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DOMINION OF CANADA

TWENTIETH
ANNUAL REPORT

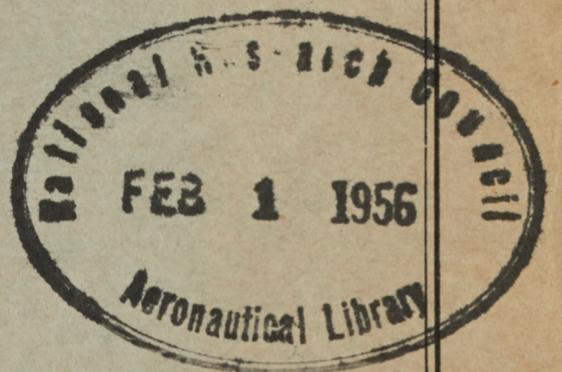
OF THE

NATIONAL RESEARCH COUNCIL



1936-1937

OTTAWA, CANADA



Price, 75 cents

DOMINION OF CANADA

TWENTIETH
ANNUAL REPORT

OF THE

*The Hon. W. D. Eckart,
Chairman, Committee of the Privy Council on
Scientific and Technical Research*

NATIONAL RESEARCH COUNCIL

Sir:

I have the honor to present to you herewith the Twentieth Annual Report of the National Research Council for the fiscal year 1936-1937.

In accordance with the provisions 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.*

1936-1937

OTTAWA, CANADA

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 LABOR

MINISTER OF NATIONAL DEFENCE

NATIONAL RESEARCH COUNCIL

THE HON. W. D. EULER,

*Chairman, Committee of the Privy Council on
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Ottawa, Ontario.

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MINISTER OF NATIONAL DEFENCE

NATIONAL RESEARCH COUNCIL
1936-1937

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TWENTIETH ANNUAL REPORT
OF THE
NATIONAL RESEARCH COUNCIL

REPORT OF THE PRESIDENT

The Research Council Act provides that "The President shall report annually upon the progress and efficiency of the work of the Council and as to its requirements" This has been done year after year and the present report is the twentieth in the series. It seems fitting therefore that, by way of introduction to this year's record of technical achievements reported from the several laboratories, attention should be directed to the development and organization of research, with special reference to its application in the study of Canadian problems.

Organization of Research

Scientific research on a large scale is of comparatively recent origin. It owes its beginnings in part to the very general human desire to add to the sum of organized knowledge, but perhaps the chief stimulus to this endeavor has come from the increased specialization in industry and the arts which has characterized the progress of civilization during this century.

In our grandfather's day, life went on much as it had for the previous thousand years or so. The farmer tilled the field and harvested his grain which he took to the local mill to be turned into flour; the shepherd tended his flocks and the wool was worked into clothing in the homes of the inhabitants; transport depended on the horse, and the village wheelwright produced from local material such simple vehicles as were needed; wood supplied the requirements for fuel; candles were made of tallow; and so about the only thing which had to be imported into any typical community was iron and this was needed in only small quantities.

During the last hundred years this simple system of life has been changed, and the change has been the *consequence of specialization*.

When men specialize they acquire not only manual skill through which the product of their labor is greatly increased, but they also acquire knowledge of a particular trade, and this special knowledge in the minds of certain individuals is the mother of invention. Out of this came the marvellous advance in the mechanical arts which has taken place and the far-reaching applications of machinery to ease the task and multiply the power and speed of man. Consequently, articles are made available in quantity to all for daily use, that in a previous age would have been luxuries, unattainable even by the wealthy.

It is the business of research to serve an expanding civilization, to find new and better methods of satisfying old requirements, to open the way to new services needed by the public, and to create the materials and technique through which they may be developed. Nowhere in all the wide range of science is any limit in sight; progress continues at an ever increasing rate and the future is beyond conjecture. In the days of the stage coach the maximum distance that could be traversed in a day did not exceed about 100 miles.

Voyages by sail across the oceans were matters of months. Today aircraft cruise at over 250 miles per hour and telegraph and telephones link the continents in instant communication. Measured on a time scale the earth has shrunk; but this very shrinkage has served to intensify the problems of mankind, especially in the industrial field.

Efficiency of industry is a matter of vital concern to everyone. A national research organization should seek to promote this efficiency in every way; to assist in turning every national resource and facility to account; to improve processes and to cheapen products so as to better the competitive position of its country in the markets of the world, and particularly to be ready to suggest new articles of manufacture when the fashion for the old diminishes or they stand in danger of being displaced. It is to these activities in aid of Canadian industry that the National Research Council is dedicated.

Pure Science

During the last half century or so the industries of the world have been modified and built up on the basis of scientific knowledge. The mechanical industries derive from Newton's laws of motion; the electrical industries are based on the early scientific work of Henry, Faraday, Maxwell, Ampère, and down the years through Kelvin, Edison and a multitude of others; aviation is the outgrowth of hydrodynamics and aerodynamics; the chemical and metallurgical industries make use of knowledge accumulated since the days of the alchemists.

Most of this fundamental information, which has made modern industry possible, was built up slowly in the universities of the world. It was not acquired for any utilitarian purpose, it came as a by-product in the search for truth. This form of research has in consequence come to be called "pure science", and it continues to hold a most important place in the scheme of things as they are.

Until towards the end of the last century only a relatively small fraction of the fundamental knowledge that had been acquired and stored up by the universities had been assimilated by industry and new knowledge was accumulating perhaps faster than it could be applied.

Applied Research

In this period, industry sought to exploit existing stores of information and often succeeded, but even for this task trained minds were needed. A demand arose for men who could understand the facts and apply them to every-day problems, and experience showed that men who had been trained in the universities in the fundamentals of mathematics, chemistry, physics, etc., were particularly useful. First, in the larger manufacturing establishments and later extending in ever-widening circles, there began to grow up organizations for what was called "applied research".

Applied research was something that most business men of that day could understand. It was immensely profitable. In contrast "pure research" was deemed academic and the men who engaged in it were thought of as people who were not practical. Business was quite content to leave to the universities the pursuit of knowledge for its own sake.

Industrial Research

At the beginning of this century some forward-looking leaders of industry recognized that industrial application had nearly overtaken the capacity of the universities to produce new facts to work on, and out of this idea "industrial research" was born.

On this continent the first step was taken in this direction in 1901 by Mr. E. W. Rice of the General Electric Company, who established under Dr. Whitney the first industrial research laboratory for the purpose of carrying on fundamental industrial research; that is, the acquisition of new scientific knowledge and the discovery of applications for this new knowledge. This new form of research, backed by the large resources of a great company, was to accelerate scientific progress and to extend the frontiers of human understanding. Dr. Langmuir, who succeeded Dr. Whitney, has rightly observed, "Such research work cannot usually be directed towards definite goals for it involves unknown factors. Success if attained is often reached by wholly unexpected methods and the problem which is finally solved is not the problem which was foreseen."

That the idea of fundamental industrial research was "practical" was soon amply proved. In the field of lighting alone three major improvements came out of the organization which Rice created, and these, in their result, decreased the cost of illumination by four-fifths. It has been estimated that, on present costs for electrical power and rates of use, the saving to the public in the United States brought about by the modern lamp as compared with the carbon filament, amounts to some five million dollars a night. It has been further estimated that for every dollar of profit made for the company by innovations developed in this laboratory, the public has been saved from 10 to 100 dollars.

The example set by the General Electric Company was quickly followed. Many of the larger industrial corporations now maintain departments of considerable size devoted to industrial research; for example, the Bell Laboratories in New York, concerned with problems in the sphere of electrical communications, have a staff of some 4,000 persons of whom about one-third are scientists holding graduate and postgraduate degrees. Mention may also be made of the contribution to industrial research fostered by Dr. Robert Kennedy Duncan, a Canadian and a graduate of the University of Toronto, at whose instigation the Mellon brothers founded and endowed the Mellon Institute for Industrial Research at Pittsburgh, which has won a high place among the research institutions on this continent.

In Canada the organization of research as a function of government dates back to the impact of the Great War. In 1916, Canada, following the example of Great Britain, established an Honorary Advisory Council for Scientific and Industrial Research. It was not contemplated at that time that this Council should set up laboratories of its own; it was to act as an agency for consultation and co-ordination between those already carrying on research in the established laboratories of the several departments of the Dominion and Provincial Governments, in the universities and in industry.

Some idea of the very limited facilities then available is given in a report prepared by the first Council which shows that the annual expenditure on research in all governmental laboratories, Dominion and Provincial, amounted to considerably less than \$100,000 and that of some 2,400 leading Canadian firms, engaged in manufacturing, who replied to a questionnaire, only 37 had laboratories which even pretended to engage in research. The total annual expenditure of these firms for research and testing, apart from salaries, the figures for which are not available, amounted to some \$135,000. That is, the total expenditure for all agencies in Canada, making a liberal estimate for the cost of research in the universities, must have been considerably less than half a million dollars annually.

Looking back at the history of the Honorary Advisory Council for Scientific and Industrial Research, it is remarkable what has been accomplished with the limited facilities at their disposal, but it is not to be wondered

that men, who were informed on the subject, should have realized the utter inadequacy of the provision which had been made and that they should have pressed for some improvement. As a result of this pressure of public opinion, the matter was repeatedly considered in Parliament and, eventually, the Research Council Act was passed in 1924 under the guidance of the late Honorable T. A. Low, then Minister of Trade and Commerce. Work continued for several years in temporary laboratories. Then in 1929-30 on the recommendation of the late Honorable James Malcolm, Parliament provided funds for new laboratories; construction was commenced in February, 1930, and the buildings were completed and opened in 1932.

As was perhaps to be expected, the appropriations made available during the period of depression were on a substantially lower scale than those planned, and as a consequence, the organization, both as regards staff and equipment, is far from complete. These deficiencies must now be rectified, and the only way in which this can be brought about is for the Council and its staff to see to it that with the facilities afforded a service of value is given to the public.

NATIONAL RESEARCH COUNCIL

Organization of the Council

The National Research Council today consists of 15 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, labor, business and finance.

The Council is a body corporate, capable of suing and of being sued, of acquiring and holding money, property, etc. By statute the Council in addition to certain specific duties set forth in the Act "shall have charge of all matters affecting scientific and industrial research in Canada which may be assigned to it by the Committee" of the Privy Council.

Apart from administration, which is organized much on the lines of a department of Government, the staff of the Council is grouped in a number of divisions, each under a director. The Division of Research Information is concerned with the collection, collation and issue of scientific information and with the general planning of co-operative investigations through committees; the Divisions of Biology and Agriculture, of Chemistry, of Physics and Electrical Engineering, of Mechanical Engineering, including Hydraulics and Aeronautics, are responsible for the direction and conduct of technical work in the fields indicated by their designations. Provision is made for the closest co-operation and collaboration between all branches concerned in any particular problem. At January 1, 1937, the staff comprised a total of 163, of whom 67 were graduates or postgraduates. In addition to the regular staff in the laboratories, 31 persons, including 14 graduates, were employed directly under various committees.

Associate Committees and Co-operative Research

In order to bring to bear the knowledge of scientific men and industrialists, and to correlate the work of all research organizations concerned, a number of so-called associate committees have been set up. These meet as the occasion may require, but in this era of limited finances much of their work has necessarily to be done by the less satisfactory method of correspondence.

The function of these committees is to direct co-operative research on the problems assigned to them; to settle the objectives; to indicate the individuals or organizations which should undertake the several component parts of the inquiry; to receive and co-ordinate the resulting information; and to make it available to those who will turn it to advantage.

By way of illustration as to the procedure followed in the establishment of these committees, the steps leading to the formation of the Associate Committee on Forestry may be noted. This example will indicate the manner in which all available information can be assembled and brought into correlation, and through which the necessities of the situation can be determined and action promoted.

The Associate Committee on Forestry had its genesis at the Petawawa Research Station in a joint meeting of the Canadian Society of Forest Engineers and the Woodlands Section of the Canadian Pulp and Paper Association. There, the field was canvassed, and it was brought very forcibly to attention that, while there were a number of organizations at work in matters connected with forestry research, it did not seem that the information was being properly brought together and harmonized. The meeting passed a formal resolution asking the National Research Council to undertake this task. This the Council gladly undertook to do and as a first step a conference was called of all organizations concerned, federal and provincial, public and private, including a number of industrial concerns. The whole field was traversed and definite conclusions reached, and as a result the Council set up the Associate Committee on Forestry, which comprehensively represents the whole industry and to which all concerned may look for correlation in their efforts, and for a national plan into which they may fit their own particular lines of research.

The work and the personnel of the associate committees at present established under the National Research Council are given in appropriate sections of this report.

It is a tribute to public interest in national research to record that since the inception of the Council hundreds of men with special scientific or industrial training have, without any remuneration whatever, associated themselves with the Council in this work, have pooled their knowledge unreservedly, and have collaborated in many important developments under the auspices of the Council. It is astonishing what can be done by good will and co-operation. The success of the associate committees as a means of promoting collaboration in research is a happy augury for the future of Canadian industry.

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 objective, 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 labor, 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 postgraduate 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. It is encouraging to note that for 1936-37 a slightly larger appropriation for this purpose has been made and it is hoped that further improvement in this situation may be found practicable in the near future. This is a matter of some importance because in the absence of similar offers at home many graduates continue to be attracted to institutions in other countries where scholarships are available. Too often it happens as a consequence that those who leave Canada under foreign scholarships find profitable appointments elsewhere with industrial concerns whose products may even be competitive with those produced in this Dominion. The fallacy of training men in Canadian institutions and then allowing them to be absorbed by foreign industries while Canadian manufacturers lag behind for lack of scientific guidance should not need to be emphasized, but it is feared that as yet many persons fail to realize the national value of these postgraduate scholarships and regard them only as evidence of paternalism on the part of a benevolent government organization.

Industrial Research in Canada

Certain aspects of industrial research in Canada merit consideration. The truth of the matter is that Canada is not doing nearly enough work of this character. There is a continued dependence on other countries for leadership and experimental results for which this country is paying tribute on an enormous scale.

As is well known, most of our principal industrial companies have affiliations with larger organizations abroad, to whom there has been a natural tendency to refer any research problems that arise from time to time. It is often very difficult to examine these problems completely, apart from the special environment in which they have come to attention. For this reason, the solutions proposed are often inadequate, and, both on this ground and on account of delays, very heavy losses are involved.

A more serious loss is due to the fact that without a corps of trained investigators on the spot, the needs of the situation cannot be fully appreciated and many opportunities for useful inventions and developments are missed or unduly delayed.

Scientific Information

Before experimental work is undertaken on any research project, it is of prime importance that a thorough study of the scientific literature on the subject should be made, for it often happens that what at first may appear to be a serious and unsolved problem, is in reality a subject that has engaged the attention of brilliant scientists in other countries who have investigated the matter and published their results. A good bibliography is therefore a necessary prelude to experimental work.

Like other forms of research, a study of the literature is a matter for experts specially skilled and experienced in the art, and for this reason the Council has established a Division of Research Information which is charged with the duty of doing this work for our other scientific divisions, for our associate committees, and, within the limitations of staff, for Canadian industry as well.

The Division of Research Information is responsible for the Council's library, which now contains upwards of 20,000 volumes of reference works and receives annually some 800 scientific periodicals and about 300 other series of publications. The aim has been to develop it as a complement to other scientific and reference libraries in the Dominion, so that, through a loan and photostat service, inquirers from anywhere in Canada may be given promptly the information of which they are in need.

The Division of Research Information also has charge of the editing and publication of the *Canadian Journal of Research*, which now supplies a medium through which the work of all Canadian scientists can, if they wish, be reported. The *Journal* now goes to most of the principal libraries and scientific institutions in the world, as well as to the leading abstracting agencies. In exchange, and by subscription, the Council receives similar publications containing the records of scientific research carried on in other Empire countries and in foreign lands. These constitute a source of information that is of inestimable value.

The National Research Council maintains membership in a number of international organizations of scientific and research workers and, whenever it is considered that a useful purpose would be served commensurate with the cost, members of the staff are detailed to attend the various meetings. The most important gathering of this kind attended by the President during the year was the British Commonwealth Scientific Conference, held in London, England, September 1936. At this meeting an opportunity was afforded for conferences with technical officers from other Empire countries and with representatives from scientific institutions in Great Britain. As a result of these discussions plans have been made to ensure the better exchange of information among the research centres of the Empire, and already scientists from Australia, New Zealand and Great Britain have visited the National Research Laboratories at Ottawa in order to familiarize themselves with the work being done in Canada and to arrange for consultations and the interchange of data.

National Research Laboratories

Accounts of the researches carried on during the year in the laboratories have been prepared by the directors of the divisions and these will be found in their appropriate sections. Mention may, however, be made here of a few of the more outstanding features.

The Division of Biology and Agriculture is devoting considerable attention to studies in the storage and transport of food, a subject that is of prime importance in marketing perishable products. Valuable information obtained during visits to Europe in the past year is being applied in work looking to the improvement of export trade arrangements. This is a very important research project and one that should yield results of great commercial value.

Another research that is giving interesting results is work on the heat treatment of barley, which has yielded mutants characterized by marked changes in spike type, that promise to be superior in certain respects to the original variety. This constitutes, so far as is known, the first demonstration

of the possibility of inducing new and valuable economic plant characters by heat treatment.

Breeding of rapid-growing disease-resistant poplar varieties is being carried on in co-operation with the Dominion Forest Service. Many other researches looking to the betterment of agriculture in Canada are under way. Equipment of the laboratories is gradually being built up to provide the best possible facilities for the conduct of investigations in this field.

Organized relationships with industry are considered to be of the greatest importance in the development and conduct of research in the Division of Chemistry. At present this division has such relationships with the laundering and cleaning industry, the asbestos industry, the leather industry, and to a less extent with the wool manufacturing and sugar industries. Such connections, whether in the form of research committees or councils, or of more formally constituted trade research associations (such as exist in England for many lines of business), enable industry to have a voice in determining the direction of research, provide a means of bringing the results of research to the attention of industry, and facilitate the application of the results to industrial practice. They also offer an economical channel through which the body of firms in a given line of business may provide financial support for research on problems of general interest to the industry.

At the present time the laundry laboratory is furnishing technical advice to 93 commercial laundering and cleaning plants and institutional laundries. As evidence of the progress that is being made it may be observed that during the year the number of plants contributing to the upkeep of the laboratory rose 24%. Service to the industry included 658 reports covering the investigation of a wide variety of new and damaged fabrics, soaps, alkalis, water analyses, and recommendations as to practice. Relations between the laboratory and the industry continue to be mutually advantageous and the whole arrangement is typical of the kind of co-operation which the National Research Laboratories hope to extend to other industrial groups.

Numerous other research projects are being carried forward. Mention may be made of investigations on storage batteries, gas research, carbon monoxide hazard, casein, potato starch, refining and bleaching clays, leather and paints.

A change in organization was made in April, 1936, whereby the Division of Mechanical Engineering was established. The new division comprises the aeronautical and fire hazard laboratories, formerly a part of the Division of Physics and Engineering, and the instrument and model shops. A large part of the work of the aeronautical laboratories continues to come from Government Departments, and particularly from the Departments of Transport and of National Defence, with whose officers the closest collaboration is maintained. Problems of particular interest among the researches carried on during the year were investigations on aircraft skis, aviation gasoline and stressed skin construction.

An aeronautical museum is being established to preserve obsolete material of historical interest in connection with the development of aviation in Canada. Engines, aircraft propeller models, and similar specimens commemorate important Canadian contributions to the development of aviation.

Measurement of hydrodynamic forces on stop logs for emergency dams in ship canals was a new and interesting study made during the year. Among other problems under investigation may be noted the work on fire hazard testing, farm windmills, gasoline specifications, aircraft instruments and the inspection and labelling of oil burners.

In the Division of Physics and Electrical Engineering fundamental research on light, sound, heat and electricity are undertaken and standardization work is carried on in these and related fields, as, for example, in metrology. Numerous examples might be cited to show the practical use that is being made of the results obtained in the laboratories. The development of an improved and highly satisfactory means of heating refrigerator cars in winter, whereby it is possible to maintain uniformity of temperature in the cars, is now being taken up commercially. Studies in heat transfer are being applied in the testing of insulating materials and in the investigation of the heat conservation qualities of textiles used for clothing. Tests are being made to determine the sound absorptive properties of building materials and the proper design of rooms for the best acoustical effects. New apparatus has been installed in the electrical engineering laboratory to provide high-voltage direct current, and further progress has been made in the precise regulation of voltage. Type approval testing of meters is being continued. In the field of general physics work has been done on the electrocution of poultry, and in the estimation of forest fire hazard, and also in atmospheric. Ultra-sonic generators for use in depth-sounding have been tested. A second cathode-ray direction finder, built during the summer of 1936, has been installed in Manitoba by the radio section. Using our own time signals sent by radio, this is being operated in synchronism with the similar station in Ottawa, thus giving an opportunity of determining accurately the point of origin of atmospheric in a wide section of northern Canada extending from Labrador to Alaska. Co-operation with a number of similar stations in the United States has been arranged.

The Council

The term of appointment of the following members expired March 31, 1936: Dr. G. S. H. Barton, Dr. Charles Camsell, Dr. A. L. Clark, Dr. A. Frigon, Mr. J. C. Smith.

Dr. Clark, Dr. Frigon and Mr. Smith were reappointed for another term of three years and Dr. R. C. Wallace, Principal of Queen's University, Kingston, who had previously served on the Council, was again appointed for a similar term.

Dr. Oskar Klotz, Professor of Pathology and Bacteriology, University of Toronto, who had been a member of the Council from 1932 onwards, died on November 3, 1936. Dr. Klotz had always taken a very keen interest in the work of the Council, especially in matters relating to education and public health. At the time of his death he was vice-chairman of the Council's Associate Committee on Tuberculosis and also a member of the Associate Committees on Parasitology and Radiology.

A Review Committee was appointed by the Council early in the year with Dean A. L. Clark as chairman and the following members: Dr. H. E. Bigelow, Dr. O. Klotz, Dean C. J. Mackenzie and Mr. Tom Moore. The committee held three meetings, inspected the work in progress in the several divisions, and made a report which contained a number of important suggestions. With reference to scholarships, the committee recommended that provision should be made for a new class of awards tenable in the National Research Laboratories. This recommendation was approved and two new classes of awards were established: (a) Open to applicants who have at least one year's postgraduate work to their credit; and (b) Open to applicants who have completed the requirements for the Ph.D. and wish to work in the laboratories of the Council for a period to bridge the gap between their academic training and their subsequent employment in industry or elsewhere.

The value of the awards in the first class was set at \$750 and for the second \$1000 per annum. Suitable regulations were established.

An agreement between the Council and Canadian Refractories, Limited, was completed during the year, whereby the company assumes responsibility for the cost and protection of all patents arising from the work on magnesian products, and the Council will receive royalties on the products covered by such patents as well as a proportion of the receipts from any patents which are sold.

The following conferences which were no longer active were disbanded: Animal Diseases; Chemists; Engineering; Fresh Water Fish Culture; Honey; Physics and Engineering Physics.

An Associate Electrical Committee was established and in the terms of reference it was provided that it should also operate as and be designated the "Canadian National Committee of the International Electrotechnical Commission," thus eliminating duplication of effort in this field.

Appointments

The following appointments to the scientific staff were made during the year:

Norman Edwin Gibbons, B.A. 1927, Queen's University; M.A. 1928, Queen's University; Ph.D. 1932, Yale University. National Research Council Bursary, 1928-1929; Arts Travelling Fellowship from Queen's University, 1929-1930; University Scholarships, Yale 1929-1930, 1930-1931, 1931-1932. Scientific Assistant in Bacteriology, Fisheries Experimental Station, Halifax, Sept. 1931-April, 1936; Assistant Bacteriologist, May, 1936-February, 1937. Appointed March 1, 1937, as Assistant Research Bacteriologist, Division of Biology and Agriculture.

John Katzman, B.Sc. 1929, McGill University; M.Sc. 1930, McGill University; Ph.D. 1933, McGill University. Governor General's Silver Medal for highest standing in the science subjects; National Research Council Bursary; Scholarship, Montreal Jewish General Hospital. Demonstrator in physics, McGill University, 1931-1934. Experimental work in acoustics, Department of Physiology, McGill University, 1935-1936. Appointed July 15, 1936, as Senior Research Assistant, Division of Research Information.

Alexander Rose, B.Eng. (Chemical Engineering) 1935, McGill University; Douglas Tutorial Bursary, 1933 and 1934; Honors in Chemical Engineering; British Association Medal. J. T. Donald and Company Ltd., Montreal, May 27 to Dec. 31, 1935; Canadian Copper Refiners Ltd., Montreal East, Feb. 11 to Aug. 18, 1936. Appointed February 12, 1937, as Junior Research Assistant, Division of Chemistry.

James Stewart Tapp, B.A. (Chemistry) 1930, University of Western Ontario; M.A., Ph.D. (Physical Chemistry) 1933, McGill University; Ph.D. (Physical and Inorganic Chemistry) 1936, University of London, England. Overseas Scholarship granted by Royal Commissioners for the Exhibition of 1851, held for three years at Imperial College of Science (University of London), South Kensington, England, 1933-1936. Demonstrator in Physical Chemistry, McGill University, 1930-1933; Demonstrator in Physical Chemistry, Imperial College, 1935-1936; (Six years' experience in physical chemical research methods). Appointed March 1, 1937, as Junior Research Chemist, Division of Chemistry.

Carl Arthur Winkler, B.Sc. 1930, University of Manitoba; M.Sc. 1931, University of Manitoba; Ph.D. 1933, McGill University. Isbister Scholarships, 1925 and 1927; University Gold Medal (Manitoba), 1930; Wheat Pool

Fellowship, 1930; National Research Council Studentship, 1931; Fellowship, 1932; Rhodes Scholar, 1933-1936, Wadham College, Oxford; research in chemical kinetics; Governor General's Silver Medal for research, McGill University, 1936. Demonstrator and Tutor, University of Manitoba, 1928-1931. Appointed April 28, 1936, as Assistant Research Biologist, Division of Biology and Agriculture.

Finances

The National Research Council derives its revenue chiefly from the parliamentary appropriation provided for its work each year, but it also administers certain trust funds and receives contributions from industries, either in support of special investigations, or in payment of laboratory fees for tests or for publications.

In the year under review earnings from fees doubled and income from trust funds rose by a substantial sum. The grant made by Parliament for 1936-37 amounted to \$510,000. In the preceding year the grant included \$500,000 in the main appropriation and \$22,615.38 to enable salaries to be restored to the levels prevailing before the five per cent deduction was made during the depression period, and for the restoration of statutory increases in salaries, which had been suspended. The total funds available to the Council for 1936-37 were \$708,233.24, as compared with \$658,326.93 in the preceding year. Thus it will be seen that, while the total funds available for the year under review were slightly larger than in 1935-36, the amount granted by Parliament was actually less in 1936-37 than in the preceding year. While the improvement in other revenue of the Council was most encouraging, emphasis should continue to be placed on the need for generous appropriations by Parliament for research for many years to come, in order that the most profitable returns may be obtained from the present investment in buildings and laboratory equipment, and that the national interest in research may be fully served.

Receipts by the Council and expenditures, including the appropriations to committees for special purposes, are shown in the financial statement which follows.

Financial Statement for the Fiscal Year 1936-1937

		Receipts
A. <i>Parliamentary Appropriation</i>		
	Main Vote.....	\$ 500,000.00
	Supplementary Vote.....	10,000.00
		\$ 510,000.00
B. <i>Special Fund</i>		
	Laboratory Fees.....	\$ 30,528.92
	Deposits on Account of Tests.....	1,134.81
	Sale of Publications.....	2,562.83
	Miscellaneous.....	6,439.12
		\$ 40,665.68
C. <i>Trust Fund</i>		
	Amount in Trust, April 1, 1936.....	\$ 27,604.77
	Grain Research Trust Fund.....	48,596.09
	Contributions from Industries, etc.....	75,304.59
		\$ 151,505.45
D. <i>Patents and Royalties Fund</i>		
	On Hand, April 1, 1936.....	\$ 1,384.39
	Royalties.....	4,677.72
		\$ 6,062.11
		\$ 708,233.24

Expenditures

A. *Parliamentary Appropriation*

Salaries.....	\$ 339,455.41
Assisted Research Grants (Transferred to Trust Fund).....	66,146.23
Scholarships.....	15,675.00
Laboratory Equipment and Supplies.....	38,359.57
Library.....	10,630.37
Patents.....	1,371.00
Publications Issued.....	13,638.82
Travelling—Council Members, Associate Committees, Staff, etc.....	14,904.40
General Expenses.....	9,819.20
	<hr/>
	\$ 510,000.00

B. *Special Fund*

Assisted Research Grants (Transferred to Trust Fund).....	18,404.45
Laboratory Equipment and Supplies.....	20,114.24
Library.....	1,012.18
	<hr/>
	\$ 39,530.87

C. *Trust Fund*

Aeronautical Committee.....	\$ 5,696.62
Asbestos Committee.....	1,388.79
Canadian Engineering Standards Association.....	12,122.49
Canadian Government Purchasing Standards Committee.....	1,363.69
Electrical Measuring Instruments Committee.....	600.00
Field Crop Diseases Committee.....	2,845.25
Fire Hazards Committee.....	3,131.26
Forestry Committee.....	1,896.03
Gas Research Committee.....	750.00
Grain Research Committee.....	34,031.14
Hydraulic Research Committee.....	8,734.53*
Laundry Committee.....	1,350.00
Magnesian Products Committee.....	10,111.31
Parasitology Committee.....	17,840.00
Radio Research Committee.....	5,387.88
Radiology Research Committee.....	962.35
Committee on Storage and Transport of Food.....	2,798.91
Survey Research Committee.....	1,121.90
Trail Smelter Smoke Committee.....	36,533.83
Tuberculosis Committee.....	9,997.69
Weed Control Committee.....	4,560.00
Wool Research Committee.....	1,570.01
Rubber Metal Bond Investigation.....	1,915.10

* Includes payment to Department of Transport on account of extra facilities at Hogs Back Dam, Ottawa, provided in the interest of hydraulic research and the regulation of the Rideau River.

REPORTS OF THE DIVISIONS

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

With some easing of the financial stringency in 1936-37, the work of the Division of Biology and Agriculture experienced a little much needed expansion. While the many practical problems referred to the Division for solution cannot yet be covered, it has become possible at least to investigate some of them more adequately.

Early in the year a biophysicist was added to the staff, to investigate especially problems in the control of humidity and other physical conditions of cold storage. The addition of a bacteriologist at the end of the year completed the nucleus (biochemist, biophysicist, bacteriologist and mycologist) of a group organized to investigate problems in the storage and transport of food. The carbon dioxide compressors described in the last report were brought into service, thus completing for the food storage studies a refrigeration plant which is second to none in quality, and if the size is small in comparison with that of plants established by some other British Dominions, it is adequate for present needs.

It was also possible during the past year for members of the staff to do more travelling than in previous years, and this led to many valuable contacts and the securing of information useful as a guide in our work. Special mention should be made of Dr. W. H. Cook's attendance at the Seventh International Refrigeration Congress, at The Hague, and the Second International Congress for Microbiology, in London. His trip included visits to low temperature laboratories on the Continent and in Great Britain, and a brief survey of trade conditions and practices affecting the export of perishable food products from Canada to Great Britain. Problems in the curing and transport of bacon were among the most important of those which came to his attention as urgently in need of investigation. Personal contacts with representatives of the food investigation staffs from different parts of the Empire laid the foundation for closer co-operation with these Dominions in solving common problems. These contacts were amplified in a number of cases by the Director, incidental to his attendance at the British Commonwealth Scientific Conference in London in September, 1936.

A point which emerged clearly from these overseas visits was that Canadian trade practices were in some respects lagging behind those of other Dominions who maintain technical liaison officers in their London offices. These officers are in a position to determine promptly what are the key problems in any particular trade, with reference to methods of handling, storing and shipping the commodity concerned. Complaints can be investigated on the spot, and full advantage taken of the extensive facilities of the Food Investigation Board for looking into all questions relating to foodstuffs imported by Great Britain. It would seem to be greatly to Canada's interest to attach such a technical officer to Canada House with the least possible delay.

While in the foregoing paragraphs emphasis has been laid on investigations in the storage and transport of food, the field in which most expansion has taken place during the year under review, it will be seen by the short reports on the work of each laboratory which follow, that in most of them it is possible to record good progress.

Plant Biochemistry and Physiology

R. NEWTON

The studies on plant growth under controlled conditions remained in suspension owing to lack of staff. Towards the end of the year the appointment of a laboratory assistant made it possible to put in hand the reconditioning of the equipment, which had been idle two years, in preparation for an active program of experiments during 1937-38.

No new work was undertaken on chemical weed killers, but Dr. W. H. Cook prepared a series of five papers covering results obtained earlier, for publication in the *Canadian Journal of Research*. These results show that lamb's quarters are about twice, and wild oats about seven times, as resistant to chemicals as are stinkweed and wild mustard. Out of 76 chemicals tested, some 20 were effective in killing the foregoing annual weeds, but only five were effective in killing perennials such as Canada thistle and sow thistle. The latter chemicals acted through the soil as well as through the leaves; they have the disadvantage of making the soil relatively barren for some time. A simple method was developed for estimating the relative toxicity of chemicals by their effect on the growth rate of plants in water culture. This is much more rapid than ordinary field or greenhouse tests, yet gives a good indication of the probable effect of the chemicals in the field.

Grain Research

Wheat

J. G. MALLOCH

Standardization of Experimental Baking Test

The necessity of completely mechanizing the baking test to reduce the variability and hence the work required to obtain accurate results has been stressed in previous reports. The punching and molding machine which was designed and constructed in the Council's laboratories has passed the initial stages of development and is under test co-operatively by the laboratories connected with the Associate Committee on Grain Research. The design of the curling mechanism has partially overcome one of the drawbacks to mechanical manipulation. The behavior of the dough in curling gives limit measurements of the stickiness and softness that are, in some ways, more valuable than the general impression of "handling quality" obtained by the baker when the operations are performed by hand.

The laboratory has co-operated with the Baking Test Committee of the American Association of Cereal Chemists.

Recording Dough Mixer

This apparatus, which was designed and constructed in the Council's laboratories, gives complex curves recording the changes in the stress transmitted through a dough made with seven grams of flour (dry matter basis) as the mixing progresses. Using simple flour and water doughs, differences between samples have been observed in ten features of the curves. So far it has been possible to study only two of these, namely the height (stress) and time of occurrence of the break which is a feature of the curves obtained from all flours. The position of this point is closely replicable, the standard errors being 1.46 mm. and 0.88 mm. for height and time respectively. The height of the break is related to the protein content of the sample, the amount of water added and possibly other factors, including the grade of the flour. The time of breakdown is practically independent of protein content, the amount of water added, the addition of inert substances or the size of the

sample, but it is affected by reagents known to affect the properties of colloids. It is concluded that the time of breakdown measures some colloidal property of the gluten and hence is related to gluten quality.

The utility of the machine for obtaining information on the quality of small samples, such as those available in the early stages of plant breeding, is greatly enhanced by the close relation between the breakdown time of flour and of ground samples of the wheat from which it was milled. This will permit the use of the apparatus without the necessity of carrying out time-consuming milling tests for which comparatively large samples are required.

The machine can also be used to follow the changes in the gluten of a fermenting dough and the effect of improvers on these changes. By diluting with an inert substance, such as wheat starch or talc, the properties of wet or dried gluten can be studied.

Barley

J. ANSEL ANDERSON

Experimental Malting and Malt Analysis

Enlargement of domestic and foreign markets for Canadian barley appears to depend primarily on improvement of malting quality through the introduction or development of new varieties which combine high yield and disease resistance with superior malting characteristics. Progress has been hampered by the lack of satisfactory methods for appraising the malting characteristics of different varieties. During the past year equipment and methods have been developed for malting small samples in the laboratory under controlled conditions (Can. J. Research, C, 15 : 204-216. 1937). A thorough test of the equipment showed that results could be reproduced with approximately the precision obtained in chemical analyses of malt (Can. J. Research, C, 15 : 242-251. 1937). The first step, the development of precise malting methods, has thus been made in the development of methods for evaluating malting quality.

In co-operation with the malting laboratory at the University of Manitoba, the Canada and Dominion Malting Companies, and the American Association of Cereal Chemists, an attempt is being made to increase the uniformity of analytical results obtained in different laboratories. Co-operative studies during the past year have resulted in considerable improvement in Canadian laboratories. Recent results indicate that methods used for extract, color and moisture are fairly satisfactory, but that the standard method for diastatic activity requires modification. (J. A. Anderson and W. O. S. Meredith.)

As a result of studies in the National Research Laboratories, a number of changes have been made in the equipment and methods used for routine malting tests at the University of Manitoba. A much improved service is now being offered to plant breeders and other barley investigators throughout the country. (J. A. Anderson and H. Rowland.)

Diastatic Enzymes of Barley and Malt

Most of the Canadian malting barley used in the United Kingdom is made into diastatic malts. Fundamental information looking to the improvement of barley for this market is being sought by studies of the development of diastatic enzymes in barley and malt. As a first step it was necessary to devise a more accurate, precise and rapid method for determining Lintner values (Can. J. Research, C, 15 : 70-77. 1937) and to carry out an exhaustive study of the sources of error in this determination (paper presented to the American Association of Cereal Chemists, May 1937, and to be published

shortly in Cereal Chemistry). Although this work was undertaken in order to provide a satisfactory yard stick for fundamental studies, it has aroused considerable interest among commercial maltsters as it indicates that the problem of obtaining uniform results in different laboratories for the diastatic power of malt is not insoluble.

Food Storage and Transport

W. H. COOK, N. E. GIBBONS, G. A. LEDINGHAM, C. A. WINKLER

Dechilling of Eggs

When eggs are removed from a refrigerated space to a warm atmosphere it is possible for a layer of condensate to form on the product which might detract from its immediate salability and hasten subsequent deterioration by accelerating the growth of micro-organisms. A study of this problem showed that any condensate which formed was taken up almost immediately by the fillers and flats used for packing. The results indicated that the rate of subsequent deterioration was somewhat greater when the eggs were warmed up under atmospheric conditions which permitted the packing to take up moisture, but the results were not conclusive. It appears that the development of a more suitable type of packing would avoid all difficulties arising from condensate formation and that artificial dechilling with dry air would then be unnecessary.

Frozen Storage of Poultry

If poultry is to be stored for more than three to four weeks it must be frozen. Under these conditions the loss of bloom, or the fresh surface appearance, and the drying of the skin, a condition known as "freezer-burn", are usually the changes which determine the storage life of the product. It was found that the deterioration caused by surface drying could be reduced to negligible proportions by decreasing the drying power of the air. This can be done either by lowering the temperature or increasing the relative humidity in the refrigerated space. The former method is seldom practicable commercially; consequently particular attention was given to the effect of relative humidity. It was found that poultry could be stored for one year without any evidence of surface drying at a temperature of $+7.5^{\circ}$ F. or lower, at relative humidities of 95 to 100%. Lower relative humidities decreased the safe storage period at all temperatures, but at a given relative humidity the decrease was less at lower temperatures. A temperature of $+7.5^{\circ}$ F. and 80% relative humidity is quite common in commercial warehouses and dressed poultry exposed to these conditions would show distinct evidence of surface drying in from three to four months. The moisture content of the skin of freshly-frozen and freezer-burnt poultry showed considerable variability but in general the skin of freezer-burnt poultry contained only about half as much moisture as that of freshly-frozen birds.

