several widely separated laboratories under different administrative authorities. Some such committees provide an invaluable advisory body for work going on in the Council's own laboratories. It is thus ensured that the best talent within and without the Council organization participates in the direction of the work. On occasions the problems of a particular industry have been solved by the active cooperation through an Associate Committee of the National Research Council and firms dependent upon the industry. Under these circumstances all generally take their proportionate share of financing.

Each year the Council spends very substantial sums—of the order of a million dollars in the last fiscal year—on grants in aid of research to Canadian universities and some other organizations. These grants provide apparatus and trained assistants to researchers who might otherwise find it difficult to carry on their work. Funds are also dispensed for a very large number of scholarships, awarded by the Council to Canadian students studying for their doctorate. Recently a generous system of post-doctorate fellowships tenable in the Council's laboratories was established. These are open to applicants from abroad as well as in Canada and pay slightly under $3000 free of income tax. In this way techniques developed in other countries are brought to Canadian research in a direct and practical way. At the same time closer personal bonds will be established with workers in other countries.

Within the Council's laboratories, physical research is concentrated mainly in the Division of Physics at Ottawa and in the Atomic Energy Project at Chalk River. However, because physics has entered into so many other branches of science a fair amount of physics is done in other divisions of the Council's laboratories. In the Division of Physics at Ottawa a very well equipped laboratory for research in molecular spectroscopy and allied fields is nearing completion. Cosmic rays are studied by photographic plates, Geiger-Müller counters, and ionization chambers both at Ottawa and in the Canadian Arctic. An optics laboratory is pursuing research in such fields as high speed cinematography, photographic optics, air photography, colorimetry, photometry, photogrammetry, and spectro-chemical analysis. Other groups are studying the thermal conductivity of metals, the physics of housing problems, industrial radiology, acoustics, electricity, x-ray diffraction, electron microscopy, and nuclear physics.

At Chalk River the heavy water pile has a high neutron flux of 4.3×10^{12} neutrons per square centimetre per second which at the time of writing is still the highest flux obtainable anywhere. This makes possible many investigations which would otherwise not be feasible. For example, the lifetime of the neutron has been determined recently, its half-life being twenty minutes. In addition much other work in nuclear physics is going on. A five Mev Van de Graaff accelerator is nearing completion. Considerable attention is given to the production of radioactive isotopes. The usefulness of these to industry is studied as a cooperative investigation with the Industrial Radiology Laboratory of the Division of Physics.

Statistics do not always prove what is intended, but it is at least interesting to note as a measure of the physical development of the National Research Council's activities that the staff has increased from a few hundred at the outbreak of the war to just under three thousand at the time of writing.

Other Research Organizations

During the war the National Research Council acted as the research organization for the three armed services. At the close of the war it was decided, as a matter of policy, that the responsibility for defence research should be given to a separate body so that the Council would be left free to devote itself to its primary purposes. The Defence Research Board was therefore created and charged with the responsibility for all defence research. Although separated administratively, the two organizations work closely together and the President of the Council is a member of the Defence Research Board. The Defence Research Board maintains laboratories, makes grants in aid of research to other organizations, and awards scholarships. Much of its work is in the field of physics. Radio propagation, ballistics, marine physics, and Arctic research problems are among the more important studied in the Board's own laboratories at Valcartier, Ottawa, Churchill, and Esquimalt.

The Department of Mines and Resources has two important branches doing a considerable amount of physical research. The Dominion Observatory at Ottawa studies meteor physics, maintenance of time standards, seismology, geomagnetism, and similar problems, while the observatory at Victoria, British Columbia is devoted mainly to astrophysics. The Department also supports a metallurgy laboratory which is unsurpassed in Canada for the study of metals and alloys. Here physicists, in cooperation with metallurgists, are taking advantage of the excellent facilities to study the mechanical properties of metals and reconcile them with the concepts of modern quantum physics.

