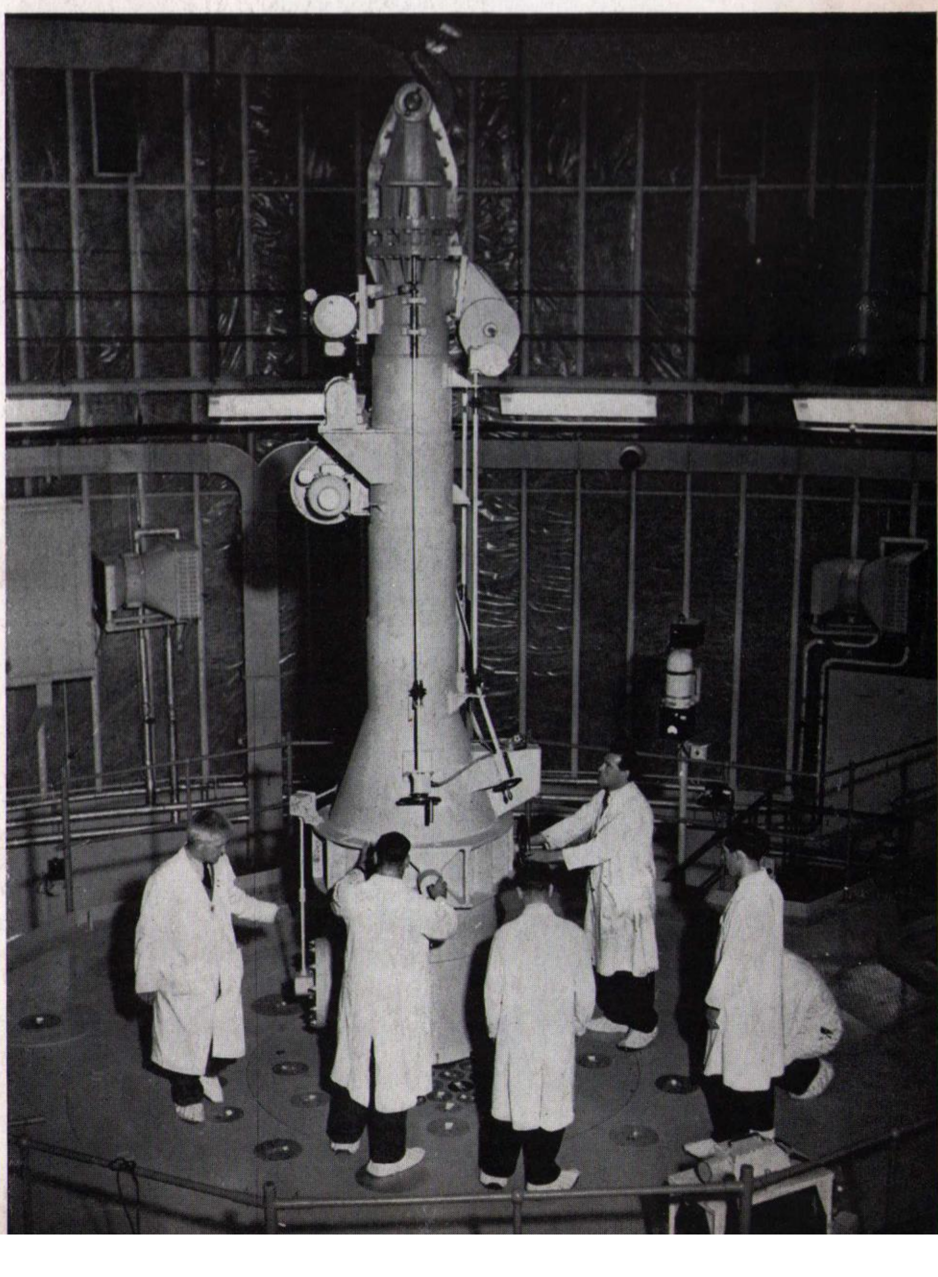
The Atomic Energy Research Establishment

HARWELL



The Atomic Energy Research Establishment

A brief guide

HARWELL

Director: Sir John Cockcroft

The Atomic Energy Research Establishment : its place in The United Kingdom Atomic Energy Authority

The Atomic Energy Research Establishment is the main establishment of the Research Group of the United Kingdom Atomic Energy Authority, the body to which Parliament, by an Act of 1954, has entrusted the development of atomic energy in the United Kingdom. Previously, from 1946 to the formation of the Authority on 19th July 1954, British atomic energy work was directed first by the Minister of Supply and then, for the first seven months of 1954, by the Lord President of the Council. Under the new Act, the Lord President retains the duty of promoting and controlling the development of atomic energy; he appoints the members of the Authority and from time to time he may, after consultation with the Authority, give to it such directions as he thinks fit.

The Authority

The Authority consists of a chairman and ten members, of whom five are full-time. The membership is set out on the opposite page.

The cover picture shows the top of Dido, a materials-testing reactor. The shielded fuel-element container, or flask, is in position for loading a fuel element into the core. Cooled and moderated with heavy water and fuelled with enriched uranium, Dido will be used principally to study the effects of radiation on materials for future reactors.

Chairman

Sir Edwin Plowden, K.C.B., K.B.E.

Members

Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S.
(*Member for Scientific Research*)

Sir Christopher Hinton, K.B.E., F.R.S.
(*Member for Engineering and Production*)

Sir William Penney, K.B.E., F.R.S.
(*Member for Weapons Research and Development*)

Sir Donald Perrott, K.B.E.
(*Member for Finance and Administration*)

Mr W. Strath, C.B.
(*Member for External Relations and Commercial Policy*)

Part-time Members

The Rt Hon. Viscount Cherwell, C.H., F.R.S.

Sir Luke Fawcett, O.B.E.

Sir Ivan Stedeford, K.B.E.

Sir Rowland Smith

Mr C. F. Kearton, O.B.E.

Secretary

Mr D. E. H. Peirson

The work of the Authority is shared by three Groups (for research, production, and weapon development) and a London office, which also acts as a co-ordinating centre for the three Groups.

The Groups

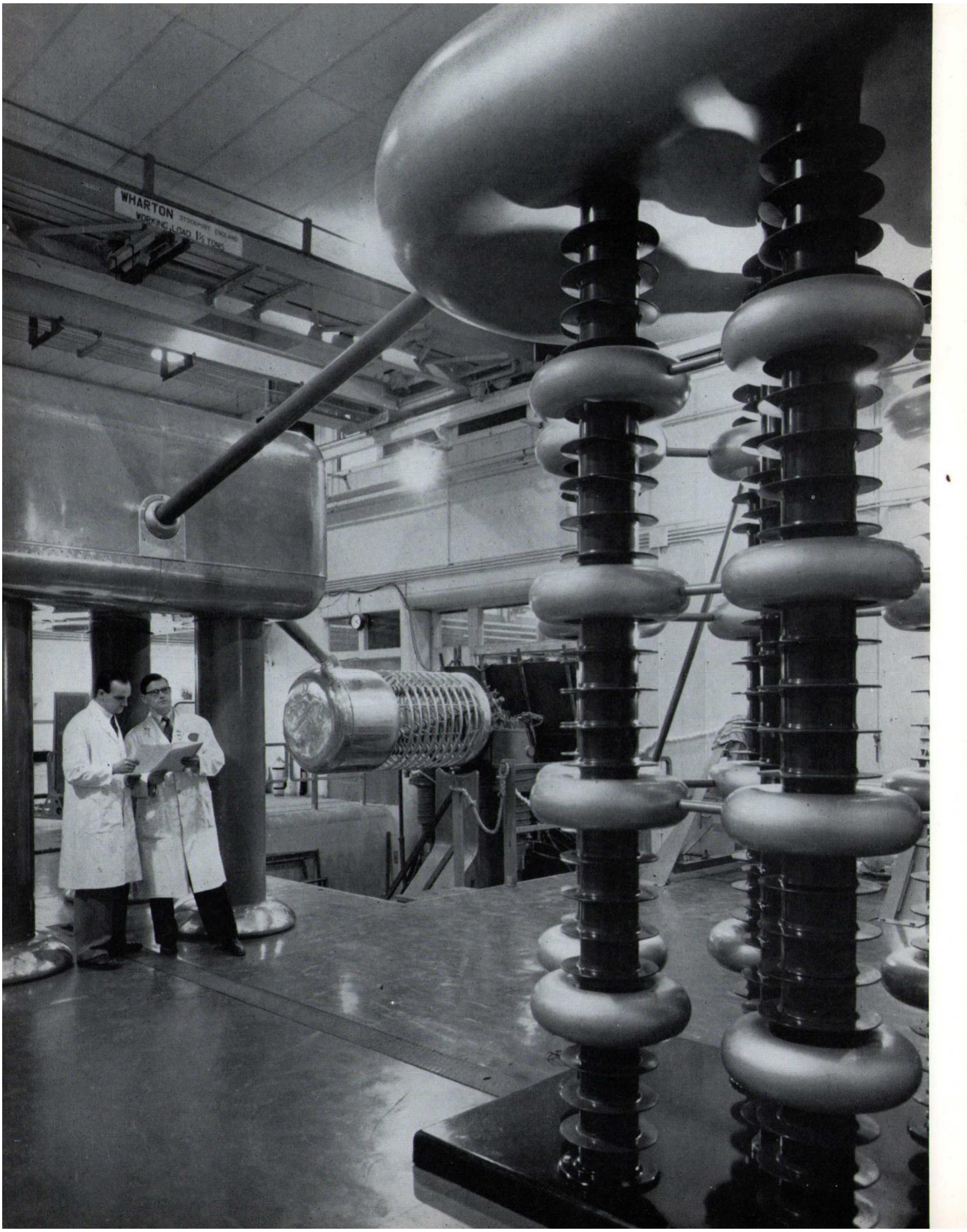
The Authority's Member for Research, Sir John Cockcroft, directs the Atomic Energy Research Establishment at Harwell, Berkshire, the subject of this booklet. The Weapons Group, led by Sir William Penney, is responsible for developing the military applications of atomic energy; its principal establishment is the Atomic Weapons Research Establishment, Aldermaston, Berkshire. The Industrial Group, whose Managing Director is Sir Christopher Hinton, has two main responsibilities: for designing, building and operating both plants to produce fissile materials and prototype nuclear power plants. The Group has its headquarters at Risley in Lancashire; its factories include the Springfields plant for extracting uranium from its ores, the Windscale Works for producing plutonium, the Capenhurst gaseous diffusion plant for separating uranium-235, and Calder Hall, the first full-scale nuclear power station in the world. The Group is building another plant on the Calder Hall pattern at Chapel Cross in Dumfriesshire; both of these plants will produce military plutonium as well as power. In addition, the Industrial Group has a large research and development programme geared to its engineering design work and it is building at Dounreay, in the north of Scotland, a 60 MW fast reactor experiment.

