TWENTY-FIRST ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL OF CANADA

1937-1938

OTTAWA, CANADA

Price, 75 cents

N.R.C. No. 807

TWENTY-FIRST ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL OF CANADA

1937-1938

OTTAWA, CANADA

THE HON. W. D. EULER,

Chairman, Committee of the Privy Council on Scientific and Industrial Research,

Ottawa, Ontario.

SIR:

I have the honour to present to you herewith the Twenty-first Annual Report of the National Research Council, for the fiscal year 1937-1938.

In accordance with the requirements of the Research Council Act, this report contains the report of the President and a statement of the receipts and expenditures of the Council during the year under review.

Your obedient servant,

A. G. L. MCNAUGHTON,

President, National Research Council.

73461—1½

THE COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

MINISTER OF TRADE AND COMMERCE, *Chairman*
MINISTER OF FINANCE
MINISTER OF MINES AND RESOURCES
MINISTER OF AGRICULTURE
MINISTER OF PENSIONS AND NATIONAL HEALTH
MINISTER OF LABOUR
MINISTER OF NATIONAL DEFENCE

NATIONAL RESEARCH COUNCIL
1937-1938

President:

MAJOR-GENERAL A. G. L. MCNAUGHTON, C.B., C.M.G., D.S.O., M.Sc., LL.D., D.C.L., Ottawa, Ont.

Secretary-Treasurer:

S. P. EAGLESON, ESQ., Ottawa, Ont.

Members:

SIR FREDERICK BANTING, K.B.E., M.C., M.D., LL.D., D.Sc., F.A.C.P., F.R.C.P., F.R.C.S., F.R.S.C., F.R.S., Professor of Medical Research and Head of the Banting Institute, University of Toronto, Toronto, Ont.

H. E. BIGELOW, A.M., Ph.D., F.R.S.C., F.C.I.C., Carnegie Professor of Chemistry, Mount Allison University, Sackville, N.B.

E. F. BURTON, B.A., Ph.D., F.R.S.C., Professor and Head of the Department of Physics and Director of the McLennan Laboratory, University of Toronto, Toronto, Ont.

W. R. CAMPBELL, ESQ., President and Treasurer, Ford Motor Company of Canada, Ltd., Windsor, Ont.

A. L. CLARK, B.Sc., Ph.D., F.R.S.C., Hon. M.E.I.C., Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.

R. H. CLARK, M.A., Ph.D., F.R.S.C., F.C.I.C., Professor and Head of the Department of Chemistry, University of British Columbia, Vancouver, B.C.

E. P. FETHERSTONHAUGH, M.C., B.Sc., F.R.S.A., M.E.I.C., Dean, Faculty of Engineering and Architecture, University of Manitoba, Winnipeg, Man.

A. FRIGON, C.E., E.E., D.Sc., A.M.A.I.E.E., A.M.E.I.C., Assistant General Manager, Canadian Broadcasting Corporation, 1440 St. Catherine Street W., Montreal, Que.

A. S. MACKENZIE, Ph.D., D.C.L., LL.D., F.R.S.C., 25 Kent St., Halifax, N.S.

C. J. MACKENZIE, M.C., B.E., M.C.E., Dean, Faculty of Engineering, University of Saskatchewan, Saskatoon, Sask.

JULIAN C. SMITH, M.E., LL.D., M.E.I.C., President, Shawinigan Water and Power Co., 611 Power Bldg., Montreal, Que.

R. J. TALLON, ESQ., Secretary-Treasurer, Trades and Labour Congress of Canada, 172 MacLaren St., Ottawa, Ont.

MGR. ALEXANDRE VACHON, M.A., Ph.M., S.T.D., D.Sc., LL.D., F.R.S.C., F.C.I.C., Dean, Faculty of Science, Université Laval, Quebec, Que.

R. C. WALLACE, M.A., Ph.D., D.Sc., LL.D., F.G.S., F.R.S.C., Principal, Queen's University, Kingston, Ont.

TABLE OF CONTENTS

TWENTY-FIRST ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

REPORT OF THE PRESIDENT

New Developments

One of the most important functions of the National Research Council is to provide a mechanism for correlation and co-operation in carrying forward scientific and industrial research. The undermentioned inventions and developments represent some items of recent progress in research under the National Research Council and its Associate Committees. They represent the product of the many organizations and many individuals, in addition to those comprising the staff of the Council's laboratories, who have worked together under the auspices of the Council.

1. Production of disease- and drought-resistant varieties of grains and grasses.
2. New rapid method of indicating oil content of flax seed developed.
3. Quality tests on wheat grades provided for the Grain Standards Committee.
4. Determination of the suitability of new wheats for public distribution on the basis of quality.
5. Malting tests developed to provide accurate information in breeding commercially valuable barleys.
6. Fundamental information collected on root systems of crop plants and weeds for use as a guide to efficient crop production and weed control.
7. Inexpensive method developed to produce plant hormones.
8. Plant hormone research applied in farm, forest, and horticultural work.
9. Simple method devised for the wax plucking of poultry.
10. Means developed for the prevention of drying of foodstuffs in refrigerators.
11. Method of packaging stored poultry improved.
12. Freezer burn in stored poultry overcome.
13. Investigation of the curing and pickling of bacon for export trade undertaken in co-operation with the packers.
14. An efficient device for heating refrigerator cars designed; this is now in extensive use on the Canadian National Railway System.
15. New plant types developed by heat treatment of seed.
16. New and superior refractories produced from Canadian raw materials.
17. Process developed to increase the yield of carbon black and motor fuel from waste Turner Valley natural gas.
18. Process developed for the production of non-mottled cast maple sugar and concentrated maple flavours.
19. Modified potato starches produced to meet domestic and industrial needs.
20. New process devised for the grading of sugar.

21. New and highly efficient distillation apparatus developed; this invention is now coming into use in a number of industries.
22. Design for streamlined locomotive developed; this design has been used by the Canadian National Railway System and in part by other railways.
23. Farm windmills for use in charging batteries designed.
24. Improvements made in seaplane floats and aeroplane skis.
25. Insulating values of building materials and clothing investigated.
26. Method of bonding metal and rubber developed and improved.
27. High voltage apparatus designed and built and put into use for standardizing X-ray equipment for medical use, and for detecting flaws in castings and forgings, etc.
28. Electric surge generator designed and built for the testing of transmission-line and other insulators.
29. The Standard Kilogramme established for Canada, as required by an Act of the Parliament of Canada of 1914.
30. Apparatus for the precise calibration of standard gauges for industry designed and built.
31. Basis laid and plans developed for the better organization of medical research.
32. Tuberculosis control and prevention measures investigated.
33. Co-operative forest research: Representative committee organized and progress made.
34. Investigation of damage to vegetation from smelter smoke completed and scientific information provided that served as a basis for the findings of an International Tribunal, as well as for further progress in studies in plant physiology.

Organization

The National Research Council consists of fifteen members selected, for terms of three years, from among men prominent in scientific work in Canadian universities or in Canadian industry. The Council is required by statute to meet at least four times annually in Ottawa. There is a President, appointed by the Governor-in-Council for a term of years, who reports directly to the Committee of the Privy Council on Scientific and Industrial Research, of which the Minister of Trade and Commerce is the chairman. The Council's membership is broadly representative of all parts of Canada and includes persons qualified to speak authoritatively on education, science, industry, labour, business and finance.

The Council is not part of a Government department; it is a corporate body capable of acquiring and holding money and property and of administering trusts related to science and research. An important advantage to the Council which comes from the type of organization prescribed is the facility afforded for collaboration and co-operation with the scientific services maintained by the departments of State as a necessary consequence of their administrative duties. Moreover, as a chartered corporation, the Council is able to deal with industry directly in negotiating agreements for the utilization of the results of research.

At the present time the staff of the Council, together with those working under committees appointed by the Council to carry out special investigations, comprises 251 men and women of whom 103 are university graduates.

The staff is organized in six divisions or sections: Biology and Agriculture, of which special mention is made in the Act; Chemistry; Physics and Electrical Engineering; Mechanical Engineering, including aeronautics and hydraulics; Research Plans and Publications; and Administration. Personnel can be grouped with complete freedom on particular problems as needs indicate.

Associate Committees

In order to correlate the work of all Canadian research organizations concerned with specific problems or groups of problems, a number of Associate Committees have been set up. These committees have been organized as a result either of the need for co-operative effort on a problem or for a study of the research needs and facilities in a given field, and the subsequent development of a programme to meet the needs by the most efficient use of the facilities available. Obviously the latter requirement involves a great deal of co-operation, and it has been the aim of the Council to foster that co-operation among scientific workers in universities and in other institutions including Government organizations. Under this policy, hundreds of men with scientific or industrial training have associated themselves with the Council in the work to which this training can give the greatest impetus, and have pooled their knowledge without reserve. The success of the Associate Committees is a monument to the good will and unselfish effort of Canadian scientists.

The Associate Committee on Medical Research may be cited as a recent example of the development of an Associate Committee. Preliminary discussions among representatives of the Canadian Medical Association, the Royal College of Physicians and Surgeons, the Department of Pensions and National Health, and the National Research Council, resulted in the calling of a Conference on Medical Research. At this Conference all Canadian organizations and institutions interested in medical research were represented. A composite picture of medical research in Canada was presented to the Conference as each institution reported on the scope of the researches in which it was engaged.

The Conference recommended that an Associate Committee on Medical Research should be set up by the National Research Council. This was done, and the Committee now has in hand the basic work of surveying the facilities for medical research in Canada. For this work, the Committee has been fortunate in securing the voluntary services of Sir Frederick Banting.

Matters of importance in connection with public health had not been overlooked in the years before the organization of the Associate Committee on Medical Research. For many years previously there had been in existence an Associate Committee on Tuberculosis, which included in its membership representatives of the medical faculties of universities, health units specializing in the control and treatment of this disease, and the Dominion Department of Agriculture, whose interests lay in the importance of a disease-free milk supply. One of the features of the work of this Committee was the study of Bacillus Calmette Guerin, known as B.C.G., as a means of control of tuberculosis in human beings as well as in cattle.

Tribute should be paid to the work done by committees that have been established long enough to have had an opportunity of showing the results of co-operation and integration. One of these, the Associate Committee on Grain Research, composed of trained men from the Dominion Department of Agriculture, the Board of Grain Commissioners, the universities of Manitoba, Saskatchewan and Alberta, and the National Research Council, has been in existence since 1926. In its early stages its primary interests were the production and grading of wheat. As the scope of the Committee's work was enlarged, subcommittees were formed to deal with soft wheat, barley,

and oil seeds, and through representation on these subcommittees other institutions, including the University of British Columbia, McGill University, the Dominion Seed Branch, as well as some industrial organizations, were associated with the work.

This Committee has an outstanding record of accomplishment in the solution of problems relating to bread wheat. It studied the drying of tough and damp wheat, and found the conditions under which this could be done without injury to the milling and baking quality of the grain. The limits of safety specified by the Committee are now being observed by all the commercial drier operators in Canada. The saving to Canadian farmers from this alone has been more than sufficient to pay the entire cost of all the Committee's investigations.

Facilities for the testing of malting quality of barley have been improved and arrangements made to ensure their efficient use in conjunction with breeding and field investigations. The technical requirements of the overseas and domestic markets have been studied, giving a sound basis for the improvement programme. An extensive investigation of cleaning and handling is being conducted, and the main sources of peeling damage have already been determined. This information is being used in an educational campaign for the elimination of the difficulty.

The discovery of the high quality of northern-grown flax, and the introduction of varieties suited to the high-quality areas, by members of the Subcommittee on Oil Seeds should lead to the conversion of some of the low-quality wheat acreage to the growing of high-quality flax.

Among the more important investigations initiated and conducted independently by the co-operating laboratories, in most cases with the financial assistance of the Committee, are: drought hardiness of cereals; quality of wheat grown on gray wooded soils; seed injury by fungicidal treatments; prevention of heating of damp grain in storage; proteins and diastase of barley; influence of weather conditions on growth and yield of wheat; factors influencing the carotene content of wheat. Early in the history of the Committee a Subcommittee on Methods was appointed and the co-operating laboratories are continually striving to improve methods of analysis and testing.

Another committee, whose functions relate to foodstuffs, is the Canadian Committee on Storage and Transport of Food. As its name implies, this organization deals with retention of quality in food in transit between the producer and consumer, and also in storage. The Committee grew out of a conference on cold storage held in 1934; from 1935 to 1937 three conferences were held to deal with problems in connection with market poultry. In January, 1938, the Committee was reorganized, and it is now a joint organization of the Dominion Department of Agriculture, the Fisheries Research Board, and the National Research Council. It has enlarged its field of investigation, and sections have been set up to deal with problems on *(a)* Fruit and Vegetables; *(b)* Meat and Meat Products; *(c)* Fish; *(d)* Engineering. A subsection or panel of the Engineering Section will deal with the control of taints in stored or transported products.

An instance of a committee appointed to work on a special problem is that of the Associate Committee on Trail Smelter Smoke, which was formed in 1929 to investigate for the Dominion Government the nature and extent of damage to vegetation in the northern part of the state of Washington by fumes from the smelter at Trail, B.C. This investigation was extended to include exhaustive experiments on the effect of sulphur dioxide on vegetation under controlled conditions. Not only has very complete information been obtained as to the conditions prevailing in the area in question, but important

data have been secured on a number of problems in plant physiology. This Committee was responsible for the presentation of the Canadian technical evidence before the International Joint Tribunal, presided over by Dr. Jan F. Hostie, Legal Adviser to the Government of Belgium. The presentation of evidence was completed in October, 1937, and judgment has since been issued. Since that time the technical information obtained by the investigators has been gathered together for publication in book form. This book will be a most complete scientific survey of the effects of fumes on vegetation, and will be of great scientific and practical importance.

The examples described indicate the methods of operation and the scope of associate committees. Some idea of the field covered by committee investigations may be given by the statement that, in addition to those already mentioned, there are committees on aeronautics, asbestos, coal classification and analysis, field crop diseases, fire hazard testing, forestry, gas research, laundry research, leather, magnesian products, market poultry, metallic magnesium, parasitology, plant hormones, potato research, radio, radiology, survey research, weeds and wool. In addition other committees are set up to deal with cases of a specialized nature which arise from time to time.

Scientific Work in the Laboratories

Since the co-operative work of associate committees requires it, a considerable part of the work of the laboratory staff fits into the programmes of these committees. In addition, however, there are always under way many studies of diverse nature. Furthermore, since the success of experimental work depends, to a great degree, upon accurate and suitable apparatus, the staff must frequently devote much time and thought to the design and construction of equipment for special purposes.

In the Division of Biology and Agriculture, the development of equipment for malting tests and for cold storage purposes has occupied an important place. The malting equipment enables the investigator to evaluate with great precision the malting quality of any sample of barley. Before the development of this equipment, efforts to combine high yield and disease resistance with the superior malting quality needed for enlarging the potential domestic and foreign market for Canadian barley were hampered by lack of sufficiently precise tests of malting quality. A much improved service is now available to the breeder of malting barleys.

The development of equipment to provide temperatures as low as −40°F. in addition to ordinary storage equipment, has simplified the study of cold storage of perishables. It is now possible to deal with produce by the quick-freezing method, instead of allowing it gradually to reach the temperature of storage. Automatic apparatus for the control of the concentration of carbon dioxide in the storage chambers facilitates studies in gas storage which is now very important commercially.

Observational visits to certain packing plants that reported trouble indicated that the development of mould on cured hams, sliminess on bacon sides, and other difficulties, required investigation. In co-operation with the industry a comprehensive study of the whole system of curing and pickling bacon is under way, with the object of improving the quality and uniformity of the Canadian output.

The Division of Biology and Agriculture has co-operated with the Dominion Department of Agriculture in the development of hybrids between the wheats and the Agropyrons (or wheat grasses). The object of this work is to obtain large-seeded drought-resistant grasses for western Canada.

In 1934 European scientists discovered that plants elaborate certain substances which, in very minute amounts, have profound effects on plant growth. These have been referred to as "plant hormones". Efforts have been made to utilize these substances as aids to plant growth by treating seeds or other plant parts with solutions of the hormones.

The solution method used elsewhere has been superseded by a method developed in the laboratories in which the substance in very small amounts is applied as a dust. By this means root development of cuttings has been stimulated. Types of cuttings that foresters have found very difficult to root have responded well to this type of treatment. Experiments also indicate that improved germination, root development and growth of leafy parts may be attained when the seed or small growing plants are treated with the dust. The substance is cheap, very minute quantities are needed, and since farmers already use dust treatment for the control of fungi, the use of the hormone will involve little extra expenditure of money or labour.

The variety of work carried out in the Division of Chemistry is so wide that only a sketchy account of some principal features may be given here. The Division has organized relations for research with the laundry and dry cleaning industry, the asbestos industry, the leather industry and, to a less extent, with the wool manufacturing and sugar industries. Much other work has basic industrial importance, *e.g.*, work on paints, rubber and textiles.

One of the most striking pieces of work of the last few years relates to the utilization of waste natural gas. It has been found that by heat treatment in a furnace of a special but nevertheless simple design, the fraction of waste gas known as stabilizer gas can be made to yield three to four gallons of liquid motor fuel of the benzol type per 1000 cu. ft. of gas. The striking result has now been secured that the residual gas from such heat treatment will yield six to seven pounds of carbon black. This combination process seems to have attractive commercial possibilities.

A distillation column has been developed that is of great interest to the oil-refining, synthetic chemical and coal-tar industries, as well as to other industries using distillation as a process. This column is more efficient in separating and purifying liquids than any hitherto available. Patents for the packing used in this column have been granted in Canada, the United States, Great Britain and France, and arrangements have been made for commercial production.

Noteworthy results have been obtained in researches on starch. The primary object of the work was to determine whether potato starch, such as might be made from potatoes in Canada, can be used in place of the corn starch, made chiefly from imported material, which is now used in Canada for most of the purposes calling for starch.

There are few industrial plants in which there are not machine parts subject, in greater or less degree, to corrosion and the waste which it entails; hence it is not surprising that the work of the corrosion laboratory, which took its origin from a study of a single case of corrosion, should be undergoing expansion. Problems ranging from the corrosion of laundry hot water pipes to that of hydro-electric power dam gates are being brought to its attention by various industries in Canada.

The work on magnesian products in the laboratories has been very profitable to Canada. The magnesian products laboratory has not only made available to the Canadian metal industry better refractories, and a greater range of them, but it has shown that these can be produced from Canadian materials. During the last year high grade refractories have been produced from dolomite, a mineral low in cost and of wide occurrence in Canada.

An investigation of various domestic barks as sources of tannin for the leather industry has been carried on in the leather laboratory. The barks of western hemlock and of some of the spruces show considerable promise. Work has been done on dressing and dyeing of buffalo skins and work is also in progress on reindeer skins for the Department of Mines and Resources.

In the rubber laboratory much has been done on the bonding of rubber to metal, including particularly the application to the manufacture of automobile engine mountings of a bonding material previously developed in the laboratories. Tests on rubber compounding ingredients, especially carbon black and clay, were carried out by the rubber laboratory in connection with research on these materials in progress in other laboratories of the Division. A considerable number of tests have been made of such materials as paints, textiles, etc., on behalf of the Canadian Government Purchasing Standards Committee.

In the Division of Mechanical Engineering there are available a wind tunnel for the testing of aeroplane models, streamlined locomotives, and any other equipment in which air resistance is important, and a model-testing basin in which somewhat similar problems in regard to water may be investigated.

Safety tests are being made continuously of domestic oil-, gas-, and gasoline-burning appliances. Safety cans intended for handling flammable fluids, particularly gasoline, have been tested to determine their reliability. For the purpose of writing specifications for hose used in forest fire fighting, laboratory and field tests are being made to determine the desirable leakage, the bursting strength and friction loss of such hose. Performance tests have been made on nozzles to determine the volume discharge and coverage. Equipment has been installed to permit tests according to Canadian, British and American methods for the determination of quality of gasoline and lubricating oils. In the engine laboratory tests for anti-knock quality of gasoline made in a small, single-cylinder engine have been found to give a good indication of the results obtainable in full-scale aircraft engines.

Five ship models have been tested during the year in the towing basin in connection with the design of private and government vessels. In two instances it was found possible to make major improvements in the propulsive characteristics. A one-hundredth scale model of a stop-log emergency dam was tested to ascertain the forces likely to be met in the operation of similar full-scale structures.

In this Division the testing of mechanical equipment forms a large part of the work. Engines, aircraft instruments, gasoline and lubricating oils have been tested for various branches of the Government service. Instruction is also given to members of the staff of the Royal Canadian Air Force in the testing, care and maintenance of the instruments used in their work.

The Division of Mechanical Engineering maintains a complete workshop for the overhaul, alteration and repair of instruments, etc. This service is also extensively used by several Government departments.

An interesting innovation is the development of the Aeronautical Museum. For some years the National Research Council, aided by the Department of National Defence, has endeavoured to preserve obsolete material connected with the development of aviation in Canada, with a view to the formation of a National Aeronautical Museum on lines similar to those of existing museums in other countries.

In the Division of Physics and Electrical Engineering, the normal fundamental phases of work on sound, light, and heat, and the studies on electrical engineering are carried on concurrently with a steadily increasing amount of testing, examination and standardization of instruments. Advice has been

given to a number of Government departments in connection with such varied matters as the acoustical treatment of rooms and buildings, apparatus for depth-sounding purposes, forest fire hazards, collection of insects, and methods of plotting results of aerial surveys.

In the metrology laboratory, apparatus for the precise calibration of standard gauges for industry has been designed and built. The standard kilogramme weight has been acquired recently and established by order-in-council as the Dominion Standard for the International Kilogramme. This completes the provision of primary metric standards for Canada which the Minister of Trade and Commerce was instructed to obtain under an Act of Parliament passed in 1914. Canada's collection of Dominion Standards, housed in a vault in the National Research Building, comprises a Yard, a Pound, a Troy Ounce, a Metre, and now a Kilogramme.

A large amount of test work is done in the Division. A satisfactory heater for use in refrigerator cars in winter to prevent freezing has been developed and is being taken up commercially. New apparatus has been installed in the electrical engineering laboratory to provide high-voltage current and progress has been made in the precise regulation of voltage. Thousands of aircraft castings are being examined by X-ray methods and a 600,000-volt apparatus has been constructed to permit expansion of this work and for standardization of equipment for hospital use. Type approval of meters is being continued. The cathode-ray compass and direction finder, detection of fires through haze, estimation of forest fire hazard, vibration in aircraft, ultrasonic generators for depth sounding, problems in camera design for air photography, and spectroscopic analyses are some of the other matters under study.

Recent additions to equipment include an electric surge generator capable of developing a million volts for use in the testing of transmission line and other insulating material.

Radium preparations in large numbers are measured and certified in the radium laboratory. Recently a device for rapid testing of radium tubes for leakage was constructed and a method for measuring the radium content of barium-radium bromide preparations was developed.

During the year steps were taken to reorganize the Division of Research Information and to establish a Section of Research Plans and Publications under an officer-in-charge reporting directly to the President. One of the functions of this new section is to provide technical secretarial services for the President and for certain of the Associate Committees. It also provides a means of liaison whereby many different activities in research, such as committee work, international affiliations, and preparation of executive instructions, can be brought into focus and the necessary executive action taken with a minimum of effort. The staff engaged in abstracting technical literature, making translations, and preparing answers to technical inquiries have been grouped in this section, into which it is proposed also to bring the administrative direction of the Library and the Canadian Journal of Research.

Work of the section on Standards and Specifications and preparation of Government Purchasing Standards for the Canadian Government Purchasing Standards Committee is being continued under the Division as heretofore. There has also been established a National Building Code Committee whose activities are recorded elsewhere in this report.

Assisted Researches

In order to make use of the facilities for research which exist in a number of Canadian universities, the Council, in the early years of its existence, developed a system of "assisted researches" so that projects of importance,

which otherwise could not be undertaken, would proceed under the competent direction of members of a university staff. An application for any particular investigation, setting forth the proposals in detail, its objectives, the facilities available, the assistance required, and the estimated cost, is submitted by the professor in charge through the head of his faculty to the National Research Council, where it is reviewed. Any grants that are made are restricted to the provision of needed apparatus, hire of labour, travelling expenses, etc., and no contribution whatever to the salary of the applicant is made. Through these grants much useful work has been accomplished and it is hoped that as more funds become available they may be given in larger numbers.

Scholarships

Information collected by the first Council, in the course of a survey of research man-power in Canada, showed that only a very few trained scientists were either working in the industries of the Dominion or available to undertake the study of the technical problems involved in the production of new materials, or for the improvement of existing processes in the light of advanced research.

An effort was made at once to improve this situation. A system of scholarships was established whereby graduates of outstanding merit were enabled to follow post-graduate studies and thus to equip themselves for leadership in the application of science to industry in Canada. The practice has been continued, although funds for this purpose were seriously reduced during the depression years. Since 1936 the appropriations have increased slightly and it is hoped that further improvement in this situation may be found practicable in the near future.

Other Activities

The National Research Council continues to be active in the field of invention. The Council has been granted eleven patents on refractories, plucking poultry, freight car design, plant hormones, alloys, and the treatment of hydrocarbon gases, and applications have been made for more than thirty patents on various subjects. Publication of scientific papers in the Canadian Journal of Research provides an outlet for records of original work in the physical, chemical, botanical and zoological sciences. In all, 144 papers were published during the year. The library with more than 1,100 scientific periodicals and about 20,000 carefully selected volumes continues to fill a need. Photostat copies, translations of foreign language articles, and literature searches are made possible by the library's resources.

Co-operation is the keynote of the Council's policy in the promotion of research. Industrial problems are investigated on the advice and with the assistance of more than thirty associate committees whose members, as already noted, are drawn from the universities, industries, Government departments, or associations concerned. The Council's laboratories are a sort of common service at the disposal of all departments of State as may be required from time to time. The Council's type of organization presents every facility for co-operation and collaboration with the scientific services of the several departments and on their side the departments have sought by all suitable means to improve the opportunities and to take advantage of the facilities thus provided. Grain research and field crop diseases, undertaken as joint investigations by the Department of Agriculture and the Council may be cited merely as examples.

To the hundreds of leading scientists and industrialists and to the Government departments and other organizations whose services have been given freely in co-operative projects, the Council and the public owe grateful thanks for a large measure of the success that has so far been attained in the field of national research.

Financial Statement for the Fiscal Year 1937-1938.

Receipts

Cash on hand in Trust Funds, 1 April, 1937	$ 65,298.32	
Parliamentary Appropriation	637,800.10	
Laboratory fees	37,882.06	
Deposits on account of tests	1,660.81	
Sale of publications	2,326.90	
Sale of bonds and interest (Grain Research Trust Fund)	38,137.31	
Contributions from industries, etc	68,975.93	
Miscellaneous	4,029.61	
Refunds of Assisted Research Grants	249.58	
Royalties and sale of patents	9,508.77	
Total receipts		$ 865,869.39

Expenditures

Salaries	$ 386,036.08	
Scholarships	22,813.20	
Laboratory equipment and supplies	96,217.34	
Library	10,180.33	
Publications issued	17,790.92	
General expenses	11,046.21	
Travelling	13,472.98	
Rehabilitation of power plant	22,692.00	
On work of the following Associate Committees:		
Aeronautical Committee	9,179.47	
Asbestos Research Committee	2,016.69	
Building and Construction Committee	250.05	
Canadian Engineering Standards Association	15,085.87	
Canadian Government Purchasing Standards Committee	2,596.13	
Electrical Committee	333.07	
Field Crop Diseases Committee	4,255.36	
Fire Hazards Committee	4,389.52	
Forestry Committee	5,332.85	
Gas Research Committee	500 00	
Grain Research Committee	36,510.09	
Hydraulic Research Committee	90.96	
Laundry Research Committee	1,470.00	
Magnesian Products Committee	7,319.65	
Metallic Magnesium Committee	360.00	
Parasitology Committee	17,840.00	
Plant Hormones Committee	1,075.97	
Radio Research Committee	17,451.62	
Radiology Research Committee	2,709.70	
Rubber and Metal Bond	3,860.83	
Storage and Transport of Food Committee	4,210.94	
Survey Research Committee	2,051.11	
Trail Smelter Smoke Investigation	25,622.64	
Tuberculosis Committee	8,980.02	
Weed Control Committee	4,156.08	
Wool Research Committee	1,200.00	
Research Grants to individuals	10,799.47	
International Affiliations	1,195.12	
Total expenditure		$ 771.092.27
Balance on hand in Trust Funds, 31 March, 1938:		
Cash	81,907.12	
Bonds (Patents and Royalties)	12,870.00	
		94,777.12
		$ 865,869.39

REPORTS OF THE DIVISIONS

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

During the year 1937-38, it has been possible to make some further improvements to the laboratory equipment of the Division of Biology and Agriculture and to continue the gradual strengthening of the staff to cope with the ever-increasing programme of work pressing upon us. The appointment of Dr. C. A. Ayre to the barley laboratory made it possible to renew studies on proteins and protein-splitting enzymes, factors of considerable importance in malting barley. The addition of Mr. W. H. White as analyst to the food storage laboratory greatly increased the number of samples that could be dealt with satisfactorily. At the end of the year Dr. L. P. V. Johnson joined the staff of the genetics laboratory, and an active programme of forest tree breeding was launched. The appointment, in the latter part of the year, of Mr. F. T. Rosser as assistant to the director promises to give the director more freedom from administrative detail and much needed time to consider the research work of the division. Mention should also be made of the special scholarships held by Dr. L. Sair and Mr. W. R. Jack, whose work in the divisional laboratories constituted on the one hand valuable training and experience to these men, and on the other contributed substantially to the progress of the projects with which they were associated. This was an innovation which must be rated a distinct success.

While a review of the year's activities of the various laboratories will be found in the reports prepared by the workers in each, introductory comment may be made here on two or three new developments.

With the co-operation of the Department of Agriculture and the Canadian meat packers, a survey was made of the methods of curing bacon in all 26 plants that export Wiltshire sides, now the most valuable among perishable products exported from this country. The survey provides a basis for work aiming at improvement in quality and uniformity of Canadian bacon. The packers have also promised co-operation in further studies with this object.

With the temporary transfer of Dr. N. H. Grace from the Division of Chemistry to the Division of Biology and Agriculture, investigations on the practical applications of plant hormones were pushed forward rapidly. So promising and important seemed the results, that patent applications were filed on three processes: (1) dusting of seeds to stimulate germination and early growth, the hormone being incorporated either with an inert dust like talc or with a standard fungicidal dust; (2) dusting of cuttings to stimulate root formation; (3) addition of hormone to chemical solutions used in seed treatment such as the standard formaldehyde treatment for smut prevention, to protect the seed from loss of germinating power. Possession of patents enables the Council to control the composition and prices of these preparations, thus protecting farmers and gardeners from exploitation.

The forest tree breeding, a joint project with the Dominion Forest Service and the Department of Agriculture, is to some extent an outgrowth of the plant hormone investigations, since the discovery of a method for inducing wood cuttings to root more freely opened up new possibilities along this line. Occasional trees with superior qualities, such as disease resistance, are sometimes found by forest rangers or other observers, and in some instances

73461—2

it may be possible to propagate these directly by cuttings. In other cases fast-growing hybrids which, if not sterile, would in any case lose their hybrid vigour after some generations of propagation by seed, may be vegetatively propagated, thus not only conserving hybrid vigour but avoiding the loss of many years in waiting for them to reach seed-bearing age. The description of this work will be found partly in the report of the laboratory of Cytology and Genetics, and partly in the report of the Associate Committee on Plant Hormones.

As an indication of the general activity of all the laboratories in the Division it may be mentioned that 23 scientific papers by the staff were published during the year.

Plant Biochemistry and Physiology

R. Newton, N. H. Grace, W. R. Jack

Plant Growth Factors

The chambers built for the study of plant growth factors under controlled conditions, first described in the report for 1932-33, were used during the latter part of the year for an experiment on the growth of Marquis wheat plants at four temperatures (45, 55, 65, and 75°F.) and four light intensities (200, 600, 1200 and 1800 foot candles). Relative humidity in all cases was held at about 70%, and the culture solutions were changed frequently to ensure that nutrition should not be a limiting factor. The experiment is still in progress and the results cannot be reported till next year. It is hoped they may show more clearly than has been known previously, how these weather factors interact on plant growth and affect the adaptation of wheat in different parts of the country. (R.N. and W.R.J.)

Plant Hormones

These recently discovered chemical substances, which in minute amounts exert a profound influence on plant growth, offer such possibilities for advances in the practice of agriculture, horticulture and forestry that they have been made the subject of experiments extremely varied in character.

The watering of dwarf barley plants growing in plots of soil in the greenhouse with dilute solutions of 1-naphthylacetic acid, a synthetic plant hormone, in an effort to induce the stems to elongate and develop heads, was without result. This does not mean that the right hormone applied in the right way would not have succeeded, and the point will be explored further as opportunity offers, since the artificial induction of fertility in a normally sterile plant might often be of great service to a plant breeder. (R.N. and W.R.J.)

Marquis wheat plants were grown in the controlled chambers mentioned above, with all conditions constant (at normal levels) except that 1/200 part naphthylacetic acid per million parts of culture solution was added to 25 of the 50 jars used. The characteristic effect of hormones applied in this way was observed, namely, all roots were shorter and thicker, and the number of secondary roots was increased. There was no significant effect on the dry weight of either roots or tops of the plants, which were a month old when harvested. In a similar experiment in a greenhouse, even 1/1000 part per million of either 1-naphthylacetic acid or 3-indolylacetic acid (the latter a natural plant hormone) was enough to produce the characteristic effect on root development in solution culture. Conversely, when the hormones, diluted with talc, were dusted on seed planted in soil in glass-sided containers, for observation, root penetration was accelerated and length increased. (R.N. and W.R.J.)

The observation in these laboratories that hormones in solution stimulate water absorption by cut flowers, lettuce plants, etc., led to some experiments to measure their effect on biocolloids. Increases in viscosity of gelatin solution and in the swelling of gelatin blocks were not greater than could be accounted for by changes in acidity and could be duplicated by the use of lactic acid.

The Went method for the bio-assay of plant hormones, by the bending of oat shoots resulting from unilateral growth when the hormones are applied to one side, was found satisfactorily applicable only to the natural hormone, 3-indolylacetic acid (heteroauxin). 1-Naphthylacetic acid gave about 1/10 to 1/15 the response obtained with heteroauxin. Several other compounds that stimulate rooting of cuttings and have other hormone-like effects caused little or no bending of oat shoots. (R.N. and W.R.J.)

The yeast method of bio-assay developed in these laboratories, which depends upon the stimulus to the initial rate of gas production in sparingly inoculated sugar solutions, seems to be applicable to all plant stimulating substances. (N.H.G.)

A number of applications of hormones to seeds, cuttings and growing plants have been published during the year (Can. J. Research, C, 15:538-546. 1937; 16:143-144. 1938. Nature, 141:35. 1938).

A simple method of treating seeds with plant hormone chemicals has been developed. This makes use of a dust carrier, which may be an inert dust such as talc, or a seed disinfectant such as an organic mercurial or copper carbonate. Stimulation of root development and top growth follows the application of a carefully controlled amount of hormone chemical. The growth stimulation is apparently dependent on the gradual supply of active chemical from the layer of adhering dust to the germinating seed and young plant. Solution methods of treating seeds with these chemicals have not usually given improved growth. (N.H.G.)

The inherent advantages of a "hormonized" dust in the treatment of seed suggested that there might be similar advantages in using this material in the treatment of cuttings over the solution method just entering into horticultural practice. Experiments proved the dust method to be not only more convenient, and in many cases more effective in inducing free and rapid rooting, but also safer; that is, there is less risk of damage by overdosage. Cuttings may be treated with hormone-containing dusts with great ease and with excellent results. (N.H.G.)

Application of plant hormones to growing plants results in stimulated growth over a given range of treatment. Excessive application of these active chemicals, however, can be damaging. These laboratory observations have suggested the possibility of applying these chemicals in fertilizers. Co-operative tests are under way to determine the response when plant hormones are applied to field crops. (N.H.G.)

The formaldehyde treatment of seed for smuts is well known and widely practised. A serious disadvantage of this disinfecting treatment is the decrease in germination and growth which is apt to follow its use, particularly when the soil is dry. It has been found that a very small amount of hormone chemical, when added to the treating solution, greatly reduces or entirely prevents this type of seed injury. Experiments have shown that the active chemical may be added to the commercial formaldehyde in correct amounts by the manufacturer. This should permit the ready use of plant hormones in all cases where formaldehyde disinfection is used, as no extra operation will be required on the part of the farmer. (N.H.G.)

73461—2½

Grain Research

Wheat

J. G. MALLOCH

Standardization of Experimental Baking Test

Work on the design of equipment for the complete mechanisation of this test has been continued. A new paddle-type water-jacketed mixer, specially designed for use with the standard quantity of flour, has been constructed. The punching and moulding machine has been tested co-operatively by the laboratories connected with the Associate Committee on Grain Research. While this machine reduced the variability slightly, the difference was not sufficient to warrant recommendation of its general adoption. However there was a marked improvement by use of the machine in one of the laboratories where the variability is already low, and this indicates that the machine will be of considerable value in reducing the influence of the manipulation of the dough when other major causes of variation are eliminated. A complete report of the test is in press (Cereal Chemistry). Experiments on improved control of temperature of the dough during fermentation and baking are under way.

Recording Dough Mixer

The quality of the bread produced from any flour depends mainly on the gas production, the quantity of protein and the colloidal characteristics of the dough. The first two of these are easily measured but the measurement of those colloidal characters related to baking quality has never been put on a satisfactory scientific basis. Many physical methods have been proposed and machines designed to give the desired information but rigid proof that they actually measure factors important in baking quality has been entirely lacking. It was reported last year that certain characters of the curves obtained with the recording dough mixer seemed to be correlated with dough quality. It has now been definitely established that it is possible to follow the changes in this quality during fermentation by use of this apparatus. So far only one character of the curves has been studied and a highly significant correlation ($r = -\cdot 84$) between the time necessary for the curvature of the line to change (breaking time) and the loaf volume when the gas production is held constant has been obtained. Statistical study of the nature of this relation and of the significance of other characters of the curves is now under way. It is useless to attempt to establish the value of such measurements on general observation or *a priori* reasoning; definite mathematical relations must be proved.

The study of differences between flours requires the use of large numbers of samples before definite relations can be established but the results of preliminary experiments are very promising and it seems probable that further study of this phase of the problem will also lead to valuable results.

Barley

J. A. ANDERSON, H. R. SALLANS, C. A. AYRE

Enlargement of domestic and foreign markets for Canadian barley appears to depend primarily on improvement in quality through the introduction or development of new varieties which combine high yield and other agronomic characters desired from the farm viewpoint, with the superior malting quality for which premiums are paid. With 185 new lines, representing crosses from 65 different parents, under study, Canadian plant breeders appear to have

the primary problem well in hand. Two secondary problems, namely the determination of what constitutes malting quality in barley and how the various contributing factors can be measured, are being studied in the National Research Laboratories. Solution of these appeared to depend on the development of satisfactory laboratory malting equipment and this part of the work is nearly completed. The investigations have now entered a second phase and are concerned with: (i) a study of the limitations of the routine malting test used in measuring varietal differences in malting quality; and (ii) comparative studies of varieties of barley of good and poor malting quality, and of the malts made from them, designed to define more clearly the various factors involved in malting quality.

Experimental Malting Equipment and Methods

Improvement in the malting equipment has this year been confined largely to the steeping equipment, which has been rebuilt to incorporate features for automatic aeration of samples and for starting the steeping of any required number of samples at any time during the day or night without attention. Experiments have also been made with a stationary cage kiln in which the air is forced through the malt. These showed that a really satisfactory experimental kiln must provide both for rotating cages and passage of the air through the malt. As a result of experience gained in the National Research Laboratories, it was possible this year to rebuild or replace various parts of the malting equipment at the University of Manitoba, thus providing a much more precise routine malting test (Sci. Agr. 17:742-751. 1937).

The laboratory malting test measures the response of samples to a standard set of conditions which simulate those used in commercial practice. It follows that not all samples are malted to best advantage and that some varieties are favoured more than others by the test. This differential response of varieties to malting method and the precision or reproducibility of the test results, constitute two of the main sources of error in the practical application of laboratory testing to the determination of varietal differences in malting quality. A series of investigations seeking to determine the limits of these errors and their significance in routine testing is under way. The first of these was made in co-operation with the Canada Malting Company, Ltd., the Dominion Malting Company, Ltd., and the University of Manitoba. The results showed that the precision of tests made by all co-operators was excellent and was almost negligible as a source of error, but that the differential effect of methods on varieties formed an appreciable source of error, though it was small by comparison with the differential response of varieties to changes in environment (Cereal Chem. 14:879-892. 1937).

The laboratory is represented on the Malt Analyses Standardization Committee of the American Association of Cereal Chemists and is working in co-operation with United States and Canadian laboratories on the development of more precise methods for malt analyses.

Diastatic Enzymes of Barley and Malt

There is some evidence that varieties with good malting qualities are generally characterized by comparatively high diastatic power as measured by the Lintner method. Whether high Lintner values are essential for malting quality is not known and this question must be answered before it is possible to evaluate the malting quality of new barley varieties.

It has been pointed out that Lintner values cannot well represent the activity of the enzymes in commercial mashes since the determination involves the use of a foreign substrate, and aqueous extracts which do not remove all the enzymes, and since no account is taken of possible differences in starch

liquefying activity. These objections are being investigated by comparing results obtained by use of the Lintner method with those obtained with other methods. As a first step it was necessary to modify existing methods in order to obtain a precise and rapid technique for determining Lintner values. This work has been completed (Cereal Chem. 14:708-720. 1937. Modern Brewer, 18:57-60. 1937).

It has been asserted that digesting malt with water and estimating the increase in reducing substances yields different, and presumably more reliable, data on diastatic power than Lintner determinations. Preliminary investigation shows that the autolytic procedure used is open to considerable criticism. An improved method has been developed and this, when applied to malts made from different varieties, yielded results showing a fairly good correlation with Lintner values. This investigation thus indicates that there is good reason for considering the Lintner determination a good index of amylase activity.

It also appears that objection to the Lintner determination because of incomplete extraction of the enzymes can be overcome by extracting in the presence of hydrogen sulphide gas or of the proteolytic enzyme, papain. Comparisons of these procedures with the usual one are being undertaken. A promising line of investigation has resulted from these studies. It has been found that when the ordinary Lintner determination is used, no correlation exists between the diastatic powers of barleys of different varieties and the diastatic powers of malts made from these varieties. However, when the barleys are extracted in the presence of hydrogen sulphide or papain, a fairly good correlation exists, and the possibility of predicting varietal differences in the diastatic powers of malts by analysis of the barleys is thus brought to light. If further investigation supports this hypothesis, an extremely useful tool for the rapid preliminary examination of large numbers of new hybrid lines of barley will probably result.

Proteolytic Enzymes of Barley and Malt

Little is known about the relation of proteolytic activity to the malting quality of barley varieties. Indirect measurements of this activity have been made by determining wort nitrogen and this has been shown to be a varietal characteristic. During the past year, two different direct methods of measurement have been developed by modification of existing techniques. Preliminary studies with these methods show that varietal differences in proteolytic activity are quite marked and indicate that comparatively high proteolytic activity is found in varieties known to be of good malting quality. There appears to be some relationship between the results of direct measurements and values obtained by determining wort nitrogen.

As a part of these studies, it seemed necessary to examine the varieties which will be used in further investigations of proteolytic activity, for differences in the protein substrate. Determinations of various protein fractions in 144 samples, representing 12 varieties grown at 12 different points in Canada, have therefore been undertaken.

Food Storage and Transport

W. H. Cook, C. A. Winkler, N. E. Gibbons, W. H. White, L. Sair

Previous investigations in this laboratory have been concerned mainly with poultry products. During the past year this work has been extended to include studies on the curing and transport of bacon, and on the effect of prefreezing treatment and rate of freezing on the quality of frozen poultry, beef,

pork and mutton. The results of earlier investigations into the frozen storage of poultry showed the importance of developing methods for measuring, maintaining and controlling the relative humidity. Further results are reported in a section dealing with the control of storage conditions. A paper summarizing the results of certain investigations on the frozen storage of poultry has been published (Proc. Brit. Assn. Refrig. 34. 1938) during the year and other articles are now in press or in course of preparation.

Poultry

Surface Desiccation

It was pointed out in the last report that surface desiccation or "freezer burn" was the first form of deterioration that became evident in frozen poultry. It has now been shown that poultry will show evidence of freezer burn after 8 to 12 weeks' storage at humidities of 85% or lower, relative to ice. Higher humidities increase the storage life somewhat but values of 95 to 100% are required to prevent surface drying for storage periods of six months to one year at 7°F. Lower temperatures permit the product to be stored somewhat longer, but at −7°F. humidities in the vicinity of saturation are still required.

Deterioration of Bloom During Storage

The bloom, or surface appearance, of frozen poultry usually deteriorates during storage even when freezer burn is absent. It has been found that this condition is also dependent on the drying that takes place from the surface, and little or no deterioration of this sort occurs at the temperatures ordinarily employed for frozen storage if high relative humidities are maintained.

Packaging of Poultry

One method of preventing loss of bloom and surface drying is to package the product in a moisture-proof container. The investigations on this subject, reported last year, have been continued. Parchment paper, waxed paper and aluminium foil, representing stocks that are progressively less permeable to moisture, have been tested as liners for poultry boxes in both the sealed and unsealed conditions. The quality of these materials and methods of application were assessed from the relative humidity within the package during the storage period, and from the condition of the product after 12 months' storage at 7°F.

The results show that the quality of the three wrapping materials increases as their impermeability to moisture increases. All of these materials preserved the product in better condition when the folds were sealed, and when treated in this way, waxed paper appears to be sufficiently impermeable to moisture to prevent surface drying over the usual storage periods. It is economically impossible, however, to seal the box liners now used in commercial practice. Moreover, provision must be made for ventilating the package to decrease the humidity if the product is to be stored in the chilled (unfrozen) state. Investigations were therefore undertaken to develop a package that could be easily sealed for frozen storage and ventilated for chilled storage. A package of this sort has been designed, subjected to initial tests, and a patent application forwarded to the United States Patent Office.

Development of Rancidity in Stored Poultry

The development of rancidity in the fat of stored poultry may also be a factor determining the safe storage life in the frozen state. This subject was investigated by determining the peroxide oxygen content of fat extracted from poultry after storage in the frozen state, at 7°F. and −7°F., for various

periods of time up to two years. The results showed that the rate of development of rancidity in the fat from different birds, stored under the same conditions, varied somewhat, indicating that the initial quality of the fat affects the keeping quality to some extent. Of the storage conditions, temperature appears to be the most important, rancidity development decreasing with the temperature. At a given temperature the tendency toward rancidity also decreases as the relative humidity is increased. In an atmosphere approaching saturation, frozen poultry may be stored for about a year at 7°F., and two years at −7°F. without becoming rancid. These results indicate that storage temperatures of about 0°F., with high atmospheric humidities, are adequate for preserving poultry from one production season to the next.

Quick Freezing of Poultry

The claimed superiority of quick-frozen poultry is based on a reduction of crystal size, loss of fluid (drip) after thawing, bacterial numbers, visceral taint, and surface desiccation. As investigators differ in their opinion as to whether the final quality is injured by slow freezing, these claims were investigated. It was found that the rate of freezing had no effect on the number of bacteria present, and little, if any, effect on the degree of surface desiccation or visceral taint development. Although the size of the ice crystals may be affected, whole birds do not yield any free drip regardless of the rate of freezing.

Freezing does change the condition of the water in the muscle, however, since determinations made on minced meat obtained from thoroughly precooled birds yielded a quantity of drip which decreased as the freezing rate increased. The amount of drip obtained from minced meat frozen within 12 hours after slaughter was found to be independent of the rate of freezing, and greater than the maximum quantity obtained from birds which are precooled for 24 hours before freezing. Since drip could only be obtained from minced poultry meat, it is doubtful whether its formation affects the quality of the product in any way. From these results it appears that the ordinary freezing rates (slow) are not injurious to the quality of frozen poultry.

Bacon

Survey of Packing Plants Exporting Wiltshire Bacon

During recent years Canada has exported increasing quantities of Wiltshire-cured bacon to the British market. Difficulties have been experienced in the curing and transport of this highly perishable product from time to time, and individual packers have referred a number of different problems to the National Research Council for investigation. Since the difficulties experienced at an individual plant may arise from its geographical location, limited facilities, etc., it was decided that a survey of the exporting plants should be made in order to determine which of the many problems were of an urgent nature, or common to a number of plants.

It was found that faulty colour and slime development were the bases of the most common complaints received from England. The variable practices employed at different plants also indicate that the Canadian product may not be as uniform as is desired by the British market. An extensive series of analyses of both the pickle and product has been undertaken, with the cooperation of the packers, to determine the variability that exists, and possible methods for obtaining such uniformity as may be required. Of the several processes involved in the manufacture of bacon it appears that the preslaughter treatment of the animals, cooling practices, curing in its several phases, and the freezing, storage and thawing of pork for the manufacture of bacon, are those most likely to affect the final quality, colour, and slime

development. Investigations into these subjects, and also certain specific practices such as wiping, draining, etc., are now under way, or will be undertaken shortly.

Analysis

A laboratory for the study of the numerous analytical problems related to food preservation was established toward the end of the year covered by this report. Considerable attention has been given to the analysis of pickle and bacon in view of the investigations outlined in the previous section. The small amounts of certain constituents that may affect the quality, and the many interfering substances present, have necessitated a thorough study of available methods, and the development of new ones.

Bacon Bacteriology

The sliming of bacon presents considerable trouble to the packers at certain seasons of the year. A number of cultures have been isolated from slimy and non-slimy Wiltshire sides. While complete identification studies have not been made on all the organisms isolated, it would seem that there is little difference qualitatively in the flora of slimy and non-slimy sides. It is believed that the only difference is in the number of organisms, slime being a visible growth. A quantitative study depends on the development of a satisfactory method of making surface counts.

Methods for quantitative studies are necessary for any further work on the value of plant operations and for plant sanitation studies. The available methods are being compared and assessed as to their usefulness.

A bacteriological study of pickle and bacon from all the exporting plants in Canada is planned for the coming year in conjunction with chemical studies. Details of tests on this material have been worked out. It has been found that pickle may be stored at cellar temperature for almost a week without any great change in bacterial numbers. This makes it possible to bring pickle from any of the plants to the laboratory for study.

Colour of Bacon

Little is known about the factors that affect the colour and colour stability of bacon. In view of the importance attached to the colour characteristics of bacon by the industry, as indicated by the survey, work has been undertaken on this subject.

A photoelectric colour comparator was constructed to measure the colour characteristics of bacon and similar materials. With this instrument, measurement of colour is independent of visual observation with all its possible errors.

Experiments have been made to determine the relation between colour of bacon and such factors as loss of moisture from the sample, storage in various gases, heat treatment, and, in a preliminary way, the effect on colour stability of concentration of the salts in the pickle. The rate of moisture loss *in vacuo* bears a linear relation to the rate of colour change. In air, the relation between colour change and moisture loss is complicated by the effect of oxygen and possibly other atmospheric components. Pure oxygen caused a rapid greying, while carbon dioxide made the colour lighter, but not grey. When bacon is heated as it is during smoking, the colour becomes lighter as the temperature is increased. The colour stability and rate of moisture loss are practically unaffected by heat treatment. Some evidence has been obtained that increased nitrite concentration in the pickle results in a bacon of somewhat greater colour stability, but the effect has so far been surprisingly small.

The colour of pork, beef and mutton has been shown to be related to the hydrogen ion concentration of the meat.

Meat

Acidity of Muscle in Relation to Drip

Since the period of storage between slaughter and freezing was found to influence the amount of drip obtained from minced poultry meat, investigations were undertaken to determine the effect of storage prior to freezing on the drip obtained from pork, beef and mutton. It was found that the drip decreased during the first 24 hours after slaughter to a value modified by the acidity of the meat. The effects of storage after slaughter, and acidity, appear to be independent. Owing to the practical importance of acidity from the standpoint of bacon curing etc., the relation between acidity and drip was first studied.

By adjusting the acidity of these meats over the range of acid values likely to occur in these tissues, it was found that little or no drip was obtained from the more alkaline samples, but that the drip progressively increased as the samples became more acid. All three meats behaved in the same manner, both with respect to the form of the acidity-drip curve, and the absolute quantity of drip obtained at a given acidity. Preliminary results indicate that the reason why beef drips after freezing, whereas mutton and pork are less likely to do so in commercial practice, is because beef is normally more acid than the other two meats.

Histological studies of frozen muscle showed that the size of the ice crystals was determined entirely by the freezing rate, the acidity having no effect on crystal size. The absence of drip from the more alkaline samples after slow freezing indicates that the condition of the proteins rather than the formation of large ice crystals is the cause of drip. Denaturation studies showed that the proteins do not lose their water-retaining capacity irreversibly, either during freezing or three days' storage at $-3°C.$, a condition equivalent to the slowest rate of freezing likely to be used in practice. It is therefore concluded that the drip obtained from muscle after freezing is determined primarily by the acidity of the tissue, the more acid meats having a lower moisture-retaining capacity, which can, however, be increased reversibly by decreasing the acidity.

Tenderness of Meat

A device has been constructed for testing the tenderness of meat and other food products. The relation between the hydrogen ion concentration of pork and beef and the tenderness in the raw state has been investigated. The tenderness of bacon subjected to various heat treatments has also been determined. Since tenderness is an important characteristic of cooked meats, it is planned to extend these experiments to cooked samples.

Control of Storage Conditions

Humidification of Freezers

The importance of a high atmospheric humidity for preserving the quality of products in the frozen state is evident from the results of the investigations mentioned in previous sections. It is particularly important when the product, for example, frozen pork for the subsequent manufacture of bacon, cannot be easily and effectively wrapped. As mentioned last year, these considerations led to a study of a possible method for increasing the relative humidity to a point approaching saturation in rooms maintained at temperatures below the freezing point.

The method consists of circulating a concentrated brine over the cooling surfaces to prevent the formation of frost, collecting this brine in suitable drip pans and returning it to the tank for recirculation and, by a small heater

attached to the side of the collecting tank, boiling off part of the water from the brine and delivering it into the atmosphere. Continuous circulation is necessary between the collecting tank and the heater, in order to prevent troublesome concentration of the salt in the latter. Nevertheless the rate of circulation must be slow in order that the brine will boil with the minimum addition of heat, which is of course added to the refrigeration load.

Tests of this method of humidification have shown that the principle is sound. It has been possible to maintain humidities of 95% or higher, relative to ice, with a heat input less than 10% of the normal refrigeration load required to maintain the temperature as the desired value. Further improvements are now under way with the object of simplifying the operation for commercial practice and increasing the efficiency. An application for a United States patent on this device has been made.

Measurement of Humidity

The investigations into the humidification of freezers and the general importance of atmospheric humidity in the frozen storage of foodstuffs, has necessitated further studies on the measurement of humidity at low temperatures. This problem is a difficult one, owing to the small amount of water vapour held by air at these temperatures.

Two types of apparatus for measuring the humidity in refrigerated spaces have been constructed and tested. One of these is a dew-point instrument designed to obviate the difficulties previously encountered in instruments of this kind. A slow stream of air lifts a liquid, the temperature of which is controlled as desired, through the mirror on which the dew is deposited. The dew-point temperature is measured by thermocouples inserted into the mirror. This instrument has been tested at temperatures as low as −15°C. with good results. Work is now in progress to make the instrument automatically operating and recording.

The other instrument was designed to measure the humidity by absorption of the moisture and measurement of the accompanying pressure change. Consistent results have not been obtained with this type of apparatus at low temperatures; adsorption of water vapour on the walls of the apparatus is probably responsible for the lack of precision.

Apple Taint in Food Products

Tainting, by apples, of other food products during transit and storage, has frequently been responsible for financial losses as a result of diminished marketability of the product. A satisfactory solution to the problem seemed to require a suitable method for the quantitative estimation of taints. High temperature combustion, with absorption of the carbon dioxide formed and its estimation conductimetrically, has been tried as a method for estimating traces of acetaldehyde vapour and ethylene in air. The results obtained were encouraging and it is probable that such a method can be adapted to the quantitative estimation of the traces of organic vapours that constitute apple taint.

