NATIONAL RESEARCH COUNCIL ANNUAL REPORT 1935-36.

National Research Council
OTTAWA
CANADA
Chemistry Division

DOMINION OF CANADA

NINETEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

AND

FINANCIAL STATEMENT

1935-1936

OTTAWA, CANADA

THE HON. W. D. EULER,
Chairman, Committee of the Privy Council on
Scientific and Industrial Research,
Ottawa, Ontario.

SIR:

I have the honor to present to you herewith the Nineteenth Annual Report of the National Research Council, for the fiscal year 1935–1936.

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

Your obedient servant,

A. G. L. MCNAUGHTON,
President, National Research Council.

25657—1½

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MINISTER OF MINES
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MINISTER OF LABOR
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NATIONAL RESEARCH COUNCIL
1935-1936

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NINETEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

REVIEW OF ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL 1935-36

Improvement of industrial technique and the better utilization of Canada's resources in men and materials continued to be the keynote of the work carried on in the National Research Laboratories during the year ended March 31, 1936. Marked success was attained in several fields, as may be seen from the following brief reviews on the work of the several laboratory divisions and other activities of the Council.

Laboratory Divisions

Chemistry

In the Division of Chemistry valuable work has been done in relation to the possible utilization of Alberta's natural gas, much of which has been going to waste for years. Optimum conditions have been determined for the production of ethylene, a starting material for the manufacture of industrial alcohol, and estimates of the cost of making alcohol from Alberta natural gas have been prepared. Further work has yielded a method by which it is possible through heat treatment to produce from each thousand cubic feet of Turner Valley "stabilizer" gas, ordinarily wasted, three to four gallons of benzene, which when blended with gasoline yields motor fuel that has very good anti-knock properties. The work also appears to have solved satisfactorily some of the technical difficulties involved in the use of alloy steel at the high temperatures required.

A second and related research dealt with the utilization of "off-gas" from the pyrolysis operations for the production of carbon black. Yields of more than double the usual practice have been obtained on a commercial scale, and extensive rubber tests have shown that the product is in every way equal to the best obtainable on the market. The significance of this work is found in the fact that at the present time all carbon black used in Canada is imported, while in Alberta the natural gas from which it could be made is being allowed to go to waste for lack of an economic method of utilization.

Substantial contributions have been made to the knowledge of the chemical principles of plants. Poisonous plants, a menace to livestock, have been studied, and the investigations have led to the separation of alkaloids which may offer practical possibilities as insecticides. New synthetic substances have been prepared which when applied in small amounts stimulate plant growth to an amazing degree. Because of their influence in causing root formation, they may prove of practical value for purposes such as the propagation of trees from clippings.

Research of considerable industrial value is being carried on in the laundry field, including the systematic study of the efficiencies of materials used in dry cleaning processes. Substantial progress has been made in studies

on the possible use of potato starches in place of those made from corn. Work on magnesian products has led to the development of a whole series of new refractories, including an improved plastic refractory that is finding a wide market.

A special wax was produced which can be used to remove the pin-feathers from fowl. It is not expensive, and by its use poultrymen can prepare for market birds which are cleanly plucked and attractive. Production is now on a commercial basis.

In the paint laboratory considerable work has been done in the preparation of specifications for the purchase of paint materials. The laboratory has developed a new method of measuring the tinting power of paints and has studied the weathering of paints and enamels, both out of doors and in an accelerated testing apparatus.

Among other chemical studies advanced during the year may be mentioned researches on asbestos, bleaching clays, dehydration of fruits and vegetables, leather and fur dressing, printing and paper, rubber, textiles, the utilization of wastes and the industrial use of agricultural products.

Biology and Agriculture

Close co-operation with provincial and federal departments of agriculture has enabled the division to make good progress in research on practical problems, the results of which are finding application in Canadian agriculture.

Research on wheat and barley has received special attention. In view of the recent situation in the wheat market, the improvement in quality and marketability of possible substitute crops has become a problem of first importance, and in this connection attention has been directed particularly to barley.

Studies have been made of the requirements for barley suitable for malting, particularly in regard to its sale in the British market. Varieties of barley are being investigated thoroughly, and laboratory examinations of the protein and diastase content, which are very important elements in a malt barley, are being made.

Weeds, which cause greater losses to agriculture than insects, plant and animal diseases combined, have been studied intensively, as their importance warrants. A comprehensive review of the literature on chemical weed killers has been made as a guide to experimental research in this field.

Cold storage of fowl, fruits and other food products, has become so widespread that the investigation of the numerous problems arising in connection with domestic and foreign trade movements of foodstuffs in storage has demanded attention. Defrosting and dechilling of poultry in such a way as to prevent the formation of condensate, which lowers the market quality, have been subjected to extensive laboratory study, as a result of which the physical conditions necessary for dechilling boxed poultry have been established. Temperature, humidity and air movement studies undertaken with a view to finding why celery losses in storage were so great in certain Montreal warehouses, provided information that has made it possible to prevent, in large measure, the losses previously suffered.

With the object of producing a forage crop for western Canada which possesses drought resistance, soil-binding properties and large seeds, an investigation is under way in the hybridization of wheats and wheat grasses. Partially fertile lines of considerable economic promise have already been produced and progress has been made in the development of a heat treatment technique whereby fertility may be induced in previously sterile hybrids.

Experiments in the production of new heritable characters in barley by heat treatments have resulted in the production of several new variants, some of which may be of economic importance.

Other work of this division includes studies on the nature of disease resistance in plants, standardization of baking tests, taints in wheat, work on root parasites of agricultural plants and statistical analyses of agricultural data.

Physics and Engineering

Of the year's work in the division, mention is made of only a few of many researches in progress or completed. International co-operation was promoted through the exchange of work with the National Bureau of Standards in Washington in the standardization of invar measuring wires. Verification of all departmental standard weights specified under the Weights and Measures Act was completed during the year and two platinum-iridium one-pound standard weights were compared. The National Research Council has the custody of one of these weights and the Speaker of the Senate keeps the other. Originally there were three, but one was lost in 1916 when the parliament buildings were burned.

Since the establishment of the radium laboratory, more than 700 needles and radium preparations have been measured and certified. Towards the end of the year the radiology laboratory constructed and was distributing six portable X-ray intensity meters for testing equipment in cancer clinics. The universities are co-operating with the National Research Council by taking charge of and operating these instruments. It is very important that patients get the correct dosage and this can be assured only by having the equipment properly standardized and tested at intervals.

A "reverberation chamber" has been built and by means of it measurements have been made for commercial firms and government departments on the sound-absorbing properties of various kinds of building materials. Useful results have been obtained.

In a study of atmospheric electrical effects, the records of the variation of the potential gradient, taken continuously for a year, indicated the existence of a new effect which might be important. Plans were made for an investigation of the electrical charging of clouds which results in thunderstorms. It is expected that an experimental study of atmospheric electrical observations taken from aeroplanes will yield valuable information.

Numerous requests for optical tests indicate increasing dependence upon spectrum analysis in industry. Considerable work was done in various applications of the photoelectric cell to photometry, and a photoelectric absorption meter of compact design and high sensitivity was developed and adapted to several purposes, notably the grading of sugar samples. To secure information for architectural and building projects an experimental study was made of the intensity of north sky light and its rate of variation.

Apparatus completed during the year enables the laboratories to make thermal insulation tests on large samples of insulating materials, partitions, and wall sections, which are necessitated by growing appreciation of the value of insulated buildings.

Another project of considerable commercial value, carried through the experimental stage during the year, was the heating of railway refrigerator cars in winter. A method was developed for the introduction of heat near the floor instead of at the ends as in present practice. Application has been made for a patent on the heater and pipe system subsequently designed.

With the co-operation of the Canadian National Railways, a coast-to-coast test was made with such good results that it is understood a fleet of refrigerator cars will be equipped with the new device at an early date. The saving from spoilage of perishable freight through the adoption of this method is expected to be substantial.

Serving several other laboratories, the electrical engineering staff have completed work on a research problem looking to the design of a precision voltage regulator for the output of either alternating or direct current machines. This will be of great use for X-ray work, photometry, electrical measurements, radio, and in fact wherever precise control of electricity is essential.

Aerial surveys provided another field of work for the physicists. A new type of plotting instrument, designed and constructed under the supervision of the Associate Committee on Survey Research, permits certain refinements in making maps from high, oblique photographs. It is particularly valuable in the mapping of previously unexplored country where no ground surveys have been made.

In the aeronautical laboratories, many varied problems in connection with the development of aviation in Canada are being studied continuously. The equipment is also used for tests of other kinds, as for example in the design of a streamlined locomotive which has been made available to the two large Canadian railway companies, both of which, towards the close of the year, had under construction locomotives of this type.

Aircraft skis have been a cause of inferior performance, but work finished this year has produced a new type of ski which indicates that aircraft so equipped will be superior to those with wheel gear. Practical tests are being made. Defects in aeroplane floats have also been corrected.

Incorporating the results of information obtained in the National Research Laboratories, a new type of freight aircraft has been designed. One machine has been built and two others are under construction by a Canadian firm for service in the north country where air-freighting is making a substantial contribution to the opening of new mining and timber areas. Numerous other problems are gradually yielding to the concentrated attack being made upon them by the scientists and engineers who comprise the staff.

Research Information

Back of the laboratory work is the Division of Research Information, which is responsible for searching the literature for records of what others have done or are doing, compiling bibliographies for convenience of reference, answering thousands of technical inquiries from all parts of the Dominion, publishing the results of scientific studies, and assisting in the co-ordination of the work under the Council's direction. The National Research Library continues to increase its usefulness; duplication of effort is avoided in a field where the need for co-operation is fully recognized.

In July, 1935, a change was made in the form of publication of the Canadian Journal of Research. Beginning as a bi-monthly in May, 1929, the Journal was placed on a monthly basis in September of that year and was continued in this form until June, 1935. From July 1, 1935, in order to provide adequately for the increasing number of papers being received, the Journal was divided into two parts, each containing two sections: Section A, Physical Sciences; Section B, Chemical Sciences; Section C, Botanical Sciences; Section D, Zoological Sciences. For the present, Sections A and B are being issued under a single cover, as also are Sections C and D, with separate pagination of the four sections to permit separate binding.

Conferences

Forestry

In co-operation with industry and with other government departments, the National Research Council organized a Conference on Forestry Research in November, 1935. This was attended by provincial and federal officials, representatives of the pulp and paper industry, lumbermen's associations, forest engineers, that is, by those interested in the conservation and development of Canada's timber. As a result of the conference, arrangements were made for the appointment of an Associate Committee on Forestry under the Council to plan and co-ordinate research in this field and to indicate who should carry it out and in what areas.

Fish Culture

A conference on research work in the field of fresh water fisheries was held in January, 1936, under the joint auspices of the Biological Board, the Dominion Department of Fisheries and the National Research Council, in order to obtain a comprehensive view of the problems of fresh-water fish culture in the several provinces, to interchange information, and to plan further research.

This conference was attended by representatives of the federal and provincial departments of fisheries, the game associations, railways, and tourist organizations. The papers read presented a cross-section of the views of all concerned in the promotion of Canadian inland fisheries, which yield an annual revenue of more than $5,000,000, or about one-seventh of the total income derived from the sea and inland fisheries together.

As a result of the conference, a National Committee on Fish Culture was formed to give direction to the work in this field throughout Canada. Members of the committee include representatives of the Biological Board of Canada, the Dominion Department of Fisheries, the National Research Council, the two principal railway companies, the Canadian Travel Bureau, and each of the provincial governments.

Associate Committees

The Associate Committee on Potato Research, appointed following the Conference on Potatoes during the preceding year, met on January 20, 1936, and formulated a program of research which is being given effect in the National Research Laboratories and in various divisions of the Department of Agriculture, both in Ottawa and at several experimental stations. To a large extent the technical problems of substituting potato starch for corn products have been solved; economic factors, however, have yet to be overcome. Potato-breeding experiments are being carried on at several stations.

The Canadian Government Purchasing Standards Committee, which is sponsored by the National Research Council, continued its work throughout the year. It was formed early in the fiscal year 1934-35 and has as its purpose the preparation of commodity specifications for Dominion Government departments.

During the year two new associate committees of the Council were established, two others were reorganized, and three associate committees, having completed their work, were disbanded.

At the suggestion of the Deputy Minister of Agriculture, an Associate Committee on Market Poultry was established under the joint auspices of the Dominion Department of Agriculture and the National Research Council in May, 1935. The appointment of this committee followed a conference

which was largely attended by representatives of the poultry produce trade, the Department of Agriculture, the National Research Council, the Canadian Produce Association and the poultry departments of the agricultural colleges at Guelph and Ste. Anne de Bellevue. In the production, storage and transport of dressed poultry, many problems, as for example those relating to refrigeration, require scientific investigation. The greater part of the commerce involved is domestic, but export trade in dressed poultry is increasing in volume and importance.

A Special Committee on Hydraulic Research was appointed by Council in November, 1935, to consider the requirements of the several departments of the Dominion Government and of industry in respect to the provision of laboratory facilities for research and testing in connection with stream flow, power development, harbor works, river control, canals and channels, hydraulic machinery and equipment. It was intended that the existing facilities at the Rideau Falls should be used for this purpose. Certain modifications and additions to the equipment are to be made if and as required.

Following a recommendation made by the Woodlands Section of the Canadian Pulp and Paper Association at Petawawa in July, 1935, the Council, in co-operation with the Dominion Forest Service, arranged for a conference of those interested in forestry research, and a meeting was held in Ottawa in November, 1935. The sessions were featured by the presentation of specially prepared papers covering the major branches of research in connection with forestry. As a result of the discussion following the presentation of these papers, the National Research Council was asked to form a committee with the object of determining what research the various forest agencies in Canada were equipped to carry out, what they were actually doing, what means of co-operation existed, and how duplication of effort could be avoided and plans formed to ensure that no vital element in the problem would be overlooked. Accordingly the Council reorganized the Associate Committee on Forestry which had been appointed in March, 1933, in order to give more adequate representation to industry and the various organizations interested in the promotion of forestry research, and to define more clearly the committee's terms of reference.

During the year the Associate Committee on Parasitology, which directs the activities of the Institute of Parasitology at Macdonald College, was reorganized to make it more representative of the interests concerned in this important subject. McGill University and the National Research Council co-operate through this committee in the direction of the research work carried on at the Institute.

The Associate Committee on Iodized Salt was disbanded during the year, having completed its work. It was agreed that any further work on the question of iodine in foods should be carried out under the jurisdiction of the Dominion Department of Health.

The Associate Committee on Helium, having discharged its functions, was also disbanded.

With the appointment of the National Advisory Committee on Agriculture, there appeared to be no further necessity of continuing the Advisory Committee on Agriculture appointed by the Council, and it was therefore disbanded.

Here it may be observed that the assistance so generously given by the members of the several associate committees, who serve without remuneration, enables the Council to carry on research in a much wider field of

endeavor in the public interest than would be possible if its activities were confined to the laboratories at Ottawa.

Reports of the work done under the several associate committees, through grants in aid of research at the universities, as well as particulars of the scholarships awarded by the Council and explanatory statements on the activities of each of the several divisions of the laboratories, are given in detail later in this report.