The Nuclear Power Programme

A great part of the work of the Research and Industrial Groups is concerned with this country's nuclear power programme. This programme was announced by the Government in February 1955; it called for the construction during the ten years 1955 to 1965 of twelve nuclear power stations capable of generating 1,500,000 to 2,000,000 kW of electricity and saving 5,000,000 to 6,000,000 tons of coal a year; at the time of writing the programme was due to be revised to take account of major technical advances since 1955. The power stations are to be built for the national electricity authorities by industry, to whom the Atomic Energy Authority is providing detailed information, doing such development work as is appropriate, and giving help in training staff.

OPPOSITE

The injector end of the 50 MeV proton linear accelerator now being built at Harwell. Protons produced in the cylindrical ion source (centre background) are accelerated by 500 kV pulses from the Cockcroft-Walton generator in the foreground. These protons are injected into the first section of the machine and there accelerated to 10 MeV. Two more sections are used to increase the energy to 50 MeV (see page 24).


WHARTON STOCKPORT ENGLAND
WORKING LOAD 1½ TONS

Organization of the Establishment

The Atomic Energy Research Establishment, Harwell, founded in 1946, has grown into one of the largest research establishments in the country. The organization at Harwell is designed to be flexible, so that changes in the emphasis in research can be accommodated readily, and adequate freedom in the scientific direction of each of the Establishment's many fields of enquiry achieved. To this end, the Establishment is divided into a number of scientific Divisions each responsible, broadly, for work in a particular field. Each Division is roughly the size of a university department and is under the leadership of a Division Head having a status comparable with that of a university professor. Some of the Divisions provide the essential services without which a large establishment cannot operate. The management board and senior staff of the Establishment are set out on the opposite page.

Engineering services in the Establishment include central design offices and workshops (both supplemented by local design offices and workshops) with additional capacity at Bracknell; there are also maintenance and operating services and arrangements for treating radioactive waste of all kinds. Scientific services include health physics, a central computing service equipped with a high-speed electronic computer and punched card machinery for collating experimental data, and a library and information service. There is a comprehensive medical service. The Reactor School provides postgraduate courses in reactor technology for suitably qualified engineers and scientists.

Harwell Council

Director	Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S.
Deputy Director	Dr B. F. J. Schonland, C.B.E., F.R.S.
Deputy Director (Engineering)	Mr G. W. Raby, C.B.E.
Chief Chemist	Dr R. Spence, C.B.
Chief Physicist	Mr D. W. Fry
Chief Metallurgist	Dr H. M. Finniston
Head of Reactor Division	Dr J. V. Dunworth, C.B.E.
Technical Secretary	Mr D. R. Willson, M.B.E.
General Secretary	Mr T. B. Le Cren

Division Heads

Division	*Division Head*
Chemistry	Dr R. Spence, C.B.
Chemical Engineering	Mr A. S. White
Electronics	Dr D. Taylor
Engineering (New Works)	Mr G. W. Dixon
Engineering Services	Mr P. Bowles
General Physics	Mr D. W. Fry
Health Physics	Dr W. G. Marley
Isotopes	Dr H. Seligman
Medical	Dr K. Williams
Metallurgy	Dr H. M. Finniston
Nuclear Physics	Dr E. Bretscher
Reactor	Dr J. V. Dunworth, C.B.E. Mr H. J. Grout (*Associate Head*)
Theoretical Physics	Dr B. H. Flowers

Technical Secretariat

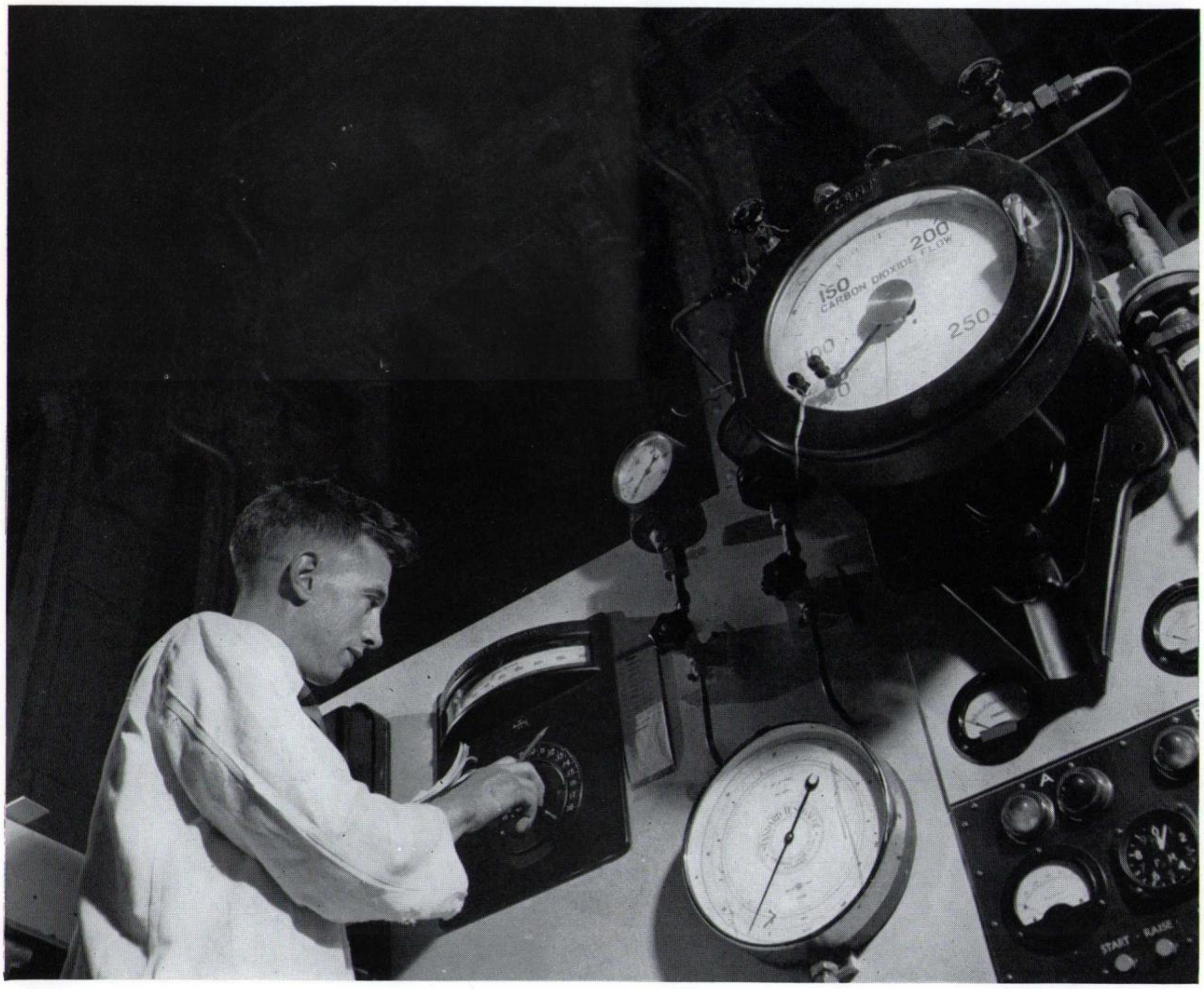
Technical Secretary	Mr D. R. Willson, M.B.E.
Industrial Collaboration Office, *Head*	Dr N. F. Goodway
Overseas Collaboration Office, *Head*	Mr J. F. Jackson, O.B.E.
Scientific Administration Office, *Head*	Mr R. M. Fishenden
Reactor School, *Principal*	Dr D. J. Littler

Administration

General Secretary	Mr T. B. Le Cren

Outstations

Radiochemical Centre, Amersham Dr W. P. Grove
A.E.A. Factory, Bracknell (Engineering Services Division)
Wantage Radiation Laboratory (Isotope Division)
Woolwich and Chatham Analytical Laboratories (Chemistry Division)



Radiation chemistry on the engineering scale — control panel of a 'loop' in Bepo for measuring the rate at which carbon dioxide reacts with graphite under power-reactor conditions. A loop is a closed circuit through the pile core; this one contains a graphite channel loaded with fuel elements.

The Work of the Establishment

The Atomic Energy Research Establishment was formed to undertake research into all aspects of atomic energy. One of its most important commitments during the early years was to advise the Industrial Group (as it is now) on the scientific and technical problems encountered in designing factories to produce atomic energy materials. Now the Establishment is concentrating on the manifold civil applications of atomic energy.

The Reactor Programme

Many suggestions for power generation were made at Harwell and by the Industrial Group in the early years and some were examined in considerable detail, but generally lack of basic data and materials prevented these ideas from being put into practice. However, by 1951 enough information had been obtained to make it worth while for a team to begin to study in detail the feasibility of using natural uranium as fuel for generating power. This two-year general study resulted in a specific design for a natural-uranium reactor, moderated by graphite and cooled with carbon dioxide, capable of generating electricity on the industrial scale and of producing at the same time considerable quantities of plutonium. On the basis of this work the Industrial Group designed and constructed the Calder Hall station which was opened by H.M. The Queen in October 1956.

Great possibilities for development of this type of reactor were revealed by the feasibility study and subsequent detailed engineering design. As a result it was made the basis for the early stages of the ten-year programme for industrial nuclear power. Already further studies by the Authority and by industry have resulted in improved designs capable of giving four times the output of Calder Hall and more improvements will certainly be made. Current work is directed especially to raising the temperature of operation, so that efficiencies can be increased and capital costs per kW of power generated reduced correspondingly.

In the later stages of the power programme the aim is to increase heat ratings still further. This can be done by using a liquid as coolant but this necessitates enriching the fuel in fissile content. Such enrichment can be achieved by using the plutonium produced in the earlier civil reactors. Plutonium has not so far been used as a power reactor fuel and the many metallurgical and nuclear physical problems presented by such use are being studied.