Cytology and Genetics

F. H. Peto, L. P. V. Johnson

Hybridization of Wheats and Wheat Grasses

This project is being carried out in co-operation with the Dominion Experimental Farms, with the object of producing a forage crop for western Canada which possesses drought resistance, soil binding properties and large seeds. The initial crosses were made in 1935, when *Agropyron glaucum* and *A. elongatum* were found to cross readily with durum and common wheats.

All of the first generation plants of wheat × *A. glaucum* were sterile but several backcrosses to the wheat parent were successful and were found to be partially fertile. A method has been developed whereby the chromosome number in sterile first generation hybrids may be doubled and it is expected that fertility may result. Plants with the doubled chromosome number are being grown this season for further test. Several first generation plants of common wheat × *A. elongatum* were self fertile and three progeny generations in addition to backcrosses have now been grown. Some of this material is very promising and is being tested at three points in western Canada for the first time this season.

A cytological study of the first two hybrid generations and backcrosses has been completed. Some of the fundamental causes of sterility in certain plants have been determined and information pointing to the correct breeding procedure to produce stable and fertile strains has been obtained. (F.H.P.)

Doubling the Chromosome Number with Colchicine

The fortuitous multiplication of chromosome sets has played an important role in evolution, but it is only within the last few years that methods for artificially doubling the chromosome number have been developed. The most effective method to date is by the use of the drug colchicine. Improved methods of application have been developed in this laboratory and are being applied to a large number of different varieties of vegetables, field crops and trees. Definite indications have been obtained that doubling has been produced in field and garden peas, navy beans, vetch and broccoli. Chromosome doubling usually results in increased size of all the plant organs, sometimes increases disease resistance, and usually increases longevity and the range of adaptation. It is hoped that this method may result in the production of valuable new varieties of cultivated plants. (F.H.P.)

Poplar Breeding and Propagation

This project was initiated in March, 1937, and is being carried out in co-operation with the Dominion Forest Service. The object is to breed rapid-growing and disease-resistant poplar varieties suitable for pulp and match stock, and for shelter belts for western Canada. Dr. Heimburger of the Dominion Forest Service discovered natural hybrids between the large-toothed aspen, *Populus grandidentata*, and the European silver poplar, *P. alba*. Many of these hybrids are very rapid-growing, exhibiting marked hybrid vigour. The wood of some of these was tested for match stock quality this year and gave very good results. About ten thousand artificial hybrids between a number of native and introduced species were made during the winter and spring of 1938. These have been sent as young seedlings to the Petawawa Forest Experiment Station to be grown and tested for type, growth rate, disease resistance and hardiness. Tests are also being carried out on the ability of many of the hybrids and parents to root by stem cuttings, since it is hoped that any superior trees developed may be propagated in this manner. (L.P.V.J.)

Cytology of the Poplars

Cytological studies have been completed on the two native aspens (*P. grandidentata*, *P. tremuloides*) and the following introduced poplar species: *P. eugenii*, *P. alba* and *P. canescens*. The native aspens and *P. eugenii* are diploid species with 19 pairs of chromosomes while *P. alba* and *P. canescens* have both diploid and triploid varieties. It appears that the extra set of chromosomes in the triploid is partially responsible for the unusual size and vigour of certain trees. Twelve natural hybrids between *P. alba* and *P. grandidentata* as well as three natural hybrids between *P. alba* and *P. tremu-*

loides have been examined cytologically and all were found to be diploids. A study of the pollen of all these trees was made and the resulting information combined with the cytological information will assist in the selection of suitable parents for further crossing work. (F.H.P.)

Conifer Breeding

This project is being carried out in co-operation with the Dominion Forest Service, and was initiated in the spring of 1938. The practical difficulty of obtaining uniformly high grade seedlings for reforestation has indicated the need for emphasis on conifer breeding. In addition, the research carried out by the Associate Committee on Plant Hormones on the rooting of conifer stem cuttings with the aid of plant hormones has indicated the possibility of propagating rapid-growing and disease-resistant trees in this manner. The initial effort will therefore be directed towards the production of superior first generation hybrids possessing, if possible, a natural tendency to root by stem cuttings. A large number of inter-varietal crosses of spruce and pine have been made this year to determine crossability. In subsequent years emphasis will be placed on a limited number of crosses, with more definite practical objectives such as the crossing of Oriental white pines, resistant to white pine blister rust, with the native white pine which is highly susceptible to this disease. (L.P.V.J.)

Microbiology

Bacteriology

N. E. GIBBONS

The laboratory has been established during the year in permanent quarters and equipped to handle problems in the bacteriology of foods. The major part of the time has been spent in studies on Wiltshire bacon, reported in the section on Food Storage and Transport (Page 24).

Some work has been done on the effect of phytohormones on bacteria and yeast. With yeast there was an early stimulation in gas production with from 1 to 5 p.p.m. naphthylacetic acid. Slight increase in lactic acid production was noticed with *Streptococcus lactis* in the early stages of fermentation (13 hours) with from 5 to 10 p.p.m. naphthylacetic acid. However, in 24 hours the acid production in controls was as great as in the hormone treated samples. The same early stimulation has been noted with lactose fermentation by *E. coli*. Any stimulation may be masked by a heavy inoculation. Apparently the action is a shortening of the lag phase of the growth cycle. In all experiments, except gelatin liquefaction, 100 p.p.m. inhibited. No stimulation of gelatine liquefaction was observed.

Since inhibition seemed to be more easily demonstrated, attempts were made to inhibit growth of various bacteria with hormone-containing talc pellets. When the pellets were placed in Petri plates that had been inoculated with the organisms, no visible inhibition in the amount of growth could be detected even with 4000 p.p.m. naphthylacetic acid or indolylacetic acid. Inhibitory effects seemed confined to metabolic activities.

Thiobacillus thiooxidans, which is found in soil, is capable of oxidizing sulphur to sulphuric acid. This oxidation restricts the use of sulphur cements. An attempt has been made to find a means of preventing the growth of these organisms. Various arsenic compounds, nickel sulphate, ammonium vanadate and potassium nitrate have been tried without success. It is planned to try other substances.

Various tests have been made for members of this and other divisions. These tests include counts on chicken meat, examination of tainted apples, examination of bread for 'rope' organisms, counts on soil removed from carpet, and determination of bactericidal action of a soap compound.

Mycology

G. A. LEDINGHAM

During all of the year under review the mycologist has been concerned with the Trail Smelter Fumes Investigation, and research in mycology has therefore been limited to assisting with certain problems of the food storage and plant hormone groups. Growth rate measurements on fungi isolated from food products in cold storage were made in this laboratory under the supervision of Dr. C. A. Winkler. These have demonstrated the possibility of measuring the growth rate of a fungus growing in a liquid medium by a technique which makes it possible to obtain the weight of the same culture at various stages of growth. This provides what is probably an absolute rather than a relative measurement without recourse to an experiment involving the large number of separate cultures necessary in the dry weight method.

Studies were made on the effect of several plant hormones on the growth of different fungi, with a view to developing a biological method of assaying the potency of hormones in dust carriers. It was found that none of the hormones had sufficient effect on fungi to make this method practicable. The production of diastase by *Aspergillus oryzae* may be stimulated slightly by addition of ten parts per million of naphthylacetic acid to the medium. The stimulation is transitory and depends to some extent on the age of the culture. Further studies will be necessary before the conditions giving the maximum response are known.

Statistical Research

J. W. HOPKINS

Agricultural Meteorology

The objects of this research are (i) investigation of the relation between weather conditions and crop growth and yield; and (ii) examination of accumulated meteorological records in order to determine the climatological characteristics of specified agricultural regions, together with the nature and extent of variations in their weather conditions from year to year.

In order to supplement a previous statistical study of field data, a greenhouse experiment was undertaken on the influence of soil moisture and air temperature, subsequent to flowering of the main tillers, on the nitrogen content of wheat. The effect of higher air temperature in increasing nitrogen percentage through accelerated respiration was evident in grain collected when in the early dough stage (about 50% dry matter). By the late dough stage there were also significant differences attributable to soil moisture. The nitrogen content of the completely ripe grain was, however, practically the same for all treatments. This is attributed to a retardation of maturity by both increased soil moisture and lower air temperature, which would permit additional losses of carbohydrate through prolonged respiration, and also possibly to differences in the extent of late tillering. Compensatory effects of this magnitude would hardly be expected under field conditions, but might occur on a reduced scale, thus increasing the difficulty of correlating nitrogen content with meteorological observations. (Can. J. Research, C, 16:135-142. 1938.)

A statistical study was made of some characteristics of the air temperatures recorded during the spring and summer months April-August at meteorological stations in central and southern Alberta and Saskatchewan. Points investigated included the general trend of the mean temperature for each of these months over a 41-year period; annual and seasonal variation in monthly mean temperature; correlation between the mean temperature at stations in different parts of the area during the same month, and during successive months at the same station; intra-monthly variation and correlation of 18 years' daily maxima and minima; and diurnal variation as indicated by hourly records for four representative years at Swift Current. The information thus obtained formed the basis of a published paper (Can. J. Research, C, 15:461-491. 1937).

It has been suggested by Irwin that a criterion of the adequacy of the number of meteorological stations within a given area would be the effective linearity of the relation between the value of any meteorological element, such as temperature, at a specified point, and the latitude, longitude and altitude of that point. The agreement between the actual and linearly graduated values at the various stations then provides a measure of the homogeneity of the area represented and the adequacy of the meteorological network in specifying its characteristics. In an application of this criterion, the linear partial regression coefficients of the 18-year average (1917-34) monthly mean air temperature recorded at 43 points in central and southern Alberta and Saskatchewan on latitude, longitude and altitude were determined for each month of the year. The monthly regression equations were found to account for most of the variance of the station averages, and hence to provide a reasonably satisfactory graduation of the climatological temperature gradients characteristic of this area at different seasons. They could not, however, be applied satisfactorily to the monthly averages for individual years, owing to greater local variation, but the indications were that, with further additions to the number of stations, fairly accurate graduation should be possible within sub-districts, even in individual years. (Can. J. Research, C, 16:16-26. 1938.)

Evaporation Studies

An experiment was undertaken in order to obtain preliminary indications respecting the possibility of reducing the loss of water through evaporation from cattle ponds by lining the bottom with a layer of some insulating material (*e.g.*, straw and puddled clay) such as is used in the construction of European "dew-ponds". The procedure adopted was to determine the amounts of water evaporated from small pans (12″ x $3\frac{1}{4}$″) insulated and uninsulated from the substratum, when exposed to outdoor conditions on the roof of the laboratory during the period August 31 to September 18, 1937. In general, water temperature and evaporation were higher in the insulated than in the uninsulated pan during the daytime, but lower at night, and over a period of 11 rain-free days the total recorded loss of water from the former was only 77% of that from the latter. The results thus suggest that insulation might have some beneficial effect, at any rate in the shallow part around the periphery of natural ponds. (With W. H. Cook.)

Design of Experiments and Statistical Analysis of Results

As in previous years, an appreciable amount of time was devoted to consultations and correspondence with other workers, in these Laboratories and in other institutions, relating to problems encountered in the planning of replicated experiments and the statistical treatment of the results of such experiments.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

Prior to the establishment of the National Research Laboratories, it was prominently in the minds of those who were advocating such establishment that one of the ways in which a central national research organization could assist the industrial life of Canada would be by undertaking, among its other activities, research projects on what may be roughly described as the Mellon Institute plan; that is, by undertaking research financially supported by and for the benefit of individual Canadian corporations on specified subjects in which they might have a particular interest. Such "sponsored" research (as it is, not very appropriately, often called) could, it was contemplated, be advantageously undertaken in cases where suitable facilities or personnel were not available otherwise in Canada, either in commercial consulting laboratories or in such laboratories as the corporations themselves might maintain.

It is gratifying to report that a substantial increase in the number of sponsored researches is in prospect, negotiations having been begun during the year and carried well along for the initiation in the Division of four additional research projects, on varied subjects, financed by Canadian industrial corporations.

A central research organization is in general particularly well placed to do such research both economically and efficiently, because of its large staff of scientific workers, embracing specialists on many subjects, and its unusually complete equipment and reference library. There are few industrial research projects that do not raise problems related to fields of science other than the field in which their main problems lie. For example, the study of refractories may raise problems involving colloid chemistry and metallography; the study of leather involves both colloid chemistry and organic chemistry; the study of asbestos involves chemistry, textile science, electricity, engineering and mineralogy; many industrial chemical projects raise not only problems of chemistry, but also matters of electrical science and of engineering. Hence a central research organization, where specialists on various subjects—not only in other branches of chemistry, but also in branches of physics, engineering and biology—can be called in for consultation in the pursuit of a research project, has an advantage over a laboratory more restricted in its scope. Further, in a central laboratory organization in which many and varied subjects are being pursued, it frequently happens that results secured in one piece of work contribute techniques and ideas of value in another.

As an instance of the advantages offered by the existence of a wide range and variety of scientific personnel in a central institute, especially when taken in conjunction with the co-operation in research which other Government science services can make, and have always kindly made, available, the study of plant hormones may be mentioned. As stated in last year's report, the Division prepared by chemical synthesis a number of substances which, when applied to plants in small amounts (amounts similar to those in which vitamins affect animals) have striking effects on growth and clearly had possible important practical applications in agriculture, forestry and horticulture. Thanks to the fact that at the same time it happened that work was also in progress in the Division on the disinfection of seeds, a novel, readily controlled, and convenient way of applying plant hormones to seeds and cuttings was developed. And during last summer the work of the Division on plant hormones was extended beyond the field of synthesis to experiments on the effect of hormones on the growth of plants, plots being prepared for outdoor planting and the facilities of the greenhouse in the Division of Biology being

made available. As the experiments progressed, the assistance of experts in various fields was sought and was freely made available by our Division of Biology and by the Department of Agriculture. The latter also provided plots for outside test plantings at the Central Experimental Farm. After promising results had been secured in these initial experiments, a more extensive course of investigation was undertaken, and, while the synthetic work was continued in the Division of Chemistry, the member of the Division's staff who had done the planting experiments was transferred to the Division of Biology and the direction of the planting aspects of the work was put under that Division. Further, an Associate Committee on Plant Hormones was organized, embracing representatives of the Divisions of Biology and of Chemistry of the National Research Council, the Dominion Department of Agriculture, and the Forestry Branch of the Department of Mines and Resources. The two last-mentioned departments are now co-operating actively in the work, and so are certain agricultural colleges and universities outside Ottawa. Steps have also been taken to protect the interests of Canadian users, by applications for patents and by arrangements for the manufacture and sale of plant hormone preparations in Canada under responsible auspices.

Work has continued and steady progress made on most of the main subjects of investigation mentioned in last year's report. Among the new lines of work taken up are:—a study of the process of treating the pitchblende of the North West Territories, with the idea of modifying it so as to make practicable the recovery, not only of radium, but also of other radioactive elements contained in the ore; the production from Canadian raw materials of magnesium, a light metal, two-thirds the weight of aluminium, of growing industrial importance; the study of materials for caulking buildings and other structures. During the year there was established in the Division a laboratory devoted specially to the study and prevention of corrosion, an agency, which, as is well known, is one of the most widespread sources of loss in the modern world and involves costs for replacement and maintenance which vary in severity in different industries but are experienced in some degree by nearly all.

Asbestos

D. WOLOCHOW, A. VAN WINSEN

Experience in the testing of milled asbestos fibre, by means of the Quebec Standard Asbestos Testing Machine, has shown that the results obtained may vary somewhat owing to differences in the handling of the fibre prior to and during the test. Work was therefore undertaken with the object of developing a standard testing procedure that would eliminate, if possible, the effects of the human factor and the influence of the previous history of the sample, upon the results obtained by means of the Quebec Standard Asbestos Testing Machine. One of the new all-metal testing machines, together with auxiliary equipment, obtained on loan from the Quebec Asbestos Producers' Association, has been installed in the laboratories for the purposes of this work. Additional apparatus has been designed and built. As a result of this research a tentative standard testing procedure has been suggested.

An experimental fibre-opening machine, also obtained on loan from the Quebec Asbestos Producers' Association, has been installed in the laboratories and a number of tests on the evaluation of fibre quality have been made with it. The small carding machine mentioned in a previous report has also been used in this connection.

Laboratory work on the production of asbestos fibre suitable for filtration purposes has been completed and filtration tests on the materials produced have been made. Arrangements for the industrial production of fibre for filtration purposes from Canadian mill fibre were under negotiation during the latter part of the year under review.

An investigation of the thermal dehydration of asbestos fibre was begun, the effect of both temperature and time of heating being studied. One phase of this work was completed, but it was decided to extend the investigation to include the various types of asbestos and the effect of dehydration on their physical properties.

Work has been done on the utilization of short fibre and of tailings or waste rock and some interesting results have been obtained. In this connection the action of several chemicals on serpentine (waste rock from asbestos milling) has been studied.

The microscopic studies of asbestos fibre were continued and a large number of photomicrographs were prepared. Examination of these has furnished information which has been of value in the study of methods for the efficient opening up or fiberizing of fibre bundles.

A method was developed for making Canadian asbestos fibre paler in colour in order to render it suitable for a special manufacturing purpose.

The survey of the uses of asbestos was continued by further visits to manufacturing firms using asbestos, and the findings have been the subject of several reports submitted to the producers.

A number of samples of asbestiform minerals have been received from parties interested in new deposits discovered in various parts of Canada. The samples were examined and reports submitted.

A paper on "Asbestos and Its Utilization" was delivered at the annual meeting of the Canadian Institute of Mining and Metallurgy.

Casein

W. GALLAY AND J. S. TAPP

A thorough study was made of the factors entering into the preparation of rennet casein, of a quality suitable for use in the manufacture of plastics, particularly buttons. As a result of this work, the procedure has been thoroughly established and the information is available to those firms in Canada contemplating the manufacture of this material. The work was carried through to the industrial scale and one Canadian firm is now producing rennet casein of a quality at least equal to that of the imported grade. A procedure has been developed also for the manufacture of a very high grade of acid casein.

The flow of casein under known pressures was measured in a laboratory-scale extruder, and the effects of such factors as moisture, ash, lactic acid, albumen and pH were noted. Pressures up to 70,000 lb. per sq. in. were used. Tests have been evolved for the rapid evaluation of caseins as to purity.

Work is being carried out on the treatment of casein to render it suitable for high-speed injection molding, which would broaden greatly the possible utilization of casein in plastics manufacture.

A large number of casein samples have been tested as to suitability for plastics manufacture.

Corrosion

A. VAN WINSEN

Investigation of the resistance to corrosion by sea water of a number of aluminium alloys and steels was continued. Sea water obtained from one particular source was found to be unusually corrosive; the source of the active reagent in this sea water was determined.

Experiments were made on the effect on the potential between submerged metal couples of additions of small amounts of compounds and combinations of compounds to city water.

A series of tests was made in order to find out under what conditions a zinc coat will not protect iron from corroding when submerged in water.

A number of industrial corrosion problems were investigated at the request of various organizations, such as paper mills, laundries, shipbuilding concerns, chemical plants, etc. Two special metallic protective coats were investigated at the request of the industries.

Distillation

D. F. STEDMAN

During this year the patents covering the highly efficient packings for fractionating columns and scrubbing towers, which were developed in the laboratories and which have been mentioned in previous reports, were taken over by the Foster Wheeler Corporation, St. Catherines, Ontario, and towers are now being developed in forms specifically suited for larger scale operations. This company is now doing further design and testing work in this direction, and several types are now available to industry.

In these laboratories extensive tests have been made in an attempt to fractionate the cresols by means of these columns, both with and without the addition of various third substances, but unfortunately it has not proved a commercial possibility.

With the help of Mr. R. M. Donald, the holder of a Special Scholarship in the laboratories, a typical crude oil from Turner Valley, Alberta, has been examined rather closely, and many of the individual compounds composing it have been identified. Some possibility is indicated that it might prove a source of petroleum solvents of rather good solvent characteristics.

Clays

W. GALLAY

Refining and Bleaching Clays

Further samples of bentonites from Western Canada have been tested as to efficiency in the refining chiefly of mineral oils. Material from one deposit in southern Saskatchewan has shown excellent results in the activated state.

A paper entitled "Canadian Bentonites" was published in the Canadian Journal of Research, B, 16:6-34, 1938. As a result, information and samples have been furnished to a number of interested enquirers. It is expected that commercial development of the Manitoba bentonite deposits will proceed in the near future. It is important to note that the Canadian consumption of bleaching and refining clays, supplied entirely by imported materials, has increased appreciably in recent years in both the petroleum and vegetable oil industries.

73461—3½

Clays in Rubber

The study of this subject has been continued by the examination of a widely used soft clay in a typical rubber stock. The clay was fractionated and the range of particle sizes measured for each fraction, by a sedimentation method. When the fractions were tested as rubber fillers, it was found that the stiffness of the stress-strain curves varied greatly with the particle size of the clay, the results in this respect corroborating previous work with other clays.

Laundering and Dry Cleaning

C. H. Bayley, B. J. Kenalty

Service Work

The laboratory has maintained active contact with the laundry and cleaning industries of Canada. Membership in the Canadian Research Institute of Launderers and Cleaners, in close connection with which the laboratory operates, has increased by 24% over the period 1936-37. There are now 115 commercial and institutional laundry and cleaning plants making use of the research and control facilities offered by the laboratory and contributing financially to its upkeep.

The "test bundle" service, designed to furnish a periodical check on the laundering and cleaning efficiency of member plants, has been widely used, and a total of 472 laundry and 100 dry-cleaning test bundles have been issued, representing an increase of 50% over the previous year. The results of these tests have indicated that a satisfactory standard of efficiency is being maintained in member plants. In only 9% of the total test pieces analyzed have the results indicated the need of improvement in plant efficiency, and in these cases the necessary recommendations have been made.

Service work carried out included 786 reports covering the investigation of a wide variety of the problems encountered by the laundry and cleaning industries. This figure represents an increase of 19% over 1936-37 and does not include major or minor researches carried out by the laboratory during the period under review. Some of the matters with which the reports have been concerned are as follows:—

(1) Tests on laundry nets. (2) Investigation of corrosion problems in dry cleaning plant equipment. (3) Examination of hospital linens reputed to have caused skin irritation. (4) Effect of repeated laundering on fabrics processed in the hotel system of a Canadian railway. (5) The investigation of improperly "preshrunk" imported shirting fabrics. (6) Dye damage in woven stripes of huck towels. (7) Calibration of capillary viscosimeters for use by the pulp and paper industry for the determination of the cuprammonium viscosity of pulp. (8) Fastness-to-laundering tests on Canadian-made upholstery fabrics and trimming braids. (9) Analyses of elastic webbing used in gas masks. (10) Launderability of casein buttons.

The laboratory has also carried out a complete survey of the laundering methods in use at the various Federal penitentiaries. Penitentiaries from east to west were visited and a comprehensive series of recommendations was prepared.

Specifications

The laboratory has co-operated with the Subcommittee on Textile Specifications of the Canadian Government Purchasing Standards Committee in the setting up of specifications covering methods of fibre identification, determination of weighting in silk and a standard method for measuring the fluidity of dispersion in cuprammonium hydroxide solutions of cotton

and regenerated cellulose rayons. In addition, a number of surveys have been carried out involving the analysis of the various grades of certain textile commodities of Canadian manufacture. This work will form the basis of tentative specifications for the following textile products: (1) Circular pillow cotton. (2) Unbleached and bleached cotton glass towelling. (3) Half-bleached linen glass towelling. (4) Bleached cotton huck towelling. (5) Bleached linen huck towelling. (6) Terry towelling and (7) Towels.

The laboratory has also collaborated with the Sub-committee on Soaps and Detergents of the above committee in the preparation of specifications covering soap for use in salt water and low titre soap for use in the laundering of woollens. It has also taken part in the work of the Joint Committee on Water Analysis sponsored by the Canadian Institute of Chemistry and the Canadian Public Health Association.

Contact with Textile Firms

Active contact has been maintained with a number of textile firms in matters relating to the launderability and cleanability of Canadian-made textiles. The work in this field has included the investigation of shrinkage problems in cotton prints and shirting fabrics. In addition, a limited contact has been made with certain members of the retail textile trade in connection with their problems in this field.

Research Work

The laboratory investigation of the laundry bleaching process using sodium hypochlorite has been concluded. The action of dilute solutions of hypochlorite on solutions of typical laundry soaps under varying conditions of pH and temperature has been determined. The effect of variations in cloth-solution ratio at various pH on the extent of chemical attack has been studied. The results indicate that in the normal laundry bleaching procedure, a considerable amount of the available chlorine of the hypochlorite is used up in reacting with the unsaturated constituents of the soap present. The extent of chemical attack on the cotton with repeated laundering is more marked at a pH of 9·5 than at pH 11 but this effect is less pronounced at high cloth-solution ratios.

The study of the effect of repeated treatment of cotton and linen with dilute alkaline solutions at 100°C. has been completed. It has been found that the amount of chemical deterioration produced by solutions of similar composition to those used in laundering is relatively slight and is proportional to the degree of alkalinity of the solution.

A full-scale study has been carried out on the effect of repeated laundering, up to 100 times, on certain typical cotton fabrics. The chemical condition of the laundered fabric has been determined by measurements of tensile strength and cuprammonium fluidity. It has been shown that in a well controlled laundering formula the extent of chemical degradation is slight and is mostly the result of the small amount of chemical attack occurring during the bleaching operation. With adequate control of the concentration of available chlorine, temperature and pH of the bleaching bath, the extent of this attack can be kept within satisfactory limits.

Work has been carried out on the efficiency of wetting-out compounds and mixtures for use in the first or "break" operation of the normal laundering formulae where the thorough wetting-out of the fabrics is of importance. Mixtures having very high rates of wetting, with respect to cotton, have been prepared and it is proposed to investigate their efficiency on a full plant scale.

The investigation of the problem of "winter damage" on which work was carried out in 1931-33 has been resumed. Exposure tests have been carried out during February and March in Montreal and Toronto and the fabrics are being examined for deterioration.

An investigation of the various factors affecting the accuracy of the cuprammonium fluidity test is in progress.

The apparatus designed for the complete recovery of tri- and perchloroethylene from filter and still sludges in dry cleaning plants using these solvents has proved of great usefulness in reducing the loss of these solvents, and one plant using the apparatus reports a 50% decrease in solvent losses.

Publications

The laboratory has continued to prepare articles dealing with various phases of laundry and cleaning practice. Articles on the following subjects have been published in the Laundry and Dry Cleaning Journal of Canada:

(1) Laminated Fabrics with Special Reference to Starchless Collars.
(2) Weighted Silk Fabrics.
(3) Corrosive Damage in Cotton and Linen Fabrics.
(4) Laundering of Damask Table Linen. Parts I, II and III.
(5) Work of the Laundry and Cleaning Laboratory, National Research Council, 1937.

In addition, the following addresses have been delivered and published:

(1) Research on Laundering (Eastern Canadian Laundryowners' Association, Ottawa, June, 1937).
(2) Technical Problems in the Laundry (Vancouver, June, 1937).
(3) Work of the Laundry and Cleaning Research Laboratory (Maritime Launderers' Association, Truro, N.S., Sept., 1937).
(4) Science and Our Clothes (Radio Address, Feb., 1938).

Contact with Other Research Laboratories

During the period under review, the laboratory has maintained active touch with other laboratories engaged in the field of laundering and cleaning research. These include the Laboratories of the British Launderers' Research Association, The American Institute of Laundering, and the New Jersey Laundryowners' Association. The laboratory is represented on the Technical Committee of the Institute for Maintaining Drycleaning Standards recently established in the United States. Contact has also been maintained with the Committees on Soaps and Detergents and on Textiles, of the American Society for Testing Materials.

Leather

W. E. GRAHAM, A. ROSE

The investigation of various domestic barks as sources of tannin was continued. Several new barks were examined: black and red spruce from New Brunswick, alder, white ash and eastern cedar. White spruce and western hemlock barks were studied in some detail. A thorough investigation of the physico-chemical properties of a concentrated white spruce extract is in progress. Other uses for waste bark are being sought.

A considerable amount of work was done on the problem of the determination of total and reducing sugars in tanning extracts. The alkaline ferricyanide method of Hassid, using ceric sulphate for back-titration of the ferrocyanide formed, and the chloramine-T method of Hinton and Macara were

thoroughly investigated, but it was decided that neither was suitable for the purpose intended. The method of standardization of dilute ceric sulphate solutions by potentiometric titration against oxalate solutions was developed to the point where it was found to be rapid, convenient and accurate.

The problem of the deterioration of shoe upper leather, with the related question of the effect of organic sizing material in shoe linings was given further attention.

A new type of flexing machine was developed to simulate the action of the foot in walking, with a device attached to feed chemical solutions to the inner side of the sample.

A new type of tannage for white leathers, to produce products resistant to hot water, is now under development in the laboratory.

As in previous years, a large number of service problems were submitted, particularly in connection with damage to boots and shoes, examination of defective leathers, analysis of tanning materials, dressing of reindeer furs and skins, etc.

Magnesian Products

L. Hodnett, P. E. Gishler

In the past few years so many new leads have been obtained in this investigation that recently it has become necessary to concentrate on work leading to the commercial application of the discoveries made rather than to open up new avenues of research. Several new lines have nevertheless been developed.

Stable Dolomitic Refractories

The furnace trials referred to in the last Annual Report have now been carried out, and while full records of service are always difficult to secure, information of definite value has been obtained. It has now been demonstrated that stable dolomitic materials and calcium silicates of extremely high refractoriness can be produced and these have special properties that should make them of considerable value in certain applications. The field is so large, however, and the types of refractories so numerous, that much time must elapse before it will be determined where each can be most economically used. In the meantime it is expected that further research will help to correct such weaknesses as have been discovered in the initial products.

Improved Magnesitic Dolomite Brick

Some years ago these laboratories developed a brick, made from Canadian magnesitic dolomite and chrome ore, of extremely high resistance to spalling, that is, to fracture when subjected to rapid temperature changes. This brick has been manufactured for several years in England, and recently production has been begun in Canada in a tunnel kiln erected especially for that purpose. A number of improvements have been effected from time to time, and in the past year the refractoriness of the brick has been further increased by utilizing information obtained in a related research and by substitution in the constituents. It is of interest to note that brick manufacturers in several countries are now using the same general principle to secure spalling resistance, but without in most cases obtaining equal success.

Chemically bonded unburned brick of a similar type have continued to prove their usefulness in special fields. They have gained wide application in Canada and other countries in the lining of high-temperature zones of cement kilns. One kiln, operating under particularly severe conditions,

recently produced 1,200,000 barrels of cement on a single lining of this type, as compared with 352,000 barrels, previously the best production obtained with high-alumina brick. When such tonnage is secured, the cost of refractories per ton of cement is almost a negligible item.

Experiments have been continued in an effort to effect a further increase in the strength of unburned brick, and this with considerable success. By adapting to the brick chemical bonds developed for use in cements and plastics, properties have been obtained which will, it is expected, broaden their field of application.

Chrome Brick

The physical and chemical properties of chrome ores vary considerably, and during the past year those from the most important world sources have been examined with a view to ascertaining their suitability for particular purposes. As a result, and by using the experience gained in the production of other types of brick, it has been possible to produce both burned and chemically bonded unburned chrome brick of superior quality. Commercial manufacture in Canada has already been begun.

Cements

In the past year fundamental information regarding plasticizing agents has been applied with success to several types of acid, basic and neutral cements which are now being manufactured commercially and are finding a ready market. This work, which has now been brought to a conclusion, is a good example of the wide applicability of a single discovery.

In the manufacture of neutral cements, advantage has also been taken of the information gained by a study of various types of chrome ore, undertaken primarily in relation to brick manufacture.

Sodium Silicate

Sodium silicate is one of the bonds most widely used in the manufacture of refractory materials, but ordinarily so much has to be used in order to secure the strength required, that the refractoriness of the product is seriously reduced. Work done in these laboratories in the past few years has demonstrated that the strength of a given amount of this bond can be quadrupled by the addition of other chemicals to sodium silicate. A further great improvement is at the same time effected by preventing the "migration" of sodium silicate to the surface of bonded materials during the process of drying. Recent work has shown that improved quality can be obtained at lower cost by the substitution of materials previously believed to be unsuitable for this purpose.

Contact with Industry

In order to ensure the practical character of the work, close contact is maintained at all times between the research laboratory and manufacturing operations. In this way uneconomical lines of investigation are eliminated, initial manufacturing problems are solved, suggestions are obtained for additional researches and, in general, steps are taken which help to bridge the gap between laboratory experiments and full-scale commercial operations. Only by the close co-operation of industry can such a result be obtained. In the near future it is hoped to make an inspection of the major metallurgical plants in eastern Canada with a view to studying the applications of refractories under widely varying conditions and devising methods of meeting more effectively the requirements of Canadian and foreign markets.

Acknowledgments

As in previous years this work has continued to receive the technical and financial assistance of Canadian Refractories Limited, and has been directed by Mr. F. E. Lathe of the Division of Research Information. The assistance of members of the staff of the Division of Chemistry, and in particular that of Dr. W. Gallay and Mr. C. W. Davis is also gratefully acknowledged. During the year advantage has been taken of the laboratory facilities of the Industrial Minerals Division of the Bureau of Mines for carrying out certain tests. Mr. J. G. Phillips of that division has rendered valuable assistance in making a microscopic study of numerous experimental and commercial products.

Metallic Magnesium

L. M. Pidgeon

During the year under review research has been initiated on the production of metallic magnesium. Being the lightest metal (its specific gravity, 1·74, may be compared with that of aluminium, 2·71) which is reasonably stable under atmospheric conditions, its use is expanding rapidly in aircraft construction. Canada possesses abundant supplies of magnesium-bearing minerals, and with cheap electric power, this country should be in a position to enter the field when the demand increases.

Research has been undertaken to examine the Canadian raw materials, and to develop suitable methods for winning the metal therefrom. The production of the metal has been in very few hands, and the existing literature is confined almost exclusively to patents. An extensive search of the patent and general literature was the first step in this investigation. On the basis of the information obtained, the problem was resolved as follows:

I. Production of magnesium oxide from suitable Canadian minerals.
II. Production of metal from the oxide by (*a*) electrolysis, (*b*) electrothermic processes.

The production of magnesium oxide is involved to some degree in any method for the production of the metal, since Canadian magnesium-bearing minerals do not occur in a suitable condition to be utilized directly. Experiments are under way on various methods for producing the oxide in reasonably pure form from magnesite, dolomitic magnesite, and serpentine, extensive deposits of all of which occur in Canada. The technical problem is readily soluble by use of chemical methods but the economic aspects may not be so readily disposed of.

Up to the present practically all the commercial metallic magnesium has been produced by electrolysis of the fused chloride. Electrothermic reduction with carbon or other suitable reducing agent is very attractive and future developments are likely to be on these lines. The electrothermic operation is carried out either in an induction furnace at reduced pressure or in an arc furnace at atmospheric pressure.

Practical work on metal production during the period under review has been confined to the electrolytic method. Special electrical equipment has been installed which is capable of delivering 600 amperes D.C. at a pressure of 30 volts. Experiments have covered production of the metal directly from the oxide in special electrolytes and also from the fused chloride. In connection with the use of anhydrous magnesium chloride, attention has been given to the direct production of this salt from magnesium oxide. This is an essential step in the commercial utilization of Canadian minerals by the electrolytic fused chloride method, as no naturally occurring magnesium chloride is available.

Milkweed

N. H. GRACE

Relatively simple bleaching and sodium hydroxide treatment of the floss of *Asclepias syriaca* (the common Canadian milkweed) produces a product of fine texture and good colour. The treated fibre cards well and appears to be suitable as a filler for such purposes as life-belts, and for any purpose for which a fine textured cellulose fibre is desirable.

Paints

C. Y. HOPKINS

A large part of the work of the laboratory consisted of the examination and testing of new materials for paint manufacture. The materials included pigments, fillers, resins and miscellaneous products. Nearly all were from Canadian sources. Two new resins which had been developed in other laboratories of the Division of Chemistry were examined to determine their usefulness in paint vehicles.

Performance tests were carried out on a wide variety of prepared paints at the request of certain government departments and other large users. Paints of the following types were included: underwater, anti-fouling, fire-resistant for shingles, heat-resistant, chemical resistant, luminous, galvanized iron primer, marine enamels, leadless paints, rubber-base paints.

Co-operative work with the Canadian Government Purchasing Standards Committee was continued and the Committee issued nine specifications for paints of various kinds.

Various test methods were studied in the laboratory to determine their value for specification use. These studies dealt with the consistency of paste colours in oil, glyceryl phthalate content of enamels, identification of graphite, heat resistance of aluminum paint, whiteness of enamels, hiding power of solid colour enamels, analysis of aluminum pigments, etc.

An examination was made of the characteristics of vehicles that affect the leafing of aluminium pigments used therewith. Viscosity, surface tension and evaporation rates were measured. The relation between leafing power of aluminium pigments and the brightness and smoothness of aluminium paints was investigated.

The problem of securing proper adhesion of paint to galvanized iron surfaces is being reviewed. Exposure tests have been commenced in which various methods of priming and pre-treating the surface are under trial.

The effect of varying light intensity on the drying time of paints has been determined. A method of accelerating the bodying of oils was tried out. Experimental varnish cooking was begun preparatory to an extended study of varnish oils and resins.

Co-operation with the Paint Committee of the American Society of Testing Materials and with the Montreal Paint and Varnish Production Club was continued.

The following articles were published: "Accelerated Tests on Paints for Wood", Symposium on Accelerated Paint Tests, Amer. Soc. Testing Materials, 1937. "Synthetic Plastics in Aircraft Construction", The Engineering Journal, December, 1937.

Plant Alkaloids

R. H. MANSKE

A number of plants not hitherto available have been chemically examined in a preliminary manner. Further work on the following is in progress: *Corydalis claviculata*, *C. pallida*, *C. ophiocarpa*, *C. ochroleuca*, *C. lutea*, *Lobelia cardinalis*, *L. siphilitica*, *Fumaria officinalis* and *Delphinium brownii*. Papers recording researches completed during the year have been published in the Canadian Journal of Research under the following titles:

The Alkaloids of Fumariaceous Plants. XV. *Dicentra chrysantha* Walp. and *D. ochroleuca* Engelm.; The Alkaloids of Fumariaceous Plants. XVI. Some Miscellaneous Observations; An Alkaloid from *Delphinium brownii* Rydb.; Anolobine, An Alkaloid from *Asimina triloba* Dunal.

Plant Hormones

R. H. MANSKE, A. CAMBRON

Owing to the increased interest in these chemical substances, which are known to bring about physiological responses in plants, considerable attention has been given to improving procedures for the preparation of those which are already known and to the synthesis of new ones. While previously plant physiologists relied upon these laboratories for the chemicals in question, this phase has largely been shifted to commercial laboratories, in at least one of which several satisfactory plant hormones are being prepared for distribution at a reasonable cost.

Synthetically, a series of homologues of α-naphthyl-acetic acid has been prepared and these are ready for testing. A number of by-products arising from this work have been encountered and their examination is in progress. (R. H. Manske)

Further work has been carried out on the synthesis of α-naphthyl acetic acid, which is one of the most active synthetic plant hormones. The method previously developed for the synthesis of this chemical has been improved by elaborating a simpler procedure and adjusting the conditions so as to cut down the time required for the preparation. These improvements have resulted in a further lowering in the cost of production of the hormone. (A. Cambron).

Plastic Caulking Materials

W. GALLAY

At the request of the Canadian Government Purchasing Standards Committee, an investigation of these materials was carried out with a view to the setting up of purchasing specifications. Such factors as composition, "skin" formation, retention of vehicle, plasticity and slumping properties were investigated. Limestone, wood, metal and glass were the structural materials involved, and a large number of commercial caulking materials of different grades were tested. On the basis of this work, tests were evolved for the evaluation of plastic caulking materials and embodied in "Tentative Specification for Plastic Caulking Compound, No. 1-GP-23, Canadian Government Purchasing Standards Committee".

Potato Starch

W. GALLAY, J. S. TAPP

Owing to high prices for table stock potatoes, practically no potato starch was manufactured in Canada during the season 1936-37. The present year was again one of low prices and the starch plants have resumed activity.

During the later part of the season, at the request of the Canadian Horticultural Council, a visit will be made to the potato starch plants with a view to increasing the market for potato starch on the basis of conclusions derived from experimental work which has been previously carried out and which was mentioned in an earlier report.

Potato dextrines have been prepared both in the laboratory and in semi-commercial batches for trial in textile plants. The laboratory dextrinizer has been modified to conform with recent industrial practice.

Radium

D. F. STEDMAN

Efforts have been directed towards finding a more direct extraction process for the radium from Canadian ore, which might also offer the possibility of extracting some of the other radioactive products in the ore. This work is showing some promise in the directions desired, but is not yet completed.

Respirators

Studies were carried out in the rubber and the textile laboratories in regard to the production in Canada of face pieces for gas masks, at the instance of the Department of National Defence. In this connection a low-capacity tensile testing machine, which makes possible accurate determinations of the stress-strain properties of low-modulus rubber stocks, was installed.

The construction and testing of containers and the production of adsorbent charcoal for them has been studied in detail.

Other work carried out in regard to gas masks and their use was on anti-dimming compounds and gas detection.

Rubber

T. R. GRIFFITH

The work carried on during the last year on the bonding of rubber to various surfaces by a special cementing resin previously developed in the laboratory was continued in collaboration with Dr. N. S. Grace. Work on the bonding of rubber to iron and steel was directed towards increasing the strength of the bond at normal and at elevated temperatures and improving its general uniformity. To achieve the latter end, a quantitative study of the relationships between viscosity of solutions, elastic recovery, plasticity of the resin, and the adhesive strength was found necessary.

During this period adhesives were developed for bonding rubber to glass, and in collaboration with Dr. E. A. Flood a strong rubber-to-zinc bond was obtained. The process used in bonding rubber to non-porous surfaces was modified so that adhesion satisfactory for certain commercial requirements could be obtained without applying heat to the assembly.

The problem of altering the properties of the resin so as to produce a good paint base was taken up in collaboration with Drs. C. Y. Hopkins and N. S. Grace. The principal difficulty was that the high molecular weight of the adhesive resulted in low solubility, whereas a paint base must be highly soluble. The problem appears to be well on the way to solution, and paints of commercial promise are now being produced.

A number of enquiries from Government Departments and outside sources relative to rubber were answered. The value of a substitute for clay as a rubber filler was determined for an interested company.

Seed Disinfectants

A. Cambron, N. H. Grace

A process for the preparation of certain organic mercury derivatives has been developed. The purpose of the work was to render available such compounds as the alkyl mercuric halides and other salts which are becoming widely used for seed disinfection, particularly for the control of the fungus causing smut in wheat. The process developed is adaptable to large scale operation and yields a very satisfactory product, both from the point of view of fungicidal value and of cost of production. (A. Cambron.)

The use of the disinfectants in the form of dusts consisting largely of an inert carrier adapted to adhere to the seed was studied. Canadian bentonites or talcs were found to be satisfactory as carriers, the dusts being equal in disinfecting power to the best imported products. On account of the fact that most of the seed disinfectants used in Canada are used in the western grain-growing areas, it is interesting to note that a Manitoba bentonite was found to be particularly suitable as a carrier. (N. H. Grace.)

Selenium

E. A. Flood

A rapid laboratory method of synthesizing organic selenides and diselenides has been developed. The method could be adapted to large scale production. The value of such selenium compounds as anti-knock agents for motor fuels is being investigated. The preliminary experiments show that the anti-knock effects of aliphatic selenium compounds are considerably influenced by the substituent organic groups.

A very simple method of applying selenium coatings to metal surfaces has been developed. The method could be adapted for coating large finished structures. Coatings have been applied to iron, aluminum, magnesium, etc. Experiments have been carried out to determine the value of selenium coatings for the protection of metals against corrosion. While these coatings alone appear to be of doubtful value, they appear promising as undercoats for paint films and for certain special purposes.

Storage Batteries

L. M. Pidgeon

Research has been continued on Canadian yellow cedar (*Chamaecyparis nootkatensis*) in connection with its use as a material for storage battery separators. Further test batteries were made up, both the Canadian wood and Port Orford cedar being used. Port Orford cedar is a wood of United States origin which is used very largely at present. The separators were supplied by a firm in British Columbia which manufactures separators of both woods, the separators being selected to represent the best available in each case. Test batteries were assembled and carried through a standardized cycle of charge and discharge. When dismantled after several months of severe treatment no appreciable difference in the condition of the separators could be noted. The variability noted previously in yellow cedar samples was not observed in these experiments. The results confirm previous conclusions to the effect that yellow cedar separators will give as good service as Port Orford cedar.

Synthetic Resins

LÉO MARION

Some of the work outlined last year, dealing with the synthesis of the lower polymers of styrene, has been completed and the results published in the Canadian Journal of Research, B, 16:213-217. 1938.

The work has been expanded to study the formation of polymers from chloro-methyl compounds. Polymers have been prepared from chloromethyl-naphthalene, bromo- and chloro-xylylenes, and from benzyl chloride. The latter especially has yielded a polymer from which a varnish can be produced which is very resistant to water. The brittleness of the polymer can be decreased by the admixture of certain quantities of rosin to the benzyl chloride before the reaction.

The polymerization of stilbene has also been studied, but the results so far obtained are not very promising.

Textiles

P. LAROSE, A. S. TWEEDIE

The report on the work on the effect of environmental and nutritional factors on the growth of wool, carried out in co-operation with the University of Alberta under the Council's Associate Committee on Wool, has been re-written in a form suitable for publication. Much work, in the way of statistical calculations, was involved.

A convenient and rapid method for the determination of the new synthetic wool, lanital, in mixtures with natural wool has been developed. The method has been shown to be applicable to the determination of other fibres in certain mixtures. The method is being studied by Committee D-13 (on Textiles) of the American Society for Testing Materials, with a view to incorporating it in their test methods if it is found suitable. The method was described in the Canadian Journal of Research, B, 16: 61-67. 1938.

An investigation was made of the viscosity of a solution of silk in zinc chloride prepared under various conditions. The investigation included the effect of the weighting of silk, the effect of various agents, hydrochloric acid, alkalies, steam, and light, on the viscosity of the silk in solution. A relation between the viscosity, the amino-nitrogen content of the silk and its tensile strength was also studied. As a result of this work it will be possible to use the method to determine the nature and extent of damage in silk goods.

The deterioration of wet cotton resulting from the uneven evaporation of water from it has been further studied and the effect of various conditions determined.

In an attempt to accelerate the standard test for the fastness of dyed fabrics to sunlight, a wide range of standard dyeings was exposed on the roof throughout the summer. The samples were placed in a fixed frame and also in a specially constructed rotating frame designed to follow the sun. The results showed the impossibility of accelerating the fading action by the use of a rotating frame.

A large part of the work carried out during the year had to do with the development of standard methods and specifications. In this connection, methods of testing for tensile strength of fabrics were investigated and the effect of varying the sizes of samples determined. As a result of this work, a new method is being proposed which combines the advantages of the two other methods generally in use, *i.e.*, the accuracy of the strip method and the

rapidity of the grab method. Some work was also carried out on the method for determining the amount of sizing material in fabrics. Various factors that might affect the results were investigated. The investigation of new methods included a study of the determination of nap in flannelettes and of the water absorbency of towels.

Canadian Government Purchasing Standard Specifications have been prepared for cotton sheetings, pillow cotton and flannelette. This involved testing a large number of representative samples for such characteristics as weight, width, sizing and finishing materials, yarns per inch, yarn count, shrinkage on laundering, tensile strength, and fluidity of the cotton in cuprammonium solution.

A study of various factors affecting the performance of linen fire hose has also been undertaken as a preliminary to preparing a specification for this material for use especially in forest protection.

Co-operation with Committee D-13 of the American Society for Testing Materials has been continued by taking part in the proceedings of the regular committee meetings and by an active interest in the development of new standards. Thus the fibre diameters of samples of mohair tops were determined by two methods and one of the proposed methods for differentiating wool from mohair was studied at the same time, as part of the work carried out by the Subcommittee on Wool, prior to establishing standards of quality for the tops.

The number of materials received from outside for testing is continually increasing. The largest number of tests have been on fastness to light. Other determinations included twist in yarn, fibre content in mixtures, tensile strength, wearing property and waterproof property, fabric construction.

An interesting case of dermatitis trouble in a woollen mill was investigated and traced to the fine dust of improperly washed chrome-dyed wool.

Interest has been shown in the Canadian Textile Societies and close contact with them is kept by frequent attendance at the regular meetings.

Analysis

C. W. DAVIS

Chiefly in order to provide data required for researches in progress in other laboratories of the Division, the analytical laboratory made the following analyses:

—	No. of Samples	No. of Determinations
Asbestos and solutions	265	638
Hormones and seed disinfectants	74	111
Metals and their corrosion products	295	639
Pigments and varnish	66	158
Refractories	462	725
Rubber	26	47
Soap and cleaning compounds	59	177
Textiles	22	68
Water	116	213
Total	1385	2776

Other materials analysed included antifreeze, brass packing ring, casein, clay, fish preservative, leather ash, natural grease, oily water and soils. Five samples of gasoline and seven samples of lubricating oil were tested. Most of the chemical testing of petroleum products was subsequently taken over by Dr. J. W. Broughton of the Oil Testing Laboratory, Division of Mechanical Engineering.

Two samples of cards were tested for the Central Pay Office. Two samples of type metal dross were analysed and an investigation was made regarding the properties of printer's ink for the Department of Public Printing.

In collaboration with the Canadian Government Purchasing Standards Committee the methods of determining free alkali or acid in coal-tar disinfectants were studied.

The determination of the hardness of water by titration with a standard soap solution was investigated.

New analytical methods used in the laboratory during the year included the determination of metals by micro spot tests, selenium in organic combination, and halogens and mercury in organic compounds.

Miscellaneous

In addition to the major subjects of study, to which the preceding sections refer, a considerable number of minor investigations were carried out, some tests were done, especially for government departments, and a large number of enquiries were dealt with. The total number of all such items, on which special reports were issued or information provided, was about 1800. The diversity of the miscellaneous matters dealt with is shown by the following examples.

Fluid for Use in Aircraft Levels. A suitable fluid for this work was developed. (D. F. Stedman.)

Porcelain Ware. Some porcelain laboratory ware made in Canada was tested and found to be of good quality. (C. W. Davis.)

Window Breakage. Causes were given for breaking of plate glass windows after being painted black. (C. Y. Hopkins.)

Floor Coverings. Wear tests were conducted on printed floor coverings. (C. Y. Hopkins.)

Power Alcohol. Information was given on the use of alcohol as motor fuel and concerning its production from agricultural products. (C. Y. Hopkins.)

Poultry Plucking Wax. Enquiries for a source of supply of this wax, developed in these laboratories, continue to come from Canada and from many foreign countries. (N. H. Grace.)

Marble Preservation. Tests were initiated to discover means for preserving lustre on Canadian black marble. (C. Y. Hopkins.)

Fingerprints. A novel method was devised of taking finger and hand prints without soiling the fingers or palms. (D. F. Stedman.)

Dried Vegetables and Fruits. Quantities of powdered, dried fruits and vegetables were prepared in these laboratories during the summer months for clinical tests at Ste. Justine Hospital, Montreal, under the direction of Dr. Georges Baril. (F. G. Green.)

Metal Spraying. Advice was given on the suitability of this process for various industrial applications. (A. van Winsen.)

River Water. The chloride content of a number of samples of river water was determined for the Department of Marine, and directions were given for assembling a portable test kit for survey work. (C. W. Davis.)

Carbon Monoxide Hazard. Determinations of the carbon monoxide content of combustion gases were carried out at intervals for the Fire Hazards Testing Laboratory of the Council. Recently assistance was given in constructing and in setting up a carbon monoxide testing apparatus for that laboratory. (A. Cambron.)

Moisture Content of Compressed Oxygen. The moisture content of oxygen in pressure bottles used by the Air Force as a supply of the gas during altitude flights was determined. The object of the determination was to control the efficiency of the drying equipment which is used for removing water vapour from the oxygen. (A. Cambron.)

Production of Urea and Its Use as Fertilizer. A report was prepared on the possible manufacture of urea from by-product carbon dioxide. The report included a survey of the literature on the relative value of urea as fertilizer as compared to other sources of nitrogen, particularly ammonium sulphate. (A. Cambron.)

Fraudulent Removal of Cancellation Marks from Postage Stamps. A method was evolved for the detection of this fraudulent procedure and a number of suspected stamps examined for the Post Office Department. (W. Gallay, J. S. Tapp.)

Agents in the Refining of Lubricating Oils. Experiments were carried out to test the efficiency of a proposed method for the removal of acids and water from used lubricating oil, with a view to its suggested use in the circulating oil lines of internal combustion engines.

The filler of a commercial filter for the oil line of engines was examined as to efficiency in coagulating and removing the sludge formed in the oil during use. (W. Gallay, J. S. Tapp.)

Silica. The distribution of particle sizes of fine silica obtained as a by-product by a Canadian industry was determined in order to determine the possible commercial uses for the material. (W. Gallay.)

Baking Powder. A number of rates of reaction tests and pH measurements were carried out on samples of baking powder, as part of a co-operative investigation of the Baking Powder Committee of the Canadian Chemical Association. (W. Gallay, J. S. Tapp.)

Gold Paint. Work was carried out on the preparation of a fast-drying gold paint for use on glazed pottery ware. (W. Gallay.)

Plastometry. Measurements of plasticity were carried out on several lubricating greases in a plastometer specially designed for very high viscosities at varying rates of shear. (W. Gallay, J. S. Tapp.)

Wastes in Oil Refining. The alkaline sludge from the manufacture of white oils was examined for possible uses. (W. Gallay.)

Retention of Clay in Newsprint. Some work has been initiated on the possibilities of increasing the retention of clay in newsprint. (W. Gallay.)

Refractories. Assistance has been afforded the Magnesite Laboratory on several problems of bonding brick, adhesives for metal to brick, use of bentonite, examination of glutrins, etc. (W. Gallay.)

Wetting Power. The wetting and spreading power of a liquid on a solid is of great importance in many industries, and several methods have been investigated for routine use. Work is contemplated on the measurement also of adhesion of certain solid-liquid interfaces. (W. Gallay, J. S. Tapp.)

Whiteness. The deviation from 100% whiteness of certain commercial samples of chemical pulp was measured photometrically. (C. H. Bayley.)

Weed Seeds. The chemical structure of a sulphur-containing substance previously isolated from hare's ear mustard has been identified. A number of related compounds were synthesized. (C. Y. Hopkins.)

Determination of Small Amounts of Copper. The Biological Board of Canada is studying the use of copper sulphate to rid lakes of undesirable fish. A method was devised for determining the small amount of copper present in lake water following this treatment. (C. W. Davis.)

Rubber in Lubricating Oil. Tests were made for the presence of rubber in lubricating oil and the effect of added rubber. (C. W. Davis.)

Sugar Analysis. Laboratory tests and other assistance were contributed to the work of the Canadian Committee on Sugar Analysis, of which the Director of the Division continues to act as chairman. (W. Gallay, A. Matte, F. G. Green.)

Maple Products. Advice concerning new maple products and on maple products in general was given. (F. G. Green.)

A great many requests came by telephone, mail or personal call with reference to (1) uses for natural products, or markets in Canada and abroad, (2) details of work under investigation in these laboratories, (3) details of industrial processes, etc., (4) sources of supply of chemicals, laboratory equipment, large scale industrial chemical equipment or materials of construction. These are replied to by members of the staff whose present work or experience is most closely allied to the nature of the enquiry.

DIVISION OF MECHANICAL ENGINEERING

J. H. PARKIN, *Director*

The Division of Mechanical Engineering is engaged almost wholly on work on aeronautics and in fire hazard testing. In addition, the Division is responsible for the operation of the instrument and model shops of the Laboratories and of the hydro-electric power plant.

The work in aeronautics consists of investigations of specific problems submitted to, or arising in the work of, the Laboratories and of tests and calibrations.

Much of the work of the Aeronautical Laboratories has been done for, and in close co-operation with the Department of National Defence. It is again a pleasure to acknowledge the effective co-operation of the Department, in supplying material, equipment and services, and the excellent relations existing between the officers of the Department and the staff of the Laboratories.

