SCIENCE IN THE UNITED STATES DURING 1954

THE third report of the British Commonwealth Scientific Office in Washington, D.C., entitled "Notes on Science in U.S.A., 1954"*, covers 1954 and is not so specifically linked with the United States fiscal year as the two previous reports. During the period under review, the only legislative activity directly affecting science was the passing of the new Atomic Energy Act, which permits an increased release of information on atomic energy to American industry and exchanges with other countries. While the possibilities of exchanging military-type information are limited, there is wide scope for co-operation on the peaceful uses of nuclear energy. The five-year nuclear power programme of the Atomic Energy Commission, which was approved in March 1954, calls for research and development at a cost of 8·5 million dollars a year and a total estimated expenditure of 199 million dollars on five specific projects on reactors of the following type: pressurized water; sodium graphite; boiling water; homogeneous; and fast breeder. Besides this, the United States Navy has expanded its programme of nuclear-powered vessels, and the Air Force is developing nuclear-powered aircraft. For the Army, a power plant, the so-called Army Package Power Reactor, is being constructed; this will develop about 2,000 kW. of electricity, and the components will be transportable by air. The Commission has replaced the previous 'study' agreements with industry by three types of participation agreements, and it was estimated that perhaps a hundred new participating agreements would be signed in 1955 in addition to the twenty study agreements by the end of 1954. In the field of particle accelerators the Commission has approved the design and construction at the Brookhaven National Laboratory of an ultra-high-energy alternating-gradient synchrotron for producing beams of protons of energies ranging up to 25,000 MeV. The value to industry of radioisotopes is now estimated at a hundred million dollars a year, and that of the ancillary industry of making instruments for the detection of radiation is expected to reach thirty-five million dollars a year by 1956. The Commission is constructing a new 200,000-dollar plant for processing radioiodine and has made available to industry the irradiation facilities of the high-intensity 30,000-kW. Materials Testing Reactor at Arco, Idaho, while a 90,000 dollar gamma-radiation plant is being constructed at Argonne primarily for use by the Army in studying food preservation. A note on nuclear developments in Canada directs attention to the valuable information which has been gained in restoring the 30,000 kW. reactor at Chalk River (called NRX). The reactor is now operating at 40,000 kW., and this greater power will reduce the time for research experiments and the production of isotopes, as well as permit tests on components for the new reactor to be made under irradiation more nearly comparable with actual conditions of exposure.

Referring to the President's Executive Order of March 1954, reiterating his support for the National Science Foundation, the report points out that the Order is important as indicating the Administration's intention that the Foundation shall be the cornerstone of the basic research effort of the United States.

* British Commonwealth Scientific Organization (North America). Notes on Science in U.S.A., 1954. Pp. iv+39. (London: H.M.S.O., 1955.) 2*s*. net.

Federal expenditure on research and development in 1954 is estimated at 2,095 million dollars, or 3·1 per cent of the total budget, and roughly half the national expenditure on research and development. Of this, 1,530 million dollars went to the Department of Defense, and, including all the work of the Atomic Energy Commission and of the Advisory Committee for Aeronautics, the proportion concerned with defence was 90 per cent. About 250 million dollars was spent on new facilities and equipment. In view of the complexities of the relation between the National Academy of Sciences and the National Research Council and of the slight understanding of those outside the United States of the relation of the Academy to the Government, the functions of both bodies are explained at some length. During 1952–53 about three-quarters of their income of 6 million dollars came from government contracts and grants.

Academic research on solid fuels was reduced in volume during the year; but in view of the state of the coal industry a programme to develop new, and maintain existing, markets for coal has been initiated. A joint survey of the comparative economics of the electric furnace and the open-hearth furnace for the production of low-carbon steel indicated substantial advantages for the electric furnace; but a complete change-over to electric furnaces would require a 12 per cent increase in the output of electricity and 25 million tons a year increase in coal consumption. In the new programme on synthetic liquid fuels emphasis has been placed on catalyst development, while in coal hydrogenation the aim is a one-stage high-pressure process giving high yields of gasoline; the chemistry and physics of the processes are receiving more fundamental study. Little further work on the gasification of coal at atmospheric pressure is contemplated, but construction of an improved pressure-gasifier at the new research station at Morgantown continued; this may permit a two-thirds reduction in the cost of compressing synthesis gas before its use in methyl alcohol, ammonia or Fischer–Tropsch synthesis. The possibility of transporting liquid methane in ships containing tanks internally insulated by a thick layer of cemented balsa wood sections is being examined, and increasing attention is being given to atmospheric pollution, on which ninety-eight laboratories in the United States were working during 1953. In the Detroit (Michigan)–Windsor (Ontario) area an International Air Pollution Study is in progress in which an international technical advisory board co-ordinates the activities of both United States and Canadian authorities, and co-operation has also been secured in attempts to reduce smoke emitted by vessels plying the Detroit River.