Two liquid-cooled reactor systems have been investigated in detail. In one, light (i.e. ordinary) water at high pressure is used as both coolant and moderator;

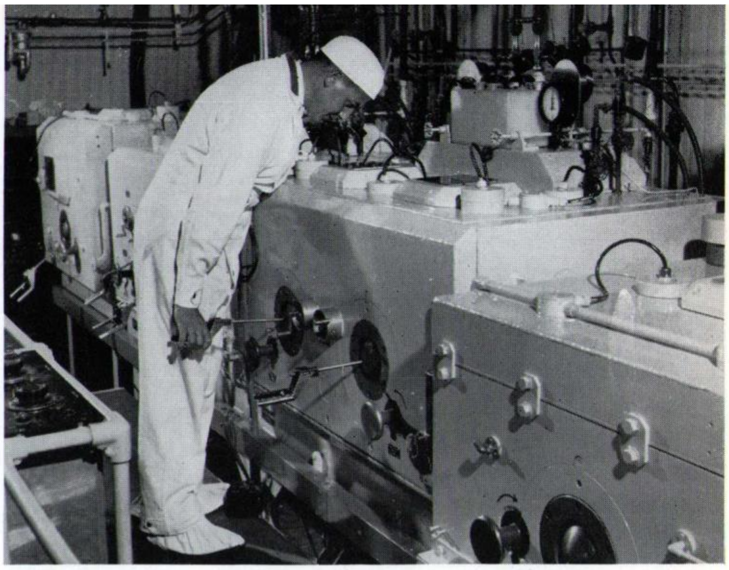
in the second, liquid sodium is used as coolant and graphite as moderator. These investigations have revealed the extent of the technological difficulties, particularly from the corrosive effects of the coolants on materials of construction. Much remains to be done before a final assessment can be made of the merits of these systems.

At Harwell feasibility studies of reactor systems are the responsibility of the Reactor Division. The work involves research in many different fields and is therefore undertaken by project groups each working on a particular system. For example, one team is studying a gas-cooled reactor system using solid ceramic fuel elements in which enriched fuel is closely associated with the moderator; it is hoped to achieve high temperatures and ratings with a corresponding reduction in the cost of power generation. The proposal presents some considerable problems, though none of them seems insoluble; thus both ceramic fuel and moderator must be designed to withstand high temperatures and strong fluxes of neutrons for long periods; chemical reactions between moderator, fuel, and coolant gas at high temperatures must be thoroughly understood; ways must be found to control any radioactive fission products which enter the primary cooling stream, without canning the fuel in metal.

Another project group is studying the possibilities of a small and rather simple reactor system using an organic liquid as moderator and coolant. Since the stability of organic liquids to irradiation is of primary importance in this application, radiation chemists are playing a large part in the development; valuable help is also being given by staff of the British Shipbuilding Research Association.

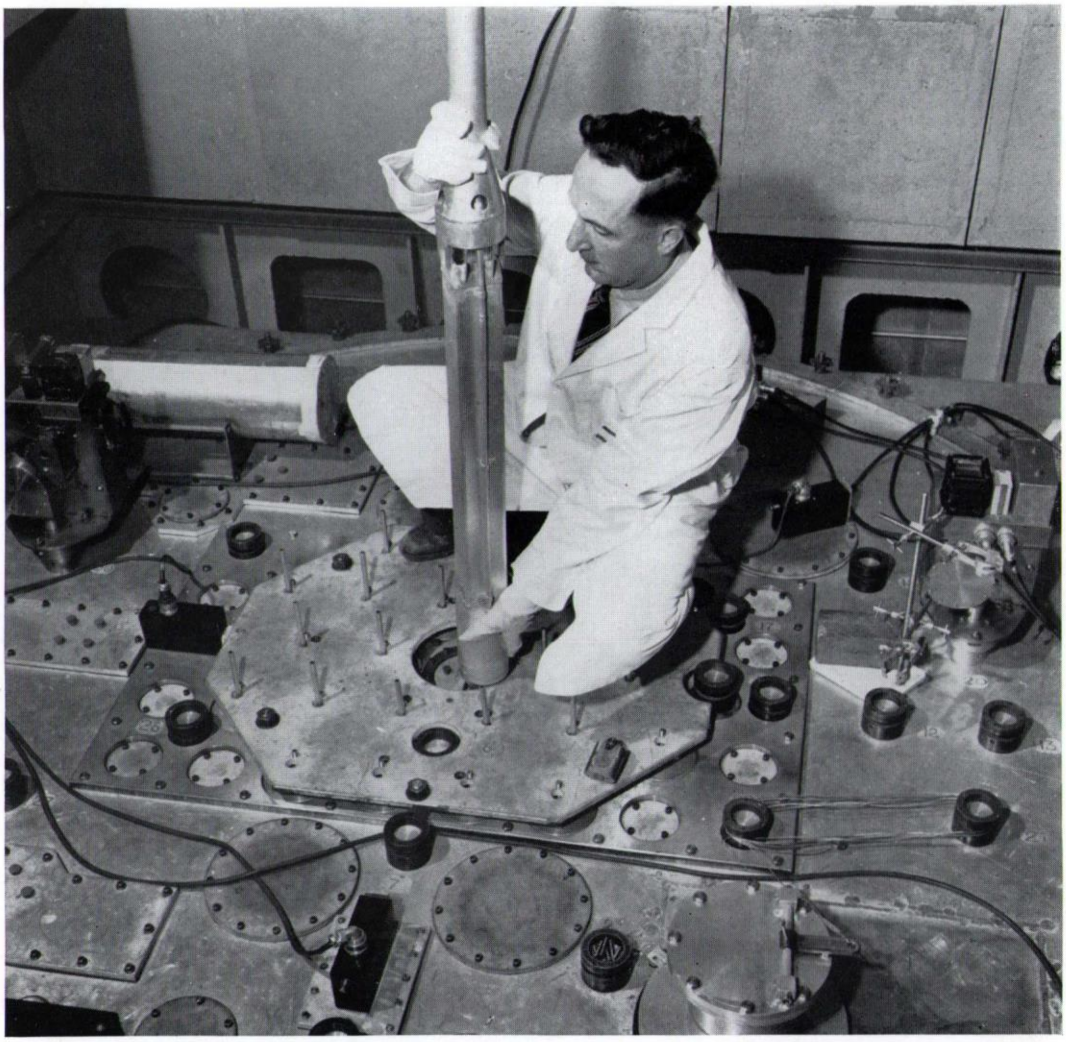
Whatever other differences may exist, the physics of reactor systems of all kinds have much in common. The Reactor Division has sections working on the general problems of reactor physics. A large part of this work is concerned with integral experiments, in which the component parts of a reactor system are observed working together as a whole, either in sub-critical assemblies or in critical assemblies operating at a power level of a few watts only (often called zero-energy reactors). Zero-energy reactors at Harwell include Dimple, for measurements on water-moderated systems, and the fast reactors Zephyr and Zeus.

In the further development of nuclear power, beyond the first ten years of the programme, it is hoped to reduce fuel costs to a very low level by developing systems in which a high proportion of non-fissile uranium-238 and thorium (the fertile materials) is converted to fissile plutonium and uranium-233; the new fuels could then be burnt either *in situ* or in other reactors. Reactors which produce more fissile material than they burn are often called breeder reactors; they consist essentially of a reacting core containing fissile material surrounded by a region containing fertile material (the blanket) in which the new fuel is created. The breeder system on which most work has been done so far is the fast-fission reactor, which has reached an advanced stage of development. Many



Shielded cells in which irradiated metal samples are prepared for metallographical examination. These studies should lead to improved fuel elements and so to reduced fuel costs.

A flotation experiment in the ore-dressing laboratory. This work is aimed at reducing the cost of recovering uranium from low-grade ores.



Loading a Dido-type fuel element into Dimple, the zero-energy (i.e. very low power) heavy-water-moderated reactor. In such a reactor radioactivity is so low that fuel elements can be handled safely shortly after shut-down, and different core arrangements can be tried easily.

Loading a fuel element into Zephyr. This zero-energy fast reactor is fuelled with plutonium rods canned in nickel; the core is surrounded by a blanket of uranium in which more plutonium is bred. With Zephyr the first British experience of fast reactor operation was gained.

formidable problems remain however, arising from the use of nearly pure nuclear fuel to give extremely high heat output in a very small volume. A reactor experiment (i.e. a reactor built primarily to enable technology and design methods to be studied) is being built by the Industrial Group at Dounreay.

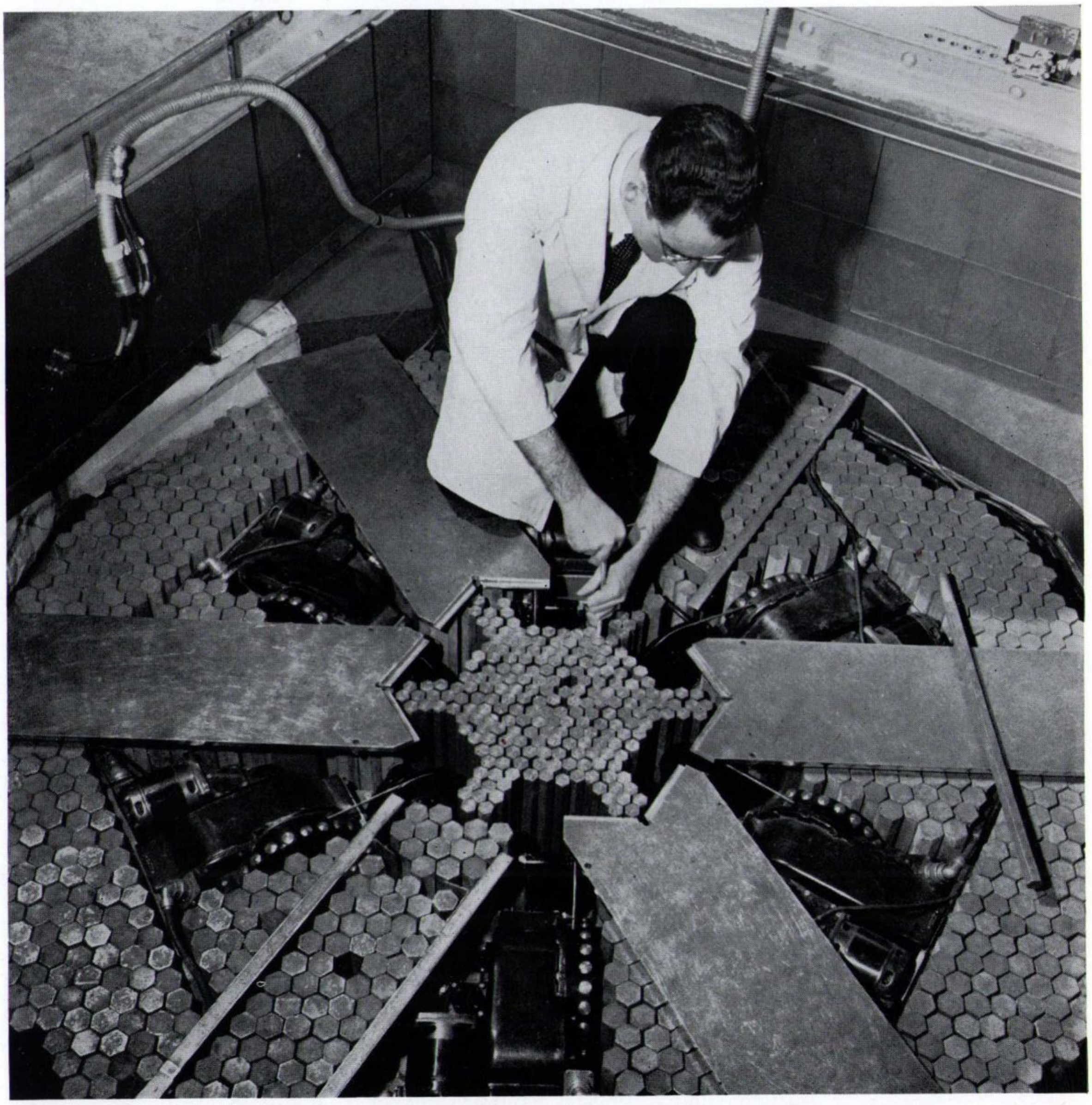
In two other breeder systems under investigation at Harwell the fuel is in the liquid, instead of the solid, state. The first of these is the homogeneous aqueous system. In this, fuel and moderator are combined in a solution of uranyl sulphate (enriched in uranium-235) in heavy water. In the second type, the liquid-metal-fuelled system, the fuel is in the form of a solution or suspension of uranium in molten metal. Both of these reactors resemble a chemical, rather than an electrical, plant and consequently chemists and chemical engineers are strongly represented in the project teams studying them.