As in previous years, groups of Royal Canadian Air Force personnel were given instruction on instruments, engines and fuels.

The facilities of the Aeronautical Laboratories comprise aerodynamic (wind tunnel), hydrodynamic (model testing basin), engine, gasoline and oil, and aircraft and allied instrument laboratories.

During the year, improvements were made in the equipment of the large wind tunnel and of the model-testing basin. Construction of a small wind tunnel of improved design was commenced. Additional equipment was provided in the engine laboratory. The gasoline and oil laboratory was provided

with instruments and equipment for precise work on gasoline, Diesel fuel and lubricating oil. The capacity and range of the testing facilities of the aircraft and allied instrument laboratory were increased to enable the laboratory to cope with the increased volume and newer types of instruments. Equipment is now available for the testing of electrical and gyro instruments.

The Ford Motor Company of Canada, Limited, generously presented the laboratories with a complete Ford V-8 engine.

During the year Dr. J. W. Broughton was appointed to the staff and assumed charge of the gasoline and oil laboratory.

In fire hazard testing, the work includes the testing for safety or reliability of operation of appliances and equipment, and the operation of a Factory Inspection and Labelling Service. Most of the work is in connection with domestic oil-burning equipment. The volume of work submitted during the year was again greater than in the previous year. The work was carried on under a severe handicap owing to the resignation of Mr. T. H. Doherty, in April. Three laboratories are now used for this work and additional equipment was provided during the year.

The work of the different laboratories is outlined in the following paragraphs.

Aerodynamic Laboratory

J. J. GREEN, G. J. KLEIN

INVESTIGATIONS

1. Farm Windmills

Little experimental work was possible on this investigation. A report was prepared and issued on the tests made previously—Report No. PAA-32, "The Design of High Speed Windmills Suitable for Driving Electric Generators". A windmill of simpler form and easier construction was designed and tested. In response to numerous requests for information on the construction of windmill-driven chargers for radio storage batteries, a pamphlet was prepared—"A Small Windmill-Generator Unit for Charging a 6-Volt Storage Battery". (G. J. Klein.)

2. Stalling of Tapered Wings

In connection with this investigation and resulting from the working out of a convenient method of calculating the characteristics of tapered wings, referred to in the previous report, an Induced Angle Calculator has been designed and constructed. This instrument enables the induced angle to be rapidly and easily determined. A paper thereon is to be prepared. (G. J. Klein.)

3. Service Aircraft

At the request of the Department of National Defence, models of service aircraft were made and tested in the wind tunnel. (J. J. Green.)

4. The Take-Off and Landing of Aeroplanes

A theoretical investigation was made of the combined effect of wind and gradient on the take-off and landing run of aeroplanes. Charts were prepared, enabling the length of run, under given conditions of wind and gradient, to be estimated quickly, in terms of the run in still air on a level surface. The analogous problem, the effect of wind and current on the take-off run of seaplanes was also investigated and charts prepared for the estimation of length and time of take-off under any given conditions.

A paper thereon was prepared and presented at the sixth annual meeting of the Institute of Aeronautical Sciences in New York, January, 1938, "Special Problems in the Take-Off and Landing of Aircraft". (J. J. Green.)

5. Streamlined Aircraft Ski

Trouble has been encountered with the streamlined ski, developed in the Laboratories, when it is fitted to a low-wing monoplane with part enclosed undercarriage. In certain cases, the ski experienced large negative pitching moments which depressed the nose. The Department of National Defence requested that an investigation be undertaken to determine the cause and provide a remedy. Wind tunnel tests have been commenced, one-half scale models of the ski and wing centre section being used. (J. J. Green.)

6. Wind Tunnel for Soil Drifting Experiments

Promising results have attended preliminary tests, with a small rough model of a new type of wind tunnel, for the investigation of soil drifting. The design was developed in response to inquiries concerning wind tunnel design from officers of the Department of Agriculture. (G. J. Klein.)

Tests

Wind tunnel tests have been made for Canadian firms on a model of a commercial aircraft when fitted with wheel, ski and float undercarriages, on a model of ski of special design, and on snowmobile propellers. (J. J. Green, G. J. Kelin.)

Model Testing Basin

K. F. Tupper

Investigations

1. Basin Boundary Interference

The investigation was begun last year, primarily with the object of ascertaining the upper and lower limits of size of ship models which can be satisfactorily tested in the Ottawa basin. A series of geometrically similar ship models, ranging in length from 2·5 to 10 feet is being used.

Through the kindness of Mr. G. S. Baker, the largest model has been tested in the two ship-model basins of the National Physical Laboratory, Teddington, England. During this year, through the kind co-operation of Professors E. M. Bragg and L. A. Baier, the whole series of models was tested in the ship-model basin of the University of Michigan. The latter has a width of 22 feet and depth of 10 feet, compared with dimensions of the Ottawa basin of 9 feet and 6 feet respectively. Valuable direct comparisons were thus possible. The work is continuing. (K. F. Tupper.)

Tests

Three models of two ships for Government service were tested in the basin, for naval architects.

Engine Laboratory

M. S. Kuhring

Investigations

1. Aviation Gasoline

Participation was begun last year in a comprehensive investigation then in progress in the United States, under the auspices of the Aviation Fuels Division, Co-operative Fuels Research Committee of the Society of Auto-

motive Engineers. The investigation was undertaken in an effort to correlate the performance of gasoline, from the point of view of detonation, in full scale aircraft engines, with evaluations based on laboratory tests.

In the tests, the engines are operated, under extreme conditions, to induce detonation, on fuels of different characteristics. In the Canadian tests, a British radial aircraft engine was used.

The Department of National Defence co-operated in the tests by supplying the engine, replacement parts, and the services of two aircraftsmen, and the United States Committee generously furnished the special blends of fuel.

The original programme of tests and certain additional tests were completed during the year. (M. S. Kuhring.)

2. Effect of Water Injection on the Operation of Aircraft Engines

The influence on power output, cylinder temperatures and other performance characteristics of an aircraft engine, of injecting water and non-freezing mixtures of water and alcohol into the charge was investigated. A British radial engine was used. The ratio of water to gasoline used ranged up to large values. Operating temperatures were reduced and power output increased. A report is in preparation. (M. S. Kuhring.)

3. Thermal Method for the Prevention of the Formation of Ice on Aircraft Wings and Propellers

Preparations for further tests of a method of using the heat in the exhaust from the engine to prevent ice formation on the wings and pusher propellers were commenced in March. Some preliminary tests were made some years ago with rather encouraging results. (M. S. Kuhring.)

Tests

Tests made included a civil-type test of an aircraft engine, tests of an engine silencer, engine tests of spark plugs and calibration of a gasoline meter.

Gasoline and Oil Laboratory

J. W. Broughton

On Dr. Broughton assuming charge of this laboratory, it became responsible for all routine tests on gasoline and lubricating oil against Canadian Government Purchasing Standards Specifications and Air Ministry Specifications, for Departments of the Dominion Government, provincial governments and others. Special tests have been made for other laboratories and there has been co-operation in certain investigations.

The routine work is summarized in the following table:

Samples	Internal	Government	External	Total
Gasoline and fuels	127	12	14	153
Lubricants	10	5	14	29
Solvents	5	—	—	5
Diesel fuel	—	2	—	2
Crude oil	2	—	—	2
	144	19	28	191

Aircraft and Allied Instrument Laboratory

S. J. MURPHY

This laboratory is engaged in the testing and calibration of aircraft and allied instruments for government departments, provincial governments and commercial firms, and in the overhaul and repair of such instruments for government departments. There was a considerable increase over last year in the volume of testing work for government departments. The variety of instruments submitted also increased.

The laboratory has rendered assistance in connection with instrument problems encountered in other government departments and in the laboratories.

In the following tables, the routine work of the laboratory is summarized for the year 1937-38 and for previous years.

TESTS MADE OF AIRCRAFT AND ALLIED INSTRUMENTS, 1937-38

——	Government	Commercial	Total
Height Instruments	191	14	205
Airspeed Instruments	200	17	217
Tachometers	221	15	236
Directional Instruments	392	20	412
Altitude Instruments	130	6	136
Engine Instruments	550	7	557
Barometers	96	7	103
Hygrometers	5	0	5
Air Thermometers	8	0	8
	1793	86	1879

TESTS MADE OF AIRCRAFT AND ALLIED INSTRUMENTS, 1931-38

Fiscal Year	R.C.A.F.	Government Departments	Commercial	Total
1931-32	512	69	79	660
1932-33	125	82	35	242
1933-34	277	28	36	341
1934-35	307	130	57	494
1935-36	832	93	66	991
1936-37	829	141	106	1076
1937-38	1679	114	86	1879

General Mechanical Engineering Investigations

1. Aircraft Skis—Snow Performance

In continuation of the work of the two previous winters on this investigation, further tests were carried on during the winter 1937-38. The tests were directed primarily to the determination of the influence of the material of the ski bottom on the running resistance and particularly on the starting resistance (*i.e.*, the force to "unstick" the ski). Tests were also made, using wax-coated skis, of the influence of the plan form and profile (lateral and longitudinal) of the ski-bottom on the performance. Flexible skis of two types, flexible as a whole and with flexible surfacing, were tested. Loadings were carried to higher values than in the previous work.

A total of 22 different half-scale model skis, with bottoms of 12 different materials, were tested.

The equipment was further improved and extended. Samples of snow were taken for density determinations, and atmospheric temperatures were observed. A report is in preparation. (G. J. Klein.)

2. Stop-logs for Emergency Dams

This investigation was undertaken to secure information regarding the hydrodynamic forces acting an a stop-log during placement, for use in the design of emergency dams.

Using a 1/100 scale model, the vertical and horizontal forces on each of the first four logs of a six-log dam were measured during the whole process of placement. Logs of circular, square and rectangular cross-section were used.

The work was completed and a paper thereon published; "Force Measurements on Stop-Log Models", Canadian Journal of Research, A, 15:181-192. 1937. (K. F. Tupper.)

3. Mercury Slip-Ring

In a preliminary study of the practicability of a mercury slip-ring, fluid friction losses in a model were measured. (K. F. Tupper.)

Tests

Miscellaneous tests include tests of aircraft ribs, of aircraft dope and of an oil filter.

Aeronautical Museum

J. J. Green

Display cases have been provided for many of the valuable exhibits now contained in the museum, and some progress has been made in preparing additional material for inclusion among the exhibits.

Fire Hazard Testing Laboratory

D. T. Hewson, G. E. Rickwood

Investigations

1. Equipment for Forest Fire Suppression

Under the auspices of the Associate Committee on Forestry and the Canadian Government Purchasing Standards Committee, tests are in progress on hose and fog nozzles. Tests have been made in the laboratory, and field tests have been made at Petawawa. Tests are being made to secure information respecting the performance of hose and nozzles; specifications may be based on these tests.

2. Aircraft Fire Walls

An investigation is being undertaken, under the auspices of the Associate Committee on Aeronautical Research, to secure information on the behaviour of fire walls, for use in the drafting of performance specifications. The test equipment is in preparation.

Routine Tests

Domestic Oil Burners

Domestic oil burners now being submitted to the laboratories are principally of the manually controlled, natural draft type, and are incorporated in heating equipment such as space heaters and ranges.

Gasoline-burning Appliances

A number of gasoline-burning heaters and ranges were tested.

Fire Extinguishers

The work on fire extinguishers was limited to tests for satisfactory operation at low temperatures of a gas-cartridge type of portable extinguisher, with methyl bromide as the extinguishing agent.

Gasoline Safety Cans

Safety cans for the carriage of gasoline are being tested.

Other Devices

Other devices submitted and tested during the year include a spark arrester for internal combustion engine exhausts, economizer for gas stoves, and a cylinder for compressed gas.

A tabulation of routine tests appears in Table I.

TABLE I

SUMMARY OF ROUTINE TESTS 1937-38

Devices	Manufacturers submitting devices	Models			Models under Test	
		Submitted	Listed	Not listed	1 April 1937	31 Mar. 1938
Domestic oil burners—manually operated—						
1937-38	10	57	58	0	16	15
Total to date	27	182	153	14	—	—
Domestic oil burners—automatic—						
1937-38	1	2	1	0	0	1
Total to date	8	32	26	5	—	—
Gasoline-burning appliances—						
1937-38	1	11	13	0	1	0
Total to date	2	15	15	1	—	—
Gasoline safety cans—						
1937-38	1	1	2	0	1	0
Total to date	3	3	2	1	—	—

Labelling and Inspection Service

The following is a summary of the operations of the service during the year:—

Factory Inspections—from Ottawa	28
from Vancouver*	9
Total	37

Labels Issued

Domestic oil burners—manually operated	8,913
Domestic oil burners—automatic	569
Gasoline-burning appliances	1,850
Gasoline safety cans	2,200
Solvent, degreasing	2,000
	15,532

**By the Provincial Fire Marshal acting for the Council.*

Instrument and Model Shops

The instrument and model shops of the laboratories comprise the following:—instrument, machine, woodworking, electrical and sheet metal shops, together with tool crib and stores, and blueprinting and photostating facilities.

The work of the shops, in general, consists of the construction, alteration, overhaul and repair of apparatus, equipment and instruments, installation and maintenance of equipment and of mechanicai and electrical services of the laboratories. The construction, adjustment and repair of equipment and instruments for other Government departments constitutes a considerable part of the work of the shops. Much of this work is on aircraft instruments for the Department of National Defence. The scope and volume of this work is shown by the following summary:

INSTRUMENTS OVERHAULED AND REPAIRED FOR OTHER GOVERNMENT DEPARTMENTS

AIRCRAFT INSTRUMENTS—		SURVEYING INSTRUMENTS—	
Height instruments	105	Transits and theodolites	47
Airspeed instruments	68	Levels	19
Tachometers	124	Binoculars, field glasses and telescopes	7
Directional instruments	120	Sextants	11
Altitude instruments	49	Alidades	2
Engine instruments	105	Astrolabe	1
Barometers	47	Compasses	6
Hygrometers	5	Cameras and accessories	2
		Miscellaneous	28
Total number of instruments			746

To illustrate the nature of the work done, some of the instruments and equipment constructed during the year are listed below:

Seed classification apparatus
Soil sterilizer
Heat-treatment apparatus for plants
Soil testing apparatus
Egg micrometers
Vibration research equipment
Aircraft radio equipment
Frequency modulator
600 K.V. X-ray generator
Radio boxes and relay rack
Trailer for radio research
Oscillograph recording camera
Instrument recording camera
Aeroplane dope testing equipment
Aeroplane ski testing apparatus
Radial stereoplotter
Prismatic astrolabe (rebuild)
Dough mixer
Ballistic pendulum
Aircraft and boat models
Special colorimeter table
Special distillation column
Special forming die
Paper pulp testing equipment
Strain testing machine
Plastometer
Leather testing apparatus
Carbon resistance furnace
Shop machine attachments
Polarized light apparatus
Electrode extruder

The shops commenced the year with 80 jobs in progress or not started. During the year, 715 jobs were requisitioned and 696 completed and, at the end of the year, there were 99 jobs in progress or not started.

Maintenance of electrical and mechanical equipment of the laboratories is consuming an increasing amount of labour.

On 1 July, 1937, jurisdiction and control over the equipment and operation of the hydro-electric power plant at Rideau Falls was transferred from the Department of Public Works to the National Research Council. Operation of the plant was made a responsibility of the Division of Mechanical Engineering and the plant now functions as part of the shop organization.

Immediately on assuming control, the Council commenced a thorough rehabilitation of the plant and the installation of a tie-line between the plant and the main building of the laboratories, to permit the plant to be operated more effectively as a source of power for laboratory purposes and to provide an essential emergency reserve. Good progress had been made with this work by the end of the year.

DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING

R. W. BOYLE, *Director*

During the past fiscal year the Division of Physics and Electrical Engineering has undertaken a steadily increasing amount of standardization and test work of all types. In the radium and X-ray laboratories, more than twenty-one grams of radium were certified and more than twenty-five hundred castings for aeroplanes examined by X-rays for defects. All laboratories have shown marked increases in the volume of work.

A number of new projects have been undertaken, among which might be mentioned the following:

(*a*) The installation of an impulse generator capable of developing instantaneous potentials up to one million volts. The design of this apparatus permits of its eventual extension to potentials up to three million volts. A special high-voltage cathode-ray oscillograph for use with this equipment is under construction.

(*b*) The construction and installation of a 15 K.V.A. constant potential unit generating 600,000 volts. This is intended primarily for the production of very high voltage X-rays, but is also applicable to other work. The X-ray tube for this unit is under construction.

(*c*) The development of apparatus for the recording of vibration in air-craft.

(*d*) The construction of portable apparatus for the Canadian Broadcasting Corporation for the measurement of the reverberation-time of broadcasting studios, etc.

(*e*) The acquisition of a set of seven weights, calibrated by the International Bureau of Weights and Measures. One of these, a kilogram, is to be established as a legal Dominion standard.

(*f*) The development of plotting machines and recording apparatus for use in aerial survey work.

(*g*) The construction of sensitometric and densitometric apparatus for the calibration of photographic plates and film, particularly those used in aerial survey work.

(*h*) The development of methods of artificial daylight production for such purposes as fox-fur grading, etc.

(*i*) The extension of the instrument transformer testing equipment by the addition of a standard multi-tap transformer and a special transformer cage.

(*j*) The development of a special type of thermostat for the control of heaters in railroad refrigerator cars.

(*k*) The design of a heavy current generator for the study of large electromagnetic forces. The construction of this apparatus has been commenced.

(*l*) The development of a cathode ray air compass and a marine direction finder by the cathode ray method.

Advice and assistance have been given other government departments on such matters as acoustic treatment, noise abatement, photographic problems, radio problems, forest fire hazard, etc.

During the year the Division has received some extra staff assistance through the auspices of the Radiology and Radio Committees but there is still grave need in some of the laboratories.

Acoustics

G. S. Field

Testing Laboratory

A number of tests to determine the acoustical efficiency of building materials were carried out for various manufacturers during the past year.

Investigation of Acoustical Quality of House of Commons Chamber

A very thorough study of the House of Commons Chamber was made with a view to improving its acoustical quality. As the result of a number of measurements and experiments carried out in the Chamber, it was determined that any acoustical treatment which might be put on the walls or ceiling would be of very little use. It appeared, however, that an individual seated in one part of the Chamber could be made to hear a speaker in any other part of the Chamber with comparative ease if a system of microphones and loud-speakers were installed. This was recommended in the report.

Test on Aircraft Engine Silencer

In collaboration with the staff of the dynamometer laboratory, a test of the silencing ability of an aircraft engine silencer was carried out.

Noise Surveys for Royal Canadian Mint

A study of the noise coming from the new refinery of the Mint was made, and suggestions were offered as to how this noise might be lessened.

Later in the year a noise survey of Sussex St. in the neighbourhood of the Mint was made, as well as of several of the streets in the same vicinity. The noise level of various forms of traffic was determined, and compared with the noise reaching the street from the Mint refinery.

Metal Detector

The development of a metal detector for the penitentiaries has been undertaken and is now well under way. This detector is designed to indicate the presence of any iron or steel that may be carried by a person passing through the pick-up coil. Its specific purpose is to prevent prisoners from carrying tools or weapons from the workshops to the cell blocks.

Reverberation Measuring Equipment for Canadian Broadcasting Corporation

Designed to enable an acoustic rating to be given to broadcasting studios, portable reverberation measuring equipment was constructed for the Canadian Broadcasting Corporation.

Tests of Ultrasonic Depth-sounders

With the collaboration of Dr. F. H. Sanders, apparatus was set up and measurements were made on several magnetostriction generators. The operating frequencies were measured and the constants of the circuits to be used with this equipment were determined.

Miscellaneous

A number of inquiries relating to problems in architectural acoustics were answered for other government departments, manufacturers, contractors and private individuals. There has been a considerable increase in such inquiries during the past year, which indicates that there is an increasing desire for better room acoustics on the part of the general public.

Electrical Engineering

B. G. Ballard, J. H. Simpson

During the past few years several requests for high voltage investigations have been received. Heretofore the laboratory has not been equipped with facilities for undertaking such work and it has been seriously handicapped by the lack of suitable generating and measuring equipment to carry out research projects. The necessity for such equipment is emphasized by the limited facilities available elsewhere in Canada. The increasing importance of impulse tests made it particularly desirable that the laboratory be in a position to apply and measure standard impulse wave forms. Accordingly a 1-million volt surge generator, having a maximum energy storage of 12,500 watt-seconds has been constructed. The design makes provision for additional units to increase the range to 3,000,000 volts or more.

A suitable cathode ray oscillograph of the cold cathode type, to be used in conjunction with the surge generator, is under construction. An accelerating voltage of 60,000 will be employed on the beam.

In addition to the surge investigations, the consideration of a high voltage power frequency laboratory has been resumed. Present plans provide for a voltage of 1,500,000.

Work is proceeding on the construction of a homopolar generator to generate large currents for the purpose of studying electromagnetic forces. The rotor is designed for a speed of 5400 r.p.m. and power will be drawn momentarily, absorbing part of the stored kinetic energy in the rotor. Pending the completion of the generator some preliminary studies on the effects of large currents have been undertaken by discharging condensers into a low impedance circuit.

The homopolar generator drive requires a higher frequency than was previously available in the laboratory for power purposes. Furthermore, a number of demands have arisen for frequencies above 60 cycles per second, and accordingly an induction frequency changer set with a variable speed drive has been purchased. This unit will generate at any frequency up to 130 cycles per second.

A 480 cycle motor generator set has been installed in the Electrical Engineering Laboratory to supply power to high voltage X-ray equipment. This additional service is also available for the Electrical Engineering Laboratory.

In co-operation with the Division of Mechanical Engineering the performance of a high speed mercury slip ring was investigated.

The Electrical Engineering Laboratory was called upon to assist in the study of the performance of a high speed belt in oil.

Many minor problems were undertaken, including the development of small power voltage regulators, flashover tests, oil burner approval and underground cable installation.

Electrical Measurements

A. J. GRANT, J. S. JOHNSON

Meter Approval

Fourteen types of meters or meter attachments were tested for Approval of Type.

Additions to Equipment

One additional standard multi-tap transformer was purchased for use in testing current transformers. This transformer is constructed as a torus, the core being high permeability nickel steel.

The errors of the standard transformers are determined by using standard resistors in the primary and secondary circuits and other transformers are compared to it by a comparison method. A "cage", in which the test transformer is placed during a comparison, was also constructed. This cage has the effect of removing the return conductor to a distance and at the same time it reduces the stray field in the vicinity of the test equipment.

A resistance, capable of absorbing twenty amperes at one hundred volts with a phase angle of less than two minutes, was constructed.

Standard of Voltage

Four voltage cells were sent to the Bureau of Standards for intercomparison with their standards. This has been an annual procedure.

Calibration and Routine Tests

There has been a considerable increase in calibration tests and routine testing over previous years.

The following types of instruments were calibrated: ammeters, voltmeters, wattmeters, standard cells, instrument transformers, standard resistances, potentiometers, volt boxes, a syncroscope and power factor meter.

Heat

C. D. NIVEN, J. D. BABBITT

Heat Insulation of Building Materials

The measurement of the thermal conductivity of building materials has been continued on the eighteen-inch hot-plate and on the six-foot hot-box. The attempt to compare the measurement on a sample of fibre board on the hot-box with that on the hot-plate was eventually given up. The results would not agree, and as everything appeared to be checked for accuracy, the conclusion was reached that the moisture content of the sample was causing trouble. A special sample has been constructed recently out of cork-board, the joints have been filled with asphalt and it is hoped that this sample will allow better agreement between the two apparatuses.

A special investigation on the effect of thickness of sample on heat transmission was undertaken on account of the fact that Professor Allcut of Toronto had called in question the validity of Fourier's Law in this connection. The results showed definitely that the thickness of a sample had no effect on its thermal conductivity provided a correction for surface resistance was applied. The results have been published (Can. J. Research, 16:82-87. 1938). The problem of moisture migration in building materials is so closely allied to the investigation of the thermal conductivity of these materials that a systematic study is being made of the permeability to moisture of certain building materials.

Some samples of high temperature insulators have been measured during the year on the high temperature hot-plate. At the present time an investigation is being undertaken on the thermal conductivity of Canadian rocks. The Department of Mines has kindly co-operated in the selection and the obtaining of the samples.

Heating of Refrigerator Cars

The development of a suitable thermostat for refrigerator cars has occupied much attention during the year. In the month of March a thermostat which had been specially designed in the laboratory was tried out under operating conditions. While it operated satisfactorily it had some undesirable features, notably its high cost; the design of a control working on an entirely different principle is to be tested instead.

Thermal Conductivity of Metals

The apparatus which was partly assembled at the time of writing the last report was tried, and gave promising results on silver, but it was so small that it was far too awkward to work with. It was, therefore, made as large as the liquid air flask would allow and this has facilitated very considerably the handling of the fine wires it contained.

The making of the sample in single crystal form presented some difficulty as the sample had to be of very small cross section. A carbon crucible was made consisting of a rod of carbon with a two millimetre diameter drill hole bored in it. This hole was filled under vacuum with molten metal. After the metal had been aged and cooled the crucible was split open. A sample can in this way be obtained without any distortion of the structure whatever, but such samples are extremely soft.

Specific Heat of Nickel

Since there is considerable difference in the specific heat of nickel at the Curie Point, as published by different observers, and since recent theoretical developments have made this measurement of importance, an investigation is being made on the variation of the specific heat of nickel with temperature. Satisfactory measurements have already been obtained at room temperature and at the temperature of liquid air, and measurements at higher temperatures will shortly be made.

General Physics

D. C. Rose

Atmospheric Electricity

The results of potential gradient observation at the laboratory and at a country station north-west of Ottawa have been completely analyzed and published (Can. J. Research, A, 15:119-148. 1937). They show that disturbances in potential gradient at places free from pollution are associated with the passage of cold fronts.

The observations on the conductivity of the atmosphere and potential gradient at different altitudes (observed from aeroplanes) which were taken during the previous year have been analyzed and prepared for publication. The method used for potential gradient measurements from aeroplanes was found to be unsatisfactory. However, it gave some indication of the effects of charged clouds. Good conductivity results were obtained, and it was shown that valuable information on atmospheric electric phenomena can be obtained by the methods used.

Ballistics

Test of armoured vest. An armoured vest designed for police use was tested. The tests involved the construction of a ballistic pendulum to measure projectile velocities. The vest was found to offer good protection of the body parts covered by it against revolver shots of ·45 calibre.

Portable gun calibration equipment. At the request of the Department of National Defence, visits were made, during the course of other duties in England, to the Research Department, Woolwich Arsenal, and the Experimental establishment, Shoeburyness, to obtain information for the Department on the best portable equipment available for the calibration of field guns.

Electrocution of Poultry

After many tests with the apparatus built for the electrical stunning of poultry it was decided that, though the method was practical, unless it should greatly improve bleeding, its advantages over ordinary methods were insufficient to warrant pushing the experiments further. It was recommended that a physiological study of bleeding be made and preliminary plans for such a study were made by the Department of Agriculture. To test the effectiveness of electrical stunning in producing good bleeding twenty birds were killed, ten by the electrical method and ten by the ordinary brain stick. After being bled and plucked they were examined externally, then roasted, and the blood content of various veins compared roughly. The results were not considered conclusive, as the number of birds tried was too small, but they showed no advantage in favour of the electrical method of killing.

Instruments for Estimating Forest Fire Hazard

The investigation of instruments designed to assist in the determination of forest fire hazard was continued. The instruments to observe radiation from test fire and the loss of heat from a copper plate when placed in contact with the forest duff were loaned to the Forest Service, of the Department of Mines and Resources, for continued tests. The recording evaporimeter was also put in service.

Mr. Wright of the Forest Service has reported that the radiation measurements show but little promise of practicability. The hot plate method is not very sensitive over the most important moisture-content range. Further experiments with a different design may be advisable. The recording evaporimeter works in a satisfactory manner except in that some trouble from vibration is evident on windy days. It is possible that slight alterations in design may improve this.

Vibration in Aircraft

At the request of the Associate Committee on Aeronautics the construction of apparatus to study vibration in aircraft was undertaken. The apparatus is designed along similar lines to that developed by the Massachusetts Institute of Technology. It consists of electromagnetic pick-ups, amplifiers and recording oscillographs with their associated equipment. All must be made portable to be carried in the aeroplane. Most of the electrical equipment has been constructed but some development work on the design and calibration of the pick-up units remains to be done.

Methods of studying vibration were examined at the Royal Aircraft Establishment, Farnborough, and at the Deutsche Versuchsanstalt fur Luftfahrt, Berlin.

Metrology and Allied Measurements

R. H. FIELD, L. G. TURNBULL

Metrology

Seven stainless steel weights, verified by the International Bureau of Weights and Measures, were acquired for use as laboratory standards. They included a kilogramme which it is proposed to establish as the legal Dominion Standard. An Order in Council was drafted, which, if approved, will have the effect of establishing this standard in terms of the Weights and Measures Act.

During the year the weights used in the course of the annual Trial of the Pyx, under the provisions of the Currency Act, were verified in terms either of the Dominion standard Troy ounce or the International Kilogramme.

The 10 foot steel bar, one of the legal Departmental Standards of the Weights and Measures Service, was also verified, and none of the graduations showed displacements exceeding 0·003″ from the values originally found for the bar in England in 1874.

Thermometry

A molten metal bath was constructed for comparing thermometers in the ranges exceeding that practicable with the oil bath.

Optical and Allied Instruments

A definite scheme was evolved, and put into practice, for the complete calibration of tri-camera oblique mounts, for use in air photography by the R.C.A.F.

As hitherto, work on instrument design for the Associate Committee on Survey Research occupied considerable time. These instruments included:

Stereo-plotting machine. The design was completed, and a considerable amount of shop work was completed.

Instrument-recording camera. After experiments and modifications satisfactory operation was achieved for the laboratory model. The possibilities are now being investigated of submitting this model to an air trial, before proceeding with the design of a practical instrument.

Terrestrial surveying camera. A smaller surveying camera, to fit in the standards of a transit alternatively with the telescope, and embodying improvements found desirable from field experience, was designed, and the construction commenced.

Transparent station pointer. A design was also prepared for a transparent station-pointer, following recommendations to the Committee by officials of the Hydrographic Service.

Routine Tests

The following list gives the main items under this heading:

	For government services	For others
Steel tapes	6	7
Hydrometers	323	1
Sets of analytical weights	—	1
Thermometers	167	25
Transits	38	—
Levels	17	—
Other surveying instruments	20	—
Air cameras	34	—

Optics

L. E. Howlett, D. C. Jones

Sensitometry and Densitometry

Work has been done in collaboration with the Department of National Defence to improve and develop the photographic technique used for survey purposes. On the recommendation of the Subcommittee on Infra-red Photography, Emulsions and Filters, etc., the installation of a complete densitometry and sensitometry laboratory is planned. Part of the apparatus has been designed and construction has been started.

Photometry

Work has been done on the development of an exposure meter for field use where infra-red phototopographic surveying is practised. This apparatus will be ready for trial during the summer of 1938.

A photometer has been developed for the purpose of distinguishing between the whiteness of different samples of bleached wood pulp. This work was performed at the request of the E. B. Eddy Company.

Some work of a preliminary nature was done on the spectrophotometry of blood pigments. Indications are that some interesting results will come out of this work. It is to be continued.

Assistance has been given in the preparation of a standard specification for tungsten incandescent lamps.

Spectroscopy

Time has been devoted to the development of a laboratory for spectroscopic analysis. Equipment has been built for the production of a direct current spark for excitation purposes.

Further work has been done on the mounting of the three-metre concave grating. Although not quite finished, the unit is now available for spectroscopic work. A medium size quartz spectrograph is also available for such work.

A number of routine spectroscopic analyses have been performed through the year.

Equipment has been designed and constructed for the production of neutral wedges for intensity measurement. Thin films of evaporated aluminium are used for this purpose.

Industry is more and more appreciating the value of spectroscopic analysis and it is the policy of the laboratory to spread the knowledge of its application and to give such assistance as is required to Canadian manufacturers who are contemplating its use.

Artificial Daylight for Colour Grading and Matching

As a result of increased interest in artificial daylight for colour grading and matching, attention has been paid to the matter of the proper kind of installation for this purpose. It is now possible to obtain the colour of any particular kind of daylight by a combination of incandescent tungsten lamps and suitable glass filters. This quality by itself is not sufficient. The diffusion of the artificial source is equally important. This has been neglected in many installations with consequent failure to satisfy the workers. Consideration has been given to the utilization of an artificial source for the grading of silver fox furs. This work is very exacting and a suitable artificial daylight will be obtained only when very adequate diffusion is provided in addition to the correct colour. It is, however, quite possible and practical.

A small room equipped with artificial daylight of proper diffusion and colour is being prepared at the laboratory for the purpose of demonstrating the possibilities of this kind of illumination and its superiority to natural daylight on account of its uniformity.

Primary Calibration of Gauge Blocks

Work on apparatus for the calibration of gauge blocks by interferometry has been continued. The apparatus is now practically complete. There remains some work of calibration to be performed before the project is completed.

Radio

J. T. HENDERSON

Atmospherics

Observations on atmospherics were made at Ottawa throughout the year and at Forrest, Manitoba, until the end of September, 1937. Observations were also made with Porto Rico and less frequently with Florida. These observations were taken daily except during the hurricane season—August and September—during which time twenty-four observations were made and a photographic record taken every two hours. Weekly observations were continued on a schedule arranged to give simultaneous records with Great Britain.

The analysis of the records made here is proceeding slowly and it is hoped to publish a complete report during the coming year. Co-operation with the observers in Florida and Porto Rico has been facilitated by two meetings with them during April, 1937, and April, 1938. It is proposed to continue observations during the hurricane season this summer, after which time it is likely that the records will be discontinued.

Communication has been satisfactorily maintained during the year with our own transmitters, and the transmitter in the laboratory was used during the summer of 1937 by the Canadian Broadcasting Corporation to communicate with the steamer *Nascopi* while it was on its annual tour to the Hudson Bay posts in the far north, to assist in some experimental work being done by some of its staff.

Cathode Ray Direction Finders

At the beginning of this year a number of pieces of test equipment to be used in the work of developing cathode ray direction finders were constructed. These include a one-kilowatt transmitter which is set up in the laboratory for use on the long wave, a small portable 40-watt transmitter, a one-kilowatt transmitter which is installed in a trailer of our own construction. The power supply for the latter is a gasoline-driven five-kilowatt alternator, which was assembled from apparatus in the laboratory.

The first model of a cathode ray direction finder for use in an aeroplane was constructed and completed about the end of October, 1937. Several disadvantages to the design having shown up in the course of construction, it was decided to proceed next with a cathode ray direction finder for use on land. This was satisfactorily completed and will be tested in the field during the coming summer. Work on the second model of the direction finder for use in an aeroplane is proceeding.

Radium and X-rays

G. C. Laurence, L. W. Ball

During the year, 327 tubes of radium bromide and 288 radium needles were measured and certified. These contained about 21·4 grams of radium.

The radiographic inspection undertaken increased rapidly near the end of the year. About 2,632 castings were examined by X-rays during this period. A few X-ray spectrographic examinations were made. Four X-ray dosemeters were overhauled and calibrated.

A 15 k.v.a., 600 thousand volt constant potential generator, intended for the excitation of high-voltage X-ray tubes and other purposes, was constructed and installed. The construction of a 600 thousand volt X-ray tube, for operation in connection with this generator was partly completed. This extra high voltage X-ray tube is to be used for X-ray inspection of castings and welds and will be capable of penetrating up to 6 inches of steel. The X-ray tube will also be used for the maintenance of radiological standards applicable to medical X-ray equipment operated at potentials above 200 thousand volts. It is intended to construct these standards during the next year.

The equipment for the measurement of the radium preparations was considerably altered and improved, and the construction of an additional apparatus for this purpose was undertaken at the end of the year. A new device for the rapid inspection of radium containers for possible radon leakage was developed, and additional equipment for radiographic inspection was constructed and installed.

Dr. H. H. Penley, National Research Council Scholar, commenced an investigation of certain effects produced in organic materials when exposed to X-rays.

Ultrasonics

F. H. Sanders

Transmission of Sound through Plates

The manner in which sound vibrations are transmitted by metal plates is directly related to the elastic properties of the metal. The information available on transmission at high frequencies is very meagre. Apparatus has been constructed for the purpose of studying this sound transmission at high frequencies, making use of the light-scattering properties of the sound field. A large number of plates of various metals and thicknesses have been examined and some interesting observations obtained. At present the work has not progressed sufficiently far for any definite conclusions to be reached. Observations are being continued.

General

Several ultrasonic generators of the magneto-strictive type have been examined and tested for their electrical and mechanical characteristics. Advice and assistance have been given to other government departments on various technical matters.

73461—5½

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

During the year with the development of work under a number of industrial agreements an increased proportion of Mr. Lathe's time was assigned to the supervision of laboratory work, and for this reason and in order to provide for the better collection, collation and issue of scientific information and the general planning of co-operative investigation through committees, the organization of a Research Plans and Publications Section was commenced, the Officer-in-charge reporting to the President direct.

For convenience, the parts of the work which have been transferred to the new section are reported in that place. Under the Division of Chemistry will be found an account of Mr. Lathe's work in connection with the laboratory investigations undertaken under industrial agreements. Reports on the Library, the Canadian Journal of Research and other publications, and of the work on Codes and Specifications are reported in the sections under these headings by the personnel in immediate charge.

National Research Library

MISSES M. S. GILL, E. TWOHEY AND D. Y. WILLOUGHBY

The library's resources have continued to expand gradually while the use made of them has increased more rapidly. Loans during the year were greater than in any previous year and four times as many books were loaned to other institutions as were borrowed. In spite of this increased usefulness of the National Research collection, it was necessary to borrow from fifteen Canadian libraries and three in the United States, and to secure photostatic copies of other material not available on loan. Through a comprehensive system of co-operation, in which the part played by other libraries is gratefully acknowledged, references on a wide variety of subjects were obtained and made available to research workers in the Council's laboratories and elsewhere in Canada.

Publications

W. W. THOMSON, J. M. MANSON, J. KATZMAN, MISS D. DESBARRES

Canadian Journal of Research

Through the Canadian Journal of Research and miscellaneous publications the Council makes a substantial contribution to scientific literature. The Journal is open for suitable papers from any Canadian research worker, and an opportunity is thus afforded for the publication of valuable papers which, prior to the establishment of the Journal, were frequently published in the United Kingdom and foreign countries. Many Canadian scientists now take advantage of this service, although the Journal still devotes much of its space to papers arising out of work done in the National Research Laboratories, or carried out in Canadian universities with financial support from the Council, through assisted researches or scholarship awards.

A total of 144 papers (1,621 pages) were published in the Canadian Journal of Research during the year. Of these, 31 recorded the results of investigations carried out by members of the staff of the National Research Laboratories, 42 were received from investigators who carried out the work described with financial assistance from the National Research Council, and 71 were submitted by other investigators.

The number of papers appearing in the various sections was as follows: Section A—Physical Sciences, 20 (229 pages); Section B—Chemical Sciences, 58 (514 pages); Section C—Botanical Sciences, 47 (608 pages); Section D—Zoological Sciences, 19 (270 pages). The total number of papers published in the Journal in the 23 months since it was divided into the four sections is: Section A, 43 (421 pages); Section B, 110 (987 pages); Section C, 80 (1,031 pages); Section D, 36 (525 pages).

Other Publications

In addition to the Journal, the following publications were issued: *(a)* an index to each section of Volume 15 of the Journal (31 pages); *(b)* The Twentieth Annual Report of the National Research Council (182 pages); *(c)* Bulletin No. 18, "Chemical Weed Killers—A Review" (111 pages); *(d)* Bulletin No. 19, "Peaux et Cuirs" (41 pages), a French translation of a previously mimeographed report dealing with leather tanning processes.

At the end of the fiscal year a cumulative author and subject index to the papers appearing in Volumes 1 to 12 of the Canadian Journal of Research, which comprise approximately 650 papers (8,000 pages) was in press.

Work was begun during the year on the publication of Bulletin No. 20, "The Fungi of Manitoba and Saskatchewan", the first of a proposed series of contributions to the knowledge of Canadian fungi.

Members of the staff also carried out other duties which made considerable demands upon their time. Dr. Thomson served on the Style Book Panel and the Editorial Subcommittee of the Canadian Government Purchasing Standards Committee, charged with the responsibility of preparing an official style book. Mr. Manson served as secretary to several committees of the Council.

Codes and Specifications

A. F. GILL

Activities in this section have been devoted in large measure to the work of the Canadian Government Purchasing Standards Committee and the National Building Code project, both of which are outlined elsewhere in this report. The secretarial work incidental to the activities of all main committees and subcommittees, in addition to much of the preparatory work, has been done by the staff of the section.

In the establishment of commodity specifications, close contact with various groups of manufacturers has been necessary and conferences have been held from time to time with their technical officers. During the year a number of addresses were delivered to professional associations and other organizations on matters pertaining to commodity standards generally and to the National Building Code project. There has been a gratifying increase of interest on the part of industry in the work on codes and specifications and excellent co-operation has been received.

Close contact has been maintained with the work of the British Standards Institution and an active part has been taken in the committee work of the Canadian Engineering Standards Association, the American Society for Testing Materials, the United States Highway Research Board, the Dominion Fire Prevention Association and the Canadian Institute of Chemistry.

RESEARCH PLANS AND PUBLICATIONS SECTION

S. J. Cook, *Officer-in-Charge*

A. C. Halferdahl, J. M. Manson, R. Ruedy, C. A. MacConkey, M. E. Whalley, J. Katzman

This Section was constituted towards the close of the year by grouping certain members of the staff of the Division of Research Information under an Officer-in-charge, reporting directly to the President.

The duties of this Section provide for continuance of the research information services such as literature searches, translations, special reports, answers to technical inquiries, previously performed by the staff members now grouped in this Section. In addition certain other services are to be provided: *e.g.*, custody of secret documents, preparation of executive instructions regarding committee organization; international affiliations of the Council; technical secretarial duties for the President and committees. The organization will be developed in the coming year.

For the year under review the following notes on research information services provided may be recorded.

Dr. R. Ruedy was asked to make a survey of research work in various fields.

In applied science, hydrodynamics has made rapid progress in recent years, particularly as regards canals and dams. Descriptions of laboratories for low, medium or high heads of water were prepared and issued as a volume entitled: New Hydraulic Laboratories and their Work. This report also pays special attention to the publication of research work in various countries.

New methods for the advancement of medical science vary from country to country, and their study gives a hint as to the proper organization of medical research. In connection with the conference on the organization of medical research in Canada, a survey dealing with national medical research associations in France, Germany, Italy, and some smaller countries was prepared.

A survey on the uses of uranium in various fields of engineering was made, in view of the large quantities of ore accumulating in the manufacture of radium. A similar survey on lithium was kept up to date, but the ores discovered abroad reduce the importance of Canadian supplies.

On account of the introduction of tensions of one million volts in X-ray work and a few millions in testing, several articles on high voltage laboratories were translated from various languages.

The booklet on "House Insulation" prepared by Dr. C. A. MacConkey was issued in mimeographed form so that it could be used for the purpose of answering the increasingly numerous inquiries on this subject. Notices of this booklet appeared in the press and many requests for copies were received.

Utilizing the National Research Council Library and other sources of information, Dr. MacConkey prepared memoranda on the value of soap test as a means of determining the hardness of water, on the malting of wheat to give flour of high diastatic activity, and on methods of waterproofing gelatine foils. Answers to a considerable number of technical inquiries from members of the Council's staff and others were also prepared. The following are a few examples of the subjects: regulations covering manufacture and sale of alcohol in Australia, statistics on world radium production, utilization of blast furnace slag, deodorization of fur storage vaults, hard surfacing pick

point bits, design of fans for pneumatic conveyors, capillary action and efflorescence in bricks. Other tasks included secretarial work in connection with a number of meetings and classification of press notices relating to special subjects.

Miss Muriel E. Whalley made an extensive study of the literature relating to the utilization of straw, paying special attention to its composition and industrial uses, as well as making an estimate of the amount of straw that is annually wasted in the prairie provinces. A bibliography of 307 references was prepared. Shorter reports with bibliographies were also prepared on the literature dealing with the rancidity and staleness of coffee; soil sterilization by electricity; eradication of rats; destruction of gophers; and the use of aluminium cooking utensils.

In addition to these reports information was collected on the following subjects: use of coconut shells; treatment of soil to prevent potato canker; biological uses of uranium compounds; use of uranium in soil; fermentation processes producing alcohols and acids; analyses of candles; emergency rations for aviators; preservation of feathers and fur coat skins; literature on explosions resulting from oil spraying, and arsenic poisoning of apples.

JOINT COMMITTEES

Associate Committee on Field Crop Diseases of the National Research Council and the Dominion Department of Agriculture

Co-operating organizations:

Board of Grain Commissioners for Canada
University of Alberta
University of Manitoba
University of Saskatchewan

The tenth meeting of the Associate Committee was held at Winnipeg, April 4-7, 1938. The summaries that follow show briefly the progress made in plant breeding for disease resistance and other characters, seed and soil treatments, the acquiring of information on the prevalence of plant diseases, and other phases of control and prevention work. Information on new cereal varieties will be found in the Report of the Associate Committee on Grain Research (Page 77).

Cereal Diseases in the Maritime Provinces

A systematic survey of cereal diseases in the Maritime Provinces was carried out in July and August, 1937. A number of severe localized outbreaks of stem rust of oats were investigated and each was found to be in the neighbourhood of a plantation of common barberry (*Berberis vulgaris*). While no close connection was observed between the presence of barberry and outbreaks of wheat stem rust, the fact was apparent that the losses from stem rust in oats, in this season at least, were traceable to the proximity of barberry. One of the outbreaks had added interest in that the spread of the rust from barberry to oats appeared to be facilitated by the presence of orchard grass (*Dactylis glomerata*).

Crown rust was prevalent, all late fields being severely affected. The first outbreaks were centered about plantings of buckthorn (*Rhamnus cathartica*). Oat smut was present in more than half of the fields examined, an indication that seed treatment is frequently improperly carried out or entirely omitted. Leaf blotch and blast of oats were common.

(Survey by I. L. Conners)

Research in Alberta

Dominion Laboratory of Plant Pathology, Edmonton

A study of isolates of *Rhizoctonia Solani* revealed great differences in pathogenicity as determined by development on potato stems. The pathogenicity was affected by soil conditions, being greater on infertile podsol soils than on fertile black loam. No differences in virulence were detected in the temperature range, 16-23°C., but there was definite reduction at 25°C. Plants recovered by producing healthy secondary and tertiary sprouts. *R. Solani* was much more virulent in natural soil than in sterilized soil, a behaviour that is in striking contrast to that of a number of cereal root-rotting pathogens.

Tests of the ability of varieties of sweet clover and alfalfa to resist the attack of certain root-rotting pathogens were made during the overwintering period, when most damage is usually produced. Alfalfa was more resistant than sweet clover to *Sclerotinia* sp., *Cylindrocarpon Ehrenbergi* and *Fusarium avenaceum*. Varieties of *Melilotus officinalis* were more resistant to *Sclerotinia* than those of *M. alba*.

Isolates of *Fusarium avenaceum* taken from diseased roots of sweet clover and alfalfa produced in culture different morphological and physiological types, but none proved to be as pathogenic as the parent cultures. A study is being made of the prevalence and importance of these in nature.

By planting wheat seeds in a quartz sand substrate and adding various nutrient solutions, together with spore suspensions of *Helminthosporium sativum*, it was discovered that the disease caused by the organism increased when the ionic concentrations of nitrogen, calcium, or potassium were less than those in the complete nutrient solution. No significant reduction of disease was obtained by an increase above that level, however. When seedling cultures were grown in nutrient solutions without sand similar results were obtained. Moreover, it was found that the addition of sugar to the infested solution, before transplanting seedlings to it, increased infection. Less infection was obtained when the inoculum was added in a 2% sugar spore suspension at the time of transplanting. Shoot length and green and dry weights of plants proved to be reliable indicators of foot-rot damage.

Five successive plantings of wheat seedlings were made in steam-sterilized and non-sterilized soil to which cultures of *H. sativum*, *F. culmorum* and *O. graminis* had been added. In the first planting the disease was more severe in sterilized than in unsterilized soil, but in subsequent plants less disease developed in both soils. The sterilized soil produced taller and heavier plants.

(Investigations under the direction of Dr. G. B. Sanford)

University of Alberta

Five collections of smut from different parts of Alberta were used to inoculate a number of varieties, strains and wild plant selections of slender wheat grass. The three varieties used are apparently resistant in the order Fyra, Grazier, Mecca. Each was immune to one or more collections of smut but not to all. Three wild plant selections were immune to all collections. Differences in the reactions of varietal strains indicated possibilities of improvement by selection. Complete control of smut of slender wheat grass was obtained by treating seed with ethyl mercury phosphate, methyl mercury nitrate, or methyl mercury phosphate.

(Investigations under the direction of Dr. A. W. Henry)

Eighteen collections of covered smut from various parts of Alberta, and one from Alaska, have been used to infect barley varieties, with the object of determining which varieties are resistant and whether there is physiologic

specialization among the collections. Four physiologic forms have been identified, and considerable information of basic value in the barley breeding programme has been collected.

More than 600 lines of hybrid barleys from 15 crosses are being developed as potential feed or malting types. Among these are 18 smooth-awned strains from the cross Trebi × Glabron. A study of genetic relationships among barley diseases has been initiated, the first work being done on the reactions of certain barley lines to loose and covered smut. Early results indicate that resistance to these diseases is inherited independently.

(Investigations under the direction of Dr. K. W. Neatby)

Some phases of the study of soil-borne disease organisms may be simplified by the use of sterilized soil, but the effects of the sterilization process on the chemical and physical characteristics of the soil must be understood. For this reason a study was made of certain characteristics of steam-sterilized and unsterilized samples of four Alberta soils. In all four soils steam sterilization reduced the capillary rise. The moisture content at the "sticky point" was reduced in sterilized samples of three soils. In the fourth, a gray wooded soil, there was little difference in this respect between sterilized and unsterilized samples. While the soils themselves differed in shrinkage there was no marked difference in shrinkage of sterilized and unsterilized samples of the same soil.

Nitrification was more active in the sterilized and re-inoculated soils, after a preliminary lag, but the degree of activity was less marked in the gray wooded soil. (Re-inoculated soils were sterilized samples re-inoculated with 1% of original soil.) More ammonia was found at first in the sterilized and re-inoculated samples but after about 12 weeks the level was about the same. Sterilization increased the sulphate content of all the soils.

(Investigations under the direction of Dr. J. D. Newton)

Research in Manitoba

Dominion Rust Research Laboratory

A field experiment in which a wheat variety known to be susceptible to head-blight was infected under controlled conditions with *Alternaria* and *Cladosporium* species showed that *Alternaria* has definite pathogenic capabilities. Isolation studies confirmed the field evidence.

Investigation has disclosed a high correlation between total rainfall for May, June and July, and the prevalence of bacterial black chaff. Other influential factors may be spring frosts, varieties grown, and the presence of insects with piercing and sucking mouth parts. The relation of insects to the disease has not been adequately investigated but it is thought that this may be a parallel case to bacterial wilt of corn.

Pseudomonas translucens was isolated from the surface and interior of discolored barley kernels in a crop that was moderately infected with bacterial blight. *Helminthosporium sativum* and *Alternaria* may also have had some part in the discoloration.

As a result of the establishment of rust nurseries at 18 points in eastern Canada and at two in British Columbia, considerable new information about the distribution of physiologic races of cereal rusts was obtained. The prevalent forms of the majority of rusts are not the same in the east as in the west. The wheat varieties Thatcher, Apex and Renown and the oat varieties and strains Vanguard, No. 7 and No. 811 were highly resistant to stem rust. These wheats had less resistance to leaf rust, and the oats little to crown rust, however.

The detection of crown rust on the oat variety, Bond, suggests the appearance in Canada of a new race of rust and indicates possible new complications in breeding for disease resistance. By means of an artificially induced epidemic of crown rust, it was shown that of 24 hybrid lines of oats tested, all but one were highly resistant. Some of these were exposed in the seedling stage to nine physiologic races of crown rust, including the form that attacks Bond. Only the variety Victoria and hybrids from it were resistant to all these races.

Studies on the relation of darkness to rust infection of cereals showed that light and darkness have no significant effect, temperature and moisture being the important factors.

Investigations into the root-rot disease caused by *Helminthosporium sativum*, *Fusarium* spp., and other fungi aim at the development of practical and effective means of control. Efforts are being made to devise accurate methods of measuring the amount of disease caused by these fungi, to determine the relative susceptibility of cereal varieties, and to develop and study positive attacks of the disease under field conditions. Seed treatment has proved to be of value in controlling only the seedling phase of this disease. The nature and prevalence of other fungi, bacteria, etc., associated with the disease are being investigated and the effects of cultural practices and other factors on these will be determined. Preliminary work has been accomplished on studies of the microflora of cereal seeds. The object of this work is the determination of kind and number of micro-organisms present and their effect on development of disease. Fifteen species, six varieties and three forms of the genus *Fusarium* have been isolated from the permanent plots set out for the study of root-rot diseases.

The testing of fungicides and of means for applying fungicidal dusts to seeds has shown the relative efficiency of smut preventives and the need for improvement in the mixing powers of certain machines. The yield from good smut-free seed of wheat, barley and hulled oats has not been increased by seed treatment in three years of a treatment experiment, but a significant increase in yield was obtained when hulless oats were treated with an organic mercury dust. Rust-resistant varieties of oats and barley have been tested for resistance to smut. Four physiologic races of loose smut have been found in Manitoba; inoculation experiments have shown that different physiologic races are present in eastern and western Canada. Storage for five years of infected seed of wheat and barley did not control loose smut. Three years' storage did not reduce the incidence of covered smut in oats and barley that had been artificially inoculated. There was a marked decline in incidence of loose smut in oats from inoculated seed in two years and a further drop in the third year.

(Investigations under the direction of Dr. J. H. Craigie)

Co-operative tests to determine the disease resistance and other agronomic qualities of varieties and strains of cereals have been continued. The breeding of new resistant wheats may be facilitated by the fact that several new strains of parent material are now available. These are poor in baking quality but are rust-resistant and vigorous in growth. Two agronomic characters now being stressed with disease resistance are earliness and resistance to drought.

The improvement of durum wheats by hybridization has not been rapid in the past but a programme of breeding now under way appears to be making good progress. Several lines produced appear to be immune to stem rust and to have resistance to bunt. It is hoped to join with these types of resist-

ance some degree at least of resistance to root rots and loose smut. Strength of straw is another character that will be stressed since most durum varieties are deficient in this respect.

Progress has been made in the development of high-yielding, plump oats, with resistance to stem rust, crown rust, smut and drought. Some of the lines now available are resistant to stem rust only, others to stem rust and smut, and still others to stem rust, crown rust and smut. Complete resistance to the rusts means, of course, resistance to all physiologic races. This has been achieved with respect to stem rust but not to crown rust, of which 45 races are known. The varieties Bond and Victoria are resistant to the 11 of these found in Canada, but since any of the other races may appear, an effort is being made to build up resistance to all 45 races.

The whole program of plant breeding is closely integrated with the work in plant pathology and also with the testing of grain from the utilization point of view which is described in the report of the Associate Committee on Grain Research (Page 77).

(Investigations under the direction of Dr. C. H. Goulden)

University of Manitoba

Further study has been made of the reliability of the plate method as a means of determining the numbers of fungi, bacteria and actinomycetes in the soil. Greater dilutions have been used in order to overcome fatigue in counting and also, if possible, to reduce probable antagonism or stimulation among colonies. It would appear advisable to develop a method for actinomyces probably based on a selective medium that would remove the uncertainty now associated with results obtained on plates designed for bacteria. Causes of discrepancy among counts of replicate plates of soil bacteria appeared to be in some factor other than laboratory technique, because satisfactory counts were obtained when pure cultures were plated out from sterilized and inoculated soil. This work was based on soil samples taken from plots laid out by the Dominion Rust Research Laboratory for a study of the effect of cropping practices on root-rot diseases.

