

cerned with invariants of motion in ionized gases. The first dealt with the spiralling of charged particles of small ratio (ϵ) of mass to charge. An adiabatic invariant, which has been discussed by H. Alfvén, for the case $\epsilon = 0$, was generalized to all powers of ϵ . The second paper, with I. Bernstein, E. Frieman and R. Kulsrud, gave an energy principle for examining the stability of a discharge channel of more general application than the customary 'normal-mode' approach.

The group at Göttingen, L. Biermann, K. Hain, R. Lüst and A. Schlüter, also reported a detailed study of the problems of hydromagnetic stability. In addition, a novel method of heating a plasma was proposed, in which an isolated mass of ionized gas is subjected to a cyclically varying magnetic field. Arguments based on equipartition of energy show that the temperature of the plasma is thereby raised.

A paper by M. Rosenbluth (San Diego) was one of several theoretical studies concerned with the stability of the pinched discharge, one of which has been mentioned earlier. Rosenbluth treated the problem of a cylindrical discharge with axial magnetic field and conducting boundary, and gave conditions for stable operation. H. L. Jordan (Aachen) also discussed the stability of pinched discharges.

In the final session, the same topic was treated by R. J. Tayler (Harwell), who gave the results of 'normal mode' calculations of stability in pinched discharges. For a system in which the current is confined to the surface of a cylindrical column of gas, he showed that no stability is possible for the first-order 'mode' for any external magnetic field if the discharge tube has an insulating wall. With a conducting boundary of not too great a radius, image forces can remove the residual instability, so that complete stability is possible. For the more general case of a volume distribution of current the situation is complex, but complete stability is not very likely.

W. B. Thompson (Harwell) considered the transition between low-current discharges controlled by diffusion and the high-current pinched discharge. H. Margenau (New Haven) presented a paper on the conductivity of plasmas with respect to microwaves in which the distribution function was assumed to have one of several simple forms and was perturbed only slightly by the microwave field. He also reported work with D. C. Kelly on power absorption from microwaves at the cyclotron resonance by electrons of low energy in a discharge. From the half-width of the resonance curve the collision frequency could be deduced.

Two papers were presented by J. G. Linhart (Geneva) and D. C. de Paekh (Washington) on the problems arising in the production of electron beams with neutralized space-charges first discussed by Bennett¹ and Budker². In the first paper by Linhart the theory of the production of such beams was considered. In the second, read by A. C. Kolb, the possibility of additional focusing of electrons by external magnetic fields was taken into account, leading to a reduction in the stabilizing proton-core and to conditions which are rather easier to realize in practice.

Two general addresses remain to be mentioned. These were by Prof. V. Gori (Rome) and Dr. A. von Engel (Oxford), and took the form of tributes to the life and work of the late Prof. Giorgio Valle.

The success of the Venice meeting lay largely in the presentation, in many of the papers, of much really new material and in the evidence thus provided of intense activity on a wide front. The next conference of the series is to be held in Upsala in 1959.

W. R. S. GARTON
R. LATHAM

¹ Bennett, W. H., *Phys. Rev.*, **45**, 890 (1934).

² Budker, G. J., *Cern Symposium Proc.*, **1**, 68 (1956).

DUTCH-NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

REPORT FOR 1955-56

THE Joint Establishment for Nuclear Energy Research (J.E.N.E.R.), situated near Oslo and operated jointly by the Norwegian Institutt for Atomenergi (IFA) and the Dutch Stichting Reactor Centrum Nederland (RCN) through a commission consisting of three Dutch and three Norwegian members, has recently issued its fifth annual report*, covering the period from July 1, 1955, to June 30, 1956.

The natural-uranium reactor, JEEP, which is moderated and cooled with heavy water and has now been in operation for nearly five years, is the main piece of research equipment at the Establishment. Its total energy release during the period under review was about 70 MW.-days, compared with 50 MW.-days for 1954-55. The reactor had a major shut-down during February 26-March 12, 1956, for the installation of a new heat-exchanger, the final stage in the introduction of a new cooling system. This heat-exchanger, which transfers the heat from heavy to ordinary water, has five times the surface area of the old exchanger, and the ordinary water is circulated from it through a cascade-type cooling tower to a reserve tank. With the new cooling system the reactor may be operated at a much higher power-level than previously, and, in addition, the operation is entirely independent of the prevailing weather conditions. The fuel elements were inspected twice, during August 1955 and March 1956, and the inside of the reactor tank once, during August 1955; their conditions were found to be satisfactory and no replacements were made.

During the year the number of shipments of radioisotopes from the Establishment totalled 614, only a small increase on the previous year's total of 579. The shipments were mainly to Norway, Sweden, Denmark and Holland. An additional 204 irradiations were made for use within the Establishment. Although the demand for radioisotopes is steadily increasing, no increase in production can be expected until the completion of the construction of the new buildings, for which plans have already been made. The report includes a list of the various isotopes produced, the number of shipments and their destinations, and the main fields of application.