Assisted Researches

During the year, grants in aid of research amounting to $158,968.48 were made by the Council to qualified research workers, to assist in researches which they were conducting in their own laboratories. Of this amount $52,068.59 was provided from the parliamentary appropriation of the Council, $18,878.72 from the special fund, and $87,481.17 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 23 associate committees appointed for the purpose of directing co-operative investigations on approved projects. In addition, grants were made to 12 individual research workers for the purpose of enabling them to carry on work in their laboratories on problems which they were specially 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 the researches in progress under grants, and investigations carried on in previous years with assistance from the Council, but now concluded, is given in this report beginning at page 128.

Scholarships

Thirty students selected from 13 Canadian universities were awarded postgraduate scholarships for the year 1936-37. The policy of assisting exceptional students to pursue postgraduate studies 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 investigation required in the promotion and development of industrial processes and looking to the better or more profitable utilization of Canadian raw materials and the expansion of markets for Canadian products.

During the 19 years ended March 31, 1936, the total number of scholarships awarded by the National Research Council was 685 to 385 persons, and the grants amounted in all to $570,053.66. 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.

Relations with Other Research Organizations

Exchange of information between the National Research Council and provincial research organizations promotes co-operation and prevents overlapping and duplication of effort. During the year arrangements were made for the exchange of visits by members of the technical staffs of the Ontario Research Foundation and the National Research Council for the discussion of research problems of mutual interest. The harmonious relations resulting from these conferences have proved beneficial.

As indicated in subsequent sections of this report, the National Research Council continues to enjoy a full measure of co-operation with the other departments of government, both provincial and federal, and it is desired to express the appreciation of the Council for the assistance received from these sources.

The Council

President of the Council

On May 31, 1935, Dr. H. M. Tory retired as President of the National Research Council after twelve years in that position, including five years in an honorary capacity and a seven-year term for which he was appointed on a full-time basis.

In recognition of his services to the cause of scientific research in Canada, and as an expression of the esteem in which he is held, the members of the National Research Council, of the associate committees of the Council and of the Council's staff united in presenting Dr. Tory with a portrait of himself and in establishing in the National Research Library a special collection of books on the history of science, a subject in which Dr. Tory has long maintained a deep interest. The portrait, which was presented on May 20, 1936, has been hung in the main reading-room of the National Research Library.

Major-General A. G. L. McNaughton succeeded Dr. Tory as President of the National Research Council on June 1, 1935.

Members of the Council

The term of appointment of the following members of the National Research Council expired March 31, 1935: Dr. A. S. Mackenzie, Dr. R. C. Wallace, Abbé A. Vachon, and Dr. J. Stephens.

Dr. A. S. Mackenzie and Abbé Vachon were reappointed for another term of three years, as from April 1, 1935. The two additional vacancies were filled by the appointment of the following: Professor C. J. Mackenzie, Dean and Professor of Civil Engineering, University of Saskatchewan, Saskatoon, Sask.; Dr. H. E. Bigelow, Professor of Chemistry, Mount Allison University, Sackville, N.B.

Losses by death during the year were recorded in appropriate resolutions passed by Council. Dean R. W. Brock and Mrs. Brock met a tragic death in an aeroplane crash in July, 1935. Dean Brock had rendered outstanding service not only to the National Research Council but to Canada as a whole, in both his private and public life. The vacancy on the Council caused by the death of Dean Brock was not filled during the year. Sir John McLennan, a member of Council from 1916 to 1931, died suddenly during his return journey to London from Paris whither he had gone to represent the Council at a conference of the International Bureau of Weights and Measures. He is remembered as a physicist of first rank and a notable organizer of scientific work.

Meetings of Council

During the year five meetings of the Council were held to review the work being carried on in the National Research Laboratories and under the auspices of the several associate committees.

At the third meeting of the year the Council appointed, in accordance with its established practice, a special committee to review and report on all its activities. The members of this committee were Dr. F. M. G. Johnson, chairman, Dr. Charles Camsell, Dr. A. L. Clark, Dr. A. Frigon, and Mr. Tom Moore.

The committee held two meetings and reported to Council at the last meeting that they had examined the financial statements bearing on expenditures made by the Council and had consulted with the heads of the divisions of the laboratories regarding the work in progress. The committee directed attention to the progress that had been made in the matter of workmen's compensation for employees of the Council, and reported that all regular employees had now come within the arrangements provided by the government in respect to compensation to injured workers or their dependents, but that it had not yet been found possible to arrange a satisfactory coverage for those serving without pay or those employed in the laboratories by associate committees and paid from grants made to these committees. It was recommended that steps be taken to protect the Council against the possibility of major claims in this connection.

In view of the reduction of the parliamentary vote for 1936-37, the committee found that reductions would have to be made during the year in the amounts provided for grants in aid of research, particularly in those made to committees, but recommended that $15,000, the same amount as in the preceding year, should be provided for scholarships. Hope was expressed that increased appropriations would soon enable Council to enlarge this field of its work.

The committee's report also included brief reviews of the staff organization and requirements of the several divisions of the laboratories, and pointed to the need for additional appropriations and increased personnel in order that the scientific staff might be relieved as far as practicable of administrative and routine testing functions and thus be able to devote the greater part of their time to research.

Staff Appointments

Applications for appointments to the scientific and technical staff of the Council are dealt with by a Board of Selection appointed by the Council, and the recommendations of the Board, when approved by Council, are subject to ratification by the Minister of Trade and Commerce, who is the Chairman of the Committee of the Privy Council on Scientific and Industrial Research, under which the Council operates.

At the meeting of Council in March, 1936, when the method of dealing with applications for appointments to the scientific and technical staff of the various divisions had been given further consideration, it was decided that the Board of Selection should consist of four members of Council, one of whom should be chairman, and the following as members *ex-officio:* the President, the director of the division concerned, and the secretary-treasurer. The four members of Council appointed to the Board were Dr. Oskar Klotz, chairman, Dr. A. L. Clark, Dr. A. S. Mackenzie, Abbé Vachon.

The following appointment was made during the year:

John D. Babbitt, B.A. (Physics) 1929, University of New Brunswick; B.A. 1932, Oxford University; D.Phil. 1934, Oxford University; Rhodes scholar for New Brunswick 1929; First Class Final Honor School of Physics, Oxford University, 1932; low temperature research with Dr. Lindemann and Dr. Mendelssohn, Clarendon Laboratory, 1932-33; astrophysical research with Dr. H. H. Plaskett, University Observatory, Oxford, 1934. Appointed October 16, 1935, as junior research physicist, Division of Physics and Engineering.

Finances

The National Research Council obtained its revenue for the year from three main sources: appropriation by parliament, $522,615.38; contributions towards the maintenance of researches being carried on in co-operation with industrial firms, $60,556.03; income from the grain research trust fund, established in 1928, $21,790.07. In addition, smaller sums were obtained from other sources, as for example, from laboratory test fees, the sale of publications, the sale of patents, and royalties on patents.

The expenditures may be divided into two classes: (*a*) expenditures in connection with the operation of the laboratories at Ottawa; (*b*) expenditures in connection with the promotion of research outside these laboratories, including co-operative investigations carried on under the associate committees of the Council, assistance to individual researchers, post-graduate scholarships, and contributions to other organizations with which these laboratories have arrangements for the exchange of information. The expenditure under the former, including salaries and the purchase of equipment, was $457,164.29 and under the latter was $163,606.09. Details of these expenditures follow.

Financial Statement for the Fiscal Year 1935-1936

S. P. EAGLESON, *Secretary-Treasurer*

Receipts

A. *Parliamentary Appropriation*			
Main Vote	$ 500,000.00		
Supplementary Vote	100,000.00		
Restoration of 5 per cent Deduction in Salaries	14,976.83		
Restoration of Statutory Increases	7,638.55		
		$	522,615.38
B. *Special Fund*			
Laboratory Fees	$ 15,485.84		
Sale of Publications	2,106.56		
Patents and Royalties	1,384.39		
Miscellaneous	1,648.82		
		$	20,625.61
C. *Trust Fund*			
Amount in Trust April 1, 1935	$ 32,739.84		
Grain Research Trust Fund	21,790.07		
From Industries, etc	60,556.03		
		$	115,085.94
		$	658,326.93

Expenditures

A. *Parliamentary Appropriation*			
Salaries		$ 300,992.23	
Assisted Researches		44,041.20	
International Affiliations		8,567.39	
Scholarships		13,205.00	
Traveling—Council Members, Associate Committees, Staff, etc		13,470.61	
Laboratory Equipment and Supplies		97,234.43	
Patents		3,809.15	
Library		13,072.32	
Publications Issued		17,781.75	
General Expense		10,441.30	
			$ 522,615.38
B. *Special Fund*			
Publications Issued	$ 362.50		
Assisted Researches	18,878.72		
			$ 19,241.22
C. *Trust Fund*			
Aeronautical Committee	$ 1,673.28		
Asbestos Committee	882.85		
Canadian Engineering Standards Association	12,862.30		
Food Storage and Transport Committee	3,250.54		
Field Crop Diseases Committee	2,061.39		
Fire Hazards Committee	2,885.78		
Gas Research Committee	1,190.00		
Grain Research Committee	31,244.95		
Laundry Research Committee	1,212.13		
Magnesian Products Committee	4,378.96		
Parasitology Committee	17,840.00		
Poultry Plucking Wax	1,130.94		
Radio Research Committee	2,868.50		
Radiology Committee	1,740.82		
Survey Research Committee	664.21		
Tuberculosis Committee	11,340.62		
Trail Smelter Smoke Committee	42,762.43		
Weed Control Committee	2,931.61		
Wool Research Committee	1,300.00		
Rubber-metal Bond Investigation	350.00		
Research Grants to Individuals	3,650.00		
Grants to Scientific Organizations	2,757.66		
	$ 150,978.97		
Less Amounts Provided from Parliamentary Appropriation and Special Fund	63,497.80		
Net Expenditure from Trust Fund			$ 87,481.17
Total Expenditure			$ 629,337.77
Balance on Hand, March 31, 1936			
In Special Fund	$ 1,384.39		
In Trust Fund	27,604.77		
			28,989.16
			$ 658,326.93

REPORTS OF THE LABORATORY DIVISIONS

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

The work of the Division of Biology and Agriculture continues to grow, in spite of its small staff. Improved equipment and organization have helped to increase the capacity of the division, but it is increasingly clear that to take care of legitimate demands for biological research on urgent problems of national importance a substantial increase in staff is necessary. Since the division was established in its permanent home on the opening of the new laboratory building in 1932, only one member has been added to its permanent staff. The creation of two new positions at the close of the current year, one in the food storage laboratory and one in the bacteriological laboratory, is very encouraging and gives hope that healthy growth at a moderate rate may once more become possible.

The concentration of effort on practical problems during the past few years has led to some neglect of pure science research. This will be rectified as soon as possible in order to maintain the balance between pure and applied science which is so essential to the continued vitality of a research laboratory.

As usual, services to other institutions, government departments, and to the country at large, by answering technical inquiries on a variety of topics, have occupied a substantial proportion of the time and energy of the staff. Much of the work is carried out in co-operation with the Department of Agriculture, some of it in the form of joint projects, a relation which is proving both cordial and effective.

A noteworthy contact developed during the year was that with the maltsters. The chemists of the two large Canadian companies have pooled their resources with those of this division for the purpose of improving methods of experimental malting and malt analysis.

The important additions to the equipment of the barley malting laboratory and also to the cold storage plant will be described in the sections relating to this work.

Plant Biochemistry and Physiology

R. NEWTON

As indicated in last year's report, work on the nature of disease resistance in plants and on the organic constituents of wheat leaves has had to be suspended owing to lack of staff to take care of other pressing work. The last paper in the series reporting these investigations was, however, published by Dr. J. A. Anderson in the current year (Can. J. Research, C, 14 : 1–10. 1936). The same suspension of activity is true, unfortunately, of studies of plant growth under controlled conditions, for which splendid equipment described in earlier reports has been developed and constructed. These studies should be renewed as soon as possible, since they represent a type of fundamental work which other institutions quite rightly look to the Council to do.

Chemical Weed Killers

During the year a comprehensive review of the voluminous literature on chemical weed killers has been practically completed by Dr. W. H. Cook, of this division, in co-operation with Mr. A. C. Halferdahl, of the Division

of Research Information. Results obtained by many workers have been condensed into some 40 large tables, classified first by the anion of the chemical used, next according to the type of experiment, whether observational, field, or laboratory study, and last by the type of plant, whether annual or perennial, or where sufficient data were available, by individual species. The value of the results reported in the literature has unfortunately little relation to their great volume. The incompleteness of most individual experiments and the entire lack of uniformity in plan or method of experimentation make it difficult to draw conclusions in the face of uncertainties as to the effect of such variables as time of application, weather and soil conditions, etc. The wisdom of Canadian workers in setting up a subcommittee to standardize experimental methods at the outset of the program launched in 1930 by the Associate Committee on Weed Control, becomes the more apparent when one attempts to compare the results of a series of uncoordinated experiments.

Grain Research

Wheat

J. G. MALLOCH

Standardization of Experimental Baking Test

The oven has been remodelled in accordance with the design worked out at the University of Saskatchewan. The uniformity of color of the loaves has been improved, indicating greater uniformity in baking conditions. The new model of the punching and molding machine was completed by the Council's workshop and after some minor changes were made, was given a preliminary test. It appears to give more consistent results than the old model. Most series have given standard errors of loaf volume between 9 and 10 cc. with a maximum of 12 cc. This means that a real difference of 25 cc. between samples could by a duplicate test be determined with certainty. This is reasonably satisfactory but it is believed that further improvement can be effected. To this end a study of the variability arising in the mixing of the dough is being made. On completion of these experiments further tests of the molder will be undertaken. Even without further improvement, the level of accuracy now attained will permit a reduction in the number of replicates necessary to obtain reliable results.

Recording Dough Mixer

This machine, which was designed to measure the characteristics of very small samples of flour, has now been remodelled and fitted with constant temperature water jackets. Its utility for the estimation of the quality of small samples is now being studied. The time necessary for the dough to break down, after development, has been reasonably constant at all absorptions used for each of the small number of flours tested so far. A large number of samples will have to be studied before reliable conclusions can be drawn.

Insecticide Taint in Wheat

In co-operation with the Entomological Branch of the Department of Agriculture, tests were conducted on the severity of tainting by ethylene dichloride: carbon tetrachloride mixture (E.D.M.) and triasol. The severity was estimated by determining the number of three-minute aerations necessary to reduce the odor below the nasal threshold. When the grain was exposed to E.D.M. vapor the taint increased almost linearly with the severity (concentration $\times$ time) of the treatment. When the insecticide was applied in liquid form the taint rose to a maximum at about 12 hours' exposure and thereafter remained constant. Triasol gave similar results.

Barley

J. Ansel Anderson

Experimental Malting and Malt Analysis

Improvement of the quality of Canadian barley, which is essential for the enlargement of foreign and domestic markets, has been hampered by a lack of adequate tests for malting quality. Investigations have therefore been undertaken with the object of developing a satisfactory malting test for small samples and of improving methods for estimating the quality of malt.

During the year malting equipment was designed and installed. It consists of duplicate sets of steep tanks, germination chambers, and kilns, and can be used with either rotary or stationary cages of various types. A tentative method for malting in rotating cages has been developed and is now ready for rigorous testing.

With the co-operation of the malting laboratory at the University of Manitoba and the Canada and Dominion Malting Companies, steps are being taken to standardize methods for malt analysis, increase their accuracy and improve the uniformity of results obtained in different laboratories. A preliminary survey shows that there is much work to be done in this field.