(Investigations under the direction of Prof. Norman James)

Research in Ontario

Dominion Experimental Farm, Ottawa

The relative abundance of micro-organisms in the rhizosphere, or zone surrounding the roots of plants, as compared with the rest of the soil, has been studied as a means of determining the relationship of these organisms to plants. Two varieties of flax, Bison, resistant to root rot, and Novelty, susceptible, were used in the study. Reward wheat was grown for purposes of comparison. The numbers of micro-organisms in the rhizosphere of wheat were found to be greater at five days after planting than at fifteen days after. In flax this difference was not clear. However, the rhizosphere of the susceptible variety, Novelty, supported larger numbers of micro-organisms than that of the resistant variety, Bison. In culture experiments, root excretions from Novelty were found to stimulate growth of *Fusarium* and *Helminthosporium*, but not *Trichoderma*. Exactly opposite results were obtained when root excretions of Bison were used.

Microbiological studies of soils differing in fertility have been continued. Total numbers of bacteria showed no relation to productivity of soil. Of the eight morphological groups of bacteria in these soils, five supplied almost 90% of the total numbers in all soils. It was not possible to relate fertility

to these or any other groups. There did appear to be some relation between cropping practice and relative abundance of certain forms. The effect of season on relative numbers of various groups was not marked.

(Investigations under the direction of Dr. A. G. Lochhead)

Field tests of resistance of oat varieties to bunt were unsuccessful in 1937 owing to the fact that even very susceptible varieties escaped infection, possibly owing to weather conditions. The varieties Vanguard, resistant to stem rust, and Erban and Lanark which are partially resistant to crown rust, yielded well in local crop tests in eastern Ontario and their performance has stimulated the interest of farmers in resistant varieties. First generation hybrids of a Vanguard × Erban cross have been crossed with a new variety that has shown complete resistance to both rusts under heavy natural epidemics, in the hope of producing a resistant variety with desirable economic characters.

The cytological study of hybrid wheats previously reported has been continued. It is now clear that plants that are comparatively stable cytologically are more likely than unstable plants to produce stable lines, hence cytological examination is now being used as an adjunct to plant breeding technique. It has been applied to a study of 336 plants from interspecific wheat crosses that were made for the purpose of developing rust-resistant wheats. Of these plants, 140 had 42 chromosomes and it is expected that desirable new types will appear in the progeny of at least 20 of these.

(Investigations under the direction of Dr. L. H. Newman)

Research in Saskatchewan

Dominion Laboratory of Plant Pathology, Saskatoon

Investigations into the water relations of wheat plants infected with *Helminthosporium sativum* showed that inoculated and uninoculated plants used approximately the same amount of water per unit of dry matter produced. The inoculated plants used less in the seedling stage, *i.e.*, during their period of stunted growth, but after the appearance of the crown roots they equalled and then surpassed the uninoculated plants in water consumption. This apparently indicates a tendency to overcome the effects of the disease, a tendency which did not appear, however, when moisture was inadequate at the time of crown root formation.

The reactions of fungi to various proprietary seed treatments have been studied under laboratory conditions as part of the attack on the problem of control of root rots. The isolation of fungi from the various levels of the wheat root system has been continued. Preliminary surveys of the influence of phosphatic fertilizers on the incidence of browning root rot indicate that these substances may reduce the disease significantly.

(Investigations under the direction of Dr. P. M. Simmonds)

Dominion Experimental Station, Swift Current

The development of strip farming as a method of control of soil drifting has increased the danger of damage from the wheat stem sawfly. This insect lays its eggs on the plants close to the borders of the field, and since the proportion of border to total area is greater in strips than in large fields, a greater proportion of the crop is damaged. For this reason an effort is being made to produce a wheat variety that will be resistant to the attack of this insect. Solid-stemmed wheats are resistant and a number of such types have been

introduced and crossed with good Canadian varieties. The programme of breeding now under way will include natural and artificial selection, and back-crossing, with the object of developing a good solid-stemmed spring wheat variety.

(Investigations under the direction of H. J. Kemp)

University of Saskatchewan

As a result of co-operation with hundreds of junior farmers and assistance of certain commercial concerns, it has been possible to carry on large numbers of tests of new varieties of wheat at points throughout Saskatchewan. These tests give information on the performance of varieties under many types of environment, and furnish the plant breeder with better means for comparison of varieties. The plant pathologists of the Dominion Department of Agriculture have also co-operated in the plant-disease phases of this work.

A special barley-breeding program initiated in 1935 aims at the development of smooth-awned barley of good malting quality. The breeding material is being used also for studies of the mode of inheritance of many barley characters. Pedigree and mass selection are both being used. The behaviour of barley varieties under various conditions of cultivation and on soils of differing fertility is being studied.

The development of smut-resistant lines of wheat, oats and barley continues. Many lines that possess a high degree of resistance are now available.

(Investigations under the direction of Dr. J. B. Harrington)

Studies on the effect of phosphorus on the development of Pythium infection indicated that phosphorus stimulates root development in wheat and also tends to decrease the vigour of the fungus. No relation was found between general microbiological activity in the soil and the development of root rot from *Pythium*, although it is possible that certain specific organisms may have an effect. In the field the addition of phosphorus markedly reduces the amount of disease.

(Investigations under the direction of Prof. V. E. Graham)

Associate Committee on Grain Research of the National Research Council and the Dominion Department of Agriculture

Co-operating organizations:

Board of Grain Commissioners for Canada
McGill University
University of Alberta
University of Manitoba
University of Saskatchewan

In the last few years the work of this committee has become diversified over almost the entire range of Canadian grain crops. To meet this changed situation, the task of organizing co-operative research projects has been delegated to subcommittees dealing with each crop. The only joint project now carried out under the direct auspices of the Committee is the important one of testing the quality of new wheat varieties. The material included in the co-operative tests of the Subcommittee on Plant Breeding of the Associate Committee on Field Crop Diseases is tested for quality by the co-operating grain research laboratories. During the past year the Committee reported favourably on the quality of Thatcher wheat and recommended to the Board

of Grain Commissioners that it should be considered eligible for inclusion in the highest statutory grades. A few varieties were found to be deficient in quality and they will be discarded. The remainder will be tested further. In the last group are several new wheats which appear to be of excellent quality, among them a selection of the newly distributed Renown, which excels the parent variety.

During the year members of the Committee have published 23 papers reporting results of the general research program. These are included in the Committee's series of papers bringing the total number published since its inception to 135. The collected papers have been issued in four bound volumes to the libraries of institutions directly interested in grain research.

Subcommittee Projects

Hard Wheat Research

The main investigation of wheat quality has been the testing of new varieties referred to above. The co-operative testing of new methods and apparatus for the determination of various phases of quality has been a feature of the recent work. The free interchange of ideas has done much to raise the general standard of accuracy in the co-operative laboratories.

The Committee have given much attention to the scientific basis of wheat grading. The recent report on the grading of frosted wheat (Can. J. Research, C, 15:567-592), the continued collection of information on the possible utility of protein content in the grading system, and the periodic recommendations with regard to the eligibility of certain varieties for inclusion in the higher grades are representative of the efforts along this line.

Specific problems are often referred to individual laboratories for investigation. Questions relating to the maturity of wheat, cracking in threshing, and the value of wheat–soya-bean blends were dealt with in this way.

Soft Wheat Research

An exhaustive study in British Columbia has shown that no suitable areas exist for the quantity production of soft wheat of the quality required by the trade. The Cereal Division and the University of Alberta have co-operated in tests of this class of wheat in the irrigated and the gray, wooded soil areas in Alberta. Plans have been made to extend the work on the latter as they seem to offer the most promise of producing soft wheat in sufficient quantity. Breeding work is in progress at the two co-operating institutions with the object of obtaining early ripening, low-protein, white wheats of the required quality.

Barley Research

The Subcommittee on Methods of Experimental Malting and Malt Analysis, on which the Canada Malting Co. Ltd., the Dominion Malting Co. Ltd., the University of Manitoba and the National Research Laboratories are represented, has continued studies designed to improve the reproducibility of results obtained when malts are analyzed in different laboratories. Further reduction in maximum differences between laboratories, and an increase in precision within laboratories, have again been obtained. The subcommittee members also co-operated in studies of malting tests made in the four laboratories (Cereal Chem. 14:879-892. 1937) and in the collection of data for a special report on the malting quality of Olli barley.

The Subcommittee on Laboratory Malting Tests, in co-operation with the Subcommittee on Breeding and Production of the National Barley Committee, has continued to function admirably as a co-ordinating agency for

malting barley investigations in Canada. During the past season, malting tests were made at the University of Manitoba on 573 samples as compared with 304 samples examined the previous year. The Subcommittee distributed these tests as follows:—238 for various variety trials; 162 for studies of the effect of environment on malting quality; 85 for studies of the effect of cultural practices; 24 for comparison of the quality of western barley grades; and 64 for studies of equipment and methods.

A much improved malting test is now in use and as a result of this and of improved field plans most of the investigations undertaken yielded useful and reliable information. A considerable body of data is being accumulated. Its usefulness was demonstrated this year when the Associate Committee was asked to decide whether Olli barley should be recommended for the malting grades. Results of comparisons of 64 paired samples of Olli and the standard variety, O.A.C. 21, were available. These showed that Olli had certain promising characteristics and others of doubtful value. The Committee deferred its decision pending the results of further investigation of doubtful points.

Oil Seeds Research

During the year, field and laboratory studies of several standard varieties of flax and plant breeders' hybrids grown at several points in Western Canada have been carried out. The effect of fertilizers on the yield and quality of flaxseed has also been investigated. The investigation of the effect of harvesting flaxseed at different stages of maturity on the physical and chemical characteristics of the seed begun in 1936, was repeated with essentially similar results. Oil deposition commenced early in kernel development; as the kernel weight increased there was a rapid increase in oil content and the saturated fatty acids were progressively transformed to unsaturated.

Studies on the possibility of sunflowers as a profitable oil seed crop have been continued. Field and laboratory tests have been carried out on promising selections grown at Saskatoon in 1937; the effect of environment on the oil content and iodine value of the Mennonite variety was investigated. The oil content and iodine value of western-Canadian-grown seed compared favourably with that of imported seed. An industrial survey as to processing methods, commercial requirements and uses has been conducted and indicates that sunflower seed oil is quite competitive with other oils.

Preliminary investigations of safflower and tame mustard as possible oil seed crops have also been carried out.

Feeding-stuffs Research

The comparative feeding trials designed to establish the relative feeding value of Canadian western barley in comparison with oats and corn for bacon hogs have been completed, and the data of four of the five replicate tests analyzed. Owing to unforeseen and unavoidable circumstances, the test that was to be carried at the Ontario Agricultural College was so much delayed in starting that it was thought desirable to proceed with the analyses of the other data in order that the results might be presented to the meeting of the National Barley Committee in the spring of 1938.

In general, the results of the 1937 feeding tests, as measured by the response of the live hogs, indicated that No. 4 C.W. barley is fully equal to corn and considerably better than oats as the basis of bacon hog rations. The grain feeds constituted from 85 to 90% of the ration fed. Mixtures of barley and oats, and corn and oats, gave results intermediate between barley and oats fed as single grains.

In so far as the characteristics of the carcasses are concerned, there was a tendency for the corn-fed lots to show a larger percentage of fat and less lean than either the barley- or oat-fed groups. In addition, the actual number of square inches in the cross-section surface of the longissimus dorsi muscle, cut at about the fourth lumbar vertebra is greater in the barley-fed hogs than in the corn-fed lots at all stations. Statistically, this difference is barely significant at odds of 19:1, but its constant tendency is certainly interesting.

A full report of the results of these trials will be presented at the National Barley Committee meeting on 8 April, 1938.

Arrangements have been made to continue for another year these co-operative feeding tests with the same organizations contributing to the cost. This year the comparisons to be studied involve the relative feeding values of the three grades of feed barley. Tests will be run at the same stations, and the outline of procedure will be identical with that of the 1937 test, which proved very satisfactory. It is expected that the actual feeding work will get under way before 1 April, 1938.

Durum Wheat Laboratory

During the year, particular attention has been given to the elaboration of quantitative physical tests for evaluating the quality of alimentary pastes. An instrument for measuring transverse breaking strength has been constructed, a standard cooking method developed and a recording tenderness tester devised for measuring the tenderness of the cooked product. The tenderness test, coupled with the water absorbed and increase in volume during cooking, has proven to be particularly valuable, and collaborative tests are under way in co-operation with the United States Food and Drug Administration and the Research Laboratories of the National Macaroni Manufacturers' Association to determine its suitability for identifying the farinaceous ingredient of alimentary pastes. A small scale rapid macaroni test employing 100 grams of wheat is under development for estimating the quality of new varieties and hybrids in early generations. Water saturated normal butyl alcohol has been adopted as the standard solvent for pigment determinations; it extracts the yellow pigments more rapidly and completely than the mixed naphtha-alcohol solvent used heretofore, and a rapid simplified procedure for mill and routine control work has been developed. Two models of a combined photoelectric colorimeter and colour analyzer have been built and studied.

In accordance with the practice begun last year, quality tests were conducted on the Tentative Standard, Tentative Export Standard samples, and Winnipeg Averages in connection with the meeting of the Western Committee on Grain Standards. A mimeographed report on the quality of the 1937 Western Canadian amber durum wheat crop was distributed to the trade. Tests have also been conducted on several series of standard varieties and hybrids grown under comparable conditions. Of the standard varieties, Mindum and Arnautka proved to be of the highest quality, and Golden Ball the lowest; three of the hybrids exhibited high quality; one of these has also been outstanding agronomically.

(Investigations under the direction of Dr. W. F. Geddes)

Grain Research in the Laboratory of the Board of Grain Commissioners

As the Grain Research Laboratory publishes an annual report detailing the various investigations undertaken, only a brief mention of certain studies, other than those reported above, is made here.

As in previous years, the laboratory has carried out surveys of the protein content of hard red spring wheat, durum wheat and barley produced in western Canada and published the results in the form of maps and mimeographed reports.

A survey has also been conducted of the protein content, oil content and drying value (as indicated by iodine number) of western Canadian flaxseed; in addition, proximate feeding-stuff analyses of the various feed grades of western Canadian wheat, oats and barley are carried out on average samples obtained from the Winnipeg Inspection Office. A report on the milling and baking quality of the various grades of hard red spring wheat was also published in mimeographed form.

In co-operation with the Subcommittee on Feeds and Feeding-stuff Analyses, proximate analyses were conducted on the feeds used in the hog-feeding trials designed to determine the relative value of oats, barley and corn.

Evidence was presented before the Turgeon Royal Grain Enquiry Commission in which the protein data accumulated by the laboratory on hard red spring wheat since 1927 were reviewed. The evidence included data on the extent of selection of high protein wheat by Canadian and United States mills and its effect on the protein content of overseas shipments, and a critical examination of various methods that have been proposed for reducing the variability in quality within grades.

An improved wide-range volume measuring apparatus for small loaves has been constructed and a paper describing the constructional details and the influence of size and shape of loaf and rate of seed flow published.

An investigation of the chemical composition of the pericarp and endosperm of flaxseed reveals that the lipide content of the hull is relatively low, the hull pigments are only slightly soluble in the usual fat solvents and play only a small part in the colour of linseed oil.

Further studies dealing with the effect on flour strength of additions of dried gluten to wheat flour are in progress, with specific reference to the gassing level and concentration of oxidizing agent required to secure maximum differentiation in the loaf volumes of flours of varying protein content.

In a study of the error of the Kjeldahl Nitrogen test, based on approximately 11,000 samples of wheat ranging in protein content from 7 to 21% and 1,500 samples of flour with protein contents ranging between 7 and 18%, the average difference between duplicates was 0·144% for wheat and 0·116% for flour; there was no relation between the magnitude of the error and protein level.

An investigation to ascertain the suitability of ash dishes manufactured from platinum, alumina, transparent and opaque fused silica, and porcelain, for the determination of wheat and flour ash has been completed. Platinum and transparent silica were found to be the most suitable.

(Investigations under the direction of Dr. W. F. Geddes)

Grain Research by the Cereal Division, Dominion Experimental Farms

The wheat quality testing laboratory of the Cereal Division is organized chiefly for the purpose of working hand in hand with the plant breeders in their programmes for the improvement of varieties for different parts of Canada. Three distinct groups of hard red spring wheat varieties, namely, the western rust-resistant group, the eastern rust-resistant group and the

special early wheat group, were investigated from the 1936 crop. The first group involved a study of the quality of 25 varieties of wheat grown at 12 different places in the three prairie provinces, the second group consisted of 12 varieties grown at 3 different places in the east and the third group comprised 24 varieties grown at 9 places in the west. In addition, studies were made on samples of special soft wheat varieties grown at a number of points in Alberta and in Ontario.

Hybrid material in the early generations and reselections of promising varieties were investigated from numerous samples grown at Ottawa, Dominion Rust Laboratory at Winnipeg and at some of the Dominion Experimental Stations, as an aid in the discarding of undesirable material and the isolation of superior sorts.

In collaboration with the National Barley Committee and the Grain Research Committee, the Cereal Division is investigating the suitability of different barley varieties for malting and feeding purposes.

The quality of different flax varieties and the influence of environment on these varieties are being investigated in connection with the Subcommittee on Flax.

(Investigations under the direction of Dr. L. H. Newman and A. G. O. Whiteside)

NOTE.—Additional information regarding the work of the Cereal Division is given in the Progress Report of the Dominion Cerealist on Cereal Work on Dominion Experimental Farms and Stations for the years 1934-37 inclusive.

GRAIN RESEARCH AT THE UNIVERSITY OF ALBERTA

A new series of nutrient culture studies involving the interrelations of two elements supplied to wheat in varying proportions has been started. The most striking result of the first year's tests is the direct effect of nitrogen absorption on the uptake of potassium.

A summary of the earlier studies on mineral nutrition has been prepared and accepted for publication in the journal, Plant Physiology. The results of individual studies have been published in the Canadian Journal of Research.

The study of gluten proteins and lipoids has been continued. The earlier conclusion that gluten protein is a reversibly fractionable complex has been substantiated by results obtained with fractional solubility methods. The importance of lipoids in determining the physical nature of gluten now seems beyond question. It has also been found that the presence of lipoids and lipoid break-down products has a marked effect on the water-holding capacity of gluten and on its apparent isoelectric point.

The production of four wheat varieties under various conditions of nitrogen fertilizer treatment was repeated. Very dry conditions again impaired the value of the experiment, but an increase in protein content with nitrogen applications was obtained. This increase was directly proportional to the amount of fertilizer used.

The quality studies on wheat samples supplied from rotations maintained by the Pathology Division of the Department of Field Crops were continued. Tests were again made with individual field replicates.

(Investigation under the direction of Dr. A. G. McCalla)

The investigations of drought resistance in wheat have, as in the past, been concerned with the development of improved varieties and the refinement of methods of breeding now in use.

In 1937, yield trials were conducted at Castor, Alberta, and at Edmonton. In all, 175 varieties and hybrid strains were tested at each point. Very dry conditions prevailed at Castor, and the yields of the varieties and strains ranged from practically nothing to eight bushels per acre. The standard varieties, Marquis, Thatcher and Red Bobs, were significantly and substantially outyielded by several of the new hybrid strains.

Forty-five new crosses between Russian introductions and standard sorts were made in 1937. This material, together with that derived from crosses made previously, is becoming so bulky that improved methods of selection are urgently needed. Efforts are being made to devise indirect methods of selection by identifying linkages between readily observable characters and drought resistance. Studies of the responses of varieties and strains to artificial drought, of comparative root development, of tillering capacity, of frequency and size of stomata, of protein content and of several other characters are in progress. A rather close negative relation between yield and protein content has been observed. By discarding very high protein material from the breeding plots, the general level of yield in comparative yield tests can be raised. Since the areas in which drought resistant wheats are urgently needed are characterized by conditions which promote high protein content in wheat, selection for very high protein content in breeding material is unnecessary. With the possible exception of the development of the primary root system, protein content of the grain is the only character found to be genetically associated with yield under conditions of limited moisture supply.

Unquestionably, progress is being made in the breeding work and also in the improvement of breeding methods.

(Investigations under the direction of Dr. K. W. Neatby)

The effect of formaldehyde seed treatment on the growth of wheat was studied under field conditions. Height measurements and dry-weight determinations were made at weekly intervals on carefully spaced plants grown from treated and untreated seed. One series of plants was grown from formaldehyde-treated seed (1-320), another from seed treated with New Improved Ceresan ($\frac{1}{2}$ oz. per bushel), and another from untreated seed. It was found that the formaldehyde treatment resulted in a marked retardation of growth during the early stages of the plants. At the end of six weeks the dry weight of plants from formaldehyde-treated seed was only 58% as great as that of control plants. Ceresan-treated seed, on the other hand, gave plants which behaved very similarly to those from untreated seed. However, plants in the formaldehyde series gradually recovered, and in 10 weeks were equal to the controls. This recovery was made possible by abundant rains in midsummer. Had the plants not been spaced, and had conditions been less favourable in the latter part of the growing season, it is improbable that this recovery would have occurred.

In the greenhouse, studies were made on root development of wheat plants from formaldehyde-treated seed. These were made in special containers provided with glass fronts. Formaldehyde caused a marked reduction in root development as compared with that in series from untreated and Ceresan-treated seed. This was true even where a 1-320 solution was used, but was considerably more pronounced when stronger concentrations were used. It was noted that the formaldehyde-treated seed moulded badly, whereas the check seed was much less affected and the Ceresan-treated seed entirely free from moulds. It is probable that such moulds developing on the seed accentuate the seed injury caused by formaldehyde.

The effect of presoaking and washing formaldehyde-treated seed with water was studied further in 1937. The results are in agreement with those previously reported.

Since the water used for making the formaldehyde solution varies widely in different parts of the country, it seemed advisable to determine whether water of different degrees of alkalinity would influence the injurious effect of formaldehyde on seed. Samples of water varying in alkalinity were made up artificially, and in addition a number of samples were obtained from farmers' wells. These were compared with distilled water. From the results obtained it is concluded that variations in composition of water samples such as are likely to occur will not appreciably affect the injurious effects of formaldehyde solution on seed.

Seed injury may occur if overdoses of organic mercury dusts are used, if the seed is stored too long after treatment, if its moisture content is high, etc.

Studies on the nature of seed injury caused by New Improved Ceresan such as occurs from the above causes, have demonstrated that it is associated with reduced diastatic activity. It is concluded that injury to wheat caused by this organic mercury dust is due, at least partly, to a deleterious effect of the enzyme diastase in the grain.

Coleoptiles of seedlings which show injury from organic mercury dusts do not elongate normally, but remain short and leathery. It was thought that this might be due in part to inactivation of the growth hormones. New Improved Ceresan inhibited growth when applied in lanolin at concentrations greater than 1-1000, to the sides of coleoptiles, but when concentrations of 1-20,000 or 1-50,000 were used growth stimulation occurred. New Improved Ceresan (1-100) mixed with hetero-auxin (1-20,000) and applied together to decapitated coleoptiles appeared almost completely to inactivate the hetero-auxin. New Improved Ceresan (1-20,000), on the other hand, did not inactivate the heteroauxin, but the exact concentration at which inactivation first occurs has not been determined. The fact that roots and coleoptiles on seedlings from injured seed show geotropic responses indicates that the capacity for auxin production and the ability to respond to it are not completely destroyed by New Improved Ceresan. Injured coleoptiles could not, however, be induced to resume normal growth by applications of heteroauxin in lanolin.

Storage experiments made on grain treated with New Improved Ceresan have demonstrated that treated grain may be injured if stored in tight containers whereas if stored in an open bin this may not occur. It is probable that injury might occur even in properly treated grain if it was stored in waterproof almost air-tight fertilizer sacks, such as are now found on many farms.

The possibility that the combined use of commercial fertilizer and organic dusts might lead to seed injury was investigated at Edmonton and Fallis, but no indication of a harmful effect of the two practices in combination was obtained.

(Investigations under the direction of Dr. A. W. Henry)

The experiments on the fertilizer requirements of Alberta peats for barley production were again carried out on fields near Edmonton and Duffield, with Peatland and O.A.C. 21 barley. At harvest time there was considerable immature second growth as a result of drought in the early part of the season and heavy rain about the middle of July.

At Edmonton the barley was too immature to thresh, but at Duffield the grain yields were moderately high, and decidedly higher than on adjacent gray, wooded soil. A "complete" fertilizer produced the highest average yield at Duffield and Edmonton, as in previous experiments.

Samples of Peatland and O.A.C. 21 barley grain grown at Duffield in 1936 were analyzed for nitrogen and phosphorus. All samples were rather high in nitrogen. Phosphorus was rather high in the samples from plots that received phosphorus fertilizer, but about normal in samples from other plots.

In an experiment on gray, wooded soil at Duffield, the application of peat alone produced a small increase in Peatland barley yield, but peat and fertilizer (ammonium phosphate) applied together gave about twice the increase produced by the fertilizer alone.

(Investigations under the direction of Dr. J. D. Newton)

Grain Research at the University of Manitoba

The cultural experiments with barley in 1937 involved three different dates and three different rates of sowing with three varieties, namely: O.A.C. 21, Mensury Ottawa 60 and Gartons. The experiment also compared fertilizer treatment with no treatment under each of the sowing dates and rates. The experiment was conducted at four stations.

The two varieties, O.A.C. 21 and Mensury Ottawa 60, showed decided reductions in yield as a result of delayed sowing. Gartons showed little reduction. The addition of fertilizer returned a small increase, but there was no evidence of significant interaction between fertilizer and rate or date of sowing or variety. The experiment will be continued for two more years.

Barley breeding work was largely suspended during 1937 because of curtailed support and reduced personnel. This work is being actively resumed. The immediate objective is a high quality malting barley that is superior in strength of straw and rust resistance to O.A.C. 21, the present standard malting barley.

(Investigations under the direction of Dr. P. J. Olson)

The malting qualities of some twenty varieties of barley have been compared during the past season. Those varieties now admitted to the malting grades made a good showing, with the exception of Peatland, which seems to be less satisfactory. Amongst the other rough-awned varieties studied, Olli and Lapland appeared to be most promising. Trebi and Bearer, and five smooth-awned varieties were shown to be inferior to the standard variety, O.A.C. 21, in one or more important characteristics. A number of strains of O.A.C. 21 grown in 1936 and 1937 were compared and found to be equal in malting quality. Tests of 12 samples of No. 3 Extra C.W. and No. 3 C.W. commercial barleys showed that the higher grade was slightly superior in malting quality.

Studies of the effect of environment on malting quality were made in both Saskatchewan and Manitoba. Although these were not comprehensive enough to provide definite results, the data indicate a tendency towards higher extract and lower diastatic power the farther north the barleys are grown.

Malting tests made in connection with the Manitoba barley cultural studies showed mainly that the differential effects of date of seeding and environment on malt quality were very considerable. Depth of seeding and fertilizer treatment had little effect on malt quality. In the third study, in which three varieties of barley were grown in five different places in a crop sequence, the varieties responded very differently to the place in the rotation and no conclusive results were obtained.

(Investigations under the direction of Dr. P. J. Olson and Dr. J. A. Anderson)

Grain Research at the University of Saskatchewan

A study was made of the protein content of Marquis, Reward, Thatcher, Apex and Renown samples grown on replicated plots at 146 points in Saskatchewan during 1937. On the average, Reward was 10·8, Renown 4·6, Thatcher 4·4 and Apex 1·1% higher in protein than Marquis. Reward, Renown and Apex all seemed to be relatively higher in protein in the north than in the south of the province, Composites based on broad soil zones were made and milled, but the baking data are not yet available.

The study of the relation of soil type to quality of wheat was continued with a greatly reduced number of samples. Owing to the drought, wheat samples, when obtainable, could be secured only from the heaviest types of soil at a given point, except in the case of the podsolized soils of northeastern Saskatchewan. In that area the Waiteville loams produced grain of much lower protein content than that produced by the Melfort silty clay loams, despite the fact that the area was unusually dry and the general protein level high. In all other parts of the province, the only samples received were from the heavier clays and clay-loams, and no comparison could be made.

The hygroscopicity of wheat has been investigated during the last year. The data indicate that many more factors than have hitherto been recognized affect the vapour pressure of wheat at equilibrium with atmospheres of definite relative humidity. The conditions under which the moisture in wheat is changed definitely affect the final equilibrium. Some of the factors that seem to be associated with hygroscopicity are time, temperature, extent of wetting and concentration of carbon dioxide in the container. The protein content of the wheat may or may not be a factor; the data so far obtained are contradictory. This work was undertaken in order to obtain the information necessary for more accurate control of respiration experiments, especially those dealing with wheats of different varieties, grades, and protein contents.

A study of the chemical composition of Russian thistle at various stages of maturity was made. This work is now ready for publication. It shows that the composition of this plant varies over a wide range, especially in respect to ash content which is exceedingly high at the flowering stage, but decreases thereafter very rapidly, a fact that may explain the widely different analyses heretofore reported.

(Investigations under the direction of Dr. R. K. Larmour)

Note,—Grain researches in the National Research Laboratories are summarized in the Report of the Division of Biology and Agriculture (Page 20).

Associate Committee on Plant Hormones

Co-operating organizations:

Dominion Department of Agriculture
Dominion Forest Service

The Associate Committee on Plant Hormones, organized in the fall of 1937 to promote and co-ordinate investigations in this field, held its first meeting in the National Research Laboratories on 12 November, 1937. Formal reports on investigations were presented by Dr. N. H. Grace, of the National Research Laboratories, by Dr. C. Heimburger, of the Dominion Forest Service, and by Mr. R. W. Oliver and Mr. J. G. C. Fraser, of the Dominion Experimental Farms. Dr. Grace's report, the greater part of which appeared in the November, 1937, issue of the Canadian Journal of Research, covered the most ground and excited a great deal of interest. A number of informal reports on minor investigations were contributed by Dr. Whitby and

other staff members of these Laboratories. Suggestions regarding further work, both independent and co-operative, were a prominent feature of the discussions, formal proposals being submitted by Dr. H. T. Güssow, with reference to the role of hormones in the formation of plant galls, by Dr. F. H. Peto, with reference to the use of hormones in the propagation of forest trees, and by Dr. R. H. Manske, with reference to chemical investigations.

In addition to proposing certain co-operative projects between the National Research Laboratories, the Department of Agriculture, and the Dominion Forest Service, the Committee prepared two resolutions for submission to the National Research Council. The first recommended that a comprehensive research programme looking towards the development of satisfactory methods of hormone application to stem cuttings of forest trees be proceeded with as soon as possible. The second emphasized the desirability of appointing a competent organic chemist to undertake, in collaboration with plant physiologists, the further investigation of natural plant hormones, and to carry on fundamental scientific research on the heterocyclic compounds related to those of natural occurrence.

In accordance with the former resolution a conference with officers of the Dominion Forest Service was held on 22 December, 1937, at which a programme of investigations on the propagation of spruce, pine, basswood and poplar by hormone treatment of cuttings, and on genetical studies and crossing of these and other trees, was outlined. Beginning 1 January, 1938, Mr. J. L. Farrar of the Dominion Forest Service was attached to these Laboratories for full time work on the propagation programme under Dr. Grace and Dr. Peto, while Dr. C. Heimburger of the Dominion Forest Service gave a considerable amount of time to it. A general study of the application of plant hormones to forest tree cuttings with particular reference to coniferous species was immediately begun. Cuttings of white and Norway spruce were successfully rooted. This justified further work on these species which is being planned for the immediate future.

Dr. L. P. V. Johnson, an experienced plant breeder, was appointed from 1 March, 1938, to devote full time to the genetical and breeding work, under the immediate direction of Dr. Peto with the important advisory help of Dr. Heimburger. Using the extensive material already collected by Dr. Heimburger and Dr. Peto, Dr. Johnson was able to start at once on a crossing programme. His work was concerned initially with the crossing of European and native aspens, with the object of obtaining fast-growing hybrids resistant to disease and drought. Later in the spring the work will be extended to coniferous trees.

Arrangements have been made with the Dominion Forest Service to transfer the work for the summer to the Forest Experiment Station at Petawawa, where good materials and facilities are available, including tree nursery accommodation, and where the working group will be further enlarged by the co-operation of forest pathologists belonging to the Department of Agriculture.

Further details of the forest tree breeding work of Dr. Peto and Dr. Johnson will be found in the report of the Division of Biology and Agriculture (Page 28).

Associate Committee on Potato Research

Following the plan developed at the first meeting of the Committee (20 January, 1936) to determine ways and means of utilizing surplus stocks of potatoes, research work was carried on by the co-operating agencies including the provincial and federal departments of agriculture. Direction of the work was maintained through subcommittees, and when it was certain that results of value had been obtained, arrangements for a general meeting were made.

The second meeting of the Associate Committee on Potato Research was held in the National Research building on 17 January, 1938, when papers were presented and discussed on the following subjects: Feeding experiments with potatoes and potato by-products on live stock and poultry, potato drying experiments, results of work in potato breeding, effects of chemical treatments for hastening and retarding sprouting, observations on phytohormones and the dormancy of new potatoes, insect investigations, starch content of potatoes and its industrial utilization, cooking tests and table quality of potatoes, seed potato production and shipments.

As a result of the studies on feeding it was considered there might be a demand for potato meal, provided the cost did not exceed about $36 a ton, which is about the equivalent of the present cost of barley as feed. The trench silo method of storage appeared to yield satisfactory results and was found to be much cheaper than drying. It was recommended that feeding experiments using raw potato silage and cooked potato silage for hogs, and mixtures with grass, hay or straw for cattle should be continued and that further work should be done on drying potatoes for hog feed. For fattening poultry it was reported that equal parts by weight of raw potatoes and a mash mixture (2 parts ground oats to one part ground barley) gave almost equally efficient gains to those obtained with the mash mixture not thus supplemented. Cooked potatoes fed in the same way gave definitely inferior results.

Breeding experiments have been directed towards production of resistance to mild mosaic, blight, scab and frost, and with a view to increasing the starch content. Definite progress has been made in the mild mosaic and late blight sections. Work is being continued on the other subjects.

A contribution to the discussion on dormancy of potatoes indicated that the use of ethylene chlorhydrin, sodium thiocyanate or thiourea as a means of breaking the dormancy of potato tubers could be used and that thioacetamide had the same effect except that in this case sprouting of non-dormant tubers was retarded.

Work on the problem of aphid and flea beetle control is to be continued as a result of the report and discussion on this subject, which is of commercial importance in relation to potato inspection.

Suggestions were made regarding the importance of considering the starch content of potatoes in breeding programmes. Potatoes of high starch content imported into Canada often produce a crop having a much lower average amount of starch when grown in this country. A potential market for two million pounds of starch in the Maritimes is an incentive for co-operative work between laboratory and plant. An investigation of processes and equipment used in potato starch plants in the east was proposed with a view to bringing the discoveries made in the National Research Laboratories to the attention of potato starch manufacturers. Plant changes, to produce the modified starches developed in the laboratories, would be very slight and would open the door to a wider market.

Consideration was given to the meaning of the term "table quality" of potatoes and also to the effect of various types of fertilizers on this quality.

The greater use of certified seed potatoes for planting in Canada was recommended. A point of added interest in this connection was the statement that shipment had been made in crates of seed potatoes from New Brunswick to South America during the year. Upwards of 100,000 crates had been used and these had required 1,000,000 feet of lumber. Most of the crates needed had been made locally, many by the farmers themselves, and sold for about 30 cents each. This had provided an important outlet for New Brunswick lumber.

Canadian Committee on Storage and Transport of Food

Co-operating organizations:

Dominion Department of Agriculture

Fisheries Research Board of Canada

The Committee was reorganized on 7 January, 1938, when the Fisheries Research Board associated itself with the Dominion Department of Agriculture and the National Research Council in the work. Sections were set up as follows: I. Fruit and Vegetables, II. Meat and Meat Products, III. Fish, and IV. Engineering. A Panel on Taints was set up under the Engineering Section. The preparation of a joint annual report was decided on. This will contain accounts of the work done by members of the Committee and will be exchanged with organizations that are engaged in work of a similar nature. While most of the time of the Committee was devoted to technical matters arising from the reports presented, considerable attention was given to problems associated with the transfer of perishables from railway car to ship. The executive was instructed to take steps towards the initiation of improvements in this phase of the transportation of perishable products.

Summaries of some of the material presented in reports are given below. The work of the staff of the National Research Laboratories is summarized in the reports of the Divisions of Biology and Agriculture (Page 22) and of Physics and Electrical Engineering (Page 62).

Fisheries Experimental Station, Halifax, N.S.

The effects of various degrees of salt concentration on the preservation of fish have been studied by treating the press-juice of fish muscle with salt and incubating it at various temperatures. Determinations of total volatile bases and trimethylamine and numbers of bacteria were made. The rate of total volatile base formation was found to vary inversely with the salt concentration, the length of the initial period of slow production increasing with higher salt concentrations. No trimethylamine was produced in the first few days, but the rate of production after that time was rapid. The onset of decomposition corresponds with the appearance of trimethylamine, and this coincides with the point at which the bacterial count is from ten to twenty millions per millilitre. Putrid odours first occur when the trimethylamine reaches a level of four to five milligrams per 100 cubic centimetres of juice, but are limited in development by low temperatures and high salt concentrations.

The effects of various types of salt used in fishing practice have been similarly determined, and it has been shown that the rate of spoilage differs with the different salts, chemically pure sodium chloride having the greatest preserving quality, followed by evaporated mined salts and crude mined salts. It was found that the differences in preserving qualities of the salts are magnified at lower temperatures, and that trimethylamine production once initiated continues at about the same rate with all salts.

Studies are under way to determine the effects of temperature and relative humidity on the development of the red halophilic bacteria that develop on fish. Attention has been given to suitable limits of relative humidity for the storage and transport of salt fish. It has been evident in damp weather that excessive moisture accumulates on the surface of the fish. The results obtained indicate that some provision should be made to dry the air in the warehouses along the Atlantic seaboard during the summer months, when relative humidities in warehouses reach 75% or more.

(Investigations under the direction of Dr. D. B. Finn)

Fisheries Experimental Station, Prince Rupert, B.C.

During 1937 improvement in the storage and transport of fresh and frozen halibut and salmon for export became part of a major programme requested by the cold storage industry. Suggestions made by the Fisheries Experimental Station at Prince Rupert with regard to improved methods of handling and stowage aboard fishing vessels were adopted with beneficial results. Among these suggestions were the construction of outward sloping shelves in the holds to facilitate drainage, the use of 0·1% benzoic acid to reduce bacterial contamination, and the shortening of fishing trips. More plentiful use of ice has reduced losses from exposure to high temperatures at receiving points.

In cold storage investigations the use of eutectic ices for the glazing of frozen fish was shown to be an improvement. The capacity of two commercial freezers was increased by 15-20% by the installation of fans on the suggestion of the Station's refrigeration engineer. In an investigation into the effect of storage under different temperature conditions on the gustatory appeal of salmon and halibut, attention is paid to the effects of freezing rates and effect of period between catching and freezing.

Railway cars that have been built for overhead refrigeration were tested in comparison with the end-bunker type of car, and the results have been published (Progress Report No. 34, Pacific Biological Station, Nanaimo, and the Pacific Fisheries Experimental Station, Prince Rupert). The use of benzoic acid ice in shipping fresh halibut and salmon has also been successfully demonstrated. The refrigeration engineer accompanied one shipment of frozen fish from Montreal to London and obtained information on the suitability of facilities for transfer from train to boat, storage on vessels, and transfer from vessel to storage at destination. A confidential report on this matter was made to the Fisheries Research Board.

(Investigations under the direction of Dr. Neal M. Carter)

Division of Bacteriology, Central Experimental Farm, Ottawa

Quantitative studies on bacteria in the pickle for curing bacon showed that the "standard" method of determining numbers is inadequate. This method revealed little more than 1% of the numbers of bacteria that were found when a medium containing 10% salt was used. The importance of maintaining a suitable salt concentration in the processes leading to counting was emphasized by the discovery that exposure to tap water for a period as short as 45 seconds killed or rendered incapable of growth as many as 90% of the organisms. The salt concentration also affected the morphological and physiological grouping of the bacteria found. The fact that obligate halophiles, facultative and non-halophilic organisms, were all found in pickle indicates the necessity of study of the types of organisms found in each stage of bacon processing.

A study of the surface contamination of Wiltshire sides at different stages in processing indicated that at killing time total numbers of organisms were small and salt tolerant organisms few. Before pickling, numbers of both salt-tolerant and non-salt-tolerant organisms had increased. After pickling there was a pronounced increase in salt-tolerant organisms and little change in the number of the others. During storage of the bacon in bales, organisms able to develop without the presence of salt showed a definite increase. This would indicate that organisms capable of causing damage prior to pickling may still be present and capable of causing defects on cured stored sides.

(Investigations under the direction of Dr. A. G. Lochhead)

Horticultural Division, Central Experimental Farm, Ottawa

Investigations of the relation between nutrition of apple trees and the reactions of the fruit to storage conditions showed that apples from heavily mulched orchards had a greater degree of shrinkage and development of core flush than those from orchards in sod. Apples grown with a relatively low supply of nitrogen, *e.g.*, on sod or on moderately fertilized land, kept satisfactorily, if they were picked at a suitable stage of maturity. An excess of phosphorus or of lime reduced keeping quality. Varieties of apples showed different responses to given storage temperatures. Accurate data on the types of spoilage in storage proved core flush to be the greatest single source of loss.

Attempts to correlate certain physical and chemical indices of maturity with keeping quality have so far been unsuccessful. There was some indication of correlation between keeping quality and rate of loss of acidity at a given storage temperature. The importance of correct sampling led to the making of uniformity studies, which have shown distinct variations in apples of one variety from different trees.

Other studies of the storage of apples deal with the effects of different mixtures of gases at different temperatures, the use of titratable acidity and trend of cell size as indicators of storability, the respiratory trend of apples in storage, the effect on quality of fumigants used for insect control, and the value of cooling fruit before shipping. It has been shown that icing cars for shipping apples relatively short distances (*e.g.*, 75 miles), is of little value unless the fruit is precooled.

Yields of celery on muck land at Ste. Clothilde, Quebec, were increased by the application of potassic fertilizers, the largest yields and best keeping quality both being produced on plots treated with muriate of potash.

(Investigations under the direction of M. B. Davis)

Ontario Agricultural College, Guelph, Ont.

More than 100 varieties of fruits and vegetables are being tested to determine their suitability for frozen-pack storage, and in this work particular attention is being paid to new seedling fruits from the Experimental Station at Vineland. Fruits are also being experimentally packed in ice cream. Some work on the respiration of tomatoes in storage has already been published (Can. J. Research, C, 16:65-83. 1938) and the experiments are being continued.

In a study of gas storage, Bartlett pears have been successfully ripened after storage for 13 months. Investigations of respiration of individual fruits, analysis of atmospheres in packed, partially closed containers, and other studies are being conducted in order to determine the optimum conditions for storage of this fruit.

Surface treatment at harvest or during storage appears at present to be the only method of controlling the Thedford root rot of celery, which develops readily at the lowest safe temperatures for storage. Laboratory trials have been successful, but the margin between control and injury, with the dips, dusts and sprays used so far, is very small, and field trials have given unsatisfactory results. A study is being made of a physiological disorder of turnips that may be accentuated after the roots have been waxed.

(Investigations under the direction of Dr. J. H. L. Truscott)

Associate Committee on Weeds of the Dominion Department of Agriculture and the National Research Council

As arranged in the previous year, a meeting of the Western Division of the Associate Committee on Weeds was held at the University of Saskatchewan, Saskatoon, 29 June, 1937, under the chairmanship of Dr. E. S. Hopkins.

Dr. Hopkins reviewed the activities of the Committee to date and stressed the importance of the work to be done. He estimated that the losses to Canadian farmers caused by the reduction of crops due to weeds were at least $75,000,000 annually. In some parts of western Canada experimental farm authorities thought that the crop reduction amounted to 30-40%. A weed survey was being carried out by the Dominion Department of Agriculture, and at many of the experimental farms experiments in weed eradication were under way. Much valuable information had already been obtained. The Seed Branch of the department placed limits on the number and kind of weed seeds permitted in seed grain, and also in commercial feeds.

Mr. F. E. Lathe of the National Research Council reported upon weed researches carried out by Drs. W. H. Cook and R. H. F. Manske of that organization. Dr. Cook had determined the effect of 76 chemicals upon four of the principal annual weeds, and had found that more than 20 of the chemicals destroyed all four species at the dosages employed. At small and intermediate dosages the chlorates were generally the most effective. Experiments indicated that the greatest efficacy of leaf sprays could be secured by using the minimum volume necessary for coverage and increasing the concentration to the required extent. Applications of various toxic chemicals to a perennial weed through the leaves and soil showed that the action was most effective through the latter. The culture solution test was found to be of no value for the purpose of determining the efficacy of chemicals in destroying perennial weeds under field conditions. Dr. Manske's studies of the alkaloids found in different species of plants had been continued and a large number of alkaloids had been isolated and identified.

Dr. A. W. Henry described experiments carried out at the University of Alberta on the eradication of dandelions in lawns, for which purpose certain copper salts showed promise. Work on the elimination of weeds from lawns by the use of competitive grasses and mixtures of grasses was regarded as encouraging. Special attention was directed to the need of work on the destruction of couch grass and downy brome grass.

Work at the weed research nursery of the University of Saskatchewan was outlined by Mr. T. K. Pavlychenko. New equipment had been secured for the study of the root systems of large perennials. A study of the root systems of the leading forage grasses was throwing light on the ability of these grasses to withstand drought conditions. Work had been started on the use of mineral fertilizers in combating weeds; results obtained in 1936 had been promising. Crested wheat grass had proved effective in smothering toad flax and sow thistle when grown in competition with these perennials. Experiments had been started on the control of wild mustard by different treatments of the field surfaces. Dormancy tests had been carried out on stinkweed seed under field conditions. The need of research in other parts of Saskatchewan on root systems and on the competition between weeds and crop plants, in order to check their ecological behaviour, was emphasized.

The weed situation in the Peace River country was reviewed in a paper by Mr. W. D. Albright. Unfortunately, many settlers moving into this area had carelessly brought in weed seeds with their effects, but the problem had

been partly taken care of by means of improved inspection. Weed seeds had also been introduced in seed grain. Both eradication studies and administrative measures were required.

Mr. C. Tice stated that one of the major problems in British Columbia arose from the large area of unoccupied lands. There was much room for improvement in the enforcement of the provincial noxious weed act. Creeping thistle, couch grass, stinkweed, hoary cress and field bindweed were given as the worst weeds in the province. Some interest had been shown in the use of chemicals for weed control.

A paper by Mr. George Batho stated that weed research in Manitoba had been carried out by the Brandon Experimental Farm, the University of Manitoba and the Provincial Department of Agriculture. Projects were under way by the department on the destruction of leafy spurge, wild oats, couch grass and other perennials. Several herbicides were being tried for the selective destruction of wild mustard growing with cereals.

Mr. J. D. Smith communicated a paper on weed control legislation in Ontario. In the previous 10 years the work of inspection had been well organized, and by 1937 about 1,000 weed inspectors were in the field. Legislation had been passed to deal with the situation existing on the highways, railway property, etc., the objective of the work being to prevent weeds from maturing seed. A bulletin on the destruction of weeds by chemicals had been published and 125 demonstration plots had been maintained throughout the province. Some 70 seed-cleaning plants had been established.

New Brunswick, according to a report by Mr. E. M. Taylor, had no provincial weed legislation. Weed control demonstrations had been conducted in several localities. The report suggested that weeds in seed sown might be classified in the primary or secondary noxious class, according to the condition of the area in which they were to be used. For general use throughout Canada and for export the seed standards should remain high.

Associate Committee on Wool of the National Research Council and the Dominion Department of Agriculture

Co-operating organizations:

Canadian Co-operative Wool Growers, Limited
Canadian Woollen and Knit Goods Manufacturers' Association
Ontario Research Foundation
University of Alberta
University of Saskatchewan
Wool Industries Research Association (Great Britain)

As stated in the previous annual report, the National Advisory Committee on Agricultural Services has established a National Sheep Committee to undertake work in the broad field of sheep husbandry. This committee has now taken over most of the activities of the Wool Growing Section of the Associate Committee on Wool, and the associate committee is now maintained primarily to deal with applications received for financial grants for wool research and any questions regarding wool not coming under the National Sheep Committee.

The National Sheep Committee has been set up with Mr. A. A. MacMillan, Live Stock Branch, Dominion Department of Agriculture, as chairman, and Mr. G. W. Muir, Central Experimental Farm, as secretary. An executive committee and the following subcommittees have been established:

1. *Subcommittee on Sheep Breeding*
   General chairman, Mr. A. A. MacMillan, Department of Agriculture, Ottawa.
   (a) Western Section
   Chairman, Dean A. M. Shaw, Department of Agriculture, Ottawa.
   (b) Eastern Section
   Chairman, Mr. G. W. Muir, Department of Agriculture, Ottawa.
2. *Subcommittee on Wool*
   Chairman, Mr. F. E. Lathe, National Research Council, Ottawa.
3. *Subcommittee on Nutrition*
   Chairman, Dr. R. D. Sinclair, University of Alberta, Edmonton.
4. *Subcommittee on Diseases and Parasites*
   Chairman, Dr. A. E. Cameron, Department of Agriculture, Ottawa.
5. *Subcommittee on Publicity*
   Chairman, Mr. W. H. J. Tisdale, Canadian Co-operative Wool Growers, Ltd., Toronto.

During the year under review no meeting of the National Sheep Committee has been called, but the following meetings of subcommittees took place in 1937:—Nutrition, 28 June, in Saskatoon; Wool, 29 June, in Saskatoon, and 17 August, in Toronto; Sheep Breeding, Western Section, 29 June, in Saskatoon, and 16 October, in Swift Current, and Eastern Section, 16 November, in Toronto.

Two projects financed in part by the Wool Growing Section of the Associate Committee on Wool have been carried on during the year: Prof. J. P. Sackville has continued his nutritional studies at Edmonton and the Subcommittee on Wool has carried out special grading of experimental fleeces in the warehouse of the Canadian Co-operative Wool Growers, Limited, at Weston, Ontario.

Of particular interest is the discovery made by Prof. Sackville that the deficiency disease of sheep noted in previous annual reports, which was prevented by the liberal use of alfalfa hay, could also be prevented by feeding minute amounts of salts of the metal cobalt. Careful analysis of the alfalfa used indicated the presence of cobalt in amounts substantially greater than in the grass fed, thus accounting for the favourable results obtained by the use of either alfalfa or alfalfa ash.

The special grading at Weston was again very informative, proving a valuable guide in the elimination of undesirable individuals from pure-bred and experimental flocks, and also affording an interesting comparison between the crosses being made of Rambouillet rams with ewes of the Ryeland, Romney Marsh and Corriedale breeds.

OTHER ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

Co-operating organizations:

Armstrong Siddeley Motors Ltd.
Canadian Airways Ltd.
Canadian Pratt & Whitney Aircraft Co. Ltd.
Canadian Vickers Ltd.
Commercial Air Transport and Manufacturers' Association of Canada
Department of National Defence
Department of Transport
Imperial Oil Limited
National Steel Car Corporation Ltd.
University of Toronto

During the year one meeting of the Associate Committee on Aeronautical Research and three meetings of a special panel composed of Ottawa members of the committee were held.

The committee considered that the importance of the work of the gasoline and oil laboratory necessitated the appointment of a trained chemist or chemical engineer with experience in petroleum technology to take charge of the laboratory. On the recommendation of the committee, Dr. J. W. Broughton was appointed to this post.

The committee has pressed the need for apparatus to study vibrations in aircraft structures, a problem which is rapidly becoming serious. A special subcommittee was formed to advise on this work. Failing to secure apparatus already developed elsewhere because of its export being prohibited, the Division of Physics and Electrical Engineering undertook to design and construct apparatus for indicating and recording vibrations. The design and construction of the instrument is now in progress under the direction of Dr. D. C. Rose. An assistant was provided by the committee.

The investigation of stressed skin construction as applied to seaplane floats, which was commenced last year (see Annual Report, 1936-37) was concluded during the present year and a report on the work was issued.

Last year, the committee reviewed the requirements for X-ray inspection of all metal castings carrying loads in aircraft structures and recommended that the required apparatus should be provided in the Division of Physics and Electrical Engineering. Provision has accordingly been made and large numbers of castings are being examined. It has been found that about 20% of all castings examined are defective. So valuable has the apparatus proved to be in this connection that efforts are being made to induce those companies that are interested to install their own equipment for this work.

The inherent disadvantages of existing apparatus for direction finding of aircraft prompted the committee last year to recommend the development of the cathode ray direction finder for aircraft work. The necessary funds for this work were generously provided by the Departments of National Defence and Transport and the provision of this apparatus is nearing completion. An account of this work is included elsewhere in this report.

The problem of developing an instrument which will indicate at all times the condition of the lubricating process in an aero engine (the oil viscosity and the rate of flow) was considered last year and a staff appointment was made to enable this question to be investigated. The work has been continued under the committee during the present year. A brief report of this work is appended.

On the recommendation of the committee, facilities have been provided in the Fire Hazard Testing Laboratory, Division of Mechanical Engineering, for the testing of various types of aircraft fire walls to British and United States specifications. It is expected that tests will be commenced shortly.

The Department of National Defence and Canadian Airways Ltd., acting on a recommendation of the committee, are carrying out winter flight trials, using low viscosity oil in the engine. The thinner oil allows easy starting in cold weather and the tests are to determine the effect of the thin oil on internal wear. So far, results are promising and the work will be continued.

The committee is planning to assist Professor Loudon, of Toronto University, in a research on the effect of cut-outs for doors and windows in monocoque (stressed-skin) fuselages. Since the calculation of the stresses is not possible, the work is to be done by photo-elastic methods.

The rapid increase in aircraft instrument repair work and the introduction of new gyro types of instrument, necessitating the use of specialized test and repair equipment, has prompted the committee to recommend a staff increase in the instrument laboratory and the provision of the new test equipment. The necessary equipment has been made available by the Department of National Defence.

The United States Army Air Corps has been using successfully an oil dilution method for rapid starting of aero engines in cold weather, gasoline being the diluent. At its last meeting, the committee recommended making tests in Canada on a similar installation as an alternative to the use of low viscosity oils. These tests are under arrangement by the Departments of National Defence and Transport.

The committee reviewed the requirements for an engine-testing dynamometer for small power engines and came to the conclusion that this equipment was desirable. On the recommendation of the committee, an order for this equipment has been placed.

Other problems investigated or under investigation at the suggestion of the committee, include the development of a method for swinging compasses in the air to eliminate the errors which remain when compasses are swung on the ground; the failure of metal propellers due to vibration; and the tail vibration experienced on a certain low-wing monoplane during hot "bumpy" weather.

Aircraft Engine Lubrication Indicator

The purpose of this investigation, conducted at the request of the Department of National Defence, is the development of an instrument capable of indicating continuously the rate of flow and viscosity of the lubricating oil in an aircraft engine.

A series of tests conducted on various types of head flowmeter indicated the orifice to be the most satisfactory for measuring flow.

An instrument capable of giving a continuous indication of lubricating oil viscosity has been devised and bench-tested with promising results. The instrument is undergoing further development and tests.

Stressed-Skin Construction (Aircraft Floats)

This investigation, commenced last year, using discarded floats supplied by the Department of National Defence, was continued and completed.

In the previous year, the floats were tested to failure, under the "two-wave" condition, and this year, under the "bow landing" condition. Interesting information was obtained on which certain general conclusions were based. A report on the investigation was issued in two parts. In addition, a report describing the design and construction of the ring balances, used successfully in the tests, was prepared.

Report No. PAS-4, Parts I and II—Strength of Stressed-Skin Structures (Aircraft Floats).

Report No. PEM-25—Design of Ring Balances.

Associate Committee on Asbestos

Co-operating organizations:

Dominion Department of Mines and Resources
Quebec Asbestos Producers' Association
Quebec Bureau of Mines

The tenth meeting of the Associate Committee on Asbestos was held in Quebec City, 2 November, 1937, under the chairmanship of Dr. G. S. Whitby, with 18 persons in attendance.