Packaging of Poultry

One possible method of reducing the losses in quality due to surface drying of a packaged product such as dressed poultry is to line the boxes with moisture-proof wrappers. With the information available from the experiments outlined in the previous section, the efficacy of a particular method of wrapping can be determined by measuring the relative humidity inside the package. Three wrapping materials, namely: parchment, wax paper and aluminium foil are being tested in this way. In commercial practice the lining is made up of flat sheets folded over the product, and it seemed likely that considerable interchange between the air in the package and the dry air of the refrigerated space could occur at the joints. This

point was studied by comparing the relative humidity in boxes lined in the usual way with that obtained in boxes in which the joints of the liner were sealed. The results to date indicate that the relatively moisture-proof liners such as wax paper and aluminium foil are superior to parchment which is permeable to moisture. It appears that these moisture-proof liners could be improved further by sealing. As sealing of the flat sheets ordinarily used is not practicable commercially, some consideration is being given to a new type of package for dressed poultry, which will permit sealing and possess other advantages over the wooden boxes now in use.

Humidification of Freezers

Another method of preventing the loss of quality due to surface drying of frozen products is to raise the relative humidity of the air in the refrigerated space. This method has the advantage that it will prevent the surface drying of all products whether packaged or exposed. The humidification of refrigerated spaces at freezing temperatures is not a simple problem, as the cooling coils are at a lower temperature than the ambient air, and at high relative humidities the cooling surfaces exert a dehydrating effect and become covered with ice. Usually the relative humidity in a freezer lies between 60 and 80%. A method has been developed for humidifying freezers to a relative humidity of 95% or more, under conditions which prevent the formation of frost on the coils, without increasing the refrigeration load significantly.

Measurement of Humidity

Studies in these, and in other, laboratories, have demonstrated the importance of humidity in relation to the keeping quality of perishables in refrigerated storage. The accurate determination of humidity at refrigeration temperatures is difficult, owing to the small amount of moisture in the atmosphere at these temperatures.

Two types of apparatus are being developed for measuring the humidity of storage rooms and packaged products at low temperatures. One of these is for use in refrigeration rooms, and can be made automatic and recording in operation. Tests have shown the manually controlled apparatus to function satisfactorily in cold-storage rooms.

For determining the humidity in packaged products, an apparatus is being developed by which the humidity is determined by absorption of the moisture and measurement of the pressure change on a sensitive pressure gauge. This apparatus is being tested.

Since both these hygrometers are capable of giving an absolute measure of the moisture content of the atmosphere, they can be used not only to measure humidities, but also to calibrate other types of instruments for the same purpose.

Precooling of Poultry

Poultry must be cooled immediately after killing and dressing in order to obtain the best quality product. Where refrigerated facilities are available, precooling is often done by hanging the birds in a room at a temperature near the freezing point. The product, however, cools more quickly if immersed in cold water and this practice is followed in some commercial plants, and is the only method of cooling that can be used on farms where refrigerated facilities are not available. A study was made of the time required for cooling, in both air and water, in relation to the size of the bird and its initial temperature. The poultry was subsequently packed and stored in the frozen state to determine the effect of the two methods of cooling on the subsequent keeping quality as determined by the changes in surface appearance or bloom.

No difference could be detected between the two methods. Bacteriological counts made on the water used for precooling indicate that the number of bacteria increase at a water temperature of 45° F. but not at 32° F. This indicates that the cooling tanks may contaminate the product and reduce the storage life in the chilled state, unless precautions are taken either to keep the temperature of the water near the freezing point, or to change it frequently.

Bloom in Relation to Grade of Poultry

The fresh surface appearance, or bloom, of the product is usually the first factor to suffer deterioration in frozen storage. In the investigations on chilled poultry, presented in the last report, it was found that the lower grades were the first to suffer loss of bloom. An investigation was initiated to determine if this was also true for poultry stored in the frozen condition. This study is not yet complete but it appears that the lower grades deteriorate in appearance more rapidly than the higher grades.

Curing and Preserving of Bacon

Little is known of the microbiological processes involved in the curing and storage of bacon. A study of these processes should be of assistance in the problem of landing uniformly cured bacon in importing countries.

A program has been outlined dealing with the relation of bacteria to curing and to uniformity of cure. While information and material are being collected on this problem, sliminess of bacon, which is of more immediate concern to the packers, is being investigated. A number of organisms have been isolated from pork, bacon, slime pickle and curing cellars. These are being studied to determine the origin of the organisms responsible for sliminess.

Growth of Molds on Chilled Poultry

Further isolations were made from the flesh of chilled poultry and a number of cold-storage molds have been separated in pure culture and identified. These organisms have been used for growth-rate experiments, and studies have also been made of their morphology, cultural differences, and temperature relations.

Since the growth of fungi on foodstuffs in general is one of the major reasons for their deterioration during cold storage, an investigation of the rate at which fungi develop under various cold-storage conditions has been started. Attention has been directed mainly to developing a method for studying the growth rates of fungi that will serve to standardize other more readily applicable, but essentially empirical, methods. Briefly, the method under investigation has been the determination of the wet-weight of a fungus at various stages of its development. Results obtained to date indicate the method to be theoretically sound and practically applicable.

Apple Taint

Tainting, by apples, or other food products during transit and storage, has frequently been responsible for serious financial losses as a result of much diminished marketability of the product. Experiments are being made to find an effective way to reduce the concentration of the odoriferous substances in the atmosphere in small-scale apple stores. Activated carbon proved to be the most effective of a number of materials studied for taking up the taint. Experiments are also being made to obtain a method for concentrating the tainting substances sufficiently to make possible a study of methods for their destruction in apple storage rooms by physical or chemical means. Concentration by condensation in liquid-air traps seems to hold promise of success.

Cytology and Genetics

F. H. PETO

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 during the summer of 1935, and *Agropyron glaucum* and *A. elongatum* were found to cross readily with durum and common wheats. The majority of the first generation plants were sterile but a few hybrid plants of *T. vulgare* (common wheat) crossed with *A. elongatum* were fertile. The second and third generations of these hybrids have been grown, and exhibit a wide range of characters intermediate between the two parents. The results to date are very promising and the project is being continued.

The cytology of the original hybrids has been published (Can. J. Research, C, 14 : 203-214. 1936) and since then plants from several new crosses made in 1936 have been examined cytologically. An explanation has also been found for the wide differences in fertility between different plants of the same cross. Progress has been made towards developing a heat-treatment method of doubling the chromosome number in sterile hybrids to induce fertility. Heat treatment of common wheat has caused chromosome doubling in several plants. These plants are not superior to their parents but the experiment has demonstrated the feasibility of the method when applied to sterile hybrids.

Heat-induced Mutations in Plants

Heat treatment of barley seeds has resulted in the appearance of a number of mutant plants (sports) in the progeny. One of these mutants, characterized by marked changes in spike type, promises to be superior in certain respects to the original variety. Initial growth tests of this mutant were conducted in the greenhouse during the winter of 1936-37, and field tests for yield and quality will be carried out during the summer. This constitutes, so far as is known, the first demonstration of the possibilities of inducing new and valuable economic plant characters by heat treatments. The mode of inheritance has been determined for ten other mutant characters and all were found to give typical Mendelian segregation ratios. These results have been published. (Can. J. Research, C, 15 : 217-229. 1937).

A cytological study was made on a heat-treated barley plant containing a sector of the spike with double the usual chromosome number (Can. J. Research, C, 15 : 445-447. 1937).

Poplar Research

In co-operation with the Dominion Forest Service a preliminary survey has been made of the problem of breeding rapid-growing and disease-resistant poplar varieties suitable for pulp, match stock, and shelter belts for western Canada. Certain natural hybrids between European and native species have been found to exhibit exceptional vigor and some evidence of disease resistance. Several of these have been examined cytologically and the most vigorous have been found to possess an extra set of chromosomes. The exceptional vigor in these plants is the result of both hybrid vigor and the vigor contributed by the presence of the extra set of chromosomes. Since poplars are easily hybridized and propagated it should be possible to combine the desirable economic characters of different species and also obtain very rapid growth. A faster growth rate will be very important under intensive management.

Microbiology

Bacteriology

N. E. GIBBONS

This laboratory was established only in the last month of the year covered by this report. First attention was given to equipment, and a beginning was made in studies on bacon curing and storage, in collaboration with the group working on problems in the storage and transport of food.

Mycology

G. A. LEDINGHAM

The mycologist was again occupied mainly with smelter fumes investigations in British Columbia, but so far as time permitted collaborated in the studies on food storage and transport in the Council's laboratories. Some attention was also given to the following two projects.

Root Parasites of Agricultural Plants

Methods were investigated for securing controlled infection in plant roots from resting spores of *Polymyxa graminis*, *Spongospora*, and *Plasmodiophora*, parasites causing disease in various agricultural plants. Observations on the life cycle of the first-named were continued to obtain further data for a paper on this subject now in preparation for publication.

Straw-fermenting Organisms

Stock cultures of organisms isolated from rotting straw stacks are being maintained, and molds from various sources are being added for use in projected fermentation studies.

Statistical Research

J. W. HOPKINS

Agricultural Meteorology

The objects of this research are: (i) investigation of the relation between weather conditions and the growth and yield of crops; (ii) examination of accumulated meteorological records with a view to determining the climatological characteristics of specified agricultural zones, together with the nature and extent of variations in weather conditions from year to year.

In continuance of a previous statistical study, the correlation between plot yields of wheat grown at experimental stations in central and southern Saskatchewan and Alberta and the amount of precipitation during the autumn, winter and spring months prior to sowing, was investigated. A significant relation was found between pre-seasonal precipitation and the yield secured from year to year on both the fallowed and stubble plots of a summer-fallow-wheat rotation, above-average moisture being associated with increased yields. There may have been some additional effect of winter snowfall, but on the whole it seems probable that the major influence was ascribable to autumn and spring rain. The relation between precipitation and agricultural yield in this area was also investigated to the extent that the available data permitted. The annual average yield of wheat per acre from 1916 to 1934 in three central and in three southern crop districts showed a significant positive correlation with the available statistics of rainfall between May 1 and July 31. Yields in the southern districts were also positively correlated with pre-seasonal precipitation. The agreement between the recorded and calculated yields was not, however, adequate for the practical forecasting of annual production. (Can. J. Research, C, 14 : 229-244. 1936.)

A statistical study was made of some characteristics of the precipitation recorded at meteorological stations in central and southern Saskatchewan and

Alberta. The general level of both autumn and winter (Sept. 1 to March 31) and spring and summer (April 1 to Aug. 31) precipitation showed undoubted variation with time over the years 1898-1934, irregular periods of above- and below-average moisture alternating. There were in addition large irregular annual fluctuations in the amounts recorded at individual stations. Correlation studies revealed no consistent association between the amount of precipitation in different spring and summer months of the same year, or between the totals for the autumn and winter, and for the following spring and summer period. The average (1916-1932) number of days on which rain fell showed a distinct seasonal trend during spring and summer, being lowest in April and highest in June. Similar variation was noted in the average amount of rain per rainy day. In all five months April-August the frequency of occurrence of different daily amounts of rain (exclusive of zero) was decidedly uneven, the smaller daily totals being much the more numerous. This is a point of importance, since the smaller rainfalls may be evaporated directly from the surface layer of soil, never becoming available for absorption by plants. Although there was a significant correlation between the total precipitation recorded at different stations in the same district during the same month, there was also considerable local variation, in each of the four districts studied, with respect to both the total amount of precipitation in any month, and its intensity, as measured by the percentage accruing from the larger daily falls. (Can. J. Research, C, 14 : 319-346. 1936.)

An allied statistical study is now being made of the air temperatures recorded at meteorological stations in central and southern Saskatchewan and Alberta. A greenhouse experiment is also in progress, which it is hoped will provide some information respecting the effect of moisture and temperature conditions subsequent to flowering on the protein content of wheat.

Inheritance of Egg Production

Co-operation was extended to the Division of Poultry Husbandry, Central Experimental Farm, Department of Agriculture, in connection with statistical studies on the inheritance of egg production in the domestic fowl. The object of the study was to secure information on various points affecting the efficiency of selective breeding for increased production. As a result of the work done, two co-operative papers were published (Sci. Agr. 17 : 382-392; 393-400. 1937) as well as others by members of the Poultry Division alone.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

The variety of work carried out in the division is such that it would hardly be appropriate, in these introductory paragraphs, to review it all, even briefly, and to point out, where it is not already obvious, the practical significance of all the items mentioned under the various sections of the report. An exception may, however, be made in the case of a few items.

Plant Hormones

The study of plant hormones, in which the division has done pioneering work, may, it is not unlikely, ultimately have profound effects on the practice of agriculture and horticulture. In 1934 it was discovered by European scientists that plants elaborate certain substances which, when applied in very minute amounts—amounts comparable with the amounts in which vitamins affect animals—produce a profound effect on plant growth. The substances were designated “plant hormones”. The term “hormones” or “chemical messengers” had previously been applied to substances such as insulin, which, secreted by certain of the ductless glands of an animal, pass

into the blood and produce effects at a distance. The division has not only devised a method of synthesizing at a relatively low cost the simplest of the natural plant hormones, *viz.*, indolyl acetic acid, but has synthesized a considerable number of related and analogous artificial substances. Tests on plants (carried out in the first instance in collaboration with the Boyce Thompson Institute for Plant Research, Yonkers, N.Y.) have shown that these synthesized substances have an effect on plant growth similar to that of the natural plant hormones. A cheap method of producing one of the most potent of these artificial hormones has been devised. Not impossibly, as research on the application of the synthetic hormones to plants proceeds, in the Council's Division of Biology and Agriculture and elsewhere, new, important practical uses for the substances will be disclosed. At present the main practical application is to induce root formation on clippings.

Corrosion

Of late much has been heard of the menace to agriculture of soil erosion; of the attrition of soil by wind and water. In industry there is ever present the menace of corrosion. There are few industrial plants in which there are not parts subject, in greater or less degree, to corrosion and the waste which it entails; to attrition, by chemical or electro-chemical action, of metal pipes, processing vessels, engine cylinders, valves, constructional parts, etc. 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, *viz.*, the corrosion of aluminium boat hulls in sea water, should be undergoing expansion, in order to study the increasing number of corrosion problems—ranging from the corrosion of laundry hot water pipes to that of hydroelectric power dam gates—which are being brought to its attention by various industries in Canada.

Refractories

The winning of metals from their ores usually involves the use of furnaces operating at very high temperatures, and calling for the use, as linings and otherwise, of products of high refractoriness. In general, it is to the advantage of the metal industry in Canada that it should have at its disposal materials of better and better resistance to heat, so that furnaces can run at the highest feasible temperatures and their throughput thus be at a maximum, and so that the time and money lost in replacing worn-out refractories will be reduced to a minimum. The refractories (Magnesian Products) laboratory has not only made available to the Canadian metal industry better refractories and extended the range of refractories available to it, but has shown how Canadian raw materials can be used in the production of such refractories. The most outstanding development of the laboratory during the year under review has been the production of high grade refractories of which the basis is dolomite, a mineral low in cost and occurring rather widely in the Dominion.

Distillation

During the year further development has been carried out on the novel form of distillation column which was invented in the division; and, in order to make the column available to industry, arrangements have been made for its commercial manufacture. The separation in a pure condition of the components of mixtures of liquids whose boiling points differ only slightly has not hitherto been practicable on an industrial scale. The new, highly efficient column offers the promise of making it practicable. Industrially, the most important complex liquid mixtures from which it has not hitherto been feasible to separate closely-boiling constituents are petroleum and coal tar. And here the new column has great possibilities. It makes possible, and, it is hoped, commercially feasible, the separation from gasoline of narrow fractions suited

for chemical synthesis or for use as fuel of high anti-knock rating for aeroplanes, etc. It offers the possibility of separating from coal tar (already the source of so many of the substances used as raw materials for dyes, drugs, antiseptics, etc.) further treasures, from which new synthetic chemicals may be made.

Casein

The research in progress in the division on casein is of interest to the dairy industry. Casein, a dairy by-product, is made from skim milk, and varies in properties according to the process used for its production. Most of the casein hitherto made in Canada has been of a type which, while suitable for use in the manufacture of coated paper, is unsuitable for the production of casein plastics, *i.e.*, molded objects, such as buttons and buckles, which can be manufactured by rendering casein plastic with water, extruding and molding the plastic material to shape and then hardening it by soaking in formalin solution. The art of making casein suitable for plastics has been developed in France, and most of the plastic casein used by the button trade in Canada has hitherto been imported from that country. Research on plastic casein has been undertaken in the laboratories, in order that it may be possible to give reliable, practical advice to the several firms in Canada wishing to take up the production of the material.

Laundering

The laundry and dry cleaning laboratory has continued to extend its services, not only to commercial power laundries in every province of the Dominion, but also to institutions, especially hospitals and hotels, which operate laundries and are anxious to bring their operations to a high standard of efficiency. It may be mentioned that during the year the services of the laboratory have been given to laundries operated at penitentiaries.

It is gratifying to record that the laboratory has during the year made an increasing number of contacts with textile manufacturers in Canada on questions concerning the laundering and cleaning qualities of various fabrics.

Good progress has been made in a program of fundamental research on that crucial laundry operation, bleaching.

Leather

Attention may be directed to an interesting outcome of a study, made in the leather laboratory, of the deterioration of the upper leather of shoes which displays itself in the appearance of cracks, especially at the places where most flexing takes place when shoes are in use. It has been found that the presence of sizing in fabric shoe linings may contribute to the deterioration of the upper leather, by giving rise, in the presence of moisture, to organic acids capable of affecting the leather. In saying this, it is not intended to leave the impression that this is the only cause of the deterioration. The nature of the tannage to which the leather has been subjected and the presence of perspiration may also be contributing causes.

Natural Gas

Further work done during the year serves to emphasize the attractiveness of the combination process for the utilization of waste natural gas (such as that in Turner Valley, Alberta), to which attention was drawn in last year's report. According to this process, natural (stabilizer) gas is first subjected to heat treatment by passage through a specially designed furnace, in order to produce liquid motor fuel, and is then burnt to produce carbon black. Using a gas consisting substantially of butane, it has been found that the first step of the process yields 4.23 gallons of benzole-type gasoline

per 1000 cubic feet of gas, and that the residual gas from the first step when burnt yields more carbon black than can be obtained by burning the original gas directly, without first converting part of it to motor fuel. This latter result, which may seem paradoxical, is due to the fact that the residual gas from the furnace is different in chemical nature from the gas passed into the furnace.

Miscellaneous and Specifications

In addition to the minor investigations listed under the section "Miscellaneous", the division has answered numerous inquiries, which are not recorded here, from industrial firms and Government departments. It has often been necessary to spend considerable time in securing the technical or technical-economic information required to answer the inquiries. It is felt, however, that there is good justification for devoting attention, within reasonable limits, to minor investigations and inquiries, not only because an immediate service is thereby being rendered to Canadian industry, but also because research problems of major importance to industry not infrequently come to light.

Somewhat similar remarks might be made concerning the efforts which have been devoted by the division, in conjunction with the Government Purchasing Standards Committee, to the preparation of standards of quality and performance of textiles, paints, soaps, etc. The work not only serves the immediate purpose of making available to the Government and to industry specifications on which to base the purchase of goods, but not infrequently discloses problems for research.

Analysis

C. W. DAVIS

Chiefly in order to provide data required for researches in progress in the division, the analytical laboratory made the following determinations: 1080 on refractories, 817 on asbestos and serpentine, 447 on washing compounds and textiles, 250 on gasolines and lubricating oils, 134 on water samples, 104 on leather and furs. Other materials analyzed included alkaloids, anti-freeze, casein, organic mercurials, pigments, rubber, starch, varnish and wax.

Fire Hazard. At the request of the Department of Insurance the following samples were tested or analyzed: six brands of matches, seven brands of fire extinguishers, a material with a low melting point used in a fire-alarm system, a cleaning compound, a sample of dust, six samples of debris from a fire.

Soap. In connection with the work of the Canadian Government Purchasing Standards Committee attempts were made to find an improved method of determining the free alkali in soap.

Aluminium Sulphate. Methods for determining the acidity of aluminium sulphate were investigated. Direct titration of 0.1-N solutions with an indicator having a color change at pH of 3.4 is recommended, and suitable indicators are being developed.

Asbestos

D. WOLOCHOW, A. VAN WINSEN

Work on the several problems mentioned in the last report was continued, with special attention being given to studies relating to the evaluation of milled asbestos fibre. This involved the detailed study of a large number of types and grades of fibres and of their screen fractions, which work was

much facilitated by co-operation received from the Quebec Asbestos Producers Association. In this study considerable use was made of the microscope in examining masses of asbestos fibre and also individual fibre units.

The effect of moisture content on the tensile strength of asbestos yarn was investigated, and the findings have been reported in a paper presented at a symposium arranged by the Textile Committee of the American Society for Testing Materials.

Further attention was given to the behavior of metals in contact with asbestos fibre.

Work was initiated on the use of asbestos as a filtering medium in industry.

A start was made on a thorough survey of the use of asbestos in the production of manufactured articles, involving visits to a variety of manufacturing plants in Canada and the United States. Already the survey has disclosed several problems on which research work is desirable in the interests of the asbestos industry.

In a previous report it was stated that it had been found that the decomposition of asbestos rock tailings by hot acid yielded a porous form of silica which was designated as "active silica" and which possessed strong sorptive powers. Further experiments with this material are reported under Miscellaneous—Sodium Silicate.

Carbon Black

L. M. PIDGEON

It was shown previously that after the fraction of natural gas known as stabilizer gas has been subjected to heat treatment (pyrolysis) in order to produce liquid motor fuel from it, the waste gas resulting from the process is a valuable source of carbon black. It was shown, in fact, that when used in the ordinary, channel procedure for making carbon black, the waste gas gives more carbon black than the original stabilizer gas would give if used directly without first converting a portion of it to liquid fuel.

During the present year research on the production and properties of carbon black from such waste gas has been concluded. Two papers on the work have been published in the Canadian Journal of Research: the first dealing with the production of carbon black from pyrolysis waste gas and recording the yields obtainable under various conditions of operation; the second dealing with the effect of various factors in the channel process on the properties of the carbon black obtained, and the relation of these factors to the sorption of dyes and the reinforcement of rubber.

Although the channel process yields black of first-class quality, it is very wasteful, since only 3 to 4% of the carbon present in the gas used is recovered. Research on improved production methods has been continued with a view to the development of an improved process which, without sacrificing quality in the product, would increase the yield and reduce the plant overhead per pound of product. Among the experiments carried out in this connection have been some on the effect of dehydrogenation catalysts. Improved yields were obtained, but it was concluded that the improvement does not justify the added complications. Substantial increases in yield were also obtained by special devices to control the secondary air required by the flame. Work on this matter is being continued.

Other work on the flame process has included the measurement of temperatures in various parts of natural-gas flames, and the distribution and

properties of carbon obtained from the different parts of the flame. The experiments have given a clearer picture of the mechanism of carbon production in the luminous flame.

The optical procedure previously used in the laboratories for the examination of rubber blacks has been extended to the evaluation of the effect of various softeners and dispersion agents in the dispersion of reinforcing agents in rubber.

Rubber tests have been carried out on samples of acetylene black produced by the makers under different experimental conditions.

Carbon Monoxide Hazard

A. CAMBRON

Work done on this subject involved: two calibrations of the carbon monoxide alarm in use in the Motor Testing Laboratory, Division of Mechanical Engineering; and determination of the variations in carbon monoxide concentration in the cabin of two planes intended for aerial survey work (Northrop Delta) during flight. Samples were taken in the course of twelve flights under various conditions as to camera openings, temperature and ventilation. This work, which also involved the calibration in the laboratory of a carbon monoxide indicator for aircraft, and the checking of its operation during flight, was carried out at the request of the Department of National Defence. Further work under this head was the determination of carbon monoxide concentration in samples of air submitted at intervals by the Fire Hazard Testing Laboratory.

Casein

W. GALLAY

One of the purposes for which casein, a product made from skim milk, is used is the production of casein plastics, for which casein of special quality is required. The consumption of such plastics in Canada has been steadily increasing in recent years. To a large extent the finished plastic is imported in the form of rods, sheets, tubes and as blanks for button manufacture. In some instances the casein is imported for processing. The amount of Canadian casein used for plastics manufacture is at present very small. Rennet casein is used almost exclusively for plastics and the quality of the casein varies very greatly depending on the method of preparation.

A thorough study is being made of the preparation of rennet casein on both a laboratory and a pilot plant scale. Processing of the casein to plastics is being studied in a laboratory extruding machine, where conditions may be varied with accuracy, and an attempt will be made to correlate the effect of variation in the conditions of manufacture of the casein with ease of plastication and quality of plastic obtainable.

Corrosion

A. VAN WINSEN

Experiments started during the previous year on the resistance to corrosion by sea water of a series of aluminium alloys and steels and the effectiveness of various protective coatings were continued, and numerous other corrosion problems, submitted by industrial concerns, were investigated.

Experiments were made to determine the potential differences between zinc, aluminium and iron when submerged in water under shorted conditions. The effect of temperature and pressure on this potential seems to be of particular interest to the metal-spraying industry.

Mr. A. C. Halferdahl of the Division of Research Information and Dr. C. Y. Hopkins of the Division of Chemistry have given valuable co-operation in this field of work.

Diatomaceous Earth

H. D. CHATAWAY

The use in rubber mixes of diatomaceous earth from Canadian deposits has been studied. It was found that for this purpose the earth should be subjected to severe milling whereby the individual diatom particles are broken down as completely as possible. If this is done the optimum loading in a standard rubber mix increases from one of 20% to one of from 40 to 50%. In other words, proper preparation makes possible the use of a greatly increased quantity of this relatively cheap filler.

Distillation

D. F. STEDMAN

During the year patents for the highly effective gauze packing for fractionating columns, which was earlier developed in the laboratories, have been granted by Canada, the United States, Great Britain and France, and satisfactory progress has been made with the applications filed in other countries.

In the laboratories a good deal of time has been given to developing shop methods for the production and assembly of the sections making up the packing. Several columns up to three inches in diameter have been made up for universities or research laboratories in Canada, the United States and Great Britain, and a large number of inquiries have been received from firms or individuals interested in this new equipment for handling liquid mixtures not readily separable by present means. Tests have been made in a column of six-inch diameter with several patterns of gauze plates to determine the optimum conditions for output, efficiency of fractionation and cost of manufacture.

Arrangements have been made for the commercial production of the packing. The company taking over this work is making tests on still larger apparatus and columns in all sizes which should soon be available to industry.

Experiments are in progress on the application of the column to certain specific industrial problems.

Gas Research

A. CAMBRON

Conversion of Butane to Aromatics

The object of the work carried out in this field is the possible utilization of certain fractions of Turner Valley natural gas for the production of benzole and other aromatic liquids suitable for motor fuel, or of olefine gases suited to the synthetic production of ethyl alcohol, ethylene glycol (non-evaporating anti-freeze), etc. In the course of the work previously reported, data were obtained on the thermal conversion of propane into aromatics and olefines in a specially designed furnace. Additional data have now been secured on the conversion of butane, large volumes of which are also potentially available in Turner Valley, into aromatics by the same process.

It has been shown that 6.5 gallons of aromatic liquids, of which 4.23 gallons boil in the gasoline range and contain about 65% benzene, can be obtained from 1000 cubic feet of butane. Under similar conditions the yield of aromatic liquids boiling in the gasoline range obtainable from propane is

2.7 gallons per 1000 cubic feet. It may be pointed out that the yields of liquids obtainable from butane as well as from propane, by high temperature thermal treatment in baffled tubes, would be materially increased if the olefines in the by-product gases were substantially freed from hydrogen and methane and recirculated through the furnace.

Protection of Heat Resistant Alloys Against Carburization

One of the most serious difficulties in the way of the commercial development of processes for the utilization of natural gas by pyrolysis has been the short life of the heat-resistant alloy tubes available for this purpose, the failure of the tubes being due to carburization. Podbielniak, for instance, (in a communication at the A.C.S. meeting at Chicago, 1933), reported that 18-8 reaction tubes, on account of the tendency of the alloy to carburize, had a service life of 25-50 hours under pyrolysis conditions, and that 28% chromium alloy tubes were also unsatisfactory for the same reason. In addition to causing structural failure of the tubes, carburization of such alloys as 18-8 chromium-nickel or 28% chromium alloy steels, which are normally resistant to air oxidation at temperatures up to 1000° C., lose that resistance and become attacked when air is passed through the hot tube to remove the carbon film which deposits on the surface of the metal, when they are used for the pyrolysis of hydrocarbon gases. The oxide film resulting from this attack is catalytically active in promoting the decomposition of hydrocarbons into carbon and hydrogen, and this reaction not only reduces the yield of liquids but necessitates frequent blowing of the tubes for removing the carbon.

It has been found, however, that the carburization of heat resistant alloys under pyrolysis conditions can be prevented by depositing on the inner surface of the tubes a film of fused boric anhydride, or a mixture of boric anhydride and chromium oxide. Tubes protected in this manner (patented) can be heated alternately under carburizing and oxidizing conditions without any chemical action on the surface. The effectiveness of the protective coating has been demonstrated by photomicrographs of etched sections of protected and unprotected alloy after alternate exposures to carburizing and oxidizing conditions for a total of over 400 hours. The precipitation of carbides and the alteration in structure in the unprotected alloy are very evident, while the protected alloy appears to be in its original condition.

Industrial Utilization of Potato Starch

W. GALLAY

Laboratory studies on starch, previously carried out incidental to an investigation of the relative merits of starches for industrial purposes, were extended. There were included investigation of the kinetics and effect of modification, the swelling of starches in pastes, comparison of commercial methods of viscosity determinations, the dextrinization of starch and modified starches, critical concentrations in starch pastes, texture of starch pastes. Experiments were carried out chiefly with potato, corn, cassava and wheat starches.

An apparatus for the sizing of individual cotton threads was devised and some preliminary work carried out on the characteristics afforded by sizing with different starches.

The following publications appeared on this subject in the Canadian Journal of Research: "The Effect of Various Starches on the Stability of Baking Powders", B, 14 : 204-215. 1936; "The Viscosity of Corn Starch Pastes", B, 14 : 360-372. 1936; "The Effect of Acid Modification on Some Properties of Starch Pastes", B, 14 : 381-390. 1936; "The Effect of Concen-

tration on the Viscosity of Starch Pastes and of Lyophilic Sols", B, 14 : 391-403. 1936; "The Alteration of the Flow Characteristics and Texture of Starch Pastes", B, 14 : 409-414. 1936.

Results obtained with various starches in laboratory and plant investigation of vegetable glues are being published in conjunction with G. L. Rosser as a bulletin of the Forest Products Laboratories of Canada.

Laundrying and Dry Cleaning

C. H. BAYLEY, B. J. KENALTY

During the year the laboratory has been actively in touch with the Canadian laundry and cleaning industries through its relation to the members of the Canadian Research Institute of Launderers and Cleaners. Periodic checks on the efficiency of the washing processes of 80 commercial and institutional laundries have been made and for this purpose 228 "test bundles" for white work and 81 bundles for colored work have been issued. The results of these tests indicate that in general a high standard of efficiency is being maintained. Advice in regard to laundrying schedules has been given on the basis of the test-bundle results.

The test-bundle service developed for use in dry cleaning plants has been extended and its usefulness in the control of the dry cleaning operation fully demonstrated.

At the present time the laboratory is furnishing technical advice to 93 commercial laundrying and cleaning plants and institutional laundries, this number representing an increase over 1936 of 24% in the number of plants contributing to the upkeep of the laboratory.

Service work for the industry included 658 reports covering the investigation of a wide variety of new and damaged fabrics, soaps, alkalies, water analyses, miscellaneous analyses and recommendations, an increase of 19% over the corresponding period for 1935-36. Some of these items are as follows:

- (1) Use of hydrogen peroxide in the bleaching of white areas in cotton prints during laundrying.
- (2) Use of Canadian bentonite in the laundrying of greasy fabrics.
- (3) Recommendations regarding proper laundrying practice in penitentiary laundries.
- (4) The effect on napped fabrics of the presence of lime and magnesium soaps with special reference to skin irritation in diaper fabrics.
- (5) Analysis of raincoat fabrics.
- (6) Shrinkage tests on cotton fabrics for Canadian manufacturers of pre-shrunk fabrics.
- (7) Comparison of the chemical properties of turkish towels bleached by sodium hypochlorite and by hydrogen peroxide.
- (8) Cause of residual odor in dry cleaned fabrics.
- (9) Cause of development of white markings on silk hosiery during dyeing (shown to be due to presence of oxidized oil).
- (10) Investigation of sulphur black dye damage in a variety of fabrics, especially in cotton shirtings with black woven stripes.

During the year steps were taken to acquaint institutions operating laundries with the work of the laboratory. This has resulted in, for the first time, the active co-operation with the laboratory of a number of institutional laundries. In addition to giving advice regarding correct laundrying methods, the laboratory has investigated such problems as improved methods of stain removal which are of particular interest to hospital laundries.

Contact with the textile manufacturing industry has been maintained and extended and several investigations and tests on a variety of problems have been carried out.

In connection with the work of the Canadian Government Purchasing Standards Committee, the laboratory has collaborated with the Subcommittee

on Textile Specifications with special reference to standards and methods of tests relating to launderability. This has included the setting up of methods of test for the measurement of shrinkage and color fastness in laundering. The laboratory has also collaborated with the Subcommittee on Soaps and Detergents in its work on the preparation of further specifications in this field, and with the National Committee on Dry Cleaning and Dry Dyeing Hazards, which was organized at the request of the Dominion Fire Commissioner, and which has recently promulgated a series of proposed regulations concerning the setting up and operation of dry cleaning establishments.

A method for the recovery of dry cleaning solvents from sludge for use in plants employing chlorinated solvents has been worked out and made available to the industry.

A systematic study of the pH values of solutions of the various soaps and alkalis used by commercial laundries has been completed.

The laboratory has adapted to its special needs the cuprammonium fluidity method developed by the British Cotton Industries Research Association which depends on the measurement of the viscosity of solutions of cotton in cuprammonium solution. It has made use of this method in its research work, in the routine examination of laundry test bundles, and in a wide variety of cases in which it has been necessary to determine the amount of chemical degradation which has taken place in a given textile material, either as the result of faulty bleaching, dyeing or finishing in the mill, or by over-bleaching during laundering.

A study is being made of the possible effects of the alkalis used in laundering in causing chemical degradation of cotton fabrics during the laundering process.

The factors influencing the degradation of cotton fabrics during laundry bleaching are being investigated. To date, the effects of variations in temperature, and in pH, over the normal laundry range, have been studied with solutions of sodium hypochlorite containing 0.1 and 0.01% of available chlorine, respectively. The extent to which oxidation of the fabric has taken place has been measured by determinations of the fluidity of the oxidized cotton in cuprammonium hydroxide solution. The relation between the amount of oxygen taken up by the fabric during oxidation and the cuprammonium fluidity has been determined for oxidation under a number of conditions. The work is being continued.

In order that the work of the laboratory may be brought before the Canadian laundry and cleaning industries, articles have been published in the *Laundry and Dry Cleaning Journal of Canada*. It is intended to continue the publication of these articles on a monthly basis as far as feasible.

The titles of articles published are as follows:

- (1) Sulphur Black Damage in Cotton Fabrics.
- (2) A Case of Over-bleaching in Table Linen.
- (3) Notes on the Removal of Some Typical Stains.
- (4) Damage in Curtain Fabrics and Window Drapes, Parts I and II.
- (5) Aniline Black Damage in Printed Cotton Fabrics.
- (6) The Work of the Laundry and Cleaning Research Laboratory of the National Research Council for 1936.
- (7) Solvent Recovery from Still and Filter Sludges in Dry Cleaning Installations Using Tri- and Perchloroethylene.
- (8) Identification of Textile Fibres.

During the period under review the laboratory has kept in touch with other laboratories in which work on laundering and cleaning is being carried

out. These have included the laboratories of the British Launderers Research Association, the American Institute of Laundering and the Laboratory of the New Jersey Laundryowners Association. The laboratory is also represented on several subcommittees of the Committee on Soaps and Detergents of the American Society for Testing Materials, and also on the Subcommittee on Household and Garment Fabrics of the Committee on Textiles of the Association.

The laboratory has at its disposal a well equipped laundry and textile laboratory, and is in a position to undertake a wide variety of problems dealing with the launderability, cleanability and general serviceability of textiles, and related problems.

Leather

W. E. GRAHAM

An investigation of various domestic barks as sources of tannin for the leather industry has been continued throughout the year. The bark of western hemlock and some of the spruces shows considerable promise. The highest recovery has been obtained from bush-peeled white spruce, but samples of this bark from logs floated in the rivers were found to have lost a large portion of their tannin content. Experiments have been made in tanning skins with these domestic tanning materials in order to evaluate the product obtained.

An extended memorandum on Canadian Hide and Skin Production has been prepared for inclusion in a monograph on Hides and Skins in the British Empire under preparation by the Imperial Institute Advisory Committee on Hides and Skins. The memorandum was prepared with the co-operation of Dominion and Provincial veterinary officers and representatives of the packing industry.

Further 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.

Investigations of fabric shoe lining materials and deteriorated upper leathers have been continued. Heavily sized fabric linings have been shown to be a source of damage to upper leather, and a report on this subject has been published.

A large number of service problems have been presented. These have included problems on stock harness, gas meter and upper leathers which have failed or deteriorated in service. Leathers, such as those now in trusses, suspected of having become deteriorated by perspiration are being examined thoroughly. In some cases the accumulation of iron or iron rust in deteriorated bark- or vegetable-tanned leathers is strongly indicated as a very active catalyst of deterioration. An extreme accumulation of iron has been found in the most seriously damaged portions of meter leathers, and very considerable rotting occurs around nails in shoes and metal fittings in truss pads.

Considerable work has been done with the glass electrode in measuring effective acidity of tan liquors. Measurements of pH have been made on various water samples and alkaline bleach liquors for other members of the staff.

Magnesian Products

N. P. PITT, L. HODNETT, P. E. GISHLER

As in previous years, this work has been carried on with the financial and technical assistance of Canadian Refractories, Ltd., and under the direction of Mr. F. E. Lathe, Director of the Division of Research Information.

The co-operation and assistance of Dr. W. Gallay, Dr. E. A. Flood and Mr. C. W. Davis of the Division of Chemistry are also gratefully acknowledged.

Stable Dolomitic Refractories

It was pointed out in the previous annual report that a great deal of laboratory work was still required to determine which were the preferred compositions of the large number available. Tests indicated that refractories with a lime-silica ratio of about 2.0 probably possessed the most desirable properties, and a substantial number of brick have been made up of this composition.

Two very important properties of refractories are a high degree of refractoriness under a superimposed load, and spalling resistance. Owing to the very high refractoriness of dicalcium silicate and periclase, equipment in Canada was inadequate to assess accurately the characteristics under load of many of the refractories produced experimentally, and arrangements were consequently made with an English company to make the necessary tests, employing a method which has been standardized in Europe. Results received up to the present time have been extremely gratifying, indicating as they do an even higher refractoriness and wider field of application than was at first anticipated.

Spalling resistance, that is, resistance to fracture when subjected to rapid temperature changes, has been obtained by the application of previously determined principles, as will be mentioned below.

Slag-resistant properties are difficult to determine in the laboratory, and it was therefore decided to prepare commercially a quantity of refractory for full-scale trials in open-hearth furnaces. An experimental rotary kiln was erected by Canadian Refractories, Ltd., at their plant at Kilmar, and a quantity of clinker produced. Although this operation was only of a semi-commercial nature, a great deal of information was accumulated which later led to the production of a quantity of clinker in one of the commercial rotary kilns. This clinker has been made into bricks and open-hearth trials have been arranged.

Improved Magnesitic Dolomite Brick

For a number of years, a burned brick from Canadian magnesitic dolomite has been manufactured in England, and an unburned brick, with chemical binders, has had very considerable success in this country. It was realized, however, that for certain high-temperature work, the refractoriness of this brick under load was not sufficiently good. An improved clinker has been developed in the laboratories and produced commercially. Trials have been arranged, and it is expected that this modification will greatly improve the quality of this product.

Cements

A considerable amount of work has been carried out on cements, both acid, basic and neutral. The principal lines of endeavor have been as follows:

(a) Reference has been made in the previous report to the incorporation of plasticizers which greatly facilitate the laying up of brick. A cement containing these plasticizers has been one of the most successful developments of the year, and arrangements are being made to manufacture this cement on a royalty basis in the United States.