New research equipment has been installed in both the metallurgy and physics laboratories, where a wide range of experimental work is being carried

* Fifth Annual Report, July 1955-June 1956, of the Dutch-Norwegian Joint Establishment for Nuclear Energy Research. Pp. iv+82. (Lilleström: Joint Establishment for Nuclear Energy Research, 1957.)

out. For casting uranium, a high-frequency (450 kc./s.) induction high-vacuum furnace supplying 22 kW. has been constructed, and metal specimens weighing 1–2 kgm. can now be melted and cast under a pressure of about 2×10^{-7} mm. of mercury. Since uranium exhibits dimensional instability, both on thermal cycling and under irradiation, a thermal cycling furnace has been built for the study of the behaviour of the metal under cycling conditions. The instability is known to be dependent upon the degree and type of preferred orientation, and a series of dilatometric experiments on preferred orientation in uranium containing 0.25 per cent chromium has been carried out. Additions to the equipment used for neutron diffraction work and for crystal structure studies included a Philips X-ray diffraction unit, a Geiger-counter diffractometer and several X-ray cameras, and studies have been made of hexamethylenetetramine, pentaerythritol, calcium hypophosphite, and mercury oxide. Other experiments conducted in the Physics Division have been concerned with the circular polarization of capture gamma-rays, and the gamma-rays emitted by fission fragments. The series of photo-nuclear reaction studies at Det Norske Radiumhospital using the betatron has been continued.

In the Chemistry Division, in addition to routine chemical and spectrographical analyses, the recovery of caesium-137 from fission products by co-precipitation with ammonium aluminium sulphate is being investigated. The study of the chemistry of plutonium has continued, and a sixty-four channel pulse height analyser, constructed in the electronics workshop, is now being used for routine analysis of uranium and plutonium mixtures.

During the second half of the year most of the work at the Establishment was concerned directly or indirectly with the Halden boiling-water reactor project, which was referred to in the report for 1954–55 (see *Nature*, 178, 1220; 1956). In 1956 the project received the official approval of the Norwegian Parliament, and the work is now well advanced. The reactor will be financed and built under the auspices of the Institutt for Atomenergi, but the design and planning are to be carried out by the Establishment. Many of the mechanical components will be produced by Norwegian firms, and negotiations are stated to be in progress with the United Kingdom Atomic Energy Authority and with the United States Government for the supply of the uranium fuel and heavy water, respectively. The reactor will be fuelled by seven tons of uranium distributed in a hexagonal lattice with a maximum of 325 fuel elements. The amount of heavy water needed as moderator and coolant is 15 tons. Initially, ten cadmium control stations will be installed, but the design allows for an additional nine if required. Although the plant will eventually supply process steam to a nearby paper mill, this is merely intended as an inexpensive way of dissipating the liberated energy, and the plant should really be regarded as an experimental engineering plant with a high degree of flexibility in design, permitting considerable variation in many of the basic specifications. The detailed discussion of the Halden project in the annual report includes a simplified schematic diagram of the reactor and associated equipment.

In the final sections of the report details are given of the various reports and publications issued by the Establishment during the period under review; of

the reactor courses given at the Establishment; of personnel and accounts; of the numerous scientific meetings and conferences at which the Establishment was represented; and of the thirty-seven guest scientists representing twelve different nations who worked at the Establishment during part or the whole of the period covered by the annual report.

THE BRISTOL MUSEUM

REPORT FOR 1956

THE annual report* of the City of Bristol Museum is, as one has come over the years to expect, a well-produced, readable and stimulating publication reflecting the activities of one of Britain's outstanding provincial museums. Putting first things first, it deals with the personnel of committee and staff, with changes of persons and of posts, with new recruits and with degrees awarded, winding up with a gracious recognition of long services rendered—retirements after 22, 22 and 26 years—a loyalty accorded and therefore clearly inspired. A novel post filled during the year is that of assistant curator in conservation, which called naturally for accommodation and equipment, a special laboratory and an iron treatment room. This is surely a realization of the best and most up-to-date in the museum tradition reflected in Dr. H. J. Plenderleith's recently published and remarkable text-book (see *Nature*, 179, 280; 1957).

In another field Bristol Museum continues to lead, namely, in its public education services, which achieve great things, not only among adults and school-children of the area, both in classes and in leisure-time societies and clubs, but also among museum men and educationists from elsewhere, who seek practical experience and inspiration to transplant to their own institutions. Work continues on the permanent exhibits, inevitably calling for improvement and re-identification as research adds to the general field of knowledge, and the fact that half the report is devoted to a list of accessions indicates both the lively outlook of the director and curators of Departments and the appeal the Museum exerts upon its supporters.

Temporary exhibitions, which do so much to enliven and attract, numbered no less than fifteen. Among the special features which have been continued with increasing success is the 'exhibit of the month', to which the city archivist has added quarterly exhibitions of Bristol playbills, concert notices, news-sheets of royal visits and so on, while the city librarian has provided material dealing with a local figure, the boy-poet Chatterton. The Museum finds a ready demand for its *Quarterly Bulletin* and for leaflets describing summer walks—which have an embarrassing success—and winter lectures. The list of conferences, together with their home ports, is a most impressive one. Yet, with all these varied offerings to a public seven days each week, the staff has time to serve on a wide range of local and national committees and to conduct research and to publish the results in scientific and learned periodicals of standing. This is a full report betokening, on the part of all concerned, a full and doubtless satisfying life.

D. A. ALLAN

* City and County of Bristol. The City Museum: Report of the Committee for the year ended 31 December 1956. Pp. 22+2 plates. (Bristol: City Museum, 1957.) n.p.