Dr. Whitby reported that the steering committee, composed of two representatives of the Quebec Asbestos Producers' Association and two representatives of the National Research Council, had held meetings during the year and had thus maintained closer contact than previously between the producers and the research staff. Nineteen technical reports from the National Research Laboratories had been distributed to members of the committee since the last general meeting. The Quebec Asbestos Producers' Association was giving very substantial financial assistance to the laboratory researches and field surveys.

Messrs. Wolochow and van Winsen described researches which they were carrying out in the National Research Laboratories. These are outlined under the report of the Division of Chemistry, Page 33.

Considerable interest was shown in a list of analyses of Russian asbestos, obtained by exchange. The question of the significance of iron in asbestos was discussed at some length. It was recognized that this depended to some extent upon the condition in which the iron occurred in the fibre.

Members of the committee and of the technical staffs of the companies belonging to the Quebec Asbestos Producers' Association were invited to come to Ottawa at any time to inspect the asbestos research laboratories of the Division of Chemistry.

Associate Committee on Chemical Standards

As in previous years co-operation with the British Standards Institution in the preparation of draft specifications on chemical products has been continued. Draft specifications received have been circulated among the members of the committee and also the other individuals or organizations having a special interest in the subjects submitted for comment. During the year the following specifications were distributed:

Chemical Apparatus, Glassware, etc.

Burettes and bulb burettes; silica basins, crucibles and capsules.

Methods of Testing

Vermilion and red pigments for paints;
Carbon black, bone black, vegetable black and lamp black;
Japanese and/or Korean sardine oil (pale);
Chick-Martin test for disinfectants;
Methods for sampling of dairy products.

Standards of Quality

Australian Technical Standard of aluminium stearate for paints and varnishes;
Technical cod liver oil for sulphonation purposes;
Veterinary cod liver oil;
Aluminium pigments;
Technical cod liver oil;
Oil pastes;
Classification of pure mineral lubricating oils;
Sizes of metal containers for food products;
Dairying standards for butter and cheese;
Disinfectant powder;
Toluoles, xyloles, coal tar naphthas, benzoles, turpentine (Australian specifications).

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

American Society for Testing Materials, Sectional Committee on the Classification of Coal
Dominion Department of Mines and Resources
Research Council of Alberta

Organized in 1928, the Associate Committee has worked closely with the corresponding United States committee, on which it has had representation. The work and suggestions of the Canadian committee have at all times received the fullest consideration in the preparation of U.S. standards, and have, in fact, played a substantial part in shaping those standards.

About two years ago standards by rank and grades were issued by the U.S. committee, and in the summer of 1937 these were approved as American standards by both the American Society for Testing Materials and the American Standards Association. That being the case, and in fulfilment of a promise previously made to the coal operators of Alberta, it was decided to circularize all the larger producers of coal in Canada, advise them of the action taken in the U.S.A. and enquire as to the acceptability of these standards for Canadian coals.

In this connection a report was prepared for the committee by Prof. Edgar Stansfield of the Research Council of Alberta, and this was distributed to the managers of all Canadian collieries having a yearly production of 5,000 tons or more, and to various other interested parties. No criticism of the American standards was received and the Associate Committee therefore decided formally to accept these standards for Canada. Steps to that end are now under way.

The proposed classification by rank is outlined in the accompanying table:

A.S.T.M. Classification by Rank—as per Designation D388-36T

Classes and Groups	Limits of Fixed Carbon (f.c.) and B.t.u. (mineral-matter-free basis) and Requisite Physical Properties
I. Anthracitic class—	
1. Meta-anthracite group	Dry f.c. 98 per cent or more
2. Anthracite group	Dry f.c. 98 to 92 per cent
3. Semianthracite group	Dry f.c. 92 to 86 per cent, non agglomerating
II. Bituminous class—	
1. Low volatile group	Dry f.c. 86 to 78 per cent
2. Medium volatile group	Dry f.c. 78 to 69 per cent
3. High volatile A group	Dry f.c. less than 69 per cent and moist B.t.u. 14,000 or more
4. High volatile B group	Moist B.t.u. 14,000 to 13,000
5. High volatile C group	Moist B.t.u. 13,000 to 11,000, either agglomerating or non-weathering
III. Subbituminous class—	
1. Subbituminous A group	Moist B.t.u. 13,000 to 11,000, both weathering and non-agglomerating
2. Subbituminous B group	Moist B.t.u. 11,000 to 9,500
3. Subbituminous C group	Moist B.t.u. 9,500 to 8,300
IV. Lignitic class—	
1. Lignite group	Moist B.t.u. less than 8,300 (consolidated)
2. Brown coal group	Moist B.t.u. less than 8,300 (unconsolidated)

The principal effect of this classification applied to Canadian coals is to promote some of the lignite and "domestic" coals of Alberta to the subbituminous class and the non-coking and non-weathering Alberta coals from subbituminous to bituminous.

The A.S.T.M. specification by grade is, to a large extent, a system of designation of analysis and properties of the coal. Thus a coal designated as (62-146) 2-4in.-132-A8-F24-S1·6 would have a fixed carbon content of 62% on the dry mineral-matter-free basis, a calorific value of 14,600 B.t.u., on the moist mineral-matter-free basis, a range of size from two to four inches and on the as-received basis (including both moisture and mineral matter) a calorific value of 13,200 B.t.u., an ash content between 6·1 and 8·0%, a fusion point of ash between 2400 and 2500° Fahrenheit and a sulphur content between 1·4 and 1·6%. This analysis would also indicate that the coal was bituminous and that it fell in the high volatile A group. This method of designating coals is coming into wide use in the United States and gives the purchaser much-needed information.

The National Research Council proposes to issue in the near future, on behalf of the committee, a bulletin explaining the systems of coal classification in some detail, in order that the Canadian producers, dealers and consumers may be familiar with their requirements and be in a position to use them. It should be borne in mind, however, that these standards have no mandatory status and their use depends upon their general acceptance by the Canadian public.

It is gratifying that it has been found possible to evolve systems of classification by rank and grade applicable to the coals of both Canada and the United States, and it is hoped that these will be generally adopted. Standards for type and use are now in preparation.

Associate Electrical Committee

The Associate Electrical Committee, which is also the Canadian National Committee of the International Electrotechnical Commission, was organized in 1937 to consider problems of an electrical nature and to advise the Council thereon.

The committee held an organizing meeting in June, 1937. It authorized the naming of an executive of eight members and also the formation of two panels: *(a)* Panel on Aluminium; *(b)* Panel on Units, Symbols, Nomenclature and Electric Measurements (this panel supersedes the Associate Committee on Electric Measuring Instruments).

Advisory Committee No. 7 of the International Electrotechnical Commission has been trying for about twenty years to obtain an International Specification of Resistivity of Aluminium. The Advisory Committee had started to determine a scientific standard but soon found itself in difficulties owing to the widely varying practices of different countries. The aluminium industry in Canada requested the National Research Council to do what was possible to clarify the situation.

The Panel on Aluminium held six meetings; it was represented at an International Conference in Ste. Margharita, Italy, in November, 1937, and expects to be represented at the plenary meeting of the I.E.C. in England, June, 1938, at which it is hoped agreement on a standard will be reached.

The Panel on Units, Symbols, Nomenclature and Electric Measurements held one meeting in February, 1938. Technical questions on the "Approval of Meters used to Determine an Electrical Bill" by the Council, are usually referred to this Committee. The Electricity Inspection Act confines itself to measurements and defines a "meter" so as to exclude attachments not involved

in the measurement—a debt collecting device is a common attachment on European meters. Such a meter had been submitted to the Council for Approval of Type. The Council did not have authority to approve such a combination and finally referred this subject to this Panel for study and recommendation.

A questionnaire was sent to the owners of more than seventy per cent of the meters in Canada. The Panel met in February to consider the replies. The replies did not show any evidence of an immediate need for such a combination. The Panel reported to that effect but recommended that the subject be left on its agenda for further study.

Associate Committee on Engineering Standards

(Main Committee of the Canadian Engineering Standards Association)

Membership

At the close of the fiscal year, 31 March, 1938, the various committees of the C.E.S.A. had a total membership of 707. The membership of the Associate Committee totalled 79.

During the year the total C.E.S.A. sustaining member organizations increased in numbers from 62 to 86, and the total of subscriber organizations dropped from 3 to 2, one subscriber of the previous year having become a sustaining member.

Change in Office Staff

It was unfortunate that during the early part of the year, the Secretary, Mr. B. Stuart McKenzie, due to ill-health, found it necessary to retire from the active secretaryship, and a new secretary was appointed. It was fortunate, however, that Mr. McKenzie agreed to remain actively associated with the work in the capacity of consultant.

Finances

Owing largely to the change in staff, the additional expense, of course, being unprovided for in the budget for the year, the financial statement showed a deficit of $1,135.88 for the year's operations. The total receipts were $15,046.08 and the total expenditures $16,181.96.

At the close of the year the Executive Committee had under consideration a plan for increasing the annual income by means of increased sustaining membership, in order that the deficit might be overcome, and also to provide for increased activity in standardization work during the coming year.

Publications

During the year twelve new publications were issued, as follows:

A43—1937—Structural Timber.
G26—1938—Commercial Quality Hot-Rolled Bar Steels. (3rd edition.)
G27—1938—Commercial Quality Cold-Finished Bar Steels and Cold-Finished Shafting. (3rd edition.)
C 3—1937—Zinc-Coated (Galvanized) Telegraph and Telephone Line Wire.
C17—1938—Alternating-Current Electricity Meters.
C22·2 No. 15—1937—Electrically-Heated Warming Pads.
No. 41—1937—Ground Clamps.
No. 42—1937—Receptacles, Plugs and Similar Wiring Devices.
No. 43—1937—Lamp-Holders having Socket Screw Shells.
No. 44—1937—Flexible Tubing (Non-metallic).
No. 49—1937—Flexible Cord and Fixture Wire.

These publications have been issued with the co-operation and approval of both manufacturing and purchasing interests, and of trade associations, educational institutions, the railways, insurance interests, and interested departments of Dominion and Provincial Governments.

Reference has been made, during the work of the various committees, to analogous publications of the British Standards Institution, Associations in other Empire countries, American Society for Testing Materials, American Standards Association, National Electrical Manufacturers' Association, the Underwriters' Laboratories, and other standardizing bodies.

The total sale of publications for the year was $1,083.27.

The Executive Committee decided that the minimum price of C.E.S.A. published standards would in future be 50 cents instead of 25 cents per copy.

Progress Report

A. Civil Engineering

Revision of Specification *A5-1927, Portland Cement*, is in progress, the committee having been reorganized for the purpose and two meetings held.

Preliminary arrangements have been made for the revision of *A23-1929, Concrete and Reinforced Concrete*, the committee chairman recommending that work should be undertaken during the coming year.

The work of the committee on National Building Code, under the National Research Council, has resulted in requests for the following standardization by the C.E.S.A.:

Standard fire tests on building construction and materials;

Specifications for several types of water and sanitary pipe;

Specifications for brick, building blocks, and mortar materials.

Reorganization of the C.E.S.A. Committee on Building Materials is underway as a result of these requests, and organization of special committees and panels for the work on the required specifications is proceeding.

B. Mechanical Engineering

Safety Code for Passenger and Freight Elevators. This important publication is in page-proof form and will be published shortly.

Screw Products—Binder Head Screws. Agreement has been reached amongst the interests concerned with No. 10 Binder Head Screws. A revision slip is being prepared for insertion in Specification B35 dealing with this subject.

Logging Chains. Three meetings of the committee have been held during the year and satisfactory progress is being made.

Axes for Forestry Purposes. Recommendations have been received to establish a standard on this commodity, and progress is anticipated during the coming year.

Safety Code for Mechanical Refrigeration. The C.E.S.A. has been requested to review and adopt the tentative Refrigeration Code "JCRQ" prepared by a joint committee in the Province of Quebec. A C.E.S.A. committee is being organized for the purpose.

Boiler Code. The Committee on Steel Plate for Boilers and Pressure Vessels has been renamed Committee on Canadian Boiler Code. Review of the A.S.M.E. Boiler Code is under way by this committee and the second meeting will be held shortly.

B12—Galvanized Steel Wire Strand. Two meetings of the committee working on the revision of this specification have been held, and what is expected to be the final draft is now being prepared for letter ballot approval.

Identification of Piping Systems—Conduits, Ducts and Cables. The committee working on the preparation of this standard have submitted their second draft specification, which has been sent out to interested organizations for comment. The general opinion expressed by such interests is very encouraging and indicates careful study and preparation by the committee.

C. Electrical Section

Canadian Electrical Code, Part I—(Inside Wiring Rules). The work of revision of the 3rd edition is nearing completion and it is anticipated that the 4th edition will be published by the end of the coming year. Meetings of the revision committees have been held at frequent intervals during the year.

Canadian Electrical Code, Part II—(Approvals Specifications for Electrical Appliances and Equipment). Specifications for specific appliances and equipment are issued from time to time as separate publications under Part II. They are prepared by the Panel on Specifications, the membership of which comprises a comprehensive representation of interests. At the present time active work is in progress on ten or twelve specifications and some twenty or more are listed for attention as time and facilities will permit.

Canadian Electrical Code, Part III—(Outside Wiring Rules), Overhead Systems. The special panel working on this specification has now provided a second draft which will be distributed for comment to various interests. This second draft has been broken down into two parts—one applicable to power supply lines and trolley lines crossing railways, the other especially prepared for communication lines crossing railways.

Bulletins to Electrical Manufacturers

The following bulletins were issued during the year:

No. 22—June 26, 1937—"Fibrous Covering for Rubber-covered Wire", describing tests on a knit type of covering as an alternative to the usual braided covering.

No. 23—June 26, 1937—"Adhesion Test for Rubber-covered Wire", introducing a new method of testing the adherence of rubber compound without removing the braided covering.

No. 24—Mar. 24, 1938—"Fibrous Coverings for Rubber-covered Wire for Use in Armoured Cable", introducing a new type of cotton wrapping, helically applied.

General Standards in Section C

C52—Paper Insulated Lead Covered Cable. This specification passed through several drafts and was advanced for final approval prior to publication. Objections to certain clauses raised by some of the power companies, however, have caused delay in publication. It is hoped to clear up these points without serious delay.

C10-1938—Tungsten Incandescent Lamps (2nd edition). The second draft of this specification is in preparation and it is expected that it will be sent out for letter ballot approval of the committee at an early date.

C49-1938—Aluminium Cable and Aluminium Cable (Steel Reinforced). A committee has been organized to prepare a standard specification under this heading. The first meeting is scheduled for April.

Control of Radio Interference. A special subcommittee has been appointed from the committee on C.E. Code to determine the part that the C.E.S.A. should take in regard to establishment of standards for measuring the degree of interference and for equipment that may be used in its control.

Revision of Procedure, Canadian Electrical Code. In order to eliminate the possibility of confusion or complication in matters of procedure relative to establishment of specifications or regulations, or in the matter of revision, a special subcommittee has been appointed to review the present procedure and recommend revisions. Several meetings have been held and a report is expected at an early date.

Arrangements are being made to call a general conference of representatives of provincial and municipal inspection bodies early this year for the purpose of co-ordinating eastern and western viewpoints on matters pertaining to the C.E. Code.

Section G—Ferrous Metallurgy

Reinforcing Materials for Concrete. The committee working on specifications under this subject held their third meeting on 13 October when they completed the revision of:

G30-1930—Billet-Steel Reinforcing Bars (2nd edition).

G31-1930—Rail-Steel Reinforcing Bars (2nd edition), and

G32-1930—Cold-drawn Steel Wire for Concrete Reinforcement (2nd edition).

The third editions of the above will be issued shortly, together with two new specifications, prepared by this committee:

G45-1938—Fabricated Steel Bar or Rod Mats for Concrete Reinforcement, and

G46-1938—Welded Steel Wire Fabric for Concrete Reinforcement.

It is the intention to publish these five specifications under one cover.

Section S—Steel Construction

S6-1938—Steel Highway Bridges. On 31 March, 1938, this revised specification has reached page-proof form and will be ready for publication shortly. This third edition has been transferred from the Civil Engineering Section (A) to Section S. Likewise, A1-1928, "Steel Railway Bridges", and A16-1930, "Steel Structures for Buildings", which are under revision, will be published under Section S in their next editions.

Structural Welding. The following standards are in page-proof form and have been submitted to the Main Committee for approval to publish:

S47-1938 T—Welding Qualification Code for Fabricators, Contractors, Supervisors and Welders for Welded Steel Buildings;

S48-1938 T—Metallic Arc (Iron and Steel) Electrodes for Welded Steel Buildings.

Since these standards are in a field where knowledge is limited, it has been decided to issue them as "Tentative" until their value has been tested over a period of a year or so, when revision can be made if advisable, to bring them into line with practical experience.

Suggestions had been received to broaden the scope of these standards to include all types of steel structures, but it was finally decided to confine the scope to steel buildings during the time that the standards are in tentative form.

Industrial Contacts

The secretary attended the winter meeting of the Canadian Electrical Association and the annual convention of the Canadian Lumbermen's Association. At these conferences a number of members of various C.E.S.A. committees were in attendance, and advantage was taken of the opportunity to hold meetings of C.E.S.A. committees, contemporarily.

Accompanied by the Chairman, Mr. J. G. Morrow, and Vice-chairman, Mr. J. M. R. Fairbairn, the secretary visited the A.S.T.M. headquarters in Philadelphia, followed by a visit to the A.S.A. offices in New York. Valuable information was obtained as to the administrative details of these two organizations.

A special subcommittee of the C.E.S.A. Executive Committee conferred with representatives of the National Construction Council relative to close liaison between the two organizations, particularly in the building construction and material field. No satisfactory agreement was reached, however, and the idea was abandoned for the time being, at least.

Financial Support

The C.E.S.A. is grateful for the fact that the National Research Council has continued to underwrite the operating expenses of the C.E.S.A. to the extent of $5,000.00 annually. Thankful acknowledgment is made for the contribution of $5,000.00 during this year. It is also fortunate that office space, mimeographing and other services have been available to the staff of the C.E.S.A. In this regard a motion was carried, at a meeting of the C.E.S.A. Executive, as follows:

"It was moved by Mr. Fairbairn and seconded by Mr. Dobson, that a vote of appreciation be submitted to the National Research Council for its constant close co-operation, goodwill and support, with especial reference to financial support, supplying of quarters for C.E.S.A. staff, mimeographing services, and numerous items such as the binding of the C.E.S.A. brief in suitable covers for presentation to the Rowell Commission."

The sustaining membership of the C.E.S.A. has increased to a total of 86 member organizations and 2 subscribers, at the end of the fiscal year. The total membership fees paid, including the subscribers' contributions, was $8,900, some of the member organizations having multiple memberships, in some cases as many as ten.

Preparations are under way at the present time to further augment this membership during the coming year to provide for additional office staff and increased activity.

The following is a list of sustaining members for 1937.

Algoma Steel Corporation Ltd.
Alberta Government Telephones
Aluminum Company of Canada Ltd.
Amalgamated Electric Corporation Ltd.
Bell Telephone Company of Canada
John Bertram & Sons Co. Ltd.
Boston Insulated Wire & Cable Co. Ltd.
British Columbia Electric Railway Co.
British Columbia Telephone Co.
B.C. Lumber & Shingle Manufacturers Association
Burlington Steel Co. Ltd.
Cables Conduits and Fittings Ltd.
Canada Cement Company Ltd.
Canada Creosoting Company Ltd.
Canada Foundries & Forgings Ltd.
Canada Iron Foundries Ltd.
Canada Wire & Cable Co. Ltd.
Canadian Acme Screw & Gear Ltd.
Canadian Bridge Company Ltd.
Canadian General Electric Co. Ltd.
Canadian Industries Ltd.
Canadian Ingersoll-Rand Co. Ltd.
Canadian Jefferson Electric Co. Ltd.
Canadian Laco Lamps
Canadian Liquid Air Co.
Canadian Lumbermen's Association
Canadian National Railways

List of sustaining members for 1937—*Concluded*

Canadian Pacific Railway Co.
Canadian Triangle Conduit Co. Ltd.
Canadian Tube & Steel Products Ltd.
Canadian Westinghouse Co. Ltd.
Coghlin Co. Ltd., B. J.
Consolidated Mining & Smelting Co. of Canada
Council of Canadian Purchasing Agents Associations
Crane Limited
Dome Mines Ltd.
Dominion Bridge Co. Ltd.
Dominion Chain Co. Ltd.
Dominion Engineering Works Ltd.
Dominion Foundries & Steel Ltd.
Dominion Oxygen Co. Ltd.
Dominion Steel & Coal Corporation Ltd.
T. Eaton Co. Ltd.
English Electric Co. of Canada Ltd.
Federal Wire & Cable Co. Ltd.
Ferranti Electric Ltd.
Foundation Co. of Canada, Ltd.
Frost Steel & Wire Co. Ltd.
Gatineau Power Company
Hamilton Bridge Co. Ltd.
Hoover Company Ltd.
Imperial Oil Ltd.
International Nickel Co. of Canada, Ltd.
McKinnon Columbus Chain Ltd.
Maritime Telegraph & Telephone Co. Ltd.
Massey-Harris Co. Ltd.
Moloney Electric Co. of Canada, Ltd.
Montreal Light, Heat & Power Consolidated
Montreal Locomotive Works Ltd.
Montreal Tramways Co.
Morrow Screw & Nut Co. Ltd.
National Steel Car Corporation Ltd.
New Brunswick Telephone Co. Ltd.
Northern Electric Co. Ltd.
Otis-Fensom Elevator Co. Ltd.
Packard Electric Co. Ltd.
Page Hersey Tubes Ltd.
Phillips Electrical Works Ltd.
Radio Manufacturers Association of Canada
Renfrew Electric & Refrigerator Co. Ltd.
St. Mary's Cement Co. Ltd.
Sangamo Company Limited
Saskatchewan Government Telephone System
Shawinigan Water & Power Co.
Shell Oil Co. of Canada Ltd.
Slater Company Limited, N.
Smith and Stone Ltd.
Solex Co. Ltd.
Square D Co., Canada, Ltd.
Steel Co. of Canada, Ltd.
Stowell Screw Co. Ltd.
Swiss Electric Co. of Canada, Ltd.
Toronto Hydro-Electric System.
Toronto Transportation Commission
Wagner Electric Manufacturing Co.
Winnipeg Electric Co.

SUBSCRIBERS, 1937—
Canadian Car & Foundry Co. Ltd.
Gilbert & Barker Manufacturing Co. Ltd.

Associate Committee on Fire Hazard Testing

There were no meetings of the committee or of the Executive of the Committee during the year. Committee work was carried on wholly by correspondence. Questions concerning the operation of the Fire Hazard Testing Laboratory were referred to the Executive of the Committee. The views of the members were sought on certain matters of policy in connection with the fire hazard testing work.

Some twenty test reports were submitted to the members for comment and expression of opinion concerning the recommendations made. The comments received have been of material assistance to the staff of the laboratory.

In April, 1937, through the resignation of Mr. T. H. Doherty, the committee lost the services of its secretary. Mr. Doherty had performed the duties of secretary in a most able and satisfactory manner and his resignation is a real loss to the committee.

National Committee on Fish Culture

At the first meeting of the executive held on 6 January, 1938, a Planning Committee under the convenorship of Dr. A. G. Huntsman was set up to draft a national programme of fish cultural research. Arrangements were made for the interchange of reports on research among all the organizations represented on the committee.

In considering grants in aid of research the executive decided, in order to make the most efficient use of funds, not to support any work that was not related to a definite programme of fish cultural investigations.

With this principle in mind a large number of applications were considered, eight of which met with approval. A number of other projects suggested by members of the executive were held in abeyance pending the acquisition of suitable personnel and sufficient financial means.

Associate Committee on Forestry

While no meeting of the committee was held during the year, work proceeded steadily and arrangements were made to hold the next meeting of the committee in June, 1938, in conjunction with the meeting in Canada of the American Association for the Advancement of Science.

The committee continued to receive full support from the industry and from the provincial departments of forestry as well as from the Dominion Forest Service.

Material for the manual on Farm Woodlots in Eastern Canada which had been in course of preparation during the year was completed and copies of the manuscript were prepared for distribution to members of the committee prior to publication.

At the suggestion of the Subcommittee on Forest Economics a bulletin was prepared by Mr. J. D. B. Harrison and published by the Dominion Forest Service as Bulletin 92 "Economic Aspects of the Forests and Forest Industries of Canada". This bulletin deals with forest resources, depletion and growth, gives a survey of Canada's forest industries, and reviews external trade and home consumption.

Co-operation was continued between the National Research Laboratories and the Dominion Forest Service in fire hazard research.

Word was received that it had been decided to establish the Imperial Forestry Bureau at Oxford where the Imperial Forestry Institute has excellent facilities for dealing with forest literature.

Financial provision for the Bureau, as arranged at the British Commonwealth Scientific Conference, London, 1936, was set at £3,000 per annum during each of the next five years, made up by contributions from governments. Distribution of this sum was made on the basis of the contributions to the other Bureaux as agreed upon by the Imperial Committee on Economic Consultation and Co-operation, 1933 (the Skelton Report) and accepted by governments. Canada's contribution, as agreed, was paid for the first year by the National Research Council.

Reference to the Imperial Bureau of Forestry has been made in this report because the preliminary steps towards co-operation in forestry matters between Canada and other countries of the British Commonwealth were taken by the Associate Committee on Forestry.

Associate Committee on Gas Research

Co-operating organizations:

Dominion Department of Mines and Resources
Research Council of Alberta
University of Alberta

Another year has passed without any meeting of the committee but it has been possible to continue the support previously extended to the work of Dr. E. H. Boomer at the University of Alberta, and an extension of the scope of the committee's activities is under consideration.

The following is a brief account of the work to which the committee has given financial assistance.

Solubilities in Hydrocarbon Systems at High Pressures

The object of this investigation has been to throw light on the present association of hydrocarbons underground in the Turner Valley. This has a bearing on the relation between the various types of oil in the valley, and its probable productive life.

In the work previously reported the gas used was methane containing about 5% nitrogen, but in the past year there has been prepared for use in the experiments, a natural gas fraction containing only 1% nitrogen. This gas, as anticipated, was found to have a slightly higher solubility and lower critical pressure than that previously used.

The Oxidation of Natural Gas at High Pressure

Some preliminary experiments on the production of oils during the process of oxidation of natural gas under pressure were carried out. The possibility of oil formation was suggested by early results and has been discussed in previous reports. Two catalysts were examined, cadmium metaphosphate and mixed copper and cadmium metaphosphates. The gas used was Viking natural gas as received; it contained sulphur. The catalysts were active in promoting oxidation with the production of methyl alcohol, a surprising result in view of the effective poisoning action of sulphur on metallic catalysts used previously. The catalysts did not, however, promote oil formation. Currently, work is in progress on six different metallic catalysts.

(Investigations under the direction of Dr. E. H. Boomer)

Associate Committee on Laundry Research

The Canadian Research Institute of Launderers and Cleaners was established in January, 1935, under the direction of the National Research Council, with the object of promoting scientific research and technical work in connection with the laundry and dry cleaning industries in Canada.

Membership in the Institute is open to all laundries and cleaners, including institutional laundry plants, in the Dominion of Canada that are accepted by the membership committee, pay the required fees and conform to the by-laws and regulations of the organization.

The Laundry and Cleaning Laboratory of the National Research Council serves in a technical, advisory and investigational capacity to the Institute. The work of this laboratory includes such research projects as studies in bleaching, detergency, launderability and cleanability of various types of cotton fabrics, corrosive problems in dry cleaning plants, the setting up of textile specifications, analysis of all types of supplies used by the industries, and the refereeing of damage reports covering the examination of fabrics alleged to have been damaged during the laundering or cleaning process.

During the year under review, the Institute has made definite progress in consolidating its position. This is clearly shown by the increasing interest in the Institute by firms engaged in these industries and by a 12% increase in membership.

Although at present the greater proportion of members are commercial laundries, attention is being directed towards extending the membership in both the dry cleaning and institutional fields.

During the present year the Institute has had under consideration a plan by which certain textile commodities may be certified with respect to their general serviceability, launderability and cleanability. It is intended to hold a conference with Canadian textile manufacturers in order to ascertain whether they desire such approval for their products and if so to enlist their

co-operation in working out details, satisfactory to them and serviceable to the public. This would enable the consuming public to distinguish between textiles of high quality and those of an inferior grade, as well as to protect the manufacturer of quality textiles against unfair competition from manufacturers of inferior fabrics and garments.

The Institute has under consideration a proposed affiliation agreement with the Institute for Maintaining Drycleaning Standards, whereby the Canadian Research Institute of Launderers and Cleaners will co-operate in servicing Canadian cleaning plants that become certified members of the Institute for Maintaining Drycleaning Standards.

A report of the activities of the Laundry and Cleaning Laboratory of the National Research Council is included in the report of the Division of Chemistry (see Page 36).

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories, Limited
Dominion Department of Mines and Resources

The laboratory work under the committee has been carried out mainly in the Division of Chemistry and an account of the investigations of the year under review will be found in the report of that division (Page 39). Arrangements are now being put into effect for the commercial manufacture in the United States of numerous products developed in these investigations. Through its agreement with Canadian Refractories Limited, the National Research Council will share in royalties received from these and other sources. It is gratifying to be able to report that the export of products developed under the committee, to various parts of the world, is continuing on an expanding scale.

Associate Committee on Metallic Magnesium

Co-operating organizations:

Dominion Department of Mines and Resources
Dominion Department of National Defence

Two conferences were held to consider whether researches into the production of metallic magnesium from Canadian sources of raw materials should be undertaken. The conferences brought out the facts that metallic magnesium is of large importance industrially and is an indispensable war material. There is no production of the metal in Canada but there are large deposits of minerals containing magnesium in Canada, and it was the opinion of the conference that work on the utilization of these sources of metallic magnesium would be desirable. An associate committee on metallic magnesium has been formed and experimental work on utilization is now under way.

Associate Committee on Oceanography

Most of the work carried on under the auspices of the Associate Committee on Oceanography has been concerned with investigations relating to problems arising from a study of Pacific coast waters. During the year consideration was given to the desirability of enlarging the scope of the committee's activities to provide for similar investigations on the Atlantic coast or alternatively of establishing a new committee to undertake this task.

Oceanography is a very broad subject and while most of the work done under the auspices of the committee has been in connection with fisheries and

biology there are problems in meteorology, physics, geology and related sciences that are of considerable importance in this connection. At the end of the year the re-organization of the committee was still under review.

Associate Committee on Parasitology

Co-operating organizations:

Dominion Department of Agriculture
Imperial Bureau of Agricultural Parasitology
McGill University
Ontario Department of Agriculture
Quebec Department of Agriculture

Horse Strongylid Control

A further increase in the amount of equipment available has enabled Dr. Parnell to make nearly 5,000 cultures during the year to determine the proportions of various substances necessary to kill the free-living stages of sclerostomes of horses in *fresh* faeces. Further cultures were made with many of the chemicals previously reported upon, and in addition, nearly 30 other chemicals have been tested. Tests with these chemicals suggest that they would be given the following comparative values, on the basis of a value of 100 for common salt.

3 Aniline
6 Pyridine
Sodium iodide
8 Zinc iodide
Naphthalene
10 Potassium iodate
12 Oxyquinoline sulphate
Carbolic acid
15 Ferrous iodide
Magnesium borate
22 Sodium fluoride
30 Formalin
40 Boric acid
Comp. sol. cresol
66 Sodium fluosilicate
80 Sodium hydroxide
100 Potassium hydroxide
Cobaltous chloride
133 Chloroform
166 Carbon tetrachloride
300 Trisodium phosphate
400 Potassium permanganate
500 1% Trichlorophenylmethyl-iodosalicyl
600 1% Sodium hypochlorite

Sheep Parasites

Mr. Griffiths continued his investigations on the overwintering of certain helminths of sheep. Although plots and stock available were limited, results were of considerable interest. The following common helminths of sheep demonstrated their ability to survive a normal winter and to cause an infection in sheep when ingested at pasture during the following spring: *Moniezia expansa*, *Ostertagia circumcincta*, *Nematodirus filicollis*, and *Trichostrongylus colubriformis*.

During the year Dr. Swales made a detailed study of the parasites of sheep in Quebec and eastern Ontario. This work was conducted under the following divisions:

(a) A survey of the parasitic diseases of lambs and adult breeding stock.

(b) A survey of the parasites present in sheep from various parts of the Dominion.

(c) Tests of anthelmintic drugs and modified methods of administration on a large scale.

(d) Tests of pasturing practices to determine their effects on the parasite burden of lambs.

(e) A determination of the effect of various parasites on the development and market value of lambs.

(f) Development and tests of new methods of eliminating adult worms (particularly nodular worms) from the large intestine.

(g) Histopathological studies of the lesions produced by single and mixed infestations in various organs.

These studies have laid a foundation for future work on sheep parasites in Canada, demonstrating the species commonly present, the species of economic importance, the means of controlling stomach worms *(H. contortus)* and means to prevent heavy infestations of several other species. It is now known when, at least, to treat nodular disease, which should be recognized as the major cause of losses in sheep flocks in eastern Canada.

In future work it is proposed that greater efforts be made to bring the treatment of nodular disease to a practical basis. It is proposed that these efforts should be directed on the basis of physiology and chemotherapy, and if possible in co-operation with people who can provide animals for experimentation.

Pathological studies on infestations of other parasites should be continued in order to determine their pathogenic role; this to be followed, if possible, by studies on the effects of nutritional practices on clinical parasitic diseases.

Strongyloides

Mr. Griffith's investigations on the bionomics of the genus *Strongyloides* have been continued, and some interesting results are being obtained. Transfers of the Agouti strain and the sheep strain have been continued in various laboratory animals. Faecal cultures from individuals have been made and examined, and types of development of the free-living generation have been observed. On transfer to the guinea pig, the Agouti strain has shown the production of filariform larvae and free males for some 20 transfers only, free females, males and filariform larvae appearing in subsequent cultures. New series have been commenced to attempt to ascertain the controlling factors responsible for various results obtained in the free-living generation.

The effects of temperature on faecal cultures and the resulting types of development are being studied. During the past year this work has entailed some 300 faecal tests and more than 2,800 observations and recordings of faecal cultures.

Fasciola hepatica

Field experiments to implicate an intermediate host for *F. hepatica* in the Lower St. Lawrence Valley were discontinued. Laboratory-reared snails have been continually exposed to miracidia of *F. hepatica*, no positive results being obtained. A report on distribution, bionomics, etc., of this fluke is in process of preparation by Mr. Griffiths, for publication in the near future.

Ascariasis of Pigs

The experiments, conducted by Dr. Swales, designed to demonstrate the effect of ascariasis on the production of bacon pigs, were not satisfactory. Daily ingestion of infective eggs of *Ascaris lumbricoides* did not produce infestations in healthy pigs, but resulted in fairly heavy infestations in previously unthrifty animals. The results were in direct opposition to those obtained two years previously on a similar number of animals, and thus no significant data could be obtained. It is deemed inadvisable to conduct further experiments of this nature when experimental animals must be in small numbers. The cost of these experiments was offset by the sale of the pigs during the summer of 1937.

Parasites of Carnivores

Apophallus venustus. Work on this parasite was continued by Dr. Cameron and several new fish carriers were implicated. It was still found impossible to infect cats by feeding them on rock bass; all other local fish appear to be carriers. There is no evidence of any type of specificity and it seems probable that rock bass remain free because of their habits.

Parametorchis noveboracensis. It was confirmed that the common white sucker is the main, if not the only, carrier of this liver-fluke. A few eggs, thought to belong to this species, were recovered from a cat to which had been fed a large number of red suckers from La Tuque; however, no worms were found on autopsy. The snail vector has not yet been identified but *Amnicola* sp. is strongly suspected. A faecal survey of sledge dogs was carried out with the assistance of the Royal Canadian Mounted Police and the Hudson's Bay Company, and the distribution has been partially ascertained. It appears to extend from northern Quebec to the height of the land in northern Saskatchewan, but it scarcely enters the North West Territories at that point. A study of its pathology in cats and dogs has been commenced. The eggs of this parasite have been found in a human case in Saskatchewan in material sent to the Institute. Subsequently Miss Ruby Harris of the Prince Albert Sanatorium (Saskatchewan) discovered two other cases in man there.

Diphyllobothrium latum. The survey referred to in the previous paragraph has shown that the "fish tapeworm" of man and carnivores is widespread in Canada, occurring as far east as Moosonee and extending west through Manitoba to Saskatchewan and down the Mackenzie basin to the Arctic. One specimen has also been received from a bear from Vancouver Island.

Skrjabingylus nasicola. A study of the causative agent of skull injury in various Canadian mammals in the weasel family was made by Dr. Swales. The parasite was considered to be *S. nasicola* which had previously been reported as causing skull perforations in weasels, skunks, etc., in various parts of the world.

Miscellaneous Hosts

Mr. Cannon made a study of the endoparasitic fauna of local starlings and found the following helminths: *Hymenolepis fasciminosa*, *Choanotaenia musculosa* and *Capillaria columbae* var. *sturni.* He has also made a study of the trematoda parasitic in ducks and geese in eastern Canada; this work is almost completed.

Thermal Death Point of Various Parasitic Ova

An apparatus has now been devised which will measure the time of exposure to a certain temperature in water very accurately. The temperature itself can be determined to within plus or minus 0·25°C. Although experiments to support recommendations on hygiene were temporarily discontinued in favour of the researches on parasites of sheep, they will be resumed in the near future. This work has been conducted by Dr. Swales in cooperation with Dr. D. K. Froman, Assistant Professor of Physics at Macdonald College.

Schistosome Dermatitis

Mr. Johnson continued his work on the larval schistosomes in local waters and several new centres of infection have been noted. This work will be continued this summer.

Miscellaneous

With the active assistance of the Health of Animals Branch of the Department of Agriculture, 729 samples of fresh pork were received from six packing plants located within 24 hours of the Institute. Each sample came from a

hog, the source of origin of which was known; they were otherwise unselected. They were examined microscopically and in addition 10 grams were digested at first by pepsin, later by papain. The latter enzyme was found superior in practice and much less expensive. Fifteen of these samples contained living trichina larvae (2·06%) and infected samples came from Manitoba, Ontario, Quebec and Prince Edward Island. A few samples—all negative—were received from Saskatchewan, New Brunswick, and Nova Scotia, but too few to assume that the parasite is absent from those provinces. A detailed description of the technique used and a provisional analysis of the results appeared in the April, 1938, issue of the Canadian Journal of Research.

In addition to the examinations recorded above, considerable experience was obtained in the preparation of a test antigen. It was found that this could be done as easily with the papain technique as with pepsin. However, tests in experimentally infected pigs were unsatisfactory, and further experience is necessary before its use can be recommended for these animals. The antigen, however, gave satisfactory results in two human cases (the only ones tested).

During the past year a considerable number of examinations of human faeces were made. Most of these came from mines and were examined (by a concentration technique) for the presence of hookworm. The numbers of composite samples (from different levels) and their sources were as follows:

Lake Shore Mines, Ontario	28
Flin Flon Mine, Manitoba	12
Copper Cliff Mine, Ontario	4
South Porcupine Mine, Ontario	18
Siscoe Mine, Quebec	4

Composite samples were asked for as they would more quickly give an indication as to whether the mine itself was infected. However, all were negative for hookworm, although the mines were selected as being those most likely to be infected. The series is not sufficiently large to draw any definite conclusions, but the results give no support to the belief that this parasite may be present in Canadian mines.

A number of samples were also received from Indian agents, including 12 from Moose Factory and eight from Dr. Lavoie, Ile a la Cross. The former were negative to parasites but the latter gave four positive cases of fish tapeworm *(Diphyllobothrium latum)*. One of these pateints also harboured eggs identical with *Parametorchis noveboracensis*, which is present in dogs in the same area. Dr. Lavoie states in correspondence that tapeworm is common in the Indians under his care and that they commonly eat raw and lightly cooked fish.

Dr. Turple, of Norway House, Manitoba, forwarded 17 samples from Indians under his care; one of these was infected with the fish tapeworm.

As the Indians at Ile a la Cross were heavily infected with fish tapeworm, and as this parasite also infects dogs, and as these animals have more access to uncooked fish than have human beings, it was decided to implement the human stools by dog faeces in order to ascertain the actual distribution of the tapeworm in Canada. In this the Institute had the co-operation of the Royal Canadian Mounted Police and the Hudson's Bay Company. A large number of samples were received from both and were carefully examined for this and other parasites. No dogs have been examined from British Columbia yet, although a number have been examined from all areas surrounding that where the parasite is found.

Other parasites of man found during this survey include a number of protozoa, among them *Entamoeba histolytica*, but owing to the fact that most samples were received by mail and that these cysts do not travel well, special search was not made for them. Several samples showed the presence of pinworms, but as these normally do not pass eggs into the stool, no idea of their frequence can be obtained. There is little doubt, however, that this parasite is an extremely common one in human beings in Canada.

During the year a special committee on veterinary control of parasitic diseases was named by the Central Canada Veterinary Association, with Dr. Swales as Chairman. The Veterinary Associations of Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan and British Columbia have each elected a member to this committee and have pledged co-operation. So far, 33 general practitioners have signified their willingness to practice parasitology under the control of the committee, and it is hoped that during 1938 improved methods of treating strongylidosis of horses will be inaugurated throughout a large part of the Dominion.

An exhibit on the helminth parasites of man was prepared for the Ottawa meeting of the Canadian Medical Association last summer. This exhibit was awarded the silver medal. Somewhat amplified, it was shown at the meeting held by the National Research Council in February on the occasion of the formation of an Associate Committee on Medical Research. A small exhibit on pinworm and trichinosis was also shown at the Annual Meeting of the Public Health Association.

The Director, who was named by the Veterinary Director General as the Canadian representative of the International Veterinary Committee on Parasitology, will attend the first meeting of this Committee, which is to be held in Switzerland in August and at which attempts will be made to collate preventive measures (including quarantines) in the various countries sending representatives. The Director has been invited to attend the British Association for the Advancement of Science Meeting to be held in Cambridge, England, August 17-24, 1938, and to show a ciné film on fish-carried trematodes. He has also been invited to present a paper on "Animal Parasites of Wild Animals" at the International Veterinary Congress in Switzerland, August 21-27, and to give a course of three lectures on animal parasitology at the University of London at the beginning of October.

In accordance with the financial arrangements with McGill University, the Director gave a short course in medical parasitology to the medical students. During the 1938-39 academic year this course will become a regular part of the medical curriculum. Dr. Swales gave a short course of instruction on plant eelworms to the plant pathology class at Macdonald College. Dr. Wm. Newton, Saanichton, B.C., kindly provided some excellent demonstration material for this course.

The following papers have been published during the past year:

By T. W. M. CAMERON—

Les parasites antagonistes des profits. Le Bulletin des Agricultures, 22: 26 and 38. 1937.

Trichinosis. Can. J. Comp. Med. 1, (2) : 5-14. 1937.

Studies on the heterophyid trematode, *Apophallus venustus* (Ransom, 1920) in Canada. Part III. Further Hosts. Can. J. Research, D, 15: 275. 1937.

A new species of Heligmosominae from the Labrador collared lemming. Papers on Helminthology, published in commemoration of K. J. Skrjabin: pp. 66-68. Moscow, 1937.

Diseases common to animals and men. Medical Annual: 142-148. 1938. (Reprinted Can. J. Comp. Med. 2: 121-128. 1938.)

Trichinosis—A public health problem. Vet. J. 93: 39-41. 1937.

Investigations on Trichinosis in Canada. I. A preliminary survey on the incidence of Trichinosis in eastern Canada. Can. J. Research, D, 16: 89-92. 1938.

On the morphology and parasitic development of *Travassosius rufus*. Khalil, 1922, a Trichostrongyle parasite of the Canadian beaver *(Castor canadensis canadensis)*. Livro Jubilar Prof. Travassos, 103-107. 1938.

By I. W. PARNELL—

Studies on the bionomics and control of the bursate nematodes of horses and sheep. IV. On the lethal effects of some nitrogenous fertilizers on the free-living stages of sclerostomes. Can. J. Research, D, 15: 127-145. 1937.

Studies on the bionomics and control of the bursate nematodes of horses and sheep. V. Comparisons of the lethal effect of some non-nitrogenous fertilizers on the free-living stages of sclerostomes. Can. J. Research, D, 16: 73-87. 1938.

By W. E. SWALES—

The practitioner's role in parasitology. Can. J. Comp. Med. 1, (1):17-22. 1937.

Anthelmintic medication. Can. J. Comp. Med. 2, (2),:57-58. 1938.

Skrjabingylus nasicola (Leuckart, 1842) Petrow, 1927, a nematode parasitic in the frontal sinuses of American Mustelidae. Livro Jubilar Prof. Travassos, 455-459. 1938.

By H. J. GRIFFITHS—

Some observations on the over-wintering of certain helminth parasites of sheep in Canada. Can. J. Research, D, 15: 156-162. 1937.

Associate Committee on Patents and Awards

This committee has been charged by the Council with responsibility for the administration of Section 11 of the Research Council Act (Page 173). Under it a subcommittee has been organized in each of the laboratory divisions, these subcommittees making recommendations to the President of the Council regarding inventions made in the laboratories and the countries in which applications for patents should be filed.

To 31 March, 1938, a total of 127 applications had been placed and 83 patents had been granted. Of these, 26 applications and 13 patents belong to the year under review.

The Council is now devoting considerable attention to the commercial exploitation of inventions made in the National Research Laboratories. A number of licences have been granted for manufacture in both Canada and foreign countries and a revenue from this source is now being received. In some cases, when researches have been undertaken at the request and expense of industrial firms, the control of patents arising out of those researches has, with the approval of the Governor in Council, been vested in the companies concerned.

In agreements between the Council and commercial concerns for the carrying out of investigations in the National Research Laboratories, clauses are inserted which protect the Canadian consumer in respect of both the supply of patented articles and materials arising out of these investigations and the prices at which they can be obtained. Licences to manufacture in Canada contain similar provisions.

Associate Committee on Radiology

Facilities for the testing and calibration of medical X-ray equipment are being extended by the construction during the last year of a 600 kilovolt constant potential X-ray installation in the National Research Council Laboratories. A high pressure standard ionization chamber suitable for the calibration of dosage meters used with extra high voltage X-ray equipment will be constructed for use with this 600 kv. installation. Investigations were completed on problems arising in the design of satisfactory small ionization chambers for practical clinical use with extra-high-voltage equipment. Such chambers are being constructed and will be available after calibration by means of the standard chamber. (The chambers only will be supplied since it was deemed advisable to leave the choice and design of the accessory amplifying equipment to the physicists who will have occasion to use the chambers in the clinics.) These chambers will be suitable also for use with radium bombs.

A comparison of the standard ionization chambers of the National Research Laboratories with those of the United States National Bureau of Standards confirmed that the difference between the standards of the two countries is too small to be clinically significant.

The committee has been fortunate in the appointment of Mr. L. W. Ball as a physicist in the Radiology Laboratories of the National Research Council. Mr. Ball was formerly engaged in the physical adjustment and control of radium and X-ray dosage at the Manchester Radium Institute, where outstanding advances have been made in this field, and he has had exceptionally extensive experience with the physical problems of radiation therapy.

Associate Committee on Radio Research

Co-operating organizations:

Canadian Broadcasting Corporation
Canadian Marconi Company
Dominion Department of Transport
Northern Electric Company

No meetings of this committee were called during the fiscal year 1937-38 but the work was carried on by a subcommittee of the main one, namely, a "Sub-Panel on Cathode Ray Compass". During this period a first model of the cathode ray direction finder for use in an aeroplane was constructed. After preliminary laboratory test it was decided to build a second model immediately, but unfortunately this schedule was interrupted by work on the marine direction finder.

Work on the direction finding of atmospherics was continued throughout the year and observations were taken at Ottawa; Forest, Manitoba; Porto Rico and Florida. The last two stations were operated independently of the National Research Council, but a co-operative scheme of observation was arranged between all stations. Further details are included in the report of the Radio Section of the Division of Physics and Electrical Engineering (Page 66).

73461—8½

At the meeting of the Council on 27 March, 1938, the work of the Associate Committee on Radio Research was reorganized, and will now be carried out by a Radio Research Committee and two special committees on "Radio Research on Marine Direction Finders" and "Radio Research on Cathode Ray Compass". The Associate Committee on Radio Research was therefore disbanded.

Associate Committee on Survey Research

Co-operating organizations:

Department of Mines and Resources
Department of National Defence

The Associate Committee on Survey Research has had an active and satisfactory year. The work has been carried out under the guidance of four subcommittees. These are:

(1) Photographic Aircraft and Cameras
(2) Mapping Methods
(3) Survey Instruments
(4) Infra-red Photography, Emulsions, Filters, etc.

The Subcommittee on Photographic Aircraft and Cameras arranged for test surveys with the Barr and Stroud seven lens camera. Difficulties were encountered with the rectifier. Although these were overcome the multi-lens type of camera was not considered as suitable for air surveys in Canada as the standard single lens camera.

The subcommittee recommended the purchase of the wide angle lens with a six inch focal length recently developed by Ross. To obtain the most out of this lens the subcommittee recommended the purchase of a new camera from the Fairchild Camera Corporation, New York, which would take a photograph measuring 24 x 24 cm.

Under the Subcommittee on Mapping Methods work has been progressing on the new stereoplotter. The final design has been approved and the construction has reached an advanced state in the instrument and model shops of the National Research Laboratories.

A well known firm specializing in universal plotting machines offered to produce a map from a strip of air photographs taken in Canada so that it might be demonstrated how successfully a universal machine could be used under Canadian conditions. After the submission of the photographs and the simple data used currently for the production of maps from air photographs in Canada a lengthy correspondence ensued. The result of the latter was to confirm the subcommittee in its opinion that the universal type of machine is too costly and elaborate for the production of the type of maps that has proved economical in Canada.

Information has been received that the Fourcade plotting machine which is being constructed by Barr and Stroud has progressed favourably during the year but it is not yet possible to predict the date of completion.

Among forest engineers and others who use air photographs in their work there is the need of a suitable instrument for the direct transfer of detail from air photographs to the base map with limited control shown on the latter. As a result of suggestions from the Forest Service, Bausch and Lomb proposed a practical design for such an instrument at the end of 1936. During the past year an opinion of this design was sought from the Subcommittee on Mapping Methods. Since the Forest Service obtained such satisfactory results from a

rough instrument incorporating similar ideas the opinion of the subcommittee was that the Forest Service was justified in proceeding with the purchase of a more elaborate instrument to determine more carefully the possibilities of the idea involved.

Several new survey instruments have been developed under the direction of the Subcommittee on Survey Instruments.

An improved design for a phototopographic camera for the Bureau of Geology and Topography has been completed. The camera is lighter and smaller than the older ones. It replaces the telescope in a small theodolite. The dimensions of the plate are reduced by half. As a result of the saving in weight, mountain climbing parties can be reduced from three men to two. The camera will receive its field trials in 1938.

The subcommittee recommended the construction of two transparent station pointers according to the design devised by Mr. Ettershank of the Hydrographic and Map Service, Victoria, B.C. These instruments are now in the course of construction and will be ready for trial during the summer of 1938.

Under the Subcommittee on Infra-red Photography, Emulsions, Filters, etc., an exposure meter for infra-red photography has been designed for the Bureau of Geology and Topography. This instrument will be completed in time for tests in the field during 1938.

Investigations on photographic films have been conducted under the supervision of this subcommittee with a view to the improvement of the technique employed in air photography. At the recommendation of the subcommittee the installation of a complete sensitometric laboratory in the National Research Laboratories is being planned. With the data obtained in this laboratory it will be possible to prescribe the best photographic technique for a particular project with consequent economy since laboratory work will replace trial flights. The value of the photographs for different purposes will be increased. Assistance has been rendered the R.C.A.F. in the preparation of a specification for the purchase of photographic film for air surveying. Numerous other matters pertaining to photographic procedure have been referred to the subcommittee and it has proved a useful clearing house for photographic problems.

The Survey Museum that was initiated during the year 1937 has progressed favourably. This progress has been due to the very generous co-operation of Government Departments and individuals interested in the project. In the West Exhibition Hall at the National Research Laboratories there is now the nucleus of a collection of historic survey equipment and allied exhibits. It is expected that with continued support from those interested there will eventually be collected a valuable history of the contribution made by Canadian workers to the art of surveying.

Associate Committee on Trail Smelter Smoke

Co-operating organization:

Dominion Department of Agriculture

Under the auspices of the committee there has recently been completed one of the most comprehensive studies ever undertaken on the effect of sulphur dioxide on vegetation. The work was carried out at the request of the Department of External Affairs in connection with an international legal case between the Dominion of Canada and the United States over the question of damage caused in northern Stevens County, Washington, about ten miles south of the international boundary, by the emission of sulphur dioxide from the stacks of the metallurgical works at Trail, B.C.

The case, involving claims by the U.S. farmers amounting to some ten million dollars, was first referred to the International Joint Commission which, after hearing the evidence of scientists representing the National Research Council, the government of the United States, and the smelting company, recommended the payment of $350,000 to cover all damages to the end of 1931. This was ultimately accepted and the question of damage since that time was submitted in 1935 to an international tribunal which, after conducting lengthy hearings for the presentation of oral and written testimony, eventually awarded a further sum of $78,000 in damages to October, 1937.

With the completion of the legal aspects of the case the results of the scientific investigation, comprising a series of fifteen scientific papers, will shortly be published in a book of about 450 pages. The subject matter includes studies of (1) the sulphur dioxide content of the atmosphere at various distances from the smelter in the area affected, (2) the sulphur content of trees and shrubs, (3) the symptoms and methods of diagnosis of sulphur dioxide injury to vegetation, (4) the influence of physical and environmental factors on susceptibility, (5) the effect of sulphur dioxide in various concentrations on conifers in natural habitat and in transplanted plots, (6) the annual ring growth of conifers as affected by sulphur dioxide, (7) the effect of various experimental fumigations on yield and chemical constituents of barley and alfalfa, (8) carbon dioxide assimilation, respiration and stomatal behaviour of alfalfa, and (9) the effect of sulphur dioxide on soils.

Atmospheric Sulphur Dioxide

Measurements of sulphur dioxide concentrations in the atmosphere of the area affected by the operations of the Trail smelter have been carried on mainly by means of automatic sulphur-dioxide recorders at fixed stations in the direction of the prevailing winds in the Columbia River valley and, on occasion, by a portable apparatus. Three automatic sulphur-dioxide recorders have been used, and the results show the conditions prevailing during the period when extensive damage was caused to vegetation (1929 to 1931), and also since that date, when, owing to the remedial measures adopted by the smelter to convert a portion of the waste sulphur dioxide to sulphuric acid, fertilizer and elemental sulphur, the duration and magnitude of the concentrations occurring in the Columbia River valley have been greatly reduced, particularly during the growing seasons. Since the adoption of these remedial measures, concentrations above 0·50 parts per million have been practically eliminated in northern Stevens County, Washington, except on infrequent occasions during the winter months when the meteorological conditions have been unfavourable for the diffusion and dilution of the gas. The data indicate a diminution of about 70% in the average gas concentration from points 6 to 15 miles south of Trail, with a dilution of a smaller order from 15 to 20 miles south of Trail.

Sulphur Content of Vegetation

The sulphur content of the leaves of conifers exposed to sulphur dioxide was found to be substantially increased over a period of time. By the analysis of a large number of collections, the different years' needles being analyzed separately, it was found possible to define areas within which sulphur dioxide had been present and to trace approximately the farthest limits of penetration of the gas. No quantitative relation was found to exist between increase in sulphur content and degree of injury, the rate of absorption of sulphur dioxide by the leaves being of much greater significance than the actual amount absorbed. The occurrence of sulphur dioxide was found to diminish rapidly with increasing altitude, and no evidence of sulphur dioxide occurrence could be found at elevations higher than 3,700 feet. Further, nearly

all of the absorption of sulphur dioxide by conifers was found to take place during the growing season, no significant amount of sulphur being accumulated in the needles during the period December to March.

Symptoms and Diagnosis of Sulphur Dioxide Injury

Observations in regard to symptoms and diagnosis were made on nine coniferous species, eleven broad-leaved species and eleven species of shrubs. For a certain period early in the growing season larch was found to be extremely susceptible to sulphur dioxide. Among the factors, other than sulphur dioxide, which must be considered in diagnosing smoke damage to forests, are winter injury, drought, fungous and insect diseases, and fire. The various discolorations and markings produced on alfalfa and barley, as a result of experimental fumigation studies, have been described in detail.