Most of the provincial governments of Canada either have already established or are considering the establishment of provincial councils, foundations, or boards intended to concern themselves specifically with research problems of peculiarly provincial concern. A goodly fraction of such work is in the physical sciences. In general, these provincial bodies are organized in a way that rather closely parallels the National Research Council of Canada. Under a governing board they maintain laboratories to varying degrees, make research grants, award scholarships, and sponsor committees in particular fields. These provincial organizations work in close cooperation with the National Research Council of Canada. One provincially supported organization somewhat different in character to the others because of the specialized nature of its work is the Manitoba Cancer Institute. This organization is very successfully coping with the problems of bringing physics to the service of medicine.

The Universities

The research work carried out in universities benefits to a large extent from the coordination effected through

the grants in aid of research from the National Research Council, the Defence Research Board, and the provincial governments. These bodies keep aware of the support each is giving in various fields. McGill University has been famous for its physical research since Lord Rutherford occupied the Macdonald Chair of Physics and carried out there his early and revolutionary work on radioactivity. It was here, under Rutherford, that O. Hahn obtained his early training in radioactivity. Since Rutherford's time McGill has been well known in other fields. The work on the Stark effect should be noted. A cyclotron just completed will provide splendid opportunities for research in nuclear physics. A new electronics laboratory was recently established to carry out work in microwave physics.

MacLennan did for the University of Toronto what Rutherford did for McGill. While head of the physics department from 1907 to 1932 he established a large well equipped laboratory for spectroscopy and the first cryogenic laboratory on this continent. The research tradition is being well maintained by the present staff in these and other fields. Research at Toronto on electron microscopy is well known. For a little over a year the department has been headed by the outstanding geophysicist, E. C. Bullard, who started there a series of important geophysical investigations. Unfortunately, Canada is losing him at the end of this year when he goes to take up his appointment as director of the National Physical Laboratory in Great Britain.

On the west coast, the University of British Columbia is making a strong bid to become one of the best schools of graduate physics and research in Canada. Facilities for granting PhD's in physics were recently established under its large and distinguished faculty. Work has been commenced in nuclear physics, theoretical physics, spectroscopy, and several aspects of the solid state. A Van de Graaff generator will be shortly in operation.

At Queen's University a seventy Mev synchrotron is being installed. Excellent research facilities for nuclear physics will thereby be provided. The Queen's department of physics is also active in other fields of physics, particularly optics. The French-speaking universities of Montreal and Laval are attaching a high importance to research in physics. At the University of Montreal cosmic rays are being studied by photographic and cloud chamber techniques. Electron diffraction by gases is being used for the determination of molecular structure. At Laval University beta ray spectroscopy and mass spectroscopy are receiving considerable attention.

There have long been interesting and important investigations on the properties of pleochroic haloes at Dalhousie, the oldest university in Canada, established at Halifax, Nova Scotia in 1789. This work is continuing. Nuclear induction experiments have been in progress for approximately two years. Researches are projected on the study of proton relaxation times in various molecular substances and the precision measurements of nuclear moments.

Microwave radiation is receiving much attention at the University of Western Ontario at London, Ontario. Work is being initiated in infrared and ultraviolet spectroscopy. The Medical School has a department of biophysics which is a subdepartment of physiology. First class opportunities are provided here for the application of modern physics to biological problems. McMaster University, at Hamilton, Ontario, has, in its physics and chemistry departments, important researches on mass spectrometry, beta ray spectroscopy, and microwave physics.

The provincial universities of Manitoba, Alberta, and Saskatchewan are all actively supporting physical research in various fields, particularly spectroscopy and nuclear physics. A twenty-five Mev betatron (the only one in Canada) has been installed at the University of Saskatchewan by funds provided from the Canadian Atomic Energy Control Board, the National Research Council, and the Cancer Institute of the Province of Saskatchewan. Fundamental as well as applied medical work is being carried out with this betatron. In addition studies of the upper atmosphere, the physical properties of snow, and specific heats of gases are being pursued in the physics department while the chemistry department is applying radioactive tracers to a variety of problems.

Industry

Before the war Canadian industry had very limited interest in physical research. This picture has now completely changed as a result of the great increase in industrialization to meet war requirements. No great powers of prophecy are needed to foresee that this trend is in-

Chalk River plant. The large building at the left houses the pile.
National Film Board of Canada