Reorganization and supervision of the routine malting tests and analyses made in the malting laboratory at the University of Manitoba have been undertaken, and improvements have been made in the execution of this important service to plant breeders and other barley investigators throughout the country.

In an endeavor to acquaint British consumers with the qualities they might expect to find in Canadian barley, especially in relation to the system of commercial grading, a popular article was prepared and published in a British journal which circulates widely among the trade. (J. Inst. Brewing, 42 : 35-44. 1936.)

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 which are being undertaken in co-operation with the research station of an English company. Progress has been made in mastering the literature on this subject and in experimenting with methods for determining the saccharifying power of malt diastase. (Henry R. Sallans and J. Ansel Anderson.)

Barley Proteins

The development of barleys of superior quality is hindered by lack of knowledge of the nature of malting quality. In an endeavor to elucidate this problem, a study was made of barley and malt proteins. The results, which have been published (Can. J. Research, C, 14 : 109-116. 1936.), suggest that the protein is a complex, only part of which is soluble in 70% alcohol, and that the selection of this solvent for separating it into two fractions is entirely arbitrary. Details of the separate effects of malting on the proteins of hulls, germs, and "kernels" will be found in the paper cited.

Owing to the apparently greater immediate importance of diastase, these studies on barley proteins have been temporarily set aside, but it is hoped to return to them later. (Robert C. Rose and J. Ansel Anderson.)

Cleaning and Handling of Barley

A report on the survey of cleaning and handling practices conducted in 1934 has been published. (Sci. Agr. 16 : 289-321. 1936.) In the fall of 1935 the survey of threshing conditions and handling in terminal elevators was repeated on a more extensive scale. Samples were collected in the field by inspectors of the Dominion Seed Branch, and in the terminal elevators at the head of the lakes by an employee of the Board of Grain Commissioners. Samples were also obtained from the malting companies, grain-handling concerns and the various inspection offices. The moisture content of the samples was determined by the Laboratory of the Board of Grain Commissioners, and the damage counts are being made by the Winnipeg Laboratory of the Dominion Seed Branch. (J. G. Malloch.)

Food Storage and Transport

W. H. Cook, G. A. Ledingham

New Equipment

To provide temperatures as low as −40° F., required in "quick freezing" and certain other experiments, two carbon dioxide compressors have been added to the refrigerating plant. These are of special design to permit of automatic operation.

A 16-point temperature recorder, using thermocouples as the sensitive elements, with several special features designed for this work, has been installed to record cooling and freezing rates in various food products, temperature variations throughout the products, and similar measurements.

An automatic carbon-dioxide recorder-controller, again with special features designed in this laboratory, has been installed for use in experiments on storage in atmospheres containing widely different concentrations of this gas. It will also be used in conjunction with equipment to be developed for controlling the concentration of other gases, such as oxygen.

A low temperature laboratory, operating at 32° F. and upwards, with all the usual laboratory services, and special services such as cold brine baths and an independently controlled chamber for equipment which generates heat, has been fitted up for examining, sampling and analyzing products which might be adversely affected by exposure to ordinary laboratory temperatures. Natural (north) light is available in this laboratory for observing such points as color and bloom of the product. Provision is also made for draining the water lines conveniently, if temperatures below the freezing point are desired.

All cold storage rooms in connection with the laboratory now have positive bottom to top circulation of air.

A battery of eight incubators was designed and constructed, with closely controlled temperatures giving a range from 14° F. (the lowest temperature at which growth in any organism has been reported), adjustable upwards as desired. This is to be used in a study of micro-organisms which affect the preservation of food in cold storage.

Defrosting and Dechilling of Poultry

The formation of condensate (sweating) on products brought out of cold storage reduces their immediate saleability and probably hastens their deterioration by accelerating the growth of micro-organisms. The defrosting and dechilling of poultry with dry air to avoid the formation of condensate, has received the attention of the Council for some time. The work of the past year has consisted of an extensive laboratory study of the temperature and

humidity of the air used for dechilling in relation to the final quality of the product. The defrosting of boxed poultry with warm, dry air appears to be impracticable owing to uneven heating of the product, which causes detrimental drying in certain parts of the box or stack, and condensate formation in others. Reducing the temperature of the air used for defrosting helps to overcome this difficulty, but quite marked deterioration takes place even with air at 50° F. At this air temperature about three days were required to raise partly frozen birds (28° F.) to 40° F. and lower air temperatures would render the process too slow to be commercially practicable.

The dechilling of poultry from 32° F. (unfrozen) to about 40 to 45° F., with air above 55° F., causes detrimental drying and condensate formation in local regions. With air at 50° F. the process was uniformly satisfactory, and can be accomplished in about 20 hours, or about one-sixth of the time required for defrosting. The dewpoint temperature of air at this temperature may vary from 1° to 10° F. below the surface temperature of the product without risk of injury. The physical conditions necessary for dechilling boxed poultry without condensate formation or deterioration have therefore been established.

Transport and Storage of Chilled Poultry under Commercial Conditions

During certain seasons chilled poultry commands a higher price on the British market than the frozen product. Before shipments of the chilled product can be recommended, the maximum safe holding period under commercial conditions must be determined. Poultry originating at eight Dominion Experimental Farms, scattered throughout Canada, were shipped alive to the nearest packing plant where they were dressed and packed. They were then shipped to Ottawa in a refrigerator car and held in the experimental cold store at 32° F. for a period comparable to that of the ocean voyage. The results obtained indicate that under these conditions the maximum safe storage period is from three to four weeks, depending on the grade of product. The first change which reduces the value of the product is a loss of bloom and in this connection the lower grade birds suffer most. Groups of mixed grades showed evidence of mold or a slight odor within 28 days from killing. Since three to four weeks are required to transport the product from certain regions in Canada to Great Britain, the above results indicate that the shipment of chilled poultry to the British market is somewhat risky, unless the transport and storage conditions can be modified or improved to extend the safe storage period.

Dechilling of Eggs

When storage eggs are exported from Canada to Great Britain they are usually allowed to warm up to some extent during the rail haul and are then shipped in an ordinary storage chamber (not refrigerated) on the vessel. Under these conditions there is little risk of condensate formation on unloading at the port of entry, but the higher product temperature hastens deterioration and necessitates immediate sale regardless of market conditions. If the product is shipped in a refrigerated space, condensate formation or sweating after unloading may lower its value. Experiments were made on natural dechilling (uncontrolled humidity) and artificial dechilling (dewpoint maintained 2 to 5° below temperature of eggs). The air temperature in both cases was 50 to 55° F. It was found that regardless of the dewpoint of the ambient atmosphere the eggs themselves nearly always lost weight while the absorbent fillers, flats and box either lost or gained weight according to the dewpoint temperature and relative humidity. This indicates that any condensate which forms on the eggs is taken up promptly by the packing

materials. Whether this is desirable from the standpoint of product quality is not known and an investigation of this problem is projected. While the present methods of packing are employed there appears to be no advantage in artificial dechilling, either from the standpoint of appearance or subsequent keeping quality.

Frozen Storage of Poultry

If poultry are to be preserved more than three or four weeks they must be frozen, and the bulk of this product exported from Canada is shipped in this condition. At the storage temperatures commonly used in this country the length of the storage period is usually determined by a loss of bloom and sales appeal, owing to the drying of the skin, a condition known to the trade as "freezer burn" and "pock-marking". Studies have been initiated to determine the temperature and humidity necessary in the cold store to prevent this condition. Methods of packing, to prevent evaporation from the package, and also the humidification of the cold rooms, are being studied in an effort to obtain a practical solution for the problem.

Growth of Molds on Chilled Poultry

A large number of molds have been isolated from poultry stored at 32° F., for study in regard to the effect of various conditions on their growth rates. First attention is being given to the development of accurate methods for measuring growth rates in these organisms. Then it will be possible to examine the various factors favoring their growth on birds in cold storage, and the possibility of suppressing or reducing the incidence of such factors.

Spoilage of Cured Meat

A preliminary inquiry, consisting of observational visits to a few packing plants reporting trouble, has indicated a large and important field of research which it is hoped to enter shortly. The development of moldiness in cured hams and sliminess in bacon sides, the liquefaction of the gelatin film of dipped hams, the nature of the organisms, both useful and harmful, in the pickle, and the general question of packing-house sanitation, are examples of problems requiring investigation.

Cytology and Genetics

F. H. PETO

Hybridization of Wheats and Wheat Grasses

This project, the inception of which was reported last year, is being carried on 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 crosses were made at the Division of Forage Plants during the summer of 1935. Pollination of 18,283 flowers of various wheat species was effected with pollen from ten species of the wheat grasses *(Agropyron)*. Only two of the *Agropyron* species crossed successfully with wheat, and from these 1,791 hybrid seeds were obtained. The resulting hybrid plants were all very vigorous, and certain of the crosses possessed promising herbage characteristics. However, with the exception of one plant they were all self sterile. During the winter of 1935–6 various heat treatments were applied to the germinating hybrid seeds in an endeavor to regain fertility by doubling the chromosome number.

Certain results of considerable interest to pure science, emerging from a cytological examination of the *Agropyron* parents and the hybrids, have been prepared for publication. (Can. J. Research, C, 14 : 203–214. 1936.) They indicate that *A. elongatum* arose through natural hybridization and chromosome doubling.

Effect of Temperature on Mutation Rates

Occasionally mutations or "sports" appearing in cultivated plant species give rise to new and useful varieties, but their appearance is so comparatively rare as to have only restricted importance in plant breeding. By heat treatment of the seed or plants of barley it has been found possible greatly to increase the number of mutations.

During the past year cytological studies were made on root tips from barley plants germinated at temperatures of 35–36° C. Under these conditions the chromosomes frequently became fractured and subsequently the fractured ends appeared to unite at random, giving rise to many structural changes. It is suspected that chromosomal changes such as these may sometimes initiate new variations in the progeny of these plants. A second paper on this work has now been published. (Can. J. Research, C, 13 : 301–314. 1935.)

The first and second generations of the progeny from heat-treated barley plants have been examined and a large number of mutant forms were found. Two of these forms have given typical monohybrid Mendelian ratios of three normals to one abnormal, while another mutant was found to be maternally inheritied. Analysis of the remainder is in progress.

Microbiology

G. A. LEDINGHAM

Root Parasites of Agricultural Plants

Owing to duties in connection with the smelter fumes investigation in British Columbia, with which the microbiologist in this division was occupied most of the year, only limited progress in the special researches of this laboratory can be reported. A paper on *Rhizophidium graminis*, a new species which has been found parasitic on wheat roots, was completed and published. (Can. J. Research, C, 14 : 117–121. 1936.) Studies on *Polymyxa graminis*, another newly discovered wheat-root parasite, have been carried forward and further comparisons made with the closely related organisms causing powdery scab of potatoes and club root of turnips. These are helping to clear up certain important points, hitherto obscure, in the life histories of these fungi.

Straw-fermenting Organisms

The organisms previously isolated from rotting straw stacks were maintained in laboratory cultures, to be ready for use as soon as active work on the utilization of straw can be renewed.

Statistical Research

J. W. HOPKINS

Influence of Weather on Crops

One cannot hope to influence the weather, but one may by the study of long-time trends in various districts learn how better to adjust methods and types of agriculture to the average conditions prevailing in such districts. With the continued accumulation of weather and crop records, one may also hope in time to develop mathematical formulas useful as an aid in estimating crop yields. For studies of this kind, recourse has been had chiefly to the weather records of the Dominion Meteorological Service and the crop records of the Department of Agriculture and the colleges of agriculture. By this means the influence of weather on the growth, yield and protein content of wheat has already been elucidated to a considerable extent. A second paper on the influence of weather conditions on the protein content was published during the year. (Can. J. Research, C, 13 : 127-133. 1935.)

Rainfall and Wheat Yield

The dominant effect of rainfall in determining crop yields in western Canada makes it a factor of special interest. Study has been given to the characteristics of the rainfall in that area, with regard to seasonal trends and variations from season to season and from place to place. The study of the relation between rainfall and yield, reported last year, has been continued, and another paper on yields in Alberta and Saskatchewan prepared for publication. In plot tests there was a significant relation between pre-seasonal precipitation (August 1 to spring) and the yield, on both summer-fallow and stubble. In farm yield returns there was a significant correlation of yield and seasonal precipitation (May 1–July 31) in all districts studied, and in the southern districts there was also a positive correlation with pre-seasonal precipitation.

Evaporation

Evaporation is an important factor affecting the availability of rainfall for plant growth. Long-time evaporation records are not yet available in Canada, but some suggestive information was obtained by a study of American data, and published. (Can. J. Research, C, 13 : 191-201. 1935.) As would be expected, evaporation was markedly influenced by wind and atmospheric humidity as well as by temperature. Variations in a given month in different years were correlated with these three factors. As the relation is not a simple one, it is desirable that weather records should always include a record of evaporation.

Accuracy of Experimental Baking Tests

As a service to four laboratories co-operating with the Associate Committee on Grain Research, statistical analyses are made of the results of their baking tests, to determine the chief sources of error and help them improve their methods. The improvement in accuracy attained after three years of such critical examination is very gratifying.

Miscellaneous Advisory Services

With the growing appreciation of the importance of statistical methods in biological and agricultural experimentation, this laboratory is called upon to do a great deal of advisory work, and occasionally to collaborate with other laboratories. Much time was given to work on a committee appointed by the Dominion Poultry Husbandman, to consider the problem of breeding for egg production. A plan was developed by this committee which it is hoped may lead to a national breeding policy. Experimental data accumulated by the Wool Committee were subjected to analysis and suggestions made for overcoming certain errors. A large proportion of time was given to reviewing and criticizing manuscripts dealing with statistical data and to answering inquiries in regard to appropriate methods of analysis for special bodies of data.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

The work carried out by the division during the year is described briefly in the sections which follow. In this introductory section attention will be drawn to certain aspects of the work which would appear to be of special interest. Before this is done, however, a few remarks will be offered on the importance of extending to other fields of work the close relationship with Canadian industry which has already been established in some of the fields with which the division is concerned.

The effectiveness in forwarding industrial activity in Canada of research carried out by the National Research Laboratories is influenced in no slight degree by the closeness of the relations which may exist between the laboratories on the one hand and industry on the other. Speaking broadly, the more industry contributes in the way of responsible guidance in choosing problems for attack, the more likely is the research to be of real, practical value to industry; and, further, the more industry makes it its business, through technical men and others in its employ, to keep in touch closely with the progress of the work, the better will it be in a position to seize upon results of value, to develop them in a practical way, and to apply them to the furtherance of Canadian industry. After several years' experience in the work of the National Research Laboratories and after a recent first-hand study of the organization of government-aided industrial research in Britain, the writer is impressed by the need for extending to additional lines of industrial activity an organized relationship between industry and the National Research Laboratories, such as has already been established or initiated for certain lines. Such an organized relationship, 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) enables industry to have a voice in determining the direction of research, provides a means for bringing the results of research to the attention of industry, and facilitates the application of the results to industrial practice. It offers an economical channel through which the body of firms in a given line of business can provide financial support for research on problems of general interest to the industry.