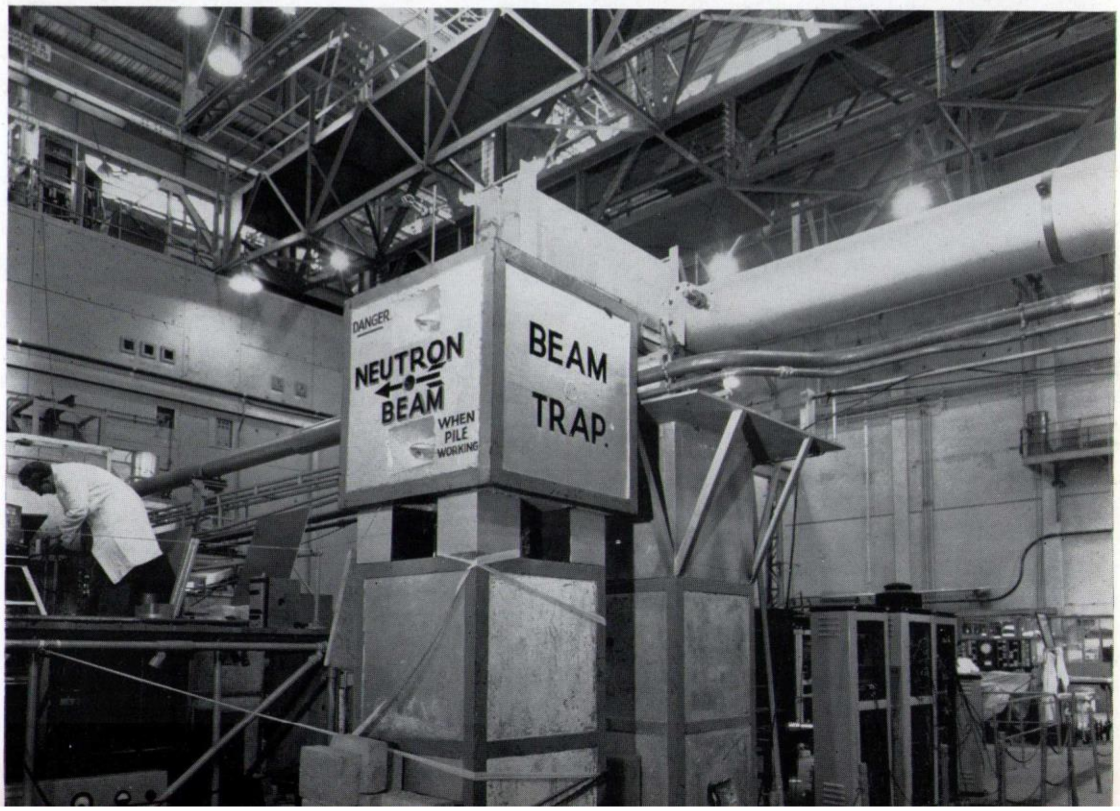
It is unnecessary to emphasize the need, in nuclear engineering, to study experimentally the effects of radiation on materials and components. So far most of this work has been done in Bepo, a 6 MW natural-uranium graphite-moderated reactor, but at the end of 1956 a heavy-water-moderated reactor called Dido was brought into operation which, because it has a maximum neutron flux some fifty times that of Bepo, will greatly accelerate these tests. A second reactor of the same type, called Pluto, is being built especially for tests of engineering equipment in pile loops. The detailed design and construction of these and other new research reactors is the responsibility of contractors working to the specifications of the Reactor Division. The Division is also responsible for the operation of all Harwell reactors.

After irradiation in one or other of the research reactors, specimens are examined to find out what has happened to them. This is a difficult job technically because the samples are intensely radioactive, and have therefore to be handled remotely, behind heavy lead or concrete shields. Existing equipment in the Metallurgy Division at Harwell is suitable for use with fairly small specimens having radioactivity equivalent to that of a hundred grams of radium. New equipment is planned which will accommodate much bigger specimens (including full-sized fuel elements) having a thousand times this activity, upon which it will be possible to make precise measurements of many physical and metallurgical properties.

Research for the reactor programme in the Chemistry, Chemical Engineering and Metallurgy Divisions is most important, especially in the development of nuclear fuels, which present some of the most difficult problems in the whole of atomic energy. An allied group of problems arises from the need to process fuel for removal of fission products and separation of newly-created fissile material; the cost of this processing has a profound effect upon the economics of power generation. One promising line of attack is the development of pyrometallurgical methods in which the fuel is kept in metallic form throughout the operation, instead of being treated in aqueous solution.

Zeus, another zero-energy fast reactor. In this the fuel is uranium-235 in aluminium-canned rods which are disposed in an hexagonal core. The core is surrounded by a reflector of natural-uranium rods in which plutonium is bred. This reactor was built to study the physics of the Dounreay fast reactor. The sodium coolant of the latter is simulated in Zeus by light metals having similar nuclear properties.




DANGER.
NEUTRON
BEAM
WHEN
PILE
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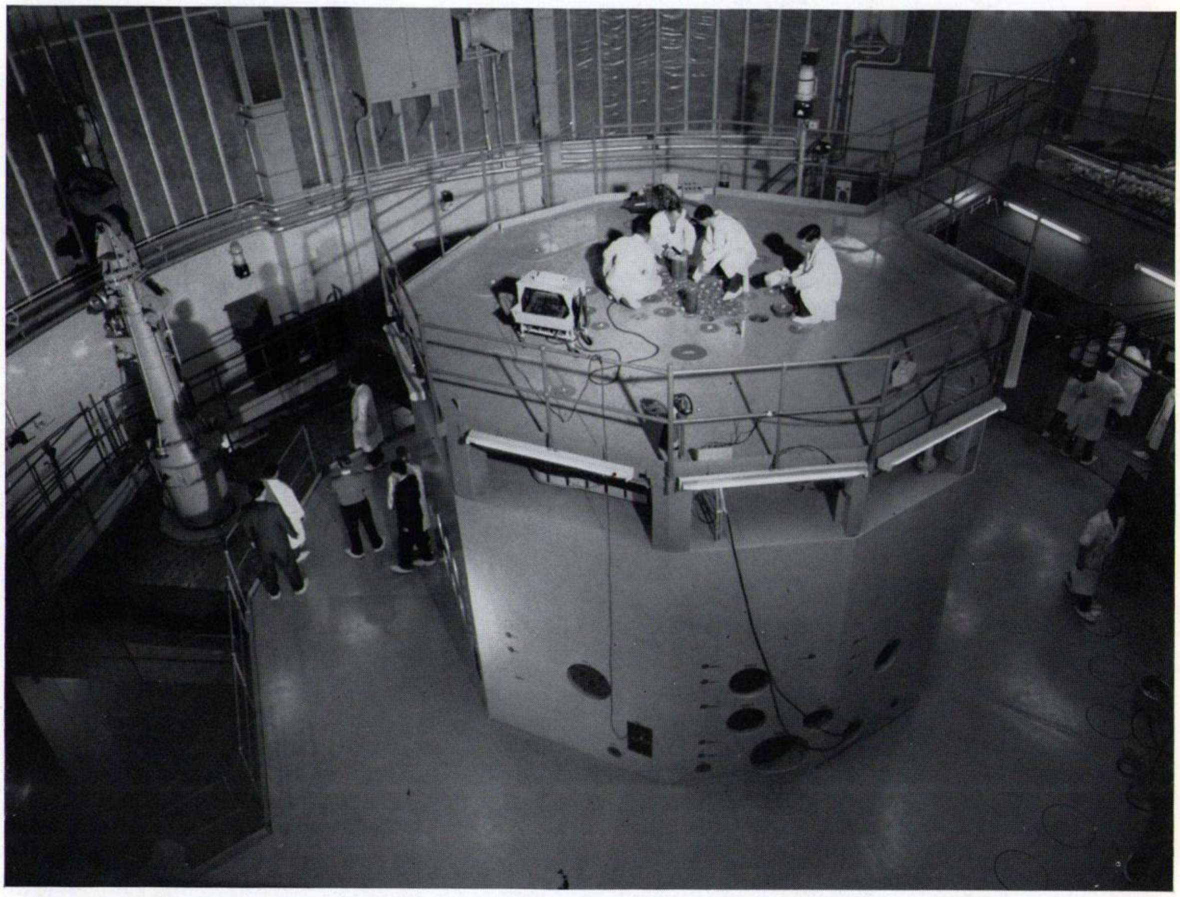
TRAP.

OPPOSITE TOP

Bepo, the 6 MW natural-uranium graphite-moderated research reactor. On the left is the discharge face, on the right the experimental face. On this face and the top of the pile some fifty experiments can be set up. In the near corner is the control panel of a pressurized-water loop. Bepo is also the principal U.K. producer of radioisotopes.