(b) A plastic basis cement, for use in laying up basic brick, has been made available commercially and is finding a gratifying industrial application.

(c) Substantial modifications have been made in the composition of two types of fireclay-base cements which had been developed in the previous year.

Sodium Silicate

Considerable study has been devoted to the use of different types of sodium silicate in refractory cements and plastics, which, it is hoped, will result in a very considerable reduction in the cost of chemically bonded refractories, and in the production of greatly improved products.

Miscellaneous

Patent protection in all the major industrial countries is being sought on the principal new products developed.

During the course of the year, Messrs. N. P. Pitt and G. W. Paterson resigned to accept positions on the staff of Canadian Refractories, Ltd.

Maple Products

L. SKAZIN

Further work was done on the preparation of cast maple sugar possessing little or no tendency to become mottled on keeping. The procedure by which this improved form of maple sugar can be made has been simplified, and instructions regarding its use are available to those who are interested.

Experiments were carried out on the preparation of alcoholic beverages from maple sugar, products made being wines, wines fortified with maple alcohol, and liqueurs. The latter, containing 35 to 55% of maple alcohol by volume and 25 to 50% of maple sugar, seem to offer the best prospects of commercial possibilities.

Further laboratory study was devoted to the preparation of maple syrup of intense maple flavor and the preparation of concentrates of natural maple flavor.

Microanalysis

L. MARION

A laboratory has been equipped for carrying out micro analyses according to the methods of Pregl. Apparatus is now available for the determination of carbon and hydrogen, for nitrogen, for acetyl, methoxyl and methyl-imino groups, and for halogens and sulphur. An apparatus has also been set up for the catalytic hydrogenation of small quantities of unsaturated compounds according to the design of Professor Späth of Vienna.

Paints

C. Y. HOPKINS

Specifications

Collaborative work with the Government Purchasing Standards Committee resulted in the completion of eleven specifications for paints and allied materials for the use of various Government Departments. The work involved the examination of numerous commercial samples of the materials, which included exterior oil paints, paste pigments, interior and exterior varnishes and exterior enamels. Test procedures for the following characteristics were investigated and revised where necessary: consistency of putty, consistency of mixed paints, hiding power of white and tinted paints, flash point of paints, varnishes and enamels, identification of linseed oil and rosin in

vehicles, color analysis by Lovibond tintometer, water and alkali resistance of varnishes and enamels, kauri reduction test for toughness and flexibility, viscosity of varnishes, skinning tests, hardness of varnish films, acid number of vehicles, leafing power of aluminium pigment.

Exposure Testing

The first series of exposure tests, which covered a period of two years, has been completed. Studies of the relation between accelerated and natural weathering of paint films have given useful results. Tests of some of the newer pigments and of various primers for wood are in progress. An accelerated weathering test of exterior enamels showed the superiority of the newer synthetic resin vehicles over some made from natural resins.

An investigation is in progress to determine the value of Canadian graphite for paints. A new mineral green pigment has been studied and subjected to exposure tests. Quantities of putty have been made on a semi-commercial scale using a form of calcium carbonate available in Canada.

Exposure tests were carried out to find the best material for sealing knots in wood prior to painting. Several materials tested gave promise of greater effectiveness than shellac at present so widely used for this purpose. In conjunction with the corrosion laboratory, a number of paints were tested for use on ships' hulls. Steel and aluminium alloy panels were coated with appropriate types of paint and subjected to an accelerated test in seawater.

Miscellaneous matters dealt with by the paint laboratory during the year have been: (*a*) analysis of paints and varnishes to specifications; (*b*) absorption of driers; (*c*) use of soybean oil in house paint; (*d*) method of painting galvanized iron; (*e*) method of painting concrete floors; (*f*) properties of casein water paints; (*g*) effect of added water on durability of house paints; (*h*) painting over greasy surfaces; (*i*) estimation of water in shellac varnish; (*j*) testing of enamels for collapsible tubes; (*k*) consistency tests for floor wax; (*l*) interfacial tension between linseed oil and water, etc.

Plant Alkaloids

R. H. MANSKE

During the year under review the investigations of *Corydalis sibirica*, *Dicentra chrysantha* and *D. ochroleuca* have been tentatively completed and the results published. The constitutions of the alkaloids corlumidine and of corypalline have been elucidated. Papers discussing this work have been published in the Canadian Journal of Research under the following titles:

"The Alkaloids of Fumariaceous Plants. XI. Two New Alkaloids, Corlumine and Corlumidine and their Constitutions."

"The Alkaloids of Fumariaceous Plants. XII. *Corydalis scouleri* Hk."

"The Alkaloids of Fumariaceous Plants. XIV. Corypalline, Corlumidine and their Constitutions."

Some progress has been made with the examination of the following: *C. claviculata*, *C. pallida*, *C. ophiocarpa*, *C. caseana* and *C. ochotensis*. The last named is of particular interest in that the tap roots appear to store nitrogen in the form of acetyl-ornithine, in an amount equal to 12% by weight of the dried root. While acetyl-ornithine is well known in products of animal origin, this is the first time it has been found in plant products. Among those plants whose investigation is in progress may also be mentioned,—*Lobelia cardinalis*, *L. siphilitica*, *Asimina triloba*, *Thermopsis rhombifolia* and *Fumaria officinalis*.

Plant Hormones

A. CAMBRON, R. H. MANSKE

Synthesis of α -Naphthyl Acetic Acid

This is one of the chemical compounds which are known to be strongly active in promoting growth or root formation in plants under certain conditions, and which are now being put on the market under various trade names. Until now this compound has been difficult to obtain owing to the lack of a satisfactory method for its preparation, and the present work was carried out with the object of finding a more convenient and possibly cheaper method of synthesis.

A method has been worked out by which the compound can be synthesized cheaply, which makes it possible now to supply the substance in larger quantities for experimentation. (A. Cambron.)

Interest in plant hormones has continued and increased and many demands from research workers both in Canada and abroad, for indolyl-acetic, indolyl-propionic and indolyl-butyric acids, have been met. Sufficient progress has been made by the research workers, particularly plant physiologists, that the successful initiation of roots on a larger variety of plants and trees, by the application of plant hormones, is beginning to be commercially feasible. (R. H. Manske.)

Plastics

L. MARION

The work carried out in this field during the year has been chiefly concerned with the study of a new method of polymerizing styrene and a study of the chemical properties and constitution of polymerized styrenes. In connection with the latter subject, some success has been attained in preparing synthetically the lower polymers of styrene.

Refining and Bleaching Clays

W. GALLAY

Further samples of bentonites from western Canadian deposits have been tested for efficacy in the refining of mineral, vegetable and animal oils. Contact was maintained with prospective commercial developments of the outstanding deposit of bentonite in southern Manitoba, and a large number of inquiries dealing with processing costs and available markets were answered. Further quantities of bentonite were activated and submitted to oil refiners for laboratory tests. Work is being carried out on the reduction of acidity of vegetable and animal oils in bleaching by means of bentonite.

Rubber

T. R. GRIFFITH

Further work has been done on the bonding of rubber to metal, including particularly the application to the manufacture of automobile engine mountings of the bonding material previously developed in the laboratories. A crucial feature of this particular application of the bonding material is that the bond must not only be strong at ordinary temperatures but must, also retain sufficient strength at the elevated temperatures to which the mountings are subjected in a car, and, in order to avoid delay in production, have sufficient strength at the temperature of vulcanization to make it unnecessary to cool the assembly before removing it from the mold in which the rubber is cured. Intensive work was directed to this crucial feature with very encouraging results.

For the Naval Service of the Department of National Defence specifications were drawn up for a rather wide range of rubber goods, including packing, valves, hose, tubing, gaskets. The specifications were drawn up to conform as closely as possible to the best present day practice in the Canadian rubber trade. A considerable amount of testing was involved in this project.

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 number of investigations were carried out for two Government Departments, including work on a problem concerning hard rubber.

Tests were carried out by Dr. Pidgeon on the quality of a series of samples of rubberized fabrics designed for use in raincoats. Later, the work was extended to include a study of the factors determining the quality of such fabrics.

Seed Disinfection

N. H. GRACE

The work on the use of formalin for the disinfection of seed wheat mentioned in last year's report has been continued and has been extended to the study of a wide range of organic compounds as seed disinfectants. Among the substances tested have been many compounds containing mercury, silver and arsenic.

Sorption

L. M. PIDGEON

(a) Measurements have been made of the sorption of gaseous ammonia and of sulphur dioxide by "active silica", a product which, as previous work in the laboratories has shown, can be made from waste asbestos rock. The influence of the activation temperature and of the method of preparation of the silica have been studied in detail. As a sorbent for ammonia, it proved to be inferior to silica gel in regard to the total amount taken up, but to be more efficient than the latter at very low pressures. Thus it is more effective in removing the last traces of ammonia from a mixture.

(b) The benzene vapor pressure relation of rubber stocks containing carbon black has been measured. Vulcanization of such stocks was found to be without effect on the vapor pressure relation. The carbon black and the rubber behave toward benzene in the same manner when mixed as when separate.

Soybeans

H. D. CHATAWAY

Following two conferences with officials of the Department of Agriculture, work on the industrial utilization of soybeans has been undertaken. Prior to this, surveys of the literature on soybeans had been completed by the Division of Research Information. This voluminous literature has been, and is now being closely studied, and contact has been made with the individual firms connected with the industry.

Industrial processes involving the use of soybeans and products from them are in a state of flux, and many costly experiments are being tried. To help the Canadian industry through this difficult period, information is being gathered from Germany, Japan, the United States and other countries, and what data are still lacking are being pieced out by laboratory research.

In the latter connection the first question to be studied is the more efficient recovery of vegetable lecithin, which is a valuable by-product in the manufacture of soybean oil and meal.

Storage Batteries

L. M. PIDGEON

Research has been continued on the Canadian wood yellow cedar (Alaska cypress, *Chamaecyparis nootkatensis*) in connection with its use as a material for storage battery plate separators. Test batteries were made up, by a Canadian manufacturer who co-operated in the research, containing both the Canadian wood and Port Orford cedar (*Chamaecyparis lawsoniani*), the latter a wood native of Oregon, U.S.A., and in wide use at present. These batteries were subjected to performance and life tests. High current discharges at 0° F. showed that the batteries containing yellow cedar had the advantage of possessing a slightly lower internal resistance. When finally dismantled at the end of nine months' life tests, the yellow cedar separators showed higher average strength but the Port Orford cedar were more uniform.

The results of this research have been published in the form of a report which has been distributed to the Canadian battery manufacturers.

Further consideration has been given to special electrolytes which are offered as rejuvenators for worn out batteries. None of the materials submitted appeared to have any merit in this connection.

Straw

L. MARION

As a part of a program for the utilization of straw, a study has been started of the resins obtainable from wheat-straw lignin and of the resins which can be prepared from lignin mixed with substances known to form plastics under a given treatment. The physical properties of such resins are to be studied as well as their utilization in various connections. When molded with other resins and fillers, lignin has been found to form plastics which offer some promise of practical usefulness.

Sugar Analysis

In addition to assisting in the organization of the Canadian Committee on Sugar Analysis, affiliated with the International Commission on Uniform Methods of Sugar Analysis, members of the division have carried out the following laboratory studies as a contribution to the committee's program of work.

- (1) Study of methods for measuring the pH of sugar products (W. Gallay).
- (2) Comparative study of methods for determining reducing sugars (L. Skazin).
- (3) The standardization of colorimetry in the sugar industry (F. G. Green).

It is expected that further laboratory work on the committee's program will be carried out during the coming year.

Textiles

P. LAROSE, A. S. TWEEDIE

In addition to the work reported under the section on Laundering and Dry Cleaning, the following work on textiles has been carried out.

A comprehensive report was prepared covering the extensive laboratory measurements which, throughout the preceding five years, were made at Ottawa on samples of wool from the individual sheep included in the experimental study which has been made at the University of Alberta, under the Council's Associate Committee on Wool, on the subject of the effect of environmental and nutritional factors on the growth of wool.

Work on which the laboratory was engaged, on the sulphur content of wool, especially of Canadian-grown wool, has been completed. The work has dealt with the development of a new, accurate and convenient method of determining sulphur in wool, and with its application to a range of wools, with special reference to the question as to whether, as had been suggested by workers elsewhere, there is a relation between the fineness of wool and its sulphur content. Two papers on the work have been published in the Canadian Journal of Research.

A convenient apparatus for projecting on a screen enlarged images of fibres viewed under the microscope was designed and built. A description of it was published in the Canadian Journal of Research. It enables the diameter of wool fibres to be measured conveniently and the scales on them to be observed.

In order to accelerate tests on the fading of dyed textiles in sunlight, a special rotating frame, to secure the maximum sunlight effect, was designed. Fading tests on standard dyeings were carried out by exposure in this frame on the roof of the Laboratories.

Some work was done on the use of hydrogen peroxide for bleaching and on the effect of impurities on the rate of decomposition of the peroxide.

Other subjects of research were concerned with: (*a*) the type of damage resulting from the evaporation of water under certain conditions from cotton cloth in bolts; (*b*) the determination of damage to silk by a viscosity method; (*c*) the regain of raw wool.

Among the miscellaneous tests carried out in the textile laboratory during the year have been: (*a*) tests on fire hose samples submitted by the Board of Railway Commissioners and by the Department of the Interior; (*b*) tests of the mothproofness of samples of treated mohair fabrics made in Canada; (*c*) determination of the fastness to light of awning braids; (*d*) determination of the strength of parachute yarn; (*e*) a comparison of the qualities of fancy wool and rayon knitting yarns; (*f*) a comparison of the wearing qualities of coating materials; (*g*) the bursting strength of rayon fabric; (*h*) the tensile strength of woollen yarns bleached by various methods; (*i*) investigation of the cause of staining of knitted wool garments; (*j*) investigation of uneven dyeing in a wool and rayon mixed fabric; (*k*) comparison of the quality of Melton cloth samples.

The following work was carried out in connection with the preparation of Government Purchasing Specifications:—

Specifications for the determination of twist in yarn and for the determination of weighting in silk were added to those previously prepared, while a number of changes were made in the others. Tests were made in order to correlate the results of tests made on the tensile strength machines in the laboratories with those in one of the Government Departments.

Twenty-five cotton fabrics comprising denims, drills, sheetings and ducks, used in some of the Government Departments, were tested for strength, thread count, yarn size, weight, shrinkage on washing, and for amount of sizing and finishing materials, in order to secure data for use in drafting specifications. Wearing tests were also carried out on these fabrics. The shrinkage on washing of various types of wool and wool and cotton flannels was determined. A thorough investigation of the washing procedure for determining shrinkage of cotton fabrics was made. Data were obtained of the shrinkage after various degrees of washing, of the effect on tensile strength, on thread count, on the amount of finishing materials, and on the variability

to be expected between samples and between duplicate determinations. A comparison was made with the ordinary laundry procedure and with a boiling method.

Miscellaneous

Explosive. A chlorate-sugar explosive was subjected to an exhaustive series of tests, to determine the physical and chemical characteristics of the mixture. (A. Cambron.)

Glycol. A patent and literature survey on the manufacture of ethylene glycol (used in non-evaporating anti-freeze and in the manufacture of non-freezing dynamite) was made, and estimates were prepared of the probable cost of production of this chemical by the two known processes. (A. Cambron.)

Adhesives. Further tests were made on the adhesivity of the glue on the new Canadian postage stamps. (W. Gallay.)

Turbine Oils. Investigations were carried out on the reclamation of used turbine oils, and recommendations were made as to the proper procedure to be followed in carrying out the reclamation. (W. Gallay.)

Wheat Starch. Wheat starch obtained as a by-product in extraction of gluten from flour was examined, especially in regard to viscosity. (W. Gallay.)

Corn. Special varieties of early-maturing corn grown in Canada were analyzed for starch content. (W. Gallay.)

Honey. During the year there have been further manifestations of interest in the special Honey Tables previously prepared in the division. The Food and Drug Laboratories of the Department of Pensions and National Health have adopted them for use when carrying out preliminary analyses of honeys for water content. (H. D. Chataway.) Study was devoted to the possible dietetic significance of the minor constituents of honey, especially the inorganic constituents. (W. Gallay.)

Mineral Filler. A precipitate silica, of high purity and great fineness, available as an industrial by-product, was examined, especially in regard to the distribution of particle size. (W. Gallay.)

Paper. Further samples of paper intended for the printing of new Dominion of Canada bonds were tested in regard to probable permanence. (H. D. Chataway.)

Portland Cement. In connection with the work of a special subcommittee of Committee C-1 on Cement, of the American Society for Testing Materials, experimental work was done on a proposed solubility test for cement. (D. Wolochow.)

Special Building Bricks. A special type of brick which is made in a simple wooden mold without the application of heat or pressure, and which it is proposed to use in the construction of low-cost houses, was tested for strength, water absorption and behavior at low, freezing temperatures. The brick was found to have practical possibilities. (A. van Winsen.)

Water Treatment. (a) Tests were made on a water-purifying device employing metal electrodes. (L. M. Pidgeon.) (b) Laboratory tests were made with regard to a patented device for the treatment of boiler feed-water. The tests included measurements of scale formation, surface tension, etc. (E. A. Flood.) (c) Work was done on a modification and simplification of the process previously developed in the laboratories for the production of a cheap water-softening sand from asbestos rock tailings. The products made so far by this modification have reasonably good capacity, but leave something to be desired in the way of resistance to disintegration when in continued use. (E. A. Flood.)

Stilbene. A new method of synthesizing stilbene has been discovered. It makes possible the production of the substance, which has hitherto been only a laboratory chemical, at a relatively low price. Attention will now be directed to possible practical uses of the substance. (E. A. Flood.)

Hand Prints. A method was developed for making prints of the hand and fingers which obviates the application of ink to the hand. (D. F. Stedman.)

Egg Candling. Attention was given to the improvement of egg candling, and especially to the use of colored filters. (D. F. Stedman.)

Photography. In connection with mapping by aerial photography, difficulties in the use of the wet colloidion process were investigated, and recommendations for improvement were made. (D. F. Stedman.)

Erased Writing. A difficult problem in identifying erased (pencil) writing was solved, a special technique being developed for the examination. (D. F. Stedman.)

Trial of the Pyx. As for some years past, one of the members of the division acted as an Assay Commissioner in the formal testing of coins minted in Canada which is conducted annually and is known by the traditional title of the Trial of the Pyx. (D. F. Stedman.)

Cement for Glass. A baking cement for glass was developed incidental to other work in progress. (D. F. Stedman.)

Aeroplane Ski Wax. Experiments were carried out with the object of discovering a "wax" composition suitable for impregnating the wood of aeroplane skis and retaining satisfactory properties at temperatures down to -60° F. (D. F. Stedman.)

Chlorinated Rubber. Experiments were made with chlorinated rubber in order to determine the best method of identifying the material in paints. (L. Marion.)

Synthetic Resins. Some experimental molding of synthetic resins was carried out, chiefly with polystyrene. Additional equipment was obtained for this work. A technique was developed for mounting small objects in transparent resin plaques for metallographic examination. (C. Y. Hopkins.)

Power Alcohol. Brief reports were prepared at intervals summarizing the developments in regard to the use of power alcohol throughout the world. (C. Y. Hopkins.)

Starch Content of Grains. Using the polarimetric method developed in the laboratory and the Rask gravimetric method, analyses for starch were made on the following materials: corn, barley malt, wheat flour, rye flour, cornmeal, cocoa. (C. Y. Hopkins.)

Nitrate of Soda. A salt which was stated to have poisoned livestock was found on analysis to be sodium nitrate. (C. W. Davis.)

Coloring Nuts. Based on experiments, recommendations were made as to a suitable method of coloring pistachio nuts. (C. Y. Hopkins.)

Albertite. Some experiments were made on the possibility of using this New Brunswick bituminous mineral in molded products. It was found that the material could be molded, and the molded products polished. By incorporating suitable synthetic resins, molded products of fair strength could be made. (A. Cambron.)

Sodium Silicate. "Active silica" (*cf.* section on Asbestos) is very reactive chemically; it has been found to offer the promise of serving for the manufacture of sodium silicate by a wet method. It readily dissolves in warm solutions

of caustic soda and enables concentrated sodium silicate solutions of unusually high silica ratio to be obtained. It has also been found to serve for the preparation of silicates of organic bases not readily obtainable from other forms of silica. (E. A. Flood.)

Metallographic Study. Use was made of metallographic examination in connection with the study of assay samples suspected to have been "salted". (A. C. Halferdahl and A. van Winsen.)

Selenium. Preliminary experiments have been made on the electro-deposition of films of selenium from non-aqueous solutions, in the hope of producing light-sensitive films free from the faults of the ordinary selenium films used in photo-cells. Some films of high sensitivity to light and high resistance have been obtained.

It has been found that wood and fibre board treated with sodium polyselenide is markedly fire-resistant. (E. A. Flood.)

DIVISION OF MECHANICAL ENGINEERING

J. H. PARKIN, *Officer-in-Charge*

On April 1, 1936, the Aeronautical and Fire Hazard Laboratories, formerly part of the Division of Physics and Engineering, and the Instrument and Model Shops, were organized in a separate division designated as the Division of Mechanical Engineering with Mr. J. H. Parkin as Officer-in-Charge.

The work of the laboratories of this division continued to consist wholly of investigations directed to the solution of specific problems submitted, and of routine tests and calibrations.

The aeronautical laboratories comprise aerodynamic (wind tunnel), hydrodynamic (model-testing basin), engine, gasoline and oil testing, and aircraft and allied instrument laboratories. Much of the work of these laboratories has been non-aeronautical in character, and has demonstrated their general usefulness.

A large part of the work of the aeronautical laboratories has been done for Government Departments and particularly for the Department of National Defence, which has co-operated effectively in the work of the laboratories and has been particularly helpful in connection with the work on aircraft skis, aviation gasoline, and stressed skin construction. It is again a pleasure to acknowledge the generous assistance rendered by the department in supplying material, equipment and services.

To increase the efficiency and safety of the Engine Testing Laboratory a number of improvements were made, including the provision of an exhaust stack, fire extinguishing and gas detection equipment, and improved control gear.

New quarters for the Gasoline and Oil Testing Laboratory were provided and equipped.

The Aircraft and Allied Instrument Laboratory is now functioning in new quarters in the Hydraulic Building.

In order to cope with the volume of work submitted, additional staff was provided in the Fire Hazard Testing Laboratory, and another laboratory was equipped and staffed for testing domestic oil burning equipment.

Aerodynamic Laboratory

J. J. GREEN, G. J. KLEIN

INVESTIGATIONS

1. Farm Windmills

The theory and design of windmills have been studied and a small trial windmill, suitable for driving a generator for charging radio batteries, has been designed and tested in the wind tunnel. Satisfactory agreement between the predicted and actual performance was secured. Some thought has been given to the design of a governor gear for windmills. A preliminary report, on the work to date, is in preparation. (G. J. Klein.)

2. Stalling of Tapered Wings

Work on this investigation, undertaken at the request of the Department of National Defence, was continued.

A series of five models of different degrees of taper, one incorporating sweep back, has been constructed.

Methods of calculating the characteristics of tapered wings have been studied. A convenient adaptation of a method, developed elsewhere, has been worked out and applied in calculating the characteristics of the models to be tested in the wind tunnel. The method has been applied in the Department of Transport in the calculation of the characteristics of an aircraft fitted with tapered wings. (G. J. Klein.)

3. Models—Service Aircraft

At the request of the Department of National Defence models of three service aircraft are being made and thoroughly tested in the wind tunnel. One object of the tests is the improvement in the accuracy of prediction of performance of aircraft from the results of wind-tunnel tests through the comparison of model-test results with full-scale performance figures available, or to be provided, for the aircraft.

One model has been completed and many tests made on it. A second model is nearing completion.

A method of prediction has been developed which gave very close agreement with flight test figures, in the case of the model already tested.

The models may also be used for determining the effects on performances of any alterations in the aircraft which may be contemplated in the future. (J. J. Green.)

4. Streamlined Locomotive

During the year the Canadian National and Canadian Pacific Railways placed in service "streamlined" locomotives. The type 6400 locomotive of the Canadian National Railways incorporated several features of the design developed in the laboratories as a result of an investigation made in the wind tunnel at the request of the Canadian National Railways (see Report for 1932-33). The C.N.R. and C.P.R. locomotives were inspected for the purpose of comparing their design with that developed in the laboratories. (J. J. Green.)

Tests

Comprehensive wind-tunnel tests have been made for a Canadian aircraft building firm in connection with the development of an aeroplane being designed specifically for commercial service in Canada.

Other work done in the wind tunnel for firms and individuals included tests of an aerofoil, a farm windmill, and snowmobile propellers.

Model Testing Basin

K. F. TUPPER

INVESTIGATIONS

1. Basin Boundary Interference

This investigation has been initiated to determine the magnitude of the basin boundary interference effects, in testing ship models of different sizes, and hence the limit of size of model for testing in the Ottawa basin. A series of similar models of various sizes in the ratio $1 : \sqrt{2} : 2 : 2\sqrt{2} : 4$ has been built, and a small amount of testing completed. The largest of the models has been sent to and tested in the two ship-model basins at the National Physical Laboratory at Teddington, England.

The need for the investigation lies in the fact that the Ottawa basin, having been installed primarily for aeronautical work, has a restricted cross section (9 ft. wide \times 6 ft. deep) while most of the work being done in the basin is marine. Since the basin is much smaller than is usual for ship-model work, it is considered highly desirable to ascertain the extent of the restriction imposed by its small size.

2. Stop Logs for Emergency Dams

The investigation, using a $\frac{1}{100}$ th scale model of a stop-log type emergency dam for a ship canal, has been resumed. The apparatus is now complete and experimental work about to commence. The purpose of the investigation is to provide information for design purposes regarding the hydrodynamic forces acting on a stop log during placement.

ROUTINE TESTS

	Government	Commercial	Total
Ship models	2	2	4
Current meters.....	8	0	8
Miscellaneous (echo sounder).....	0	1	1

Engine Laboratory

M. S. KUHRING

INVESTIGATIONS

1. Aviation Gasoline

Supplementing the results obtained in a comprehensive investigation made in the United States in an effort to correlate the performance of gasoline, from a detonation point of view, in an aircraft engine, with that in a laboratory testing unit, tests are in progress in the laboratory using a British-built aircraft engine kindly supplied by the Department of National Defence and special blends of gasoline furnished by the American Committee.

2. Carbon Monoxide in Aircraft Cabins

At the request of the Department of National Defence, and in co-operation with Dr. Cambron, of the Division of Chemistry, the concentration of carbon monoxide in the cabins of certain service aircraft under different conditions has been investigated.

1. Aircraft Engine Type Tests

TESTS

Five civil type tests to Air Ministry specifications were made in the laboratories on two aircraft engines. The granting of Type Certificates of Airworthiness by the Department of National Defence, in accordance with

the International Requirements for Air Navigation, and Air Regulations, Canada, is based on the results of such tests.

2. Gasoline and Lubricating Oil

Routine tests, against Air Ministry and Canadian Government Purchasing Committee specifications, were made on samples of gasoline and lubricating oil for Dominion Government Departments, provincial governments and others, as indicated in the following summary.

In studying the characteristics and seasonal variation therein, of gasoline on sale in Ottawa, the tests of samples collected monthly during one year, totalling some 300, were reviewed.

The results of tests of a number of samples obtained in the west were also reviewed, in order to secure information pertaining to the characteristics of gasoline on sale in the Prairie Provinces.

SUMMARY OF ROUTINE TESTS OF GASOLINE AND LUBRICATING OIL

Samples	Internal	Government departments	External	Total
Gasoline.....	40*	30	66	136
Lubricating oil.....	—	16	25	41

* Exclusive of tests of samples of fuel used in aircraft engine type tests.

Aircraft and Allied Instrument Laboratory

S. J. MURPHY

1. Instruction and Assistance

Again this year instruction was given an aerial survey training class of the Royal Canadian Air Force. Instructional courses, of two weeks' duration each, covering the testing, care and maintenance of aircraft instruments were given two non-commissioned officers of the R.C.A.F. Information regarding laboratory equipment and technique was supplied to a technical school in which establishment of a course in aircraft instruments was under consideration.

Assistance, in connection with methods of aircraft height determination for photographic purposes, was rendered the R.C.A.F. personnel and commercial aircraft operators.

The laboratory co-operated with the R.C.A.F. in an attempt to improve the performance of a blind landing height indicator.

A vane type minimum air velocity warning device for the engine cooling system of the engine testing laboratory was designed, constructed and installed.

2. Auxiliary Recording Camera

The construction of the camera was advanced to the point where trial photographs could be made.

3. Vibrations in Aircraft

At the request of the Associate Committee on Aeronautical Research an investigation was made of the instruments available for the measurement of vibrations in aircraft.

4. Tests of Aircraft and Allied Instruments

The following tables summarize the routine work of the laboratory.

During the year the practice was adopted of using lead seals, embossed with the letters "NRL", to attach the "serviceable" tags to Royal Canadian Air Force instruments which have been tested in the laboratories and, in the case of instruments of British manufacture, found to comply with Air Ministry Standards or, in the case of instruments of United States manufacture, found to comply with the manufacturers' standard.

Again this year a number of aneroid barometers for survey purposes were adjusted and tested for the Province of Quebec.

TESTS MADE OF AIRCRAFT AND ALLIED INSTRUMENTS, 1936-37

	Government	Commercial	Total
Height instruments.....	139	17	156
Airspeed instruments.....	137	22	159
Tachometers.....	113	23	136
Directional instruments.....	221	21	242
Attitude instruments.....	75	4	79
Engine instruments.....	154	6	160
Barometers.....	129	13	142
Hygrometers.....	2	0	2
	970	106	1076

INSTRUMENTS OVERHAULED, 1936-37

	Government	Commercial	Total
Height instruments.....	129	—	129
Airspeed instruments.....	95	—	95
Tachometers.....	103	—	103
Directional instruments.....	145	—	145
Attitude instruments.....	55	—	55
Engine instruments.....	132	—	132
Barometers.....	84	13	97
Hygrometers.....	2	—	2
	745	13	758

General Mechanical Engineering

G. J. KLEIN

INVESTIGATIONS

Aircraft Skis—Snow Performance

Continuing the work on an aviation problem of peculiar interest to Canada, and following the development of a ski of improved aerodynamic design, a study was begun of skis from the viewpoint of their snow performance.

The results of tests made during the winter of 1935-36, to investigate the effect of form, proportions and material of the ski bottom, speed, and snow conditions on the resistance of skis were analyzed and a report thereon was issued.

Report PEM-22—Interim Report on the Snow Characteristics of Aircraft Skis—Klein.

In preparation for tests during the winter of 1936-37 the recording instrument of the dynamometer was improved and a snow microscope and instrument for measuring the bearing power of snow were designed and made.

Also, additional models were constructed to investigate further the promising behavior, observed during the tests of the previous winter, of wax-surfaced skis.

Unfortunately lack of snow during most of the winter rendered it possible to make only a limited number of tests.

TESTS

A towing dynamometer was calibrated and suggestions were offered for the improvement of its design.

Aeronautical Museum

For some years the National Research Council, aided by the Department of National Defence, has endeavored 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. During the past year special efforts were made to secure exhibits illustrating the pioneer work of Dr. Alexander Graham Bell and his associates at Baddeck, Nova Scotia, where the first aeroplane flight in the British Empire was made, and of Mr. W. R. Turnbull, of Rothesay, New Brunswick, one of the earliest workers in the realm of scientific aeronautics. As a result of these efforts, valuable material has been donated and is now on display, commemorating these important Canadian contributions to the development of aviation. A number of obsolete aircraft and engines, and a variety of accessories and equipment are also on display, the whole collection at the present being housed in one of the Exhibition Halls of the National Research Laboratories. In the task of collecting and preserving material for this museum the co-operation of Mrs. Gilbert Grosvenor and Mrs. David Fairchild, daughters of the late Dr. Alexander Graham Bell, Messrs. F. W. Baldwin and J. A. D. McCurdy, his associates, of Mr. W. R. Turnbull, of the Departments of National Defence and Transport, and of the Canadian Flying Clubs Association, is gratefully acknowledged.

Fire Hazard Testing Laboratory

T. H. DOHERTY

The volume of work submitted to the laboratory necessitated the addition during the year of one testing engineer to the staff and the provision of additional space and further equipment.

Domestic Oil Burners

Most domestic oil burners now being submitted to the laboratory are of the manually controlled type, and are incorporated in heating equipment such as space heaters.

The work on domestic oil burners is summarized in Table I.

Gasoline Burning Appliances

During the year, the testing of gasoline burning stoves, ranges and heaters was begun. A number of models have been tested with satisfactory results, and listed (Table I).

Fire Extinguishers

A number of hand-operated fire extinguishers of the foam, alkali-acid, and anti-freeze types on the market were thoroughly tested in the laboratory.

Based on the results of these tests, tentative drafts were prepared of Section 1a, Requirements for the Design, Construction and Operation of Portable Chemical Extinguishers of the Foam Type; and Section 1b, Require-

ments for the Design, Construction and Operation of Portable Chemical Extinguishers of the Alkali-Acid Type. Ultimately the two sections will be included in Part I, Portable Fire Extinguishers, of a general Safety Code for Fire Extinguishers and Fire Extinguisher Equipment. These drafts were discussed with manufacturers and are now being revised.

Gasoline Safety Cans

The safety standard for gasoline safety cans has been revised.

Safety cans are now being submitted for listing (Table I).

Other Devices

Other devices and materials submitted for testing and on which tests have been completed, or are in progress, include degreasing solvent, safety switch for industrial oil burners, a spark arrester for internal combustion engine exhausts, and a fire extinguisher for motion picture projectors.

TABLE I

—	Manufacturers submitting devices	Models submitted	Models listed	Models not listed	Models under test	
					April 1 1936	Mar. 31 1937
Manually operated oil burners 1936-37	6	32	40	9	33	16
Total to date....	23	125	95	14	—	—
Automatic oil burners, 1936-37...	—	—	—	—	—	—
Total to date....	8	30	25	5	—	—
Gasoline-burning appliances 1936-37	1	3	2	—	—	1
Total to date....	2	4	2	1	—	—
Gasoline safety cans 1936-37.....	1	1	—	1	1	1
Total to date....	2	2	—	—	—	—

Labelling and Inspection Service

Arrangements were completed for the Fire Offices Committee, London, to carry out factory inspections in England, for the Council, on listed devices for shipment to Canada.

Inspections are made, in British Columbia, under the Provincial Fire Marshal.

The following is a summary of the operations of the service for the year:

Factory inspections

From Ottawa—Toronto, Ont.....	6
Montreal, Que.....	3
Waterloo, Que.....	4
Chambly Canton, Que.....	1
Lansing, Michigan.....	1
	15
From Vancouver.....	16
From London (England).....	1
Total.....	32

Labels issued

Domestic oil burners—automatic.....	358
Domestic oil burners—atmospheric.....	6575
Gasoline burning appliances.....	200
Degreasing solvent.....	1000
<hr/>	
Total.....	8133
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Instrument and Model Shops

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

The work, generally, includes the construction, alteration, repair and overhauling of apparatus, instruments and equipment, installation and maintenance of equipment and of mechanical and electrical services of the laboratories. The construction, repair and adjustment of instruments for other Government Departments constitute a considerable part of the work of the shops. Much of this work is on aircraft instruments for the Department of National Defence. The volume and scope of this work is illustrated by the following summary:

INSTRUMENTS OVERHAULED AND REPAIRED FOR OTHER GOVERNMENT DEPARTMENTS

<i>Aircraft instruments</i>		<i>Surveying instruments</i>	
Height instruments.....	129	Alidades.....	6
Airspeed instruments.....	95	Barometers.....	97
Directional instruments.....	145	Compasses.....	26
Tachometers.....	103	Levels.....	24
Attitude instruments.....	55	Transits and theodolites.....	39
Engine instruments.....	132	Binoculars, field glasses, telescopes	2
		Cameras and accessories.....	36
Hygrometers.....	2	Miscellaneous.....	75

There are listed below, to illustrate the nature of the work done, some of the instruments constructed during the year:

Atmospheric Recording Camera	Frequency Response Recorder
Condenser Microphones	Corrosion Racks
Anemometer	Wall Crane
Interferometer Parts	Oscillograph Boxes
Volumeter	Radio Boxes and Relay Racks
Plant Heat Treatment Apparatus	Electric Tachometer
Windmill	Radial Stereoplotter
Sun Exposure Rack	Instrument Recording Camera
Aircraft and Boat Models	Radial Positioner
Snow Testing Apparatus	

The shops began the year with some 148 jobs in progress, or not started. During the year, 620 jobs were requisitioned and 688 completed and, at the end of the year, 80 jobs were in progress, or not started.

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

DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING

R. W. BOYLE, *Director*

As noted in the preceding section, the aeronautical and fire-hazard laboratories, which were formerly a part of this division, were included in the new Division of Mechanical Engineering established April 1, 1936. The Division of Physics and Electrical Engineering, with Dr. R. W. Boyle as

Director, now comprises the various physical and electrical engineering laboratories.

In addition to a steady increase in the amount of testing, examination and standardization of instruments which the Division of Physics and Electrical Engineering has been called upon to perform, a number of new projects have been started. The construction of the primary standard of mutual inductance is progressing steadily. A test model has been made and work is in progress on the necessary calibration equipment. The second station for the recording of atmospheric electrical disturbances has been completed and simultaneous records have been taken at the two stations since December 9, 1936. Frequent records are also taken in collaboration with two stations operated by the Radio Research Board of Great Britain and with two stations in the United States. The facilities of the optics laboratory have been greatly increased by the installation of a three-metre optical grating. In the X-ray laboratory, arrangements are being made for the installation of 600,000-volt apparatus for radiological and radiographic use. A small portable unit for radiographic purposes has been acquired and has already proved very useful. The electrical measurements laboratory has increased its resistance standards by several new units and a high-voltage condenser for use with a Schering bridge has been constructed. Further equipment for the calibration of gauge blocks in terms of light wave-lengths has been added and it is hoped that the laboratories will soon be in a position to carry out absolute verification on gauges up to five or six inches in length. A set of weights is being obtained for use as reference standards of mass and is being verified by the International Bureau of Weights and Measures. A precision balance is being constructed for the metrology laboratory by one of the leading manufacturers of such equipment under the supervision of a national laboratory. The development of methods of heating railroad cars for the shipment of perishable products in winter has progressed steadily with very gratifying results.

Advice has been given and assistance rendered to a number of Government Departments on the acoustic treatment of rooms and buildings, apparatus for depth-sounding purposes, electrocution of poultry, forest fire hazard, collection of insects, methods of plotting results in aerial survey work, and other such problems.

Acoustics

GEO. S. FIELD

Acoustical Testing Laboratory

During the year measurements have been made on the sound absorptive properties of various building materials, experiments have been carried on to determine the best methods of mounting wall-boards from a sound absorption point of view, and an investigation has been undertaken to determine the effect on the test results of certain characteristics of the room in which these tests are carried out. Continuous efforts are being made to improve the test methods and apparatus so that greater accuracy may be obtained in the acoustical measurements.

Architectural Acoustics

Several acoustical surveys of rooms were made for Government Departments and detailed directions given for improving the rooms acoustically. A suggested acoustical treatment for the Victoria Museum, which was carried out, appears to have given satisfactory results.

Microphone Measurements

Three standard microphones, to be used for inter-comparison purposes, were constructed and calibrated for constant pressure at the diaphragm.

Efforts were made to make "free wave" measurements on the roof of the acoustics laboratory, but local noises prevented very accurate results being obtained. It was decided to defer the complete calibration until a large padded room could be constructed.

Miscellaneous

A sound level meter was constructed and partly calibrated. A final calibration awaits the padded room mentioned above. Miscellaneous inquiries relating to acoustical matters were dealt with during the year.