Influence of Certain Factors on Susceptibility

Among the most important factors which have been found to influence the susceptibility of plants to sulphur dioxide may be mentioned the concentration of gas and length of fumigation, the relative humidity of the atmosphere, light, soil moisture, rate of absorption and age of plant. A high relative humidity renders plants very susceptible to injury and this was found to be one of the most important factors in bringing about rapid absorption of the gas, owing to its effect on stomatal aperture. Although plants are much more susceptible in sunlight than in darkness there appears to be, in sunlight, a wide range of light intensity over which increasing light does not appreciably influence the results obtained. Decrease in soil moisture has comparatively small effect until the wilting point is approached, after which the plants become very resistant. The results obtained experimentally when gas concentrations, humidity, and other conditions in the field were duplicated in parallel experiments with plants under cabinets, have been found quite comparable with those observed in the affected area.

Effect of Sulphur Dioxide on Conifers

The susceptibility of yellow pine and Douglas fir was found to vary in a marked manner with the seasons, the period of maximum susceptibility to sulphur dioxide occurring during early spring and summer. During the late summer, autumn and winter, conifers in natural habitat are very resistant to sulphur dioxide. In comparison with susceptible crop plants, such as barley and alfalfa, conifers are much more resistant to sulphur dioxide, even during the growing season. The apparent susceptibility of conifers in a smelter area is due to the evergreen character of the foliage. Since the needles remain on the trees from three to nine years the effects of the gas are to a large extent related to the increase in sulphur content from year to year, the accumulation finally reaching a point where the threshold value for sulphur is exceeded. In experimental fumigations, where the trees were severely injured by sulphur dioxide, residual effects on growth were definitely established, the height growth being measurably retarded for about two years after the sulphur dioxide treatment.

Trees growing in transplanted plots under irrigation were found to be definitely more susceptible to sulphur dioxide than those growing in natural habitat. Of the conifers, larch in certain stages of growth was found to be the most sensitive to sulphur dioxide.

The Effect of Sulphur Dioxide on the Diameter Increment of Conifers

Since the annual growth rings of trees constitute a permanent record of the reaction of trees to their environmental conditions, they constitute a valuable source of information regarding any unusual condition, such as exposure to smelter fumes, to which the trees may have been subjected in

their past history. Recognizing this fact, the committee arranged to have cores removed, by boring, from a large number of conifers growing in Northern Stevens County, Washington, and the adjoining territory. These cores were measured for annual growth back to 1915, which was well before the time when complaints were received of smoke damage to trees in the State of Washington. In the four years 1929, 1930, 1934 and 1936, 10,043 trees were bored and more than 175,000 measurements were made on the cores.

The analysis and interpretation of these measurements was obviously a large task, one made more difficult by the fact that annual growth may be reduced by insufficient precipitation and by damage from insects, fungous diseases, fire and other causes, while stimulation may result from the cutting of large trees from dense stands of timber. In this case the situation was further complicated by the fact that for some years a smelter was operated at Northport near the centre of the area in which damages were claimed from the smelter at Trail. The correct interpretation of ring growth was made possible only by a study of a great number of trees growing in relatively large groups throughout the affected area, and by comparing the growth of these trees with that of the same species in nearby districts unaffected by smelter smoke.

It was found in this study that serious damage to yellow pine and Douglas fir, the chief commercial varieties in the area, had occurred over a period of years in the valley of the Columbia River adjoining the boundary, and that with increasing distance down the river from the smelter and up the tributary streams the damage decreased in a fairly regular way to approximately the limits of the area in which smoke markings were observed on field crops, where the effect on diameter growth disappeared. The increase in damage with the severity of the fumigations and the recovery of the trees after remedial measures were applied were strikingly evident. It was also found possible to measure the effect of the operation of the Northport smelter and to distinguish it from that of the smelter at Trail.

Effect of Sulphur Dioxide on Yield of Crop Plants

The results of a large number of experiments demonstrate that in the absence of typical markings on the leaves there is no decrease in yield and consequently no effect which might be termed "invisible injury". Prolonged treatment, in some instances throughout the whole period of growth of a crop, with concentrations of the order of 0·10 to 0·30 parts per million of sulphur dioxide, the concentrations being maintained below the point at which visible markings are produced on the leaves, had no effect whatever on the yield, the plants being normal in every respect as regards tillering, height, growth and reproduction. A reduction in yield was found to be correlated with a definite amount of leaf injury, resulting generally from the application of concentrations in excess of 0·50 parts per million. With high atmospheric humidity and other factors favourable to rapid sulphur dioxide absorption, some injury could be produced with concentrations of 0·30 to 0·50 parts per million, with a consequent reduction in yield, if the duration of the gas was sufficiently prolonged. Plants showed a marked capacity for recovery from the effects of single, short, injurious fumigations.

In alfalfa fumigated during the period of active growth prior to the flowering stage, there was a definite relation between the extent of leaf discoloration and the reduction in yield. With barley, on the other hand, fumigations of an injurious character in the pre-flowering period had a more pronounced effect on the straw than on the grain, while treatment during the flowering period resulted in a much greater effect on the yield of grain than on the yield of straw.

Carbon Dioxide Assimilation and Respiration

The carbon dioxide assimilation and respiration of alfalfa throughout the entire range of concentrations from less than 0·10 to 7·0 parts per million of sulphur dioxide were studied intensively. With the average concentration in the neighbourhood of 0·10 p.p.m. the carbon dioxide exchange was maintained at a normal rate, even when the plants were fumigated throughout the entire period of growth of a crop. In fact, experiments carried out in the range of 0·17 p.p.m. indicated a small but definite increase in photosynthesis and reduction in respiration, resulting in an increase in the net amount of carbon dioxide assimilated during the period of treatment, provided there was no leaf injury. With higher concentrations of gas a small but measurable decrease in the carbon dioxide assimilation became evident with concentrations in the neighbourhood of 0·50 p.p.m. As the concentration was increased to 0·75 p.p.m. this depression of the carbon dioxide assimilation became more pronounced. Short intermittent treatments of a few hours' duration with concentrations in this range resulted in a decrease in the net amount of carbon dioxide assimilated, even in the absence of visible injury. The effect was found to be only transitory in character, in that the plants recovered their normal rate of carbon dioxide exchange soon after the gas had been removed from the atmosphere. With concentrations in excess of 1·00 p.p.m. the reduction in carbon dioxide assimilation in sunlight was quite marked, even when the gas was present for periods of only 20 to 40 minutes. With fumigations of this type not only was photosynthesis reduced, but the subsequent night respiration was stimulated, so that the net assimilation was even more reduced. Very high concentrations of sulphur dioxide (approximately 4·00 to 5·00 p.p.m.), when present during the night, caused a reduction in respiration, but there was no pronounced effect on the subsequent photosynthesis in daylight during the period following the gas treatment. The results of these experiments indicate that if concentrations in excess of 0·50 p.p.m. are not present in the atmosphere of a smelter area, and provided that the fumigations in themselves are not sufficiently prolonged to cause visible leaf markings, the carbon dioxide exchange or susceptible plants will not be interfered with, even though sulphur dioxide visitations occur frequently during the growing season.

Stomatal Behaviour

The stomatal behaviour of alfalfa was studied in the presence of a wide range of concentrations, from 0·10 to 5·80 p.p.m. With the highest concentrations a marked effect, producing total or partial stomatal closure, was observed within a few minutes after the application of the gas. With lower concentrations the effects gradually decreased until eventually the stomata were not affected without definite markings on the leaves. Concentrations in the range of 0·44 to 0·76 p.p.m. caused no response when present for four-hour periods. Some interference with stomatal functions was found after four days' continuous treatment with 0·40 p.p.m., but this coincided with the appearance of chlorotic and acute markings on the leaves. With concentrations lower than 0·30 p.p.m. no measurable closure of stomata was found even where the gas was applied for many hours, and stomata were found to be fully functional after 504 hours' treatment with 0·10 p.p.m.

Soils

An extensive investigation was carried out on the hydrogen ion concentration, base saturation and sulphate content of soils in the area subject to visitations of sulphur dioxide. Data obtained from a large number of samples indicate that in the vicinity of the smelter, for a distance of about 10 miles in the direction of the prevailing winds, there is a marked increase in acidity, de-

crease in base saturation and increase in sulphate content of soils with increased proximity to the smelter. This effect diminished quite rapidly with increasing distance and became negligible at 10 to 14 miles from the smelter. During the course of this work an opportunity was afforded to compare the results of several methods of determining the base exchange capacity and pH of soils.

(Investigations carried out by M. Katz, A. W. McCallum, G. A. Ledingham, and F. E. Lathe)

Associate Committee on Tuberculosis

Co-operating organizations:

Dominion Department of Agriculture
Qu'Appelle Indian Health Unit
Queen Alexandra Sanatorium
Queen's University
University of Alberta
University of Montreal
University of Toronto

Experimental work done under the auspices of the committee during the year under review is summarized below.

Vaccination Against Tuberculosis with B.C.G. Vaccine, University of Montreal

Vaccination of infants with B.C.G. has been carried out at the University of Montreal since June, 1926. To date, 15,782 children have been vaccinated, 3,574 during 1937. Of the vaccinated group, 619 have been in contact with positive sputum cases of tuberculosis, and 995 unvaccinated controls live in similar circumstances, approximately three-quarters of them in the same homes as the vaccinated children. To make the two groups comparable, a number have been excluded, leaving 573 vaccinated and 943 controls with practically the same intensity of contact, the same supervision and the same living conditions.

To date 37 vaccinated children and 128 controls have died, the crude death rate of the vaccinated group being 53% of that of the control. Eleven of the vaccinated children and 50 of the controls died of tuberculosis, the rate in the former group being only a little more than one-third that of the unvaccinated children. In groups with the same duration of contact, the tuberculosis mortality rate is from 40 to 70% more favourable to the vaccinated than the unvaccinated children.

Twenty-nine cases of tuberculosis have developed among the vaccinated, 108 among the control children, the general tuberculosis morbidity rate being thus 59% lower in the vaccinated group. Since 1932 the tuberculosis morbidity and mortality rates and the general mortality rates have been consistently in favour of the vaccinated children.

(Investigations under the direction of Dr. J. A. Baudouin)

Research at the B.C.G. Laboratories, University of Montreal

The preparation and control of B.C.G. vaccine has been continued. In 1937-38, 24,712 ampoules were prepared, sufficient for 7,584 vaccinations, an increase of 803 over the preceding year.

No change in the virulence of B.C.G. has been noted since 1933. Of 57 vaccinated guinea pigs autopsied between January, 1933, and March, 1935, 15 animals, 26·3%, showed omental nodules, and of 92 autopsied between March, 1935, and June, 1937, 22 animals, 24·4%, showed these lesions.

To test the immunizing properties of B.C.G., injections of virulent tubercle bacilli were given to 53 unvaccinated and to 43 vaccinated guinea pigs, 81 days after vaccination. Local lesions appeared two to three weeks later in vaccinated than in control animals. On the 82nd day, 15 autopsied controls all showed gross tuberculous lesions, especially in the spleen, while 17 vaccinated animals showed none or only microscopic lesions in the local glands. On the 160th day 65% of the controls were dead, but none of the vaccinated animals. On the 215th day 97% of the controls, and 50% of the vaccinated were dead. The longest survival period of a control animal was 148 days, and of a vaccinated, 451 days.

(Investigations under the direction of Dr. Armand Frappier)

Vaccination of Indian Children with B.C.G. in Saskatchewan

Tuberculosis has been a major cause of death among Indians, comprising 32% of the total mortality between 1930 and 1934, ten times that among the whites. Segregation of active cases has markedly reduced the disease in the boarding schools, but the mortality is very high among infants and children of 15 to 19 years returning from school to the reservations. Tests of B.C.G. vaccine are being made in these two groups.

Between October, 1933, and December, 1934, 51 infants were vaccinated orally with B.C.G., and between January, 1935, and May, 1937, 79 were vaccinated subcutaneously. Among the former, five vaccinated children died, none of tuberculosis, and seven controls died, two of tuberculosis; among the latter, seven vaccinated and seven controls died, none of tuberculosis, but one control has tuberculous adenitis.

Between March, 1934, and October, 1937, 190 boarding school children were vaccinated subcutaneously. No cases of tuberculosis have developed among vaccinated or controls. One vaccinated child died of a non-tuberculous cause. B.C.G. vaccination has not produced any ill effects.

(Investigations under the direction of Dr. R. G. Ferguson)

Intravenous and Subcutaneous Vaccination with B.C.G. in Experimental Bovines

Since early in 1932, tests have been conducted by the Alberta Committee on Tuberculosis to compare the results of combined intravenous and subcutaneous primary B.C.G. vaccination and of simple subcutaneous primary vaccination in calves, both methods followed by annual subcutaneous vaccination. Ninety-two calves from tuberculosis-free herds were isolated in 1932 and fed only pasteurized milk. At four months of age, after negative tuberculin tests, 50 were given double vaccination with B.C.G., intravenously and subcutaneously, 42 were kept as controls. The herd was isolated until July, 1934, and the vaccinated group revaccinated three times subcutaneously. Tuberculin tests in January, 1933, and June, 1934, showed all animals negative.

In July, 1934, tuberculosis contacts were made by placing six vaccinated and six control animals in a proven tuberculous herd, and by adding to the isolated herd three aged tuberculous cows and inoculating three of the controls with virulent bovine tubercle bacilli. Contact was maintained until May, 1936, when the last-mentioned six contact animals were all proven tuberculous by autopsy. In 1938, of the original 92 animals, two vaccinated and

one control are still living, and two vaccinated and four controls were eliminated from the experiment. Of the remaining 46 vaccinated, two showed evidence of tuberculosis on slaughter (4·3%), both from the isolated herd. Of the remaining 37 controls, 17 showed tuberculosis (54·9%), four from the tuberculous and 13 from the isolated herd.

Two known tuberculous herds were also investigated. Previous to 1932 the calves received primary subcutaneous vaccination with B.C.G. and annual subcutaneous vaccination thereafter. They were fed on milk from the tuberculous herd and kept in contact from birth. Of 88 of these, slaughtered between 1932 and 1938, 31, or 35·2%, showed tuberculosis; 56 are still living. Since 1932, double primary vaccination, intravenously and subcutaneously, has been used in these herds, followed by annual subcutaneous vaccination. The calves are separated from the herd for one month and fed pasteurized milk. Of 96 of these animals killed between 1932 and 1938, six, or 6·3%, had tuberculosis; 186 are still living. An accurate comparison between the two methods of primary vaccination cannot yet be made as the latter group is of younger animals, but the available evidence favours the combined method of subcutaneous and intravenous inoculation.

(Investigations under the direction of Dr. A. C. Rankin)

SPECIAL COMMITTEES

Special Committee on Gas Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Services

During previous years (see annual reports for the years 1933-34 to 1936-37) the committee recommended (1) definitions for the units of measurements required in gas meter testing; (2) specifications for the approval of type of positive displacement gas meters and (3) the procedure for the approval of type of large capacity gas meters for which the Council, owing to lack of funds, has been unable to equip a suitable testing laboratory. These recommendations were adopted, at that time, by the Council.

It has been necessary to retain the committee for dealing with special cases which are not covered by the above regulations. During the past year, no special cases were met with.

Special Committee on Hydraulic Research

Co-operating organizations:

Dominion Department of Mines and Resources (Dominion Water and Power Bureau)
Dominion Department of Public Works
Dominion Department of Transport

In the previous year, this committee recommended the establishment of a laboratory for river flow and hydraulic structure investigations and submitted a proposal covering the establishment of a laboratory in a portion of a building of the National Research Laboratories Annex. An item for the equipment of the laboratory was included in the estimates of the Council for 1938-39.

During the year under review, the committee has been inactive, pending further developments in connection with the proposed laboratory.

Membership is unchanged since the 1936-37 report, excepting that a successor to Major N. B. McLean, retired from the Government Service, has not been named.

National Building Code Committee

For a number of years the National Research Council has been receiving representations from various industrial and professional organizations in Canada requesting that it undertake the preparation of a model building code which could be used by municipal authorities throughout the country as a basis for regulations controlling structures erected within their jurisdiction.

During the year under review the whole situation was reviewed in collaboration with the Dominion Housing Administration and the Dominion Fire Commissioner, and it was considered that the benefit that would accrue from the completion of such a task would justify the time and expense involved. Accordingly, on 10 December, 1937, an exploratory conference was held under the honorary chairmanship of the Hon. C. A. Dunning, Minister of Finance. The following were represented:

Royal Architectural Institute of Canada
Association of Canadian Fire Marshals
Engineering Institute of Canada
Department of Pensions and National Health
Canadian Manufacturers' Association
Canadian Engineering Standards Association
Department of Mines and Resources
Dominion Housing Administration
Canadian Housing and Planning Association
Dominion Fire Commissioner
Dominion Board of Insurance Underwriters
National Research Council

This meeting gave its unanimous support to the proposal that a national building code be prepared, and subsequently gave its approval to the form of organization recommended. The project as now organized is under the joint sponsorship of the National Research Council, the Dominion Housing Administration and the Dominion Fire Commissioner. The honorary chairman is the Hon. C. A. Dunning, Minister of Finance, and the chairman is General A. G. L. McNaughton, President of the National Research Council. Contact with government and municipal authorities, professional bodies and manufacturers is maintained by means of a comprehensive advisory committee composed of some 60 representatives of government departments, both federal and provincial, municipal authorities, professional associations and industrial and trade associations having national standing.

The active committee work is under the direction of an administrative committee, the chairman of which is Mr. F. W. Nicolls, Director of the Dominion Housing Administration. Each main section of the work, construction requirements, fire protection, and requirements bearing upon health and sanitation, is under a separate committee, and under these the necessary subcommittees and panels have been established. Some 70 individuals are serving on the various working committees and subcommittees.

As indicated by the titles of the sections the problem is being attacked in a comprehensive way and it is hoped that when completed the document will represent a contribution of the first magnitude to housing problems in this country. When the work was first undertaken, it was estimated that approximately two years would be required for its completion. Noteworthy progress has, however, been made and it is now hoped that the code will be ready for publication considerably in advance of that time.

The Standards and Specifications Section of the Division of Research Information is supplying the secretarial and all necessary professional and clerical assistance in this project.

Canadian Government Purchasing Standards Committee

The function of this committee is primarily to prepare commodity specifications for the use of the departments of the federal government in purchasing supplies. Its work is conducted on a co-operative basis, the membership of the working subcommittees and panels being composed of representatives of various departments of the government who are either interested in using the specifications or who can make a technical contribution to their preparation.

Official members of the main committee are the deputy ministers of participating departments. General supervision of the work and allocation of funds for laboratory investigations is in the hands of a Committee on Plans and Administration, the membership of which consists of the chairmen of the various subcommittees.

At the end of the fiscal year there were fifteen subcommittees and panels in existence. No new ones had been added during the year but the initiation of work on solid fuels and several other projects was under consideration.

During the year the committee sponsored a number of laboratory investigations on matters associated with the preparation of specifications. The most important of these dealt with paints, textiles and the aging properties of bond paper. The last-named investigation, which was carried on by the Forest Products Laboratories of the Department of Mines and Resources, is approaching completion, and it is expected that in the near future it will be possible to prepare adequate specifications defining the aging qualities of paper. An investigation of the properties and testing of masonry caulking materials was carried on during the year in the Council's Division of Chemistry and a specification based upon the results obtained was issued.

The Subcommittee on Editorial Practice, which has been preparing a government style book, has completed its work and the manuscript has been submitted to the Secretary of State for publication.

During the year 3079 copies of specifications were supplied on request to government departments and 2970 were sent to inquirers outside the government service. The number of requests for copies of specifications is showing a consistent and gratifying increase and the specifications are being used to an increasing extent by industrial firms and other organizations in making their own purchases. The following is a list of specifications, tentative and final, issued as at 31 March, 1938:

Tentative Specifications:

1-GP- 6	Putty for Glazing, Types I and II.
1-GP-10—1937	Exterior Linseed Oil Paints, White Lead-Zinc Oxide Type, White and Tinted. (Amended Dec. 22, 1937).
1-GP-12	Schedule of Standard Paint Colours.
1-GP-14—1937	Red Lead (Dry Pigment Paste, and Mixed Paint). (Amended Dec. 22, 1937.)
1-GP-15—1937	Titanium-barium Pigment, Paste in Oil. (Amended Dec. 22, 1937.)
1-GP-16—1937	Shellac Varnish. (Amended Dec. 22, 1937.)
1-GP-17—1937	Exterior Enamel, White and Grey. (Amended Dec. 22, 1937.)
1-GP-18—1937	Exterior Varnish. (Amended Dec. 22, 1937.)
1-GP-19	Varnish Vehicle for Aluminum Paint (Type 1, for Exterior and Marine Use on Metal).
1-GP-20	Varnish Vehicle for Aluminum Paint (Type 2, for Exterior Use on Wood).

Tentative Specifications:—Concluded

1-GP-21	Varnish Vehicle for Aluminum Paint (Type 3, for High Temperature Use).
1-GP-22	Aluminum Pigment for Paint (Type 1, Dry Powder).
1-GP-23—1937	Plastic Caulking Compound.
1-GP-24	Aluminum Pigment for Paint (Type 2, Paste).
1-GP-25—1937	Marine Paint, White Lead-Zinc Oxide Type, White and Tinted. (Amended Dec. 22, 1937.)
1-GP-26—1937	Exterior Enamel, Glyceryl Phthalate Type, White and Orange. (Amended Dec. 22, 1937.)
1-GP-27—1937	Marine Paint, Red and Black. (Amended Dec. 22, 1937.)
1-GP-28—1937	Exterior White Linseed Oil Paint. (Amended Dec. 22, 1937.)
2-GP- 9	Scouring Compounds.
2-GP-11	Methods of Sampling and Analysis of Soaps.
2-GP-12	Liquid Metal Polish.
2-GP-13—1938	Low Titre Chip and Powdered Soap for Laundry Purposes.
3-GP- 2—1937	Fuel Oil. (Amended Dec. 15, 1937.)
3-GP- 4	Petroleum Lubricating Oils.
3-GP- 6	Diesel Fuel Oil.
4-GP- 2—1938	Schedule of Methods of Testing Textiles.
8-GP- 1—1937	Testing Sieves. (Amended Dec. 15, 1937.)
10-GP- 1—1938	Burned Fire-clay Brick for Stationary Boilers.
10-GP- 2	Questionnaire *re* Stationary Boiler Installations.
10-GP- 3—1937	Refractory (High Temperature) Cements for Boiler Settings.
12-GP- 1—1937	Safety Glass.
14-GP- 1	Clinical Thermometers.
15-GP- 1	Flake Calcium Chloride.
15-GP- 3—1937	Disinfectant, Coal-Tar Type.

Specifications Issued as Final:

1-GP- 1—1937	Linseed Oil, Raw, Unrefined. (Amended Dec. 22, 1937.)
1-GP- 2—1937	Linseed Oil, Boiled. (Amended Dec. 22, 1937.)
1-GP- 3—1937	Turpentine for Paint, Type I. (Amended Dec. 22, 1937.)
1-GP- 4—1937	Paint Thinner (Petroleum Spirits), Type I. (Amended Dec. 22, 1937.)
1-GP- 5	Paint Thinner (Petroleum Spirits), Type II.
1-GP- 7—1937	Liquid Paint Drier, Types I and II. (Amended Dec. 22, 1937.)
1-GP- 8	Automobile Radiator Antifreeze Liquid, Types I and II.
1-GP- 9	White Lead, Basic Carbonate, Paste in Oil.
1-GP-11	Zinc Oxide, Paste in Oil.
1-GP-13	Paste Floor Wax.
2-GP- 1	Liquid Toilet Soap.
2-GP- 2	Household Bar Soap.

Specifications Issued as Final:—Concluded

2-GP- 3	Laundry Chip Soap and Laundry Powdered Soap.
2-GP- 4	Soft Soap.
2-GP- 5	Milled Toilet Soap.
2-GP- 6	White Floating Soap.
2-GP- 7	Liquid Household Soap.
2-GP- 8	Bar Toilet Soap.
3-GP- 1—1937	Gasoline (Amended Dec. 15, 1937.)
3-GP- 3	Illuminating Oils.
3-GP- 5—1937	Aviation Fuel.
6-GP- 1	Standard Mailing Envelopes.
6-GP- 2	Letterhead Papers.
6-GP- 3	Standard Dimensions of Letterhead and Report Paper.
6-GP- 4	Attendance Register.
6-GP- 5	Absence Record.
6-GP- 6	Summary of Absence Record.
6-GP- 7	Schedule of Standard File Backs and File Folders.
6-GP- 8	Requisition for File (Form).
6-GP- 9	Report of Files Charged (Form).
6-GP-10	File Charge Out Record (Form).
11-GP- 1	Creosote.

Hold-over Committee of the Fifth Pacific Science Congress

Efforts to find a place of meeting for the Sixth Pacific Science Congress were continued by the Hold-over Committee throughout the year but without success. In view of the provision in the constitution that the interval between Congresses should not exceed five years, letters were dispatched to the member countries of the Pacific Science Association requesting that approval be given by the member countries to a proposed amendment reading as follows:

> "Pacific Science Congresses shall ordinarily be held at intervals of not less than two years nor more than five years, and if while a Congress is being held an invitation or more than one invitation is received, then the time and place of meeting for the next Congress shall be determined by the Pacific Science Council, but if no invitation is received then a Hold-over Committee shall be appointed to consider the situation and to decide on the action to be taken, and it shall be within the power of the Hold-over Committee to extend the interval between Congresses beyond the ordinary maximum of five years."

Concurrence in this proposed amendment was received in due course.

Towards the end of the year information was received regarding a possibility that an invitation might be extended to the Association to hold the Sixth Pacific Science Congress in San Francisco, California, U.S.A., during 1939.

INVESTIGATIONS BY INDIVIDUAL RESEARCHERS

Each recipient of a grant from the National Research Council is required to submit annually a report of the progress of the research work being carried out under his direction. A number of such reports are summarized below. Some researches of this type have been described under the Reports of

Associate Committees. In addition the Council has published in the Canadian Journal of Research, during the year, scientific papers giving the detailed results of many experiments carried out by grantees. A list of the researches in progress is supplied as a supplement to these reports of current work.

Research on Cement

The Heats of Formation of the Silicates of Calcium

The heats of formation of β-dicalcium silicate and tricalcium silicate at 20° C. from α-quartz and calcium oxide have been determined. The heat of the important reaction between calcium oxide and dicalcium silicate to form tricalcium silicate has also been determined by three different methods. This enables one to calculate the corresponding heats of formation, heats of reaction, and free energy at any temperature up to about 1500° C. by combination with known specific heat data. Incidentally, the relative heats of solution of α-quartz, silica glass and silica gel in hydrofluoric acid were determined, as well as the specific heats of hydrofluoric acid of various concentrations. The data for the latter given in the literature were found to be much in error.

The determination of the heats of formation of α-monocalcium silicate, natural Wollastonite and the 3 : 2 calcium silication is now being proceeded with.

The Thermochemistry of the Aluminates of Calcium

Very pure samples of the different aluminates have been prepared for the thermochemical work. A study is being made of the heat of solution of crystalline anhydrous alumina, the monohydrate, and the trihydrate of alumina, with a view to defining the heats of formation of the aluminates of calcium with respect to a definite form of crystalline alumina. Preliminary work has also been done on the heat of solution of the aluminates themselves in acid.

It is also hoped that the thermochemical work will throw some light on the controversy as to the true composition of the so-called "5 : 3" and "3 : 5" calcium aluminates.

(Investigations under the direction of Dr. T. Thorvaldson, University of Saskatchewan)

Structure of Dextran

Dextrans are a class of bacterial polysaccharides which have come into prominence owing to work done in immuno-chemistry. Experimental work has been carried out by dextran being synthesized by *Leuconostoc mesenterioides* and it has been found to be a glucose polysaccharide, which on methylation and hydration yields tetramethyl methyl glucoside, trimethyl methyl glucoside and dimethyl methyl glucoside in the molar proportions of 1 : 3 : 1. The tetramethyl methyl glucoside was shown to be 2 : 3 : 4 : 6; the trimethyl methyl glucoside to be 2 : 3 : 4 and the dimethyl methyl glucoside to be either 2 : 4 or 3 : 4. Hydrolysis with dilute acids gave a product which is readily soluble in water. This, on methylation and hydrolysis, showed a chain of 10–12 glucose units. In this connection, synthesis of 2 : 3 dimethyl, 3 : 4 dimethyl and 2 : 4 dimethyl glucoses was then carried out. The dextran synthesized by *Leuconostoc dextranicus* was found to be a glucose polysaccharide, which on methylation and hydrolysis yielded a small amount of tetramethyl methyl glucoside, mainly 2 : 3 : 4 trimethyl methyl glucoside, and about 8% of a dimethyl methyl glucoside which was probably the 3 : 4 dimethyl derivative.

(Investigation under the direction of Dr. H. Hibbert, McGill University)

Reactions Involving Atomic Deuterium, Free Radicles, etc.

Continuing the work carried out in the previous year a study was made of the kinetics of some of the more important elementary reactions involved in the decomposition of the hydrocarbons, particularly those of the methyl and ethyl radicals, and of hydrogen and deuterium atoms. The reaction of hydrogen atoms with ethane was investigated by the Wood-Bonhoeffer method and the existence of the reaction of $H + C_2H_6 = CH_4 + CH_3$ was confirmed, constituting strong evidence against the validity of the Rice-Herzfeld free radicle mechanisms. The reaction of hydrogen atoms with propane was also studied. The mercury photosensitized decomposition of ethane and the reaction of hydrogen and deuterium atoms with ethane were subjected to thorough investigation, and it was established that the primary step in the ethane decomposition is a C-H bond split. Evidence was also found that the reaction $CH_3 + C_2H_6 = CH_4 + C_2H_5$ does not occur readily. A similar investigation of propane is in progress. Sources of cadmium resonance radiation suitable for photosensitization were developed, thus opening up a new field for photochemical investigation, and the study of cadmium photosensitized hydrocarbon reactions was begun. The thermal decomposition reactions of the lower paraffins were also subjected to accurate investigation, and trustworthy values for the activation energies of these reactions were established for the first time. This permits comparisons being made of the paraffin decompositions. The results suggest that the higher paraffins decompose by mechanisms involving an initial free radical split, followed by very short chains. The nitric oxide inhibited decomposition of butane is under investigation. Preliminary results indicate the presence of short chains in the butane decomposition. Further study of the reactions of atomic hydrogen and of the methyl and ethyl radicles is in progress, since it is becoming evident that these reactions are of fundamental importance in chemical kinetics. Seven papers and reviews on this work were published and five others are in course of publication.

(Investigation under the direction of Dr. E. W. R. Steacie, McGill University)

Growth of Populations of *Tribolium confusum*

This is a continuation of previous studies. Sufficient data on egg-laying rates under normal conditions have now been accumulated and a study of the rate of egg consumption by males has been made. The previous finding that egg-eating is associated with reduction of fecundity led to the search for a medium in which egg-eating would be reduced. The addition of 3% of finely ground wheat germ to the flour produced the desired effect on the thrift of the colonies, and it is now possible to obtain data over much longer periods. The data obtained should add to the understanding of behaviour of dense populations and show the importance in post-parasite relations of time delay in the act of parasitism. Further study is being made of the importance in population problems of such factors as sex ratios and crowding. Apparatus for the collection of the gas produced by the colonies is now in operation.

(Investigations under the direction of Dr. John Stanley, Queen's University)

Soil Investigations in Quebec

In recent work in Quebec it has been noted that the yield of oats is markedly increased and the colour of the straw brightened when the podsol soil on which the crop is grown has been treated with sodium carbonate. Analysis of the straw has shown that the iron content is much greater than

the normal for crops on these soils. Preliminary investigations indicated that the sodium carbonate exerted considerable solvent action on the iron and organic matter in these soils, and that the iron in solution was probably in an "iron-humate" complex. An account of the study of the chemical nature of these compounds has been published (Can. J. Research, B, 16 : 91-96. 1938).

The podsol soils of Quebec are almost all deficient in available phosphate, and this has to be supplied in some form. In farm practice phosphate fertilizers and manure are commonly used. A study of the availability of the phosphorus present in these soils (Can. J. Research, B, 15 : 475–479. 1937) showed that a considerable proportion is in organic combination. By far the greater part of the phosphorus dissolved in water extracts is organic phosphorus, much of which would not be available to the crop. The amount of inorganic phosphate soluble in dilute acids is very small and could not supply crops over an extended period.

Investigations into the phosphorus relations of these soils were hampered by the fact that no satisfactory method of determining total organic phosphorus was available. An effort was therefore made to develop such a method by applying the use of the photoelectric colorimeter to the ceruleomolybdate reaction. A satisfactory, sensitive and accurate method has been determined and described. (Can. J. Research, B, 16 : 97–108. 1938).

(Investigations under the direction of Dr. W. D. McFarlane, Macdonald College, Quebec)

Researches in Progress

Grantees and Addresses	Subject of Research
Dr. G. Baril, Laboratories, Ste. Justine Hospital, Montreal, Que.	Preparation of powdered apple by means of desiccation in vacuo.
Dr. E. F. Burton, Dept. of Physics, University of Toronto, Toronto, Ont.	Study of motion of air in horns of different shapes.
Dr. E. F. Burton, Dept. of Physics, University of Toronto, Toronto, Ont.	Electron optics.
Dr. E. F. Burton, Dept. of Physics, University of Toronto, Toronto, Ont.	Measurement of the velocity of light using an oscillating quartz crystal.
Dr. T. W. M. Cameron, Institute of Parasitology, Macdonald College, Que.	Parasites of man in Canada.
Dr. J. Dearness, London, Ont.	Publication of a catalogue of fungi.
Prof. C. McL. Fraser, Dept. of Zoology, University of British Columbia, Vancouver, B.C.	Publication of work on hydroids of the Pacific coast of Canada and the United States.
Dr. J. S. Foster, Macdonald Physics Laboratory, McGill University.	Measurement of radiations from the cyclotron
Dr. D. K. Froman, Physics Laboratory, Macdonald College, Que.	Cosmic rays
Prof. R. D. Gibbs, Dept. of Botany, McGill University, Montreal, Que.	Determination of the seasonal variation in water and gas content of species used in the pulp and paper industry in Eastern Canada.

RESEARCHES IN PROGRESS—Concluded

Grantees and Addresses	Subject of Research
Prof. W. H. Hatcher, Dept. of Chemistry, McGill University, Montreal, Que.	Investigation of refractive power of organo-chemical compounds.
Dr. H. Hibbert, Dept. of Cellulose Chemistry, McGill University, Montreal, Que.	1. Action of bacteria and enzymes on carbohydrates and polysaccharides. 2. Structure of dextran. 3. Starchless potato.
Prof. G. Krotkov, Dept. of Biology, Queen's University, Kingston, Ont.	Diurnal variations in the sugars and respiration of wheat leaves.
Dr. R. J. Lang and Prof. S. Smith, Dept. of Physics, University of Alberta, Edmonton, Alta.	Ultra-violet spectroscopy with vacuum grating spectrograph.
Prof. Marie-Victorin, Dept. of Botany, University of Montreal, Montreal, Que.	Flora of Eastern Canada.
Prof. Marie-Victorin, Dept. of Botany, University of Montreal, Montreal, Que.	Compilation of geographical and statistical list of Quebec plants.
Dr. O. Maass, Dept. of Chemistry, McGill University, Montreal, Que.	Investigation of the persistence of the liquid state at the critical temperature.
Prof. W. D. McFarlane, Dept. of Chemistry, Macdonald College, Que.	Mineral deficiency of Quebec soils.
Nova Scotia Institute of Science, Halifax, N.S.	Publication of a catalogue of scientific periodicals in the libraries of the Maritime Provinces.
Prof. H. F. Roberts, Dept. of Plant Physiology, University of Manitoba, Winnipeg, Man.	Analyzing and preparing for publication experimental data on germination and growth of seedlings.
Prof. J. F. Snell, Dept. of Chemistry, Macdonald College, Que.	Study of the adequacy of refractometric methods for the determination of total solids in solutions occurring in factory and refinery practice and in syrups and molasses.
Dr. John Stanley, Dept. of Biology, Queen's University, Kingston, Ont.	Growth of populations of *Tribolium confusum* Duv.
Prof. E. W. R. Steacie, Dept. of Chemistry, McGill University, Montreal, Que.	Exchange reactions involving deuterium.
Dr. T. Thorvaldson, Dept. of Chemistry, University of Saskatchewan, Saskatoon, Sask.	Investigations on concrete deterioration.
International Hydrographic Bureau, Monte Carlo, Monaco.	Preparation of the General Bathymetric Chart of the Oceans.

SCHOLARSHIPS

Forty-seven graduates of Canadian universities were awarded post-graduate scholarships by the National Research Council for 1937–38. The usual awards of Fellowships, Studentships and Bursaries tenable at universities were supplemented this year by five Special Scholarships tenable in the National Research Laboratories. It is intended that these new awards will provide a means for research workers with considerable training to become acquainted with the type of problems to be met with in industry, so that improved service to Canadian industry may be given. Three of these Special Scholarships are of the value of $1000 and two of $750; for the former group only post-doctorate students are eligible and for the latter a master's degree is a requisite. The names of the successful candidates, the university from which each graduated, the institution at which the candidate elected to work, and the subject of study, are tabulated below.

The Twentieth Annual Report contained a summary of scholarship awards and the amounts actually expended by Council on scholarships from 1917–18 to 1936–37. The totals from this summary are given here together with the classification of awards and the expenditure for 1937–38.

Scholarships Held During the Year, 1937-1938

Special Scholarships

Grantee	Graduated	Where Held	Subject of Research
Jones, D. C.	New Brunswick	National Research Council	Physics (Spectroscopy).
Penley, H. H.	Saskatchewan	National Research Council	Physics (Radiology).
Sair, L.	Manitoba	National Research Council	Biology and Agriculture (Malting).
Donald, R. M.	Saskatchewan	National Research Council	Chemistry (Crude oils).
Jack, W. R.	British Columbia	National Research Council	Biology and Agriculture (Application of plant hormones).

Fellowships

Grantee	Graduated	Where Held	Subject of Research
Brown, A. G.	Saskatchewan	McGill	Physical Chemistry.
Howard, Miss A.	McGill	McGill	Cytogenetics.
Walker, L. R.	McGill	McGill	Physics.

Studentships

Grantee	Graduated	Where Held	Subject of Research
Alexander, W. A.	Queen's	McGill	Chemistry.
Eliot, C. G.	McGill	McGill	Organic Chemistry.
Calhoun, J. M.	Alberta	McGill	Physical Chemistry.
Holder, C. H.	Mount Allison	McGill	Physical Chemistry.
Lieff, M.	Queen's	McGill	Cellulose Chemistry.
Neal, G. M.	British Columbia	Toronto	Biology.
Newman, L. T.	Toronto	Toronto	Physics.
Parlee, N. A. deV.	Dalhousie	McGill	Physical Chemistry.
Pelletier, P. E.	Laval	Laval	Inorganic Chemistry.
Piche, L.	Montreal	Montreal	Organic Chemistry.
Smith, W. M.	New Brunswick	McGill	Physical Chemistry.
Ward, A. G.	Queen's	Queen's	Physics.

Bursaries

Grantee	Graduated	Where Held	Subject of Research
Bohonos, N.	Alberta	McGill	Organic Chemistry.
Brickman, L.	Manitoba	McGill	Cellulose Chemistry.
Brown, R. A.	McGill	McGill	Geology.
Crutcher, Miss A. M.	Toronto	Toronto	Physics.
Cushing, I. B.	Saskatchewan	Saskatchewan	Organic Chemistry.
Dacey, J. R.	Dalhousie	Dalhousie	Physical Chemistry.
Davis, J. A.	Western Ontario	Western Ontario	Chemistry.
Ferguson, A. J.	McGill	McGill	Physics.
Fordyce, R. G.	British Columbia	McGill	Cellulose Chemistry.
Godard, H. P.	British Columbia	McGill	Cellulose Chemistry.
Graham, R. P.	Queen's	Queen's	Organic Chemistry.
Hay, G. E.	Toronto	Toronto	Mathematics.
Hay, R. H.	Queen's	Queen's	Physics.
Hogg, A. D.	Saskatchewan	Toronto	Mechanical Engineering.
Janis, Allan A.	Toronto	Toronto	Physical Chemistry.
Johns, H. E.	McMaster	Toronto	Physics.
Katz, L.	Queen's	Queen's	Physics.
Ledingham, G. F.	Saskatchewan	McGill	Genetics.
McIntosh, R. L.	Dalhousie	McGill	Physical Chemistry.
Noble, W. J.	New Brunswick	McGill	Physics.
Pall, D. B.	McGill	McGill	Physical Chemistry.
Potvin, R.	Laval	McGill	Physical Chemistry.
Prebus, A.	Alberta	Toronto	Physics.
Shipley, J. H.	Alberta	McGill	Physical Chemistry.
Siminovitch, D.	McGill	McGill	Botany.
Soley, R. C.	Mount Allison	McGill	Physical Chemistry.
Stallworthy, W. B.	Toronto	Toronto	Biology.

Summary of Scholarship Grants, 1917-18 to 1937-38

Date	Special scholarships*		Fellowships		Studentships		Bursaries		Amount actually expended by Council
	No.	Value	No.	Value	No.	Value	No.	Value	
1917-18 to 1936-37	—	—	98	—	257	—	359	—	$ 585,729.41
1937-1938	3 2	$1,000 $ 750	3	$700	12	$600	27	$500	$ 22,813.00
Totals	5	—	101	—	269	—	386	—	$ 608,542.41

* *Tenable in National Research Laboratories.*

Appointments to the Staff

The following appointments were made to the technical staff of the Laboratories during the year:

Alfred Matte, B.A., 1924, Laval University; B.Sc., Ecole Superieure de Chimie, Laval University, 1928; Junior Research Chemist, Canadian International Paper Co. (Hawkesbury), 1928-1931; Mill control chemist, Viscose Laboratory, Kipawa Mill, Canadian International Paper (Temiscaming), 1931-1937; Chemist-Laboratoire d'Analyses (Quebec), 1937-1938; appointed 15 February, 1938, as Senior Research Assistant, Division of Chemistry.

Stanley Dale Lash, B.Sc., A.C.G.I., 1928, University of London; Ph.D., 1933, University of Birmingham; Bowen Scholar, University of Birmingham, 1932; Three years in reinforced concrete and structural steelwork design (Montreal, Vancouver and London); Four years research on steel and concrete structures including two as research assistant to the Steel Structures Research Committee. Instructor in Civil Engineering, University of British Columbia, 1935-1938; Associate member Institution of Civil Engineers, Institution of Structural Engineers, Engineering Institute of Canada. Appointed as Junior Assistant Engineer, 15 March, 1938, Division of Research Information.

Frederick Thomas Rosser, B.A., 1935, McMaster University, M.A. (with honours), 1936, University of Western Ontario; High School Teacher's certificate, 1936, Ontario College of Education, University of Toronto; Cornell University summer school, 1934. Public School Principal, 1922-1931; Demonstrator in Biology, McMaster University, 1934-1935; Demonstrator in Botany, University of Western Ontario, 1935-1936; Bacteriologist, Swift Canadian Co., Toronto, 1936-1937. Appointed 7 September, 1937, as Junior Research Biologist, Division of Biology and Agriculture.

John Frederick James Thomas, B.Sc., 1933, Queen's University; M.Sc., Queen's University, 1935; Robert Bruce Schloarship, 1930; (Research grant at Queen's University June-Aug., 1933); Demonstrator in Analytical Chemistry, Queen's University, 1934. Analytical chemist (research on silicosis), Hollinger Consolidated Gold Mines Ltd., Timmins, June 1934-June 1937; International Nickel Co., Copper Cliff, September 1937-March 1938. Appointed 1 March, 1938, as Senior Research Assistant, Division of Chemistry.

Lionel Graham Turnbull, B.A. (Engineering Diploma) Mount Allison University, 1930; B.Sc., Mount Allison, 1932; M.A., Dalhousie University, 1933; Ph.D., University of Toronto, 1936. Demonstrator in Physics, Mount Allison University, 1930-31; Demonstrator in Physics, Dalhousie University, 1931-1933; Demonstrator and Lecturer in Physics and Mathematics, summers of 1932, 1933, Maritime Summer Schools, Sackville, N.B.; Demonstrator in Physics, University of Toronto, 1934-1935; Research Associate, Battelle Memorial Institute, Columbus, Ohio, 1936-1937; Special Open Fellowship, University of Toronto, 1935-1936. Appointed 16 August, 1937, as Junior Research Physicist, Division of Physics and Electrical Engineering.

APPENDIX A

Papers Published in the Canadian Journal of Research by the Holders of Assisted Research Grants, Describing Work to which Financial Assistance has been extended by the National Research Council during the Fiscal Year 1937-38

Author	In co-operation with	Title and reference
Boomer, E. H. and Broughton, J. W.	University of Alberta.....	The oxidation of methane at high pressures. I. Preliminary experiments. Can. J. Research, B, 15: 375-382. 1937.
Boomer, E. H. and Johnson, C. A.	University of Alberta.....	The precision combustion analysis of gases. Can. J. Research, B, 15: 363-366. 1937.
Boomer, E. H. and Thomas, V.	University of Alberta, Carnegie Corporation, and Research Council of Alberta.	The oxidation of methane at high pressures. II. Experiments with various mixtures of Viking natural gas and air. Can. J. Research, B, 15: 401-413. 1937.
Boomer, E. H. and Thomas, V.	University of Alberta, Carnegie Corporation, and Research Council of Alberta.	The oxidation of methane at high pressures. III. Experiments using pure methane and principally copper as catalyst. Can. J. Research, B, 15: 414-433. 1937.
Boomer, E. H., Johnson, C. A. and Argue, G. H.	University of Alberta.....	Equilibria in two-phase, gas-liquid hydrocarbon systems. I. Methods and apparatus. Can. J. Research, B, 15: 367-374. 1937.
Boomer, E. H., Johnson, C. A. and Thomas, V.	University of Alberta.....	The preparation of pure methane from natural gas. Can. J. Research, B, 15: 360-362. 1937.
Burns, E. L. M. and Field, R. H.	Department of National Defence, Ottawa.	The radial-stereoplotter. Can. J. Research, A, 15: 85-99. 1937.
Cameron, Thomas W. M...	Institute of Parasitology, Macdonald College, McGill University.	Concepts and mechanisms of resistance in helminthic infections. Can. J. Research, D, 15: 77-90. 1937.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the heterophyid trematode *Apophallus venustus* (Ransom, 1920) in Canada. Can. J. Research, D, 15: 275. 1937.
Cook, W. H., Pavlychenko, T. K., Manson, J. M. and Garrow, P.	University of Saskatchewan and University of Alberta.	Chemical weed killers. III. Relative toxicity of several chemicals to perennials under field conditions. Can. J. Research, C, 15: 442-449. 1937.
Dyer, W. J. and McFarlane, W. D.	Faculty of Agriculture, Macdonald College, McGill University.	A study of the iron in a podsol soil by means of an improved dipyridyl method. Can. J. Research, B. 16: 91-96. 1938.
Dyer, W. J. and Wrenshall, C. L.	Faculty of Agriculture, Macdonald College, McGill University.	An improved method for the determination of phosphate by photoelectric colorimetry. Can. J. Research, B, 16: 97-108. 1938.
Foster, W. R. and Henry. A. W.	University of Alberta.....	Overwintering of certain cereal pathogens in Alberta. Can. J. Research, C, 15: 547-559. 1937.
Fowler, Frances L., Buckland, Irene K., Brauns, Fritz and Hibbert, Harold	McGill University, Canadian Pulp and Paper Association, American Association for the Advancement of Science.	Studies on reactions relating to carbohydrates and polysaccharides. LIII. Structure of the dextran synthesized by the action of Leuconostoc mesenterioides on Sucrose. Can. J. Research, B, 15: 486-497. 1937.
Froman, Darol K. and Stearns, J. C.	Macdonald College and University of Denver.	The altitude effect on the specific ionizing power and zenith angle distribution of cosmic rays. Can. J. Research, A, 16: 29-40. 1938.
Griffiths, Henry J.....	Institute of Parasitology, Macdonald College, McGill University.	Some observations on the overwintering of certain helminth parasites of sheep in Canada. Can. J. Research, D, 15: 156-162. 1937.
Holder, C. H. and Maass, O.	McGill University.....	Density-pressure-temperature relations of the hydrogen chloride-propylene system in the critical temperature-pressure region. Reaction velocity near the critical temperature. Can. J. Research, B, 15: 345-351. 1937.
McRae, John A. and Marion, Léo.	Queen's University.....	A synthesis of 1-hydroxy-2-naphthoic nitrile. Can. J. Research, B, 15: 480-485. 1937.
Malloch, J. G., Geddes, W. F., Larmour, R. K. and McCalla, A. G.	University of Alberta, Grain Research Laboratory, Board of Grain Commissioners, University of Manitoba and University of Saskatchewan.	The quality and grading of frosted wheat. Annual surveys of the 1930 to 1935 western Canadian crops. Can. J. Research, C, 15: 567-592. 1937.
Mather, D. T. and Thorvaldson, T.	University of Saskatchewan....	The action of saturated steam in dicalcium ferrite and on tetracalcium aluminoferrite. Can. J. Research, B, 15: 331-339. 1937.
Miller, M. J.....	Institute of Parasitology, Macdonald College, McGill University.	The parasites of pigeons in Canada. Can. J. Research, D, 15: 91-103. 1937.
Miller, M. J.....	Institute of Parasitology, Macdonald College, McGill University.	The experimental infection of pigeons and poultry with *Ascaridia* and *Heterakis*. Can. J. Research, D, 15: 105-110. 1937.
Moore, R. G. D., Wright, George F., and Hibbert, Harold.	McGill University and Canadian Pulp and Paper Association.	Studies on lignin and related compounds. XXIX. A study of the acidic hydroxyl groups in spruce lignin. Can. J. Research, B, 15: 532-535. 1937.

Author	In co-operation with	Title and reference
Neatby, K. W. and McCalla, A. G.	University of Alberta and Dominion Department of Agriculture.	Correlation between yield and protein content of wheat and barley in relation to breeding. Can. J. Research, C, 16: 1-15. 1938.
Parnell, I. W.	Institute of Parasitology, Macdonald College, McGill University.	Studies on the bionomics and control of the bursate nematodes of horses and sheep. IV. On the lethal effects of some nitrogenous fertilizers on the free-living stages of sclerostomes. Can. J. Research, D, 15: 127-145. 1937.
Sallans, H. R., Snell, J. M., Mackinney, H. W. and McKibbin, R. R.	Macdonald College, McGill University.	Water soluble acid substances in the raw humus of podsol soils. Can. J. Research, B, 15: 315-320. 1937.
Sinclair, A. T. and McCalla, A. G.	University of Alberta	The influence of lipoids on the quality and keeping properties of flour. Can. J. Research, C, 15: 187-203. 1937.
Steacie, E. W. R.	McGill University	The reaction of deuterium atoms with methane at high temperatures. Can. J. Research, B, 15: 264-273. 1937.
Steacie, E. W. R. and Alexander, W. A.	McGill University	Free radicals in organic decomposition reactions. I. The thermal decomposition of mixtures of methyl ether and deutero-acetone. Can. J. Research, B, 15: 295-304. 1937.
Wardle, Robert Arnold and McColl, Ellen Louise.	University of Manitoba	The taxonomy of *Diphyllobothrium latum* (Linné, 1758) in western Canada. Can. J. Research, D, 15: 163-175. 1937.

APPENDIX B

Papers Published by Members of the National Research Council Staff during the Fiscal Year 1937-38

The President of the National Research Council

Title	Reference
Research in Canada	Canadian Society of Cost Accountants and Industrial Engineers, Montreal, 29 September, 1937.
National Research Council	Engineering Institute of Canada, Hamilton Branch, 5 October, 1937.
Research in Canada with special reference to the work of the National Research Council	Canadian Club, Ottawa, 11 December, 1937.
The work of the National Research Council	Shawinigan Falls Chemical Association, 17 January, 1938.
Role of research in national economy and its bearing upon governmental administration.	Canadian Seminar of Public Administration, 2 March, 1938.
Research in Canada with special reference to the work of the National Research Council.	Canadian Club, London, 9 March, 1938.
Research as a national effort	The Professional Institute Journal, April, 1938.

Division of Biology and Agriculture

Author	Title	Reference
Anderson, J. A.	Laboratory malting. I. Equipment	Can. J. Research, C, 15: 204-216. 1937.
Peto, F. H.	Genetical studies on mutants in the progeny of heat-treated barley.	Can. J. Research, C, 15: 217-229. 1937.
Anderson, J. A. and Meredith, W. O. S.	Laboratory malting. II. Precision	Can. J. Research, C, 15: 242-251. 1937.
Anderson, J. A. and Rowland, H.	Studies on malting quality. I. 1935 Variety trials	Sci. Agr. 17: 593-600. 1937.
Cook, W. H. and Halferdahl, A. C.*	Chemical weed killers. A review	National Research Council Bull. 18, 1937.
Cook, W. H.	Chemical weed killers. I. Relative toxicity of various chemicals to four annual weeds.	Can. J. Research, C, 15: 299-323. 1937.
Cook, W. H.	Chemical weed killers. II. Factors affecting estimation of toxicity of leaf sprays.	Can. J. Research, C, 15: 380-390. 1937.
Cook, W. H., Pavlychenko, T. K., Manson, J. M.* and Garrow, P.	Chemical weed killers. III. Relative toxicity of several chemicals to perennials under field conditions.	Can. J. Research, C, 15: 442-449. 1937.
Anderson, J. A. and Rowland, H.	Modified equipment and methods for the routine malting test and a study of its precision.	Sci. Agr. 17: 742-751. 1937.
Sallans, Henry R. and Anderson, J. Ansel	Sources of error in the determination of the diastatic power of malt.	Cereal Chem. 14: 708-720. 1937.
Hopkins, J. W.	Agricultural meteorology. Some characteristics of air temperature in Alberta and Saskatchewan.	Can. J. Research, C, 15: 461-491. 1937.
Cook, W. H.	Chemical weed killers. IV. Relative toxicities and loci of absorption of selected chemicals applied to perennials.	Can. J. Research, C, 15: 451-460. 1937.

*Member of staff of the Division of Research Information.

Division of Chemistry

Author	Title	Reference
Bayley, C. H.	Laminated fabrics, with special reference to starchless collars.	Laundry & Dry Cleaning J. of Canada, April, 1937.
	Weighted silk fabrics	*Idem*, May, 1937.
	Corrosive damage to cotton and linen fabrics	*Idem*, July, 1937.
	Damage in curtain fabrics and window drapes	*Idem*, August, 1937.
	Research guides laundering and cleaning progress	*Idem*, November, 1937.
	Laundering of damask table linen	*Idem*, November, 1937; January and April, 1938.
	Research and service. The work of the Laundry and Cleaning Laboratory, National Research Council, Ottawa, 1937.	*Idem*, February, 1938.
	Science and our clothing	*Idem*, March, 1938.
Gallay, W., and Rosser, G. L.	Vegetable glues for plywood and veneers	Dominion Forset Service Circular, 50, December, 1937.
Gallay, W.	Canadian bentonites	Can. J. Research, B, 16: 6-34. 1938.
Graham, W. E.	Some observations on the physical properties of leather	Shoe and Leather J., November, 1937, 71-72.