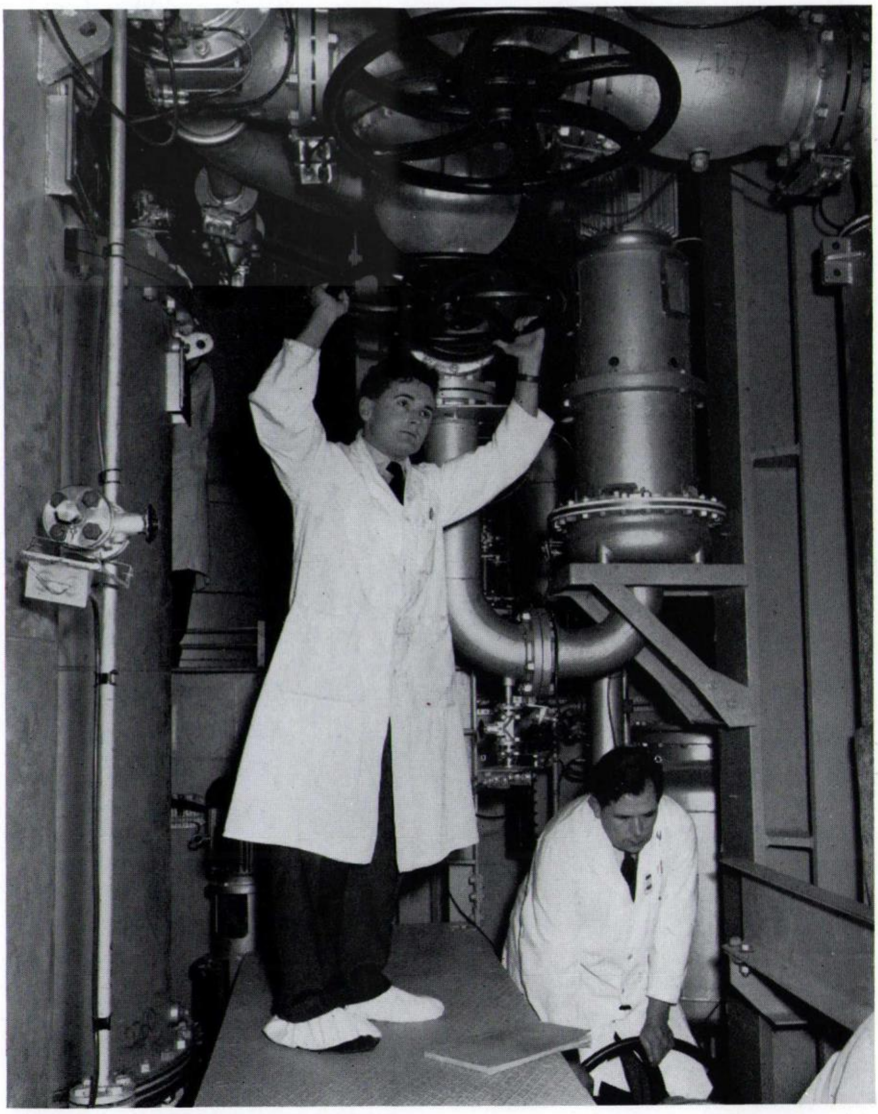
OPPOSITE BOTTOM

An experiment with Bepo: the flight tube of the velocity selector used for measuring neutron cross-sections at low energies. Designers need to know accurately the nuclear cross-sections, over a wide range of neutron energies, of all the materials, including impurities, likely to be present in a reactor; several different methods have to be used to obtain these data.



Dido, showing the ten-sided concrete shield with some of the holes (blocked by shielding plugs) into which samples are inserted for irradiation. Dido is housed in a cylindrical steel pressure vessel designed to contain any radioactive material that might be released accidentally.

Pumps and heat exchangers underneath Dido. The heavy water is pumped through the core where it is heated; the warm heavy water is then cooled by ordinary water in these heat exchangers and recirculated to the core.



The Isotope Programme

Another important part of A.E.R.E.'s work is the production of radioisotopes and the development of new applications, particularly to industrial processes. During the last year consignments worth over £500,000 were despatched, more than half of them overseas. Most isotopes are made by irradiation in Bepo; the new reactors Dido and Pluto will be used to produce some isotopes with higher specific activity. The Isotope Division at Harwell is responsible for irradiations in the reactors and accelerators, including special irradiations, and for beta-gamma-active products not requiring chemical processing after irradiation; the Division is responsible also for marketing separated stable isotopes. Radioisotopes which have to be separated chemically from irradiated material are prepared at the Radiochemical Centre, Amersham (an outstation of A.E.R.E) which also produces and markets natural radioactive materials and labelled compounds of all degrees of complexity.

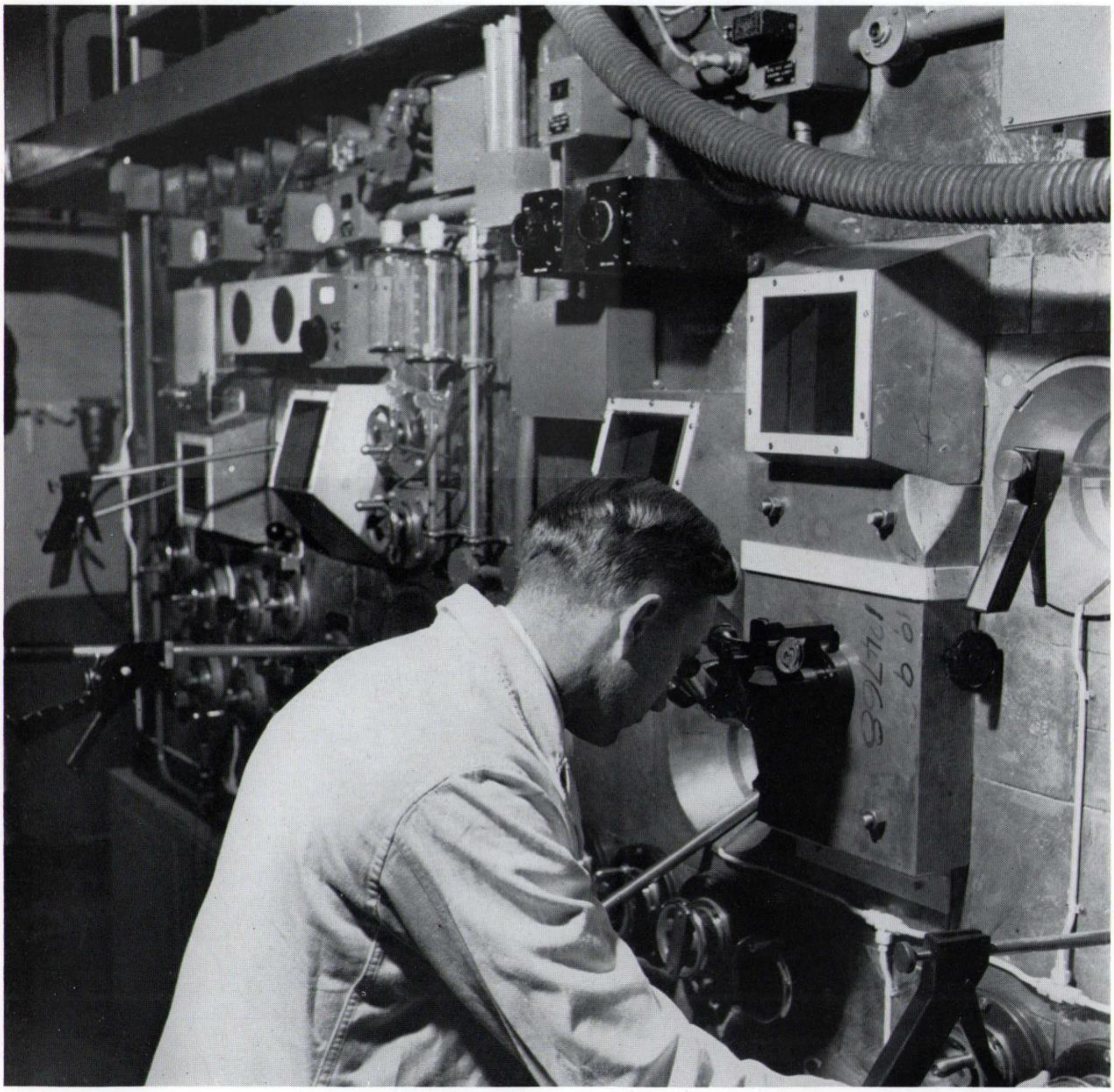
Much progress has been made in co-operation with the Industrial Group on the separation of caesium-137 and strontium-90 from fission product wastes of the plutonium plant at Windscale. The first large caesium-137 sources have already been installed in British hospitals and there will be an increasing demand for this and other separated fission products.

The Isotope Division runs a consultant service for industry which is continually developing new industrial and research applications of radioisotopes. Recently the Division has extended its work by forming a Technical Irradiation Group to develop a close collaboration with industry in exploiting large sources of radiation such as will become available as more nuclear power stations are built and produce more fission product wastes. In its new irradiation laboratories near Wantage the Group is studying, among other applications, the use of radiation to preserve food-stuffs, sterilize pharmaceuticals, produce new strains of seeds for agriculture, and to accelerate or initiate chemical reactions or treat plastics and rubbers to give them improved properties.

The radioactive and stable isotopes marketed by the Isotope Division and the Radiochemical Centre are listed in catalogues published by these two departments. The Isotope Division catalogue can be obtained from the Isotope Information Office, A.E.R.E., which also deals with enquiries about the isotope advisory and experimental service. The catalogue of Amersham's products can be obtained from the Radiochemical Centre. Information about the four-week postgraduate training courses in isotope techniques, which are given at Harwell, will be supplied by the Isotope School, A.E.R.E.