At present the Division of Chemistry has an organized relationship for research with the laundering and dry cleaning industry, the asbestos industry, the leather industry, and to a slighter extent the wool manufacturing and the sugar industries. The work already under way in the division on other subjects (*e.g.*, paint, rubber, cotton and other textiles) or which, with increase of staff, might be taken up with advantage on still further subjects (*e.g.*, alloys and non-ferrous metals, canning, printing, ink and the graphic arts, etc.) might with advantage be put on a similar basis.

Among the results recorded in the following sections one of the most striking relates to the utilization of waste natural gas. In researches previously carried out in the laboratories, with the object of discovering means of utilizing natural gas, such as is wasted in large quantity in the Turner Valley, Alberta, it was found that by heat treatment in a furnace of a special but nevertheless simple design the fraction of waste gas known as stabilizer gas can be made to yield three to four gallons of liquid motor fuel of the benzol type per 1000 cu. ft. of gas. The striking result has now been secured that the residual gas from such heat treatment will yield six to seven pounds of carbon black (an important component of auto tires) per 1000 cu. ft. of original gas, whereas the original gas if burnt as such yields only four to five pounds of black. In other words, by a combination process, not only can three to four gallons of motor fuel be obtained but, in addition, carbon black in excess of that which the gas would give if no motor fuel were secured. This combination process seems to have attractive commercial possibilities. It may be added that the overhead cost of producing carbon black by means of it should be considerably lower than such cost in existing plants in Texas and other southern states, since the latter operate on lean natural gas and yield only 1.5 lb. of black per 1000 cu. ft. of gas put through.

Attention may be drawn to the section headed Biochemistry. Work in this field had as its original objective to secure information about the

chemical principles, especially alkaloids (some poisonous to livestock), present in certain groups of wild plants native to Canada. During the course of this work there have been made unexpected discoveries which may prove to be of great practical importance, which could not have been foreseen and which were not contemplated when the research program was begun. This outcome illustrates the fact that valuable practical results often arise, as by-products, from "pure" research motivated merely by a general desire to ascertain the facts of nature. The discoveries in question are *(a)* the synthesis of a number of "plant hormones", *(b)* the discovery that the alkaloids of the giant larkspur, a plant growing wild in southern Alberta, are powerful insecticides. Plant hormones when administered to plants in amounts of the order used in the administration of vitamins to animals have amazing effects on growth. Because of their special action in producing root formation, they may prove to be of great value in planting clippings of apple and other trees. Samples of the synthetic hormones made in the division have been supplied to laboratories and nurserymen in many parts of the world for experiment.

The practical bearings of the section which is modestly headed Distillation and in which reference is made to the separation of isotopes (*i.e.*, the different forms of a single element of which many of the elements, once thought to be uniform and simple, are now known to be composed) are not perhaps immediately obvious. Yet they are of intense practical interest to the oil refining and synthetic chemicals industries, the coal tar industry, and to other lines of manufacture involving distillation, for in the work in question there has been developed a distillation column probably more efficient for the separation of liquids and their purification than any column hitherto available. It may seem a far cry from "heavy water", the isotopic form of water which has recently attracted so much attention, to aviation gasoline. Yet the same efficient column which, experiments in the laboratories have shown, is capable of separating the one part of heavy water in 6000 parts of ordinary water, may also be applicable in the production of gasoline with such superlative anti-knock qualities (octane number: 100) as to enable aeroplanes to make longer journeys on a given load of gasoline.

Noteworthy results have been obtained in researches on starch. The primary object of the work was to determine whether potato starch, such as might be made from potatoes in Canada, can be used in place of the corn starch, made chiefly from imported material, which is now used in Canada for most of the purposes calling for starch. It was found, in accord with experience in Europe, that potato starch cannot in its original condition be used with satisfaction in place of corn starch for many purposes. The matter was not however allowed to rest at that point. Could potato starch be given some simple treatment which would make its paste-forming properties similar to those of corn starch? A clue to the problem was afforded by the consideration that, whereas the extraction of starch from potatoes involves merely washing out the starch from the ground potatoes by cold water, the extraction of starch from corn involves, as a first step, steeping the corn in warm acidulated water, and that this step must modify the behavior of the starch. Very substantial progress has been made in the direction of modifying potato starch so as to render it suitable for laundry work and for culinary purposes—two of the largest uses for corn starch—and so as to extend the number of uses in the textile industry, for which it is suitable. Good results have also been obtained with potato starch, suitably processed, as a glue in the manufacture of plywood, for finishing bond paper, and for a number of other purposes.

Research directed to improving the process of disinfecting smut-infected seed grain by means of formalin is important to the grain grower because formalin is cheap, and to the chemical industry because formalin is made in Canada from a product of wood distillation (wood alcohol).

It is interesting to note that, incidental to a study of the applicability of a new analytical method, devised in the laboratories, to the determination of starch in samples of wheat representative of various grades from the western crop, it was observed that Garnet wheat has a markedly higher starch content (55%) than Marquis (51 %).

About 1500 buffalo hides are now available yearly from herds in western Canada. A satisfactory tanning procedure, which gives strong, supple skins, has been worked out, and attention is now being directed to the problem of dyeing the hair on the skin a suitable and uniform shade.

On the subject of paint, mention may be made of an improved method, developed in the laboratories, of measuring the "hiding power" of paints. This depends on applying a definite quantity of paint to a black matt surface and then measuring the light reflected. Valuable information on the quality of outdoor paints has been obtained, by exposing painted panels to the weather on the roof, and comparing the results with those in an artificial weathering machine in which panels are exposed alternately to the light of an arc lamp and to a water spray.

Steady progress has been made during the year on the difficult problem of getting an accurate picture of a mass of asbestos fibre such as results when asbestos is released from asbestos-containing rock by crushing and other operations.

The wax mixture developed previously for use in plucking chickens has come into wide use in preparing poultry for the market. The carcass is dipped in the molten wax; the latter, when removed after being allowed to set, pulls the pin-feathers along with it and leaves a clean bird. Further study has been given to details of the process.

In connection with the work on maple products attention may be drawn to the development of an improved procedure for making cast maple sugar. The procedure involves little more trouble than that commonly used for making maple sugar; the product however shows much less tendency to lose its uniformity and become mottled on keeping.

The scope of the work of the laundering laboratory has been extended to embrace dry cleaning. A method for checking the efficiency of dry cleaning plants has been developed. It is somewhat on the lines of the method used for checking the efficiency of laundries in removing dirt from cotton fabrics. White flannel is deliberately soiled gray in a standard manner, and, after it has been through the dry cleaning process, its approach to whiteness is measured quantitatively by optical apparatus. The dry cleaning research includes a study of non-inflammable cleaning solvents, such as trichlorethylene, the manufacture of which is being undertaken in Canada.

Methods have been worked out for cleaning linen which has been soiled in certain special ways and which offers special difficulties. Among the cases worked out during the year have been the removal of the more obdurate stains on hospital linen due to medical preparations and discharges, and the cleaning of severely soiled towels used by linotypers. Many interesting cases of damage in laundered or cleaned articles, ranging from rugs to pillow cases, have been studied. Some of the causes to which damage has been

traced have been—lack of balance and other textile defects in the weaving and construction of fabrics, uneven shrinkage, exposure to sunlight, the use of underarm deodorants, discharge printing on textiles, etc.

In an investigation undertaken with the object of promoting the utilization of Canadian deposits of magnesian carbonates, success has been attained in the production of a stable refractory from dolomite and other raw materials. A large commercial application of this development is anticipated. This investigation has also resulted during the year in (1) perfection of a method of manufacturing a strong, unburned, basic brick, (2) major improvements in the quality of refractories bonded with sodium silicate, (3) development of a method of increasing the plasticity and workability of refractory cements, and (4) production of a greatly improved refractory with hydraulic bond. The immediate commercial application of these results of experimental work and the gratifying response of industry to the new development demonstrate the very practical character of the laboratory researches.

Alberta Bitumen

A. CAMBRON

Samples of blown Alberta bitumen of various consistencies have been prepared in a specially designed 10-gallon kettle. In order to obtain materials suitable for testing as rubber compounding agents, in flooring and roofing compositions, and in paints, samples of various fusing points and penetrations have been prepared. It has been found that, on account of the appreciable percentage of relatively low-boiling hydrocarbons in Alberta bitumen, a condition not encountered in petroleum asphalts, the time required for obtaining a product with a given fusing point and penetration is considerably reduced, if the air-blowing is carried out under such conditions that the vapors carried over with the air stream are condensed and collected, instead of being allowed to reflux into the kettle. By this procedure a liquid fraction is obtained which, with the condensing equipment used in the present experiments, amounted to 20% by weight of the bitumen charged. It is indicated that, with a more efficient condenser, the liquid fraction recovered would amount to 25–30% of the charge, depending on the time of blowing and the solid product desired.

Apples

N. H. GRACE

Dried Apples

A brief study was made of the discoloration of dried apples during extended periods of storage. The observations emphasized the importance of control of the sulphur dioxide content on drying.

Apple Taint

An introductory study has been made of certain aspects of the tainting, by apples, of certain food products in transit and storage. It was found that the nasal threshold for apple taint, using the synthetic apple oil described by Power and Chestnut, lies in the region between 0.004 and 0.008 milligrams per litre. Preliminary observations indicate that useful data concerning apple taint can be secured by concentration of the odoriferous material by adsorption, following this with chemical study.

Asbestos

D. Wolochow, A. van Winsen

The evaluation of milled asbestos fibre, particularly of the spinning grades, has been the chief problem under investigation. Owing to the number of factors which must be considered and because of the industrial and commercial implication, this is a vexing problem, and progress towards its solution has of necessity been slow. Several methods for measuring at least some of the physical characteristics which affect the relative values of spinning fibres of varying texture have been developed, and a large number of samples representing all the current grades of spinning fibre have been tested. The results obtained have been presented to the producers in several detailed reports. Towards the end of the year there was obtained a laboratory-size carding machine, which when it is installed will facilitate the study of the carding qualities of asbestos. The work has embraced full-scale factory spinning tests.

The study gives promise, not only of providing a fuller understanding of the various factors which determine the behavior of a given mass of asbestos fibre, but also of suggesting improvements in the milling methods and the machine used to extract fibre from asbestos rock.

The industrial importance of asbestos products has been recognized by the American Society for Testing Materials in the formation of a Subcommittee on Asbestos for the purpose of drawing up standard specifications for asbestos products. An active part has been taken in the work of this committee during the year.

Further work on the separation of magnetic iron from asbestos (a subject of special interest in connection with the use of asbestos in the electrical industry) indicates that the removal of this undesirable constituent is feasible, using a wet method. Mechanical means for achieving this are being considered.

A comparative study was made of crude asbestos fibres from different sources, the necessary chemical analyses being made by C. W. Davis.

Among other matters studied were (*a*) the weathering of asbestos, (*b*) the behavior of metals when in contact with asbestos fibre, (*c*) the effect of asbestos insulation on heating coils, (*d*) experiments on a new method of treating asbestos with tars, resins, etc., in order to produce a light-weight, water-shedding bonded material.

The recovery of fibre from asbestos tailings by wet processes and the utilization of the tailings have been studied further. Information has been furnished to several individuals interested in the process, mentioned in previous reports, for producing active silica and magnesium salts from serpentine and in the process, also mentioned previously, for making molded products from asbestos. Samples of active silica have been supplied to persons wishing to try this material for various purposes.

Biochemistry

R. H. Manske

Plant Hormones

Indolyl-valeric acid has been synthesized and its effects on the stimulation of root formation and plant growth studied by Dr. P. W. Zimmerman, of the Boyce Thompson Institute for Plant Research, Yonkers, N.Y. This work, as well as a collaborative research on indolyl-acetic acid (the heteroauxin of Kögl) with Dr. R. W. Jackson of Yale University, has been

recorded in the Canadian Journal of Research. Further work on the latter acid has resulted in a relatively simple synthesis, and these two acids as well as indolyl-propionic acid have been supplied to commercial and numerous research laboratories throughout the world. Owing to their pronounced phyto-physiological action, especially in leading to root formation on plant clippings, considerable demand for these chemicals is anticipated.

Plant Alkaloids

Further progress in the isolation, identification and pharmacological study of the alkaloids of Fumariaceous plants has been made. Special interest centres in the results of an investigation of *Corydalis scouleri*, a native of the Pacific Coast. Of the ten alkaloids isolated from this plant two new ones are corlumine and corlumidine, the latter on methylation yielding the former which is a stereoisomer of adlumine, but not the optical antipode. The former has also been found in *C. sibirica*, further examination of which has yielded eight alkaloids.

The following new species have been obtained, and since the results of preliminary work are satisfactory, further investigation is in progress,—*C. claviculata*, *C. pallida*, *Dicentra chrysantha*, *D. ochroleuca*, *Thermopsis rhombifolia*, *Lupinus macounii* and *L. pusillus*. Others, obtainable in insufficient quantity, have been examined but many of them yielded results of little interest.

Mr. A. Kelsall of the insecticide laboratories at Annapolis Royal, N.S., has reported favorably on the alkaloids of *Delphinium brownii* and further material is in course of preparation. Chemical study of the alkaloid has revealed its close relation to the aconite alkaloids, alkaline hydrolysis yielding an oxygenated basic fragment together with anthranitic and methyl-succinic acids.

Carbon Black

L. M. PIDGEON

A new method has been developed for the production of finely divided carbon from hydrocarbon gases. The method depends on the direct thermal decomposition of gas by passing it through externally heated tubes. Ordinarily, such a procedure would result in the building up of graphitic carbon on the walls of the tubes, since decomposition would take place mainly on the walls because they are at a higher temperature than the interior of the tube, and the tube would soon become plugged with carbon. In the new method the refractory reaction tubes used are porous, and this is its special feature. The tubes are heated in a gas-fired furnace under such conditions of pressure that a portion of the flue gas passes through the tube wall. As a result, the reacting gas is unable to reach the wall and deposition of carbon thereon is thus avoided.

The method gives far higher yields than the usual channel process (which involves essentially the collection of "soot" from luminous flames) of making carbon black or than any of the thermal decomposition processes now in use. From gas similar in composition to the waste "dry" gas in Turner Valley, Alberta, yields of carbon as high as 18 lb. per 1000 cu. ft. have been obtained by the method; from stabilizer gas, such as is produced in more limited quantity in Turner Valley, 60 lb. Such yields represent a recovery of 55–60% of the carbon in the gas. Previous thermal cracking methods seldom achieved a recovery of more than 20%, while the recovery in the standard channel process is not more than 5%.

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Extensive rubber tests have shown that black produced by the new porous tube process is superior in quality to most other blacks produced by cracking processes, but is not equal to channel black in its reinforcing action in rubber stocks.

It has been found that the residual gas from the pyrolysis of stabilizer natural gas gives, by the channel process, black of as good a quality as that obtained from the dry natural gas now used commercially in making carbon black by the process; and, further, that the yield of black obtainable from it is higher than from dry natural gas.

Owing to the large amounts of gas which are still being wasted in various parts of the United States, the carbon black industry has not been forced to seek actively for improved production methods. That this situation may be drawing to a close is, however, suggested by the 1935 conservation law passed in Texas, the carbon black clauses of which were upheld in recent court decisions.

In addition to research on production methods, experiments have been continued in the laboratories on the testing of carbon blacks, particular attention having been given to the use of optical methods. Carbon black samples submitted by a development company in Alberta were tested.