Electrical Engineering

B. G. BALLARD

Most of the additional equipment required has been built in the laboratory and is of a special nature, as, for example, a direct coupled amplifier to feed a Duddell type oscillograph from feeble sources of power, an adjustable oscillator capable of relatively large outputs at the lower frequencies, a special direct current supply with adjustable taps having an output of 1500 volts for industrial electronic investigations, and a source of high voltage direct current. This latter unit provides the laboratory with adjustable direct current voltages up to 140,000 and has proved very useful.

The performance of speed-indicating and speed-controlling equipment previously developed for use on ultrasonic sounding gear was studied. The drift of the setting of the speed controller has been gratifyingly small and may possibly be reduced still further if necessary. The speed indicator functioned with complete satisfaction under all service conditions. While this equipment was under observation the radio direction finder, gyroscopic compass and amplifiers used in conjunction with the sounding equipment were also studied.

Work has been continued on precision voltage regulators and one has been developed that responds to the root mean square value of the wave form and eliminates the necessity of batteries.

Further assistance was given in laying out the electrical distribution system for the R.C.A.F. at the Trenton depot which is now nearing completion.

Extensive tests were undertaken to determine the hazards involved in the use of various types of fire extinguishers in the vicinity of live electric circuits, and some time was devoted to the study of mechanical forces resulting from large transient currents.

Numerous minor studies during the year included work on: dielectric tests, power consumption, frequency doubling and tripling devices, communication lines, control, lighting, electrolytic processes, and development of special meters.

Electrical Measurements

A. J. GRANT, J. S. JOHNSON

Meter Approval

Ten types of meters or metering attachments were tested for Type Approval.

Electrical Measurements

Standard Cells. The yearly practice of sending some cells to the National Bureau of Standards for a comparison test has been continued. These tests indicate that the National Research Council voltage standard is being maintained with a satisfactory degree of accuracy.

Standards of Resistance. Three units were added to the resistance standard equipment during the year. These units permit intercomparison of units of the same nominal value in the more important ranges and, consequently, decrease the possibility of inaccuracy due to unexpected changes.

A high-voltage air condenser has been completed, its capacity calculated and check tested. It has been used as a standard in testing potential transformers at voltages higher than the range of the shielded-resistance equipment.

The model standard mutual inductance was completed. A great deal of work has been done in preparation for measuring, calculating and testing this standard. The actual measurements will probably begin in the fall of 1937.

Routine Tests. There has been a marked increase in the number of routine tests on the various types of measuring equipment.

General Physics

D. C. ROSE

Atmospheric Electricity

The analysis of continuous potential gradient records taken for a year ending December 1, 1935, was completed. In order to investigate effects which might be caused by pollution from the cities of Ottawa and Hull, a potential-gradient-recording station was operated for four months during the summer and autumn of 1936 in an open field about seven miles northwest of the outskirts of Hull. The results were studied from two points of view, the diurnal variation, and disturbances in the potential gradient. The diurnal variation agreed in general with similarly situated stations elsewhere. The study of disturbances showed clearly that all disturbances could be accounted for by local meteorological conditions.

Some observations were taken on potential gradient and conductivity at different altitudes from aeroplanes during the autumn and winter of 1936-37. Considerable difficulty was experienced in measuring potential gradient by usual methods. The results have not been completely analyzed but tend to indicate that only cumulo-nimbus clouds carry electric charges.

Electrocution of Poultry

Further experiments have been carried out on electrical methods of killing poultry in preparation for marketing. By applying the electrodes, accompanied by a magnetic field, to the head, in such a way that the current was directed towards the brain centre controlling feather release, results were obtained which in most cases compared well with the "brain-stick" method, in so far as feather release was concerned, but as the equipment required is more involved and expensive than that needed for the brain stick, it is not considered that the electrical method will prove practicable unless it also produces greatly improved bleeding. This point is being studied further by the Department of Agriculture.

Instruments for Estimating Forest Fire Hazard

At the request of the Forest Service Branch of the Department of Mines and Resources, investigations have been started in co-operation with the forest protection officers of that service on improved methods of measuring moisture content of forest duff and other methods of assisting in the estimation of fire hazard. Electrical methods of measuring moisture content of duff were considered and some preliminary trials made which gave no promise of success. A new recording atmometer was designed and constructed which could be used either with the Livingstone atmometer bulbs or the Wright evaporimeter pans. Apparatus was constructed to measure the heat absorp-

tion of the forest floor by measuring the rate of heat loss of a hot copper plate placed on it as a possible method of estimating inflammability. A promising investigation has also been started on the use of radiation measurements from test fires as a method of estimating inflammability.

Heat

C. D. NIVEN, J. D. BABBITT

Heat Insulation of Building Materials

Measurement of the conductivity of materials used in building construction has been continued throughout the year, using the eighteen-inch hot plate and the six-foot hot box. A special investigation on the thermal conductivity of air-spaces was undertaken and the results will be published soon in "Heating, Piping and Air-conditioning." The comparison of measurements on fibre board obtained in the hot box and by means of the hot plate is still being made,—this fundamental investigation has offered much difficulty as the board absorbs moisture in the hot box.

Heating of Refrigerator Cars

The work, started some time ago in co-operation with the Canadian National Railways, has been continued, and a heating system has been developed which is satisfactory for protecting perishables against frost. The feasibility of thermostatic control on the draught was investigated under operating conditions and found reasonably good, and the development of such a control is now being undertaken. Cost appears to be the determining factor as to whether it will be adopted.

Air Conditioning

The work begun on the eupatheoscope some time ago was completed and published. The conclusion was reached that the eupatheoscope did not offer a sufficient improvement over an ordinary thermometer to justify its intricacy. The work emphasized the importance of temperature gradient.

The Rutledge Pure Air System was tried and found to have possibilities. This system was reported on at the end of a note published on the eupatheoscope in the Canadian Journal of Research, 15, A:25-33. 1937.

Heat Transmission of Fabrics

This investigation, which is intimately connected with comfort temperature, and thus with air conditioning, has revealed several important points. In still air it has been found, for instance, that heat loss from a cylinder is retarded mainly by the stillness of the air surrounding the cylinder rather than by the fabrics covering it. Results to date will soon be published.

Temperature Standardization

The work in progress last year connected with the calibration of the platinum platinum-rhodium thermocouple at the melting points of silver and copper was completed. The work was found to necessitate the designing of a gas-tight furnace for the copper-temperature point. As the design was simple as well as novel, a description of it was published.

A platinum thermometer has been standardized at the oxygen point, thus extending the range of standardization down to liquid air temperatures.

Thermal Conductivity of Metals and Alloys

Apparatus has been partly assembled for this work. A furnace suitable for aging the samples has been constructed which operates satisfactorily when used for growing single crystals.

Specific Heats

Apparatus is being assembled to determine the specific heats of certain metal alloys.

Metrology and Allied Measurements

R. H. FIELD, W. J. LINFORD

Gauge Standardization

Progress was made in the application of interferometry to gauge measurement. The equipment at present in use permits lengths of gauges up to one centimetre to be measured absolutely.

Methods employed elsewhere for the absolute measurements of longer gauges by interferometry have been examined and the construction of equipment for making such measurements has been commenced. (R. H. Field and L. E. Howlett.)

Mass Standardization

Some stainless steel weights have been ordered for use as reference standards of mass. These weights are being verified at the International Bureau of Weights and Measures, and it is proposed to establish one of them as the legal Dominion prototype of the kilogram.

Optical and Allied Instruments

Most of the problems falling under this heading were from the Associate Committee on Survey Research. These included:

Radial-stereoplotter. This plotter was completed, and handed over to the Geographical Section, General Staff, Department of National Defence.

Radial-positioner. A practical design was prepared for this device, the instrument was constructed and is now undergoing practical trial.

Horizon registration in low oblique photographs. Theoretical and experimental investigations showed that it was quite practicable to register the horizon with the aid of a mirror fixed in front of the camera. The actual installation in the aircraft and the interpretation of the record in a simple manner to yield tilt angles, present further problems which require solution before the method can be applied in practice.

Instrument-recording camera. The film-actuating mechanism designed for this camera has been incorporated in an experimental camera, with which it is proposed to conduct laboratory, and possibly, air trials. (R. H. Field and S. J. Murphy.)

Ortho-stereoplotter. A design is being prepared for a stereoplotting machine for air photographs based on simplified principles, which should permit cheap construction.

Routine Tests

While it has not been possible to devote much time to the maintenance of standards and associated duties, the usual volume of routine work has been disposed of without any serious delays in returning instruments submitted. The main items are listed in the following table.

	For Government Services	For Others
Steel tapes.....	8	7
Hydrometers.....	296	—
Sets of analytical weights.....	—	2
Single weights.....	—	1
Thermometers.....	237	33
Transits.....	42	3
Levels.....	15	—
Other surveying instruments.....	26	—
Air cameras.....	30	3
Air camera lenses.....	—	1
Safety glass.....	8	—
Tensile tests.....	3	—

Radium and X-rays

G. C. LAURENCE

Eighty-six radium needles and 218 tubes of radium bromide, having a total value of about \$400,000, were measured and certified during the year. Changes were made in radium measuring equipment to improve its precision and reduce the hazards to technicians. A device for rapid testing of radium tubes for leakage was constructed. A method for measuring the radium content of barium-radium bromide preparations was developed.

An experimental and theoretical investigation of the use of thimble chambers for the measurement in roentgens of gamma rays from radium preparations was carried out. The conclusions that were reached in this investigation will be the basis of an attempt to establish suitable standards for the measurement of extra hard X-rays and gamma rays.

Equipment has been provided for radiography of small aluminium alloy castings. A 600,000-volt generator has been designed and will be constructed during the coming year. It is intended primarily for excitation of a 600,000-volt X-ray tube for extra hard X-ray standardization, research and industrial radiography.

Some changes have been made in the portable standard ionization chamber to eliminate certain instrumental sources of error and provide a direct check of the primary standard, but these alterations are not yet completed. Five of the six portable ionization chambers that were constructed for testing clinical equipment were overhauled, a number of defects were eliminated, the circuit was altered and the instruments made more satisfactory for practical use.

Light

L. E. HOWLETT

Spectroscopy

Grating. Considerable work has been done on the design and construction of a mounting for the three-metre grating bought during the last fiscal year. A design has been completed which permits the utilization of two methods of using the grating: (1) the Meggers and Burns method; (2) the Eagle method. The actual construction is well advanced and it has been possible to secure spectrograms with it which indicate that the grating will prove very satisfactory. Already it has been used for certain routine work. A special Ten-Test room has been constructed to house the grating.

Analyses. Several analyses by spectroscopic methods have been made as well as a number of other miscellaneous tests involving spectra.

Photometry

Aging of Printing Inks. For an industrial firm an investigation was carried out on the grading of printing inks for fastness of color when exposed to sunlight. A photoelectric device has been developed and installed in the company's plant for continuous measurement of the amount of sunlight and daylight to which certain samples are subjected before they show discoloration. This equipment is reported to be doing its work satisfactorily.

Tests of Headlights. A number of tests have been carried out for the Government of Saskatchewan on various anti-glare devices which had been suggested for automobile headlights.

Miscellaneous Photometric Tests. A number of routine tests were undertaken on the photometric characteristics of various articles such as laminated glasses, filters, etc.

Pulp Grades. Preliminary investigations have been made for an industrial firm on the development of a photometer for grading sulphite pulp for relative whiteness.

Sine Wave Electric Current Generator

(A. J. GRANT, J. S. JOHNSON, L. E. HOWLETT)

A piece of equipment to generate a pure sine wave a-c. current has been designed and built, in which a light wave falling on a photo cell is interrupted by means of a carefully prepared sector disc to produce sine wave illumination. The resultant photoelectric current is amplified to the desired amount. Any frequency can be obtained depending on the controlled speed of the sector.

Radio

J. T. HENDERSON

Atmospherics

A second cathode ray direction finder was built during the summer of 1936. Several improvements were incorporated and the new equipment has proved to be more reliable and more convenient in operation than that at Ottawa. The new equipment was installed at Forrest, Manitoba, during the month of September. Communication with Manitoba has been regularly maintained since then, using radio telegraph transmitters which were constructed in the laboratories.

Since December 9, 1936, photographic observations of the direction of arrival of atmospherics have been made simultaneously at Ottawa and Forrest. The records have been taken daily at noon. Once a week observations are made simultaneously with two stations operated by the Radio Research Board of Great Britain.

Toward the end of March preliminary attempts to take observations from three points on the North American continent were made by including Porto Rico as the third station. Since then, records have been taken at four points in a co-operative program with the Universities of Porto Rico and Florida.

Reduction and analysis of the records is now proceeding and it is hoped to continue the observations at least until the end of the year.

Primary Standard of Mutual Inductance

A preliminary model of the final standard has been completed by the Instrument and Model Shops and work is now progressing on the gauges required to measure the diameter of the primary cylinder.

Cathode Ray Direction Finders

In view of the many advantages of this instrument, a development program to adapt this type of radio direction finder to commercial service has been undertaken and it is expected some of the equipment will be tested under operating conditions during the summer of 1937.

Radio Receiver Tests

The acoustic output of 21 broadcast-band receivers was measured for the Canadian Radio Broadcasting Commission during the month of May, 1936.

Ultrasonics

F. H. SANDERS

Scattering of Light by Sound Waves

The study of the relation between the manner in which light is scattered by high-frequency sound waves and the various physical properties of a liquid, described in the last report, has been completed. Results showed good agreement with theory and it is hoped to apply this method to a study of absorption coefficients of various liquids at high frequencies.

Radiation Pressure on Small Spheres

An investigation of the nature of a sound field using small spherical torsion balances has been carried out and its results compared with theory. It appears possible that this type of balance may be useful in extending the proposed measurements of absorption in liquids to regions of lower frequency where the light-scattering methods are not applicable.

Miscellaneous

Several ultrasonic generators for use in depth-sounding have been tested in the laboratory and in the model-testing basin (in collaboration with G. S. Field).

In another field advice and assistance were given to the Entomological Branch of the Department of Agriculture in regard to apparatus for the collection of insects in the new Parasite Laboratory and a satisfactory insect collector developed.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

The Division of Research Information includes a research information and translation service, sections on publications and standardization, and the National Research Library, which is the nucleus of what it is hoped will become a national source of references on the scientific literature of the world. The division also assists in the maintenance of close liaison in matters of common interest between the several divisions of the National Research Laboratories, the universities, the industries that have research laboratories and the numerous associate committees engaged in the direction of scientific investigations. To facilitate this purpose, members of the division serve in a secretarial capacity on many of the Council's committees. The division also maintains contacts with research organizations in other countries by correspondence and exchange of publications, and, when practicable, through visits to other institutions, or by attendance at meetings of scientific societies or international conferences. It also deals with patent applications relating to discoveries or inventions by members of the laboratory staff.

During the year, the director was invited to visit a number of centres where he gave addresses before scientific societies on subjects of technical interest. Mr. S. J. Cook served as secretary of the Canadian delegation to the British Commonwealth Scientific Conference in London, England, September, 1936. Mr. A. C. Halferdahl was a member of several special committees dealing with problems of metallurgical or patent interest. Mr. A. F. Gill attended several of the meetings arranged by the American Society for Testing Materials and other organizations, for the study of standard specifications and continued to participate in the work of the committee on stabilized road construction, of the United States Highway Research Board. Their activities in respect of salt stabilized roads grew out of preliminary laboratory investigations made by the National Research Council a number of years ago.

Brief accounts of the various branches of work carried on in this division are given in the following paragraphs.

National Research Library

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

Library loans increased 11.3% over the previous year and there was a similar expansion in the use of the material in the reading room. Accessions showed a slight increase, 2782 volumes being catalogued. In addition, a considerable number of reports, bulletins and circulars were received, but were not separately catalogued. The library now receives approximately 800 periodicals and 300 other serial publications.

New material of interest included a special collection of early aeronautical publications and a number of books and subscriptions to journals dealing with various branches of the building and construction industries.

Publications

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

Of the 125 papers published in the Canadian Journal of Research during the year, one-fifth recorded the results of research carried out in the National Research Laboratories, and about one-third of the number were papers received from investigators who were working with financial assistance from the National Research Council. Sixty-one papers were received from other sources.

Since July, 1935, the Journal has been published monthly in four sections. Distribution of the papers, by sections, with the total number of pages in each, was as follows: Section A—Physical Sciences, 23 papers (192 pp.); Section B—Chemical Sciences, 52 papers (473 pp.); Section C—Botanical Sciences, 33 papers (423 pp.); Section D—Zoological Sciences, 17 papers (255 pp.).

Twelve volumes of the Journal were published before it was divided into sections. For convenience of reference a cumulative index of the papers in these volumes is being prepared and, at the end of the year, much of this material was ready to print. For Volume 13 an index for each of the four sections was prepared last year, and similar indexes for the sections in Volume 14 have been compiled and published.

In addition to the Journal and the indexes, two reports were published: Report No. 29, The Comparative Feeding Values for Poultry of Barley, Oats, Wheat, Rye and Corn (50 pp.); and the Nineteenth Annual Report of the National Research Council (166 pp.). Two bulletins were edited for

publication, but had not yet been printed at the end of the year. These were: Bulletin 18, Chemical Weed Killers, a Review; and Bulletin 19, Peaux et Cuirs, a French translation of a description of leather tanning processes previously published. Publication of "reports" has been discontinued; hereafter the two miscellaneous series will appear as "bulletins".

Numerous other reports, either typewritten or in manuscript, intended for issue in mimeographed form were edited during the year by the publications staff.

Research Information Service

S. J. COOK, A. C. HALFERDAHL, C. A. MACCONKEY, R. RUEDY, MISS M. E. WHALLEY

A study of what others have done often makes it possible to find satisfactory solutions for problems that appear at first glance to require experimental laboratory work. In Canada the examination of articles published in the technical magazines and journals of the world is particularly useful, because laboratory research in this Dominion is on a less extensive scale than in many of the older countries.

The Research Information Service undertakes the preparation and issue of bibliographies on selected subjects, translations of articles published in foreign journals, and searches of the scientific literature on matters of special interest. In addition, a voluminous correspondence is carried on each year, largely in reply to technical inquiries from manufacturers and others who write to the Council for advice or information on industrial problems or research projects.

Mr. A. C. Halferdahl has charge of all work relating to patent searches other than on magnesian products. A special committee considers inventions and discoveries made by members of the laboratory staffs, and if it is decided that a discovery has the required novelty to justify an application for a patent on it the necessary particulars are obtained and the search is made.

In another field, Mr. Halferdahl has been working for some time in close co-operation with the Division of Chemistry in the establishment of a special laboratory for studies on the factors which cause corrosion of metals in fresh and salt water, particulars of which are given on page 37. In this connection also Mr. Halferdahl served on a special committee appointed at the request of the Associate Committee on Forestry by the Canadian Engineering Standards Association to study corrosion losses in logging chains which are used so extensively in forest and mill operations. An organization meeting of this committee has been held.

Other work undertaken by Mr. Halferdahl during the year included the preparation of an annotated bibliography on formaldehyde and mercurial fungicides for wheat, a review of the literature on ozone in ventilation, the collection of references on gas analysis and explosions, metallographic examination of a mine drill core sample, and brief reports on nickel plating stereotypes, the utilization of pyrite for the production of sulphur, and the electro-deposition of copper and nickel.

Dr. C. A. MacConkey brought up to date the survey of the literature on soybeans he had previously made, and acted as secretary at three conferences held in the early part of the year to consider the general problems involved in the production and utilization of soybeans in Canada.

Dr. MacConkey prepared a brochure on house insulation. The increasing public interest in problems of insulation to prevent heat losses from houses has brought many inquiries to the Council for information regarding the values of different types of insulating materials, and it was with a view to

meeting these requests that the preparation of the bulletin was undertaken. In addition to preparing replies to a number of inquiries of minor interest and making numerous translations, Dr. MacConkey made searches of the literature on the manufacture and use of phosphates and on the use of selenium and tellurium compounds as "anti-knock" materials, prepared a bibliography of books on asphalt and road making, and made studies of the literature on the following subjects: Fatty acids and their manufacture, graphited oils, toxicity of cockleseed, bonding agents for abrasive wheels, nitrites, use of ammonium bisulphite in wood cooking, production of vanillin from sulphite liquor, solvents for wood flour plastics, standards for graphite pigments for paints, and cleaning metal surfaces by sand or pulverized steel.

As part of an investigation on laboratory methods for the determination of hardness in water, Dr. MacConkey prepared a survey of the literature on special methods of water analysis, based on a list of 55 references.

Dr. R. Ruedy continued a number of investigations which he had begun in the previous year, namely, on the use of lithium, vibrations in power lines, ice formation and growth, and frequency of thunderstorms. He also prepared a number of abstracts and made numerous translations from foreign periodicals, especially on the subject of surveying.

A comprehensive report on heat loss through windows and the manuscript for a report on moisture on windows were prepared, in which the scattered, published material on these important subjects was reviewed. In the first of these reports the influence of losses due to the transfer of heat at the glass surface was discussed, and it was found that the variable nature of the losses due to leaks was determined not so much by the type of construction as by the workmanship. From the knowledge obtained in the study of heat losses through windows, it was possible to undertake a study of the conditions under which moisture condenses on windows. A report based on recent experiments in this field was intended to fill a gap commonly found in text books on heating and ventilating.

A paper based on a study of the accuracy with which heat losses through windows may be computed is being published in the *Canadian Journal of Research*.

The importance of knowing the depths to which frost penetrates has been emphasized in the recent cold winters (1932-33 on the prairies, 1933-34 in Ontario and 1934-35 in the east). Dr. Ruedy reviewed the work done in Canada on this subject and prepared a report. Heat conduction formulas and calculations give results which explain satisfactorily the rapid disappearance of the frost in spring, but before the actual depths of frost penetration can be computed the theory must be expanded to include provision for variation in the composition of the soil. Planned tests instead of scattered experiments on this subject appear to be needed.

The increased speed of engines has called for improved types of indicators to replace the slow classical device commonly used. A report prepared by Dr. Ruedy on the work carried out with optical and electrically operated indicators shows that in their present state of development these are suitable for use in the laboratory, but that a more sturdy type, not affected by temperature, remains to be developed for routine testing.

At the suggestion of the Dominion Department of Agriculture a bibliography on the industrial uses of waste agricultural products, consisting of 332 references, was compiled by Miss Muriel E. Whalley. Based on this bibliography, a report of 40 pages was written on the present statistical

aspect and the various secondary industrial uses made of these commodities in industry.

Some time ago, the attention of the National Research Council was directed to the importance of mineral deficiencies in relation to the growth and reproduction of farm animals, and the Division of Research Information was asked to prepare a report on this subject. This task was entrusted to Miss Whalley and a large amount of material was collected. In order to make a part of it available to the public, a bibliography consisting of 987 entries was compiled, with a cross reference to the principal subjects. Additional material is being held for further reference.

Two short bibliographies were also prepared by Miss Whalley on the effect of leaf injury by insects on crop yield and the chemical composition and physical properties of tomatoes, as well as brief reports relating to the use of coconut shells, the influence of poisonous gases on health, the manufacture of fertabs, the cultures for soy sauce, ash of honey and data on castor beans.

Standards

A. F. GILL

During the year the National Research Council was represented in two projects sponsored by the Dominion Fire Commissioner. These were entitled, respectively, the "National Conference on the Regulation and Control of the Transportation, Storage, Distribution and Sale of Petroleum and Flammable Petroleum Products" and the "National Committee on Dry Cleaning and Dry Dyeing Hazards". The National Research Council supplied the secretariat and did the preparatory work for the latter committee. Its findings, after approval by the Association of Canadian Fire Marshals, were published by authority of the Dominion Fire Prevention Association in the form of model regulations, intended for adoption by Canadian municipalities.

The National Research Council was represented by Messrs. A. F. Gill, and F. G. Green of the Division of Chemistry, on a joint committee on water analysis sponsored by the Canadian Institute of Chemistry and the Canadian Public Health Association, and having as its object the adoption of standard methods of water analysis and standardization of methods of reporting analyses, consideration also being given to the possibility of classifying industrial waters in Canada. The committee was able to submit preliminary recommendations covering its two main terms of reference and has also initiated laboratory investigations on a number of analytical problems that have arisen.

Conferences were held on several occasions with technical officers of Canadian oil refineries in connection with the work of the Canadian Government Purchasing Standards Committee and the standardizing activities on fuel oil and gasoline undertaken on behalf of the provinces.

During the year the question of fire rating of structural materials came to the fore on several occasions through representations both from private firms and from the Dominion Fire Commissioner. This culminated in the presentation of a resolution from the executive of the Dominion Fire Prevention Association requesting the National Research Council to undertake the formulation of suitable standards of fire resistance and the testing and classification of construction materials so that regulatory measures could in future have an authoritative basis.

The possibility of preparing a national model building code was also discussed with a number of interested organizations during the year, and a paper on this subject was presented at a conference on planning and housing which was held in conjunction with the 1937 meeting of the Union of Canadian Municipalities and the Dominion Conference of Mayors. This conference subsequently adopted a resolution recognizing the need of a national building code and requesting the National Research Council and the Dominion Housing Administration to investigate the field and, if deemed advisable, to undertake the preparation of an adequate code.

Two short bibliographies were also prepared by Miss Whalley on the effect of heat injury by insects on crop yield and the chemical composition and physical properties of tomatoes, as well as bullet reports relating to the use of coconut shells, the influence of poisonous gases on health, the manufacture of fertilizer, the culture for soy beans, soil of honey and data on castor beans. The culture for soy beans, soil of honey and data on castor beans were prepared by Miss Whalley and the other two by Miss Whalley and Mr. A. F. Garroway.

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REPORTS OF CO-OPERATIVE INVESTIGATIONS

During the year grants in aid of research amounting to \$176,819.92 were made by the Council for the conduct of co-operative investigations under associate committees and to assist qualified research workers in carrying on approved researches in their own laboratories. Of this amount \$66,146.23 was provided from the parliamentary appropriation of the Council, \$18,404.45 from the special fund, and \$92,269.24 from the trust fund. The greater part of the last mentioned amount was provided by Canadian industry and from the trust monies held by the Council for grain research.

Grants were awarded by the Council to 19 associate committees appointed for the purpose of directing co-operative investigations on approved projects. In addition, 28 research projects were in progress with financial assistance from the Council. Grants for these latter investigations were made for the purpose of enabling individual research workers to carry on work in their own laboratories on problems which they were especially qualified to investigate, and which had been approved by the Council. Grants were also made to several scientific organizations for the purpose of stimulating and co-ordinating research work in Canada, or in order to secure the results of researches in fields which were of importance to the Council.

A list of researches in progress under grants in aid to individual workers is given on page 128, following the reports of the current year's activities. Reports of the activities of the associate committees, special committees, and of investigations carried on by individual researchers during the year are given hereunder.

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 ninth meeting of the Associate Committee was held at Winnipeg, April 5-8, 1937. The following summaries indicate progress made in plant breeding, plant disease survey, life-history studies and seed and soil treatments. Information on the development of new cereal varieties will be found in the report of the Associate Committee on Grain Research, page 78.

THE CANADIAN PLANT DISEASE SURVEY FOR 1936

Stem rust of wheat caused slight damage in Canada in 1936, in contrast with its destructiveness in 1935. Dry weather and heat limited the development of the disease and largely obscured the damage from rust. Barley leaf rust, which is not as common as wheat leaf rust in eastern Canada, was prevalent at Fredericton, N.B.

There was little change in the prevalence of wheat bunt in western Canada, as compared with that in previous years. Of the cars of wheat inspected at Winnipeg, 0.8% graded smutty.

A foot- and root-rot survey was made in Saskatchewan in 1936, but not in the other two Prairie Provinces. In Saskatchewan take-all caused a trace of damage in five fields of 277 examined, while ordinary foot rot caused moderate damage in 257 of 277 fields examined. Prematurity blight, the cause of which is unknown, occurred in a few fields, and browning root rot in eight out of 131 fields.

In 1936 plant disease survey work was handicapped by lack of funds, with the result that only a very incomplete outline of the disease picture for the season is possible.

(Survey compiled by I. L. Conners.)

RESEARCH IN ALBERTA

Dominion Laboratory of Plant Pathology, Edmonton

Many isolates from *Rhizoctonia solani* have proved to be non-pathogenic to potatoes. This organism has been shown to be most destructive at a soil moisture content of 22%. A new method of testing potato varieties for resistance to this organism has been found.

A number of species of *Cylindrocarpon* and *Fusarium* have been isolated from diseased alfalfa and sweet clover in Alberta. These species cause different degrees of damage and do not all attack plants at the same stages of growth. Laboratory studies indicate that temperature relations determine the time of attack and therefore the stage of growth at which the host plant suffers damage. Some of the organisms are moderately to highly pathogenic to wheat, oats and barley.

A new technique for studying the effect of nutrients on the development of foot and root rot has provided more information on the effects of phosphorus, potash, calcium and nitrogen. Three years' work on the treatment of wheat seed with powdered pitchblende shows that a slight reduction in bunt infection was obtained. This reduction may in reality be due to stimulation of the wheat plant by the ore.

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

University of Alberta

Although commercial strains of slender wheat grass have proved susceptible to smut, collections of wild plants were made in the hope that some of these would prove to be resistant. Seed from these plants was inoculated with smut. Some of the strains produced no smut and others very little, indicating immunity or resistance.

The growth of *Ophiobolus graminis* in agar was stimulated by the addition of alcohol extracts of root-tips of wheat, but no effect was obtained by the addition of water extracts. Evidently some growth-promoting substance is present in the alcohol extract.

In studies of growth in sterilized and unsterilized soil it was found that wheat started in the former headed earlier, stooled more and grew taller than that started in the latter, when both lots were transplanted into the field. There were no consistent differences in the percentages of smut from inoculated seeds started in the same ways. Evidently the organisms in normal soil have no suppressing effect on the smut organism. The types of microorganisms which come into soil after sterilization are now being studied.

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

In barley breeding attention is being given to the improvement of varieties for feeding and for malting purposes, special emphasis being laid on resistance to loose and covered smuts. Most of the material now being tested traces to breeding work done in 1934. Selections are being made on the basis of high protein in smooth-awned strains and low protein in rough-awned strains, with due consideration to other characters.

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

Since the study of soil organisms in the laboratory frequently involves the use of sterilized soil as a medium, it is important to know what are the effects of sterilization on the soil itself. In studies of soils of three types common to Alberta it was found that sterilizing caused major changes in rate of nitrification and availability of phosphorus, but no significant change in hydrogen ion concentration or in certain physical properties. This work is being continued.

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

RESEARCH IN MANITOBA

Dominion Rust Research Laboratory

The stability of the resistance of ten varieties of wheat to two races of stem rust was studied under different conditions of atmospheric humidity, light, and soil fertility. No radical changes in reaction occurred under the conditions used, although some slight changes were noted. In experiments on the effect of length of day on growth and rust reaction, plants of the Hope variety receiving only six and ten hours of daylight were retarded in growth. Plants grown under reduced light intensity showed signs of a breakdown of resistance to rust.

The regular survey for physiologic races of rusts in the Prairie Provinces was supplemented in 1936 by observations at eleven points in the eastern provinces and one in British Columbia. It was found that some races predominated in the east and others in the west, and that the number of races in British Columbia and in the east was greater than the number in the Prairie Provinces, probably because of the presence of the barberry in those areas.

The production of the uredial and telial stages of stem rust on the barberry was reported this year. Heretofore these stages were known to occur only on the grains and grasses.

Studies on foot- and root-rot organisms in the soils of the Winnipeg area disclosed that *Fusarium* spp. and *Helminthosporium sativum* are generally present, but that they do not always produce appreciable parasitic effects on plants. Dusting wheat seed with mercury compounds reduced the amount of seedling blight and root rot and improved seedling emergence and yield on normal soils. On soils treated with ammonium phosphate the dusts appeared to reduce yield slightly.

Two permanent series of plots were laid out at the Dominion Rust Research Laboratory for the study of (i) the effects of different cultural practices on the incidence of root rot, and (ii) the effects of different manurial treatments on the control of these diseases. In addition, an investigation of the relative prevalence of soil fungi and bacteria was started. While considerable detailed work is involved at the outset in developing accurate methods for this work, valuable data should result. The first season's work indicated that there is an association between the species of fungi present and the fertility gradient of the soil.

Investigations on cereal smuts showed that the organic mercury dusts, New Improved Ceresan and Leytosan, improved germination and effectively controlled smut. Treatment of wheat with solutions of these dusts has been suggested for districts where farmers use the "floater" treatment to remove ragweed seeds. The concentration of solution most suitable for such treatment has been determined. Experiments showed that the yield from smut-free seed of wheat, barley and hulled oats was not increased by treatment with copper or mercury dusts but the yield from smutty seed was increased as a result of suppression of the smut. Seed treated with New Improved Ceresan was kept in storage for a year without injury to germination. A second physiologic form of loose smut has been discovered in Manitoba. Varieties of wheat that are resistant to loose smut in western Canada may be susceptible in the east because the physiologic races of smut in the two areas are not the same.

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

In the program of breeding for rust resistance, such varieties as Renown have been produced by crossing, and while crossing is being continued, re-selection within the already established varieties is now proceeding. By this means some strains have been developed from Renown that have lower carotene content, greater leaf-rust resistance and greater uniformity than the parent variety. Tests for quality are now made in the early stages of development of new varieties and strains, thus saving time and effort. About 6000 bushels of Renown were distributed during the past year and two new varieties are being prepared for distribution in 1938, while a third is being increased pending some further information as to its milling and baking quality.

Some hybrids from a number of crosses between Iumillo and some of the bread-wheat varieties are immune to as many as five of the eight races of stem rust to which they have been exposed. In this respect these hybrids are superior to Marquillo, which has been the best variety produced from Iumillo crosses in the past. These hybrids show mature plant resistance in the field. Greenhouse studies with many physiologic forms and chromosome studies of the hybrids are also being conducted.

In the co-operative tests, 16 strains and eight varieties of oats were tested at seven prairie stations in 1936. A new variety of oats, Vanguard, is to be distributed in 1937. This variety from a Hajira \times Banner cross, is resistant to stem rust and is stronger strawed and earlier than the Banner parent. It shows wide climatic adaptation but is somewhat low in weight per bushel and weight per 1000 kernels.

Barley selection was carried on under conditions of fairly heavy natural rust epidemic in 1936. Approximately 1100 single plant selections were made from the progenies of crosses between the rust-resistant Peatland and the smooth-awned varieties Newal, Wisconsin, Pedigree 38, Glabron and Byng. Genetic studies indicate that hull adherence and texture in barley are inherited on simple Mendelian lines.

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

RESEARCH IN ONTARIO

Central Experimental Farm, Ottawa

A microbiological study of three soils was started with the objects of determining the role of different micro-organisms in soil fertility and of testing methods for this determination. Three methods of making counts were used, one of these being a newly developed soil-slide dilution method.

Preliminary results showed little correlation between productivity and bacterial numbers. Further, no great differences were obvious in the incidence of different bacteria in the soils studied. Surprising morphological and biochemical differences among the organisms were noticed, many variants of comparatively few species being found.

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

Plant selections have been made from 20 hybrid lines of oats that were being developed for resistance to crown rust in eastern Canada. These have been grown under epidemic conditions and reselected on the basis of agronomic characters. Some are superior to Alaska, Legacy and Victory but have weak straw. The best of them will be used in crosses with such varieties as Vanguard. From the Vanguard crosses it is hoped that hybrids combining resistance to stem rust and crown rust may be obtained.

In tests for rust resistance two new varieties, Lenroc, from Cornell University, and Erban, a recent introduction by the Ontario Agricultural College, show practical immunity. Data on a five-year study of resistance to oat blast are now undergoing final analysis and will be published soon.

The cytological study of pollen mother cell irregularities in wheat has been continued. Generally speaking, the smaller the proportion of irregularity in the pollen mother cells, the less variation there is in the progeny. Thatcher wheat competed favorably with Marquis in having a small proportion of irregular pollen mother cells. Many varieties and strains now under test in the field by the plant breeders are being studied cytologically at the same time.

Varietal tests for resistance to flax wilt have been carried on for a number of years and common varieties are now well classified according to their resistance. The better resistant types have been used for hybridization and a number of selections from (N.D.R. 52 × Diadem) × Bison are particularly promising for smut resistance, yield and earliness.

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

RESEARCH IN SASKATCHEWAN

Dominion Laboratory of Plant Pathology, Saskatoon

Studies of different isolates of *Ophiobolus graminis* have not yet indicated the cause of their wide differences in pathogenicity. Tests for resistance to this organism in the field did not disclose any marked varietal resistance among standard varieties. Similar results were obtained in field tests with *Helminthosporium sativum*, but in greenhouse tests definite differences were obtained, relatively low infection rates being shown by Marquis, Apex, Thatcher and Canus. In the field, deep seeding resulted in greater infection by *H. sativum* and increased rates of seeding gave increased yield. Plants grown from seed of low vigor were more liable to injury from root rot than those from seed of good vitality. The work on isolation of fungi from wheat roots at successive levels was continued, organisms associated with root rots being usually found in the upper foot.

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

University of Saskatchewan

In testing the late-sowing test for rust resistance, which was described last year, the results were compared with laboratory tests made at the Dominion Rust Research Laboratory. There was almost perfect agreement between the two sets of data. Seed of the variety Apex, which traces back to a cross made in 1927, has now been distributed to farmers in Saskatchewan.

In the present program of spring wheat breeding there are 14 crosses and backcrosses, eight of which carry factors for stem rust resistance. Six others are being used in the hope of producing a good early wheat to replace Garnet in northern districts. In 12 supplementary co-operative variety tests Thatcher yielded well, particularly in the south, although it did not excel Marquis in the north. Reward was the outstanding variety for seed characters and grade. Extensive investigations of the root-rot resistance of wheat varieties have been carried out in co-operation with the Dominion Laboratory of Plant Pathology at Saskatoon.

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

During 1936, samples of soil from selected type profiles were examined to determine their micro-population. It was discovered during study of the technique used that the time elapsing between collection of the sample and making counts in the laboratory causes variations in the counts. Accordingly all phases of the methods of microbiological analysis for use in this project are being investigated. While results are not complete, the effects on the bacterial counts of air drying, of different shaking methods and of different dispersion media have been roughly determined. It was found that 29 out of 120 bacterial cultures isolated from soil were antagonistic to *Helminthosporium sativum*.

(Investigations under the direction of Dr. J. Mitchell.)

Phosphate fertilizer seeded with grain appears to be one of the best means of controlling browning root rot in Saskatchewan. An effort was made to determine how this effect is brought about but the results were not clear-cut. However, it appears that the phosphate helps the plant to escape the disease, rather than to make it more resistant.

A study of the species of *Pythium* parasitic on wheat in Britain and in Canada showed that *P. arrhenomanes* is the most important in both countries. *P. graminicolum* is important in Britain only. Species of *Pythium* could be isolated with ease from wheat seedlings grown in soil collection from virtually any field in which cereals had appeared in the rotation.

(Investigations under the direction of Prof. T. C. Vanterpool.)

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

The work of this committee on problems relating to the quality of wheat, barley, and flax has progressed satisfactorily. Fifteen papers reporting the results have been published during the year in the committee's series, bringing the total to 112. In addition several reports have been made to the Board of Grain Commissioners, the National Barley Committee and other organizations, on specific questions.

Further co-operation with the National Barley Committee has been arranged by the appointment of a Subcommittee on Feeds and Feeding-stuff Analysis. This committee will report to both organizations on problems relating to the feeding value of Canadian grains, particularly barley.

JOINT INVESTIGATIONS

Frost Injury of Wheat

Statistical analysis of the data obtained from a six-year survey of the quality of frosted wheat has shown that milling quality is closely related to the percentages of immature and heavily frosted kernels in the sample and also to the weight per measured bushel. Protein content is the best single index of baking quality but the percentages of immature and heavily frosted kernels modify this relation. The quality of all samples decreases with increasing percentages of immature kernels; heavily frosted kernels, on the other hand, have a more deleterious effect on low protein than on high protein samples. A report on this investigation will be published shortly.