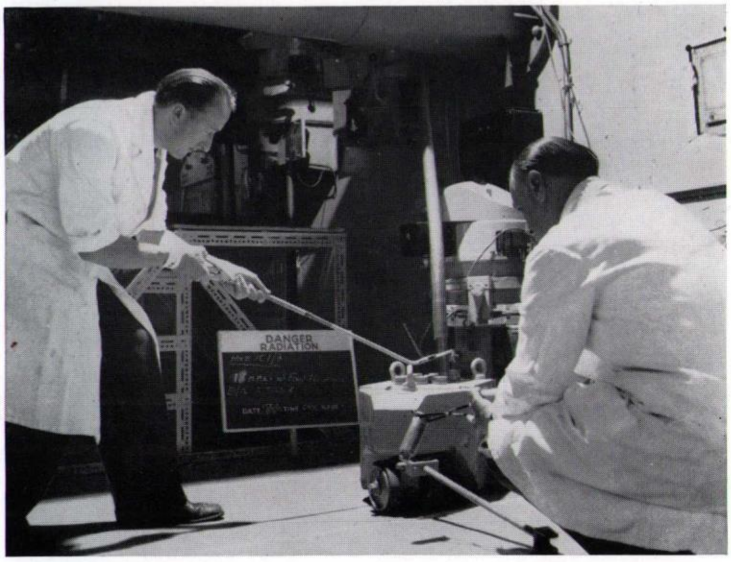
Fundamental Research

It is of vital importance that in an establishment whose main purpose is to explore a new and wide field of science there shall be men of independent mind who can approach a subject from a fundamental standpoint unhampered by the urgent problems of technological applications. To provide an atmosphere

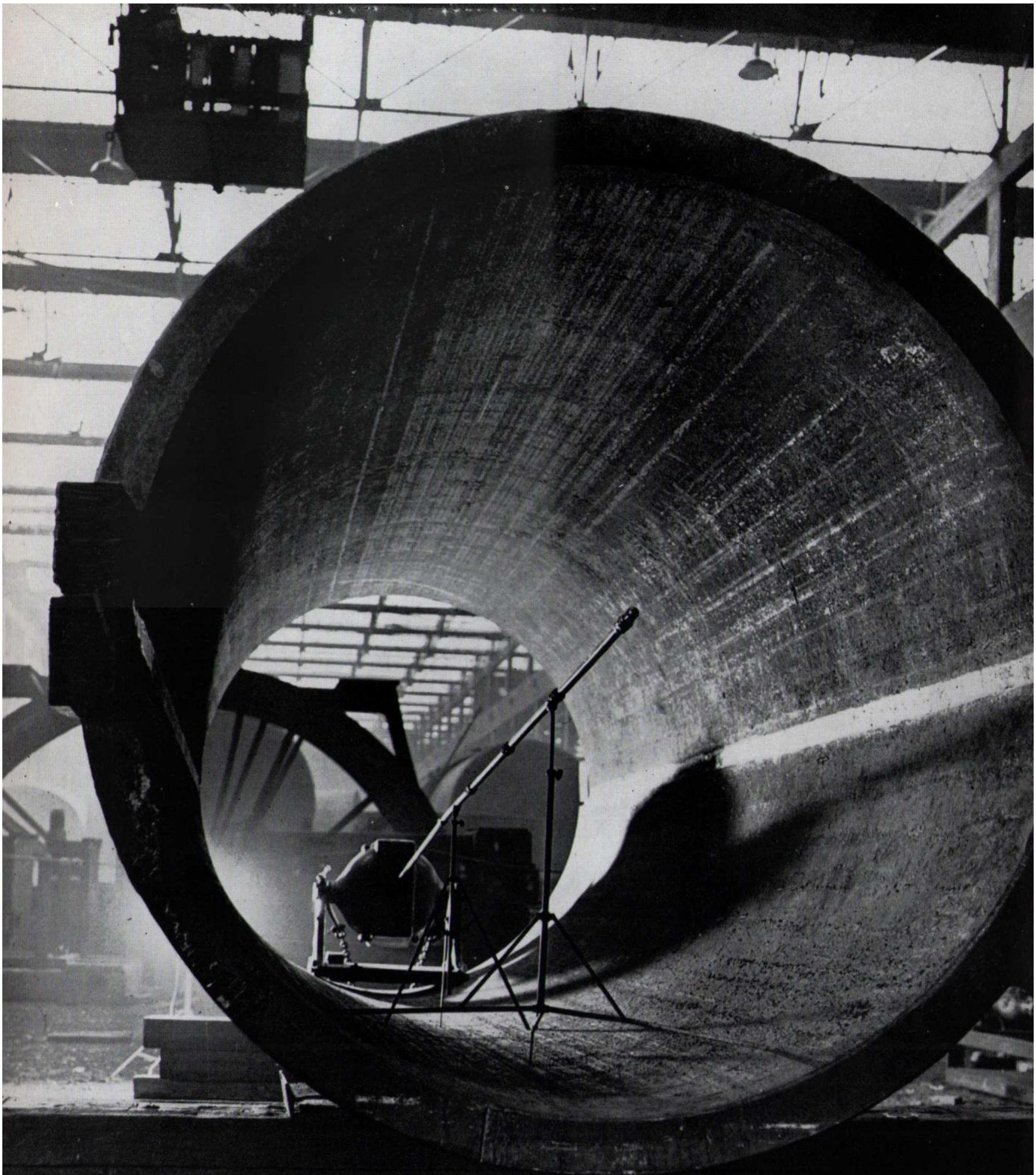


Heavily shielded apparatus, operated by remote control, used for experiments on high-temperature processing of irradiated fuel. Processing costs are an important element in the cost of nuclear power; it may be possible to reduce them by keeping the fuel in the metallic state and removing fission-products by slagging or other metallurgical methods.

Radioisotope production: the apparatus used for putting samples of inactive material into Bepo, where they are transmuted into radioisotopes.



Radioisotope production: an irradiated sample being removed from the reactor into a lead trolley for transport to the processing or packing centre.



in which men of this kind can work effectively, it has always been the policy at Harwell to devote about 20 per cent. of the effort to fundamental research in nuclear physics, radiochemistry, solid-state physics, theoretical physics and like fields.

For experiments in nuclear physics there are available, besides the reactors, a 110-inch synchrocyclotron, a 3·5-MeV Van de Graaff generator, and a 15-MeV linear accelerator used principally as a pulsed neutron source. Design of new accelerators is one of the responsibilities of the General Physics Division, which is building, in collaboration with industry, a 50-MeV proton linear accelerator. In addition, design studies are being made of a new type of proton synchrotron to accelerate protons to 6,000 – 7,000 MeV with an intensity in the beam considerably greater than that in existing high energy machines.

The General Physics Division has a long-term research programme on the possibility of controlling thermonuclear reactions. This is of great scientific interest since the field of research combines both high temperature and nuclear physics. Ultimately this work may enable power-generating fusion reactors to be built but there is still far to go before such become practicable.

Nuclear physicists studying the cosmic radiation, especially the properties of the extensive air showers, have built a very large array of Geiger counters; this appears to be the best instrument available anywhere for determining the absolute intensities of particles at high energies, and the only one for studying time variations in the highest energy region.

Important programmes of research in the Chemistry Division include studies of the heavy elements from thorium upwards, and work on radiation chemistry, using neutrons in Bepo and electrons and gamma-radiation from a 2-MeV Van de Graaff machine. Research in the Metallurgy Division includes studies of the curious solid-state properties of uranium and plutonium, of the effect of radiation on metals generally and particularly on fissile metals, and of corrosion.

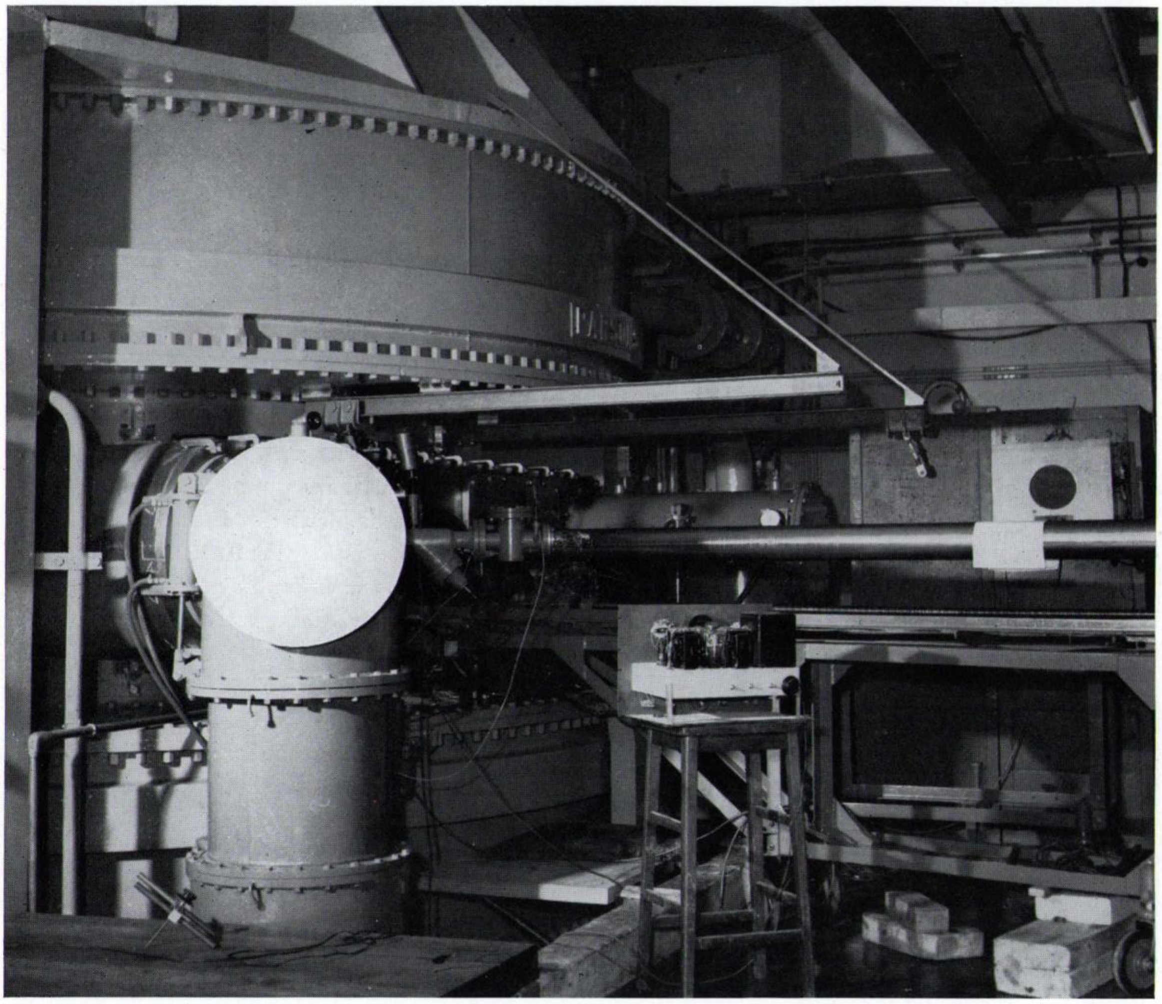
Health Physics and Electronics

It is well known that exposure to penetrating radiation and to some radioactive isotopes is detrimental to health unless the exposure is limited to low values which are laid down in internationally-agreed standards. To ensure that these standards are adhered to both inside and outside the Establishment, the Health Physics Division operates a comprehensive radioactivity monitoring

OPPOSITE

Using a radioisotope (contained in the axial tube) as a source of gamma rays to radiograph a joint. There are many industrial applications of radioisotopes, especially to process control, inspection, and testing. Photo: G. A. Harvey Ltd, Greenwich.