Corrosion

A. van Winsen

An experimental study was completed on the causes responsible for the serious corrosion of a special aluminium alloy of particular interest to a government department and to certain industrial firms. A large number of photomicrographs were made. Following this study a more extensive series of experiments has been initiated in order to investigate the corrosion resistance to sea water of a series of aluminium alloys and steels and the effectiveness of a variety of protective coatings. In addition to samples exposed to aerated seawater in the laboratory, samples have been immersed in the water of the harbor at Halifax, N.S.

Diatomaceous Earth

Miss H. D. Chataway

Work on Canadian deposits of diatomaceous earth, during the past year, has centered round the process of calcining with salt. As a result of extensive study the proper conditions for the carrying out of the process have been discovered. The products obtained are in general white, and differ from the original material in various other important physical properties.

As was expected the process definitely improves the crude earth from the point of view of its use as a filter-aid in sugar refining and other industrial operations. Therefore, where the naturally occurring material is not too badly broken, this process is available for the production of a satisfactory filter-aid. A medium quality filter-aid has been prepared in the laboratory from typical British Columbia material, although previously this was not considered a raw material suitable for the purpose.

Other uses for the calcined material are being investigated.

Distillation

D. F. Stedman

The special type of highly efficient distillation columns which has been developed in the laboratories is exciting considerable interest both for laboratory and industrial work, and designs and equipment are now being assembled for their construction on a larger scale. The first columns were $1\frac{1}{4}$ in. in diameter. A column 6 in. in diameter has now been built and its efficiency demonstrated.

Using a $1\frac{1}{4}$-in. column, 26 ft. long, vacuum-jacketted, and following up work reported last year, a further effort has been made to separate the isotopes of oxygen, by fractionation of the liquefied gas. In various samples, kindly analyzed by Dr. W. Bleakney of Princeton University, the ratio of $O^{18} : O^{16}$ has been increased or decreased by amounts up to 30%, but there are still various details in the equipment and technique which need perfecting. Results are interesting in indicating a relatively large difference in boiling point for the isotopes, and it is hoped to be able to take full advantage of this difference and obtain much better separation in the near future.

Ethyl Alcohol from Ethylene

A. Cambron

This work is being carried out as part of the investigation into the possible utilization of Turner Valley natural gas. In the course of this investigation the optimum conditions were determined for the production of ethylene by heat treatment of the gas. A study has now been made of the production of alcohol from ethylene, particularly in regard to the several factors influencing the rate of hydration of ethylene in the liquid phase in sulphuric acid, and the yield of alcohol based on the acid used. It has been shown that the rates of absorption of ethylene in sulphuric acid as determined by previous investigators has been erroneously interpreted as representing the rate of reaction between the ethylene and the acid. An apparatus specially designed for improving the liquid gas content has been constructed. With this apparatus the rate of solution of ethylene in sulphuric acid is considerably increased during the absorption stage of the hydration process, the time required for converting the acid into the corresponding mono- and di-ethyl sulphates being reduced to less than a fourth of that reported in the literature. As a consequence of the reduction in the time required for the reaction, it has been found that the amount of side reaction such as polymerization of the ethylene or the reduction of the acid, was appreciably reduced, resulting in a lowering of the acid consumption for a given yield of alcohol. The laboratory experiments indicate, for instance, that the acid consumption under the conditions used was 2.08 kg. per kg. of alcohol produced. After inquiring into the cost of reconcentrating the spent sulphuric acid, an estimate of the cost of producing ethyl alcohol from Turner Valley gases has been prepared.

Formaldehyde as a Fungicide

A. Cambron, N. H. Grace

The use of dilute formaldehyde solution for controlling stinking smut in seed wheat occasionally results in appreciable damage to the seed. Such a damage results in lower germination, and it has been suggested that it is caused by the formation of a film of formaldehyde polymer on the seed coat. The present investigation, initiated at the request of and supported financially by the Canadian producers of formaldehyde, is being carried out to determine whether the formation of a solid polymer on the surface or the penetration

of the solution through the seed coat is responsible for the damage, also whether such damage can be prevented by the addition of suitable reagents to the formaldehyde solution or by altering the procedure now followed for treating the seed. The investigation is being carried out in co-operation with the Seed Branch, Department of Agriculture, where the germination tests of the treated wheat samples are being done. A number of treated wheat samples have already been tested and it is intended to complete the investigation in the course of the coming summer.

Honey

In the previous report mention was made of a special hydrometer for the determination of the moisture content of honey, based on extensive measurement of the relation between the density and moisture content of honeys. Detailed specifications for the hydrometer were prepared and supplied to the Department of Agriculture. The instruments were manufactured commercially and were available in time for the 1935 crop. Without this hydrometer and the color grader previously developed, the government grading and inspection of honey, which is now being rapidly developed and put into force by the Department of Agriculture, would have been impossible in its present scope and intent.

Industrial Uses for Agricultural Products

C. Y. Hopkins

Starch Content of Wheat

The value of the direct polarimetric method of determining starch which was developed in the laboratories and to which reference was made in the last report has been confirmed by further experience with it. Using this method, a survey was made of the starch content of twelve grades of wheat of the 1935 crop. It was found that the variation in the amount of starch is small in the straight grades, but that the quantity is markedly less in rusted wheat. Garnet wheat was found to be distinguished from Marquis by a marked higher starch content.

A paper by C. Y. Hopkins and R. P. Graham on "The Starch Content of Some Samples of Canadian Wheat" was published in the Canadian Journal of Research, 12 : 820-824. 1935. This dealt with samples representative of the 1934 crop. A further paper on representative samples from the 1935 crop will be issued shortly and will include data on the specific gravity of the kernels of different grades, and data determined by the Grain Research Laboratory, Winnipeg, on the flour yields.

Power Alcohol

Developments in the use of power alcohol in foreign countries were followed closely. A survey was made of the possibility of manufacturing power alcohol from potatoes, with special reference to the Maritime Provinces and to the economics of the question.

Grain Screenings

With a view to extending the possible uses of refuse screenings from grain, the necessary conditions for destroying the viability of weed seeds by heat were studied. The results were submitted for publication under the title "Thermal Death Point of Certain Weed Seeds".

Industrial Utilization of Potato Starch

W. GALLAY, A. C. BELL

A study was made of the relative merits of various starches and starch products for a number of industrial purposes. The study will be continued. The work was carried out to a large extent from the practical viewpoint. Contact was made wherever possible with the industries concerned and laboratory studies were extended in several instances to commercial-scale trials. Consideration was given also to the economic phases of the problem. The suitability of a starch for a specific purpose depends upon its special properties, and hence the processing of the starches by various means was studied, with a view to adaptation for specific purposes.

The following indicates very briefly the nature of the investigations made:

(a) Culinary—Ordinary potato starch is definitely unsatisfactory for most culinary uses. A slight inexpensive modification was devised and the processed starch tested in culinary products. Reports from two leading Schools of Domestic Science have pronounced this processed starch satisfactory for general culinary use.

(b) Baking Powder—An extensive study of the stability of various types of baking powder containing different starches has been completed. It was shown that the starches with small granular size lend greatest stability to baking powders and therefore that potato starch is inferior for this purpose. The results of this investigation will appear in a forthcoming issue of the Canadian Journal of Research.

(c) Paper—A laboratory study of the relative merits of various starches in the tub-sizing of paper has been completed, and the results will be published shortly in the Canadian Journal of Research. In conformity with general commercial practice, oxidized starches were used. Oxidized potato starch was found to produce the best results. The physical tests were carried out in co-operation with the Forest Products Laboratories, Montreal.

Commercial-scale tests of potato starches in both beater-sizing and tub-sizing, are being conducted and the results will be available shortly.

(d) Vegetable Glue—Laboratory studies of vegetable glues from different starches were made in co-operation with the Forest Products Laboratories, Ottawa. Plant trials were conducted also at two factories. It was found generally that vegetable glue from potato starch is very satisfactory in the concentrations commonly used for the cheaper plywoods, but that the strengths obtained in higher concentrations such as used for furniture veneering are inferior to those of cassava glues. Further work on modifications of potato starch is necessary.

(e) Confectionery—Laboratory studies were made of the properties of the pastes of various starches and commercial trials were made of the suitability of several soluble potato starches in confectionery manufacture. The results indicate generally that potato starch can probably be adapted to this purpose to meet the requirements of various products.

(f) Laundry—Laboratory studies on the relative stiffness and other properties of various starches were extended to commercial trials in three power laundries. Excellent results were obtained with potato starch for practically all classes of work, different modifications being adaptable to meet the varied requirements of individual laundries. Various modifications are well adapted also for household laundry use.

(*g*) *Glucose*—Comparative aging tests of glucose made from potato starch and from corn starch were carried out.

(*h*) *Dextrins and British Gums*—A laboratory dextrin roaster was designed, the details of which will be published shortly in the Canadian Journal of Research. Conditions of time, temperature, acid concentration, pretreatment of the starch and other factors were studied in relation to the dextrin produced. The characterization and general properties of various dextrins and their application in textile and adhesive products are being studied.

(*i*) *Textile*—A preliminary investigation of different starches in warp-sizing has been made. Laboratory studies in textile finishing have been extended to commercial trial in one instance.

(*j*) *Foundry*—A study of some gelatinized starches has been initiated and the products will be tested as core binders.

Inks and Paper

Further consideration has been given to difficulties encountered in the photo-gelatin engraving process of reproducing views. This has included the examination of the various gelatins used in the process. Continued improvement in results is reported by a firm which gave effect to the recommendations made. (W. Gallay.)

Samples of paper intended for the printing of new Dominion of Canada bond issues were tested in regard to their probable permanence. The literature on paper permanence was reviewed, preparatory to undertaking, in collaboration with the Forest Products Laboratory, Montreal, the preparation of specifications for papers of a high degree of permanence. (H. D. Chataway.)

Consideration was given to the problem of obtaining an ink suitable for printing butter-wrap paper by a new, rapid process, involving the use of a rapidly evaporating ink. (H. D. Chataway.)

The possibility of using ground limestone as a paper filler was examined. (C. Y. Hopkins.)

In some types of recording equipment used in aircraft, especially recording altigraphs, the record is rolled very soon after being made. For such recorders a special ink was developed, which, while not drying on the pen, will dry rapidly on the record, without spreading. (D. F. Stedman.)

Sealing wax samples were examined for a government department.

Studies on the use of oxidized starch for paper finishing are referred to in the section on Potato Starch.

Laundering and Dry Cleaning

C. H. Bayley, B. J. Kenalty

The laboratory's "test bundle" service has been in active operation during the year, 367 bundles for white work and 132 bundles for colored work having been issued to members of the Canadian Research Institute of Launderers and Cleaners. Members of the Institute are required to process these bundles, at frequent intervals, in order that the efficiency of their washing operations, as regards detergency, tensile strength loss and whiteness retention may be determined. This service, which is supported financially by members of the Institute, has resulted, during the past year, in the maintenance of a high standard of efficiency in 68 Canadian commercial laundries.

A method of checking the efficiency of dry cleaning in a quantitative way has been worked out. It depends on the use of flannel which has been deliberately soiled in a standard manner. Based on this method, a test bundle service for use in dry cleaning plants has been initiated and is being used by members of the Institute operating dry cleaning plants, and bundles have been issued to members of this Institute. Recommendations based on the results of these tests have resulted, in many cases, in a definite improvement in quality of work.

Service work for the industry included 552 reports covering the investigation of new and damaged fabrics, soaps, alkalis, water analyses, miscellaneous analyses and recommendations.

In view of the close relations existing between laundering and textile problems, it is the policy of the laboratory to keep in close touch with new developments in the textile field. For this purpose, visits were made to 18 textile plants during the year.

In connection with the work of the Canadian Government Purchasing Standards Committee, the laboratory has collaborated with the Subcommittee on Soap and Detergent Specifications in the drafting of further specifications and methods of tests for soaps and detergent products, and with the Subcommittee on Textiles in the drafting of methods of tests for textiles.

The investigation of the possibility of the production of a cheap water softener prepared from Canadian raw materials has been continued. It has been found possible to prepare a synthetic base-exchange material of high capacity for waters containing up to eleven grains of calcium and magnesium hardness.

The systematic study on the dry cleaning efficiency of the various dry cleaning solvents, soaps and assistants is being continued. Some of the newer types of synthetic detergents consisting of sulphated, fatty alcohol derivatives appear from the work of the laboratory to have considerable usefulness as dry cleaning assistants.

The experiments carried out in conjunction with the Department of Household Science, University of Toronto, for the purpose of comparing the efficiencies of commercial laundering and household washing machines, have been completed.

A systematic study of the laundry bleaching process is in progress. In this connection it has been found possible to measure chemically the degree of chemical tendering in cotton fabrics subjected to one bleaching in the laundry, and this chemical method is now being applied in checking the efficiency of laundries by test bundles. The effect of pH, temperature, presence of metallic compounds and of certain types of stains on the degree of chemical attack which cotton undergoes in the bleaching process is being studied and there is every likelihood of information of practical value being secured.

A method has been developed for distinguishing between chemical degradation due to oxidizing attack and to acid attack in cotton fabrics.

Leather

W. E. GRAHAM

During the year an exhaustive study has been undertaken and is still in progress on the nature and quantity of tannin to be found in the barks of various species of trees native to Canada. It would appear that certain of these barks have commercial possibilities, and the investigations include studies of the leather making qualities of the tannins and the necessary details for satisfactory extract manufacture.

With a view to improving the appearance of buffalo skins for coats and robes detailed studies have been carried out on the dyeing of the wool. The skins are at present being obtained in somewhat bleached condition and it is concluded that their appearance can be satisfactorily improved by dyeing.

Further studies have been made on deteriorated chrome upper leather. Attention has been recently directed to fabric lining materials as a contributing cause of damage.

A variety of service problems has been investigated. These include leather dressings, gummy spue on waterproof stuffed upper leather, channel cements, staining of gabardine by leather peaks in military caps, dyed furs alleged to have caused dermatitis, and physical properties of leathers.

Consideration has been given to polishes for the factory-finishing of shoes; to leather used in gas meters, and to the influence of drought on the suitability of western hides for the production of sole leather.

Magnesian Products

N. P. Pitt, L. Hodnett, G. W. Paterson

Laboratory work has followed along the lines of previous years, being almost entirely of a commercial character, and has been carried out with the financial and technical assistance of Canadian Refractories Ltd. As before, direction of the work has been in the hands of Mr. F. E. Lathe, Director of the Division of Research Information.

Stable Dolomitic Refractories

Completion of the greater portion of the laboratory work on new dolomitic refractory clinkers, briefly outlined in the previous report, has led to patent applications being placed in the leading steel-making countries of the world.

Dolomite, a compound of calcium and magnesium carbonates, is of widespread occurrence, and is used in the steel industry in large quantities, both burnt and in the raw condition. Many methods have been proposed for the use of this very refractory material in the manufacture of basic brick, but little success has been attained, owing to the readiness with which such brick hydrate and break down on exposure to atmospheric moisture. It was determined in the laboratory that, by mixing silica with dolomite and a stabilizing agent, and correctly proportioning the basic and acid constituents, a refractory could be obtained which would not only withstand atmospheric hydration but also the action of steam for long periods. The method therefore makes possible the production of stable dolomitic clinkers, which can be used in open-hearth furnaces or made into brick, and also permits the manufacture of stable dolomite brick directly from a correctly prepared mixture of burnt dolomite and sand. The new method may be applied to a wide range of materials, from low-lime magnesites at one extreme to limestone at the other.