Quality of New Wheat Varieties

The committee has continued to co-operate with the Subcommittee on Plant Breeding of the Associate Committee on Field Crop Diseases by testing the milling and baking quality of new strains of wheat. Two new rust-resistant varieties, Apex and Renown, were approved as satisfactory for distribution. Reports on the quality of several varieties and their ability to meet the specifications of the various grades were made to the Board of Grain Commissioners.

SUBCOMMITTEE PROJECTS

Soft Wheat Research

The first phase of the soft wheat project conducted in co-operation with the University of British Columbia, wherein a large number of winter and spring wheat varieties have been grown in several localities in British Columbia, is now nearing completion. To supplement the agronomic data, protein determinations were made on the threshed grain by the Dominion Grain Research Laboratory. The data are being compiled by Dr. G. G. Moe. From these results the possibilities of areas in British Columbia capable of producing satisfactory soft wheat for pastry flour purposes should be ascertained.

The possibilities of areas in Alberta capable of producing satisfactory soft wheat are also being investigated. In co-operation with the University of Alberta, varieties of soft white spring wheat are being tried on some of the gray wooded soils west of Edmonton. Wheat of low protein is produced in these areas but so far the varieties available are a little too late in maturing to escape frost damage. Consequently, a breeding program has been initiated by the Cereal Division and by the University of Alberta to produce satisfactory soft wheat varieties of early maturity. At the Lethbridge Experimental Station the possibilities of growing soft wheats on irrigated land are being investigated.

The program of the Cereal Division, Dominion Experimental Farms (under the direction of Mr. J. G. C. Fraser), has for its objective the development of low protein wheats which will produce satisfactory flour for the cake and pastry trade. Varieties from several sources, which were reputed to be low in protein, have been collected and tested for several years and those giving the best promise either in themselves or from a breeding point of view, have been used as parents. In many instances, it was unfortunately found that the most promising sorts were subject to leaf rust, stem rust, smut, or a combination of all three in some cases. For Canadian conditions, many of the varieties which were suitable in some particular character were found to be too late in maturity. Thus the matter of disease and maturity became important problems to be considered in this soft, spring wheat program.

To overcome this late maturity, an early white wheat, Quality A, was used in many of the crosses.

The program was divided into four groups of crosses as follows: Group I, Most promising soft, white spring wheats crossed with Quality A; Group II, Most promising soft, white, winter wheats crossed with Quality A; Group III, Less promising spring wheats with Quality A, employing a bunt-resistant parent in some of the crosses; Group IV, Australian, white, spring wheats crossed on Quality A.

By using the greenhouses, it has been possible to sow this year (1937) the F_3 hybrids of the first two groups on which the emphasis has naturally been laid.

In order to combat the losses due to stem rust, some of the F_2 hybrids have been crossed with rust-resistant, red, spring wheats and these will be back-crossed to re-establish the white grain characters in a larger proportion of cases.

It is too soon to predict any definite trends in this work which will have to be carried on for several more years before it can be hoped to find anything really satisfactory.

Barley Research

The work of the Subcommittee on Methods of Experimental Malting and Malt Analyses has been carried on in close co-operation with the National Research Laboratories and is summarized in the report of the Division of Biology and Agriculture, page 26.

The Subcommittee on Laboratory Malting Tests (formerly, the Subcommittee on Malting Barley Research), in co-operation with the Subcommittee on Breeding and Production of the National Barley Committee, has been able to effect further co-ordination of barley researches in Canada and to allot the available malting tests to better advantage. Malting tests for replicated variety trials are being confined to those varieties which are agronomically promising and these will be grown at eight stations selected as far as possible from good malting barley areas. Several investigations of the effects of cultural practices on malting quality, being carried on in Saskatchewan and Manitoba, have been co-ordinated and will be treated as one project. An increased number of tests were allotted to investigations of the effect of environment on malting quality with the object of obtaining adequate information on the suitability of plans now in use for these studies. A study of the results obtained with 1935 crop samples (summarized under Grain Research at the University of Manitoba, page 86) showed that useful information can be obtained only from adequately replicated experiments. For this reason the subcommittee has decided to reduce to a minimum the number of tests allotted to plant breeders' selections and miscellaneous varieties grown at one or two stations only.

The 523 samples grown in 1936, which are to be tested this year, were allotted as follows: variety trials, 132; effect of cultural practices, 85; effect of environment, 180; plant breeders' selections, 30; and for studying and improving the malting test, 96.

Oil Seeds Research

As the Subcommittee on Flax has recently extended its studies to other oil bearing seeds, the name of this subcommittee has been changed to the "Subcommittee on Oil Seeds", and Dr. L. E. Kirk, Dominion Agrostologist, who is in charge of sunflower seed investigations, has been added to the

membership. Under the auspices of this subcommittee, field tests are conducted by the Dominion Department of Agriculture and by the Universities of Alberta and Saskatchewan, while the quality tests are made by the laboratory of the Board of Grain Commissioners.

Studies on flaxseed have included variety and fertilizer trials and an investigation of the effect of harvesting at different stages of maturity on the physical and chemical characteristics of the seed. The maturity studies in western Canada have shown that, as the kernel develops, its oil content rapidly increases and the saturated fatty acids are progressively transformed to unsaturated; under dry conditions these processes were found to be largely completed by the fifteenth day after flowering. The value of flaxseed screenings, as a source of oil, is also being investigated.

The possibilities of sunflowers as a profitable oil-seed crop are being investigated, and laboratory studies are in progress with a view to ascertaining the properties and uses of the oil. The tests to date indicate that it possesses high quality as a salad and cooking oil and is of value in paint manufacture.

Feeding-stuffs Research

As a result of a resolution passed at their meeting in 1936, the National Barley Committee appointed a committee to arrange for a series of feeding trials designed to evaluate the nutritive value of the feeding grades of barley for hogs, and by agreement, this committee was constituted as a Subcommittee of the Grain Research Committee. The project was to be undertaken on a co-operative basis in which the western grain producers would supply the feeds, certain eastern agricultural colleges and experimental farms would provide the animals and staff for carrying out the actual feeding, and the Dominion Department of Agriculture would contribute toward costs of preparing, printing and distributing the report.

A series of five tests on this scheme were arranged for and are at present under way. Inasmuch as the grades of barley are about to be changed from those at present in force, this first series of tests involves a comparison of only No. 4 C.W. barley with oats and corn, with the expectation that in subsequent trials the new barley grades will be studied.

While no reports are yet available from other stations, the pigs on test at Macdonald College are showing marked differences in growth on the various rations, those on barley showing the best progress. It is expected that final data will be available before the end of this calendar year.

DURUM WHEAT LABORATORY

The durum laboratory, which is operated in conjunction with the Grain Research Laboratory of the Board of Grain Commissioners, has completed another successful year's work. A satisfactory standardized experimental technique for the production of semolina and macaroni products has been developed and published (*Cereal Chem.* 13 : 497-521. 1936) and considerable attention has been given to the elaboration of quantitative methods for testing the finished product. Technological tests on durum wheat have been of considerable value to the Grain Inspection Branch, particularly in the preparation of the tentative standard samples; at the 1936 meeting of the Western Committee on Grain Standards a report covering the results of tests on Winnipeg averages and tentative standards of the various durum wheat grades was presented and samples of macaroni exhibited. For the first time a mimeographed report on the quality of the western Canadian amber durum wheat crop was distributed. Three papers dealing with experi-

mental durum testing methods and the macaroni-making characteristics of Canadian amber durum wheat were published during the year in a macaroni trade journal. Quality tests have been conducted on several series of standard varieties and hybrids; the macaroni-making quality of "Golden Ball" was found to be so inferior that a recommendation was made to the Board of Grain Commissioners advising the exclusion of this variety from the first two grades.

An extensive survey of various commercially available organic solvents has indicated that normal butyl alcohol is superior to the mixed naphtha alcohol solvent now in general use for the quantitative determination of carotenoid pigments, and a revised method incorporating the use of this solvent is being prepared for publication.

(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 review of certain studies, other than those reported under the subcommittee on oil seeds and under durum research, is given here.

A paper covering a study of the effect on loaf volume of proving doughs to a definite height as compared with proving for a fixed time has been published in *Cereal Chem.* 14 : 233-238. 1937; of the two methods, proving for a fixed time was considered preferable.

The comparison of various methods for measuring flour gassing power, referred to in the last annual report, has been completed and submitted for publication in *Cereal Chemistry*. Diastatic values, determined by the standard procedure involving diastasis for one hour at 30° C., were not sufficiently highly correlated with the actual gas production in sugarless doughs to permit diastatic activity and flour gassing-power to be regarded as synonymous terms. Three common methods of measuring gas production in fermenting doughs were found, however, to give closely similar results.

The investigation dealing with the effect on flour strength of additions of dried gluten prepared from flours of widely varying strength has now been completed. Raising the protein level of a weak flour to that of a strong one imparts definite strength as evidenced by improved dough quality, increased loaf volume, enhanced loaf appearance and type of farinogram. The greatest improvement resulted from the addition of dried gluten from strong Canadian flour.

A study of various published methods for the micro determination of bromine in biological materials has been carried out and a method developed for the quantitative determination of bromine in treated flours.

Studies regarding the utility of the Brabender farinograph for evaluating flour strength are being continued. Several hundred farinograms have been made and certain curve measurements are being correlated with the loaf volume data.

The comparative quality, as indicated by farinograph and experimental baking tests, of flours milled on an Allis Chalmers and a Brabender automatic experimental mill, has been investigated. The Brabender mill gave lower yields of less refined flour which was of lower baking strength. The Brabender testing technique failed to differentiate as satisfactorily between the quality of strong Canadian wheats as the regular laboratory methods involving milling on the Allis Chalmers mill and the test baking of the flours.

As in previous years, the laboratory has carried out surveys on the protein content of hard red spring wheat, durum wheat and barley and on the oil content and quality of flaxseed produced in western Canada. In co-operation with the Division of Biology and Agriculture, National Research Council, a study of the feasibility of establishing minimum protein contents for export wheat has been undertaken, the protein data accumulated by the laboratory on wheat at various stages of marketing being utilized. This problem is to receive further consideration before any definite pronouncement is made.

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

GRAIN RESEARCH BY THE CEREAL DIVISION, OTTAWA,
DOMINION EXPERIMENTAL FARMS

The Cereal Division has been actively interested in improving the purity of the wheat crops in western Canada through the work of the Dominion Crop Testing Plan. By this plan the farmer has been able to secure good seed of approved varieties with little or no cash outlay and is thus able to improve his commercial grades by growing more uniformly ripened crops. In this respect, there is a steady improvement taking place although quite a large number of farmers still grow badly mixed crops.

A study of the varietal composition and protein percentage of cargo shipments of wheat for a period extending from 1928 to 1934 was published in April, 1936. (Sci. Agr. 16 : 409-423). In protein percentages for the years 1932, 1933, 1934, the Atlantic and Pacific Manitoba 1 Northern cargoes averaged about the same, while the Pacific shipments of Manitoba 2 Northern and 3 Northern averaged substantially less than the Atlantic shipments. Considerable variation in protein percentages between cargoes existed within each grade, but this was noticeably less for the Manitoba 1 Northern grades. Some evidence was obtained to indicate that the variability in protein occurring in the different cargo samples is very largely dependent on the districts from which the wheat is drawn to make up the cargoes, as protein percentages are influenced more by environment than by variety. It was pointed out that the segregation of Garnet from the Manitoba 2 Northern grades should have a substantial effect on the improvement of this grade, as it will not only remove a wheat of different milling qualities from Marquis but one largely grown in the low protein areas.

A statistical study of the significance of wheat protein percentage differences in varietal trials was made for 28 varieties grown in quadruplicate plots at three experiment stations. The error due to plot variability exceeded the laboratory error. The major influences of station and replication gave negative correlations between yield and protein content. The rod row plot system used for comparing varieties agronomically appears to be satisfactory for producing samples for quality comparisons in so far as the protein determination is concerned, as the error of prediction does not appear to be large.

The quality testing varieties bred for rust resistance, early maturity and other characteristics occupy a large part of the program in the milling and baking laboratories. In the samples originating at the Dominion Rust Laboratory many new lines are coming forward in which rust-resistant sorts have been further crossed with the standard high quality varieties Marquis and Reward. Selections of some of the rust-resistant varieties like Renown are being tested for quality, and in the case of the latter variety a new selection R.L. 716.6 appears to have merit over the parent variety, as indicated in samples grown at Winnipeg for the past two years.

Comparisons were made of varieties grown in Argentina from samples obtained from three experiment stations in that country. The data indicated

that some very good quality varieties are available to the growers in Argentina although none of the samples equalled in baking strength the good wheats of the Manitoba Northern class.

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

NOTE.—Additional information on the work of the Cereal Division is given in the Report of the Dominion Minister of Agriculture.

GRAIN RESEARCH AT THE UNIVERSITY OF ALBERTA

Water culture studies on nitrogen, phosphorus and sulphur nutrition of wheat were carried on, and the conclusion that limited nitrogen supply results in increased phosphorus absorption, originally reached as a result of field studies, was confirmed.

The studies on the relation of lipoidal substances to quality and keeping properties of flour have been continued. A complete summary of the results obtained up to July, 1936, has been published (*Can. J. Research, C. 15 : 187–203. 1937*). The most important conclusions are that lipoids are necessary for the formation and maintenance of the typical structure of dough and gluten, and that lipoids contained in gluten should be considered as part of the gluten complex, and not as impurities in the protein.

A series of four varieties of wheat was produced under various conditions of nitrogen fertilizer treatment with the object of obtaining a series of samples of each variety with as wide a range in protein content as possible. Although the very dry summer impaired the value of the experiment, the results indicated that with better growing conditions, the experiment should produce the type of material desired. The experiment is being repeated.

The quality studies on wheat samples supplied from the rotations maintained by the Pathology Division of the Department of Field Crops were continued. The individual field replicates have been used in these studies during the past two years, and valuable data relating to replicate and field errors are being accumulated.

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

The investigations concerned with breeding wheat for resistance to drought have been continued and extended.

Field tests of varieties and new hybrid strains have been conducted at Brooks, Alberta, under conditions of extreme drought for a number of years. In 1935, owing to the severity of the test, nothing was harvested. In 1936, the results were of considerable interest, particularly in relation to the performance of several new strains. The experimental error was, however, unduly high and, as a result, the field testing work has been transferred to Castor, Alberta, where conditions are, as a rule, less severe.

The difficulty encountered in securing accurate field results has necessitated a thorough investigation of the possible utility of laboratory methods of selection for resistance to drought. Reference has been made in previous reports to the subjection of breeding material to artificial drought in a machine specially designed for that purpose. The design of the machine has been altered and several improvements effected, with the result that the experimental error has been substantially reduced. By means of this machine, also by testing the tolerance of wheat seedlings to growth in concentrated sugar solutions, and by comparative root studies, striking differences between varieties and strains have been established. The extent to which these differences are associated with yield under field conditions when moisture is limited remains to be seen.

Several new crosses have been made on a large scale between standard varieties and new, allegedly drought-resistant, Russian varieties. Selection from material in these crosses will be commenced in 1937, and further crossing undertaken.

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

Seed treatment with formaldehyde reduced germination and caused stunting of the shoots and roots of the seedlings. Emergence of cereals and flax in the field was reduced and the yield was significantly lowered in some instances. The deleterious effect was very marked when frosted wheat was used as seed. On the other hand, new improved Ceresan and Standard Leytosan caused no seedling injury even when applied at double the recommended rates of application, while Leytosan P reduced shoot growth only slightly. The emergence and yield of wheat, oats and barley in field tests were consistently better when the seed was treated with the dusts than when formaldehyde was used. The dusts increased the yield of frosted wheat more than that of normal wheat. Bison flax treated with Leytosan P gave higher yields than the untreated checks.

Formaldehyde tended to inactivate the growth hormone, heterauxin, as shown by the oat coleoptile test. This inactivation might account in part for the injurious effect of formaldehyde. Exposure of dry wheat to the vapors of organic mercury dusts appeared to increase the diastatic activity but, when the dusts were mixed directly with the ground wheat, the activity decreased.

In an attempt to find means of reducing the bad effects of formaldehyde, four special preparations supplied by the manufacturers were tested, but the results were similar to those with the ordinary commercial grade. Presoaking in water before treatment increased the emergence in field tests but had little effect on the yield. Washing after treatment increased both emergence and yield. In greenhouse tests a combination of these treatments was better than either alone and even better than the untreated check, but these results have not yet been confirmed in the field.

Injury by formaldehyde was increased when the solutions used had been stored in dilute form or when the grain was stored after treatment. Low moisture content of the grain favored seed injury.

Wheat treated with organic mercury dusts, and stored in the laboratory in stoppered flasks, did not show appreciable injurious effects until after above eight weeks' storage. Oats and barley showed no significant injury until after eight weeks' storage. Flax treated with organic mercury dusts tended to benefit from storage during the first two weeks and did not show injury until after six weeks' storage.

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

The experiments on the fertilizer requirements of Alberta peats for barley production were repeated at Edmonton and Duffield using O.A.C. 21 and Peatland varieties. The season was exceptionally dry and the fertilizers did not appear to affect the maturity or yield of grain very much. At Duffield, Peatland outyielded O.A.C. 21 by about five bushels per acre but at Edmonton there was no significant difference. The straw yield was markedly increased by fertilizing, a "complete" fertilizer being most effective, followed by nitrogen and phosphorus alone or in combination.

The peats and the underlying soils were analyzed. The latter are high in the principal ash constituents as well as in total ash, but the calcium and phosphorus were lower in every case than in the peat. The sulphur content

of the peat is very high in comparison with the underlying soil or with the mineral soils in general. This may help to explain the beneficial effect of peat applied as an amendment to sulphur-deficient gray wooded soils.

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

GRAIN RESEARCH AT THE UNIVERSITY OF MANITOBA

Investigations of the effect of, (i) fertilizers and date of seeding, (ii) rate of seeding, and (iii) position in a crop rotation, on the malting quality of barley are being continued. Tests made in the 1935 crop showed that date of seeding had an important effect on malting quality but that the optimum date differed for different varieties. Results for other factors were inconclusive and showed the necessity for expansion and reorganization of the investigations. The university is also carrying on a program of variety testing and breeding work with barley.

The experimental malting laboratory made duplicate tests on 304 samples of barley grown in 1935. Studies of the effect of cultural practices on malting quality, described above, contributed 47 samples. An investigation of the effect of environment was made with 57 samples grown in Saskatchewan. These represented samples of three varieties obtained from 16 localities, and samples of two of the varieties from five additional localities. Significant differences were demonstrated between localities but the investigation was too small to make possible a study of the relation of malting quality to the cereal variety zones for the province.

The uniform variety trials contributed 123 samples. Tests were made of 14 varieties, each of which was grown at from four to 13 experimental stations in Canada. Not one of the eight smooth-awned varieties tested produced both as high an extract yield and diastatic power as the standard variety O.A.C. 21. The rough-awned varieties proved to be equal or slightly superior to the standard, Olli being the most promising (*Sci. Agr.* 17 : 593-600. 1937). The remaining 76 samples represented miscellaneous varieties and plant breeders' selections.

GRAIN RESEARCH AT THE UNIVERSITY OF SASKATCHEWAN

A general study of the effect of soil on protein content and quality of wheat in Saskatchewan was begun in 1936. Large numbers of samples were obtained from areas in which there were sharply marked different soil types. Great variability in protein content was noted in all such areas, whereas in areas known to be of a single uniform soil type the variability was small. With regard to specific soil effect, the only conclusions justified by the data of last year are that previously wooded soils and poorly drained or alkali soils both tended to produce lower than average protein. Composites were made of samples from the various soil types and the milling and baking tests of these are in progress.

A critical examination of the effect of tempering time on the characteristics of flour and offals produced on the experimental mill showed that reduction of the initial tempering time from 48 hours to two hours had no appreciable effect on the ash content, protein content, moisture content or yield of flour. The shorter tempering times reduced the amount of shorts and increased the amount of bran, but the sum of the two remained the same.

The replicated study of the hydrolytic effect of sodium hydroxide solutions of various concentrations on gluten protein was made. At room temperature (22° C.), dispersion of gluten in all concentrations of NaOH from 0.0125 *N* to 0.6 *N* appreciable hydrolysis of amide nitrogen after 31 days.

The dispersion in 0.6 *N* NaOH lost all the amide *N* (as determined by acid hydrolysis) in three days. With the higher concentrations there was distinct evidence of deamination and of secondary hydrolytic cleavage.

When gluten was digested at the boiling point with NaOH solutions of concentration 0.125 *N* or higher, the hydrolysate contained 16–27% more amide nitrogen and considerably less amino nitrogen than the acid hydrolysate. Hydrolysis was not complete even with 4 *N* NaOH solution after 24 hours.

(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 25.

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

While no meeting of the committee was held during the year, work was continued according to the plan referred to in the previous report.

A brochure of 81 pages on the chemical composition and nutritive value of potatoes was prepared in the Division of Research Information, and copies were distributed to the members of the committee and others interested in this subject. Distribution was also made to the members of the committee of a bulletin published by the Potato Marketing Board in the United Kingdom, entitled "The Potato as an Article of Diet".

In the Division of Chemistry research on the industrial utilization of potatoes was continued, and a comprehensive account of this work will be found on page 39.

Co-operating agencies, including the provincial and federal departments of agriculture, have carried on investigations in the feeding of potatoes to livestock and poultry, and have also conducted potato breeding experiments in order to obtain precise scientific information on the genetics of potato propagation.

Associate Committee on Storage and Transport of Food of the National Research Council and the Dominion Department of Agriculture

This committee, which consisted at the outset of only a small executive, was re-organized, as reported last year, on a sectional basis in order to cover the wide diversity of interests represented. During the year under review the scope of the committee was again increased, by adding to its membership representatives of the Fisheries Research Board, and authorizing the organization of additional sections. In addition to the main committee, the organization now includes a small executive group, dealing mainly with financial matters, and the following five sections: (1) meat, poultry and eggs; (2) fish; (3) fruit and vegetables; (4) engineering; (5) taints. This kind of organization is intended to facilitate conference between groups of persons interested in various aspects of the widely diversified problems relating to the storage and transport of perishable commodities.

For various reasons only the poultry section (before its re-organization on the broader scope indicated above) met during the past year. This meeting was held in Ottawa on May 27, 1936, to consider which of the many problems facing the poultry industry deserved first attention, and to hear progress reports on the various projects under way in the National Research

Laboratories. These are reviewed in the reports of the Division of Biology and Agriculture, pages 27-29.

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

In accordance with a policy decided upon when this committee was re-organized, that meetings of eastern and western sections should usually be held in alternate years, the first meeting of the eastern section was held at the Central Experimental Farm, Ottawa, July 3 and 4, 1936. Considerable time was devoted to an inspection, under the guidance of Dr. E. S. Hopkins, of the extensive field experiments on weed control under way at that institution. This was supplemented by illustrated lectures by other members of the Division of Field Husbandry, while Mr. H. Groh, of the Division of Botany, reported on his weed survey of eastern Canada.

Professor J. E. Howitt described studies under way at the Ontario Agricultural College, including co-operative experiments on weed eradication, experiments on the germination of perennial sow thistle and on the destruction of rootstocks of this and other perennial weeds, and on the longevity of weed seeds in horse manure. Mr. Omer Caron, of the Quebec Department of Agriculture, presented a report, illustrated with lantern slides, showing that spraying with 20% salt brine, or with 2.5% copper sulphate solution, had given promising results in controlling mustard in grain crops, with respect both to efficacy and to profitableness.

Mr. G. M. Taylor, Mr. George Maheux, and Mr. J. D. Smith, representing respectively the provincial agricultural departments of New Brunswick, Quebec and Ontario, discussed weed control measures in these provinces, with special respect to legislation. As a result of these discussions a sub-committee was appointed to study the question of co-ordinating federal and provincial legislation relating to the inspection of weeds, seeds, feeds and fertilizers, all of which has a bearing on the dissemination and control of weeds. Questions in regard to the disposal of screenings, which had been raised at the previous year's meeting, were discussed by Mr. C. Sweet, of the Seed Branch.

ASSISTED RESEARCHES

While no report was given at the above meeting on the weed investigations at the Universities of Manitoba and Saskatchewan, which are assisted by the National Research Council, and in Saskatchewan by the Dominion Department of Agriculture also, it is of interest to indicate briefly the progress of these studies during the year under review.

In Manitoba, Dr. McRostie and Mr. Silversides were successful in controlling dandelions experimentally with copper nitrate sprays. Cultural treatments were developed for controlling leafy spurge, and the competitive value of annual forage crops for wild oat control was demonstrated. Progress was made with a provincial weed survey, and with botanical and chemical studies of selected species.

In Saskatchewan, Mr. Pavlychenko continued to improve his equipment and technique for the study of root systems, a study which had already done much to elucidate the botanical basis of adaptation to drought and other conditions by both weed and crop plants, and the nature of the competition between various associated species. Forty-two excavations of grass sods during the current year yielded information of practical value in the re-establishment of grasses on drifting soils. Crested wheat grass has been

proved capable of choking out completely toad flax and perennial sow thistle in two years, and greatly reducing in the same period the prevalence of poverty weed, hoary cress, Canada thistle and bindweed. Experiments on the use of fertilizers as an aid in combatting weeds were initiated this year, with promising results. Studies were also begun on the weed seed population of the soil as affected by drought and various cultural treatments. Stinkweed seed has been found to germinate most freely in the first season after production, and to increase in dormancy with age.

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)

This committee has been organized in two sections, dealing with wool growing and wool manufacture, respectively. The latter has been the more active and in the last few years the projects which it has undertaken have related more and more to the breeding of sheep. This has involved in some cases the ownership of hundreds of animals. It has been recognized that the facilities of the Department of Agriculture are better adapted than those of the Council for projects of this kind, and following the establishment of the Associate Committee on Wool as a joint committee of the two organizations, the aid of the Department of Agriculture was obtained in the purchase of experimental flocks.

The National Advisory Committee on Agricultural Services has established, in co-operation with the Dominion Department of Agriculture and other bodies, a National Sheep Committee, the scope of whose work is broad enough to include every phase of sheep husbandry. In order to avoid duplication of effort, the Council agreed to disband the Wool Growing Section when the work of the National Sheep Committee advanced to the point where it was ready to assume responsibility for the continuation of the projects already under way. Arrangements to that end are now being made.

At this time it therefore appears desirable to present the following brief summary of work carried out to date by the Associate Committee on Wool.

1. WOOL RESEARCH AT THE UNIVERSITY OF ALBERTA

(a) Effect of Environmental Factors on Wool

At early meetings of the associate committee the question was raised whether Canadian climatic conditions would permit the growing here of wool of the finest grades and highest quality. As a consequence an investigation, supplementing preliminary experiments previously made, was carried out over a five-year period at the University of Alberta under the direction of Prof. J. P. Sackville, to determine the effect, if any, exerted on wool yield or quality by such factors as temperature, humidity, plane of nutrition, mineral supplements and time of shearing. Samples of wool taken before and after each year's experiments were tested by Dr. P. Larose and staff in the National Research Laboratories.

A full report on the above work is now in preparation. This report will show that under the conditions of the experiment the above factors, excepting only the plane of nutrition, have no large effect on either the quality or quantity of the wool produced. Even the plane of nutrition had no marked effect, except when it was maintained so low that the experimental sheep lost weight, in which case the wool was reduced in quality and seriously impaired in strength.

(b) Deficiency Diseases of Sheep

Prof. Sackville and others have in recent years observed that sheep maintained for long periods of time on dry feed consisting of non-leguminous hays and grains show symptoms of unthriftiness, low reproductive ability and unsatisfactory wool production. This condition was observed in some of the experiments on the effect of environmental factors and, in order to determine whether it was caused by the lack of necessary elements in the diet, various supplements were added to a basic ration of dry, non-leguminous hay and grain. Six groups of sheep were used, of which one was a control fed on the basic ration alone.

The control group showed the usual symptoms of unthriftiness and yielded wool weak in staple and lacking in uniformity. Supplements consisting of (a) green pasture, (b) mineral matter and (c) cod liver oil all effected some improvement, but these supplements added to the basic ration were definitely inferior to a diet of alfalfa hay, which produced fleeces of first-class quality in every respect. These results have been made known to Canadian ranchers, and experiments have been continued in order to determine, if possible, what factor in the alfalfa is responsible for the highly satisfactory result obtained by its use.

2. WOOL RESEARCH AT THE UNIVERSITY OF SASKATCHEWAN

It was recognized from the beginning of the committee's work that none of the ordinary types of sheep were wholly satisfactory from all points of view, when grown under range conditions in western Canada.

The hardiness of the Rambouillet, largely the result of its dense, uniform covering of fine wool and its ability to secure food on the open prairie under winter conditions, are attributes regarded by the committee as almost indispensable, but this breed unfortunately ranks very low in mutton quality, a serious defect in view of the fact that the annual lamb crop is worth several times as much as that of wool. The Down breeds, though generally possessing good mutton quality, lack the stamina necessary for life under range conditions.

The committee was of the opinion that an effort should be made by crossing to combine in a single breed the hardiness and wool yield and quality of the Rambouillet with the mutton quality of the other breeds. Preliminary experiments to that end were undertaken by Dean A. M. Shaw, who first used a considerable number of breeds to determine which, if any, offered sufficient encouragement to justify a more comprehensive investigation.

There was used for these preliminary experiments a foundation flock of high-grade Rambouillet ewes and purebred rams of the Corriedale, Ryeland, Romney Marsh, Cheviot and English Leicester breeds. Work was not done with black-faced varieties, as it was considered essential to eliminate the possibility of black fibres in any new breed.

The experiments had not progressed far before Dean Shaw concluded that he could eliminate the Romney Marsh, Cheviot and English Leicester,

as the progeny of the first cross in all cases was considered unsatisfactory, either from the point of view of wool or mutton.

On the other hand, both the Corriedale-Rambouillet and Ryeland-Rambouillet crosses gave results regarded as justifying further work. The former showed improved mutton conformation over the Rambouillet and an excellent quality of wool, the staple being long and strong and grading about 60's. This is a grade which not only brings a good price in normal years but ordinarily is of such character that it affords the animal excellent protection against the severe weather experienced on the range. The Ryeland-Rambouillet cross was regarded as superior in mutton quality to that of the Corriedale-Rambouillet cross. In wool quality, it was on the whole poorer, but some excellent fleeces indicated the possibility of improvement in this respect. The work was therefore continued with both these breeds.

In the meantime, Dr. W. H. Fairfield had carried out, at the Lethbridge Experimental Station, experiments (to be described later) with the Corriedale-Rambouillet cross, and the committee recommended that further work with that cross be left to him, but that Dean Shaw should continue with the Ryeland-Rambouillet cross on a larger scale in a definite attempt to establish a new type of sheep, combining the best characteristics of these breeds.

Up to this point, such financial assistance as Dean Shaw had received had come through the committee from the National Research Council, but it was at this time agreed that experiments involving the ownership of animals could best be handled by the Dominion Department of Agriculture, which therefore took over the responsibility for the financial support of the project. At the same time, the committee was made a joint committee of the two organizations.

About 200 high-grade Rambouillet ewes were then secured and the required number of purebred Ryeland rams, and a long-term breeding program was begun. The first matings of the F_2 ewes and rams—after rigid selection—took place in the fall of 1936.

3. MASS BREEDING EXPERIMENT AT CARDSTON

One of the committee's earliest projects was a mass breeding experiment with the Corriedale and Rambouillet breeds carried out at Cardston, Alberta, under the direction of a subcommittee consisting of Dr. Fairfield, Chairman, Prof. Sackville and Dean Shaw. The reason for doing the work on a large scale was that the cross was believed to be a good one, and it was hoped, by using a large number of animals, to secure results in a shorter time.

Arrangements were made by the committee with Mr. Nielson, prominent Cardston rancher, whereby about 200 Rambouillet ewes of good grade and uniformity were crossed with Corriedale rams, a check experiment with Rambouillet rams also being undertaken. This experiment was continued for several years, but was eventually discontinued when a shortage of feed in southern Alberta compelled the transfer of a large part of the flock from that area. The results had not been satisfactory, in that wool had been lower in count without corresponding increase in fibre length, but a marked improvement in the mutton quality of the progeny was fully established. While this particular experiment was not a success, the associate committee nevertheless felt that the Corriedale-Rambouillet cross might, under more favorable conditions, prove a desirable one. The subcommittee in charge also thought that better results might have been secured if closer supervision had been possible.

4. EXPERIMENTS WITH CORRIEDALE SHEEP AT LETHBRIDGE

Some years before the associate committee was organized, Dr. Fairfield had begun, at Lethbridge, experiments with the Corriedale breed. He had first made a Lincoln-Rambouillet cross, thus nearly duplicating the origin of the Corriedale breed in New Zealand, and in succeeding years had mated the progeny of this cross with purebred Corriedale rams, thus eventually establishing a flock of "Canadian Corriedales". At the same time, a flock of purebred Corriedales was maintained from stock obtained from New Zealand and the United States.

Dr. Fairfield (working without financial assistance from the committee) arranged a cross-breeding project in co-operation with Mr. M. L. Holtman at Skiff, Alberta, in which Canadian Corriedale rams were crossed with Rambouillet ewes of high grade. This project has now been continued over a period of years. On the whole, the committee has been greatly impressed with the quality of the wool produced. Mr. Holtman has evidently taken excellent care of his sheep, and this care, combined with a happy selection of breeds for crossing purposes, has resulted in the production of heavy fleeces and long, strong, bright wool, quite comparable in most respects with the best "colonial" wool. About the only faults found with it have been its wide range of fineness (the Corriedale rams used not having been of a uniform type) and a broadening out at the tip, characteristic of many fleeces.

The committee, encouraged by this success, has recommended that Dr. Fairfield make a systematic attempt to establish a new dual-purpose breed based on the Corriedale-Rambouillet cross. The Department of Agriculture has agreed and steps to that end are now being taken.

5. SPECIAL GRADING AT WESTON

Early in the committee's work it was realized that the ordinary grading of fleeces would be insufficient to permit a proper evaluation of the results of the experimental work. Arrangements were accordingly made with Mr. W. H. J. Tisdale, of the Canadian Co-operative Wool Growers, Limited, whereby experimental fleeces would be specially graded at the Weston warehouse of the Co-operative by a competent wool grader. Such special grading has been carried out each year since the experimental fleeces became available, and detailed information has been obtained on such properties as fineness, length of staple, strength, lustre, kempiness, black fibre, uniformity and probable shrinkage upon scouring, as well as any special characteristics of individual fleeces. This work has been indispensable to the success of the nutritional and breeding projects.

Additional information has been secured from special shipments made by Mr. Tisdale to the British firm of Windeler and Company, who have arranged for a special examination of these shipments and have submitted comments upon the wool from the point of view of its suitability for the British market. Emphasis has, in several cases, been placed upon certain factors not recognized by the producers as of prime importance. This has afforded a valuable guide in the elimination of undesirable characteristics.

6. WOOL INVESTIGATIONS IN THE NATIONAL RESEARCH LABORATORIES

Reference has already been made to tests carried out by Dr. Larose and staff on samples of wool from Prof. Sackville's experimental animals. (See also page 48.) Actually, hundreds of thousands of tests and measurements have been made, in order to secure as much information as possible for use in the interpretation of results. Not only was the greatest care necessary

to detect small differences occurring between experimental groups, but the same care was required to ensure that evidence should not appear where no difference actually existed.

Advantage was taken of the facilities of the National Research Laboratories to check the fibre diameter and shrinkage of individual fleeces against the professional grading at Weston. In general, the differences found were relatively unimportant, and the conclusion has been reached that special grading by a competent man is quite comparable in value with the elaborate tests required to check fleeces in the laboratory.

Considerable work has also been done in the wool laboratory on projects not directly related to the activities of the associate committee. Methods have been worked out for the measurement of resilience and the determination of sulphur in wool, and moisture regain, and the relation between sulphur content and fineness have been studied. There has also been carried on experimental work of a type which is of greater interest to the textile manufacturer than to the producer of wool.

OTHER ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

Co-operating organizations:

Armstrong-Siddeley Motors Ltd.
Canadian Airways Ltd.
Canadian Pratt and Whitney Ltd.
Canadian Vickers Ltd.
Dominion Department of National Defence
Dominion Department of Transport
Fairchild Aircraft Ltd.
Imperial Oil Ltd.
University of Toronto

The forty-first meeting of the Associate Committee on Aeronautical Research was held on November 23, 1936.

Reports were tabled indicating the progress made in investigations undertaken at the committee's instigation, *viz.*:

1. The investigation of stressed skin construction as applied to seaplane floats.
2. The development of an instrument to indicate at all times the oil lubrication conditions in an aircraft engine.

Undertaking the first investigation had been strongly urged at the last meeting of the committee and funds had been allotted for the work. A research assistant had been appointed and the investigation work has progressed rapidly during the year. A number of unserviceable floats, supplied by the Department of National Defence, have been tested for the two-wave landing condition. A brief report of this work is appended.

A research assistant, appointed under the committee, has been working on the lubrication investigation. It is hoped to be able to develop an instrument indicating viscosity and flow to replace the oil temperature and pressure instruments at present used. A brief report of this work is appended.

The construction and testing of wind tunnel models of certain aircraft and the possibility of doing research work on the problem of vibration in aircraft were also reported on. With regard to the latter question, the chair-

man appointed a subcommittee to look into the problem of vibration in aircraft and to make recommendations as to what work should be done.

Mr. T. W. Siers of Canadian Airways informed the committee that its recommendation for further flying tests with low viscosity oil would be carried out by Canadian Airways Ltd.

A list of exhibits, secured for the National Aeronautical Museum, dealing with the very early days of aviation in Canada, was tabled; the Aeronautical Museum itself is reported on elsewhere.

The committee discussed the provision of an X-ray inspection machine for the 100% examination of aircraft castings. It was considered that equipment already proposed for the laboratories will be adequate for the requirements of aeronautical inspection.

An outline of the function and operation of the cathode ray compass was given to the committee, together with a demonstration of the equipment. The committee strongly urged the development of this extremely useful instrument and the necessary steps are being taken to that end.

It was reported that aircraft operators and manufacturers had shown much interest in the laboratory reports issued dealing with problems of special interest to them.

An interim report on the snow characteristics of aircraft skis was tabled, covering the measurements of snow resistance and unsticking force for various types of ski bottom. This work is reported on elsewhere. The committee urged the continuation of this research, which is of great importance to aircraft operators, and the dissemination of the information already obtained, to the operators.

The committee inquired into the progress of tests to correlate knock rating of aviation gasolines with actual operation in an aero-engine. These tests are being conducted in the Engine Testing Laboratory of the National Research Council and the committee was able to see the work in progress. This question is reported on elsewhere.

Problems brought up for discussion by committee members were as follows:—

1. The effect of carrying extra or spare floats, on the performance of an aeroplane.
2. The elimination of compass errors discovered in the air after the compass has been swung to the ground.
3. The diagnosis and prevention of tailplane vibration experienced intermittently by a certain low-wing monoplane on very hot summer days.
4. The undertaking of comparative tests on aircraft fire-walls to United States and British specifications.

The committee expressed its appreciation of the action of the Department of National Defence in granting financial assistance for the carrying on of certain investigations.

Stressed Skin Construction (Aircraft Floats)

This investigation was undertaken with the object of deriving a knowledge of the stresses and modes of failure of stressed skin structures. Since the behavior under load of a complete structure is not always predictable from a consideration of the characteristics of its various sections and components, it was deemed desirable to test full scale complete structures.

Owing to the prohibitive cost involved in testing, to destruction, new structures, and to the importance of floats, in Canadian aviation, the initial

investigation was made using a number of discarded aircraft floats, supplied by the Department of National Defence.