Looking along the outer vacuum envelope of the proton linear accelerator. The 50 MeV accelerating tube, in three sections, is more than one hundred feet long and over this length, axial alignment is accurate to 0·02 inches. Particle accelerators like this are essential tools for the nuclear physicist. His studies of the structure of the nucleus depend upon experiments on the interactions between nuclei and elementary particles at all energies; these machines provide the required particles.



The 110*-inch synchrocyclotron is capable of accelerating protons to* 180 *MeV. In this picture the circular horizontal magnet polepieces can be seen and, in the foreground, one of the large vacuum pumps. Among the more important experiments that have been done with the cyclotron have been measurements of cross-sections at high energies and studies of the polarization of protons and neutrons when these particles are scattered at various energies by nuclei of different masses.*

service over a considerable area around Harwell as well as within its buildings. The Division is consulted at an early stage in the design of experiments, to ensure that all possible protection is provided. Research to extend the principles upon which protection is based has included important studies of the fallout of radioactive material after nuclear explosions.

Radiation monitoring is but one of many operations in nuclear science that require electronic equipment of specialized design. Most of this equipment can now be supplied by industry, which has collaborated closely with Harwell from the earliest days when nearly all this apparatus had to be developed and made at the Establishment, but special equipment is often wanted in the laboratories or for instrumentation of new reactors. These demands are met by a programme of electronic development and of research into new techniques, such, for instance, as the application of transistors.

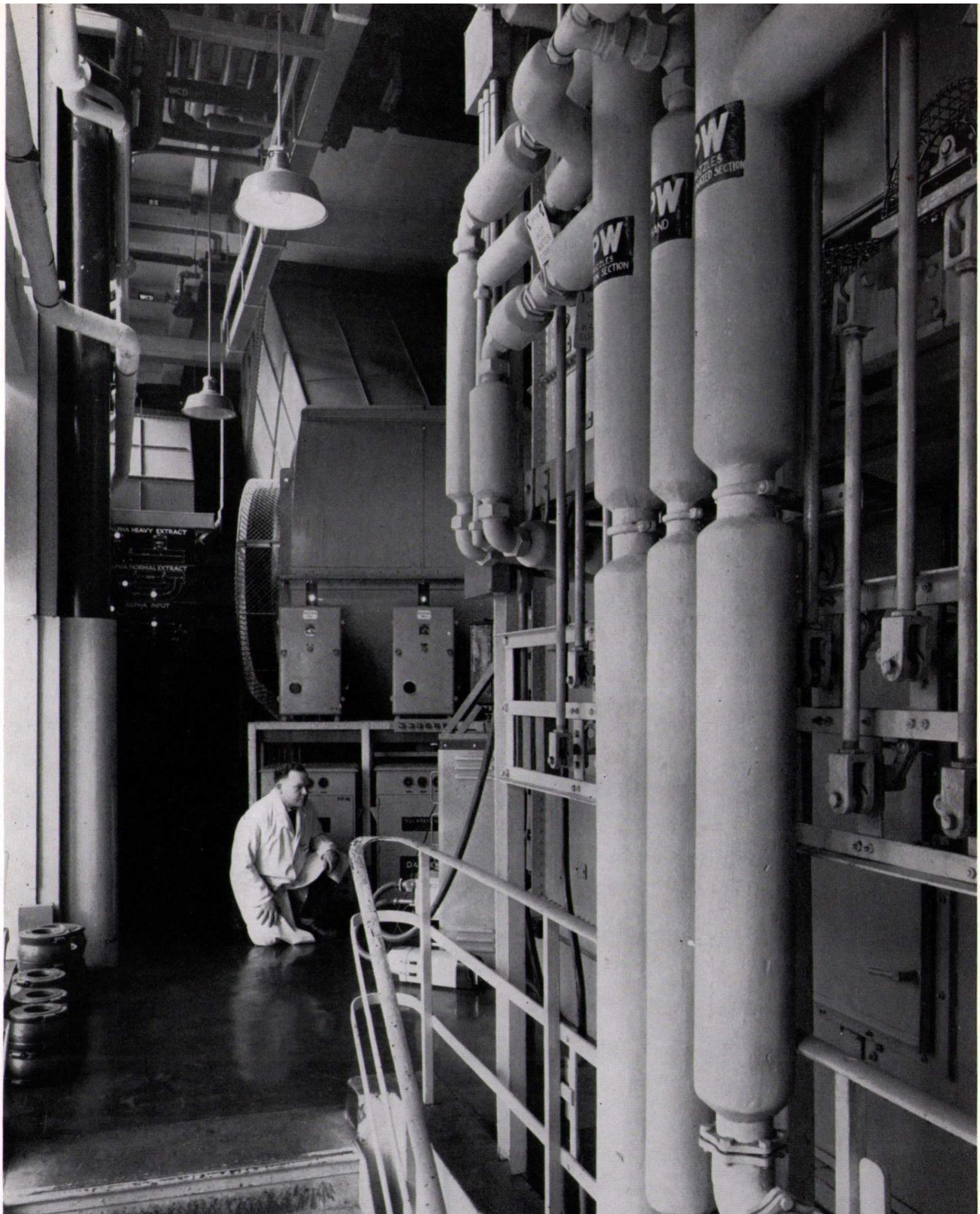
Library and Information Service

The results of work at Harwell are published in two ways: first through the normal medium of scientific and technical journals, and second in the form of unclassified (i.e. non-confidential) reports. These reports are available to the public through certain libraries designated as depositories by the Authority; many of them are also on sale through Her Majesty's Stationery Office. A list of reports, translations and patent specifications, published by the Authority and of articles in periodicals by Authority Staff, is issued each month by the Library at Harwell and may be obtained free from the Librarian. Other lists and general bibliographies of Authority publications are detailed in a recent pamphlet A.E.R.E. Lib/L1 *Sources of information in atomic energy*, a copy of which will be sent free on application to the Librarian.

Special bibliographies on selected subjects are prepared from time to time by the Information Office at Harwell and, within the limits of available effort, the office will compile other bibliographies in answer to requests from industry, universities, and other research institutions.

The A.E.R.E. Library holds a comprehensive stock of atomic energy literature, and material that cannot be obtained elsewhere may be borrowed by other libraries through the normal library channels; material cannot be lent to individual enquirers.

OPPOSITE
Air-conditioning and ventilating plant occupies the entire upper storey of the radio-chemical laboratory, Building 220. By this plant, the air in the laboratories can be changed up to 120 times a minute to remove all traces of radioactivity.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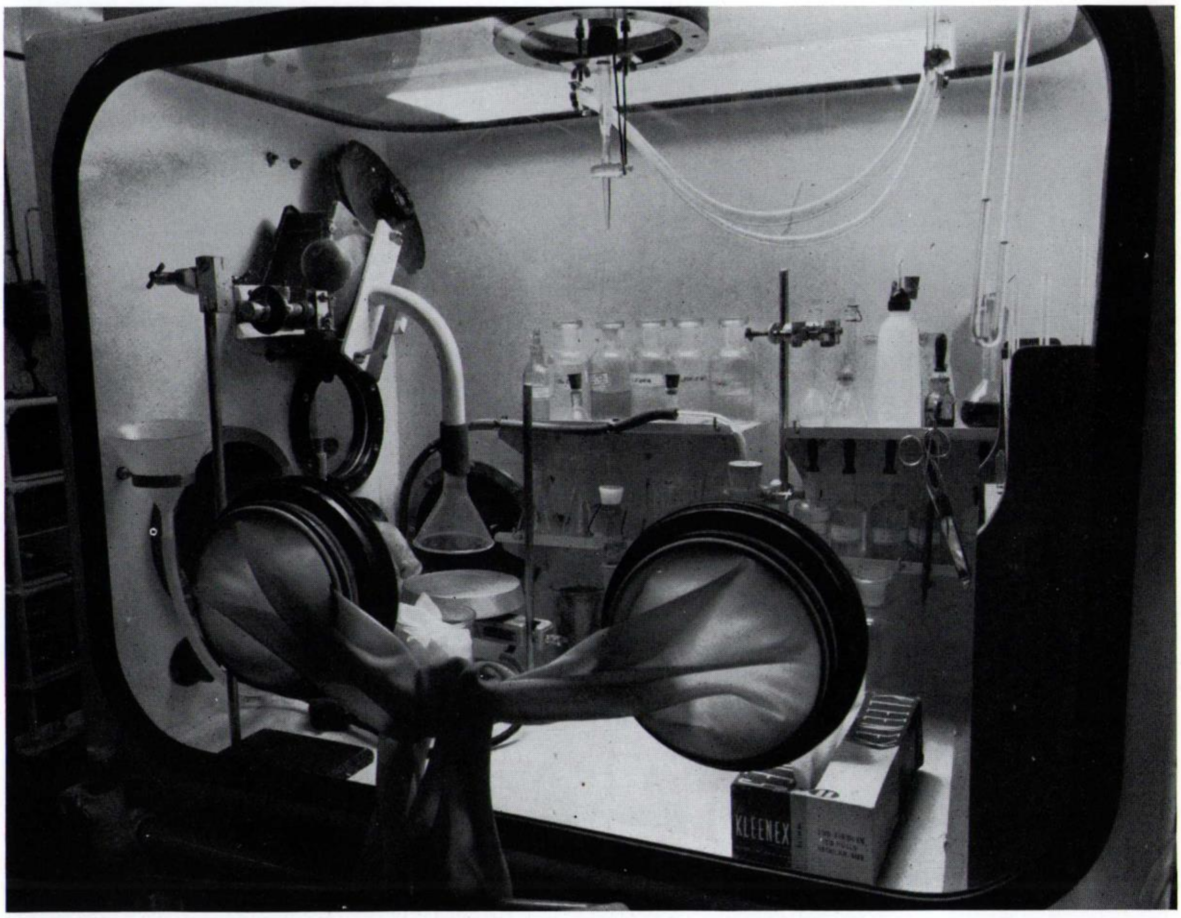
ALPHA INPUT