A large number of new refractories are thus made available. They are characterized by extremely low cost of production as compared with other basic and neutral materials. Their refractoriness is such that it is difficult to clinker some of the most desirable mixtures in commercial kilns. Obviously, some time will be required to determine which are the preferred compositions and in what fields these can be most usefully applied.

Chemically Bonded Brick

This work has been carried out with the co-operation of the staff of the Mines Branch, and making use of the equipment which is available there.

A very successful installation of unburned brick, which were developed by J. W. Craig and have been previously described, was made in Portland cement kilns. Following this installation a demand arose for a chemically bonded unburned brick with greater strength at all temperatures than can normally be obtained with the organic binders previously used.

Work begun in the previous year was continued with considerable success, and a chemical bond possessing the desired characteristics was developed. Cold strengths have been obtained which are considerably higher than those of the imported competitive unburned brick and, in fact, higher than those of many burned brick. Patents have been applied for on the binder used.

Plastic Refractories

The development of a plastic refractory in the laboratories, primarily for use in tap-holes of open-hearth furnaces, has already been described. Commercial applications showed that this refractory, though serviceable, had one fault in common with similar competitive materials—during the drying process, the soluble bond would migrate to the surface being dried and form there an extremely hard skin, leaving the interior greatly weakened and frequently leading to early failure.

Laboratory tests led to the incorporation and commercial adoption of a chemical which, though present in very small proportion, gives the refractory mass uniform strength throughout. The improved plastic refractory is finding a ready market in Canada, England and the United States. It is anticipated that this method of preventing migration of soluble binders will be applicable to many other refractories, both acid and basic, and this field is now being explored.

Cements

Considerable difficulty is ordinarily encountered in laying up basic and acid brick, owing to the absorption by the brick of the water and bond in the cement, thus rendering the latter difficult to work, making impossible a proper adjustment of the position of the brick, and tending to flux the brick with the excess of cement used.

By the inclusion of a combination of chemicals in such cements, both of these difficulties have been overcome, and their general working properties have been greatly improved. The character of the new cements is such that they very gradually give up admixed water, however porous the brick, and thus permit the making of very thin joints, a matter of importance when mechanical strength and high refractoriness are required. This combination of chemicals has already been included in five cements which are now commercially available.

A new bonding cement, for use with an aggregate of crushed brick, has given good service in repairs made to soaking pits.

Refractories with Hydraulic Binders

The hearths of reheating furnaces are frequently made of basic or neutral plastic refractories which are rammed in place. In many of the smaller furnaces, however, ramming is impractical owing to the limitations of space. Under these circumstances, it is desirable to employ a hydraulically bonded refractory which can be shoveled into the furnace, leveled off and allowed to harden. Such a refractory has been developed in the laboratory and is now being used in the hearths of reheating furnaces.

Maple Products

L. Skazin

The production of concentrates of natural maple flavor was studied on a semi-commercial scale. The optimum conditions for the different stages of the process were established and plans were drawn up for the operation of the process on a commercial scale. Information and samples are available to those interested in installing the process.

The nature of changes which take place when ordinary cast maple sugar becomes mottled on keeping was investigated. Experiments were carried out which led to the development of a technique by which it is possible to produce maple sugar, which does not differ in appearance from the familiar cast sugar, except in the almost complete absence of mottling.

Some further progress was made during the short sap season of 1935 in the study of the factors which control the development of maple flavor when sap is boiled down to syrup.

Milkweed

N. H. Grace

A study has been made of the possibilities of utilizing both the bast fibres and the seed hairs of the common milkweed (*Asclepias syriaca*). A considerable number of methods of retting the stalks in order to isolate the bast fibres were examined. Simple dew-retting methods appeared to be moderately satisfactory. After examination of the fibres, it was concluded that, in view of the availability and quality of flax and of hemp fibre, the possibility of commercial development is doubtful.

Study of the seed hairs and actual spinning tests with the material indicated that milkweed floss cannot be used satisfactorily for textile purposes in its natural state. This is due to the physical nature of the fibre, especially its smoothness and straightness. The lack of the superficial roughness and twist characteristic of cotton limits the possibilities of milkweed floss as a textile fibre in its natural state. It was found however that by chemical treatment the fibre can be changed materially and given a rough surface and a twist. The textile possibilities of such modified fibre have not yet been explored.

The purification of the floss has been studied and a simple procedure developed by which the ash content can be reduced to less than 0.1%. Such purified material may have possible uses as a source of high grade cellulose for chemical purposes.

The floss has been examined as a filling for life belts and other life-saving appliances. It compares favorably with kapok, a material commonly used for such articles. It was found that while milkweed floss takes up rather more water than kapok, its larger bulk gives it greater weight-supporting powers.

Paints

C. Y. Hopkins

The program of exposure testing of paints which was begun a year ago has been extended and now includes house paints, paints for use on galvanized iron, and synthetic resin enamels for exterior use. The object has been to make systematic observations on the actual behavior out of doors of paints made with different components. A further object was to determine the reliability of an accelerated laboratory test for ascertaining, in a few weeks,

how paints will behave to sun and rain. The preliminary results show a satisfactory degree of correlation between outdoor and accelerated weathering tests.

Weathering of enamels has been followed by means of gloss measurements and it is found that this method gives a reliable numerical record of the deterioration of the coating. Gloss is measured by means of the Pulfrich photometer.

A practical test for hiding power of ready-mixed paints or of pigment-in-oil pastes was developed. Methods of measuring other properties of paints such as mobility and drying time were studied.

In collaboration with a committee representing various government departments, standard specifications were drawn up for the following materials: white lead paste, zinc oxide paste, liquid paint driers, raw linseed oil, boiled linseed oil, turpentine, thinners, putty for glazing and paste floor wax. A large amount of laboratory work was involved.

Miscellaneous matters dealt with by the paint laboratory during the year have been: *(a)* the composition of stencil paint, *(b)* the cause of the discoloration of painted plaster walls, *(c)* paints for laboratory walls, *(d)* acid-proof paint for steel, *(e)* aluminium priming paint for interior woodwork, *(f)* the use of marl in paint, *(g)* paint for biological laboratories, *(h)* paint for a structure made of aluminium alloy, *(i)* specifications for mineral spirits, *(j)* paint for window-shade cloth, etc.

Refining and Bleaching Clays

W. GALLAY

Further samples of bentonites from western Canadian deposits have been investigated as to their efficacy for oil refining. Advice has been given in a number of instances in regard to processing costs and available markets. Two of the most important deposits in southern Manitoba were visited and contact maintained with prospective commercial developments.

Rubber

T. R. GRIFFITH

The work undertaken earlier on the bonding of rubber to metal was directed particularly to the development of a cement capable of withstanding elevated temperatures and hence applicable to the production of rubber-cushioned mountings for the engines of automobiles. It appeared that the cement could be used with satisfaction for bonding other materials in addition to rubber and metal and as a primer for the application of protective coatings, and it was found that the material had possibilities as a molding composition. Promising results have been secured in all these connections.

A large number of tests were made on rubber mixtures containing carbon black, in connection with the researches on carbon black mentioned in another section.

A considerable number of tests on rubber products were made for government departments. A new tensile testing machine suited to the testing of light gauge rubber stock was installed.

Attention was devoted to the preparation of specifications for a wide range of rubber goods for use in purchasing by a government department. It is hoped to complete these specifications after further experimental study.

The problem of the deterioration of certain lines of printed rubber goods was studied and solved, one of the constituents of the rubber printing ink being found responsible.

A problem relating to the cement used in making rubber-set brushes was studied.

Preliminary consideration has been given to the problem of storage of certain classes of rubber goods, and it is hoped to undertake a systematic study of the matter.

The problem of discovering the most suitable dusting powder for preventing adhesion occurring when surgeons' gloves are sterilized was the subject of experiments.

Selenium

A. Cambron

Work has been initiated with the object of finding, if possible, new outlets for selenium, a material now obtained as a by-product in copper refining and available in increasing quantities in Canada. It is too early to report in any detail on this work, but it may be said that interesting results have already been secured in the use of selenium compounds in the concentration of certain ores. The Ore Dressing Division of the Department of Mines provided valuable co-operation in this phase of the work.

Soap

C. H. Bayley, C. W. Davis

In collaboration with the Canadian Government Purchasing Standards Committee, specifications were prepared for the following soap products: Household bar soap, bar toilet soap, milled toilet soap, white floating soap, liquid toilet soap, liquid household soap, soft soap, laundry chip soap and laundry powdered soap. Standard methods of sampling and analysis of soap were drawn up for use in connection with these specifications.

Sorption

The influence of the mastication of rubber and of the incorporation in it of the reinforcing ingredient, carbon black, on the sorption of organic vapors by the material has been studied. Experiments have been made on the influence of molecular size on the adsorption of vapors by fractions of polystyrene. (L. M. Pidgeon.)

A study was started on the possibility of determining the surface area of screen fractions of ground rock by measuring the sorption of dyes. (A. van Winsen and R. P. Graham.)

Storage Batteries

L. M. Pidgeon

Further tests are being carried out with reference to the quality of the British Columbia wood, yellow cedar (Alaska cypress, *Chamaecyparis nootkatensis*) when used for separators between the plates as compared with Port Orford cedar *(Chamaecyparis lawsoniani)*. The latter is native to Oregon, and is used extensively by storage battery manufacturers. The tests are being carried out in conjunction with a Canadian battery manufacturer, special batches of batteries being assembled for the purpose.

Consideration was given to a special electrolyte proposed for addition to automobile batteries.

Water Treatment

E. A. Flood

Further work has been done on the development of a cheap water-softening sand from Canadian raw material originating in the asbestos mines. To date no water-softening sand of Canadian origin has been available. Results indicate that a product with a capacity about equal to some of the natural softening sands such as "Zeodur" can be produced at a cost of about $1.50 per cubic foot.

At the request of a government department an investigation is being made of a device for the treatment of boiler-feed water which is claimed to prevent the formation of scale in steam boilers and to remove scale previously deposited.

Two samples of boiler compounds and several samples of water were examined in connection with the treatment of boiler-feed water in Regina—a city with a very hard water supply.

Wax Plucking of Poultry

N. H. Grace

In co-operation with the Livestock Branch, Department of Agriculture, work was continued on the wax method of dressing poultry. A detailed publication, "The Use of Wax in the Plucking of Poultry", has been prepared. Some twenty-five thousand copies were printed in English and French. Demonstrations on wax plucking were carried out at various points throughout Canada and a gratifying degree of interest was displayed by the public.

In the early stages of development wax was prepared in these laboratories for trial purposes, some twelve tons of poultry-plucking wax being prepared and distributed. The wax is now available through regular commercial channels, and any desired quantity may be secured by users.

It has been shown that satisfactory results are obtained in the wax dressing of most types of ducks, turkeys and geese.

Since the treatment to which the bird is subjected prior to waxing may have an important bearing on the results obtained by wax, a study was made of the effect of various roughing methods on the ease of removal of pin feathers. Details of this study will be published shortly.

Changes which take place in poultry-dressing wax following overheating during reclamation have been studied experimentally. A large number of new wax mixtures were prepared and examined, with the object of developing a mixture more particularly adapted to use by packing plants, which generally semi-scald the birds before applying wax. Promising results have been obtained, and one of the mixtures is being tried in large scale tests.

Wool

P. Larose, Miss A. S. Tweedie

The laboratory examination of samples of wool from each of the individual sheep included in an experimental study, conducted at the University of Alberta, under the Associate Committee on Wool, and dealing with the influence of humidity, temperature, plane of nutrition and mineral feeding on fleece characteristics, was completed. A full report on the five-year program of work which has been carried out in connection with this study will be issued shortly.

The work on the regain (moisture take-up) of wool has been continued and it is expected shortly to publish the data secured.

A large number of analyses of wool for sulphur-content have been made by a new method, which has been shown to be accurate and expeditious.

As a result of further tests carried out by means of it, the machine designed in the laboratories for measuring the wearing qualities of cloth by determining resistance to abrasion and rubbing has been modified.

Other work on wool and woollen fabrics carried out during the year has dealt with: (*a*) the ash-content of wool, (*b*) measurement of the fibre diameters of certain exceptionally fine wools grown in Ontario, (*c*) shrinkage tests on knitted fabrics, (*d*) process oil on knitted wool material, (*e*) marking bathing suits in a permanent manner, (*f*) applying permanent markings to mackinaws.

Cotton

P. Larose, Miss A. S. Tweedie

The study of methods of determining the fastness of dyes has been continued. Twenty-two standard dyeings comprising British, American and German proposed standards, were made and tested for fastness to light by exposure to sun on the roof and by exposure to the artificial aging by a carbon arc in the machine known as the "Fugitometer". The results enabled a comparison of the methods to be made and brought out the advantages and disadvantages of each.

Trouble due to uneven dyeing of knitted cotton material experienced by a large textile mill was studied and various possible sources of the trouble were investigated.

Artificial wool made in Italy from casein (the chief protein of milk) by a new process was examined and a report on the findings published in the Canadian Textile Journal. The fibre was found to be equal in fineness to wool of moderate fineness (60's count), to take dye satisfactorily, to have about half the strength of wool and to contain a high proportion (4.5%) of ash.

The tendering of sized rayon yarn due to the use of a special size was investigated and recommendation made by which the trouble was overcome.

Samples of tent duck specially treated in a variety of ways were tested as regards resistance to mildew, waterproofness, fastness to light and fastness to washing.

A schedule of standard test methods for the examination of textile materials was worked out as a basis for the subsequent preparation, under the Canadian Government Purchasing Standards Committee, of specifications for a variety of textiles. This has involved a good deal of laboratory work. The schedule covers the following: 1. Conditioning. 2. Moisture content. 3. Fibre identification and quantitative determination. 4. Determination of sizing, finishing, etc. 5. Breaking strength and elongation. 6. Tear resistance. 7. Weight, thread count, width. 8. Color fastness to light, weather, laundering, water, salt water and soap, crocking, perspiration. 9. Shrinkage on laundering and on sponging. 10. Water permeability.

Miscellaneous

Ink for Recording Altigraph. In some types of recording equipment used on aircraft the record is rolled very soon after being made. For such recorders a special ink was developed which, while not drying on the pen, will dry rapidly on the record, without spreading. (D. F. Stedman.)

Liquid for Aircraft Levels. It was desired to find a liquid of good viscosity, low freezing point, fairly high boiling point, good meniscus, which is not unduly hygroscopic, corrosive or unstable, and which does not attack rubber. This problem was studied and recommendations were made. (D. F. Stedman.)

Carbon Monoxide Hazard. The carbon monoxide in the air of the control room of the Engine Testing Laboratory was determined at intervals during bench tests of airplane motors. Subsequently, as a precaution against the building up of dangerous concentrations of carbon monoxide in the room, an apparatus was set up to provide a continuous record of the concentration of the gas in the laboratory. (A. Cambron.)

Removal of Thiophene from Saturated Hydrocarbons. In connection with the purification of hydrocarbons such as benzene, a useful procedure has been worked out which removes thiophene very rapidly. The previously known methods of accomplishing this are either tedious or drastic or both. Details of the process will shortly be published in the Canadian Journal of Research. (D. F. Stedman.)

Rancidity. Experiments have been conducted on the use of oatmeal flour for the prevention of rancidity in fats. (H. D. Chataway.)