These floats have been tested to failure under shearing and bending loads approximating those encountered in service. Although the peculiarities of float construction render the results obtained not generally applicable to other types of aircraft structures, it will be possible to draw conclusions of general interest and to present a pictorial and graphical record of float failure of particular interest to float designers, in a forthcoming interim report. The investigation is still proceeding.

Engine Lubrication Indicator

The object of the investigation is to develop means, suitable for use in an aircraft (or motor car), to indicate continuously the condition (viscosity) and the rate of flow of the lubricating oil.

A viscosity indicator on the market was tested and found to lack the accuracy required.

Tests are being made, using Venturi tubes, orifices and nozzles, under different conditions, to determine if such devices are capable of use for this purpose.

The apparatus used in the tests has been improved from time to time to increase the accuracy of the results and reduce the time required for the tests.

Associate Committee on Asbestos

Co-operating organizations:

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

The ninth meeting of the committee was held in Montreal on June 23, 1936. The following subjects were discussed:—

The problem of open and crudy fibres; spinning tests on washed fibres; magnetic iron in asbestos; fundamental studies of fibres; the effect of milling machines on fibres; the chemical analysis of asbestos fibres; the sulphur content of asbestos; the chemical reactivity of asbestos; mineralogical studies; calcination tests on fibre pencils; the formation of sheets for tensile tests; the relation of asbestos to corrosion; the utilization of asbestos tailings; the recovery of magnetic constituents in tailings; wet-ground serpentine; the manufacture of active silica and magnesium salts; serpentine and plant growth; asbestos cements; wet milling; the adsorption of bonding agents by asbestos fibres; molded products; the uses of specially cleaned fibre.

A summary of work done on certain of these subjects will be found in the report of the Division of Chemistry on page 35.

The committee discussed the possibility of establishing a closer contact between the research staff and industry, with a view to making the work of as practical a character as possible. After careful consideration it was decided to set up a steering committee with two representatives each of industry and the research staff. At a subsequent meeting of the Quebec Asbestos Producers Association, Captain J. G. Ross and Mr. C. H. Shoemaker were chosen to represent the industry; Dr. G. S. Whitby and Mr. D. Wolochow were named for the Division of Chemistry. This small committee has met several times during the year and has thus been able to keep in closer touch with the progress of research than was possible through the less frequent meetings of the associate committee.

Associate Committee on Chemical Standards

Co-operation with the British Standards Institution in the preparation of draft specifications on chemical products has been continued, and the plan has been extended to include the distribution of similar material occasionally received from South Africa and Australia. Draft specifications received from these institutions have been circulated among the members of the committee and also to other individuals or organizations having a special interest in the subjects submitted for comment.

To March 31, 1937, there have been received 126 chemical specifications for circulation in Canada under this plan. During the year the following specifications were distributed:—

Chemical Glassware: bomb calorimeter thermometers, density bottles, density hydrometers, entrainment distillation apparatus, one-mark capillary pipettes, Ostwald-Folin pipettes.

Methods of Testing: analysis of soaps, crucible swelling test for coal, pitch sampling, sampling of gelatins, sampling of glue.

Miscellaneous: chemical symbols and abbreviations.

Standards of Quality: chemical lead, dimensions for silica ware, sardine oil, synthetic resin molding materials, whale oil.

Associate Electrical Committee

An Associate Electrical Committee has been formed to advise the Council on electrical matters in general and also to act as the Canadian National Committee of the International Electrotechnical Commission.

This committee will absorb the work of the Associate Committee on Electrical Measuring Instruments which has given invaluable service and whose original program is nearly completed.

The new committee is in process of formation. The following organizations have been requested to suggest as members men who are familiar with the branch of the electrical industry they represent:—

Canadian Electrical Associations; Canadian Manufacturers Associations; Canadian Transit Associations; Canadian Chemical Associations; Engineering Institute of Canada; Canadian Engineering Standards Association; Ontario Hydro-Electric Power Commission. The engineering faculties of Canadian universities will also be represented.

It is anticipated that the first meeting will be held in June.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association is an autonomous body operating under Letters Patent issued by the Secretary of State on January 21, 1919. Its chief object is to establish engineering standards for industry. The main committee is recognized by the National Research Council as its Associate Committee on Engineering Standards and as such receives financial support from the Council to supplement the revenue obtained from industry. At March 31, 1937, the Association had a total membership of 708, including 78 in the main committee and 20 executive committee members.

All work of the Association is carried forward by various working committees who give their services voluntarily, the executive work being done by a paid secretary and staff, with headquarters at Ottawa, provided by the National Research Council.

NEW PUBLICATIONS

There have been 14 publications issued during the year, as follows:

C22.2—Canadian Electrical Code, Part II

No. 0-1936—Definitions and General Requirements (2nd edition).

No. 12-1936—Electric Portable Lighting Devices (Portables) (2nd edition).

No. 25-1936—Enclosures (other than Explosion-proof) for use in Hazardous Locations.

No. 29-1936—Panelboards.

No. 30-1936—Enclosed Branch-circuit Cutouts.

No. 32-1936—Electrically-operated Refrigerating Machines.

No. 34-1936—Electrode Receptacles for Luminous-tube Signs.

No. 35-1936—Low-voltage Control-circuit Wire and Cable.

No. 36-1936—Electrical Appliances for Hair Dressing and Hand Drying, etc.

No. 38-1936—Rubber-covered Wires and Cables. (Mimeograph edition).

No. 39-1936—Cutout Bases.

No. 40-1936—Cabinets and Cutout Boxes.

These specifications outline conditions which must be met to secure approval of sale of the particular type of apparatus in Canada. They have been prepared with the full co-operation of interested manufacturers, insurance interests and inspection departments, and also in co-operation with the British Standards Institution, the National Electrical Manufacturers' Association, and the Underwriters' Laboratories at Chicago.

C22.3—Canadian Electrical Code, Part III

No. 3-1936—Inductive Co-ordination (Definitions and Principles). (Mimeograph edition).

No. 4-1936—Conductive Co-ordination (Principles and Practices). (Mimeograph edition).

These specifications have been issued in mimeograph form on a more or less tentative basis, and constitute reports prepared by sub-panels under a general Panel on Standards for Outside Wiring.

PROGRESS REPORT

A—Civil Engineering and Construction

Structural Timber. The specification passed through two drafts, and after being thoroughly discussed has been approved by all committees and was in galley-proof form before the end of the year. It was presented in this form at the annual meeting of the Canadian Lumbermen's Association. The specification will be printed very shortly.

B—Mechanical Engineering

Screw Products: Binder Head Screws. The suggestion to add a No. 10 screw to this specification is still under consideration, and it has been suggested that a No. 3 and possibly a No. 2 be added.

Elevator Safety Code. The special panel of the committee is still working on the second draft and it is expected that a report will be received very shortly.

Logging Chains. A new committee has been organized to consider specifications for logging chains, and it held an organization meeting on January 27, 1937. The situation was thoroughly discussed and it has been decided to issue a questionnaire to the pulp and lumber companies, asking for information on field experience in the use of these chains.

C—Electrical Work

Canadian Electrical Code, Part I

Preparations are being made for a fourth edition of the Code, and a preliminary meeting was held in Regina on September 14–16, 1936. As a result of this meeting, it has been decided to divide the Code committees into eastern and western groups to facilitate the work of Code revision and interchange of comments. The provincial code committees are being re-organized with the object of reducing the number of members and making them more definitely representative.

Canadian Electrical Code, Part II

This covers Essential Requirements and Minimum Standards for Electrical Equipment, and the work consists of issuing approval specifications prepared by the Panel on Specifications which co-operates with industrial representatives. The work continues to be active, and up to date. There have been 54 specifications under consideration, of which 43 have been published, including the 12 indicated above. It will be noted that two of these publications were second editions of specifications previously issued. During the year, the Panel on Specifications has held 16 meetings, at which the following specifications were discussed: switchboards; ground clamps; receptacles, plugs and similar devices; lamp-holders having socket screw-shells; flexible tubing; rigid steel conduit; electric air-heaters; air-cooled transformers; non-metallic sheathed cable; flexible cord and fixture wire; knife switches; armored cord and cable; domestic electric clothes-washing machines, and motors (other than explosion-proof) for use in hazardous locations. Specifications for electrically-heated warming pads, and for ground clamps, are out for letter ballot approval, and consideration has also been given to the following specifications which are in draft form: asbestos-insulated stove wire, and flexible steel conduit. The specification for oil circuit breakers has now been handed over to a special committee and will be issued as a general specification. A second edition of Specification No. 2, Electric Signs, is under consideration, and some revisions to existing specifications will be covered by special stickers which are now being prepared.

Canadian Electrical Code, Part III

Outside Wiring. Under Sub-panel No. 1, dealing with overhead systems, great difficulty has been experienced in getting approval of the crossing specification, but this is in the hands of a special panel and a revised edition is being prepared. Under Sub-panel No. 3, a report on Definitions and Principles for Inductive Co-ordination has been published, as indicated above. The draft covering Principles and Practices for the Prevention of Radio Interference is still under consideration, and preparations are being made for a conference to consider the whole subject in the light of regulations which have been framed in connection with the Canadian Broadcasting Act. Under Sub-panel No. 4, the report on Principles and Practices for Protecting Underground Structures from the Effects of Stray Currents Originating in Direct Current Electric Railway Systems, has been published as indicated above.

Bulletins to Electrical Manufacturers. Three bulletins have been issued during the year, mainly in connection with the work under Part II of the

Canadian Electrical Code. Detailed information on these bulletins has been given in the C.E.S.A. Quarterly Bulletin.

Insulated Power Cable. This draft specification has been under consideration by a special committee of the Canadian Electrical Association, which has just reported, and it is hoped now that it will be possible to proceed with the approval and publication of this specification. Work will also be revived on the draft dealing with armoring for cables.

Enamelled Magnet Wire. This specification is still under consideration and no further report is available.

Oil Circuit Breakers. A special committee which has taken over the preparation of this specification is now engaged in the preparation of a sixth draft, and it is hoped that this will be available shortly for distribution to the committee members for letter ballot. In the preparation of the specification, the British Standards Institution specification, and standards of the International Electrotechnical Commission have been given careful consideration.

Galvanized Telegraph and Telephone Wire. The final draft of this specification has been approved, and the specification will shortly be in the hands of the printer.

Electricity Meters. This includes a specification for demand meters, and the final draft was approved by all C.E.S.A. committees, but some further revisions have been proposed, some of which were considered at a meeting of the committee held on April 7, 1936. As a result of consideration of the comments, it has been impossible to proceed with the printing of the specification, but it is hoped shortly to get final agreement.

G—Ferrous Metals

Commercial Bar Steels. The committee is still considering proposed revisions to the existing specifications, but final agreement has not yet been reached.

Reinforcing Materials for Concrete. The draft of the proposed revisions is still before the committee, and final agreement is not yet reached.

S—Steel Construction

Steel Highway Bridges. A final draft of revisions to the specification is now before the committee for final approval and a letter ballot will shortly be issued.

Structural Welding. Draft specifications covering Metallic Arc Electrodes for Welded Steel Buildings, and Welding Qualification Code for Fabricators, Contractors, Supervisors and Welders, have been approved by the respective panels and have been sent to the Subcommittee on Procedure, Specifications and Standards for Steel Construction before submission to the Sectional Committee.

INDUSTRIAL CONTACTS

The Secretary has had the privilege of attending annual meetings of the Canadian Manufacturers Association; Interprovincial Chief Boiler Inspectors' Conventions; Dominion Fire Prevention Association; Canadian Construction Association; Engineering Institute of Canada; Canadian Lumbermen's Association, and the Aviation Lighting Committee of the Illuminating Engineering Society. At the Canadian Manufacturers' Association a morning session was devoted to the discussion of the work of the C.E.S.A.

SALE OF PUBLICATIONS

The sale of publications continues to be active and the C.E.S.A. specifications are reaching an ever widening field, which is an encouraging development. There has also been considerable demand for publications issued by the British Standards Institution, which are supplied through the C.E.S.A.

INDUSTRIAL SUPPORT

There has been a slight recession in the amount received from industrial sources during the year, but it is believed that a considerable improvement will be shown during the coming year. Resignations have been received from three sustaining members and one subscriber, and one new sustaining member was secured during the year. The total number of sustaining members is 62 and three subscribers. The total amount received was \$5,225, or a decrease of \$125 from 1935. Preparations are being made for an active campaign to secure additional funds, under the direction of a Special Finance Committee.

The following is a list of sustaining members and subscribers for 1936:—

Algoma Steel Corporation, Ltd.	Eaton Company Ltd., T.
Aluminium Company of Canada Ltd.	English Electric Co. of Canada, Ltd.
Amalgamated Electric Corporation Ltd.	Federal Wire and Cable Co. Ltd.
Bell Telephone Company of Canada.	Ferranti Electric Limited.
British Columbia Electric Railway Co. Ltd.	Gatineau Power Company.
British Columbia Telephone Company.	Gilbert and Barker Mfg. Co. Ltd.
Burlington Steel Company Ltd.	Imperial Oil Limited.
Cables, Conduits and Fittings Ltd.	Maritime Telegraph and Telephone Co. Ltd.
Canada Cement Company Ltd.	Massey-Harris Company Ltd.
Canada Creosoting Company Ltd.	Moloney Electric Company of Canada Ltd.
Canada Iron Foundries, Ltd.	Montreal Light, Heat and Power Consolidated.
Canada Wire and Cable Co. Ltd.	Montreal Locomotive Works Ltd.
Canadian Bridge Company Ltd.	Montreal Tramways Company.
Canadian General Electric Co. Ltd.	New Brunswick Telephone Co. Ltd.
Canadian Industries Ltd.	Northern Electric Company Ltd.
Canadian Ingersoll-Rand Co. Ltd.	Otis-Fensom Elevator Co. Ltd.
Canadian Laco Lamps Ltd.	Packard Electric Company Ltd.
Canadian National Railways.	Phillips Electrical Works Ltd.
Canadian Pacific Railway Company.	Radio Manufacturers Association of Canada.
Canadian Triangle Conduit Co. Ltd.	St. Mary's Cement Co. Ltd.
Canadian Westinghouse Co. Ltd.	Sangamo Company Ltd.
Coghlin Co. Ltd., B. J.	Shawinigan Water and Power Company.
Consolidated Mining and Smelting Co. Ltd.	Shell Oil Company of Canada, Ltd.
Council of Canadian Purchasing Agents Associations.	Slater Company Ltd., N.
Dome Mines Limited.	Smith and Stone Limited.
Dominion Bridge Company Ltd.	Solex Company Ltd.
Dominion Engineering Works Ltd.	Square D. Company of Canada, Ltd.
Dominion Foundries and Steel Ltd.	
Dominion Steel and Coal Corporation Ltd.	

Steel Company of Canada Ltd.
 *Swiss Electric Co. of Canada, Ltd.
 Stowell Screw Company Ltd.

Winnipeg Electric Company.

Toronto Hydro-Electric System.
 Toronto Transportation Commission.

Subscribers

Canadian Acme Screw and Gear Ltd.
 Canadian Jefferson Electric Co. Ltd.
 Canadian Tube and Steel Products
 Ltd.

*New Member.

The National Research Council has continued its financial support and the provision of office and mimeographing facilities, and a satisfactory year's work has been completed with the funds available, but it is to be understood that the chief limitation to the work which can be carried on is the amount of funds.

The total receipts for the year were \$12,122.49, and the total expenditure for the year, \$12,099.56. The balance which was carried over on April 1, 1937 was \$60.21.

Associate Committee on Fire Hazard Testing

The fourth annual meeting of the Associate Committee on Fire Hazard Testing was held in Ottawa on June 19, 1936. This was the only meeting held during the past year.

A memorandum on proposed system of listing and approval of hazardous devices, and devices for the detection, suppression and control of fire was submitted for discussion. Report PFE-1 describing tests and examination of nine hand-operated fire extinguishers of the Soda-acid, Foam and Anti-freeze types was discussed, in consideration of specifications to be drafted covering this type of equipment. Two reports (a) Revised Regulations, (b) Report PFO-M1018, issued during the previous year, were also discussed.

Six bulletins were issued to the committee for comment and criticism. Five of these were reports PFO-M1022, PFO-M1023, PFO-M1027, describing test work on oil-burning space heaters; PFG-4, describing test work on gasoline-burning appliances; and PFS-3, describing test work on a degreasing solvent. Listing of the devices and products described in these reports was recommended.

A memorandum suggesting the use of decalcomania transfers in place of metal labels was submitted for discussion, as a result of which it was decided to continue the use of metal labels.

One meeting of the executive committee was held in Ottawa. The main business of this meeting was to discuss the expenditure of money from the funds of the Associate Committee. The executive committee approved of the appointment of a second laboratory assistant. During the past year two laboratory assistants and one laboratory helper have been employed under the Associate Committee.

Two resignations from the Committee were accepted and two new members appointed to replace the retiring members. Mr. H. H. Vaughan resigned and was replaced by Mr. J. G. Morrow, Chairman of the C.E.S.A. Mr. J. Clark Reilly resigned and was replaced by Mr. Hugh Doran of the Canadian Construction Association.

Associate Committee on Forestry

The Associate Committee on Forestry was formed by the National Research Council in January, 1936, in accordance with a recommendation made by a representative conference of forestry officials and research workers held in Ottawa in November, 1935. Discussions at the conference indicated anxiety on the part of foresters as to the trend of the situation in respect to forestry and woods industries and the hope that proper and timely remedial measures could be put into effect. It was the concensus of opinion that the Associate Committee would be able to bring together the various organizations interested in forestry research and thus to lay the basis for collaboration among the existing agencies in the formulation of an adequate plan of forestry research in the Dominion.

At the first meeting of the committee, held in April, 1936, consideration was given to a compilation of the problems in forest research that had been prepared by the Dominion Forest Service. This document contained an outline of the major problems and included notes on the work done, the reports published, and the further work that appeared to be necessary to complete the investigations, together with suggestions as to the organizations, Federal, Provincial, university or industrial, that might be invited to undertake the projected studies. The report itself was divided into seven sections: fundamental studies, silviculture, forest mensuration, forest protection, forest economics, forest engineering, and forest products research.

Subcommittees were appointed to study the various problems and to advise the committee regarding its program. Subsequently, a questionnaire was sent to the members inviting them to submit their considered views on the proposals put forward. Out of the recommendations received, it was possible to find several projects on which work could be undertaken immediately that would be of general interest. For example, special attention was devoted to the study of fire hazards. In this connection a recording atmometer was rebuilt in the Division of Physics and Electrical Engineering of the National Research Laboratories and put into service during the summer of 1936; a second instrument combining the features of an evaporimeter and an atmometer was constructed; radiation from test fires was investigated; and preliminary measurements of the rate of absorption of heat by forest duff have been made. Other investigations carried out at the instance of the committee during the year included work on the preparation of standard specifications on logging chains; and the collection of information on the types of wood-burning stoves made in Canada for comparison with improved types offered by European manufacturers.

At the British Commonwealth Scientific Conference in London in September, the proposal to establish an Imperial Forestry Bureau was approved for recommendation to the governments of the countries of the Commonwealth. As and when this bureau is established, it will provide an abstracting and translation service that will be of the greatest value to forest research workers throughout the Empire. It is proposed that the National Research Council should undertake responsibility for the dissemination in Canada of the information collected by the bureau.

Throughout the year the members have been giving serious consideration to the ways in which the committee can most usefully discharge its functions. At the second meeting held in Ottawa on January 13, 1937, the purpose of the committee was fully discussed and elaborated. Following a general discussion, subcommittees were again appointed to consider and summarize

the views expressed and to recommend definite projects of immediate importance as a basis for the committee's further activities.

In March, 1937, an investigation of farm woodlots in eastern Canada was undertaken with a view to the preparation of a manual on the subject for the information and guidance of farmers, with the idea of stimulating interest in the revenue producing possibilities of the farm woodlot. A competent forester was engaged to make the study, and it was proposed that after the necessary field work had been done, the manuscript would be prepared for publication both in English and in French. It was expected the work would be completed during the ensuing year.

Thus the basis has been laid for collaboration by the existing agencies interested in forest research in all parts of the Dominion. Procedure has been by agreement, and every organization represented on the committee has made a substantial contribution to the proceedings.

Associate Committee on Gas Research

Co-operating organizations:

Carnegie Corporation
Dominion Department of Mines and Resources
Research Council of Alberta
University of Alberta

In the last few years no general meeting of the committee has been called. It has, however, been possible for the Dominion Department of Mines and Resources to continue the sampling of gas from all new wells drilled in Canada and for the Research Council of Alberta to continue, with assistance from the Carnegie Corporation and the National Research Council, investigations of a fundamental character and of practical interest. The following is a brief outline of the work carried out in the laboratories of the University of Alberta.

Solubilities in Hydrocarbon Systems at High Pressure

This work, while strictly speaking an investigation in pure science, is of particular interest from the point of view of underground conditions in the Turner Valley, as it is intended eventually to throw light on the present association of hydrocarbons underground. Up to the present the actual hydrocarbons present in the Turner Valley have not been used, but the products of one of the commercial wells have now been separated by fractionation and will be included in an early series of tests. The recent production of crude oil in the Turner Valley raises very interesting questions which must be taken into account in planning future work and in drawing conclusions from the laboratory experiments. The possibility exists that the gas-naphtha phase in the valley arises from the crude oil, the naphtha content being that part of the crude oil evaporated into the gas phase because of the high pressures existing in the producing horizon.

The Oxidation of Natural Gas at High Pressures

The work to date has been only of a preliminary character. Some of the catalysts used have been very readily poisoned by sulphur and the poisoning has been found to be of a permanent character, indicating that substantially complete removal of the sulphur will be necessary. The commercial application of the process will depend upon a high relative and absolute yield of methanol per pass of gas mixture over the catalyst. Unfortunately it is difficult to combine high relative with high absolute yield, as the

conditions necessary are radically different. A search is being made for catalysts which will yield directly a substantial quantity of oil.

Reactions with Gases Containing Olefines

Some further work has been carried out on the pyrolysis of Turner Valley stabilizer gas for the production of gases containing high percentages of gaseous olefines. The concentration previously obtained has been substantially improved by the use of baffles in the tubes. Arrangements are now being made to secure still higher heat transfer and improved results are expected.

Experiments are also being done on the polymerization of gases containing olefines with a view to the production of oil. This work has been of a preliminary character, but a close relation between oil quality and oil yield has been demonstrated. Information has also been obtained as to the conditions of temperature, pressure and rate of flow. Careful control of all factors is necessary for good yield.

(Investigation under the direction of Dr. E. H. Boomer.)

Associate Committee on Laundry Research

At a national conference of launderers and cleaners held in Ottawa in January, 1934, it was decided to extend the facilities of the Associate Committee on Laundry Research of the National Research Council to include research and service work for the cleaning industry; as a result the Canadian Research Institute of Launderers and Cleaners was organized.

The object of the Institute is to promote scientific research and technical work in connection with the laundry and cleaning industries. Membership is open to all launderers and cleaners, including institutional laundry plants, in the Dominion of Canada, accepted by the membership committee, who pay the required fees and who conform to the by-laws and regulations of the Institute.

The laundering and cleaning laboratory of the National Research Council serves in a technical, advisory and investigational capacity to the Institute. The work of the laboratory includes such research projects as studies in bleaching, detergency, launderability and cleanability of various types of fabrics, the setting up of textile specifications, analyses of all types of supplies used by the industries, and the refereeing of damage reports covering the examination of fabrics reputed to have been damaged during the laundering or cleaning process.

During the year an agreement between the Institute and the Laundry-owners National Association of the United States and Canada was completed and signed, under which laundry plants in Canada desiring to take advantage of the L.N.A. approval plan may apply to the L.N.A. for such approval in the usual way and when they have met all the requirements for the approval of their plant, the L.N.A. will certify the plant to the Institute, which in turn will issue the approval certificate to the plant in its own name. Subsequent inspections will be carried out by the inspection staff of the L.N.A. which will keep the Institute informed as to the standing of each approved plant. It has been arranged that test bundle rating in connection with the approval plan shall be based on the test bundle reports issued by the Institute to its members.

A report of the activities of the laundering and dry cleaning laboratory of the National Research Council is included in the report of the Division of Chemistry (see p. 40).

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories, Limited
Dominion Department of Mines and Resources

An account of the laboratory work carried out under this committee will be found in the report of the Division of Chemistry on page 42. In the last two years, relatively little work has been done outside these laboratories, although some of the facilities of the Mines Branch have still been made use of as required, and the co-operation of their staff has been made available to the committee.

The close co-operation of the industrial and research staffs which has characterized this investigation from the beginning has been continued throughout the past year. It is not too much to say that this co-operation has been a major factor in the successful commercial application of the results of the laboratory work.

A substantial revenue is now being derived by the National Research Council from royalties on products developed in this investigation, and a further increase in these royalties as the industry expands may be anticipated.

Associate Committee on Oceanography

Co-operating organizations:

Biological Board of Canada
British Columbia Department of Fisheries
British Columbia Department of Health
Dominion Department of Fisheries
Dominion Department of Transport
Hydrographic Service of Canada
Meteorological Service of Canada
Naval Service of Canada
Oceanographic Laboratories, University of Washington
University of British Columbia

The annual meeting of the Pacific Division of the American Association for the Advancement of Science, held in Seattle in June, 1936, brought together most of the members of the main committee and subcommittees. There resulted a thorough discussion of problems in Pacific oceanography as they affect Canada and the United States, both in their local bearing and in their relation to similar problems elsewhere, as well as to larger problems in a wider field. Arrangements were later made for visits to the Oceanographic Laboratories of the University of Washington at Friday Harbor and to the Biological Station at Nanaimo.

Financial support for oceanographic research shows no signs, as yet, of returning to a par with that of pre-depression years. Good progress has nevertheless been made in the investigation of problems that have been in hand for some time, and there have been several new developments in these, or in minor matters related to them.

During a 10-day expedition of the University of Washington research motor ship, the *Catalyst*, physical and chemical observations were made along the east coast of Vancouver Island, in Hecate Strait, and off all coasts of the Queen Charlotte Islands.

Taxonomic work on certain animal classes or orders and life history studies of several species added much to the available information on the fauna of the coast. Biological material collected on the Catalyst trip, when examined, will help to indicate distribution trends.

Pacific Oceanographic Research of the Biological Board of Canada

The following investigations were carried out by the Pacific coast staff of the Biological Board of Canada without financial support from the committee. Further details of these and related investigations will be found in the Board's annual report for the year 1936.

In physical and chemical oceanography, extensive additions have been made to the hydrodynamic data for the open ocean, mainly off the coast of Vancouver Island, through the co-operation of the Naval Service. These data, when analyzed, were charted to indicate the nature and the direction of the ocean currents in that region. The number of stations where daily physical and chemical observations were made, has been increased, until there are now 11 stations, pretty well covering the whole coastal area. These observations have been correlated with the data obtained from hydrodynamic measurements.

In fundamental biology, perhaps the most striking feature of the year was the success that attended the propagation, from stimulated spawning, of the Japanese oyster, *Ostrea gigas*, in Ladysmith Harbor.

Progress has been made in the investigation of numerous problems affecting several species that come into prominence in the commercial fisheries, although the type of work has changed little from that of previous years. One innovation, the tagging of pilchard and herring, promises well. Metal tags are inserted into the body cavity of these fish and are recovered in the fish meal plants or in the salteries by making use of magnets. Already there is some indication that this may help to solve some of the migration puzzles and questions having to do with the possible mixing of schools or races.

In fisheries technology much attention has been given to extending the investigation of the potency of certain vitamins in the oils of different species of fish, and of the same species at different times of the year or under different conditions. Further experiments on fish oils have been made to find satisfactory uses for them in the commercial field.

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 Parasitology

Horse Strongylid Control

Owing to the provision of more equipment and improved techniques, Dr. Parnell has made more rapid progress in determining the proportions of various substances necessary to kill the free-living stages of Sclerostomes of horses. During this period over 3,000 cultures have been completed, a number approximately equal to that completed in the previous three years.

Fifty-four chemicals have been tested to determine their lethal effect on these larvae. Those found more effective than common salt, which is the chemical regularly used, were as follows, the numbers indicating the approximate number of units by weight which would be required to sterilize the same weight of fresh feces as would 100 units of salt:

Chloropicrin 1, calcium cyanide 5, *o*-dichlorbenzene 6, paradichlorbenzene 6, potassium iodide 15, urea 22, carbon disulphide 26, calurea 33, sodium borate 50, "powdered" cyanamide 50, ammonium carbonate 50, potassium xanthogenate 50, "granular" cyanamide 66, cupric chloride 66, zinc chloride 66, ammonium chloride 80, ferric chloride 80, ferrous chloride 80.

Liver Fluke Disease

Dr. Swales completed his studies of the histopathology of fascioloidiasis magna. Examination of both naturally and experimentally infested ruminants supported his hypothesis that the large Bovidae are naturally resistant to the presence of *F. magna* and that the host-tissue defence prevents the successful reproduction of the parasite. Sheep, on the other hand, are unable to combat the parasite which makes long and destructive migrations through the liver tissue, thus causing profound pathological processes which may result in the death of the host. The observations that Cervidae are normal and tolerant hosts were accepted as proved for purposes of comparison.

Although the investigation on *Fasciola hepatica* has been continued by Mr. Griffiths, no further elucidation of the life cycle has been attained. One collecting trip was made during the summer of 1936 and with the co-operation of Mr. A. La Rocque, a survey was made of the molluscan fauna of this area. No species other than those previously collected were obtained. However, *Fossaria parva*, a probable host of *F. hepatica* was encountered some 35 miles from the infected area. A possible migration might, another year, find this species on the farms surveyed. Continued exposure of snails collected on this trip to *F. hepatica* miracidia, has failed to give any positive results.

Warble Fly Eradication

Attempts were made to prepare a solution of rotenone in oil, which could be emulsified and used as a clean, easily applied larvicide on dairy cattle. The practical tests of the preparations were disappointing. It was apparent that the larvicidal properties of the rotenone had been reduced to a considerable extent in the preparation of the solutions. Control tests using the standard derris powder and soap again indicated that these preparations have satisfactory larvicidal properties but are not clean or easy to apply.

Nodular Disease

Observations have been made that numerous nodules on the intestine of four-tooth and full-mouthed ewes result in poor wintering of the animals and the lamb crop from these animals may be extremely poor. As no cases of severe oesophagostomiasis of young animals have been observed, it seems probable that the major loss to the farmer is caused by the low results from old cases of nodular disease, which generally are not infested with live parasites. As it is unlikely that the free-living stages of *O. columbianum* can over-winter on pastures in any part of Canada, the best means of combatting this disease is to destroy the adult parasites in the young host which is being held over for breeding purposes.

In an attempt to find means of removing the adults in a manner which could be used under Canadian conditions, Dr. Swales designed an instrument with the object of dosing sheep with capsules of dry drugs and simultaneously

giving a liquid which would close the oesophageal groove and thus direct the capsule towards the fourth stomach. If a suitable anthelmintic, which is relatively soluble, reaches the abomasum directly, its action in the lower intestine should be adequate to remove strongyles such as *O. columbianum*. Tests on eight animals which were killed directly following the administration of dummy capsules indicated that the instrument has a definite effect in directing the dose towards the abomasum. In an effort to see the effect of the instrument, work is now in progress on a number of rumenotomies on sheep of various ages.

Stomach Worms of Sheep

Dr. Swales autopsied 134 sheep from Quebec and eastern Ontario in November, December and January 1936-1937. The abomasa were examined in detail and the following stomach worm infestations were recorded:

Parasite	No. of sheep infested	Ave. number parasites per infested animal	Total parasites
<i>Haemonchus contortus</i>	82	45.4	3,724
<i>Ostertagia circumcincta</i>	99	154.2	15,262
<i>Trichostrongylus axei</i>	124	605.4	75,068

Following these examinations a study of the bionomics and pathogenicity of *T. axei* was commenced. This work has been retarded by difficulties in obtaining infective larvae from experimental cultures. Owing to the large proportion of *T. axei* present, recommendations have been made that sheep owners should adopt a drench composed of copper sulphate and 40% nicotine sulphate.

Tapeworms of Sheep

A few attempts to elucidate portions of the life cycle of *Moniezia expansa* have failed. Direct ingestion of eggs under natural conditions for three months failed to bring about infestations. A lamb which was exposed to a plot infected by sheep the previous year acquired tapeworm infection within 24 hours. The infection was detected 38 days later by fecal examination.

Miscellaneous Sheep Parasites

During attempts to rear worm-free lambs, it was discovered that several nematodes are able to pass the winter on pasture. These include: *Nematodirus*, *Ostertagia* spp. and *Trichostrongylus* as well as the cestode *Moniezia expansa*. This fact is of some importance and the data are being studied by Mr. Griffiths. Mr. Griffiths has also published a detailed description of the parasitic larval stage of *Chabertia ovina*, a common and important nematode of sheep.

Strongyloides

Cross-infection experiments with various strains have shown results of extreme interest. Agouti strains to guinea pigs have given consistent direct development into infective larvae and free-living males for some 14 generations. The sheep strain has also shown tendencies along this line when transferred to the rabbit, whereas in the sheep itself the usual cycle showed few males but numerous free-living females; the infective larvae are produced both directly and indirectly. This strain, when transferred to the rabbit in large numbers, has been shown to be significantly lethal to the individual

concerned after a short period of time. Routine examinations have continued to show the Agouti strain to be indirect in development.

The entire life cycle of this parasite in as many species as possible will be studied. Types of development are also being studied and an attempt is being made to determine the cause of this variation in type.

Sheep Field Trials and Anthelmintics

Practical field trials that were being conducted both at this Institute and with the co-operation of several farmers have had to be suspended since it has been found that this work must first be supplemented by *in vitro* experiments in the laboratory. The anthelmintic and toxic properties of organic and inorganic chemicals to larvae have to be determined *in vitro*. Those chemicals showing desirable qualities in the former respect, and properties suitable for later incorporation with salt, in the form of licks, would subsequently be tested in the field, when the necessary equipment, animals, etc., are available.

Ascariasis

With the co-operation of Wilsil's Farm, Vaudreuil, Que., a test of the effect of ascariasis on suckling pigs has been commenced by Dr. Swales. This test will be continued until the young pigs are of marketable age, at which time arrangements have been made to market them for slaughter under strict supervision.

In parallel with this, test experiments are in progress to determine the exact thermal death point of all stages of development of the ova, and the relative value of various solutions of low surface tension for destroying eggs by heat. In this connection an apparatus has been built in co-operation with Dr. D. K. Froman for the critical measurement of the thermal death points in exposures as low as 1/10th second.

The work reported by the Director last year on the biology of *Apophallus venustus* of dogs, cats and foxes was continued and the life cycle confirmed. Studies were made on the distribution of the cysts in fish and a commencement was made on the pathology of the condition in cats. Thanks to the co-operation of Dr. Angrove, human stools from men at the Ste. Anne's Military Hospital were examined and in one a few eggs of what was probably this trematode were discovered. This work also will be repeated this year.

A closely related species—*Cryptocotyle lingua*—has been found in silver fox and ranch mink in Nova Scotia. It is, however, carried by salt-water fish and its snail host is a salt-water snail, introduced into Canada in 1855 in ballast from Europe. Almost certainly, the parasite came with the snail.

Parametorchis noveboracensis

The Canadian liver-fluke of carnivores has been a serious parasite of sledge dogs in the north for many years and complaints from the Royal Canadian Mounted Police have been received on several occasions. It is also found in mink and is proving to be equally serious there. Moreover, it is closely related to the human liver-flukes of the Old World and consequently is of considerable economic interest. As its life cycle and distribution were both unknown, an investigation into these points was begun.

A focus of infection was found in a mink ranch at Lake Edward, Quebec Co., Que., as the result of carcasses sent in during the course of the survey, and as this lake is easily reached by rail, it was decided to begin investigations there. By analogy, it should have a life cycle similar to that of *Apophallus*, and so fish were netted in the lake and fed by species to local cats. The only fish

found to be infected were suckers, but these were so heavily infected that two and one-half small fish were sufficient to kill an experimental cat. Snails also were collected in large numbers and examined in the laboratory and in a species of *Amnicola*, cercariae which probably represent the larvae of this fluke were discovered. It is proposed to continue this life-history work to investigate the effects of cold on the cysts in the fish and to attempt to find a medicinal treatment for the fluke. The parasite is also present at La Tuque and an attempt will be made to examine human stools from that neighborhood.

Meanwhile, with the help of the Royal Canadian Mounted Police, a survey is in progress of the incidence of the parasite in sledge dogs in the police stations west of Quebec. A considerable number of positive findings has already been made but only a few stations have so far sent in material.

Poultry and Other Birds

Dr. Swales' work on *T. crami* of ducks was completed. This included complete elucidation of the life cycle, comparative studies on the parasite in domestic and wild ducks, and ecological studies on the intermediate hosts. This work was done in detail because of the previous lack of knowledge of the biology of this group of parasites, and because *T. crami* appears to be by far the most common and important helminth parasite of domestic ducks in Quebec. It is suggested that waters inhabited by ducks should be balanced by the addition of aquatic vertebrates in order to prevent severe infestations of *T. crami*.

Mr. Miller completed his studies on the common parasites of pigeons. He recorded the presence of *Echinostoma paraulum* from pigeons from America for the first time, redescribed *Ascaridia columbae* and made considerable observations on its biology. He attempted to transfer this parasite to chickens and *A. galli* and *Heterakis gallinae* of chickens to pigeons and found that *Ascaridia columbae* will develop in young chicks to a 96-hour stage; *A. galli* and *H. gallinae* are not transmissible to pigeons.

Mr. Cannon, a fourth year student in Agriculture, is examining starlings locally for the presence of parasites. Three tapeworms and a nematode have been discovered. It is of interest to note that these birds are notorious carriers of gape-worms in Europe, although none has been found in them here.

Miscellaneous

The application of control measures as a result of the work carried out by Dr. Swales in Manitoba in 1935, has brought about a marked decrease in the number of cases of dermatitis contracted at Clear Lake, Manitoba. This was in spite of the fact that 1936 was a particularly bad year for dermatitis throughout the west and in Ontario. One severe case of the dermatitis was recorded locally and Mr. L. Johnson's continued work resulted in the recording of two species of schistosome cercariae in Lake St. Louis, one of which produced typical lesions and was identified as *Cercaria elvae* Miller, 1923. This work will be continued.

The survey of internal parasites of wild life has been continued and up to date the following wild animals have been examined for adult parasites, the figures in brackets showing the percentage infected: 243 carnivores (50%), 248 rodents (75%), 3 insectivores (—), 6 bats (100%), 20 herbivores (50%), 478 birds (61%), 277 fish (70%). Further carcasses were received from Trinidad and a number of new species of worms from that island were described, including the very rare whipworm of cats. Mr. Métivier, the Government Veterinary Surgeon at Trinidad, in conjunction with the Institute, described a

number of sheep worms from British Guiana, and Mr. Hutson, Government Veterinary Surgeon at Antigua, sent in a collection for confirmatory diagnosis.

A considerable number of fecal examinations have been made for the diagnosis of parasites, in addition to those referred to earlier in this report.

As a matter of general interest it may be noted that many distinguished visitors have been received in the Institute during the year and, on the other hand, as opportunities were afforded, members of the staff attended important scientific gatherings.

The Director gave a short course in medical parasitology to the medical students at McGill, and Dr. Swales gave two lectures and a laboratory period on plant eel-worms to the Plant Pathology Class at Macdonald College.

The Deputy Minister of Agriculture has appointed the Director Official Correspondent in Canada to the Imperial Bureau of Agricultural Parasitology.

He has also been appointed a member of the Canadian Committee of the International Veterinary Congress by the Veterinary Director General of Canada, a member of the Committee on Parasitology of the United States Livestock Sanitary Association by the President of that Association, and a member of the Committee on Animal Health Problems by the Canadian Society of Animal Production (Eastern Section).