Industrial Collaboration and Extra-mural Research

Harwell's share in the Authority's important task of disseminating knowledge of nuclear technology in industry is to supply information about research work. A great part of the Establishment's work is available through the publications just described, but for many purposes industry requires access to information that is confidential because it has military or commercial value. To provide for this the Authority may make 'access agreements' with individual firms to cover

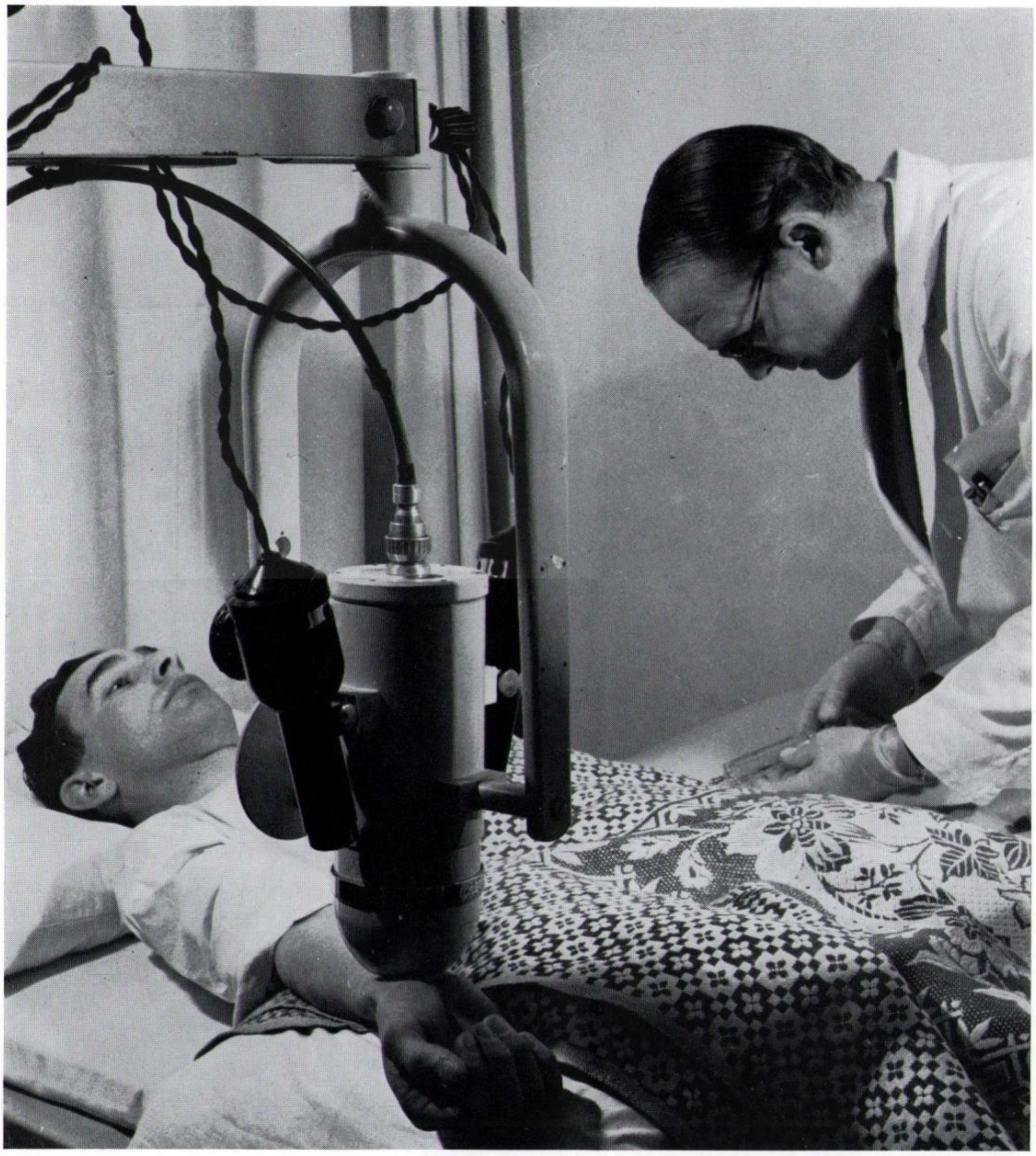
specified fields of knowledge. Access agreements relative to A.E.R.E. work are made through the Industrial Collaboration Office at Harwell to whom enquiries should be addressed.

The same Office is responsible for initiating contracts for extra-mural research and development. It has always been the policy at A.E.R.E. to use whenever practicable the special skills and experience of industry in development and to enlist the aid of university departments for research in the more academic problems.



A plutonium glove-box. Apparatus is manipulated with double PVC gloves sealed into the perspex wall; air pressure within the box is below atmospheric, so that all leaks are inwards.

OPPOSITE
Glove boxes in the plutonium laboratory. Methods by which plutonium might be used as fuel for future reactors are being studied.



Radioisotopes have many applications to medical research; they are also useful in diagnosis and therapy. In this picture (taken at the Royal Marsden Hospital) the rate at which blood flows from wrist to wrist, is being determined by injecting an isotope into one wrist and detecting its arrival by a counter placed over the other.

List of Addresses

United Kingdom Atomic Energy Authority
St. Giles Court, 1/13 St. Giles High Street, London, W.C.2
Telephone Museum 6838

U.K.A.E.A. Research Group
Atomic Energy Research Establishment
Harwell, Didcot, Berks.
Telephone: Abingdon 1220

U.K.A.E.A. Industrial Group
Industrial Group Headquarters
Risley, Warrington, Lancs.
Telephone: Warrington 2170

U.K.A.E.A. Weapons Group
Atomic Weapons Research Establishment
Aldermaston, Berks.
Telephone: Reading 0060

The Radiochemical Centre
White Lion Road, Amersham, Bucks.
Telephone: Little Chalfont 2278

Atomic Energy Authority Factory
Western Road, Binfield, Bracknell, Berks.
Telephone: Bracknell 1078

U.K.A.E.A. Research Group (Wantage)
Wantage Radiation Laboratory
Grove, Wantage, Berks.
Telephone: Wantage 458

U.K.A.E.A. Research Group (Woolwich)
Woolwich Outstation
Building C.37, Royal Arsenal, Woolwich, London, S.E.18
Telephone: Woolwich 2044

U.K.A.E.A. Research Group (Chatham)
Chatham Outstation
H.M. Gun Wharf, Chatham, Kent
Telephone: Chatham 4201

Some Publications on the Work of the U.K.A.E.A.

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Films on Atomic Energy

A full list of 145 films on atomic energy and related matters has been prepared by the Scientific Film Association and published in the Scientific Film Review vol. 2 No. 4 (October 1956); copies of the journal may be obtained from the Editorial Office, 164 Shaftesbury Avenue, London, W.C.2 price 3s. 9d. A short list of films may be obtained gratis from the Scientific Administration Office, A.E.R.E.

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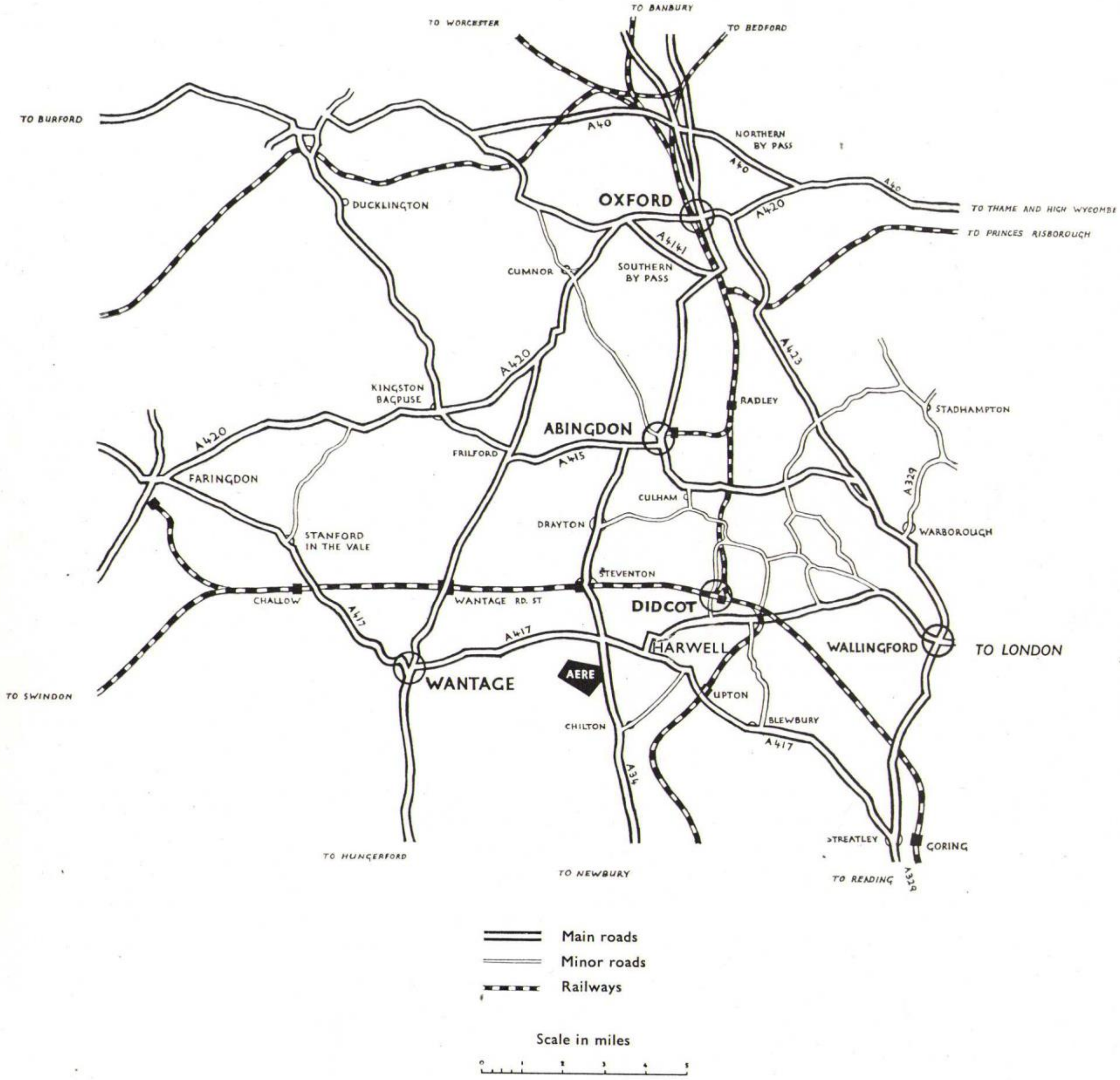
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