DIVISION OF CHEMISTRY—*Concluded*

Author	Title	Reference
Hopkins, C. Y.	Synthetic plastics in aircraft constructions	Engineering J., 1937, 858-859.
Larose, P.	Wool-lanital blends	Can. Textile J., 23 July, 1937, 32-33.
	A new method for the determination of various fibres in mixtures, with special reference to the determination of lanital in wool-lanital mixtures.	Can. J. Research, B, 16: 61-67. 1938.
Manske, R. H.	The alkaloids of Fumariaceous plants. XIV. Corypalline, Corlumidine and their constitutions.	Can. J. Research, B, 15: 159-167. 1937.
	The alkaloids of Fumariaceous plants. XV. *Dicentra Chrysantha* Walp. and *Dicentra ochroleuca* Engelm.	*Idem*, B, 15: 274-277. 1937.
	An alkaloid from *Delphinium brownii* Rydb	*Idem*, B, 16: 57-60. 1938.
	Anlobine, an alkaloid from *Asimina triloba* Dunal	*Idem*, B, 16: 76-80. 1938.
	The alkaloids of Fumariaceous plants. XVI. Some miscellaneous observations.	*Idem*, B, 16: 81-90. 1938.
	Alkaloids	Can. Chem. Process Industries, March, 1938, 72-3, 75.
Marion, L., and McRae, J. A.	A synthesis of 1-hydroxy-2-naphthoic nitrile	Can. J. Research, B, 15: 480-485. 1937.
Pidgeon, L. M.	Studies of carbon black. III. The channel process. Production from pyrolysis waste gases.	*Idem*, B, 15: 139-155. 1937.
	Studies of carbon black. IV. The channel process. The effect of draft control and channel height on rubber reinforcement, sorption, and volatile content.	*Idem*, B, 15: 187-207. 1937.
Stedman, D. F.	Fractionating columns of high efficiency	Can. Chem. & Met., June, 1937, 214-216.
	Improved packed fractionating columns	Can. J. Research, B, 15: 383-400, 1937.
Whitby, G. S., Green, F. G., and DeBlois, W. H.	Advances in Canadian chemical industry	Can. Chem. & Met., June, 1937, 206-208.
		Chem. Met. Eng., June, 1937, 308-310.
	Developments in the chemical industry in Canada	Amer. Inst. Chem. Engineers, 33, 510-530. 1937.
Whitby, G. S.	Tyres	India-Rubber J., 95: 359-360. 1938.

DIVISION OF MECHANICAL ENGINEERING

Author	Title	Reference
Parkin, J. H.	Trans-Atlantic air transport, London-Montreal	Eng. J. 20: 611-647. 1937.
Boomer, E. H. and Broughton, J. W.	The oxidation of methane at high pressures	Can. J. Research, B, 15: 375-382. 1937.
Green, J. J.	Special problems connected with the take-off and landing of aircraft.	Can. J. Research, A, 16: 1-16. 1938.
Tupper, K. F.	Force measurements on stop-log models	Can. J. Research, A, 15: 181-192. 1937.
Kuhring, M. S.	Recent developments in aircraft fuels	Eng. J. 20: 876. 1937.

DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING

Author	Title	Reference
Babbitt, J. D.	Note on testing of aluminum foil insulation	Heating, Piping and Air Conditioning, 9: 577-599. 1937.
Babbitt, J. D.	The spectrum of α-Lyrae	Can. J. Research, A, 15: 161-180. 1937.
Rose, D. C.	The atmospheric potential gradient at Ottawa, Can.	Can. J. Research, A, 15: 119-148. 1937.

DIVISION OF RESEARCH INFORMATION

Author	Title	Reference
Ruedy, R.	Coefficient of heat transfer for vertical surfaces in still air.	Can. J. Research, A, 15: 109-117. 1937.
Gill, A. F.	Industrial standardization	Hardware and Metal, April 2, 1938.
Gill, A. F.	Gasolene standards	Motor in Canada, April, 1938.

APPENDIX C

Publications of the National Research Council

In order to facilitate distribution, a revised list of publications of the National Research Council is being prepared. This list of 773 publications includes Annual Reports of the Council; Technical Reports Nos. 1-18; Bulletins Nos. 1-19; Mimeographed Reports not hitherto listed; papers reprinted from the Canadian Journal of Research which contain (i) reports of experimental work carried on in the National Research Laboratories, (ii) reports of work done elsewhere with financial assistance from the National Research Council.

All of these reports have been arranged and numbered in order of publication. Each paper in the series will now be identified by an "N.R.C. No." Copies of the list of publications may be obtained on request from

The National Research Council,
Ottawa, Canada.

The Canadian Journal of Research has not been included in this series, but particulars with regard to the Journal are given below:

	Price Per Number	Price Per Volume Unbound
Vol. 1, May to December, 1929	$ 0.50	$ 1.50
Vol. 2, January to June, 1930	0.50	1.50
Vol. 3, July to December, 1930	0.50	1.50
Vol. 4, January to June, 1931	0.50	1.50
Vol. 5, July to December, 1931	0.50	1.50
Vol. 6, January to June, 1932	0.50	1.50
Vol. 7, July to December, 1932	0.50	1.50
Vol. 8, January to June, 1933	0.50	1.50
Vol. 9, July to December, 1933	0.50	1.50
Vol. 10, January to June, 1934	0.50	1.50
Vol. 11, July to December, 1934	0.50	1.50
Vol. 12, January to June, 1935	0.50	1.50
Index to Volumes 1-12, Canadian Journal of Research, per copy	$ 1.00	
Vol. 13—		
Sec. A.—Physical Sciences } July to December,		
Sec. B.—Chemical Sciences } 1935	0.50	1.25
Sec. C.—Botanical Sciences } July to December,		
Sec. D.—Zoological Sciences } 1935	0.50	1.25
Four sections complete (Vol. 13)	....	2.00
Vol. 14—		
Sec. A and B, January to December, 1936	0.50	2.50
Sec. C and D, January to December, 1936	0.50	2.50
Four sections complete (Vol. 14)	....	4.00
Vol. 15—		
Sec. A and B, January to December, 1937	0.50	2.50
Sec. C and D, January to December, 1937	0.50	2.50
Four sections complete (Vol. 15)	....	4.00
Vol. 16—		
Sec. A and B, January to December, 1938	0.50	2.50
Sec. C and D, January to December, 1938	0.50	2.50
Four sections complete (Vol. 16)	....	4.00

APPENDIX D

LIST OF MEMBERS OF ASSOCIATE COMMITTEES AND CONFERENCES*

Research Committees

Associate Committee on Aeronautical Research

Air-Commodore E. W. Stedman, O.B.E., A.R.C.Sc., F.R.Ae.S., M.E.I.C., M.I.C.E., Chairman. Chief Aeronautical Engineer, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.
W. A. Acton, B.Sc., Civil Aviation Radio Engineer, Department of Transport, Ottawa, Ont.
F. P. H. Beadle, F.R.S.A., A.F.R.Ae.S., A.F.I.Ae.Sc., National Steel Car Corporation, Hamilton, Ont.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
Wing-Commander A. T. N. Cowley, B.Sc., A.M.E.I.C., R.C.A.F., Superintendent, Air Regulations, Civil Aviation Branch, Department of Transport, Ottawa, Ont.
Squadron-Leader A. Ferrier, M.C., B.Sc., D.I.C., A.M.E.I.C., A.F.R.Ae.S., A.F.I.Ae.Sc., Chief Aeronautical Engineer, Department of Transport, Ottawa, Ont.
T. R. Loudon, B.A.Sc., M.E.I.C., Professor of Applied Mechanics, University of Toronto, Toronto, Ont.
Wing-Commander C. M. McEwen, M.C., D.S.C., Assistant Director, Air Staff Duties, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.
G. McIntyre, B.Sc., F.C.S., M.I.P.T., Chief Chemist, Imperial Oil Ltd., Sarnia, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)* President, National Research Council, Ottawa, Ont.
R. J. Moffett, F.R.S.A., A.M.I.M.E., A.F.R.Ae.S., A.F.I.Ae.S., M.S.A.E. Manager and Chief Engineer, Aircraft Department, Canadian Vickers, Ltd., Montreal, Que.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C., Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
J. Patterson, M.A., F.R.S.C. Director, Meteorological Service, Department of Marine, 315 Bloor Street W., Toronto, Ont.
T. W. Siers, Esq. Superintendent of Maintenance, Canadian Airways Ltd., Winnipeg, Man.
Major H. E. Taber, B.Sc., S.M., S.D. Technical Officer, Royal Canadian Corps of Signals, Department of National Defence, Ottawa, Ont.
M. Windsor, Esq. Armstrong-Siddeley Motors, Ltd., Ottawa, Ont.
James Young, Esq. President, Canadian Pratt and Whitney Aircraft, Ltd., Longueuil, Que.
J. J. Green, B.Sc., A.R.C.Sc., D.I.C., Ph.D., A.F.R.Ae.S., A.F.I.Ae.S., Secretary. Assistant Research Engineer, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

Associate Committee on Asbestos

The President, National Research Council, Chairman.

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Vice-Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
G. M. Boyd, B.Sc., Nicolet Asbestos Mines, Limited, Norbestos, Que.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
A. O. Dufresne, M.Sc. Director, Quebec Bureau of Mines, Quebec, Que.
A. C. Halferdahl, M.A.Sc. National Research Council, Ottawa, Ont.
A. S. Johnson, Jr., Esq. Managing Director, Johnson's Company, Thetford Mines, Que.
Eugene Larochelle, B.A., C.E. Inspector of Mines, Province of Quebec, Quebec, Que.
Captain J. G. Ross. Mines Manager, Asbestos Corporation, Limited, Thetford Mines, Que.
C. H. Shoemaker, B.S., E.M., Room 1062, Sun Life Bldg., Montreal, Que.
O. C. Smith, Esq. President, Bell Asbestos Mines, Ltd., Thetford Mines, Que.
E. E. Spafford, Esq. Quebec Asbestos Corporation, East Broughton, Que.
W. B. Timm, B.Sc. Chief, Bureau of Mines, Department of Mines and Resources, Ottawa, Ont.
A. W. G. Wilson, A.M., Ph.D., M.I.M.M., A.I.M.E., G.S.A. Chief Technical Consultant, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

**As at 31 March, 1938, with some revisions as to official titles and changes in addresses, received subsequently.*

Associate Committee on Coal Classification and Analysis

The President, National Research Council, and the Deputy Minister, Department of Mines and Resources, Joint Chairmen.
F. A. Combe, M.E.I.C., P.E.Q., M.A.S.M.E. Consulting Combustion and Steam Engineer, 1188 Phillips Square, Montreal, Que.
J. B. deHart, M.Sc., M.E.I.C. Superintendent, Correspondence Department, Institute of Technology and Art, Calgary, Alta.
J. R. Donald, B.A., B.Sc., P.E.Q., M.E.I.C. Director, J. T. Donald Company, 1181 Guy Street, Montreal, Que.
George Drummond, B.Sc. Drummond Company, McGill Building, McGill Street, Montreal, Que.
G. S. Eldridge, B.Sc. Consulting Engineer, Cave Building, 567 Hornby Street, Vancouver, B.C.
A. E. Flynn, A.R.S.M., D.I.C. Professor of Mining, Nova Scotia Technical College, Halifax, N.S.
John D. Galloway, M.Sc. 611 Rogers Bldg., Vancouver, B.C.
R. E. Gilmore, M.Sc. Senior Engineer, Division of Fuels, Department of Mines and Resources, Ottawa, Ont.
F. W. Gray, Esq. Assistant General Manager, British Empire Steel Corporation, Sydney, N.S.
B. F. Haanel, B.Sc. Chief, Division of Fuels, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
Chas. R. Hazen, M.Sc. Vice-President, Milton Hersey Company, 980 St. Antoine Street, Montreal, Que.
B. R. MacKay, B.Sc., Ph.D., F.G.S.A., F.R.S.C. Geological Survey Division, Department of Mines and Resources, Ottawa, Ont.
W. E. McCullen, Esq. Department of Lands and Mines, Fredericton, N.B.
T. M. Molloy, Esq. Commissioner of Labour and Industries, Regina, Sask.
J. H. H. Nicolls, M.Sc. Division of Fuels, Department of Mines and Resources, Ottawa, Ont.
L. J. Rogers, B.A.Sc., M.A. Associate Professor of Chemistry, University of Toronto, Toronto, Ont.
F. H. Sexton, D.Sc., LL.D. President, Nova Scotia Technical College, Halifax, N.S.
Edgar Stansfield, M.Sc. Professor of Industrial Research, University of Alberta, Edmonton, Alta.
C. Tasker, M.Sc. Research Fellow in Fuels, Ontario Research Foundation, 47 Queen's Park, Toronto 5, Ont.
L. R. Thomson, M.E.I.C. Consulting Engineer, 620 Cathcart Street, Montreal, Que.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Field Crop Diseases of the National Research Council and the Dominion Department of Agriculture

Robert Newton, Ph.D., D.Sc., F.R.S.C., Joint Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C., Joint Chairman. Director, Science Service, Department of Agriculture, Ottawa, Ont.
E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. Deputy Minister, Department of Agriculture, Ottawa, Ont.
H. T. Güssow, LL.D., F.R.S.C. Dominion Botanist and Associate Director, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)* President, National Research Council, Ottawa, Ont.
L. H. Newman, B.S.A., D.Sc. Dominion Cerealist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. M. Manson, B.S.A., M.Sc., Secretary. Research Plans and Publications Section, National Research Council, Ottawa, Ont.

Western Section

A. H. R. Buller, D.Sc., Ph.D., LL.D., F.R.S., F.R.S.C. Emeritus Professor of Botany, University of Manitoba, Winnipeg, Man.
J. H. Craigie, Ph.D., F.R.S.C. Director, Dominion Rust Research Laboratory, Winnipeg, Man.
W. P. Fraser, M.A. Professor of Biology, University of Saskatchewan, Saskatoon, Sask.
C. H. Goulden, Ph.D. Dominion Rust Research Laboratory, Winnipeg, Man.
J. B. Harrington, B.S.A., Ph.D. Professor of Field Husbandry, University of Saskatchewan, Saskatoon, Sask.

A. W. Henry, M.S.A., Ph.D. Associate Professor of Plant Pathology, Department of Field Crops, University of Alberta, Edmonton, Alta.
K. W. Neatby, Ph.D. Professor of Genetics and Plant Breeding, University of Alberta, Edmonton, Alta.
P. J. Olson, M.Sc., Ph.D. Professor of Plant Science, University of Manitoba, Winnipeg, Man.
G. B. Sanford, B.S.A., M.S., Ph.D. Dominion Laboratory of Plant Pathology, Edmonton, Alta.
P. M. Simmonds, Ph.D. Dominion Laboratory of Plant Pathology, University of Saskatchewan, Saskatoon, Sask.
W. P. Thomson, M.A., Ph.D., F.R.S.C. Professor of Biology, University of Saskatchewan, Saskatoon, Sask.

Eastern Section

D. L. Bailey, Ph.D. Professor of Botany, University of Toronto, Toronto, Ont.
G. H. Berkeley, M.A., Ph.D. Dominion Laboratory of Plant Pathology, St. Catharines, Ont.
Frank L. Drayton, Esq. Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Ont.
F. J. Hockey, Esq. Dominion Laboratory of Plant Pathology, Kentville, N.S.
A. W. McCallum, B.Sc.F., M.A. Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Ont.
H. N. Racicot, B.A. Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Ont.

Associate Committee on Fire Hazard Testing

J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C., Chairman. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
B. G. Ballard, B.Sc. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
W. P. Dobson, M.A.Sc., M.E.I.C., M.A.I.E.E. Chief Testing Engineer, Hydro-Electric Power Commission, 620 University Ave., Toronto, Ont.
Hugh Doran, Esq. Doran Construction Company, 78 Bank Street, Ottawa, Ont.
S. P. Eagleson, Esq. Secretary-Treasurer, National Research Council, Ottawa, Ont.
Ernest Lavigne, B.A.Sc., C.E. Fire Commissioner of the Province of Quebec, Parliament Buildings, Quebec, Que.
Edward McGrath, Esq. Fire Commissioner of Manitoba, 332 Legislative Building, Winnipeg, Man.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)* President, National Research Council, Ottawa, Ont.
Tom Moore, Esq. 82 Seneca Street, Ottawa, Ont.
J. G. Morrow, Esq. Inspecting Engineer, Steel Company of Canada, Ltd., Hamilton, Ont.
W. J. Scott, B.A. Fire Marshal of Ontario, Parliament Buildings, Toronto, Ont.
J. Grove Smith, Esq. Dominion Fire Commissioner, Department of Insurance, 45 Rideau Street, Ottawa, Ont.
A. H. S. Stead, Esq. Manager, Dominion Board of Insurance Underwriters, 388 St. James Street, West, Montreal, Que.
G. E. Thomas, Esq. President and General Manager, La France Fire Engine and Foamite Limited, 195 Weston Road, Toronto 9, Ont.
J. A. Thomas, Esq. Fire Marshal of British Columbia, 823 Vancouver Block, Vancouver, B.C.
G. E. Rickwood, B.Sc., Secretary. Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

Associate Committee on Forestry

Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D., Chairman. President, National Research Council, Ottawa, Ont.
B. F. Avery, B.Sc.F. Woods Manager, Great Lakes Paper Company, Ltd., Fort William, Ont.
A. Bedard, M.A., M.F. Directeur, l'Ecole d'Arpentage et de Genie Forestier, Université Laval, Quebec, Que.
T. F. Blefgen, Esq. Director of Forestry (Alberta), Department of Lands and Mines, Edmonton, Alta.
G. Percy Burchill, B.Sc.F. South Nelson, N.B.

D. Roy Cameron, B.A., B.Sc.F. Dominion Forester, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
G. W. I. Creighton, B.A., B.Sc.F. Provincial Forester, Department of Lands and Forests, Halifax, N.S.
W. A. Delahey, B.Sc.F. Canadian International Paper Co., Sun Life Bldg., Montreal, Que.
J. Miles Gibson, B.Sc. Professor of Forestry, University of New Brunswick, Fredericton, N.B.
D. A. Gillies, Esq. Chairman, Research Committee, Canadian Lumbermen's Association, c/o Gillies Lumber Co., Ltd., Braeside, Ont.
C. D. Howe, M.A., Ph.D. Dean, Faculty of Forestry, University of Toronto, Toronto, Ont.
Howard Kennedy, M.C., B.Sc. Manager, Quebec Forest Industries Association Ltd., 65 St. Anne St., Quebec, Que.
Henri Kieffer, C.E. Chief, Quebec Forest Protection Service, Department of Lands and Forests, Quebec, Que.
W. Lawrence Killam, Esq. B.C. Pulp and Paper Co., 708-14 Bank of Nova Scotia Bldg., Vancouver, B.C.
F. Malcolm Knapp, M.S.F. Professor of Forestry, University of British Columbia, Vancouver, B.C.
A. Koroleff, M.F. Secretary-Forester, Woodlands Section, Canadian Pulp and Paper Association, 3420 University Street, Montreal, Que.
R. W. Lyons, B.Sc.F. Vice-President and General Manager, Bonifas, Marenisco, Michigan, U.S.A.
D. A. Macdonald, B.Sc.F. Assistant Dominion Forester, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
E. C. Manning, B.Sc.F. Chief Forester, Department of Lands, Victoria, B.C.
T. A. McElhanney, B.A.Sc. Superintendent, Forest Products Laboratories, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
G. L. Miller, B.Sc.F. Chief Forester, Department of Lands and Mines, Fredericton, N.B.
G. C. Piché, M.A., M.F. 874 Sherbrooke Street East, Montreal, Que.
E. H. Roberts, Esq. Director of Forests, Department of Natural Resources, Regina, Sask.
R. L. Seaborn, Esq. Manager, Woodlands Department, Mersey Paper Co. Ltd., Liverpool, N.S.
James Smart, Esq. Assistant Controller and Chief Inspector, National Parks Bureau, Department of Mines and Resources, Ottawa, Ont.
Sidney Smith, Esq. Messrs. Bloedel, Stewart & Welch, Ltd., 510 West Hastings Street, Vancouver, B.C.
Colonel H. I. Stevenson, D.S.O. Provincial Forester, Department of Mines and Natural Resources, Winnipeg, Man.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.
Ellwood Wilson, B.A., B.Sc., F.S.F.G.B. Post Office Box 43, Knowlton, Que.
J. O. Wilson, B.A. Association of Forest Engineers of the Province of Quebec, 277 Laurier Avenue, Quebec, Que.
B. M. Winegar, Esq. Canada Creosoting Co., 432 Canada Cement Company Bldg., Montreal, Que.
W. G. Wright, B.S., F.E. Price Brothers & Co., Ltd., Quebec, Que.
E. J. Zavitz, M.S.F. Provincial Forester, Department of Lands and Forests, Toronto, Ont.
J. D. B. Harrison, M.Sc.F., Joint Secretary. Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
S. J. Cook, M.A., Joint Secretary. Officer-in-Charge, Research Plans and Publications Section, National Research Council, Ottawa, Ont.

Associate Committee on Gas Research

The President, National Research Council, Chairman.

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Vice-Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
E. H. Boomer, M.Sc., Ph.D. Associate Professor, Department of Chemistry, University of Alberta, Edmonton, Alta.
P. V. Rosewarne, M.A. Division of Fuels, Department of Mines and Resources, Ottawa, Ont.
Edgar Stansfield, M.Sc. Professor of Industrial Research, University of Alberta, Edmonton, Alta.
R. C. Wallace, M.A., Ph.D., D.Sc., LL.D., F.G.S., F.R.S.C. Vice-Chancellor and Principal, Queen's University, Kingston, Ont.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Grain Research of the National Research Council and the Dominion Department of Agriculture

Robert Newton, Ph.D., D.Sc., F.R.S.C., Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
T. J. Harrison, B.S.A. Assistant Commissioner, Board of Grain Commissioners, Winnipeg, Man.
L. E. Kirk, Ph.D. Dean of Agriculture, University of Saskatchewan, Saskatoon, Sask.
R. K. Larmour, Ph.D. Professor of Chemistry, University of Saskatchewan, Saskatoon, Sask.
J. G. Malloch, Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L.. LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
K. W. Neatby, Ph.D. Professor of Genetics and Plant Breeding, University of Alberta. Edmonton, Alta.
L. H. Newman, B.S.A., D.Sc. Dominion Cerealist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
P. J. Olson, M.Sc., Ph.D. Professor of Plant Science, University of Manitoba, Winnipeg, Man.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. M. Swaine, Ph.D., F.R.S.C., *(Ex officio)*. Director, Science Service, Department of Agriculture, Ottawa, Ont.
W. F. Geddes, Ph.D., F.C.I.C., Secretary. Chemist-in-Charge, Dominion Grain Research Laboratory, Winnipeg, Man.

Associate Committee on Laundry Research

The President, National Research Council, Chairman.

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Vice-Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
Hugh Adams, Esq. Manager, Brighton Laundry Ltd., 826 Bloor Street West, Toronto, Ont.
S. P. Eagleson, Esq. Secretary-Treasurer, National Research Council, Ottawa, Ont.
G. Ross Marshall, Esq. c/o South Shore Laundry Co., St. Lambert, Que.
R. E. Richardson, Esq. Manager, Crown Laundry, Sherbrooke, Que.
H. Vail, Esq. Manager, Vail's Laundry, Ottawa, Ont.
C. H. Bayley, M.A.Sc., M.A., Secretary. Division of Chemistry, National Research Council, Ottawa, Ont.

Associate Committee on Leather Research

The President, National Research Council, Chairman.

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Vice-Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
Charles Annable, Esq. President, Donnell and Mudge, 8th Street, New Toronto, Ont.
G. T. Beardmore, Esq. Beardmore Belting Co., Ltd., Acton, Ont.
S. G. Bennett, B.A.Sc., A.M.E.I.C. Beardmore Leather Limited, 37 Front Street East, Toronto, Ont.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
L. O. Breithaupt, Esq. Breithaupt Leather Co., Corner Weber and Breithaupt Streets, Kitchener, Ont.
Jos. Daoust, Esq. Daoust, Lalonde & Co., Montreal, Que.
E. J. Davis, Jr., Esq. Davis Leather Co., Ltd., Newmarket, Ont.
W. S. Edwards, Esq. Edwards and Edwards, Cobourg, Ont.
K. M. Kilbourn, Esq. Wickett & Craig, Ltd., Don Esplanade, Toronto, Ont.
W. H. Lytle, Esq. A. R. Clarke & Co., Ltd., 633 Eastern Ave., Toronto, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
J. A. Thurston, Esq. c/o J. Leckie Co. Ltd., 220 Cambie Street, Vancouver, B.C.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

73461—10

Associate Committee on Magnesian Products

F. E. Lathe, M.Sc., Chairman. Director, Division of Research Information, National Research Council, Ottawa, Ont.
G. M. Carrie, B.Sc. General Manager, Canadian Refractories Limited, Canada Cement Building, Montreal, Que.
J. W. Craig, B.Sc. Canadian Refractories Limited, Canada Cement Building, Montreal, Que.
H. Fréchette, M.Sc. Chief, Division of Industrial Minerals, Bureau of Mines, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
A. C. Halferdahl, M.A.Sc. National Research Council, Ottawa, Ont.
N. P. Pitt, M.A. Canadian Refractories Limited, Canada Cement Building, Montreal, Que.
D. W. Stewart, B.Sc. Canadian Refractories Limited, Kilmar, Que.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
A. F. Gill, M.A., Secretary. Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Market Poultry of the Dominion Department of Agriculture and the National Research Council

J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C., Chairman. Director, Science Service, Department of Agriculture, Ottawa, Ont.
E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
R. K. Baker, B.A. University of Saskatchewan, Saskatoon, Sask.
E. D. Bonyman, Esq. Dominion Live Stock Branch, Department of Agriculture, Ottawa, Ont.
John I. Brown, Esq. (Chairman, Produce Trade Sub-committee), Manager, Poultry Department, Canada Packers Ltd., Montreal, Que.
J. Burns, Esq. P. Burns and Company, Calgary, Alta.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. Cormie, Esq. Department of Agriculture, Edmonton, Alta.
G. Robertson, Esq. Dominion Poultry Husbandman, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
N. H. Grace, M.A., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
W. R. Graham, B.S.A. Professor and Head of the Department of Poultry, Ontario Agricultural College, Guelph, Ont.
H. S. Gutteridge, B.S.A. Poultry Division, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
C. Henderson, Esq. Henderson-Stuart, 500 McGill Bldg., Montreal, Que.
M. C. Herner, B.S.A. Manitoba Agricultural College, Winnipeg, Man.
G. Hilton, V.S., H.M.R.C.V.S. Veterinary Director General, Department of Agriculture, Ottawa, Ont.
C. R. Ironside, Esq. Manager, Swift Current Produce Company, Swift Current, Sask.
W. A. Landreth, Esq. President and General Manager, Canadian Poultry Pool, 402 Lombard Bldg., Winnipeg, Man.
J. P. Landry, Esq. Department of Agriculture, Truro, N.S.
Rev. Fr. Leopold, D.S.A. Director, Oka Agricultural College, La Trappe, Que.
E. A. Lloyd, M.S.A. Head, Department of Poultry Husbandry, University of British Columbia, Vancouver, B.C.
A. G. Lochhead, B.A., M.Sc., Ph.D. Dominion Agricultural Bacteriologist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
W. A. Maw, M.S.A. Assistant Professor of Poultry Husbandry, Macdonald College, Que.
F. M. Nash, Esq. Senior Poultry Fieldman, Charlottetown, P.E.I.
Robert Newton, Ph.D., D.Sc., F.R.S.C. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
E. M. Raney, Esq. Manager, Produce Department, Swift-Canadian Company, Toronto, Ont.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
G. B. Rothwell, B.S.A. Dominion Live Stock Branch, Department of Agriculture, Ottawa, Ont.
Wm. Scott and Company. 44 Water Street, Vancouver, B.C.
C. H. Weaver, D.V.Sc. Health of Animals Branch, Department of Agriculture, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. A. Wiggins, Esq. Manager, Produce Department, Canada Packers Ltd., West Toronto, Ont.
L. Wood, Esq. Department of Agriculture, Fredericton, N.B.
W. A. Brown, M.S., B.S.A., Secretary. Chief, Poultry Services, Department of Agriculture, Ottawa, Ont.

Associate Committee on Medical Research

Sir Frederick Banting, M.C., M.D., LL.D., D.Sc., F.R.C.S., Chairman. Director, Department of Medical Research, Banting Institute, University of Toronto, Toronto, Ont.

Ex officio Members:

The President, National Research Council.
The Deputy Minister, Department of Pensions and National Health.
The President, Canadian Medical Association.
The President, Royal College of Physicians and Surgeons of Canada.

Members:

G. H. Ettinger, B.A., M.D. Professor, Department of Physiology and Embryology, Faculty of Medicine, Queen's University, Kingston, Ont.
A. Grant Fleming, M.C., M.D., D.P.H., F.R.C.P. Dean of the Faculty of Medicine and Professor of Public Health, McGill University, Montreal, Que.
J. Ernest Gendreau, B.A., L. es Sc., M.D., D.Phil., F.C.I.C. Faculty of Sciences, University of Montreal, Montreal, Que.
Duncan A. Graham, M.B., F.R.C.P. Head of the Department of Medicine, Banting Institute, University of Toronto, Toronto, Ont.
V. E. Henderson, B.E., F.R.C.P. Secretary-Treasurer, The Banting Research Foundation, Toronto, Ont.
T. H. Leggett, M.D., C.M. 287 Elgin Street, Ottawa, Ont.
Donald Mainland, M.B., Ch.B., D.Sc., F.R.S. Professor of Anatomy, Dalhousie University, Halifax, N.S.
C. L. Pierre Masson, M.D. Professor of Pathological Anatomy, University of Montreal, Montreal, Que.
J. C. Paterson, M.B., M.D., L.M.C.C. Director of the Pathological Department, Civic Hospital, Ottawa, Ont.
W. G. Penfield, Litt.B., M.D., B.Sc., M.A., D.Sc., F.R.C.S., F.R.S.C. Professor of Neurology and Neuro Surgery, McGill University, Montreal, Que.
P. H. T. Thorlakson, M.D., C.M., M.R.C.S., L.R.C.P., F.R.C.S. Professor of Surgery, Faculty of Medicine, University of Manitoba, Winnipeg, Man.
Arthur Vallée, M.D. Professor of Pathological Anatomy and Secretary of the Faculty of Medicine, Université Laval, Quebec, Que.
C. B. Stewart, B.Sc.Med., M.D., C.M., L.M.C.C., Assistant Secretary. National Research Council, Ottawa, Ont.

Associate Committee on Metallic Magnesium

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
G. S. Farnham, M.Sc., Ph.D. Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
M. F. Goudge, B.Sc., Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
F. E. Lathe, M.Sc. Director, Division of Research Information, National Research Council, Ottawa, Ont.
John McLeish, B.A., F.S.S. *(Ex officio)*. Director, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
L. M. Pidgeon, M.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
D. F. Stedman, B.A.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
Air-Commodore E. W. Stedman, O.B.E., A.R.C.Sc., F.R.Ae.S., M.E.I.C., M.I.C.E. Chief Aeronautical Engineer, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.
W. B. Timm, B.Sc. Chief, Bureau of Mines, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
A. W. G. Wilson, A.M., Ph.D., M.I.M.M., A.I.M.E., G.S.A. Chief Technical Consultant, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
A. C. Halferdahl, M.A.Sc., Secretary. National Research Council, Ottawa, Ont.

Associate Committee on Oceanography

C. McLean Fraser, M.A., Ph.D., F.R.S.C., Chairman and Secretary. Professor and Head of the Department of Zoology, University of British Columbia, Vancouver, B.C.
A. T. Cameron, M.A., D.Sc., F.I.C., F.C.I.C., F.R.S.C. Chairman, Fisheries Research Board, University of Manitoba, Winnipeg, Man.

83461—10½

Neal M. Carter, Ph.D. Director, Fisheries Experimental Station, Prince Rupert, B.C.
W. A. Clemens, Ph.D. Director, Pacific Biological Station, Nanaimo, B.C.
F. N. Denison, Esq. Meteorological Service, Victoria, B.C.
R. E. Foerster, M.A., Ph.D. Assistant Director, Pacific Biological Station, Nanaimo, B.C.
A. G. Huntsman, B.A., M.B. Professor of Marine Biology, University of Toronto, Toronto, Ont.
A. H. Hutchinson, M.A., Ph.D. Professor and Head of the Department of Botany, University of British Columbia, Vancouver, B.C.
J. P. McMurrich, M.A., Ph.D., LL.D. Professor Emeritus of Anatomy, University of Toronto, 20 Foxbar Road, Toronto, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
John Patterson, M.A., F.R.S.C. Director, Meteorological Service, Toronto 5, Ont.
Sir F. Stupart, F.R.S.C. 15 Admiral Road, Toronto, Ont.

Associate Committee on Parasitology

Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D., Joint Chairman. President, National Research Council, Ottawa, Ont.
A. E. Morgan, M.A., Joint Chairman. Principal, McGill University, Montreal, Que.
Robert Newton, Ph.D., D.Sc., F.R.S.C., Vice-Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. Deputy Minister, Department of Agriculture, Ottawa, Ont.
W. H. Brittain, M.Sc., Ph.D. Vice-Principal, Macdonald College, Que.
A. E. Cameron, V.S. Department of Agriculture, Ottawa, Ont.
T. W. M. Cameron, T.D., M.A., B.Sc., D.Sc., Ph.D., M.R.C.V.S. Director, Institute of Parasitology, Macdonald College, Que.
R. L. Conklin, D.V.M., M.Sc. Veterinarian and Professor of Animal Pathology, Macdonald College, Que.
A. Grant Fleming, M.C., M.D., D.P.H., F.R.C.P. Dean of the Faculty of Medicine and Professor of Public Health, McGill University, Montreal, Que.
R. T. Leiper, M.D., D.Sc., F.R.S. Director, Imperial Bureau of Agricultural Parasitology and of the Institute of Agricultural Parasitology, Winches Farm Drive, Hatfield Road, St. Albans, England.
Adrien Morin, B.S.A. Chief, Live Stock Branch, Department of Agriculture, Quebec, Que.
L. Stevenson, B.V.Sc., M.S. Provincial Zoologist, Ontario Department of Agriculture, Ontario Veterinary College, Guelph, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.
T. Fred Ward, Esq. Secretary, Macdonald College, Que.
S. P. Eagleson, Esq., Secretary. Secretary-Treasurer, National Research Council, Ottawa, Ont.

Associate Committee on Plant Hormones

Robert Newton, Ph.D., D.Sc., F.R.S.C., Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.

Department of Agriculture

E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farm, Department of Agriculture, Ottawa, Ont.
M. B. Davis, B.S.A., M.Sc. Dominion Horticulturist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
F. Dimmock, B.S.A., M.S.A. Dominion Agrostologist, Department of Agriculture, Ottawa, Ont.
H. T. Güssow, LL.D., F.R.S.C. Dominion Botanist and Associate Director, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
L. H. Newman, B.S.A., D.Sc. Dominion Cerealist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.

Department of Mines and Resources

C. Heimburger, Ph.D. Dominion Forest Service, Department of Mines and Resources. Ottawa, Ont.

National Research Council

A. Cambron, B.A., M.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
N. H. Grace, M.A., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
R. H. Manske, M.Sc., Ph.D., F.R.S.C. Division of Chemistry, National Research Council, Ottawa, Ont.
F. H. Peto, B.S.A., M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
Fred T. Rosser, M.A., Secretary. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.

Associate Committee on Potato Research of the National Research Council and the Dominion Department of Agriculture

H. T. Güssow, LL.D., F.R.S.C., Joint Chairman. Dominion Botanist and Associate Director, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Joint Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
L. F. Burrows, B.S.A. Secretary, Canadian Horticultural Council, 114 Vittoria Street, Ottawa, Ont.
M. B. Davis, B.S.A., M.Sc. Dominion Horticulturist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
W. Gallay, B.A., M.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
Arthur Gibson, LL.D., F.R.S.C. Dominion Entomologist, Entomological Branch, Department of Agriculture, Ottawa, Ont.
N. H. Grace, M.A., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
E. S. Hopkins, B.S.A., M.S., Ph.D. Assistant Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
L. S. McLaine, M.Sc. Chief, Division of Plant Protection, Department of Agriculture, Ottawa, Ont.
L. W. Muir, B.S.A. Dominion Animal Husbandman, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
Robert Newton, Ph.D., D.Sc., F.R.S.C. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
F. H. Peto, B.S.A., M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. Robertson, Esq. Dominion Poultry Husbandman, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.
John Tucker, Esq. Chief Inspector, Seed Potato Certification Service, Division of Botany, Department of Agriculture, Ottawa, Ont.
S. J. Cook, M.A., Secretary. Officer-in-Charge, Research Plans and Publications Section, National Research Council, Ottawa, Ont.

Associate Committee on Radio

R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Chairman. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
A. N. Fraser, B.Sc. Department of Transport, Ottawa, Ont.
A. Frigon, B.Sc., D.Sc., A.M.A.I.E.E., A.M.E.I.C. Assistant General Manager, Canadian Broadcasting Corporation, Ottawa, Ont.
Lt.-Commander H. Kingsley. Royal Canadian Navy, Department of National Defence, Ottawa, Ont.
Major W. L. Laurie, R.C.C.S. Department of National Defence, Ottawa, Ont.
H. J. MacLeod, M.Sc., M.A., Ph.D. Professor Electrical Engineering, University of Alberta, Edmonton, Alta.
Commander E. R. Mainguy. Director of Naval Reserve, Royal Canadian Navy, Department of National Defence, Ottawa, Ont.

Squadron Leader R. E. McBurney, B.Sc. Advisory Officer for Air Signals, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. President, National Research Council, Ottawa, Ont.
Gordon Olive, Esq. Chief Engineer, Canadian Broadcasting Corporation, Montreal, Que.
A. S. Runciman, E.E. Superintendent of Transmission Lines, Shawinigan Water and Power Co., Power Building, Craig Street West, Montreal, Que.
V. G. Smith, B.A.Sc. Assistant Professor of Electrical Engineering, University of Toronto, Toronto, Ont.
Lt.-Col. W. A. Steel, M.C., B.A.Sc. Consulting Radio Engineer, Ottawa Electric Building, Ottawa, Ont.
H. J. Vennes, B.A., F.A.S.A., M.I.R.E., A.M.E.I.C. Transmission Engineer, Northern Electric Co., 1261 Shearer Street, Montreal, Que.
J. T. Henderson, M.Sc., Ph.D., Secretary. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.

Associate Committee on Radiology

Frank Allen, M.A., Ph.D., LL.D., F.R.S.C., Chairman. Head of the Department of Physics, University of Manitoba, Winnipeg, Man.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
S. P. Eagleson, Esq. Secretary-Treasurer, National Research Council, Ottawa, Ont.
J. Ernest Gendreau, B.A., L. es Sc., M.D., D.Phil., F.C.I.C. Faculty of Sciences, University of Montreal, Montreal, Que.
J. A. Gray, O.B.L., B.S., D.Sc., F.R.S.C. The Chown Research Professor of Physics, Queen's University, Kingston, Ont.
E. L. Harrington, A.M., Ph.D., F.Am.P.S., F.R.S.C. Professor of Physics, University of Saskatchewan, Saskatoon, Sask.
G. H. Henderson, M.A., Ph.D., F.R.S.C. Professor of Mathematical Physics, Dalhousie University, Halifax, N.S.
S. R. Johnston, M.D. Radiologist, Victoria General Hospital, Halifax, N.S.
W. A. Jones, M.D., F.R.C.P.(C). Cancer Clinic, Kingston General Hospital, Kingston, Ont.
John D. Leitch, Esq. Physicist, Ontario Department of Health, Parliament Buildings, Toronto, Ont.
P. A. Macdonald, M.Sc., Ph.D. Radium Physicist, Department of Physics, University of Manitoba, Winnipeg, Man.
W. R. McClelland, Esq. Division of Metallic Minerals, Department of Mines and Resources, Ottawa, Ont.
Herbert McGuffin, M.D. Director, Radium and X-ray Institute, 224 - 7th Ave. West, Calgary, Alta.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
R. K. Paterson, M.D. Head of the Radiology Department, Ottawa Civic Hospital, Ottawa, Ont.
Edmour Perron, M.D. Director, Department of Electroradiology, St. Sacrement Hospital, Quebec, Que.
A. H. Pirie, M.D., Royal Victoria Hospital, Montreal, Que.
C. W. Proud, M.D. Radiologist, St. Paul's Hospital, Vancouver, B.C.
G. E. Richards, M.B. Director, Department of Radiology, Toronto General Hospital, Toronto, Ont.
W. Lloyd Ritchie, M.B. Montreal General Hospital, Montreal, Que.
J. K. Robertson, M.A., F.R.S.C. Professor of Physics, Queen's University, Kingston, Ont.
Earle E. Shepley, M.D. Radiologist, Saskatoon, Sask.
G. M. Shrum, M.A., Ph.D. Associate Professor of Physics, University of British Columbia, Vancouver, B.C.
Geo. S. Young, M.D. Medical Arts Building, Toronto, Ont.
G. C. Laurence, M.Sc., Ph.D., Secretary. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.

Canadian Committee on Storage and Transport of Food

Executive:

Robert Newton, Ph.D., D.Sc., F.R.S.C., Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
A. T. Cameron, M.A., D.Sc., F.I.C., F.C.I.C., F.R.S.C. Chairman, Fisheries Research Board, University of Manitoba, Winnipeg, Man.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.

A. M. Shaw, B.S.A. Director of Marketing Service, Department of Agriculture, Ottawa, Ont.
J. F. Singleton, Esq. Associate Director of Marketing Service (Dairy Products), Department of Agriculture, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.
J. M. Manson, B.S.A., M.Sc., Secretary. Research Plans and Publications Section, National Research Council, Ottawa, Ont.

Ex officio Members:

President, National Research Council.
Secretary-Treasurer, National Research Council.

Members at Large:

E. S. Archibald, B.A., B.S.A., LL.D., D.Sc. Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
George Hilton, V.S., H.M.R.C.V.S. Veterinary Director General, Department of Agriculture, Ottawa, Ont.
G. Robertson, Esq. Dominion Poultry Husbandman, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
L. D. Wilgress, B.A. Director, Commercial Intelligence Service, Department of Trade and Commerce, Ottawa, Ont.

Fruit and Vegetables Section

M. B. Davis, B.S.A., M.Sc., Convener. Dominion Horticulturist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
H. T. Güssow, LL.D., F.R.S.C. Dominion Botanist and Associate Director, Science Service. Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
A. G. Lochhead, B.A., M.Sc., Ph.D. Dominion Agricultural Bacteriologist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
H. R. Murray, M.Sc. Assistant Professor of Horticulture, Macdonald College, Que.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Servcie, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. H. Truscott, M.Sc., Ph.D. Department of Horticulture, Ontario Agricultural College, Guelph, Ont.
Colonel R. L. Wheeler. Associate Director of Marketing Service (Fruit), Department of Agriculture, Ottawa, Ont.

Meat and Meat Products Section

W. H. Cook, M.Sc., Ph.D., Convener. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
W. A. Brown, M.S., B.S.A. Chief, Poultry Services, Live Stock Branch, Department of Agriculture, Ottawa, Ont.
N. E. Gibbons, M.A., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
H. S. Gutteridge, B.S.A. Poultry Division, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
E. G. Hood, Ph.D. Chief, Division of Dairy Research, Department of Agriculture, Ottawa, Ont.
A. G. Lochhead, B.A., M.Sc., Ph.D. Dominion Agricultural Bacteriologist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
F. H. S. Lowrey, V.S. Divisional Superintendent, Meat Inspection, Department of Agriculture, Ottawa, Ont.
W. A. Maw, M.S.A. Assistant Professor of Poultry Husbandry, Macdonald College, Que.
G. W. Muir, B.S.A. Dominion Animal Husbandman, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
L. W. Pearsall, B.S.A. Assistant Chief, Marketing Service, Department of Agriculture, Ottawa, Ont.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.

Fish Section

D. B. Finn, Ph.D., Convener. Director, Fisheries Experimental Station, Halifax, N.S.
S. A. Beatty, M.A., Ph.D. Fisheries Experimental Station, Halifax, N.S.
N. M. Carter, M.A.Sc., Ph.D., F.R.G.S. Director, Fisheries Experimental Station, Prince Rupert, B.C.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
N. E. Gibbons, M.A., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
A. Labrie, D.Sc. Fisheries Experimental Station, Grand River, Gaspé, Que.
A. G. Lochhead, B.A., M.Sc., Ph.D. Dominion Agricultural Bacteriologist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
I. L. Pugsley, Ph.D. Fisheries Experimental Station, Prince Rupert, B.C.

Engineering Section

C. A. Winkler, Ph.D., Convener. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
D. LeB. Cooper, M.Sc., Ph.D. Fisheries Experimental Station, Halifax, N.S.
C. D. Niven, B.Sc., M.A., Ph.D. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
Colonel R. L. Wheeler. Associate Director of Marketing Service (Fruit), Department of Agriculture, Ottawa, Ont.
O. C. Young, Esq. Fisheries Experimental Station, Prince Rupert, B.C.

Taints Panel

C. A. Winkler, Ph.D., Convener. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
M. B. Davis, B.S.A., M.Sc. Dominion Horticulturist, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
H. A. Derby, Ph.D. Chief, Division of Dairy Markets and Cold Storage, Department of Agriculture, Ottawa, Ont.
E. G. Hood, Ph.D. Chief, Division of Dairy Research, Department of Agriculture, Ottawa, Ont.
S. C. McLennan, Esq. Marketing Service (Transportation), Department of Agriculture, Ottawa, Ont.
Colonel R. L. Wheeler. Associate Director of Marketing Service (Fruit), Department of Agriculture, Ottawa, Ont.

Associate Committee on Survey Research

Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D., Chairman. President, National Research Council, Ottawa, Ont.
W. H. Boyd, B.Sc. Chief, Topographical Survey, Bureau of Geology and Topography, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
Lt.-Col. E. L. M. Burns, O.B.E., M.C. General Staff Officer, 1254 Bishop Street, Montreal, Que.
R. D. Craig, B.S.A., F.E. Forest Economist, Forest Service, Department of Mines and Resources, Ottawa, Ont.
A. L. Cumming, B.Sc., D.L.S. Superintendent, Mackenzie District, N.W.T.; and Secretary, Yukon Affairs, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
R. J. Fraser, Esq. Senior Hydrographer, Hydrographic and Map Service, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.
F. C. C. Lynch, Esq. Chief, Bureau of Geology and Topography, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
Major J. E. Lyon. Geographical Section, General Staff, Department of National Defence, Ottawa, Ont.
Squadron-Leader A. L. Morfee. Assistant Staff Officer, Operations, Royal Canadian Air Force, Ottawa, Ont.
Noel J. Ogilvie, D.L.S., M.E.I.C. Dominion Geodesist, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

F. H. Peters, D.L.S. Surveyor General; and Chief, Hydrographic Service, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.
J. M. Wardle, B.Sc., M.E.I.C. Director, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.
A. M. Narraway, B.Sc., D.L.S., Joint Secretary. Consulting Aerial Surveys Engineer, Bureau of Geology and Topography, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
L. E. Howlett, M.A., Ph.D., Joint Secretary. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.

Subcommittee on Mapping Methods

R. B. McKay, Esq. Topographical Surveys Division, Department of Mines and Resources, Ottawa, Ont.
R. D. Craig, B.S.A., F.E. Forest Economist, Department of Mines and Resources, Ottawa, Ont.
R. D. Davidson, Esq. Geographical Section, Department of National Defence, Ottawa, Ont.
R. H. Field, Esq. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
R. J. Fraser, Esq. Senior Hydrographer, Department of Mines and Resources, Ottawa, Ont.
L. E. Howlett, M.A., Ph.D. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
F. T. Jenkins, Esq. Canadian Airways Ltd., 1011 Confederation Bldg., Montreal, Que.
Major John E. Lyon. Geographical Section, Department of National Defence, Ottawa, Ont.
P. E. Palmer, Esq. Aerial Survey Engineer, Department of Mines and Resources, Ottawa, Ont.
James W. Paterson, Esq. Woods Manager, E. B. Eddy Company, Hull, Que.
F. R. Wilcox, Esq. Canadian International Paper Co., Maniwaki, Que.

Subcommittee on Photographic Aircraft and Cameras

Air Vice-Marshall G. M. Croil, Convener. Department of National Defence, Ottawa, Ont.
Major John E. Lyon. Geographical Section, Department of National Defence, Ottawa, Ont.
R. B. McKay, Esq. Topographical Surveys Division, Department of Mines and Resources, Ottawa, Ont.
Squadron-Leader A. L. Morfee. Assistant Staff Officer, Operations, Royal Canadian Air Force, Ottawa, Ont.
A. M. Narraway, B.Sc., D.L.S. Consulting Aerial Surveys Engineer, Bureau of Geology and Topography, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
Air-Commodore E. W. Stedman, O.B.E., M.I.C.E., M.E.I.C., F.R.Ae.S., A.R.C.Sc. Chief Aeronautical Engineer, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.

Subcommittee on Photography

L. E. Howlett, M.A., Ph.D., Convener. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
W. H. Miller, Esq. Department of Mines and Resources, Ottawa, Ont.
Squadron-Leader A. L. Morfee. Assistant Staff Officer, Operations, Royal Canadian Air Force, Ottawa, Ont.
H. E. Seeley, Esq. Dominion Forest Service, Department of Mines and Resources, Ottawa, Ont.
D. F. Stedman, B.A.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
Squadron-Leader C. C. Walker. Department of National Defence, Ottawa, Ont.
J. G. Wright, B.S., F.E. Dominion Forest Service, Department of Mines and Resources, Ottawa, Ont.

Subcommittee on Survey Instruments

J. L. Rannie, Esq., Convener. Geodetic Service, Department of Mines and Resources, Ottawa, Ont.
W. M. Dennis, Esq. Geodetic Service, Department of Mines and Resources, Ottawa, Ont.
R. H. Field, Esq. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
R. J. Fraser, Esq. Senior Hydrographer, Department of Mines and Resources, Ottawa, Ont.
R. B. McKay, Esq. Topographical Surveys Division, Department of Mines and Resources, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

Harry Parry, Esq. Department of Mines and Resources, Ottawa, Ont.
M. F. Phelan, Esq. Department of National Defence, Ottawa, Ont.
H. E. Seeley, Esq. Dominion Forest Service, Department of Mines and Resources, Ottawa, Ont.
B. W. Waugh, Esq. Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.

Subcommittee on Survey Museum

L. E. Howlett, M.A., Ph.D., Convener. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
Gordon M. Dallyn, Esq. Canadian Geographical Society, Ottawa, Ont.
Major John E. Lyon. Geographical Section, Department of National Defence, Ottawa, Ont.
P. E. Palmer, Esq. Aerial Survey Engineer, Department of Mines and Resources, Ottawa, Ont.
Harry Parry, Esq. Department of Mines and Resources, Ottawa, Ont.
President of the Canadian Institute of Surveying, *(Ex officio)*. Ottawa, Ont.

Associate Committee on Trail Smelter Smoke

The President, National Research Council, Chairman.

G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. Deputy Minister, Department of Agriculture, Ottawa, Ont.
Charles Camsell, B.Sc., LL.D., F.R.S.C. Deputy Minister, Department of Mines and Resources, Ottawa, Ont.
F. E. Lathe, M.Sc. Director, Division of Research Information, National Research Council, Ottawa, Ont.
J. E. Read, K.C. Department of External Affairs, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C. Sc., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
S. P. Eagleson, Esq., Secretary. Secretary-Treasurer, National Research Council, Ottawa, Ont.

Associate Committee on Tuberculosis

The President, National Research Council, Chairman.

G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. Deputy Minister, Department of Agriculture, Ottawa, Ont.
J. A. Baudouin, M.D., D.P.H. Director, Ecole d'Hygiene sociale appliquée, Maple Wood Avenue, Montreal, Que.
J. G. FitzGerald, M.D., LL.D., F.R.S.C. Professor of Hygiene and Preventive Medicine; and Director, Connaught Laboratories and School of Hygiene, University of Toronto, Toronto, Ont.
Armand Frappier, B.A., M.D., L. es Ch.Sc. Head of the Department of Bacteriology, University of Montreal, Montreal, Que.
S. Hadwen, D.V.S., F.E.S. Director of Veterinary Science, Ontario Research Foundation, 47 Queen's Park, Toronto, Ont.
George Hilton, V.S., H.M.R.C.V.S. Veterinary Director General, Department of Agriculture, Ottawa, Ont.
D. J. MacKenzie, M.D. Director, Provincial Health Laboratory, Halifax, N.S.
C. D. McGilvray, M.D.V., D.V.Sc. Principal, Ontario Veterinary College, Guelph, Ont.
J. C. Meakins, M.D., F.R.S.P., F.R.S.(E)., F.R.S.C. Professor of Medicine and Director of the Department, Director of the University Clinic, McGill University; and Physician-in-Chief, Royal Victoria Hospital, Montreal, Que.
A. G. Nicholls, M.A., M.D., C.M., D.Sc., F.R.S.C. c/o Canadian Medical Association, 3640 University Street, Montreal, Que.
Maurice G. Panisset, B. es L. et Sc., D.V. Professor of Infectious Diseases, Quebec Veterinary School, La Trappe, Que.
T. Parizeau, M.D. Faculty of Medicine, University of Montreal, Montreal, Que.
A. C. Rankin, C.M.G., M.D., C.M., D.P.H., M.R.C.S. Professor of Bacteriology and Hygiene, Director of Provincial Laboratory, and Dean of the Faculty of Medicine, University of Alberta, Edmonton, Alta.
G. B. Reed, B.Sc., Ph.D. Professor of Bacteriology, Queen's University, Kingston, Ont.
A. Savage, B.S.A., D.V.M., M.R.C.V.S. Dean, Manitoba Agricultural College, Winnipeg, Man.
W. Stuart Stanbury, B.A., M.D. Pathologist, Mountain Sanatorium, Hamilton, Ont.
E. L. Stone, M.B., C.M.G. Director of Medical Services, Department of Mines and Resources, Ottawa, Ont.

J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. *(Ex officio)*. Director, Science Service, Department of Agriculture, Ottawa, Ont.
P. R. Talbot, V.S., D.V.M. Provincial Veterinarian, Department of Agriculture, Edmonton, Alta.
Arthur Vallée, M.D. Professor of Pathology and Bacteriology, Laval University, Quebec, Que.
E. A. Watson, V.S. Chief Pathologist, Department of Agriculture, Ottawa, Ont.
G. J. Wherrett, M.D., M.R.C.P. Executive Secretary, Canadian Tuberculosis Association, Plaza Building, Ottawa, Ont.
R. E. Wodehouse, O.B.E., M.D., D.P.H. Deputy Minister, Department of Pensions and National Health, Ottawa, Ont.
S. P. Eagleson, Esq., Secretary. Secretary-Treasurer, National Research Council, Ottawa, Ont.

Associate Members

W. A. Dryden, Esq. Brooklin, Ont.
P. H. Moore, B.S.A. Superintendent, Colony Farm, Essondale, B.C.
R. R. Ness, Esq. Howick, Que.
D. Raymond, Esq. President, Windsor Hotel, Montreal, Que.
R. A. Wright, Esq. President, Western Canada Livestock Union, Drinkwater, Sask.

Associate Committee on Weeds of the Dominion Department of Agriculture and the National Research Council

E. S. Hopkins, B.S.A., M.S., Ph.D., Joint Chairman. Assistant Director, Dominion Experimental Farms, Department of Agriculture, Ottawa, Ont.
Robert Newton, Ph.D., D.Sc., F.R.S.C., Joint Chairman. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. *(Ex officio)*. Deputy Minister, Department of Agriculture, Ottawa, Ont.
George Batho, Esq. Secretary, Weeds Commission, Department of Agriculture, Winnipeg, Man.
W. H. Cook, M.Sc., Ph.D. Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
J. G. Coulson, M.A. Assistant Professor of Plant Pathology, Macdonald College, Que.
H. Groh, B.S.A. Division of Botany, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
J. B. Harrington, B.S.A., Ph.D. Professor of Field Husbandry, University of Saskatchewan, Saskatoon, Sask.
A. W. Henry, M.S.A., Ph.D. Associate Professor of Plant Pathology, University of Alberta, Edmonton, Alta.
J. E. Howitt, M.S. Department of Botany, Ontario Agricultural College, Guelph, Ont.
L. E. Kirk, B.A., M.S.A., Ph.D. Dean of Agriculture, University of Saskatchewan, Saskatoon, Sask.
F. E. Lathe, M.Sc. Director, Division of Research Information, National Research Council, Ottawa, Ont.
O. S. Longman, Esq. Field Crops Commissioner, Department of Agriculture, Edmonton, Alta.
Georges Maheux, B.A., F.E. Entomologist, Department of Agriculture, Quebec, Que.
R. H. Manske, M.Sc., Ph.D., F.R.S.C. Division of Chemistry, National Research Council, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
G. P. McRostie, M.S.A., Ph.D. Professor of Agronomy, Ontario Agricultural College, Guelph, Ont.
Walter R. Shaw, Esq. Department of Agriculture, Charlottetown, P.E.I.
J. D. Smith, Esq. Director of Crops, Seeds and Weeds Branch, Department of Agriculture, Toronto, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. *(Ex officio)*. Director, Science Service, Department of Agriculture, Ottawa, Ont.
C. Sweet, B.S.A. Chief, Seed Division, Seed Branch, Department of Agriculture, Ottawa, Ont.
E. M. Taylor, Esq. Field Husbandman, Soils and Crops Division, Department of Agriculture, Fredericton, N.B.
C. Tice, Esq. Field Crops Commissioner, Department of Agriculture, Victoria, B.C.
S. H. Vigor, B.S.A. Field Crops Commissioner, Department of Agriculture, Regina, Sask.
W. H. Wright, B.S.A., Secretary. Chief, Laboratory Division, Seed Branch, Department of Agriculture, Ottawa, Ont.