A 16 mm. film of the three fish-carried trematodes has been made, and other films are planned and are in preparation. Models of various domestic mammals are also under construction in which parasites, mounted in gelatine, are shown in the organs in which they occur in nature. Grateful acknowledgment is made of the gift of a flock of ten Leicester sheep presented to the Institute by Dr. Archibald of the Central Experimental Farm, Ottawa. These sheep, which are being wintered, by arrangement, at the Stock Farm, Macdonald College, are intended to supply lambs for experimental purposes.

The Institute also received two lemming from northern Quebec from Captain Balcom of the Government Icebreaker "N. B. McLean." One is still alive. It is hoped to secure more this year to assist in a study of their parasites and reasons for the cycles of abundance of these important food animals in the north.

Dr. Parnell, during a visit to England, interviewed the Welwyn Metal Products Company and as a result the firm agreed to present to the Institute a sample cabinet for the growing of grass from cornseed in ten days. Mr. L. C. McOuat, of the Canadian Pacific Railway, has arranged for its transportation from England to Ste. Anne, and the Customs, at the request of the National Research Council, have waived duty. The cabinet offers the opportunity of raising animals free from the usual worm parasites and may, in addition, have other valuable advantages to Canadian agriculturists.

The following papers have been published during the past year:

By T. W. M. CAMERON—

"Studies on the Heterophyid Trematode, *Apophallus venustus* (Ransom, 1920) in Canada. I. Morphology and Taxonomy." Can. J. Research, D, 14: 59-69. 1936.

"Studies on the Endoparasitic Fauna of Trinidad Mammals. IV. Further Parasites from Trinidad Deer." Can. J. Research, D, 14: 165-167. 1936.

"Studies on the Endoparasitic Fauna of Trinidad Mammals. V. Further Parasites from the Ocelot." Can. J. Research, D, 15: 24-27. 1937.

"The Institute of Parasitology, McGill University." Vet. J. 92: 439-443. 1936.

By T. W. M. CAMERON—*Concluded*

- "Les gastrophiles du cheval." Le Bull. des Agr. 21: 8, 20-21, and 23. 1936.
- "The Internal Parasites of Man in Eastern Canada." Med. Log. 2: 50-63. 1937.
- "Studies on the Heterophyid Trematode, *Apophallus venustus* (Ransom, 1920) in Canada. II. Life History and Bionomics." Can. J. Research, D, 15: 38-51. 1937.
- "Concepts and Mechanisms of Resistance in Helminthic Infections." Can. J. Research, D, 15: 77-90. 1937.
- "Veterinary Education in Canada." Vet. J. 93: 102-106. 1937.
- "A New Species of Heligmosomina from the Labrador Collared Lemming." (Being published in Russia).

By W. E. SWALES—

- "Further Studies on *Fascioloides magna* (Bassi, 1875) Ward, 1917, as a Parasite of Ruminants." Can. J. Research, D, 14: 83-95. 1936.
- "*Tetrameres crami* Swales, 1933, a Nematode Parasite of Ducks in Canada. Morphological and Biological Studies." Can. J. Research, D, 14: 151-164. 1936.
- "Some Aspects of the Sheep Parasite Problem of Quebec." J. Agr. 40: (1) pp. 13 and 33. 1936.
- "L'hygiène vétérinaire dans Québec." Le Bull. des Agr. 21: 8 and 20. Dec. 1936.
- "*Tetrameres crami* Swales, 1933, an Important Parasite of Ducks in North America." Proc. N. Am. Wild Life Conf. 491-493. 1936.
- "Les maladies communes de la volaille." Bull. des. Agr. 22: 9 and 48. 1937.
- "Treatments to be Recommended for Various Worm Parasites of Sheep in Canada." Fam. Her. & Weekly Star, Mar. 10, p. 5. 1937.

By I. W. PARNELL—

- "Studies on the Bionomics and Control of the Bursate Nematodes of Horses and Sheep. II. Technique." Can. J. Research, D, 14: 71-81. 1936.
- "Studies on the Bionomics and Control of the Bursate Nematodes of Horses and Sheep. III. Further Observations on the Toxicity of Urine and some Related Substances for Sclerostome Larvae in Feces." Can. J. Research, D, 14: 172-180. 1936.
- "Red Worms in Horses." The Field. 168: 1564, Dec. 19, and 1610, Dec. 26, 1936. 169: 38, Jan. 2, and 87, Jan. 9, 1937.
- "Some Notes on Worms Liable to Affect Miners and Some Chemical Speculations on Hookworms in Mines." Can. J. of Mining, May, pp. 242-246. 1937.
- "Some Methods of Controlling the Spreading of Internal Parasites of the Horse." Agr. & Live-Stock in India, 6: 291-295. (Reprinted from J. Roy. Army Vet. Corps, 6: 138-141. 1935).

By H. J. GRIFFITHS—

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By M. J. MILLER—

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By H. V. M. MÉTIVIER—

"Some Important Parasites of Sheep from British Guiana." *Trop. Agr.* 14: 4. 1936.

Associate Committee on Patents and Awards

Under the Associate Committee on Patents and Awards there operates in each division of the Council a Subcommittee on Patents, which makes recommendations to the President with respect to the placing of patent applications.

To date 101 applications for patents have been placed. During the year under review 25 patents have been granted and 34 additional applications have been filed.

The Council's procedure in disposing of patents by sale or licence—involving approval by the Governor in Council—is set out in Section 11 of the Research Council Act (page 173). 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.

Several of the Council's patents are now being exploited commercially, both in Canada and in foreign countries, and the Council is beginning to derive a revenue from this source. In Canada, special arrangements are made for the purpose of protecting the Canadian consumer with respect to both the supply of the patented article and the price at which it can be obtained.

Associate Committee on Radio

Co-operating organizations:

Canadian Broadcasting Corporation
 Canadian Marconi Company
 Dominion Department of Transport
 Northern Electric Company

No meeting of this committee was held during the year but at a meeting of the Associate Committee on Aeronautical Research on November 23, 1936, it was recommended that further work on the development of cathode ray direction finders be carried out. The Department of Transport and the Department of National Defence have each contributed grants-in-aid in order to carry out the proposals of the Aeronautical Committee.

At a meeting of the National Research Council on March 25, 1937, the personnel of the Radio Committee was amended as given on page 152.

Associate Committee on Radiology

The construction of a 600 kv. X-ray installation has been undertaken to provide facilities for standardization and research on X-rays generated at over 200 kv. Further details are given in the report of the Division of Physics and Electrical Engineering. It is hoped to have this equipment in operation early in 1938. Five of the six portable ionization chambers that were placed in university laboratories for service in nearby clinics have been altered and improved. The activities of the committee have been greatly restricted during the year by the demands of other duties on the time of the laboratory staff. The committee has approved the appointment of a professional physicist and an additional laboratory assistant to assist in its work, and it is expected that greater progress in its program will be possible during the coming year.

Associate Committee on Survey Research

Co-operating organizations:

Dominion Department of Mines and Resources

Dominion Department of National Defence

Work was carried out under the guidance of subcommittees on photographic aircraft and cameras, mapping methods, camera auxiliaries, and infrared photography.

On the recommendation of the Subcommittee on Photographic Aircraft and Cameras, a Ross Xpres lens, six-inch focal length, complete with cone, was purchased. Use of this lens, as compared with the eight-inch lens now employed, will reduce the number of photographs in aerial surveying by approximately 73% and the photographic mileage flown by approximately 52%. The lens will be used through the 1937 season and further recommendations will be made as to its adoption for general use.

The multi-camera mounts were further developed with a view to increased rigidity and interchangeability. Approval was given to the provision of six new mounts, sufficient to complete the equipment of all photographic aircraft employed on this type of photography.

The subcommittee recommended consideration of additional automatic pilot equipment with a view to adoption of this modern aid if its value were proved. It also recommended the purchase of four additional aircraft at an estimated cost of \$240,000, and that the selection of the type to be purchased should be based on tests to be made by the Royal Canadian Air Force.

The Subcommittee on Photographic Aircraft and Cameras arranged for the provision of wireless sets for aircraft and for ground stations to be established at temporary operating bases in remote areas. Provision of this equipment will give added safety to aircraft and crews, and increase efficiency, especially when surveyors employed in establishing control points are being moved from one observation point to another. Purchase of a Zeiss wide-angle camera was referred to a small committee for further information and reports from foreign users.

Under the Subcommittee on Mapping Methods, a report was prepared on the East Templeton experiment which showed the degree of accuracy attained in plotting with the Zeiss aeroplotter as determined by a ground survey of the plotted area.

The radial stereoplotter, completed in the Instrument Shop of the National Research Laboratories, proved satisfactory and is being used in

the Geographical Section for extending radial line control. A paper giving a full description of it will appear in the *Canadian Journal of Research*. An improved plotting machine was suggested by Colonel Burns and the design and construction of a working model to determine its practicability has been undertaken by the National Research Council.

A simple instrument was devised by Mr. Waugh of the Surveyor General's Office for making the relative co-ordinate and radial movements of the photographs and tracing linen mechanically instead of by hand in the usual way. A practical instrument was designed and built by the National Research Council and is now undergoing trial in the Surveyor General's Office.

The Forest Service of Canada consulted the subcommittee regarding a proposed instrument, based on the stereoscope, for transferring detail from air photographs to existing maps. Modifications in the instrument were suggested by the subcommittee and construction of the device was referred to the Bausch and Lomb Optical Company, Rochester, U.S.A., who developed a practical design for such an instrument.

Colonel Burns, who had been convener of the subcommittee since its inception in 1933, resigned the position in November, 1936, owing to his transfer to Montreal as Officer Commanding of that Military District.

Under the Subcommittee on Camera Auxiliaries, work on the instrument recording camera has been continued and a laboratory model made. This will be subjected to tests which, it is hoped, will prove the practicability of the device.

At the request of the Forest Service of Canada, experiments were made on a mirror attachment to cameras for registering the horizon on low oblique photographs. Results of this work are contained in report No. P.M. 173. The matter has been referred to the Subcommittee on Photographic Aircraft and Cameras for decision as to whether it is possible in practice to mount such an auxiliary in an airplane.

During the year shrinkage and distortion tests were carried out on six samples of photographic film and one sample of photographic paper. Measurements were taken frequently over a period of nearly four months. The findings were embodied in a report dated December 2, 1936. At present two photographic papers are under test.

The Subcommittee on Infra-red Photography sponsored a few photographic flights using infra-red film.

A general meeting of the Associate Committee was held on March 18, 1937, at the National Research Laboratories to reorganize the subcommittees and to arrange their personnel to conform with reorganizations which had taken place within co-operating departments. The subcommittees under the new arrangements are: (i) Mapping Methods; (ii) Infra-red Photography, Emulsions, Filters, etc.; (iii) Photographic Aircraft and Cameras; (iv) Survey Instruments.

A small executive was appointed by the committee as before to carry on its business between meetings.

At this meeting of the Associate Committee it was decided to establish a permanent museum for historical survey instruments and kindred exhibits. One of the Exhibition Halls of the National Research Laboratories was offered and accepted as a place to house the proposed collection.

Associate Committee on Trail Smelter Smoke

Co-operating organization:

Dominion Department of Agriculture

The National Research Council, which was charged by the Dominion Government with responsibility for a technical investigation required in connection with alleged damages in the northern part of the State of Washington by fumes from the metallurgical plant at Trail, B.C., has for some years been conducting, through the committee, investigations of conditions in that area. The program of work, now nearly completed, has been carried out along two main lines of investigations as follows:

I. (a) Studies in the Trail-Northport area on the concentration and duration of sulphur dioxide in the atmosphere; (b) The effect of sulphur dioxide on native vegetation in regard to sulphur content; (c) The effect of sulphur dioxide on crops; (d) The effect of sulphur dioxide on forests; (e) The effect of sulphur dioxide on soils.

II. The experimental fumigations at the Dominion Experimental Station at Summerland, B.C., on alfalfa, barley, winter wheat, and conifers. (a) The effect of various concentrations on the yield of alfalfa and cereals; (b) The effect of sulphur dioxide on the carbon dioxide assimilation of alfalfa; (c) Stomatal behavior and internal leaf structure under the influence of sulphur dioxide; (d) Chemical studies on the effect of sulphur dioxide on protein, carbohydrates and sulphur content; (e) Absorption studies on soil; (f) Susceptibility studies on larch, Douglas fir, yellow pine, etc.

The results of most of these investigations have already been incorporated in confidential reports submitted to the Dominion Government, but these cannot be released until the completion of a study of the whole subject by an international tribunal recently set up for the purpose.

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

In the past few years it has been customary to hold the annual meeting of the committee early in the new fiscal year for the presentation of reports on work carried out during the previous 12 months. The reports presented at the meeting on June 17, 1936, were summarized in the annual report of the Council for the year 1935-1936. The meeting planned for the early spring or summer of 1937 has been postponed until some of the experimental work under way has been further advanced. In the meantime, all the researches recently in progress under the auspices of the committee are being continued.

SPECIAL COMMITTEES**Special Committee on Electrical Units and Regulations***Co-operating organizations:*

Dominion Department of Trade and Commerce
Electricity and Gas Inspection Services

During the year under review two reports have been forwarded to Council from this committee. The first, the eighth report of the committee, recommended the adoption of certain revisions to the Specifications for Approval of Type of Watthour and Ampere Hour Meters and to the Specifications for Approval of Type of Instrument Transformers and Phase Shifters. The second, the committee's ninth report, recommended the adoption of a set of instructions to be issued to manufacturers and others submitting meters for type approval. These two reports have been approved by the National Research Council and new or revised specifications have been prepared.

Special Committee on Gas Units and Regulations*Co-operating organization:*

Electricity and Gas Inspection Services

The Special Committee on Gas Units and Regulations was appointed by the Council on February 26, 1932, to investigate and define the standard units of measurement used in testing gas meters and to recommend regulations for the approval of type of gas meters.

The committee submitted definitions for the following units of measurement which were officially approved by the Council; the foot and the inch, the pound, the second, standard gravity, temperature, the British thermal unit, pressure, the cubic foot, the standard cubic foot bottle, and the cubic foot of gas.

The standard cubic foot bottle has been completely overhauled and will be recalibrated in the near future.

On the recommendation of the committee, the following primary standards were transferred from the Standards Branch of the Department of Trade and Commerce to the National Research Council: the standard pound avoirdupois; the troy ounce; the standard yard; the standard gallon; a copy of the metre des archives; a subdivided inch; a copy of the international meter.

The committee drafted specifications for approval of type of positive displacement gas meters which were revised after being submitted to the various interested parties for criticism. The Council approved the regulations, effective from January 1, 1935 (see Annual Report for the year 1934-35).

The committee has considered the question of approval of type of large capacity gas meters. Owing to lack of funds the Council has been unable to equip a suitable laboratory for the approval testing of large capacity gas meters and it appears impossible to foresee when the Council can make such laboratory provision. Since it was expedient that some procedure be established for the type approval of large capacity gas meters whenever such cases may arise in Canada, it was resolved that the Council may at its discretion send its competent officer or officers to the manufactory, or to a suitable testing laboratory, or to the place of installation, to determine by test or otherwise the suitability of the meter for the purposes of sale of gas

in Canada, and the approval of its type. This resolution was approved by the Council at its 108th meeting.

During the past year the committee was called upon to consider the approval of a Holmes BM gas meter. This meter is a large capacity nutating type having an oil seal. Inasmuch as this meter was a special case and had satisfactorily passed performance tests in a gas meter testing station in England, approval of type was granted under authority of Article IV, paragraph 2, of Regulations and Specifications for Approval of Type of Positive Displacement Gas Meters, January 1, 1935.

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

The Special Committee on Hydraulic Research was appointed in 1935 for the purpose of considering the requirements of the various Dominion Government Departments and of industry in respect of the provision of laboratory facilities for research and testing in connection with stream flow, power development, harbor works, river control, canals, hydraulic machinery and equipment, etc., and having regard to existing facilities at the Rideau Falls and to the modifications which can be made thereto without undue expenditure, to specify the facilities which the committee recommends should be made available.

During the year under review, the committee completed a survey of the needs of all interested parties with respect to hydraulic laboratory facilities. A study was made of hydraulic laboratories in other countries and the classes of work being undertaken. A delegation of three members of the committee visited several of the foremost hydraulic laboratories of the United States, to obtain first hand knowledge of their design and operation.

On the basis of the information obtained, a preliminary proposal has been drawn up for a hydraulic laboratory at the Rideau Falls' site.

Canadian Government Purchasing Standards Committee

This committee, which prepares purchase specifications on a co-operative basis for the use of Government Departments, continued its activities during the year. Noteworthy progress was made by several of the subcommittees. The following is a list of specifications, tentative and final, issued as at March 31, 1937:—

Tentative Specifications:

- 1-GP- 6 Putty for Glazing, Types I and II.
- 1-GP-10 Exterior Linseed Oil Paints, White Lead-zinc Oxide Type, White and Tinted.
- 1-GP-12 Schedule of Standard Paint Colors.
- 1-GP-14 Red Lead (Dry Pigment Paste, and Mixed Paint).
- 1-GP-15 Titanium-barium Pigment, Paste in Oil.
- 1-GP-16 Shellac Varnish.
- 1-GP-17 Exterior Enamel, White and Gray.

Tentative Specifications:—Concluded

- 2-GP- 9 Scouring Compounds.
 2-GP-11 Methods of Sampling and Analysis of Soaps.
- 3-GP-2 Fuel Oil.
 3-GP-4A Machine Oils.
 3-GP-4B Dynamo Oils.
 3-GP-4C Automotive Engine Oils.
 3-GP-4D Aircraft Engine Oils.
 3-GP-4E Diesel Engine Oils.
 3-GP-4F Air Compressor Oils, Compounded.
 3-GP-4G Marine Engine Oils, Mineral.
 3-GP-4H Marine Engine Oils, Compounded.
 3-GP-4J Steam Cylinder Oils, Mineral.
 3-GP-4K Steam Cylinder Oils, Compounded.
 3-GP-4M Steam Turbine Oils.
 3-GP-4P Gear, Chain and Wire Rope Lubricant.
 3-GP-5 Aviation Fuel.
- 4-GP-2 Schedule of Methods of Testing Textiles.
- 8-GP-1 Testing Sieves.
- 10-GP-1 Burned Fire-clay Brick for Stationary Boilers.
 10-GP-2 Questionnaire *re* Stationary Boiler Installations.
- 12-GP-1 Safety Glass.
- 14-GP-1 Clinical Thermometers.

Specifications Issued as Final:

- 1-GP-1 Linseed Oil, Raw, Unrefined.
 1-GP-2 Linseed Oil, Boiled.
 1-GP-3 Turpentine for Paint, Type I.
 1-GP-4 Paint Thinner (Petroleum Spirits), Type I.
 1-GP-5 Paint Thinner (Petroleum Spirits), Type II.
 1-GP-7 Liquid Paint Dryer, Types I and II.
 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.
 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 Gasoline.
 3-GP-3 Illuminating Oils.

Specifications Issued as Final:—Concluded

- 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.

The committee now comprises twelve subcommittees and three panels,—a subcommittee on specifications for chemicals, and panels on safety glass, fire hose, and thermometers having been added during the year.

A Subcommittee on Plans and Administration has been formed to act in a general advisory capacity and to administer any funds available for laboratory investigations in respect of specifications. The personnel comprises the chairmen of the other subcommittees. Funds have been provided for an investigation in the Forest Products Laboratories, Montreal, of the aging properties of bond papers, and also for laboratory work on paints in the Division of Chemistry of the National Research Council. Arrangements have also been made for a comprehensive laboratory survey of various types of textiles and for determination of the properties of commercial masonry caulking materials.

The subcommittee on editorial practice, which has been preparing a government style book, has virtually completed its work and it is expected that the manuscript will be ready for publication in the very near future.

British Commonwealth Scientific Conference

The British Commonwealth Scientific Conference, held in London, England, September 21–October 8, 1936, was attended by representatives of the United Kingdom (including Northern Ireland), Canada, Australia, New Zealand, South Africa, Irish Free State, Newfoundland, India, Southern Rhodesia, and by officials from the Colonial office.

The Canadian Delegation, appointed by P.C. 2368, comprised Major-General A. G. L. McNaughton, President, National Research Council; Dr. G. S. H. Barton, Deputy Minister, Department of Agriculture; Dr. R. Newton, Director, Division of Biology and Agriculture, National Research Council; Dr. J. M. Swaine, Director of Research, Department of Agriculture; Mr. L. B. Pearson, First Secretary, Office of the High Commissioner for Canada, in Great Britain; M. Pierre Dupuy, Second Secretary, Canadian Legation, Paris; Secretary, Mr. S. J. Cook, Division of Research Information, National Research Council.

The British Commonwealth Scientific Conference, 1936, had its origin in the recommendations of the Imperial Committee on Economic Consultation and Co-operation (1933), which met in London under the Chairmanship of Dr. O. D. Skelton, Under-Secretary of State, Department of External Affairs, Canada. These recommendations which were subsequently approved by the participating Governments provided that “the question of what research activities should in future be carried out co-operatively should be considered

at a conference to be summoned as early as possible, consisting partly of the administrative and scientific heads of national research organizations and departments and partly of such other persons as the several Governments may select," and that "there should be careful and periodical examination of the various institutions at Empire conferences suitable for the purpose."

Among the more important institutions requiring consideration were the eight bureaux and the Executive Council which had been set up on the recommendation of the Imperial Agricultural Research Conference, 1927. These bureaux were established to serve as clearing houses for the interchange of information between research workers in their respective branches of agricultural science throughout the various parts of the Commonwealth. They were to be supported co-operatively by all Governments, and as a result of the work of an Organizing Committee, which met in 1928, were placed in the charge of an autonomous body known as the Executive Council, which is representative of contributing Governments. In its final form this body marks a new development in intra-Imperial organization, in that the membership of the Council is on a basis of equality of representation and the Council is not responsible to any one Minister or Government, but, through its constituent members, responsible to all Governments.

Later, on the recommendation of the Imperial Committee on Economic Consultation and Co-operation (1933), the Executive Council was entrusted with the supervision of the administration and finances of two organizations considerably older than the bureaux, namely, the Imperial Institute of Entomology and the Imperial Mycological Institute. The work of these institutes is in part similar to that of the bureaux, but also includes services which involve research. Moreover, as it was not possible for various reasons, to assemble in the winter of 1933-4 a special British Commonwealth Conference to select from among the numerous research schemes which had up to September 30, 1933, been aided from the Empire Marketing Fund those which all or some Governments might be prepared to support on a co-operative basis, that work also was assigned to the Executive Council by the Governments of the British Commonwealth of Nations.

The particular purpose of the Conference was to review the activities of the eight Imperial Agricultural Bureaux, the Institutes of Entomology and Mycology and Farnham House Laboratory; to consider the scale and distribution of financing; to examine the need for further bureaux; and to explore the possibilities for closer collaboration in the distribution of research information among Empire countries.

Previous to the assembly of the Conference, the possibility of convening a general scientific conference, competent to exchange information and to discuss selected scientific subjects interesting several parts of the Commonwealth or affecting several scientific departments, was a subject of correspondence. A conference with such an extensive program did not prove practicable, and in view of the principles enunciated by the Imperial Committee on Economic Consultation and Co-operation, the Governments agreed that the Conference should consider and report on the following subjects: the work, finance, direction and possible extension of usefulness of the Imperial Bureaux of Soil Science, Animal Health, Animal Nutrition, Plant Genetics (for crops other than herbage), Plant Genetics (herbage plants), Fruit Production, Animal Genetics, Agricultural Parasitology; the Imperial Institute of Entomology and the Imperial Mycological Institute: the work of Farnham House Laboratory; future arrangements for the Journal of Dairy Research; proposals for new bureaux in dairy science and forestry; co-operation in scientific research; collaboration in the collection and maintenance of plant

material required for crop improvement; research activities on the transport and storage of foodstuffs, on the control of insect infestations in stored products, and on the properties and utilization of wool; interchange of research workers and programs, as well as of information on research on building materials and methods; advisability of periodical specialist conferences; questions arising from the Third Mycological Conference, 1934.

On the British Commonwealth Scientific Conference, therefore, was laid the responsibility of defining those services within the scope of its inquiry, which it recommended should be organized on a co-operative basis, and of proposing, with due regard to the need for economy, the financial provision necessary for the conduct of those services for a definite period of years.

The principal results and recommendations of the Conference are summarized below:

(a) Establishment of a Bureau for Dairying was recommended in order to render the increasing fund of literature published in foreign languages more readily available to Empire research workers through an abstracting and translation service.

(b) A bureau to serve forestry research workers in a similar way was also recommended.

(c) The work of the several bureaux and institutes was reviewed in detail. Visits were made to each bureau by representative groups of delegates. Numerous recommendations regarding the operations of the bureaux during the next five years, and embodying the views of all delegates, were given approval at the final plenary session.

(d) It was agreed that in accordance with the recommendation of the Imperial Committee on Economic Consultation and Co-operation, 1933, the Governments should be asked to arrange for the assembly of a further conference of this kind in 1941.

(e) The usefulness of periodical specialist conferences was recognized, but it was thought it would be impracticable at present to convene either a General Commonwealth Scientific Conference or one covering the whole field of the science of agriculture.

(f) It was recommended that Governments give consideration to the benefits to be obtained through the interchange of visits by research workers in given fields, and the extension of arrangements for the freer exchange of information regarding programs of work.

(g) It was recommended that Governments encourage the proposal to hold a conference to consider the organization of research on the utilization of wool, and that as an interim measure Governments be asked to consider the continuance of support through the Executive Council of the Imperial Agricultural Bureaux to the work of the Wool Industries Research Association.

The report of the proceedings, issued as Cmd. 5341, January, 1937, was sent to the Governments of the British Commonwealth of Nations, and the recommendations contained in it have since been approved by all Governments.

Holdover Committee of the Fifth Pacific Science Congress

During the year the Holdover Committee continued to seek a place of meeting for the Sixth Pacific Science Congress, but without much success. Unfortunately the Government of Fiji, from whom an invitation had been received in the previous year, found on further consideration that the accommodation available in Fiji was inadequate to permit the holding of a Congress there, and in June 1936 withdrew their invitation. Communications were

then sent to the member countries in the Pacific Science Association advising them of this development and inviting their further suggestions. At the end of the fiscal year no decision had yet been reached.

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. Summaries of such reports will be found below. In addition, the Council has published during the year in the Canadian Journal of Research scientific papers giving the detailed results of many such investigations. Supplementing the reports of current work is a list of the researches in progress during the year, showing the names of the grantees and the subjects which are being investigated.

Diphyllobothrium latum (Broad Tapeworm)

To determine the extent of the distribution of the broad tapeworm in Manitoba, fecal containers were placed in hospitals in Winnipeg, Churchill, Flin Flon and The Pas. No material, however, was obtained from the outlying points and 500 examinations of feces from Winnipeg hospitals proved negative. From a microscopical investigation of samples from Manitoba (men, dogs and foxes), Leningrad, Finland and Japan, it is hoped to be able to show that a difference exists between the local and foreign material. Tests on dogs, at weekly intervals, over a period of months, showed that infestation caused no alteration in the calcium-phosphorus ratio of the blood. At the same time hemoglobin estimations, and red cell, white cell and differential leucocyte counts were made.

Rate of growth of worms *in situ* was also studied, but measurements were to some extent vitiated by parts of worms passing out of the dogs and being lost.

(Investigation under the direction of Prof. R. A. Wardle, University of Manitoba.)

Growth of Populations of *Tribolium confusum*

This work was a continuation of previous studies. Data were accumulated on the more simply determined biotic constants. It was found possible to determine some of these indirectly from the equations, and to show striking agreement. Progress was made in determining the mean speed of movement of the beetles using a special apparatus for laying down even laminae of flour. There appeared to be a tendency for females to wander at the bottom of the flour and males at the top. Work was continued on the determination of the rate of growth of egg population and the data so obtained were found to agree with the previously published equation. A periodic fluctuation occurs, probably owing to intense egg-eating, which was shown to cause the ovaries to degenerate, although some females were unaffected.

An apparatus was built for the accurate timing of the hatching of eggs, and a histogram of egg-hatching was worked out. A method was developed for collecting the gas given off by the beetles.

Investigation of the sexing of adult beetles failed to reveal any external secondary sexual character. Work is in progress to find a method of putting identification marks on beetles.

Several papers on this work have been prepared.

(Investigation under the direction of Dr. John Stanley, Queen's University.)

Cercarial Dermatitis in Manitoba

A study was made of the incidence of furcocercous cercariae over a representative area, their life history, and their ability to cause dermatitis. The various types of lake shores, ponds and sloughs in a considerable portion of Manitoba were found to be suitable habitats for at least seven species of snails, of which five are capable of acting as intermediate hosts to trematodes possessing furcocercous cercariae. Ten species of the latter were found of which three definitely produce dermatitis in man. Eighteen out of thirty blue-winged teal ducks were found to be infested with the adult stage of a schistosomid trematode, and adult worms were obtained from fledging birds from a slough where dermatitis-producing cercariae were plentiful. A second species of adult schistosome was found in herring gulls from outside points. Fifteen other species of aquatic birds were examined in small numbers and found negative for schistosomes. Attempts to culture blood flukes in artificial media were only moderately successful, and attempts to infect snails with eggs from feces of infested birds were negative.

*(Investigation under the direction of Prof. R. A. Wardle,
University of Manitoba.)*

Causes of Infertility of Quebec Podsol Soils

Co-operating organization:

Macdonald College

Recent investigations by the Soil Fertility Committee at Macdonald College showed that the treatment of typical Quebec lowland, sandy, podsol soils with sodium carbonate results in a marked increase in the yield of oats. Since it has been shown that a large proportion of the total phosphorus in these soils is in organic combination, it was considered that the beneficial effects of sodium carbonate might be due, at least in part, to the effect of dissolving organic phosphorus compounds.

In these experiments, sodium carbonate has been observed to effect a marked increase in the soluble organic matter, the increase being roughly proportional to the amount of sodium carbonate added, and, to a lesser degree, to the length of time the sodium carbonate was allowed to act. A direct solvent effect of sodium carbonate on the iron-containing compounds of the soil has been shown. There is no evidence that the distribution of phosphorus in the soil is significantly affected by sodium carbonate. There is, however, a slight increase in soluble phosphorus compounds when the action of sodium carbonate is prolonged.

It has further been observed that the oat straw grown on soil treated with sodium carbonate has a bright, golden yellow color, which is in marked contrast to the rusty color of the straw from untreated soil. Analyses of the straw show that, where the soil has received a full application of 1000 lb. of sodium carbonate per acre, there is a marked increase in iron and decrease in calcium and manganese, correlated with an increased yield and bright color of straw.

Alkali has been found to extract a significant amount of organically bound iron from podsol soil. Practically all of this iron is contained in the humic acid fraction. It would appear from the results obtained so far that no significant amount of iron in the humic acid fraction is linked to nitrogen. This investigation is being continued.

(Investigation under the direction of Dr. W. D. McFarlane.)

Soil Investigations in Quebec

Co-operating organization:

Macdonald College

The study of the water-soluble organic materials removed from the humus layers of Quebec podsol soils has been continued. The extraction and fractionation described in a previous report have been repeated, greater attention being paid to the quantitative aspects of the work, and to the presence of such elements as sulphur and nitrogen. While no new substances have been identified, two of the fractions show promising results. Identification has been hindered by the use in previous work of small quantities of raw humus, but methods have been developed for the fractionation of larger quantities. Small amounts of four acids whose methyl esters can be distilled have already been obtained, and the use of larger initial quantities of soil should facilitate the identification of these. It is hoped to study the soils which occur under the most common conifer, spruce, and to determine whether any of their component substances are toxic to plants.

(Investigation under the direction of Dr. R. R. McKibbin, Macdonald College, McGill University.)

An Attempt to Measure the Velocity of Light, Using an Oscillating Quartz Crystal

If a beam of plane-polarized monochromatic light is passed along the optic axis of a quartz crystal, total extinction can be obtained by crossing the emergent plane with an analyzing Nicol. The rotary power of the crystal can be made to oscillate by applying an oscillating e.m.f. along the electric axis. It has been suggested that this property of the vibrating crystal be used to measure the velocity of light.

Light that has passed through a polaroid is made to pass through a vibrating crystal and is reflected by a mirror back through the crystal. The beam is then reflected by a half-silvered mirror through an analyzing polaroid and through a telescope. The two polaroids are crossed and no light appears in the telescope. The crystal is set in vibration and light appears in the field of vision because the crystal at some point in its cycle has a different rotary power for the light on its first transmission than it has on its return. If the distance to the reflecting mirror is such that the crystal passes through one complete cycle when the light returns, no light will appear in the telescope. With these data the velocity of light was calculated to be 3.02×10^5 km. per sec. with an error of 1% or greater.

In practice a minimum in intensity is obtained and not total extinction. A photoelectric cell was tried to measure the variation in light intensity. The response of the cell to the light was satisfactory, but in spite of thorough shielding, the oscillator field greatly affected the measurements.

To obtain a more marked minimum, a thin 41° plate together with a third polaroid, which will be placed on the side of the crystal facing the reflecting mirror, will be tried. This arrangement will permit the light to pass in flashes as the field is applied and will stop the light from the inactive portions of the crystal.

(Investigation under the direction of Dr. E. F. Burton, University of Toronto.)

Reactions Involving Atomic Deuterium, Deutero-compounds, etc.

In order to clear up certain discrepancies the reaction of deutero-atoms produced by an electrical discharge with methane was investigated at temperatures up to 500° C. The activation energy was found to be 12.9 ± 2 Kcal. Complete agreement between the results of various experimental methods for this reaction was obtained. The mercury-photosensitized decomposition of ethane was investigated and an improved technique was developed which eliminated the complicating secondary processes involved in previous investigations, and permitted a better insight into the mechanism of the process. Simplifications in the reaction mechanism resulting from this research will, it is expected, open up a whole field of investigation with other simple hydrocarbons. A new method was devised for detecting the intervention of free radicals in the decomposition of organic compounds and this was applied to an investigation of the mechanism of methyl ether decomposition. In addition to being of scientific interest, the method of investigating free radical reactions promises to be of great interest, particularly in its application to the more important hydrocarbon decompositions, as in the petroleum and allied industries. Several papers covering this work have been published or are in course of publication.

*(Investigation under the direction of Prof. E. W. R. Steacie,
McGill University.)*

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. 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.
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.	<ol style="list-style-type: none"> 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.

RESEARCHES IN PROGRESS—Concluded

Grantees and Addresses	Subject of Research
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 above the critical temperature.
Dr. R. R. McKibbin, Dept. of Chemistry, Macdonald College, Que.	Mineral deficiency of Quebec soils.
Prof. W. A. Maw, Dept. of Poultry Husbandry, Macdonald College, Que.	Distribution of fat in the body of fattened chickens.
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.
Dr. John Stanley, Dept. of Biology, Queen's University, Kingston, Ont.	Growth of populations of <i>Tribolium confusum</i> Duv.
Prof. E. W. R. Steacie, Dept. of Chemistry, McGill University, Montreal, Que.	Exchange reactions involving atomic 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.
Prof. R. A. Wardle, Dept. of Zoology, University of Manitoba, Winnipeg, Man.	Cercarial dermatitis of man in Manitoba.
Prof. R. A. Wardle, Dept. of Zoology, University of Manitoba, Winnipeg, Man.	Survey of fish tapeworm in Manitoba.

SCHOLARSHIPS

Twenty-nine students, selected from thirteen Canadian universities, were awarded postgraduate scholarships for the year 1936-37 by the National Research Council. The policy of assisting exceptional students to pursue postgraduate work in Canadian universities has been followed since the inception of the Council, the object being to build up in Canada a supply of well trained scientists capable of undertaking and carrying through any research investigations required in the promotion and development of industrial processes looking to the better or more profitable utilization of Canadian raw materials and the expansion of markets for Canadian products.

Awards were of three classes: bursaries—\$500; studentships—\$600; fellowships—\$700. Grants for 1936-37 included two fellowships, eleven studentships, and seventeen bursaries. The names and academic degrees of the successful candidates, the university from which each graduated, the department of science in which each was to carry on his postgraduate work, and the subject of the research undertaken, are tabulated below:

29 Scholarships Held During the Year 1936-1937

FELLOWSHIPS

Grantee	Graduated	Where Held	Subject of Research
D. C. Jones.....	B.A., University of New Brunswick.	Department of Physics, McGill University Montreal, Que.	The Stark effect in the spectrum of the HD molecule.
E. H. Vestine.....	B.Sc., University of Alberta.	Department of Terrestrial Magnetism, University of London, London, England.	The current-system of magnetic disturbance in polar regions.

STUDENTSHIPS

Grantee	Graduated	Where Held	Subject of Research
A. G. Brown.....	B.Sc., University of Saskatchewan.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of the mechanism of olefine-halogen hydride reactions in the liquid state.
R. A. Findlay.....	B.A., M.A., University of British Columbia.	Department of Physical Chemistry, McGill University, Montreal, Que.	The thermal conductivities of cellulosic materials.
P. A. Giguere.....	B.A., L.Sc. and Chemistry, Laval University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The preparation and properties of deuterium peroxide.
T. J. G. Henry.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Physics, McGill University, Montreal, Que.	The study of the absorption of the Balmer lines in excited hydrogen.
Miss A. C. Howard....	B.Sc., McGill University.	Department of Genetics and Cytology, McGill University, Montreal, Que.	Study of somatic metaphase chromosomes in strains of mice.
M. W. Johns.....	B.A., M.A., McMaster University.	Department of Physics, University of Toronto, Toronto 5, Ont.	Analyses of singly and doubly ionized mercury atoms, and trebly ionized mercury atoms; investigation of hyperfine structures in the thallium spectra.
A. Nadeau.....	B.A., M.A., B.Sc., M.Sc., Laval University.	Department of Biochemistry, Laval University, Quebec, Que.	The study of amyolytic enzymes of maple sap.
H. H. Penley.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Physics, Queen's University, Kingston, Ont.	Scattering of X-rays at small angles.
E. R. Pounder.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The influence of crossed electric and magnetic field on the helium spectrum.
H. Taube.....	B.Sc., University of Saskatchewan.	Department of Physical Chemistry, University of Saskatchewan, Saskatoon, Sask.	Kinetics of the photochemical decomposition of ClO ₂ in carbon tetrachloride solutions; also chemical and thermochemical knowledge of chlorine hexoxide (Cl ₂ O ₆).
L. Walker.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The range of the protons emitted by silicon under alpha-particle bombardment.

BURSARIES

Grantee	Graduated	Where Held	Subject of Research
W. A. Alexander.....	B.A., Queen's University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The thermal decomposition of organic substances from the standpoint of free radicals.
J. M. Calhoun.....	B.Sc., University of Alberta.	Department of Physical Chemistry, McGill University, Montreal, Que.	The influence of pretreatment of wood on its subsequent delignification.
C. G. Eliot.....	B.Sc., McGill University.	Department of Organic Chemistry, McGill University, Montreal, Que.	The addition reactions of 2, 3-diphenylbutadiene.
N. H. C. Fraser.....	B.Sc., University of Alberta.	Department of Geology, Queen's University, Kingston, Ont.	Occurrences of titanium minerals in eastern Ontario.
C. H. Holder.....	B.Sc., Mt. Allison University.	Department of Physical Chemistry, McGill University, Montreal, Que.	An investigation of reaction velocities near the critical temperature and pressure region.
M. Lieff.....	B.A., M.A., Queen's University.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	The structure of lignin and its relation to other constituents present in wood.
G. M. Neal.....	B.A., University of British Columbia.	Department of Biology, University of Toronto, Toronto, Ont.	The distribution of the rotifers in Br. Col. and their relationship in the food cycle of small fry of the fresh water lakes of B.C.
S. M. Neamtan.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Stark effect in the molecular spectrum of deuterium.
L. T. Newman.....	B.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Study of colloidal gold.
N. A. DeV. Parlee.....	B.Sc., Dalhousie University.	Department of Physical Chemistry, Dalhousie University, Halifax, N.S.	Reaction kinetics of various monomolecular gas reactions.
P. E. Pelletier.....	B.A., Seminary of Quebec, L.Sc., B.Sc., Laval University.	Department of Inorganic Chemistry, Laval University, Quebec, Que.	Study of precipitation of metallic salts.
L. Piche.....	L. es Sc.Ch., University of Montreal.	Department of Organic Chemistry, University of Montreal, Montreal, Que.	Study of <i>d</i> -substituted semicarbazones of sugars.
H. L. Sanders.....	B.Sc., M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Phase boundary potentials.
W. M. Smith.....	B.Sc., University of New Brunswick.	Department of Physical Chemistry, McGill University, Montreal, Que.	Thermal decomposition of a series of related compounds.
J. N. Swartz.....	B.Eng., McGill University.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	The action of chlorine on alkali lignin and the mechanism of the bleaching of Kraft pulp.
A. G. Ward.....	B.A., Queen's University.	Department of Physics, Queen's University, Kingston, Ont.	Large-angle scattering of β -rays and a study of the β -rays of radium E and uranium X.

