various designs; the measurement of the sound field from small jets at supersonic speeds, combined with schlieren investigations; and the measurement of the turbulence structure in the mixing region at the jet exit, both at low and high speeds. Laboratory work being carried out at the University of Southampton, which is supported by the Ministry of Supply, includes the development of a shock tube for recording the interaction between an eddy and a shock wave; the

development of an optical eddy-counting technique, including a focusing device; the measurement, by means of the hot-wire technique, of turbulence, velocity and temperature distribution along the jet; the examination of noise from jets of non-circular shape; and the study of noise emitted from special jet extensions, with annular corrugated orifices, designed to reduce low-frequency noise. Important fundamental research on the origin and nature of jet noise is also proceeding at the Universities of Manchester and Edinburgh.

The problem of aircraft noise was also debated in the House of Lords on July 7, when, for the most part, the question of legislation and responsibility for minimizing noise was discussed. Lord Hawke said that perhaps the most hopeful line of approach is in experiments with devices which act upon the gas when it leaves the jet and provide something in the nature of a gigantic exhaust box.

PHYSICAL SOCIETY ANNUAL REPORT FOR 1953

AT the annual general meeting of the Physical Society, held at the Royal Institution, London, on May 25, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1953 were presented and adopted. During the year the membership rose by 29 to 2,130, and the sale of publications continued to increase both at home and abroad. The new scheme of subscriptions which came into operation on January 1, 1953, by which subscriptions for publications are separated from the subscriptions for membership, has worked smoothly and appears to be serving better the needs of members. There has also been a steadily growing interest in the reprint service which was introduced at the same time. The treasurer's report shows that any loss of income resulting from the lowering of the Fellows' subscription from three to two guineas has been more than compensated for by the increased income from the sale of publications of the Society. The cost of the provision of *Science Abstracts*, now no longer provided to members, was reduced from approximately £2,500 to £500. The income accruing to the Society as a result of the publication of the "Handbook of Scientific Instruments and Apparatus", the catalogue of the Society's 1953 exhibition of scientific instruments and apparatus, was considerable, amounting to nearly £4,000, and the balance of income over expenditure for the year was £1,794.

In addition to five science meetings held in London during the year, two-day meetings were held at the University of Leeds during March 31–April 1, and at King's College (University of Durham), Newcastle upon Tyne, during July 13–14; a conference on ionization phenomena in discharges, sponsored jointly by the Electrical Research Association, the Institute of Physics and the Physical Society, was held at the Clarendon Laboratory, Oxford, during July 18–23. The thirty-seventh Guthrie Lecture was delivered by Prof. Max Born, who spoke on the conceptual situation in physics and its prospects of development. The eighth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society were presented to Mr. J. A. Ratcliffe in Paris in May, when Mr. Ratcliffe delivered the Holweck Discourse on the subject of diffraction

of radio waves by the ionosphere. Prof. J. Bartels, of the University of Göttingen, received the seventh Charles Chree Medal and Prize on October 23, and for his address described Chree's influence on present-day geophysics. The thirtieth Duddell Medal was presented to Prof. W. Sucksmith, who gave a talk on "Some Magnetic Measurements—Techniques and Applications", and the ninth Charles Vernon Boys Prize to Prof. F. C. Williams, who spoke on "Cathode-Ray Tube Storage for Digital Computers".

Brief details of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustics Groups, together with a list of the numerous bodies on which the Society is represented, are given in the annual report. The activities of the Groups were not so varied as in former years, though the usual science meetings and summer meetings were held. The expenditure of the Groups fell markedly during the year, and, although the expense of the Groups to the Society was thus less than usual, it is emphasized that this is not a healthy sign since the activities of the Groups are vital to the welfare of the Society and any financial commitment entailed in their activities is more than offset by the contribution made by the Groups to the well-being of the Society.

At the annual general meeting the officers and council of the Society for 1954–55 were elected as follows: *President*, Prof. H. S. W. Massey; *Vice-Presidents in addition to ex-Presidents*, Mr. J. H. Awbery, Dr. R. C. Evans, Dr. A. B. Wood and Prof. S. Devons; *Honorary Secretaries*, Dr. C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Ordinary Members of Council*, Dr. T. E. Allibone, Dr. A. H. Cooke, Prof. F. C. Frank and Prof. G. O. Jones.

ARTIFICIAL AND NATURAL COLORATION OF DIAMONDS

MOST diamonds in their natural state are coloured; but the origin of the colour is still largely a mystery. There is little evidence that it is due to impurities, nor is it clear as to whether the colour is generally confined to the surface or distributed throughout the diamond, though in some cases, usually diamonds coloured yellow or yellow-green, the colour has been reduced or removed by polishing and grinding the surface. The colour has then been attributed to natural radioactivity. In 1923, S. C. Lind and D. C. Barwell established that diamonds were coloured green by bombardment with alpha-particles from radium, and there have been several reports during the past decade of the colouring of diamonds by proton and deuteron bombardment, though beta-, gamma- and X-rays seem to have little or no effect. The evidence suggests that diamonds are more readily coloured by energetic heavy particles. This supports the theory that the colour centres are connected with the vacant lattice sites and interstitial atoms formed when the bombarding particles collide with the carbon atoms of the diamond lattice.

A recent study by R. A. Dugdale of the effect of neutron bombardment of diamonds in the Harwell pile BEPO and of high-energy electron bombardment and of subsequent heat treatment confirms this view