Associate Committee on Wool of the National Research Council and the Dominion Department of Agriculture

The President, National Research Council, Chairman.

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Vice-Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
G. S. H. Barton, C.M.G., B.S.A., D.Sc.A. Deputy Minister, Department of Agriculture, Ottawa, Ont.
A. E. Craig, Esq. Sales Manager, Barrymore Cloth Company, 1179 King Street West, Toronto 2, Ont.
D. C. Dick, Esq. President, Textile Dyers Corporation, Cobourg, Ont.
W. H. Fairfield, M.S., LL.D. Superintendent, Experimental Farm, Lethbridge, Alta.
Major D. Hallam. Secretary, Canadian Woollen and Knit Goods Manufacturers' Association, 350 Bay Street, Toronto 2, Ont.
P. Larose, M.Sc., Ph.D. Division of Chemistry, National Research Council, Ottawa, Ont.
H. W. Lundy, Esq. Manager, Penman's Ltd., Paris, Ont.
A. A. MacMillan, B.S.A. Live Stock Branch, Department of Agriculture, Ottawa, Ont.
A. Morin, B.S.A. Chief, Live Stock Branch, Department of Agriculture, Quebec, Que.
Robert Newton, Ph.D., D.Sc., F.R.S.C. Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont.
G. E. O'Brien, B.S.A. Manager, Canadian Co-operative Wool Growers, 217 Bay Street, Toronto 2, Ont.
D. N. Panabaker, Esq. Hespeler, Ont.
G. B. Rothwell, B.S.A. Live Stock Commissioner, Department of Agriculture, Ottawa, Ont.
J. P. Sackville, B.S.A., M.A. Professor of Animal Husbandry, University of Alberta, Edmonton, Alta.
A. M. Shaw, B.S.A. Director of Marketing, Department of Agriculture, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. *(Ex officio)*. Director, Science Service, Department of Agriculture, Ottawa, Ont.
W. H. J. Tisdale, B.S.A. Assistant Manager, Canadian Co-operative Wool Growers, 217 Bay Street, Toronto 2, Ont.
F. A. J. Zeidler, M.A., Ph.D., F.C.I.C. Chemical Engineer, 134 College Street, Toronto, Ont.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

ADVISORY COMMITTEES

Associate Committee on Chemical Standards

G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Chairman. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
H. E. Bigelow, Ph.D., F.R.S.C. Director, Chemistry Department, Mount Allison University, Sackville, N.B.
A. F. G. Cadenhead, Esq. Shawinigan Chemicals, Ltd., Shawinigan Falls, Que.
R. H. Clark, Ph.D., F.R.S.C. Professor of Chemistry, University of British Columbia, Vancouver, B.C.
H. Wyatt Johnson, Ph.D. Chief, Pulp and Paper Division, Forest Products Laboratories of Canada, Department of Mines and Resources, Montreal, Que.
H. M. Lancaster, B.A.Sc. Chief Dominion Analyst, Food and Drugs Laboratory, Corner Sussex and John Streets, Ottawa, Ont.
F. E. Lathe, M.Sc. Director, Division of Research Information, National Research Council, Ottawa, Ont.
I. R. McHaffie, B.A., D.Sc. Canadian Industries Ltd., Beaver Hall Bldg., Box 1260, Montreal, Que.
Gordon C. McEwen, B.A. Vice-President and General Manager, Imperial Varnish & Colour Co., Ltd., 8 Morse Street, Toronto, Ont.
Gordon McIntyre, Esq. Chief Chemist, Imperial Oil Ltd., Sarnia, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
A. O. Ponder, Esq. General Manager, Dominion Tar and Chemical Co., Ltd., Canada Cement Company Bldg., Montreal, Que.
C. H. Robinson, B.A. Dominion Agricultural Chemist, Science Service, Central Experimental Farm, Department of Agriculture, Ottawa, Ont.
Mgr. Alexandre Vachon, M.A., Ph.M., S.T.D., D.Sc., LL.D., F.R.S.C., F.C.I.C. Dean, Faculty of Science, Université Laval, Quebec, Que.
E. Viens, Esq. Director, Testing Laboratories, Department of Public Works, Ottawa, Ont.
C. H. Wright, M.Sc., Ph.D. Chemical Department, Consolidated Mining and Smelting Company of Canada, Ltd., Trail, B.C.
S. J. Cook, M.A., Secretary. Officer-in-Charge, Research Plans and Publications Section, National Research Council, Ottawa, Ont.

Associate Electrical Committee

R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Chairman. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
B. G. Ballard, B.Sc. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
de Gaspé Beaubien, B.Sc. Consulting Engineer, Room 1104, University Tower, 660 St. Catherine Street, Montreal, Que.
J. T. Burt-Gerrans, Phm.B., M.A., Ph.D., F.C.I.C. Associate Professor of Electro-Chemistry, University of Toronto, Toronto, Ont.
C. V. Christie, M.Sc., M.E.I.C. Professor of Electrical Engineering, McGill University, Montreal, Que.
J. L. Clarke, M.E.I.C., B.Sc. Transmission and Foreign Wire Relations Engineer, Bell Telephone Company of Canada, Montreal, Que.
W. P. Dobson, M.A.Sc., M.E.I.C., M.A.I.E.E. Chief Testing Engineer, Hydro-Electric Power Commission of Ontario, 620 University Ave., Toronto, Ont.
E. P. Fetherstonhaugh, M.C., B.Sc. Dean of the Faculty of Engineering and Architecture, University of Manitoba, Winnipeg, Man.
A. Frigon, B.Sc., D.Sc., A.M.A.I.E.E., A.M.E.I.C. Assistant General Manager, Canadian Broadcasting Corporation, Montreal, Que.
A. G. Grier, M.Sc., A.M.A.I.E.E. Manager, Distribution Equipment Division, Canadian General Electric Company, Ltd., Toronto, Ont.
E. Holder, Esq. Meter Engineer, Shawinigan Water and Power Co., Power Building, Montreal, Que.
Alex. Larivière, C.E., B.A.Sc., M.E.I.C., A.M.I.R.E. Quebec Public Service Commission, Court House, Quebec, Que.
George W. Lawrence, B.A.Sc. Manager, Sangamo Company, Ltd., 183 George Street, Toronto, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
J. F. Neild, Esq. Toronto Transportation Commission, 35 Yonge Street, Toronto, Ont.
H. W. Price, B.A.Sc. Professor of Electrical Engineering, University of Toronto, Toronto, Ont.
A. S. Runciman, E.E. Superintendent of Transmission Lines, Shawinigan Water and Power Co., Power Bldg., Craig Street W., Montreal, Que.
M. V. Sauer, M.E.I.C., B.A.Sc. Hydraulic Engineer and General Superintendent, Generating Stations, Electrical Department, Montreal Light, Heat and Power Consolidated, Montreal, Que.
V. G. Smith, B.A.Sc. Assistant Professor of Electrical Engineering, University of Toronto, Toronto, Ont.
J. L. Stiver, B.A.Sc. Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa, Ont.
A. J. Grant, B.Sc., Secretary. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
J. A. Ouimet, B.A., B.Eng., Assistant Secretary. Canadian Broadcasting Corporation, Ottawa, Ont.

Associate Committee on Engineering Standards

J. G. Morrow, Esq., Chairman. Inspecting Engineer, Steel Company of Canada, Ltd., Hamilton, Ont.
J. M. R. Fairbairn, Esq., Vice-Chairman. Chief Engineer, Canadian Pacific Railway Co., Montreal, Que.
H. H. Vaughan, Esq., Vice-Chairman. Consulting Engineer, 1111 Beaver Hall Hill, Montreal, Que.
R. J. Durley, M.I.C.E., M.E.I.C., M.A.S.M.E., Honourary Secretary. General Secretary, Engineering Institute of Canada, 2050 Mansfield Street, Montreal, Que.
H. G. Bertram, Esq. The John Bertram & Sons Co., Ltd., Dundas, Ont.
F. L. C. Bond, Esq. General Superintendent, Canadian National Railways, Montreal, Que.
R. W. Boyle, M.Sc., Ph.D., F.R.S.C. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
J. G. Broderick, Esq. Council of Canadian Purchasing Agents' Associations, Hamilton, Ont.
C. B. Brown, Esq. Canadian National Railways, Montreal, Que.
Major G. A. Browne, Esq. Assistant General Superintendent, Engineering Branch, Department of Pensions and National Health, Ottawa, Ont.
Col. C. J. Burritt. 53 Queen Street, Ottawa, Ont.
J. C. Callaghan, Esq. Steel Company of Canada, Ltd., Hamilton, Ont.
J. S. Cameron, Esq. Northern Electric Co., Ltd., Montreal, Que.
K. M. Cameron, Esq. Chief Engineer, Department of Public Works, Ottawa, Ont.
E. V. Caton, Esq. Winnipeg Electric Company, Winnipeg, Man.

C. V. Christie, B.Sc., M.A. Professor of Electrical Engineering, McGill University, Montreal, Que.
A. L. Clark, B.Sc., Ph.D., F.R.S.C., Hon. M.E.I.C. Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
W. P. Copp, B.A., B.Sc., M.E.I.C. Professor of Civil Engineering and Head of the Department, Dalhousie University, Halifax, N.S.
H. A. Cooch, Esq. Canadian Westinghouse Co., Ltd., Hamilton, Ont.
A. H. Cowie, Esq. Dominion Bridge Co., Ltd., Montreal, Que.
Eng. Commander A. D. M. Curry. Director of Naval Engineering, Department of National Defence, Ottawa, Ont.
W. P. Dobson, M.A.Sc., M.E.I.C., M.A.I.E.E. Chief Testing Engineer, Hydro-Electric Power Commission of Ontario, 620 University Avenue, Toronto, Ont.
McN. Dubose, Esq. Saguenay Power Company, Ltd., Arvida, Que.
P. M. Draper, Esq. Trades and Labour Congress of Canada, Ottawa, Ont.
Commander C. P. Edwards, O.B.E., F.I.R.E., A.M.E.I.C. Chief of Air Services, Department of Transport, Ottawa, Ont.
E. P. Fetherstonhaugh, M.C., B.Sc., M.E.I.C. Dean, Faculty of Engineering and Architecture, University of Manitoba, Winnipeg, Man.
A. G. Fleming, Esq. Canada Cement Company, Ltd., Montreal, Que.
H. Frechette, Esq. Chief, Division of Industrial Minerals, Bureau of Mines, Department of Mines and Resources, Ottawa, Ont.
G. G. Gale, B.Sc. Vice-President and General Manager, Gatineau Power Company, Victoria Building, Ottawa, Ont.
H. B. Greensted, Esq. Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ont.
A. R. Greig, B.Sc. Professor of Mechanical Engineering, University of Saskatchewan, Saskatoon, Sask.
R. A. Hackbusch, Esq. Radio Manufacturers' Association, Toronto, Ont.
L. C. Harris. Canadian Johns-Manville Co. Ltd., Montreal, Que.
Dr. T. H. Hogg. Chairman, Hydro-Electric Power Commission, Toronto, Ont.
Lieut.-Col. G. B. Howard. Chief Inspector of Arms and Ammunition, Department of National Defence, Quebec, Que.
R. E. Jamieson, M.Sc. William Scott Professor of Civil Engineering, McGill University, Montreal, Que.
H. D. Johnston, Esq. Wire and Cable Manufacturers Technical Committee, Brockville, Ont.
H. S. Johnston, Esq. Nova Scotia Power Commission, Halifax, N.S.
F. H. Kester, Esq. Canadian Bridge Company, Ltd., Walkerville, Ont.
D. G. Kilburn, Esq. Board of Railway Commissioners for Canada, Ottawa, Ont.
W. C. Laidlaw, Esq. R. Laidlaw Lumber Company, Ltd., Toronto, Ont.
O. O. Lefebvre, B.A.Sc., D.S. Provincial Electricity Board, Montreal, Que.
A. H. Lemmon, Esq. British Columbia Telephone Co., Vancouver, B.C.
A. Lighthall, B.Sc. Assistant Professor, Department of Civil Engineering, University of British Columbia, Vancouver, B.C.
K. J. McArdle, Esq. "Canadian Business", Montreal, Que.
R. V. Macaulay, Esq. Chief Engineer, Bell Telephone Company of Canada, Montreal, Que.
I. C. Mackie, Esq. Dominion Iron and Steel Company, Ltd., Sydney, N.S.
R. H. Mather, Esq. Shawinigan Water & Power Company, Montreal, Que.
H. E. McCrudden, Esq. Bell Telephone Company of Canada, Montreal, Que.
T. A. McElhanney, B.A.Sc. Superintendent, Forest Products Laboratories, Lands, Parks and Forests Branch, Department of Mines and Resources, Ottawa, Ont.
D. W. McLachlan, Esq. Engineering Branch, Department of Transport, Ottawa, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.
*J. F. Neild, Esq. Toronto Transportation Commission, 35 Yonge Street, Toronto, Ont.
Lieut.-Col. G. Ogilvie, C.M.G. Department of National Defence, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
J. B. Porter, E.M., Ph.D., D.Sc., M.I.C.E., M.E.I.C. Emeritus Professor of Mining Engineering, McGill University, Montreal, Que.
P. L. Pratley, Esq. Monsarrat & Pratley, Drummond Building, Montreal, Que.
R. A. Rigg, Esq. Director, Employment Service of Canada, Department of Labour, Ottawa, Ont.
J. H. Roaf, Esq. Clayburn Company, Ltd., Vancouver, B.C.
J. G. Robson, Esq. Timberland Lumber Company, Ltd., New Westminster, B.C.
A. C. Ross, Esq. Ross-Meagher Limited, Ottawa, Ont.
W. E. Ross, Esq. Canadian General Electric Company, Ltd., Toronto, Ont.
R. L. Sargant, Esq. Canadian Lumbermen's Association, Ottawa, Ont.
Col. E. Schmidlin. Department of National Defence, Ottawa, Ont.
J. A. Shaw, Esq. Canadian Pacific Railway Company, Montreal, Que.
J. Grove Smith, Esq. Dominion Fire Commissioner, Department of Insurance, 45 Rideau Street, Ottawa, Ont.

A. H. S. Stead, Esq. Dominion Board of Insurance Underwriters, 388 St. James Street W., Montreal, Que.
Air-Commodore E. W. Stedman, O.B.E., A.R.C.Sc., F.R.Ae.S., M.E.I.C., M.I.C.E. Chief Aeronautical Engineer, Royal Canadian Air Force, Department of National Defence, Ottawa, Ont.
John Stephens, M.A., M.A.I., D.Sc., M.E.I.C. Professor of Mechanical Engineering and Drawing, University of New Brunswick, Fredericton, N.B.
J. L. Stiver, B.A.Sc. Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director, Science Service, Department of Agriculture, Ottawa, Ont.
L. A. Thornton, Esq. Saskatchewan Power Commission, Regina, Sask.
W. B. Timm, B.Sc. Chief, Bureau of Mines, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
G. H. Tomlinson, Esq. Howard Smith Paper Mills, Ltd., Montreal, Que.
E. J. Turley, Esq. Montreal Light, Heat and Power Consolidated, Montreal, Que.
G. A. Vandervoort, Esq. New Brunswick Electric Power Commission, Saint John, N.B.
E. B. Wardle, Esq. Consolidated Paper Corporation, Ltd., Grand'Mere, Que.
F. E. Waterman, Esq. Toronto Brick Company, Ltd., Toronto, Ont.
R. S. L. Wilson, B.Sc. Dean, Faculty of Applied Science, University of Alberta, Edmonton, Alta.
C. R. Young, B.A.Sc., C.E., M.E.I.C. Professor of Civil Engineering, University of Toronto, Toronto, Ont.
Col. W. R. McCaffrey, B.A.Sc. Secretary, Canadian Engineering Standards Association, National Research Council, Ottawa, Ont.
B. S. McKenzie, B.A., B.Sc., M.E.I.C., M.C.I.M.M., Consultant. Canadian Engineering Standards Association, National Research Council, Ottawa, Ont.

Associate Committee on Iron Ores

J. G. Morrow, Esq., Chairman. Inspecting Engineer, Steel Company of Canada, Ltd., Hamilton, Ont.
Frank D. Adams, Ph.D., D.Sc., LL.D., F.R.S., Hon. M.E.I.C., Hon. M.I.M.M., Hon. M.A.I.M.M.E., Emeritus Vice-Principal, Emeritus Dean of the Faculty of Graduate Studies and of the Faculty of Applied Science, and Logan Professor of Geology and Palaeontology, McGill University, Montreal, Que.
George A. Guess, M.A. Professor of Metallurgical Engineering, University of Toronto, Toronto, Ont.
H. E. T. Haultain, M.I.M.M., M.E.I.C. Professor of Mining Engineering, University of Toronto, Toronto, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. President, National Research Council, Ottawa, Ont.
Alfred Stansfield, D.Sc., A.R.S.M., M.E.I.C., F.R.S.C. Professor of Metallurgy, McGill University, Montreal, Que.
W. B. Timm, B.Sc. Chief, Bureau of Mines, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Patents and Awards

The President, National Research Council, Chairman.

Frank D. Adams, Ph.D., D.Sc., LL.D., F.R.S., Hon. M.E.I.C., Hon. M.I.M.M., Hon. M.A.I.M.M.E. Emeritus Vice-Principal, Emeritus Dean of the Faculty of Graduate Studies and of the Faculty of Applied Science, and Logan Professor of Geology and Palaeontology, McGill University, Montreal, Que.
J. Watson Bain, B.A.Sc. Professor of Chemical Engineering, University of Toronto, Toronto, Ont.
Col. O. M. Biggar, K.C. Smart & Biggar, 8 O'Connor Street, Ottawa, Ont.
Charles Camsell, B.Sc., LL.D., F.R.S.C. Deputy Minister, Department of Mines and Resources, Ottawa, Ont.
A. L. Clark, B.Sc., Ph.D., F.R.S.C. Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
F. J. Hambly, Esq. Manager, Electric Reduction Co., Buckingham, Que.
Watson Sellar, Esq. Comptroller of the Treasury, Department of Finance, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary. Director, Division of Research Information, National Research Council, Ottawa, Ont.

SPECIAL COMMITTEES

Canadian Government Purchasing Standards Committee

Chairman: The President of the National Research Council.
Members: Deputy Chiefs of Government Departments.
Secretary: A. F. Gill, M.A., National Research Council, Ottawa.

SUBCOMMITTEE ON PLANS AND ADMINISTRATION

Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D., Chairman. President, National Research Council, Ottawa, Ont.
Howells Frechette, M.Sc. Chief, Industrial Minerals Division, Bureau of Mines, Ottawa, Ont.
J. F. Harkom, B.Sc., M.E. Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
H. M. Lancaster, B.A.Sc. Chief Dominion Analyst, Food and Drug Laboratory, Department of Pensions and National Health, Ottawa, Ont.
T. A. McElhanney, B.A.Sc. Superintendent, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
J. C. Shipman, Esq. Director and Superintendent of Printing, Department of Public Printing and Stationery, Ottawa, Ont.
J. M. Swaine, B.S.A., M.Sc., Ph.D., F.R.S.C. Director of Research, Department of Agriculture, Ottawa, Ont.
W. B. Timm, B.Sc. Chief, Bureau of Mines, Department of Mines and Resources, Ottawa, Ont.
E. Viens, B.A. Director, Testing Laboratories, Department of Public Works, Ottawa, Ont.
G. S. Whitby, A.R.C.Sc., M.Sc., Ph.D., LL.D., F.R.S.C. Director, Division of Chemistry, National Research Council, Ottawa, Ont.
A. F. Gill, M.A., Secretary. Division of Research Information, National Research Council, Ottawa, Ont.

Special Committee on Gas Units and Regulations

R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Chairman. Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
H. A. Dupré, A.C.G.I., M.I.C.E., M.E.I.C. Assistant Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa, Ont.
R. H. Field, Esq. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
J. J. Green, B.Sc., A.R.C.Sc., D.I.C., Ph.D., A.F.R.Ae.S., M.I.Ae.S. Assistant Research Engineer, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.
F. H. Sanders, B.A., M.A., Ph.D. Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
J. L. Stiver, B.A.Sc. Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa, Ont.
G. J. Klein, B.A.Sc., Secretary. Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

National Committee on Fish Culture

This Committee was established following a conference on fresh-water fish culture arranged jointly by the Department of Fisheries, the Biological Board of Canada, and the National Research Council.

National Research Council:

The President of the National Research Council *(Ex officio)*.
Dr. Robert Newton, Director, Division of Biology and Agriculture, National Research Council, Ottawa, Ont., Joint Secretary and Joint Convener of the Executive.

Fisheries Research Board of Canada:

The Chairman, Fisheries Research Board of Canada *(Ex officio)*.
Mr. J. A. Rodd, Director of Fish Culture, Department of Fisheries, Ottawa, Ont., Joint Secretary and Joint Convener of the Executive.

Dominion Department of Fisheries:

Mr. J. J. Cowie, Director of Fisheries Promotion and Inspection, Department of Fisheries, Ottawa, Ont.

Canadian Travel Bureau:

Mr. D. Leo Dolan, Director, Canadian Travel Bureau, Department of Transport, Ottawa, Ont.

National Parks Branch:

Mr. Hoyes Lloyd, Supervisor, Wild Life Protection, National Parks Bureau, Department of Mines and Resources, Ottawa, Ont.

Provincial Representatives:

Nova Scotia—Mr. F. A. Harrison, Chief Clerk, Department of Lands and Forests, Halifax, N.S.

Prince Edward Island—Mr. Harry H. Cox, M.L.A., Morell, P.E.I.

New Brunswick—Mr. G. A. Estey, Grand Falls, N.B.

Quebec—Mr. B. W. Taylor, Biologist and Director of Fish Culture, Department of Labour, Game and Fisheries, 206 Biological Building, McGill University, Montreal, Que.

Ontario—Mr. D. J. Taylor, Deputy Minister, Department of Game and Fisheries, Toronto, Ont.

Manitoba—Professor Ferris Neave, Department of Zoology, University of Manitoba, Winnipeg, Man.

Saskatchewan—Mr. G. C. McDonald, Supervisor of Fisheries, Department of Natural Resources, Regina, Sask.

Alberta—Mr. R. T. Rodd, Director of Fisheries, Department of Agriculture, Edmonton, Alta.

British Columbia—Mr. George J. Alexander, Assistant to the Commissioner of Fisheries, Victoria, B.C.

Canadian Pacific Railway Company:

Major G. G. Ommanney, Development Commissioner, Montreal, Que.

Canadian National Railways:

Mr. E. G. Poole, Tourist and Convention Bureau, Montreal, Que.

Special Committee on Hydraulic Research

J. T. Johnston, B.A.Sc., Chairman. Controller and Chief Engineer, Dominion Water and Power Bureau, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.

R. deB. Corriveau, B.Sc. Assistant Chief Engineer, Engineer's Branch, Department of Public Works, Ottawa, Ont.

Norman Marr, B.A.Sc. Senior Hydraulic Engineer, Dominion Water and Power Bureau, Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, Ont.

Major N. B. McLean. Chief Engineer, River St. Lawrence Ship Channel Branch, Department of Transport, Ottawa, Ont.

Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L., LL.D. *(Ex officio)*. President, National Research Council, Ottawa, Ont.

J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C. Director, Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

J. H. Ramsay, B.Sc., C.E. Senior Hydraulic Engineer, Department of Transport, Ottawa, Ont.

K. F. Tupper, B.A.Sc., Secretary. Division of Mechanical Engineering, National Research Council, Ottawa, Ont.

73461—11

NATIONAL BUILDING CODE PROJECT

Honorary Chairman: Honourable C. A. Dunning, Minister of Finance.
Chairman: The President of the National Research Council.

Advisory Committee

Government Bodies

Federal:

Department of Finance. F. W. Nicholls, Department of Finance, East Block, Ottawa, Ont.
Department of Insurance. J. Grove Smith, Dominion Fire Commissioner, Department of Insurance, Plaza Building, Ottawa, Ont.
Department of Pensions and National Health. G. H. Ferguson, Chief, Public Health Engineering Division, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
Department of Mines and Resources. T. A. McElhanney, Superintendent, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
Department of Labour. R. A. Rigg, Director, Employment Service of Canada, Department of Labour, Ottawa, Ont.
Department of Trade and Commerce. G. D. Mallory, Commercial Intelligence Service, Department of Trade and Commerce, Ottawa, Ont.
Department of Justice. W. S. Lawson, Chief Engineer, Penitentiary Branch, Department of Justice, Ottawa, Ont.

Provincial:

Alberta—W. D. Stacey, Provincial Superintendent of Buildings, Department of Public Works, Parliament Buildings, Edmonton, Alta.
British Columbia—Honourable F. M. MacPherson, Minister of Public Works, Victoria, B.C.
Quebec—F. X. Ahern, Assistant Fire Commissioner, Province of Quebec, Quebec, Que.
Saskatchewan—A. E. Fisher, Provincial Insurance Commissioner, Regina, Sask.
Manitoba—Honourable J. S. McDiarmid, Minister of Mines and Natural Resources, Winnipeg, Man.

Municipal:

Canadian Federation of Mayors and Municipalities. Mayor Stanley Lewis, Ottawa, Ont.

Other Government Bodies:

Ontario Research Foundation. Dr. H. B. Speakman, Director, Ontario Research Foundation, 43-47 Queen's Park, Toronto, Ont.

Professional Associations:

Association of Canadian Fire Marshals. F. X. Ahern, Assistant Fire Commissioner, Quebec, Que.
Canadian Engineering Standards Association. J. G. Morrow, Chairman, Canadian Engineering Standards Association, Steel Company of Canada Ltd., Hamilton, Ont.
Canadian Hospital Council. Dr. Harvey Agnew, Secretary, Canadian Hospital Council, 184 College St., Toronto, Ont.; A. J. Swanson, Superintendent, Toronto Western Hospital, Bathurst St., Toronto, Ont.; James Govan, Hospital Architect, Govan, Ferguson and Lindsay, 515 Jarvis St., Toronto, Ont.
Canadian Institute of Chemistry. W. E. Patterson, Chief Chemist, Sternson Laboratories, Brantford, Ont.
Canadian Institute on Sewage and Sanitation. G. H. Ferguson, Chief, Public Health Engineering Division, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
Canadian Medical Association. Honourable Dr. H. A. Bruce, 134 Bloor St. E., Toronto, Ont.
Canadian Medical Association. Dr. T. A. Lomer, Medical Officer of Health, City Hall, Ottawa, Ont.
Canadian Public Health Association. Dr. R. St. J. Macdonald, Department of Hygiene, McGill University, Montreal, Que.
Engineering Institute of Canada. J. A. Lalonde, Chief Engineer, A. Janin and Co. Ltd., 1460 Sherbrooke St. W., Montreal, Que.
National Housing and Planning Association. H. L. Seymour, 87 Cartier St., Ottawa, Ont.
Royal Architectural Institute of Canada. W. J. Abra, 55 Metcalfe St., Ottawa, Ont.
Association of Professional Engineers of Alberta. Prof. I. F. Morrison, University of Alberta, Edmonton, Alta.; H. W. Meech, Suite 114, McFarland Building, Lethbridge, Alta.

The Engineering Profession in British Columbia. F. W. MacNeill, Registered Electrical Engineer, 1065 West Pender St., Vancouver, B.C.; S. J. Crocker, Registered Mechanical Engineer, 551 Howe St., Vancouver, B.C.
Association of Professional Engineers of the Province of Manitoba. P. Burke-Gaffney, 779 Jessie Avenue, Winnipeg, Man.; H. M. White, 98 Grosvenor Avenue, Winnipeg, Man.
Association of Professional Engineers of the Province of New Brunswick. H. J. Crudge, President, Association of Professional Engineers of the Province of New Brunswick, Moncton, N.B.; J. N. Flood, 111 Princess Street, Saint John, N.B.; F. P. Vaughan, 94 Germain Street, Saint John, N.B.
Association of Professional Engineers of Nova Scotia. Colonel F. W. W. Doane, Consulting Engineer, Young Avenue, Halifax, N.S.; C. A. Fowler, Engineer and Architect, Capitol Building, Halifax, N.S.
Association of Professional Engineers of the Province of Ontario. Dr. A. H. Harkness, 57 Bloor Street, Toronto, Ont.
Corporation of Professional Engineers of Quebec. F. X. Ahern, Assistant Fire Commissioner, Quebec, Que.
Association of Professional Engineers of Saskatchewan. J. J. White, Building Inspector, Regina, Sask.; H. M. Weir, Building Inspector, Saskatoon, Sask.

Industrial or Trade Associations:

Asphalt Roofing Manufacturers of Canada. G. M. Walker, Secretary, Asphalt Roofing Manufacturers of Canada, 4 St. Thomas Street, Toronto, Ont.
Canadian Ceramic Society. C. A. Booth, 897 Bay Street, Toronto 5, Ont.
Canadian Construction Association. H. J. Graham, The A. I. Garvock Co., Regent Theatre Building, Ottawa, Ont.
Canadian Institute of Plumbing and Heating. C. J. Coté, Manager, Crane Limited, 148 Bank Street, Ottawa, Ont.
Canadian Institute of Steel Construction. R. C. Manning, Canadian Institute of Steel Construction, 57 Bloor Street West, Toronto, Ont.
Canadian Manufacturers' Association. H. M. Jaquays, Vice-President, The Steel Company of Canada Ltd., Montreal, Que.
Cedar Shingle Industry. G. S. Raphael, Secretary-Manager, Consolidated Red Cedar Shingle Association of British Columbia, 811 Metropolitan Building, Vancouver, B.C.
Dominion Board of Insurance Underwriters. A. H. S. Stead, Manager, Dominion Board of Insurance Underwriters, 388 St. James Street West, Montreal, Que.
Industrial Accident Prevention Associations. R. B. Morley, General Manager, Industrial Accident Prevention Associations, 600 Bay Street, Toronto, Ont.
Lumber Industry. W. H. Greene, Secretary-Manager, Lumber and Timber Association of Ontario, 1508 Metropolitan Building, Toronto, Ont.; W. J. LeClair, Manager, White Pine Bureau, 38 King Street West, Toronto 2, Ont.
Rigid Wood Fibre Insulating Board Manufacturers of Canada. G. M. Walker, Secretary, Asphalt Roofing Manufacturers of Canada, 4 St. Thomas Street, Toronto, Ont.
Secretary: A. F. Gill, National Research Council, Ottawa, Ont.

Administrative Committee

F. W. Nicolls (Chairman), Department of Finance, East Block, Ottawa, Ont.
W. J. Abra, 55 Metcalfe St., Ottawa, Ont.
G. H. Ferguson, Chief, Public Health Engineering Division, Department of Pensions and National Health, Daily Building, Ottawa, Ont.
Colonel C. S. L. Hertzberg, Harkness and Hertzberg, Engineers, 57 Bloor Street West, Toronto, Ont.
T. A. McElhanney, Superintendent, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
J. Clark Reilly, General Manager, Canadian Construction Association, 56 Sparks Street, Ottawa, Ont.
J. Grove Smith, Dominion Fire Commissioner, Department of Insurance, Plaza Building, Ottawa, Ont.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Committee on Construction

F. W. Nicolls (Chairman), Department of Finance, East Block, Ottawa, Ont.
W. J. Abra, 55 Metcalfe Street, Ottawa, Ont.
A. B. Doran, Doran Construction Co. Ltd., 78 Bank Street, Ottawa, Ont.
Colonel C. S. L. Hertzberg, Harkness and Hertzberg, Engineers, 57 Bloor Street West, Toronto, Ont.
R. H. Macdonald, Ross and Macdonald, Architects, 1010 St. Catharine Street West, Montreal, Que.

T. A. McElhanney, Superintendent, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
A. J. C. Paine, Architect, Room 609A, Sun Life Building, Montreal, Que.
E. Viens, Director, Testing Laboratories, Department of Public Works, West Block, Ottawa, Ont.
Professor C. R. Young, Department of Civil Engineering, University of Toronto, Toronto 5, Ont.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Committee on Fire Protection

J. Grove Smith (Chairman), Dominion Fire Commissioner, Department of Insurance, Plaza Building, Ottawa, Ont.
J. Clark Reilly (Vice-Chairman), General Manager, Canadian Construction Association, 56 Sparks Street, Ottawa, Ont.
B. G. Ballard, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Ont.
C. E. Baltzer, Division of Fuels, Testing and Research Laboratories, Department of Mines and Resources, Ottawa, Ont.
Raymond Brunet, Edgar Brunet & Son, General Contractors, Hull, Que.
W. L. Clairmont, Office of the Dominion Fire Commissioner, Department of Insurance, Plaza Building, Ottawa, Ont.
R. A. Crysler, Technical Staff, Canada Cement Co. Ltd., Toronto, Ont.
W. H. G. Flay, Dominion Reinforcing Steel Co., 396 Somerset Street West, Ottawa, Ont.
J. F. Harkom, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
T. H. Higginson, Automatic Sprinkler Co. of Canada Ltd., 6998 Jeanne Mance St., Montreal, Que.
E. S. Malloch, Division of Fuels, Testing and Research Laboratories, Department of Mines and Resources, Ottawa, Ont.
G. D. Mallory, Chief, Metal and Chemical Exports Division, Commercial Intelligence Service, Department of Trade and Commerce, West Block, Ottawa, Ont.
R. C. Manning, Canadian Institute of Steel Construction, 57 Bloor Street West, Toronto, Ont.
R. L. Sargant, Secretary, Canadian Lumbermen's Association, Fraser Building, Ottawa, Ont.
R. A. Seasons, W. G. Edge Co. Ltd., 150 Gloucester Street, Ottawa Ont.,
A. H. S. Stead, Manager, Dominion Board of Insurance Underwriters, 388 St. James Street West, Montreal, Que.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Committee on Health and Sanitation

G. H. Ferguson (Chairman), Chief, Public Health Engineering Division, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
James Adam, 263 MacLaren Street, Ottawa, Ont.
C. E. Baltzer, Division of Fuels, Testing and Research Laboratories, Department of Mines and Resources, Ottawa, Ont.
G. A. Browne, Assistant General Superintendent, Engineering Branch, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
W. F. M. Bryce, City Hall, Ottawa, Ont.
F. O. Hamel, Architect's Branch, Department of Public Works, Hunter Building, Ottawa, Ont.
Alan K. Hay, 20 Lakeview Terrace, Ottawa, Ont.
J. H. Irvine, City Hall, Ottawa, Ont.
J. M. Kitchen, City Hall, Ottawa, Ont.
N. B. MacRostie, 193 Sparks Street, Ottawa, Ont.
E. S. Malloch, Division of Fuels, Testing and Research Laboratories, Department of Mines and Resources, Ottawa, Ont.
H. J. Morin, 75 Sparks Street, Ottawa, Ont.
C. M. Pitts, 2 Mill Street, Ottawa, Ont.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Advisory Members

Dr. J. J. Heagerty, Chief Executive Assistant, National Health, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
A. E. Berry, Director, Sanitary Engineering Division, Department of Health, Parliament Buildings, Toronto, Ont.
F. M. Brickenden, Engineer-in-charge, Western District, Department of Pensions and National Health, Box 4710, Postal Station B, Winnipeg, Man.

Aimé Cousineau, Sanitary Engineer, Department of Health, City Hall, Montreal, Que.
T. J. Lafreniere, Sanitary Engineer, Provincial Bureau of Health, 89 Notre Dame Street East, Montreal, Que.
Dr. F. S. Parney, Medical Advisor, Civil Service, National Health, Department of Pensions and National Health, Daly Building, Ottawa, Ont.
A. H. Perry, Engineer-in-charge, Pacific District, Department of Pensions and National Health, P.O. Box 1012, Vancouver, B.C.

Subcommittee on Wood Construction

T. A. McElhanney (Chairman), Superintendent, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
W. J. Abra, 55 Metcalfe Street, Ottawa, Ont.
J. H. Byrne, Engineering and Construction Service, Department of Mines and Resources, Ottawa, Ont.
D. Kemp Edwards, 25 Bayswater Avenue, Ottawa, Ont.
W. H. Greene, Secretary-Manager, Lumber and Timber Association of Ontario, 1508 Metropolitan Building, Toronto, Ont.
W. J. LeClair, Manager, White Pine Bureau, 38 King Street West, Toronto 2, Ont.
A. L. Perry, Perry, Luke and Little, Architects, 1405 Bishop Street, Montreal, Que.
G. S. Raphael, Secretary, Consolidated Red Cedar Shingle Association of British Columbia, 811 Metropolitan Building, Vancouver, B.C.
G. H. Rochester, Forest Products Laboratories, Department of Mines and Resources, Ottawa, Ont.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Subcommittee on Masonry

R. H. Macdonald (Chairman), Ross & Macdonald, Architects, 1010 St. Catherine Street West, Montreal, Que.
Aimé Collet, Engineer, Collet Frères Ltée., Contractors, 361 Metcalfe Avenue, Westmount, Que.
C. D. Harrington, Anglin Norcross Corp. Ltd., 24 Ramezay Road, Westmount, Que.
J. J. Hyland, Dominion Housing Administration, Department of Finance, Ottawa, Ont.
J. B. Stirling, E. G. M. Cape & Co., New Birks Building, Phillips Square, Montreal, Que.
Ludger Venne, 3607 St. Denis Street, Apt. 3, Montreal, Que.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

Corresponding Members

A. W. Fosness, Chief Engineer, Carter Halls Aldinger Company Ltd., Winnipeg, Man.
Colonel J. F. Keen, Vancouver, B.C.
J. Y. McCarter, McCarter & Nairn, Vancouver, B.C.
George Northwood, Winnipeg, Man.

Subcommittee on Steel

Colonel C. S. L. Hertzberg (Chairman), Harkness and Hertzberg, Engineers, 57 Bloor Street West, Toronto, Ont.
R. C. Manning, Canadian Institute of Steel Construction, 57 Bloor Street West, Toronto, Ont.
Dr. S. D. Lash (Secretary), National Research Council, Ottawa, Ont.

Corresponding Members

Sidney Hogg, St. John Dry Dock and Shipbuilding Company Ltd., Saint John, N.B.
Professor A. Macdonald, Faculty of Civil Engineering, University of Manitoba, Winnipeg, Man.
Fred Newell, Dominion Bridge Company, Ltd., P.O. Box 280, Montreal, Que.
Major W. G. Swan, C.E., M.E.I.C., 814 Birks Building, Vancouver, B.C.

Subcommittee on Reinforced Concrete

Professor C. R. Young (Chairman), Department of Civil Engineering, Electrical Building, University of Toronto, Toronto 5, Ont.
W. Aldridge, Assistant Commissioner of Buildings, Winnipeg, Man.
Dean C. J. MacKenzie, University of Saskatchewan, Saskatoon, Sask.
J. M. Oxley, Chapman and Oxley, Architects, 372 Bay Street, Toronto, Ont.
J. B. Stirling, E. G. M. Cape and Co., New Birks Building, Phillips Square, Montreal, Que.
E. Viens, Director, Testing Laboratories, Department of Public Works, West Block, Ottawa, Ont.
R. B. Young, Testing Engineer, Ontario Hydro-Electric Power Commission, 620 University Avenue, Toronto, Ont.
A. F. Gill (Secretary), National Research Council, Ottawa, Ont.

73461—12

Outside Committees on which the National Research Council has Representation

There have been constituted by various authorities, numerous other committees on which the National Research Council has representation as shown below.

Authority	Committee	Representative of the National Research Council
American Association of Cereal Chemists	Malt Analysis Standardization	J. A. Anderson, M.Sc., Ph.D., Division of Biology and Agriculture.
	Standardization of Laboratory Baking	J. G. Malloch, M.Sc., Ph.D., Division of Biology and Agriculture.
American Chemical Society	Editorial Board, J.A.C.S.	G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Director, Division of Chemistry.
American Society for Testing Materials		F. E. Lathe, M.Sc., Director, Division of Research Information (Official Representative of the National Research Council).
	Committee B-3 on Corrosion of Non-ferrous Metals and Alloys	A. C. Halferdahl, B.S., M.A.Sc.
	Subcommittee I on Total Immersion Test	
	Subcommittee II on Alternate Immersion Test	
	Subcommittee III on Spray Test	
	Subcommittee VI on Atmospheric Corrosion	
	Subcommittee VII on Corrosion of Liquids	
	Committee C-1 on Cement	D. Wolochow, M.A., C.E., Division of Chemistry.
	Committee C-5 on Fire Tests of Materials and Construction	Vacant.*
	Subcommittee I on Standard Specifications for Fire Tests of Materials and Construction	
	Subcommittee V Nomenclature and Definitions	
	Subcommittee VII Size of Test Samples	
	Committee C-7 on Lime	A. F. Gill, M.A., Division of Research Information.
	Subcommittee II on Structural Lime	
	Subcommittee IX on Research Problems	
	Committee C-8 on Refractories	F. E. Lathe, M.Sc., Director, Division of Research Information.
	Subcommittee I on Tests and Specifications	A. C. Halferdahl, B.S., M.A.Sc.
	Subcommittee II on Research	F. E. Lathe, M.Sc., Director, Division of Research Information.
	Committee D-1 on Preservative Coatings for Structural Materials	
	Subcommittee III on Testing of Paint Vehicles	
	Subcommittee V on Linseed Oil	

*Former member was T. H. Doherty, B.Sc.

Outside Committees on which the National Research Council has Representation—Continued

Authority	Committee	Representative of the National Research Council
American Society for Testing Materials—*Continued*.....	Subcommittee VII on Accelerated Tests for Protective Coatings..	C. Y. Hopkins, M.A., Ph.D., Division of Chemistry.
	Subcommittee VIII on Methods of Analysis of Paint Materials..	
	Subcommittee IX on Varnish....	
	Subcommittee XV on Specifications for Pigments Dry and in Oil when Marketed in that Form.....	
	Subcommittee XVIII on Physical Properties of Materials.....	
	Committee D-2 on Petroleum Products and Lubricants.....	J. W. Broughton, M.Sc., Ph.D., Division of Mechanical Engineering A. F. Gill, M.A., Division of Research Information.
	Subcommittee V on Viscosity....	
	Subcommittee VIII on Distillation	
	Subcommittee XI on Turbine Oils	
	Subcommittee XXIII on Carbon Residue.....	
	Technical Committee A on Gasoline.....	J. W. Broughton, M.Sc., Ph.D., Division of Mechanical Engineering.
	Section I on Gum.....	
	Section II on Corrosion.....	
	Section III on Vapor Lock....	
	Section IV on Detonation....	
	Section V Specifications.....	
	Technical Committee B on Motor Oils.....	
	Technical Committee C on Fuel Oils (including Diesel Fuel)....	Vacant.*
	Section I on Domestic and Industrial Fuel Oil.....	
	Section II on Diesel Fuel Oils.	A. F. Gill, M.A., Division of Research Information.
	Technical Committee D on Stoddard Solvent.....	C. H. Bayley, M.A.Sc., M.A., Division of Chemistry.
	Committee D-8 on Bituminous Waterproofing and Roofing Materials.....	A. Cambron, B.A., M.Sc., Ph.D., Division of Chemistry.
	Committee D-9 on Electrical Insulating Materials.....	B. G. Ballard, B.Sc., Division of Physics and Electrical Engineering.
	Committee D-11 on Rubber Products.....	G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Director, Division of Chemistry.
	Committee D-13 on Textile Materials.....	C. H. Bayley, M.A.Sc., M.A., Division of Chemistry. P. Larose, M.Sc., Ph.D., Division of Chemistry. D. Wolochow, M.A., C.E., Division of Chemistry.

*Former member was T. H. Doherty, B.Sc.

Outside Committees on which the National Research Council has Representation—Continued

Authority	Committee	Representative of the National Research Council
American Society for Testing Materials—*Concluded*	Subcommittee A-3 on Wool and Its Products	P. Larose, M.Sc., Ph.D., Division of Chemistry.
	Subcommittee A-4 on Asbestos and Its Textile Products; Section I on Asbestos Textiles.	D. Wolochow, M.A., C.E., Division of Chemistry.
	Committee D-15 on Thermometers and Laboratory Glassware	R. H. Field, Division of Physics and Electrical Engineering.
	Committee D-19 on Water for Industrial Uses	F. G. Green, B.Sc., Division of Chemistry.
	Committee E-1 on Methods of Testing; Technical Committee III Particle Size and Shape, Section on Sub-sieve Sizes	W. Gallay, B.A., M.Sc., Ph.D., Division of Chemistry.
	Committee E-2 on Spectrographic Analysis	L. E. Howlett, M.A., Ph.D., Division of Physics and Electrical Engineering.
	Sectional Committee on Specifications for Sieves for Testing Purposes	R. H. Field, Division of Physics and Electrical Engineering.
American Standards Association	Sectional Committee on Acoustical Measurements and Terminology	G. S. Field, M.Sc., D.Sc., Division of Physics and Electrical Engineering.
Canadian Committee on Sugar Analysis		G. S. Whitby, M.Sc., Ph.D., LL.D., A.R.C.Sc., F.R.S.C., Director, Division of Chemistry, Chairman.
		F. G. Green, B.Sc., Division of Chemistry.
	Subcommittee on Colorimetry	F. G. Green, B.Sc., Division of Chemistry, Chairman.
	Subcommittee on Hydrogen Ion Concentration	W. Gallay, B.A., M.Sc., Ph.D., Division of Chemistry.
Canadian Council on Nutrition	Executive	Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture.
Canadian Engineering Standards Association	Executive and Main Committee	Major-General A. G. L., McNaughton, C.B., C.M.G., D.S.O., M.Sc., D.C.L.,LL.D. (*Ex officio*), President, National Research Council.

Outside Committees on which the National Research Council has Representation—Continued

Authority	Committee	Representative of the National Research Council
Canadian Engineering Standards Association—*Concluded*	Main Committee	R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Director, Division of Physics and Electrical Engineering. J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C., Director, Division of Mechanical Engineering—Co-opted Member.
	Committee on Aluminium Cables	A. J. Grant, B.Sc., Division of Physics and Electrical Engineering.
	Committee on Building Materials	A. F. Gill, M.A., Division of Research Information.
	Committee on Dielectric Strength and Insulation Resistance	B. G. Ballard, B.Sc., Division of Physics and Electrical Engineering.
	Sectional Committee on Electrical Work	B. G. Ballard, B.Sc., Division of Physics and Electrical Engineering.
	Committee on Electricity Meters	R. W. Boyle, M.Sc., Ph.D., F.R.S.C., Director, Division of Physics and Electrical Engineering. A. J. Grant, B.Sc., Division of Physics and Electrical Engineering.
	Committee on Incandescent Tungsten Lamps	A. F. Gill, M.A., Division of Research Information. L. E. Howlett, M.A., Ph.D., Division of Physics and Electrical Engineering.
	Panel on Logging Chains	A. C. Halferdahl, B.S., M.A.Sc.
	Panel on Specifications for Part II of Canadian Electrical Code	B. G. Ballard, B.Sc., Division of Physics and Electrical Engineering.
	Subcommittee on Radio Interference	J. T. Henderson, M.Sc., Ph.D., Division of Physics and Electrical Engineering.
	Committee on Reorganization of Canadian Electrical Code	B. G. Ballard, B.Sc., Division of Physics and Electrical Engineering.
Canadian Institute of Chemistry and Canadian Public Health Association	Joint Committee on Water Analysis	A. F. Gill, M.A., Division of Research Information. F. G. Green, B.Sc., Division of Chemistry.
Canadian Society Textile Colorists and Chemists	Textile Education Committee	P. Larose, M.Sc., Ph.D., Division of Chemistry.
Conference on Agricultural Statistics	Committee on Agricultural Meteorology	Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture. J. W. Hopkins, M.Sc., Ph.D., Division of Biology and Agriculture.

Outside Committees on which the National Research Council has Representation—Concluded

Authority	Committee	Representative of the National Research Council
Dominion Fire Commissioner	Committee on Liquefied Petroleum Gases	A. F. Gill, M.A., Division of Research Information.
Interdepartmental Committee	Flax	Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture. N. H. Grace, M.A., Ph.D., Division of Biology and Agriculture.
Institute for Maintaining Drycleaning Standards	Technical Committee	C. H. Bailey, M.A.Sc., M.A., Division of Chemistry.
International Institute of Refrigeration	Commission III—Biology, Food Chemistry, and Health	W. H. Cook, M.Sc., Ph.D., Division of Biology and Agriculture.
International Scientific Radio Union	Committee on Radio Physics	G. S. Field, M.Sc., D.Sc., Division of Physics and Electrical Engineering.
	Committee on Wave Propagation	R. W. Boyle, M.Sc., Ph D., F.R.S.C., Director, Division of Physics and Electrical Engineering. J. T. Henderson, M.Sc., Ph.D., Division of Physics and Electrical Engineering. D. C. Rose, M.Sc., Ph.D., F.R.S.C., Division of Physics and Electical. Engineering.
National Advisory Committee on Agricultural Services		Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture.
National Barley Committee		Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture.
National Committee on Dry Cleaning and Dry Dyeing Hazards		C. H. Bayley, M.A.Sc., M.A., Division of Chemistry.
National Sheep Committee	Executive	Robert Newton, Ph.D., D.Sc., F.R.S.C., Director, Division of Biology and Agriculture.
	Executive and Subcommittee on Wool	F. E. Lathe, M.Sc., Director, Division of Research Information.
Radiological Society of North America	Standardization Committee	G. C. Laurence, M.Sc., Ph.D., Division of Physics and Electrical Engineering.
Society of Automotive Engineers	Aviation Fuels Division of the Co-operative Fuels Research Committee	M. S. Kuhring, Division of Mechanical Engineering.

APPENDIX E

14-15 George V.

———

CHAPTER 64.

The Research Council Act.

[*Assented to 19th July, 1924.*]

HIS MAJESTY, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

1. This Act may be cited as *The Research Council Act, 1924.*

2. In this Act, unless the context otherwise requires,—

(a) "Committee" shall mean the Committee of the Privy Council on Scientific and Industrial Research;

(b) "Chairman" shall mean the Chairman of the Committee of the Privy Council on Scientific and Industrial Research;

(c) "Council" shall mean the Honorary Advisory Council for Scientific and Industrial Research;

(d) "President" shall mean the President of the Honorary Advisory Council for Scientific and Industrial Research.

3. There shall be a Council to be called "The Honorary Advisory Council for Scientific and Industrial Research".

4. (1) The Council shall consist of not more than fifteen members who shall be appointed by the Governor in Council on the recommendation of the Committee.

(2) The members of the Council, with the exception of the President, shall hold office for a period of three years, and not less than four members shall retire each year. Provided that of the members first appointed under this Act, not more than five shall each be appointed for a period of three years, not more than five members shall each be appointed for a period of two years, and not more than five members shall each be appointed for a period of one year.

(3) Any retiring member shall be eligible for reappointment.

5. There shall be a President of the Council who shall be appointed by the Governor in Council on the recommendation of the Committee. The President shall be the chief executive officer of the Council and shall have supervision over, and direction of, the work of the Council and of the officers, technical and otherwise, appointed for the purpose of carrying on the work of the Council. He shall receive such salary and be employed for such term of office as the Governor in Council may prescribe, and such salary shall be paid out of the moneys provided for the work of the Council.

6. The Council shall have charge of all matters affecting scientific and industrial research in Canada which may be assigned to it by the Committee, and shall also have the duty of advising the Committee on questions of scientific and technological methods affecting the expansion of Canadian industries or the utilization of the natural resources of Canada.

7. The Council is hereby constituted a body corporate capable of suing and being sued and having the power to acquire money, securities, real estate or property by gift, grant, bequest, donation or otherwise, and of holding lands, tenements, hereditaments, goods, chattels and any other property, movable or immovable, for the purpose of, and subject to, this Act.

8. The Council shall meet at least four times a year in the city of Ottawa on such days as may be fixed by the Council, and may also meet at such other times and places as the Council may deem necessary.

9. No member of the Council, with the exception of the President, shall receive any payment or emolument for his services, but each member shall receive such payments for travelling and other expenses in connection with the work of the Council as may be approved by the Governor in Council.

10. Without thereby limiting the general powers of the Council conferred upon or vested in it by this Act, it is hereby declared that the Council may exercise the following powers namely:—

(a) To make by-laws for the conduct of its business;

(b) To control and direct the work of the Council through the President, and, in case of the illness, absence or suspension of the President, or in the case of vacancy in the office of President, through an Acting President temporarily appointed by the Council;

(c) To undertake in such way as may be deemed advisable—

(i) To promote the utilization of the natural resources of Canada;

(ii) Researches with the object of improving the technical processes and methods used in the industries of Canada, and of discovering processes and methods which may promote the expansion of existing or the development of new industries;

(iii) Researches with the view of utilizing the waste products of said industries;

(iv) The investigation and determination of standards and methods of measurements, including length, volume, weight, mass, capacity, time, heat, light, electricity, magnetism and other forms of energy; and the determination of physical constants and the fundamental properties of matter;

(v) The standardization and certification of the scientific and technical apparatus and instruments for the Government service and for use in the industries of Canada; and the determination of the standards of quality of the materials used in the construction of public works and of the supplies used in the various branches of the Government service;

(vi) The investigation and standardization, at the request of any of the industries of Canada, of the materials which are or may be used in, or of the products of, the industries making such a request;

(vii) Researches, the object of which is to improve conditions in Agriculture;

(d) To have charge of, and direction or supervision over, the researches which may be undertaken, under conditions to be determined in each case, by or for single industrial firms, or by such organizations or persons as may desire to avail themselves of the facilities offered for this purpose;

(e) To expend such sums of money as may be annually appropriated by Parliament for the work of the Council or which shall have been received by the Council through bequest, donation or otherwise;

(f) With the approval of the Committee, to appoint such scientific, technical and other officers as shall be nominated by the President, and to fix the tenure of such appointments, to prescribe the several duties of such officers, and, subject to the approval of the Governor in Council, to fix their remuneration;

(g) Subject to the approval of the Chairman, to publish, from time to time, such scientific and technical information as the Council may deem necessary.

11. (1) All discoveries, inventions and improvements in processes, apparatus or machines, made by a member or any number of members of the technical staff of the Council shall be vested in the Council and shall be made available to the public under such conditions and payment of fees or royalties or otherwise as the Council may determine, subject to the approval of the Governor in Council.

(2) The Council, with the approval of the Governor in Council, may pay to its technical officers and to others working under its auspices who have made valuable discoveries, inventions or improvements in processes, apparatus and machines, such bonuses or royalties as in its opinion may be warranted.

12. All the receipts and expenditures of the Council shall be subject to examination and audit by the Auditor General.

13. (1) The President shall report annually to the Council upon the progress and efficiency of the work of the Council and as to its requirements, and shall make such recommendations therein as he may deem necessary.

(2) The Council shall, after the conclusion of the fiscal year, make a report to the Committee containing the report of the President to the Council and also containing a statement of the receipts and expenditures of the Council during the preceding fiscal year. Such reports shall be printed and laid before Parliament within fifteen days of the making thereof, or, if Parliament is not then in session, within fifteen days after the commencement of the next session of Parliament.

14. Chapter twenty of the statutes of 1917 is repealed.

INDEX