A summary of the scholarships awarded by the Council during the 20 years ended March 31, 1937, has also been prepared for convenience of reference. During this period, 98 fellowships, 257 studentships, and 359 bursaries have been awarded. The total amount expended by the Council on postgraduate scholarships was \$585,729.41.

The Council has, therefore, during this period very considerably increased the number of research workers available for service in Canadian industries and universities, and in the Dominion and Provincial Government services. There is great need, however, for the provision of further scholarships. At the present time many graduates find it impossible from their own funds to meet the cost of doing postgraduate research and are therefore obliged to seek assistance. When aid of this kind is not forthcoming from Canadian scholarships, students often find it necessary to take advantage of fellowships offered by universities in other countries, particularly in the United States. The disadvantage of this to Canada is that many of these students subsequently find employment in American industries and do not return to Canada.

The summary follows:

Summary of Scholarship Grants

Date	Fellowships		Studentships		Bursaries		Amount actually expended by Council
	No.	Value	No.	Value	No.	Value	
1917-18.....	3	\$ 1000	4	\$ 750	.....	.....	\$ 5,550.00
1918-19.....	2	1200	5	750	.....	.....	7,150.00
1919-20.....	1	1000	18	750	6	500	20,850.00
	3	1200					
	1	1000					
1920-21.....	1	1500	10	750	8	500	17,700.00
	1	1200					
	3	1000					
1921-22.....	1	1500	8	1000	27	750	38,575.00
	6	1200					
1922-23.....	3	1200	22	1000	13	750	35,725.00
1923-24.....	1	1500	8	1000	25	750	37,830.00
	11	1200					
1924-25.....	1	1500	12	1000	30	750	40,101.66
	3	1200					
1925-26.....	1	1500	17	1000	22	750	40,082.75
	3	1200					
1926-27.....	1	1500	17	1000	20	750	41,105.00
	5	1200					
1927-28.....	1	1750	16	1000	27	750	41,855.00
	4	1200					
1928-29.....	1	1750	17	1000	29	750	43,720.00
	3	1200					
1929-30.....	1	1750	18	1000	26	750	49,990.00
	3	1500					
	6	1200					
1930-31.....	1	1750	22	750	35	600	59,535.00
	1	1500					
	5	1000					
1931-32.....	5	1000	22	750	25	600	38,490.00
1932-33.....	4	1000	9	750	8	600	17,605.00
1933-34.....	5	550	6	500	6	450	9,160.00
1934-35.....	2	550	6	500	18	450	11,825.00
1935-36.....	2	550	9	500	18	450	13,205.00
1936-37.....	2	700	11	600	16	500	15,675.00
	98	.....	257	.....	359	.....	585,729.41

Regulations governing the award of bursaries, studentships, and fellowships are given below:

Regulations Governing Bursaries, Studentships and Fellowships

A. General Regulations

1. These bursaries, studentships and fellowships are intended, not to facilitate attendance on ordinary collegiate studies, but to enable students who have passed through a university curriculum and have given distinct evidence of capacity for original research (or, in the case of bursaries, students who have at least won high distinction in scientific study during their undergraduate course) to continue the prosecution of science with the view to aiding its advance or its application to the industries of the country. Evidence of this capacity is strictly required, this being the main qualification. The most suitable evidence is the presentation of a research already performed.
2. They are open on equal terms to men and women, and are awarded to the applicants who are deemed best qualified by the evidence submitted.

A. General Regulations—Continued

3. An applicant for a bursary, a studentship or a fellowship must be a British subject resident in Canada.
4. An applicant to be eligible for a first award must not have passed the thirtieth anniversary of his birth on March 31 of the year of application.
5. A married person cannot hold a bursary, studentship or fellowship.
6. A candidate must (1) be a *bona fide* graduate of a university or college in which special attention is given to scientific study, or (2) have received an equivalent training in an institution possessing adequate facilities of a scientific character for providing such training.
7. The departments of science in which capacity for research will be accepted as qualifying for an award are: Biology, Chemistry, Engineering, Geology, Metallurgy, Mineralogy, Physics and Mathematics.
8. Application for a bursary, studentship or fellowship must be made by the candidate to the Research Council. He shall submit a complete record of his academic career. Recommendations must be submitted from the heads of the scientific departments with which he was connected, and professors or instructors under whom he studied, showing that in their estimation he promises to be worthy of training for scientific research. All such recommendations must be forwarded to the Research Council by the professor recommending the candidate and through the head of the department concerned. The candidate shall state the institution at which he intends to study, and the general line of work to be followed. The application will be considered and decided upon by the Research Council or by a special committee appointed by the same.
9. Each applicant must arrange for his admission to some approved university, and submit with his application a statement from the professor under whom he intends to work in such university that such professor has agreed to undertake the supervision of his work with the approval of the head of the university department concerned. Such supervisor will be expected to submit to the Council a confidential report on the grantee's work at the mid-year and on the conclusion of the award.
10. The date of the beginning of the tenure of an award shall coincide with the beginning of the academic session of the university at which the grantee is to carry on his work. In very exceptional circumstances, the Research Council, upon receipt of a formal application from the grantee, may permit a change of tenure to be made.
11. Successful candidates are required to devote themselves for a period of at least eight months of each year wholly to the objects of the award, and during that time are forbidden to hold any position of emolument or to engage in teaching.
12. The holder of a bursary, studentship or fellowship shall furnish on or before February 1 a detailed mid-year report of his work up to that time; and also on completion of the tenure of his award, and not later than July 31, a complete and detailed report of the work carried on during the entire year.

A. General Regulations—Concluded

13. The National Research Council shall have the right to publish under its own auspices information arising from work done under an award, and no paper covering work carried out under an award may be published without permission from the Council.

In each case a copy of the manuscript shall be filed with the National Research Council before publication and evidence shall be submitted that the professor who directed the work has approved the manuscript and the plans for publication; information shall also be furnished as to the journal in which it is proposed to publish and the expected date of publication. One reprint of the published paper shall be forwarded to the Council as soon as available. When publishing, due credit shall be given to the National Research Council for the assistance received therefrom.

14. Awards are payable as follows: 40 per cent on October 1; 50 per cent on February 1, or thereafter, on receipt of a satisfactory first half-yearly report; 10 per cent after the expiration of the period of tenure and the submission to the Research Council of a satisfactory report on the work of the holder for the whole period.

15. A person who holds a bursary is expected to qualify for a studentship, and as a general rule a bursary will not be renewed for a second year; but a person may be awarded a studentship a second time, or a fellowship a second time. In no circumstances, however, will the Council make more than three years' grants to any one person under any combination of bursaries, studentships and fellowships. However, a Travelling Fellowship may be awarded to one who has already received three awards, if in the opinion of the Research Council the applicant be of outstanding ability.

B. Special Regulations Governing Bursaries

16. A bursary is of the value at present of \$500.

17. Application for a bursary must be made not later than March 1.

18. The principal work of the holder of a bursary must be a research in some branch of science, but he is expected to give considerable time to an advanced course of study.

19. A person who has held a bursary and who has, during his tenure of it, shown distinct evidence of capacity for original research is eligible to be a candidate for a studentship.

20. A bursary must be held at a Canadian university approved by the Council.

C. Special Regulations Governing Studentships

21. A studentship is of the value at present of \$600.

22. Application for a studentship must be made not later than March 1.

23. The principal work of the holder of a studentship must be a research in some branch of science, the extension of which is important to the national industries; but he may give a reasonable amount of time to an advanced course of study.

24. A person who has held a studentship and whose work has been highly satisfactory to the Council is eligible to be a candidate for a second studentship, or even for a fellowship.

C. Special Regulations Governing Studentships—Concluded

25. A first studentship must be held at a Canadian university approved by the Council; but a second studentship may, by special permission of the Council, be carried on in an approved scientific laboratory or works.

D. Special Regulations Governing Fellowships

26. A fellowship is of the value at present of \$700.

27. Application for a fellowship must be made not later than March 1.

28. A fellowship will be awarded only to a candidate whose record shows that he possesses the capacity to conduct independent research.

29. The principal work of the holder of a fellowship must be a research in some branch of science, the extension of which is important to the national industries.

30. A person who has held a fellowship and whose work has been of great excellence is eligible (subject to the provisions of Section 15) to be a candidate for a second fellowship. In no circumstances will a third fellowship be awarded.

Address all communications to—

The Secretary,
NATIONAL RESEARCH COUNCIL,
OTTAWA, ONTARIO.

February, 1937.

APPENDIX A

Papers Published by the Holders of Assisted Research Grants, and Describing Work to which Financial Assistance has been Extended by the National Research Council during the Fiscal Year 1936-1937

Author	In co-operation with	Title and reference
Aamodt, O. S. and Platt, A. W.	University of Alberta.....	Varietal testing for the reaction of oats to diseases, especially covered smut. Can. J. Research, C, 14: 425-437. 1936.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the endoparasitic fauna of Trinidad. III. Some parasites of Trinidad carnivores. Can. J. Research, D, 14: 25-38. 1936.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the heterophyid trematode, <i>Apophallus venustus</i> (Ransom, 1920) in Canada. Part I. Morphology and taxonomy. Can. J. Research, D, 14: 59-69. 1936.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the endoparasitic fauna of Trinidad mammals. IV. Further parasites from Trinidad deer. Can. J. Research, D, 14: 160-167. 1936.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the endoparasitic fauna of Trinidad mammals. V. Further parasites from the ocelot. Can. J. Research, D, 15: 24-27. 1937.
Cameron, T. W. M.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the heterophyid trematode, <i>Apophallus venustus</i> (Ransom, 1920) in Canada. Part II. Life history and bionomics. Can. J. Research, D, 15: 38-51. 1937.
Griffiths, H. J.....	Institute of Parasitology, Macdonald College, McGill University.	On the fourth stage larva of <i>Chabertia ovina</i> . Can. J. Research, D, 14: 168-171. 1936.
Guest, G. H. and Larmour, R. K.	Sask. Agr. Research Foundation and the University of Saskatchewan.	The effect of fermentation on some properties of gluten. Can. J. Research, C, 14: 222-228. 1936.
Levitt, J. and Scarth, G. W.	McGill University.....	Frost-hardening studies with living cells. I. Osmotic and bound water changes in relation to frost resistance and the seasonal cycle. Can. J. Research, C, 14: 267-284. 1936.
Levitt, J. and Scarth, G. W.	McGill University.....	Frost-hardening studies with living cells. II. Permeability in relation to frost resistance and the seasonal cycle. Can. J. Research, C, 14: 285-305. 1936.
Moore, R. G. D. and Hibbert, H.	McGill University and Canadian Pulp & Paper Assoc.	Studies on lignin and related compounds. XXVIII. The behavior of lignin towards activated hydrogen. Can. J. Research, B, 14: 404-407. 1936.
Parnell, I. W.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the bionomics and control of the bursate nematodes of horses and sheep. II. Technique. Can. J. Research, D, 14: 71-81. 1936.
Parnell, I. W.....	Institute of Parasitology, Macdonald College, McGill University.	Studies on the bionomics and control of the bursate nematodes of horses and sheep. III. Further observations on the toxicity of urine and some related substances for sclerostome larvae in feces. Can. J. Research, D, 14: 172-180. 1936.
Pavlychenko, T. K.....	Univ. of Saskatchewan, and the Dom. Dept. Agriculture.	The soil-block washing method in quantitative root study. Can. J. Research, C, 15: 33-57. 1937.
Sadler, W., Eagles, B. A., Bowen, J. F. and Wood, A. J.	Empire Marketing Board and Univ. of B.C.	Cheese-ripening studies. The influence of different extracts on the acid production of lactic acid bacteria. Can. J. Research, B, 14: 139-151. 1936.
Smith, S. and Convey, J....	University of Alberta.....	The hyperfine structure separations of some terms in the Thallium III spectrum. Can. J. Research, A, 14: 139-151. 1936.
Swales, W. E.....	Institute of Parasitology, Macdonald College, McGill University.	Further studies on <i>Fascioloides magna</i> (Bassi, 1875) Ward, 1917, as a parasite of ruminants. Can. J. Research, D, 14: 83-95. 1936.
Swales, W. E.....	Institute of Parasitology, Macdonald College, McGill University.	<i>Tetrameres crami</i> Swales, 1933, a nematode parasite of ducks in Canada. Morphological and biological studies. Can. J. Research, D, 14: 151-164. 1936.
Torrie, J. H.....	University of Alberta.....	Inheritance studies of several qualitative and quantitative characters in spring wheat crosses between varieties relatively susceptible and resistant to drought. Can. J. Research, C, 14: 368-385. 1936.
Trister, S. M. and Hibbert, H.	Can. Pulp and Paper Assoc. and Mr. Harry Bronfman, Montreal.	Studies on reactions relating to carbohydrates and polysaccharides. LII. The preparation, separation and identification of the isomeric propylidene, isobutylidene, <i>t</i> -amylidene and dibromoethylidene glycerols and the general properties of glycerol cyclic acetals. Can. J. Research, B, 14: 415-426. 1936.
Woodford, E. K., and McCalla, A. G.	University of Alberta.....	The absorption of nutrients by two varieties of wheat grown on the black and gray soils of Alberta. Can. J. Research, C, 14: 245-266. 1936.

APPENDIX B

Papers Published by Members of the National Research Council Staff During the Fiscal Year 1936-1937

THE PRESIDENT OF THE NATIONAL RESEARCH COUNCIL

Title	Reference
The relation of research to industry.....	Technical Section, Canadian Pulp and Paper Association, January 29, 1936.
The value of research in industry.....	Chamber of Commerce, Hamilton, Ont., March 3, 1936.
The National Research Council and industry.....	Society of Chemical Industry, Montreal Section, April 15, 1936.
Industrial and scientific research as applied to manufacture, with special reference to the part played by the National Research Council.	Canadian Manufacturers' Association, Annual Meeting, Quebec, Que., June 3, 1936.
The trajectory chart for the graphical solution of the gunnery problems of crest clearance and air burst ranging.	Published for private circulation, January 3, 1937, reprinted as a Supplement to Canadian Artillery Summary, April, 1937.
Organization of research in Canada.....	Nova Scotian Institute of Science, Halifax, N.S., February 15, 1937.

DIVISION OF BIOLOGY AND AGRICULTURE

Author	Title	Reference
Anderson, J. A. and Sallans, H. R.	Determination of the diastatic power of malt in degrees Lintner by means of a ferricyanide reagent.	Can. J. Research, C, 15: 70-77. 1937.
Hopkins, J. W.....	Weather and wheat yield in western Canada. II. Influence of pre-seasonal precipitation on plot yields. III. Relation between precipitation and agricultural yield.	Can. J. Research, C, 14: 229-244. 1936.
Hopkins, J. W.....	Agricultural meteorology: Some characteristics of precipitation in Saskatchewan and Alberta.	Can. J. Research, C, 14: 319-346. 1936.
Hopkins, J. W.....	Effect of fertilizers on yield and malting quality of Manitoba barley.	Sci. Agr. 17: 250-259. 1937.
Hopkins, J. W., Munro, S. S. and Bird, S.	Inheritance of egg production in the domestic fowl. IV. Reliability of progeny tests of sires.	Sci. Agr. 17: 393-400. 1937.
Munro, S. S., Bird, S. and Hopkins, J. W.	Inheritance of egg production in the domestic fowl. III. Differences in transmitting ability of dams and the degree of dam-daughter and correlation.	Sci. Agr. 17: 386-392. 1937.
Peto, F. H.....	Hybridization of <i>Triticum</i> and <i>Agropyron</i> . II. Cytology of the male parents and F_1 generation.	Can. J. Research, C, 14: 203-214. 1936.
Peto, F. H.....	Heat induced tetraploidy in barley.....	Can. J. Research, C, 14: 445-447. 1936.

DIVISION OF CHEMISTRY

Author	Title	Reference
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Bayley, C. H.....	A case of overbleaching in table linen.....	Laundry & Dry Cleaning, J. Can. 16 (5): 14. 1936.
Bayley, C. H.....	Canadians organize research.....	Nat. Cleaner & Dyer, 27 (5): 50, 68. 1936. (Also appeared in Starchroom J.)
Bayley, C. H.....	Notes on the removal of some typical hospital stains...	Laundry & Dry Cleaning, J. Can. 16 (6): 12. 1936.
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Bayley, C. H.....	Damage in curtain fabrics and window drapes. Part II.	Laundry & Dry Cleaning, J. Can. 16 (10): 16. 1936.
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DIVISION OF CHEMISTRY—*Concluded*

Author	Title	Reference
Bayley, C. H.....	The work of the Laundry and Cleaning Research Laboratory, National Research Council, Ottawa, 1936.	Laundry & Dry Cleaning, J. Can. 17 (1): 14. 1937.
Bayley, C. H.....	Solvent recovery from still and filter sludges in dry cleaning installations using tri- and perchlorethylene.	Laundry & Dry Cleaning, J. Can. 17 (2): 14-16. 1937.
Bayley, C. H.....	Identification of textile fibres. A simplified method.	Laundry & Dry Cleaning, J. Can. 17 (3): 14. 1937.
Gallay, W.....	The effect of concentration on the viscosity of starch pastes.	Can. J. Research, B, 14: 391-403. 1936.
Gallay, W.....	The alteration of the flow characteristics and texture of starch pastes.	Can. J. Research, B, 14: 409-414. 1936.
Gallay, W. and Bell, A. C...	The effect of various starches on the stability of baking powders.	Can. J. Research, B, 14: 204-215. 1936.
Gallay, W. and Bell, A. C...	The viscosity of corn starch pastes.....	Can. J. Research, B, 14: 360-372. 1936.
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Grace, N. H.....	A comparative study of semi-scalding and dry-roughing in relation to the ease of removing pin feathers by wax dressing.	Sci. Agr. 17: 50-55. 1936.
Grace, N. H.....	Wax picking. Simple methods for small growers.....	Turkey World, Oct. 16-17, 43-46. 1936.
Graham, W. E.....	Highly sized fabric linings as a cause of deterioration of chrome upper leather.	Shoe & Leather J. 20: 54-56. 1937.
Graham, W. E.....	The Leather Research Laboratory of the National Research Council, Ottawa.	Shoe & Leather J. 20: 46-47. 1937.
Hopkins, C. Y.....	Thermal death point of certain weed seeds.....	Can. J. Research, C, 14: 178-183. 1936.
Larose, P.....	Casein wool. Properties and commercial possibilities of new wool substitute.	Can. Textile J. 53 (8): 45-46. 1936.
Larose, P.....	Benzene rings. (Letter).....	J. Soc. Chem. Ind. 55: 547. 1936.
Larose, P.....	A convenient microprojection apparatus.....	Can. J. Research, A, 14: 131-133. 1936.
Larose, P. and Tweedie, A. S.	The determination of sulphur in wool.....	Can. J. Research, B, 15: 65-74. 1937.
Manske, R. H.....	The alkaloids of fumariaceous plants. XI. Two new alkaloids, Corlumine and Corlumidine, and their constitutions.	Can. J. Research, B, 14: 325-327. 1936.
Manske, R. H.....	The alkaloids of fumariaceous plants. XII. <i>Corydalis scouleri</i> Hk.	Can. J. Research, B, 14: 347-353. 1936.
Manske, R. H.....	The alkaloids of fumariaceous plants. XIII. <i>Corydalis sibirica</i> Pers.	Can. J. Research, B, 14: 354-359. 1936.
Manske, R. H.....	The natural occurrence of acetyl-ornithine.....	Can. J. Research, B, 15: 84-87. 1937.
Pidgeon, L. M.....	Studies of carbon black. II. The channel process—Production from the natural gas of Turner Valley, Alberta.	Can. J. Research, B, 14: 127-137. 1936.
Whitby, G. S. and Cambron, A.	Possible new uses for Canadian natural gas.....	Can. Mining Met. Bull. Aug. 497-502. 1936.
Whitby, G. S. and Green, F. G.	Advances in Canada in the realm of chemical engineering.	Chem. Eng. Congress of the World Power Conference, June, 1936.

DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING

Author	Title	Reference
Ballard, B. G.....	An electronic speed governor.....	Can. J. Research, A, 14: 134-158. 1936.
Field, G. S. and Henderson, J. T.	Testing of loudspeakers in radio receivers.....	Proc. Roy. Soc. Canada, Ottawa Meeting, May, 1936.
Field, R. H.....	Elementary principles of stereo-plotter for air photographs.	Can. Surveyor, Jan. 1937.
Henderson, J. T.....	Performance of radio receivers.....	Proc. Roy. Soc. Canada, Ottawa Meeting, May 1936.
Henderson, J. T.....	Changes in the earth's electric field.....	Proc. Roy. Soc. Canada, Ottawa Meeting, May 1936.
Henderson, J. T.....	Effect of lightning flashes on a wireless receiver.....	Proc. Roy. Soc. Canada, Ottawa Meeting, May 1936.
Laurence, G. C.....	Measurement of extra-hard X-rays and gamma rays...	Can. J. Research, A, 15: 67-78. 1937.
Laurence, G. C.....	The measurement of very hard X-rays in Roentgens...	Phys. Rev. 51: 374. 1937.

DIVISION OF PHYSICS AND ELECTRICAL ENGINEERING—*Concluded*

Author	Title	Reference
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Niven, C. D.....	A gas-tight furnace for thermocouple standardization..	Can. J. Research, A, 14: 177-180. 1936.
Rose, D. C.....	Measurement of projectile velocities by photocell method.	Can. J. Research, A, 15: 1-14. 1937.
Sanders, F. H.....	Diffraction of light by ultrasonic waves.....	Proc. Roy. Soc. Canada, Ottawa Meeting, May 1936.
Sanders, F. H.....	Diffraction of light by ultrasonic waves.....	Can. J. Research, A, 14: 158-171. 1936.
Sanders, F. H.....	Diffraction of light by ultrasonic waves.....	Nature, 138: 285. 1936.

DIVISION OF MECHANICAL ENGINEERING

Author	Title	Reference
Green, J. J.....	Aerodynamic improvements in aircraft ski design.....	Can. Aviation, 9 (4): 8-10. 1936.
Green, J. J.....	The story of the "Silver dart".....	Can. Aviation, 10 (1): 6, 7, 10. 1937.
Green, J. J.....	Early aeronautical research in Canada, Part II.....	Can. Aviation, 10 (2): 7, 9, 13. 1937.
Green, J. J.....	Early aeronautical research in Canada, Part III.....	Can. Aviation, 10 (3): 14, 15, 22. 1937.
Tupper, K. F.....	Note on the acceleration of ships.....	Can. J. Research, A, 15: 15-24. 1937.

DIVISION OF RESEARCH INFORMATION

Author	Title	Reference
Lathe, F. E. and Pitt, N. P.	New Canadian refractories and their applications....	Proc. Chem. Eng. Congress, June, 1936.

NOTE.—The total number of papers published by members of the staff of each division of the National Research Council from the opening of the new laboratories (1932) to date is as follows:—

Division of Biology and Agriculture.....	60
Division of Chemistry.....	140
Division of Physics and Electrical Engineering.....	45
Division of Mechanical Engineering.....	28
Division of Research Information.....	26
Total.....	299

APPENDIX C

Publications of the National Research Council

Annual Reports

Annual Reports for fiscal years 1916-17 to 1936-37.

Canadian Journal of Research

The Journal has been issued since May, 1929. Complete sets are still available, at the following prices:

Volumes 1-12, unbound, each.....	\$1.50
Volumes 1-12, single copies.....	.35
Volume 13—	
Sections A and B, Physical and Chemical Sciences, unbound, each volume.....	1.25
Sections C and D, Botanical and Zoological Sciences, unbound, each volume.....	1.25
Single issues, Sections A and B or C and D.....	.25

Subscription rates, postage paid to any part of the word, are as follows:

Sections A and B.....	\$2.50 per year
Sections C and D.....	\$2.50 per year
Four sections complete.....	\$4.00 per year

NOTE.—Only a limited free distribution of technical reports and bulletins can be made. Single copies of any of those not out of print are available at 25c. each.

Technical Reports

Report Number	Title	Date	Author
1.	The Briquetting of Lignites.....	1918	R. A. Ross.
2.	The Recovery of Vapors from Gases.....	1918	Harold S. Davis and Mary Davidson Davis.
3.	The De-tarring of Gas by Electrical Precipitation. (Out of print).....	1918	J. G. Davidson.
4.	Nicotine and Tobacco Waste. (Out of print)....	1919	A. D. Hone.
5.	Canadian Waste Sulphite Liquor as a Source of Alcohol.....	1919	V. K. Krieble.
6.	An Investigation into the Question of Early Putre- faction of Eviscerated Fish in which the Gills have been Left. (Out of print).....	1919	L. Gross.
7.	Survey of General Conditions of Industrial Hygiene in Toronto.....	1921	Associate Committee on Industrial Fatigue.
8.	A Method of Smelting Titaniferous Iron Ore. (Out of print).....	1921	W. M. Goodwin.
9.	Food Requirements of the Ranch Fox.....	1921	G. E. Smith.
10.	Fuel Saving Possibilities in House Heating.....	1922	L. M. Arkley and James Govan.
11.	The Red Discoloration of Cured Codfish. (Both English and French editions).....	1922	F. C. Harrison and Miss Margaret Kennedy.
12.	The Discoloration, Smut or Blackening of Canned Lobster. (Out of print).....	1923	F. C. Harrison and E. G. Hood.
13.	Cultural Criteria for the Distinction of Wood- destroying Fungi.....	1924	Clara W. Fritz.
14.	The Utilization of the Low Grade Iron Ores of Canada.....	1924	Subcommittee on Iron Ores.
15.	Marine Borers on the Atlantic Coast of Canada...	1925	R. H. M'Gonigle.
16.	The Relation of Bacteria to the Quality of Graded Butter.....	1926	Wilfred Sadler and R. L. Vollum.
17.	The Mosquitoes of the Lower Fraser Valley, British Columbia, and Their Control.....	1926	Eric Hearle.
18.	Investigations on the Treatment of Nova Scotia Oil Shales.....	1926	A. E. Flynn.

Technical Reports—Concluded

Report Number	Title	Date	Author
19.	Bacteriology of Certain Sea Fish.....	1926	F. C. Harrison.
20.	Consideration of the Relation between the Distribution of Toredon Navalis and Temperature and Salinity of its Environment.....	1926	R. H. M'Gonigle.
21.	The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer.....	1927	J. H. Fox.
22.	An Experimental Study of Sieving.....	1928	J. B. Porter.
23.	The Storage of Apples in Air-cooled Warehouses in Nova Scotia.....	1928	S. G. Lipsett.
24.	The Drying of Wheat.....	1929	Associate Committee on Grain Research.
25.	The Drying of Wheat (Second report).....	1932	E. Stansfield and W. H. Cook.
26.	Weed Survey of the Prairie Provinces.....	1932	J. M. Manson.
27.	Weeds and Their Control.....	1932	G. P. McRostie, L. E. Kirk, G. Godel, W. G. Smith and J. M. Manson.
28.	Comparative Feeding Values for Livestock of Barley, Oats, Wheat, Rye and Corn.....	1933	E. W. Crampton.
29.	Comparative Feeding Values for Poultry of Barley, Oats, Wheat, Rye and Corn.....	1936	E. W. Crampton.

NOTE.—The series of technical reports has been discontinued. Future publications will appear as "Bulletins."

Bulletins

Bulletin Number	Title	Date	Author
1.	The Need of Industrial Research in Canada.....	1918	Frank D. Adams.
2.	Researches on Sound Measurement with Reference to the Testing of Fog Signal Machinery.....	1918	L. V. King.
3.	How to Handle Frozen Fish. (Out of print).....	1918	E. E. Prince.
4.	Hints on Frozen Fish. (Out of print).....	1918	E. E. Prince.
5.	Science and Industry.....	1918	J. C. Fields.
6.	The Heating of Houses, Coal and Electricity Compared. (Out of print).....	1918	A. S. L. Barnes.
7.	The Manufacture of Ethyl Alcohol from Wood Waste. (Out of print).....	1919	G. H. Tomlinson.
8.	Some of the Problems of the Fox Raising Industry. (English edition out of print).....	1920	Andrew Hunter.
9.	The Honorary Advisory Council for Scientific and Industrial Research and its Work. A Brief Resume of the Activities of the Council up to 1921. (Out of print).....	1921	Frank D. Adams.
10.	A Plan for the Development of Industrial Research in Canada.....	1921	R. F. Ruttan.
11.	Nitrogen Fixation. (Out of print).....	1924	Associate Committee on Nitrogen Fixation.
12.	Nitrogen in Industry.....	1926	Associate Committee on Nitrogen Fixation.
13.	Interim Report on Protein Content as a Factor in Grading Wheat.....	1929	R. Newton and J. G. Malloch.
14.	Report on Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat.....	1930	R. Newton.
15.	Review of Literature Dealing with Health Hazards in Spray Painting.....	1930	Associate Committee on Spray Painting.
16.	Health Hazards in the Radium Industry.....	1935	John D. Leitch.
17.	Radium Dosage.....	1936	G. C. Laurence.
18.	Chemical Weed Killers.....	1937	W. H. Cook and A. C. Halferdahl.
19.	Peaux et Cuirs.....	1937	W. E. Graham.

NOTES:

(1) A bulletin entitled "The Use of Wax in the Plucking of Poultry," by Dr. N. H. Grace, has been published jointly by the National Research Council and the Dominion Department of Agriculture.

(2) In addition to the foregoing list of printed reports and bulletins issued by the Council, 53 reports have been mimeographed and 263 typewritten. Most of these reports were prepared in response to requests for information on specific subjects and were intended only for limited distribution.

(3) See also Note to Appendix B.

APPENDIX D

Publications of the Canadian Engineering Standards Association

(The National Research Council's Associate Committee on
Engineering Standards)

No.	
A 1—1928	Standard Specification for Steel Railway Bridges (third edition). Price 50c.
A 1a—1928	Material Specifications, Steel Railway Bridges (second reprint). Price 15c.
C 2—1929	Standards for Single-phase Distribution Transformers (second edition).
C 3—1924	Standard Specification for Galvanized Telegraph and Telephone Wire (reprint).
B 4—1921	Standard Specifications for Wire Rope for Mining, Dredging and Steam Shovel Purposes (out of print).
A 5—1927	Standard Specification for Portland Cement (second edition). (Out of print).
A 6—1929	Standard Specification for Steel Highway Bridges (second edition). Price 50c.
D 7—1922	Standard Specification for Flexible Steel Wire Rope and Flexible Strand for Aircraft Purposes.
C10—1923	Standard Specification for Tungsten Incandescent Lamps.
D11—1924	Interim Report on the Manufacture, Testing and Use of Gasoline.
B12—1924	Standard General Specification for Galvanized Steel Wire Strand.
E13—1924	Standard Specification for Railway Wire-fencing and Gates.
C14—1924	Standard Specification for Reinforced Concrete Poles.
C15—1924	Standard Specification for Eastern Cedar Poles (out of print).
A16—1930	Standard Specification for Steel Structures for Buildings (second edition).
C17—1925	Standard Requirements for A.C. Watthour Meters.
B18—1930	Established List of Stove Bolts (second edition).
A19—1926	Standard Classification for Items of Highway Expenditure.
A20—1927	Standard Specifications for Movable Bridges.
C21—1927	Standard Specification for Control Cable for Electrical Power Plant Equipment.
C22—1935	Canadian Electrical Code—Part I (third edition)—Inside Wiring Rules.
C22.2	Canadian Electrical Code—Part II—Approval Specifications.
No. 0—1936	Definitions and General Requirements (second edition).
No. 1—1932	Power-operated Radio Devices.
No. 2—1933	Electric Signs.
No. 3—1933	Electrical Equipment for Oil-burning Apparatus.
No. 4—1935	Construction and Test of Enclosed Switches. Price 50c.
No. 5—1934	Service-entrance and Branch-circuit Breakers.
No. 6—1933	Electric Clocks.
No. 7—1933	Portable Electric Displays and Incandescent Lamp Signs.
No. 8—1934	Capacitors (Electrical Condensers).
No. 9—1933	Electric Fixtures.
No. 10—1933	Electric Floor-surfacing and Cleaning Machines.
No. 11—1934	Fractional Horsepower Motors.
No. 12—1936	Electric Portable Lighting Devices (Portables). (second edition)
No. 13—1935	Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment.
No. 14—1935	Industrial Control Equipment in Ordinary (<i>i.e.</i> , Non-hazardous) Locations. Price 50c.
No. 16—1935	Insulated Conductors for Power-operated Radio Devices.
No. 17—1935	Cable for Luminous-tube Signs and for Oil-burner Ignition Equipment.
No. 18—1934	Outlet Boxes.
No. 19—1935	Soldering Lugs.
No. 20—1935	Motor-operated Blowers and Stokers.
No. 21—1935	Cord Sets.
No. 22—1935	Electrical Equipment for Measuring and Discharge Devices for Explosive or Flammable Liquids.
No. 24—1935	Construction and Test of Automatic Motor-control Devices of Small Capacity.
No. 25—1936	Enclosures (other than Explosion-proof) for Use in Hazardous Locations.
No. 26—1935	Auxiliary Gutters, Junction-boxes and Pull-boxes.
No. 27—1936	Wireways and Busways.
No. 29—1936	Panelboards.
No. 30—1936	Enclosed Branch-circuit Cutouts.

- No. 32—1936 Electrically-operated Refrigerating Machines.
 No. 33—1936 Electric Cranes and Hoists.
 No. 34—1936 Electrode Receptacles for Luminous-tube Signs.
 No. 35—1936 Low-voltage Control-circuit Wire and Cable.
 No. 36—1936 Electrical Appliances for Hair Dressing and Hand Drying, etc.
 No. 38—1936 Rubber-covered Wire and Cables (Mimeograph edition).
 No. 39—1936 Cutout Bases.
 No. 40—1936 Cabinets and Cutout Bases.
- C22.3 Canadian Electrical Code—Part III—Standards for Outside Wiring.
- No. 3—1936 Inductive Co-ordination, Definitions and Principles.
 No. 4—1936 Conductive Co-ordination, Principles and Practices for Protecting Underground Structures from the Effects of Stray Currents Originating in Direct Current Electric Railway Systems.
- A—23—1929 Standard Specification for Concrete and Reinforced Concrete. Price \$1.00.
- No.
 G24—1929 Standard Specification for Sampling for Check Analysis of Steel Billets, Bars and Shapes.
 G25—1929 Standard Specification for Carbon Steel Billets and Bars of Forging Quality.
 *G26—1929 Standard Specification for Commercial-quality-hot-rolled Bar Steels.
 *G27—1929 Standard Specification for Commercial Cold-finished Bar-steels and Cold-finished Shafting.
 G28—1929 Standard Specification for Carbon Steel Castings.
 B29—1932 Established List of Machine Screws and Nuts (second edition).
 G30—1930 Standard Specification for Billet-steel Reinforcing Bars (second edition).
 G31—1930 Standard Specification for Rail-steel Reinforcing Bars (second edition).
 G32—1930 Standard Specification for Steel Wire for Concrete Reinforcement (second edition).
 B33—1932 Established List of Cap Screws, Set Screws and Studs, Common and Semi-finished, Slotted and Castellated Hexagon Nuts.
 B34—1934 Established List of Non-heat-treated Machine, Carriage and Plough Bolts, and Common Square and Hexagon Nuts.
 B35—1933 Established List of Binder Head Screws.
 B37—1932 Standard Blade Punching for Road Grading Machinery.
 A36—1935 Standard Dimensions for Building Brick.
 G38—1935 Standard Specifications for Carbon-steel Forgings.
 S39—1935 Standard Specification for Mild Structural Steel.
 S40—1935 Standard Specification for Medium Structural Steel.
 S41—1935 Standard Specification for Structural Silicon Steel.
 S42—1935 Standard Specification for Structural Rivet Steel.

NOTE.—*G26—1929 and G27—1929 are published in one volume.

The above are on sale at 25 cents per copy, except as noted. On orders of 50 or more copies of any individual specification a discount of twenty per cent (20%) is allowed.

Copies will be sent postpaid on application to: The Secretary, Room 3064, National Research Building, Ottawa, Canada.

APPENDIX E

LIST OF MEMBERS OF ASSOCIATE COMMITTEES AND CONFERENCES

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of Transport, Ottawa, Ont.
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A.F.I.Ae.Sc..... National Steel Car Corporation, Hamilton,
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A.M.E.I.C., R.C.A.F..... Superintendent; Air Regulations, Civil Avia-
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New Brunswick—Mr. G. A. Estey, Grand Falls, N.B.

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Saskatchewan—Mr. G. C. McDonald, Supervisor of Fisheries, Department of Natural Resources, Regina, Sask.

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	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, A.R.C.Sc., M.Sc., Ph.D., LL.D., F.R.S.C., Director of Division of Chemistry.
American Society for Testing Materials.....	Official Representative of the National Research Council.....	F. E. Lathe, M.Sc., Director of Division of Research Information.
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	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....	Vacant.*
Subcommittee V Nomenclature and Definitions.....	Vacant.*	
Subcommittee VII Size of Test Samples.....	Vacant.*	
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 of Division of Research Information.	
Subcommittee I on Tests and Specifications.....	A. C. Halferdahl, B.S., M.A.Sc., Division of Research Information.	
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	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
		Subcommittee V on Viscosity....	J. W. Broughton, M.Sc., Ph.D., Division of Mechanical Engineering.
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Section IV on Detonation.....			
Section V Specifications.....			
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Technical Committee C on Fuel Oils (including Diesel Fuel)....			
Section I on Domestic and Industrial Fuel Oil.....			
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Outside Committees on which the National Research Council has Representation—Concluded

Authority	Committee	Representative of the National Research Council
Conference on Agricultural Statistics.....	Committee on Agricultural Meteorology.....	R. Newton, B.S.A., M.Sc., D.Sc., Ph.D., F.R.S.C., Director of Division of Biology and Agriculture J. W. Hopkins, M.Sc., Ph.D., Division of Biology and Agriculture.
Dominion Fire Commissioner.....	Committee on Liquefied Petroleum Gases.....		A. F. Gill, M.A., Division of Research Information.
Interdepartmental Committee.....	Flax.....	R. Newton, B.S.A., M.Sc., D.Sc., Ph.D., F.R.S.C., Director of Division of Biology and Agriculture. N. H. Grace, M.A., Ph.D., 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.A., M.Sc., Ph.D., F.R.S.C., Director of 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 Electrical Engineering.
National Advisory Committee on Agricultural Services.....		R. Newton, B.S.A., M.Sc., D.Sc., Ph.D., F.R.S.C., Director of Division of Biology and Agriculture.
National Barley Committee.....		R. Newton, B.S.A., M.Sc., D.Sc., Ph.D., F.R.S.C., Director of 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.....		R. Newton, B.S.A., M.Sc., D.Sc., Ph.D., F.R.S.C., Director of Division of Biology and Agriculture.
Radiological Society of North America.....	Standardization Committee.....	G. C. Laurence, M.Sc., Ph.D., Division of Physics and Electrical Engineering.

* Former member was T. H. Doherty, B.Sc.

APPENDIX F

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 monies 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.

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