Animal Glues. In collaboration with the Forest Products Laboratories, Ottawa, experiments were carried out in an attempt to correlate the joint strength of a glue with its physico-chemical properties. The work is still in progress. (W. Gallay.)

Floor Detergents. Further work was carried out on the abrasive properties of cleaning powders for use on floors, porcelain, etc., and a simple test was developed for the rough classification of scouring powders as regards their scratching characteristics. (A. van Winsen.)

Analysis. Chiefly in order to provide data required for researches in progress in the division, the analytical laboratory made analyses of the following samples: 217 of refractories, 162 of asbestos, 25 of metals and alloys, 69 of soap, 64 of water, 25 of aviation gasoline, 100 of motor gasoline, 8 of lubricating oil, 14 of pigments. Other materials analyzed included rubber samples, tanning extracts, textile material, varnish driers, antifreeze, water pipe incrustations, etc. (C. W. Davis.)

Matches, Spontaneous Combustion. In co-operation with the Department of Insurance and the match manufacturers, 37 samples of matches were tested. In connection with a fire, the possibility of Javel powder leading to spontaneous combustion was investigated. (C. W. Davis.)

Molasses. An examination of the slop from the fermentation of molasses was made to determine the possibility of extracting glycerine from it. (C. W. Davis.)

Fish Stocking. In conjunction with the Biological Board, tests were made at intervals on water from a lake which had been treated with copper sulphate in order to destroy the existing fish population preparatory to stocking the lake with trout. (C. W. Davis.)

Rubber in Lubricating Oil. The effect of the addition of rubber to a lubricating oil was studied. Such addition was found to be without the marked effect on the carbon residue, both before and after oxidation, that might have been expected. (C. W. Davis.)

Inquiries. During the year inquiries to the number of 1,938 were dealt with by the division. In addition to those relating to the major subjects of research in hand, inquiries on many miscellaneous matters are included in

this total. A few examples of the miscellaneous subjects dealt with are as follows: Bleaching beeswax, measuring molasses, birch tar, deciphering faded writing, material for luminescent screens, icing sugar decoration, fumigation chemicals, reclamation of old battery boxes, lubrication of packings, waxing fruit and vegetables, utilization of distillery by-products, dehydration of fruits and vegetables, asphalt emulsions, firelighters, gum for postage stamps, pinholes in collapsible tin tubes, softening vegetable ivory.

DIVISION OF PHYSICS AND ENGINEERING

R. W. BOYLE, *Director*

J. H. PARKIN, *Assistant Director*

The Division of Physics and Engineering has been called upon to perform a greater number of tests, examinations and standardizations of instruments than in the preceding year. The reverberation chamber, hot-box apparatus and liquid air plant, installed or completed during the previous year, have been used extensively. Work on the construction of a standard mutual inductance to provide Canada with a primary standard of electrical inductance and capacity is continuing; it is expected that several years will be required to construct and calibrate the final apparatus. A further series of tests of commercial radio receivers for the Canadian Radio Broadcasting Commission has been performed and a new method of measuring the acoustic output of radio receivers has been developed. A second unit for the recording and direction-finding of atmospheric disturbances is nearing completion and will shortly be shipped to a companion western station. In conjunction with the original apparatus being set up at the Britannia Heights station, this will provide a means of locating the exact point of origin of such disturbances and of determining the meteorological value of the project.

The following new equipment has been installed or constructed during the last year: *(a)* Interference apparatus for absolute calibration of gauge blocks in terms of light wave-lengths; *(b)* Spectrophotometric apparatus for the measurement of the light transmission of filters, glasses, solutions, etc., over a range of wave-lengths from the visible red to the far ultra-violet; *(c)* A precision micro-balance for the accurate determination of small weights; *(d)* A large comparator for use on aerial survey photographs; *(e)* Apparatus for the provision of the highly constant voltage required by the X-ray and photometry laboratories; *(f)* Six secondary standard ionization chambers to be distributed throughout Canada for the calibration of the dosage meters used in cancer treatment; *(g)* A Schering bridge and associated equipment for a-c. measurements at high voltages; *(h)* Two standard current transformers for precision a–c. measurements.

A great deal of assistance has been given government departments in various problems of a physical nature. These include the design of new control mechanism for depth sounders, electrical methods of killing poultry, design of apparatus for determining the rate of evaporation in forest areas, design and construction of apparatus for aerial survey work, methods of noise reduction, etc.

Acoustics

GEO. S. FIELD

Acoustic Testing Laboratory

A number of measurements have been made on the sound absorptive properties of various building materials. The greater number of these were for the manufacturers, though some were made for other government departments.

Experiments are under way to determine the best methods of mounting wallboards from a sound absorption or sound deadening point of view. The effect of area of sample on the measured values of the absorption is also being studied in detail.

A sample of material which had been measured by the United States Bureau of Standards was tested in the laboratory. The two sets of measurements have been carefully checked against each other, and experiments have been made to determine whether certain discrepancies could be attributed to aging of the material.

Radio Receiver Tests

A number of receivers were tested for their over-all response by the radio laboratory. Advice and assistance on the acoustic aspect of the work were rendered as the work progressed.

Microphone Measurements

During the past year a standard microphone was prepared and carefully calibrated. Experiments have been undertaken to determine the best method of using this microphone to calibrate other microphones.

Miscellaneous

Several tests were conducted to determine the reduction in the noise from an aeroplane exhaust using a new type of exhaust silencer recently developed in this country.

An acoustics survey was made for the Department of Finance to determine the possibility of deadening the noise from the machines in two of their rooms connected with the Central Pay Office. A method of treatment was suggested.

Aeronautics

J. H. PARKIN, J. J. GREEN, G. J. KLEIN, S. J. MURPHY, K. F. TUPPER, AND M. S. KUHRING

As in the preceding year, the work in the aeronautical laboratories has consisted of investigations directed to the solution of specific problems submitted, and to routine tests and calibrations. This work has been more than sufficient to occupy the time of the staff and has necessitated suspension of work on less urgent investigations and on problems of a more general character. For the same reason, thorough calibration of much of the major equipment has had to be postponed and little time has been available for the design of permanent apparatus to replace temporary improvised equipment now in use, or of apparatus needed in the other laboratories.

Again it will be seen that much of the work done in the laboratories has been non-aeronautical in character. A large proportion of the work has been done for government departments, and particularly for the Department of National Defence. The close and hearty co-operation of this Department in the work of the laboratories has continued, and it is a pleasure to acknowledge again the generous assistance of the department in supplying materials, equipment and services.

No major changes in, or additions to, the equipment of the aerodynamic laboratory were made during the year.

Tests in the model testing basin have demonstrated the effectiveness of the beaches and overflow troughs in the suppression of waves. Some tests have been made using 10-ft. models of boats. Check tests are to be made on one 10-ft. model in the William Froude Tank, Teddington, England, to determine the extent of wall interference effects in the Ottawa basin on models of this size.

In the engine laboratory, to prevent the entry of exhaust fumes into the observation room and to suppress the noise issuing from the laboratory during the type-testing of high-power aircraft engines, alterations have been made and additional equipment provided, with satisfactory results.

New quarters are being provided for the gasoline- and oil-testing laboratory to enable the staff to cope with the work required and to reduce the health and fire hazards.

The aircraft and allied instrument laboratory occupied new quarters in the Hydraulic Building at the end of the year.

Instruction in the care and maintenance of aircraft instruments was given to a non-commissioned officer of the Royal Canadian Air Force and a mechanic of the Ontario Provincial Air Service.

The large increase in the number of instruments to be overhauled and adjusted for the Royal Canadian Air Force necessitated the provision of additional staff in the laboratory and shop.

To release space required for the laboratories of the Department of Pensions and National Health and to provide space for the proposed hydraulic laboratory, one-half of the former hardwood factory was reconditioned by the Department of Public Works and is now occupied as the Hydraulic Building, by the aircraft and allied instrument laboratory, radium emanation laboratory, aeronautical library and certain offices.

Aerodynamic Laboratory

Canoes on Aeroplanes

In north country operations, canoes are frequently carried on aeroplanes. An investigation was made in the wind tunnel to determine the effect on the performance of an aeroplane, of a canoe carried in different positions and to find the best position, from an aerodynamic standpoint, in which to carry the canoe. Eleven positions for the canoe were investigated, using a model of a standard 16-foot canoe, and in some cases a canoe model with detachable ends. Report No. PAA–24 issued. (J. J. Green.)

Aeroplane Cockpit

At the request of the Department of National Defence, wind tunnel tests were made on the model of a certain transport aeroplane, which it was planned to use for photographic operations, to determine the effect on the performance of moving the cockpit forward of the wing to improve the pilot's vision. The width of cockpit, to provide the maximum field of view forward and downward, without adversely affecting the aeroplane performance, was also determined. Report No. PAA–23 issued. (J. J. Green, G. J. Klein.)

Farm Windmill

This investigation is being made in an attempt to design a windmill, for developing electric power on farms, capable of operating in light winds.

The dynamometer, for the measurement of torque, thrust and speed, has been constructed and tried out in the wind tunnel.

Some work has been done in connection with a light windmill for use in charging radio batteries. A windmill on the market and one designed and made in the laboratories have been tested.

Information pertaining to the design and performance of windmills and of propellers for snow sleds has been supplied to numerous inquirers, located principally in western Canada. Two snow-sled propellers were awaiting test at the close of the year. (G. J. Klein.)

Stalling of Tapered Wings

At the request of the Department of National Defence, a study has been begun of the stalling of heavily tapered wings as used on many modern aircraft. On such wings, the stall commences at the wing tips instead of at the centre of the wing and the effect on lateral control by the ailerons may consequently be serious. A theoretical study has been made which will be supplemented by tests in the wind tunnel. (G. J. Klein.)

Aircraft Models

Models are being made of three aircraft purchased by the Department of National Defence, and these will be thoroughly tested in the wind tunnel. Comparison of the performance predicted from the wind tunnel tests of the models, with the results of acceptance tests of the aeroplanes, will supply valuable information for the prediction of performance from model tests. In addition, the models will be available for tests to determine the effects of any modifications it may be desired to make in the machines. (J. J. Green.)

Cup Anemometer

At the request of the Director, Meteorological Service of Canada, wind tunnel tests were made to determine the torque on anemometer heads fitted with flanged and with beaded cups. Report issued No. PAI–147. (J. J. Green.)

Comparison of Model and Full-scale Tests for Stability of an Aeroplane

In 1934, at the request of the Department of National Defence, an investigation was made in the wind tunnel to determine the cause of longitudinal instability in a float aeroplane used for photographic operations. Later, the structural changes to remedy the instability, which were recommended as a result of the study, were made in an R.C.A.F. machine, and the machine was thoroughly tested. The reports of the pilot on the flying characteristics of the machine before and after modification show satisfactory agreement with the predictions based on the wind tunnel test. Marked improvement in stability was reported. Report issued No. PAA–15A. (J. J. Green.)

Bank and Turn Indicators

At the request of the Department of National Defence, an investigation was made of the alleged insensitivity of certain bank and turn indicators. The sensitivity of the instrument under different suctions was determined and the complete instrument installation with Venturi and connecting tubing of different lengths was then tested in the wind tunnel over a range of air speeds. Comparative tests of other instruments and Venturis were also made. Report No. PAI–150 issued and another in preparation. (J. J. Green, S. J. Murphy.)

Model-testing Basin

Current Meter Rating

A number of ratings of current meters for the Interdepartmental Water Levels Board were made during the past year.

Based on laboratory tests of new meters and of meters before and after periods of service, an analysis of the behavior of the "Alberta" current meters was prepared. The "Alberta" meter, developed by the Department of the Interior, is a screw type meter employing ball bearings. Reports issued—No. PAH–20 to 27 and PAH–29 to 36. (K. F. Tupper.)

R.C.M.P. Patrol Boats

Models of a 120-ft. patrol boat were tested in the basin for the Royal Canadian Mounted Police. Resistance tests of the model to the original lines indicated unsatisfactory characteristics and models to three other sets of lines were tested. Improved performance was obtained.

Models to 1/12th and 1/24th scale were employed. It is proposed to send the 1/12th scale model to the William Froude Tank, Teddington, England, for check tests, Mr. G. S. Baker, Superintendent, having kindly consented to make such tests for the Council. These tests are desired in order to determine the feasibility of testing 10-ft. models in the Ottawa basin.

In addition, tests were made in connection with the bilge keels. Report No. PAH–28 issued; others in preparation. (K. F. Tupper.)

Stop Logs for Emergency Dams

At the request of the Engineer-in-charge, St. Lawrence Waterways, tests were made in the basin last year to determine the hydrodynamic forces on stop logs for the emergency closing of ship canal locks. Following these preliminary tests it was decided to construct a scale model of a canal section. The new model will reproduce much more closely full-scale conditions. This apparatus has been constructed and has been fitted with special balances to measure accurately the hydrodynamic forces involved. (K. F. Tupper.)

Singapore IIC Hull (1/12th scale)

The model, kindly loaned by the Air Ministry, for testing in the Ottawa basin, to check equipment and technique, proved too large for the improvised balance in use. The tests await the design and construction of the permanent towing balance. (K. F. Tupper.)

Engine Laboratory

Gasoline

Tests and investigations in connection with gasoline, completed or in progress, include the following:

(a) Effect, on doped gasoline, of long exposure to sunlight and electric light as in the container of a visible dispenser.

The characteristics of doped gasoline exposed in a glass container have been determined periodically over a period of one year. The final report is in preparation. (M. S. Kuhring.)

(b) Seasonal variation in characteristics of commercial gasoline as sold to the public.

Samples of gasoline, on sale in Ottawa, were collected monthly throughout one year and tested. Reports issued:—Nos. PAF–105, 105A, 108, 111, 113, 129, and 134. The final report is in preparation. (M. S. Kuhring.)

(c) Determination of characteristics of gasolines on sale in certain cities in western Canada.

A number of samples of gasoline were secured for testing to obtain information as to the characteristics of gasoline on sale in the prairie provinces. The samples have been tested and the report is in preparation. (M. S. Kuhring.)

(d) Tests of samples of gasoline for the provinces.

Certain provinces have enacted legislation for the control and sale of gasoline and many samples of gasoline have been and are being tested for these provinces. Samples have also been tested for one province which was investigating the sale of gasoline within its boundaries. Reports issued: Nos. PAF-117, 119, 123, 124, 126, 127, 128, 133, 141, 143, 144, 146, 148. (M. S. Kuhring.)

(e) Routine tests of samples of gasoline for the Royal Canadian Air Force, Post Office Department, aircraft operators, aircraft engine builders, oil refiners and others. Reports issued: Nos. PAF-102, 103, 104, 106, 107, 109, 112, 114, 115, 116, 120, 122, 130, 132, 135, 136, 138, 149. (M. S. Kuhring.)

(f) Aviation gasoline.

This laboratory is co-operating in a comprehensive investigation now nearing completion in the United States, that was undertaken in an effort to develop a laboratory method of testing aviation gasoline for detonation characteristics that would show satisfactory agreement with results obtained in engines in service. A radial air-cooled aircraft engine of British manufacture is being used. The engine, kindly loaned by the Department of National Defence, has been fitted with special pistons and valves, generously supplied by Armstrong-Siddeley Motors Ltd. The necessary special blends of gasoline have been provided by the American committee. The equipment has been prepared and practice tests have been made using an obsolete engine loaned by the department. Further work awaits completion of certain urgent tests. (M. S. Kuhring.)