Interest in solar energy is expanding, and at a conference at Madison, Wisconsin, in June 1953 graphical methods were demonstrated for analysing the economics of collector design; the basic mechanism of photosynthesis was discussed from the point of view of quantum mechanics and thermodynamics, and of photolytically induced endothermal chemical reactions, while the Bell Telephone Co., Inc., has announced a photoelectronic cell consisting of a very thin plate of metallic silicon yielding, in full sunlight, power at the rate of about 50 watts per sq. yd. The mass culture of algae is also receiving much attention, and a feature of a symposium at the Boston meeting in December 1953 of the American Association for the Advancement of Science was the disclosure that much of the present work is with algae other than *Chlorella*.

Although water is an abundant resource in the United States, it can no longer be taken for granted, and the rapid increase in the use of ground water for air conditioning appears to be causing concern; but there appear to be insufficient data on water losses in all phases of the cycle of water supply and use. Active work continues on the desalting of water; but nothing yet published suggests that provision of irrigation water in quantity by this method is approaching economic possibility. In agriculture the main development during the year, especially in the western States, was the use of liquid fertilizers. Several nitrogenous solutions are on the market, and other solutions, containing nitrogen, phosphates and potash, are available for use with low-pressure spraying equipment or for insertion into irrigation water. As regards insecticides the present trend is to concentrate on substances which can be absorbed into the plant system and, by their presence in the plant cells, prevent attack by insects or infection by disease. Growth-regulating substances are being used not only for removing unwanted plants but also for controlling the rate of development of ornamental shrubs, to delay the flowering of fruit trees, and even to retard the growth of lawn grass. In animal production, the main developments on the nutrition side have been the use of antibiotics to accelerate the fattening of cattle, and the evolution of a system by which pigs can be weaned at five days old. In 1952, about 30 per cent by weight of all antibiotics produced in the United States was fed to farm animals. Further developments by industrial interests and by the official research centres during 1953 and the first half of 1954 may well make 1954 the last 'experimental' year in regard to the full-scale commercial production in the Americas of kenaf, the jute substitute. The problem of mechanical harvesting has not been solved, however, but chemical retting may go far to place the industry in a strong position.

In metals and metal physics, work on the sintering of iron ores has received considerable impetus, and many trials have been made with a high proportion of sinter in the burden. Attention is being given to the development of domestic sources of supply of titanium, and a new plant, with an annual output of a hundred thousand tons of ilmenite, is under construction in Florida; it is of the 'travelling lake' type and uses a battery of Humphrey spirals on a raft which floats in a lake of its own making and proceeds through the deposit as ore is taken in at the front of the raft and waste material discharged at the rear. Several firms have been working on the casting of titanium and titanium alloys, and the major difficulty of surface contamination appears to have been overcome. The potentialities of the Colorado Plateau as a source of uranium were emphasized during the year, and the release of the classified metallurgical work on beryllium has permitted a comprehensive view of the present state of beryllium metallurgy in the United States. Satisfactory methods are now available for the metallographic examination of beryllium and its alloys; but, apart from an aluminium casting, no beryllium-rich alloy is known to be in use, although beryllium might find extensive use in reactors if the cost were reduced to 25 dollars/lb. of pure beryllium raw metal. In fundamental research, much work is being done on single-crystal specimens, whereby grain-boundary effects and some other variables are eliminated. Interest is widespread in the development of chemical methods for the extraction of metals, in place of normal smelting procedures, to which low-grade ores, tailings and slags are often not amenable, and considerable attention has been paid to low-grade domestic sources of manganese, as well as to the extraction of copper, nickel, cobalt and uranium from low-grade ores. In 1953 the sale of synthetic detergents in the United States exceeded for the first time that of soap, and this increasing use is presenting problems of sewage disposal and water supply, particularly the growing use of non-ionic materials, which now account for 10 per cent of the production. There is also evidence that detergents may have a deleterious effect on the sewage-digesting bacteria.

Several research groups are considering the possibilities of mechanical aids to translation, and a feature of this report is a brief but excellent bibliography of recent articles and reports.

DETECTION OF ATMOSPHERIC DUST AND TEMPERATURE INVERSIONS BY TWILIGHT SCATTERING

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THE detection of meteoritic dust and the tracing of its passage through the atmosphere is important in view of the evidence produced by Bowen[1] that rainfall (when added for many stations or many years) is correlated with the advent of meteor showers. Discontinuities in the scattered sunlight during twilight have been reported by Grandmontagne[2] and de Vaucouleurs[3], and the hope of displaying these more prominently and perhaps identifying them with regions of dust led to the experiments to be described.

During twilight, light received from a cone of 1° vertical angle was recorded by a photocell with filter at the focus of a large lens. The light was interrupted 250 times per sec. by a rotating slotted disk, and the alternating current from the photocell amplified and balanced against a fixed voltage, the difference between the fixed and varying voltages being read at 10-sec. intervals. Whenever the difference reached a certain level, it was reduced to zero by adjusting the gain of the amplifier. The rate of change of the deflexion of this meter was then approximately proportional to the ratio of the rate of change of illumination (dI/dt) to the illumination (I).

To emphasize the contribution of dust particles to the scattered light, the large forward scattering of particles comparable in size with the wave-length was utilized by looking in the vertical plane containing the sun at an angle of 20° to the horizon. Height was defined by the intersection of the grazing ray from the sun's centre with the line of sight, with a fixed allowance of 68′ for refraction. To make the shadow as sharp as possible, only light of red and infra-red wave-lengths was accepted by the equipment.