Indicating Engine Lubrication

Some further work has been done on this investigation, seeking to develop an accurate means for indicating the flow, and possibly the viscosity, of the oil in the lubrication system of an engine. (M. S. Kuhring.)

Aircraft Engine Type Tests

Type tests, to Air Ministry Specifications, of aircraft engines are made in the laboratories. 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.

Civil type tests of two engines were in progress at the end of the year.

The Department of National Defence is kindly assisting in these type tests by supplying the services of two aircraftsmen. (M. S. Kuhring.)

Silencer for Aircraft Engines

In co-operation with Mr. G. S. Field who made the sound measurements, several tests have been made of an aircraft engine silencer of new type. Observations were made of the effect of the silencer on engine power, exhaust back pressure and exhaust noise. Reports issued Nos. PAE-20, 22 and 23. (M. S. Kuhring.)

Lubricating Oil

Except for government departments, tests of lubricating oil are only undertaken for which special equipment, not available in commercial laboratories, is required. Samples of oil for use in aircraft engines are tested to Air Ministry Specification, for the Royal Canadian Air Force, aircraft operators and others. Reports issued: Nos. PAO-22 and 23. (M. S Kuhring.)

Exhaust Tail Pipe

In 1932 there was developed in the laboratory an improved form of exhaust tail pipe for aircraft engines, causing less exhaust back pressure than the usual form of pipe. This tail pipe was subsequently flight tested, during summer operations, by the Royal Canadian Air Force and the report on the tests has now been received. The exhaust pipe was reported as satisfactory and an improvement on other types. The exhaust pipe is still in service on the aeroplane. (M. S. Kuhring.)

Aircraft and Allied Instrument Laboratory

Radium Luminous Compounds

To supply information required by the Department of National Defence, an investigation was made of the deterioration of radium luminous compounds as applied to instrument dials. Three different compounds and some four methods of application were used. The relative brightness of the markings was observed immediately after application in 1931 and again in 1932, 1935 and 1936.

Useful information concerning the influence of the compound, its strength and method of application, on the rate of deterioration was obtained. Report issued: No. PAI-178. (S. J. Murphy.)

Intervalometers

On the recommendation of the Associate Committee on Survey Research, an investigation of reported inaccuracies in the intervalometers used by the Royal Canadian Air Force on aerial photographic surveys to trip automatically the shutters of the air cameras at regular intervals of time, was undertaken in collaboration with Mr. John Carroll of the Topographical and Air Service Bureau, Department of the Interior. Laboratory tests were made on five intervalometers, as used in the service, three of earlier type, and two of an improved type. Tests were made at different temperatures, different applied voltages, and with the intervalometers inclined to the horizontal. The limitations on accurate time spacing of the intervals by the intervalometers were determined. Report issued No. PAI-179. (S. J. Murphy.)

Altigraph for Aerial Survey Use

The instrument, developed in the laboratory, is undergoing flight tests. A manual recording circuit has been added to the instrument. (S. J. Murphy.)

Auxiliary Recording Camera

This instrument, designed to record the information necessary to fix the position of the aerial photograph at the time of exposure, is now being constructed in the shops. (R. H. Field, S. J. Murphy.)

Tests of Aircraft and Allied Instruments

The following tables summarize the routine work of the laboratory. (S. J. Murphy.)

TESTS MADE OF AIRCRAFT AND ALLIED INSTRUMENTS, 1935-36

—	Government	Commercial	Total
Height instruments	103	4	107
Airspeed instruments	165	11	176
Tachometers	159	14	173
Directional instruments	207	6	213
Attitude instruments	47	3	50
Engine instruments	153	6	159
Barometers	91	20	111
Hygrometers	0	2	2
	925	66	991

INSTRUMENTS OVERHAULED, 1935-36

—	Government	Commercial	Total
Height instruments	98	—	98
Airspeed instruments	100	—	100
Tachometers	86	—	86
Directional instruments	141	—	141
Attitude instruments	47	—	47
Engine instruments	127	—	127
Barometers	74	20	94
	673	20	693

Reports issued: Nos. PAI-126 to 179 inclusive. (S. J. Murphy.)

Miscellaneous Investigations

Aircraft Skis—Snow Performance

The object of this investigation is to secure information, now lacking, on the resistance and bearing power of skis on snow and the influence thereon of different factors such as snow condition, speed, form, proportions and material of the ski bottom. A few preliminary tests were made late in the spring of 1935.

The towing dynamometer was remodelled to record the resistance and attitude of the skis.

Difficulty was encountered in securing a means of towing the dynamometer that would be capable of operating in all snow conditions and possessed of the adequate speed range. Finally, through the co-operation of the Department of National Defence, a half-tractor was kindly loaned by J. S. Innes Limited, Toronto, Ontario. The tractor performed very satisfactorily. Tests were carried on continuously at the Ottawa Air Station over a period of about four weeks during February and March, 1936. As the tests progressed, additional ski models, having bottoms of different materials and forms, were constructed and tested. It is planned to continue the tests next winter.

An instrument has been designed and constructed to determine the bearing power of snow.

In connection with this investigation, particularly, it is desired to acknowledge the willing co-operation of the Department of National Defence and of the Officer Commanding, Ottawa Air Station. (G. J. Klein.)

Bearings

In an effort to secure information regarding the operating characteristics of small ball-bearings, for use in the construction of instruments where knife edges are not suitable, an investigation has been begun. Apparatus has been developed and some tests have been made. (G. J. Klein.)

Strength Tests of Aircraft Ribs

Further tests for strength of aircraft wing ribs have been made for the Department of National Defence. Reports issued: Nos. PAS-2, 2A, 2B, 2C and 3. (J. J. Green.)

Aircraft Dope

The equipment has been prepared for the testing of aircraft dope, in accordance with Air Ministry Specification. This work is being undertaken at the request of the Department of National Defence. (J. J. Green.)

Strength of Rectangular Flat Plates

This investigation was continued by a graduate student at the University of Saskatchewan using, in part, equipment which had been prepared in the laboratory. A thesis, covering the work to date, has been submitted. The work is being continued at the university.

Prevention of Formation of Ice on Aircraft Propellers

Preliminary tests were made in the engine laboratory, late in the spring of 1935. A model for the wind tunnel tests has been constructed. Pressure of other work has prevented further tests during the present year. Interim Report issued: No. PAE-19.

Atmospheric Electricity

D. C. Rose

The study of atmospheric electrical effects has been proceeding slowly. Records of the variation of potential gradient were taken continuously for a year ending December 1, 1935. The records indicate the existence of a new and important effect. The electrical content of the atmosphere appears to change quite suddenly at the passage of a fresh mass of polar continental air over the observation station. The change is indicated by a reduction in the mean deviation from the mean diurnal variation of the potential gradient. Further work is necessary to separate the effect of new air masses from the effect of pollution of the air by dust and smoke, etc., from the City of Ottawa. To do this plans are being made for a country station during the summer of 1936.

Plans are also being made for further investigation of the electrical charging of clouds which results in thunderstorms. It is hoped that study of atmospheric electric observations taken from aeroplanes will yield valuable information on this point.

Ballistics

D. C. Rose

The photoelectric cell method of measuring the velocity of projectiles was developed for use with field guns. A portable apparatus was constructed which could be carried in a light truck using battery power. The apparatus was taken to the Petawawa military camp and tested with 18-pounder field guns. Three photoelectric cell and lamp stations were used, the first and last being 50 and 150 feet from the muzzle respectively. Very good results were obtained, velocities being measured with a probable error of about two feet per second in velocities of the order of 1600 ft. per sec.

The same apparatus was applied to ultra-high velocities on the experimental rifle range in the National Research Laboratories, with a view to testing the Newton .22 experimental rifle designed by officers of the Department of National Defence. It was found necessary to alter some of the electrical parts of the equipment in order to obtain results at high velocities (up to 5500 ft. per sec.). When this had been done, measurements were made on the velocities of bullets fired from the .22 experimental rifle. The accuracy, however, was considerably lower than that obtained with projectiles of lower velocity. With a view to obtaining results that would be at least similar to those obtained at lower velocities, trials were undertaken which indicated that the accuracy at high velocities probably could be improved by making further alterations in the recording equipment.

Electrocution of Poultry

D. C. Rose

In the slaughter of animals for food, electrical stunning before killing has been found in other countries to give improved bleeding and less chance of spoiling the meat by bruising. Similar methods of electrical stunning have been tried in these laboratories on chickens, with a view to improving the feather release in order to make plucking easier, and also to improve bleeding if possible. A large number of experiments with different electrodes and different points of application have been tried. It was found that, if the electric current could be directed to the part of the brain which controls the feather muscles, very good dry plucking could be achieved. Further experiments will be carried out to obtain a good comparison with this and other methods of killing, such as the usual brain stick. After electrical stunning the bird is bled in the usual way and, while the bleeding always appears to be satisfactory, some physiological measure of perfection in the operation is necessary before electrical killing can be compared with other methods. The practicability of the method for use on farms is also being considered. The experiments were carried out at the request of members of the Department of Agriculture and with the assistance of officers of the Poultry Division.

Electrical Engineering

B. G. Ballard

Electrical Laboratory Equipment

Increasing demands for precisely regulated voltage necessitated the installation of an additional motor generator set in the engineering laboratory. This unit is provided with an electronic voltage regulator previously developed in the laboratory. Voltage is held constant to within + or −0.1% and this control may be effected on either the alternating current or direct current end of the motor generator. The regulator may also be adapted for speed control so that constant frequency may be secured.

Reactor units, whose impedence may be controlled so as to give a constant output voltage, are under construction. The reactors are provided with a direct current winding so disposed that no voltage is induced in it from the alternating current coils, and the reactance is controlled by adjusting the degree of direct current saturation in the iron. The direct current is to be controlled by an electronic regulator similar to that employed for the motor generator.

Laboratory Power Supply

The nature of the investigations carried on in the laboratory has made the consequences of a power failure increasingly serious. The main building of the laboratory is fed from a single feeder through an open delta trans-

former bank and a fault in either the feeder or transformer would, with the exception of a few loads, supplied by battery power, interrupt all work requiring electricity as well as the general heating facilities.

In view of this situation, a study of the possibility of carrying power from the Council's hydroelectric plant on the Annex property to the main building has been undertaken. The plan makes provision for an underground cable between the two properties, which would serve as an additional standby power supply for both properties. The proposal makes provision for any operating contingency that is likely to arise, and if put into practice would also effect a reduction in power bills.

Electric Service for the R.C.A.F. at Trenton

Assistance was given to the Royal Canadian Air Force in laying out its distribution system for the new training station at Trenton. The nature of the station and the requirements of aviation have presented some interesting problems. The entire distribution system is carried in underground cable and the load requirements are in many respects similar to those of a small industrial town. Power is required for workshops and hangars, street lighting, residential quarters, offices, water supply, radio station, etc.

Some time has also been devoted to construction under way at the Rockcliffe airport.

Speed Indication and Control for Echo-sounding Gear

Owing to unsatisfactory governor performance of the ultrasonic echo-sounding gear employed in charting underwater contours, the Canadian Hydrographic Service sought assistance in measuring speed of the driving motor so that proper corrections for errors in speed might be made on the chart. The motor has a rating of approximately 1/16 horsepower and any attempt to attach a tachometer to the existing equipment presented several difficulties. Moreover, the required accuracy of speed indication was somewhat closer than is possible with most tachometers. The problem was solved by employing a vibrating-reed frequency meter. Small slip-rings were attached to the direct-current driving motor and connected to the frequency meter. Since these instruments will respond either to mechanical or electrical vibrations, a mechanical link between the motor and meter might enable them to perform satisfactorily in service; it was felt desirable, however, to connect the meter electrically.

The present speed control employs a centrifugal governor operating a rheostat in the field circuit of the driving motor. In view of the trouble encountered, an electrical governor was developed in the laboratory. All moving parts and springs were eliminated and it is believed the new governor will prove more reliable than the centrifugal units. While it is somewhat more expensive, the extra cost is justified by the fact that the accuracy and reliability of apparatus costing several thousand dollars is contingent upon the successful performance of the governor. It employs a static inverter, to change direct current to alternating current, of which the frequency is determined by an electric oscillator. The output of the inverter is fed into slip-rings on the driving motor and supplies sufficient power to maintain synchronism despite changes in load voltage or field strength.

Miscellaneous

Various minor investigations and tests have been undertaken including oil burner approval, elimination of troublesome static electricity, determination of electrical conductivity of fire extinguisher fluids, overhauling an hydraulic direction-flow unit, investigating electric thermostats, etc. In addition, considerable time has been devoted to work of the Canadian Engineering Standards Association.

Electrical Measurements Laboratory

A. J. Grant, J. S. Johnson

Meter Approval

"Type Approval" tests were made on 11 types of meters or meter attachments, 49 types of current transformers, 7 types of potential transformers and 5 types of phasing transformers.

A study of the effect of temperature on meter lubricants was carried out and reported. The results indicate that more work should be done on the state of the bearing immediately after an extended period of zero motion.

Electrical Measurements

Considerable work has been done to augment the laboratory facilities in making measurements at commercial frequencies. A Schering bridge suitable for high-voltage work has been added to the equipment. The companion high-voltage condenser has been designed and will be available shortly. By means of these it will be possible to measure imperfect condensers, such as bushings and dielectrics at the normal testing voltages.

Two standard current transformers were obtained during the year. Both have ring cores of Mumetal. One transformer has a tapped primary and covers current ranges from 60 to 1000 amperes. The other transformer is intended for use with an inserted primary for higher current ratings; it has a copper shield between the permanent secondary and inserted primary windings to eliminate any errors due to uneven distribution of the primary turns. The shield is one-half inch thick. The errors of these transformers are quite small and nearly constant for all values of secondary current, being less than 0.1% and one minute phase angle.

A working model of a primary standard mutual inductance is being constructed. Considerable work has been done in preparation for testing it to check the calculated value.

The laboratory has used a watt bridge on several occasions in calibration work. This bridge, consisting of standardized resistances and a mutual inductance, can be present for any value of watts at commercial voltages, currents and frequencies; when the detector indicates zero deflection the watts and power factors are known within the accuracy of the resistances and mutual inductance used. This bridge circuit is particularly useful at the lower power factors where the usual methods are not conducive to accuracy.

Routine Electrical Tests

Routine tests were made on the following types of instruments:— current transformers, potential transformers, potentiometers, voltmeters, ammeters, wattmeters, bridges, resistors and standard cells.

Fire Hazard Testing Laboratory

J. H. Parkin, T. H. Doherty

While there was a reduction in the number of oil burners submitted for test as compared with the previous year, the number and variety of other devices increased and the laboratory staff was taxed beyond capacity. As a consequence, certain test work was delayed and other work suspended. The Associate Committee on Fire Hazard Testing rendered useful service in effecting a liaison between the laboratory, industry, the underwriters, and the Provincial Fire Marshals.

Additional equipment and further space have been provided to enable the laboratory to cope more effectively with the work required.

Domestic Oil Burners

During the year, five manufacturers submitted a total of 12 models of atmospheric oil burners; five of these were complete oil-burning stove units, and one was an oil-burning radiant heater. Listing was granted to five models of atmospheric burners and to the oil-burning radiant heater. One atmospheric burner failed to meet requirements and the remainder are still under test. No automatic burners were submitted during the year. The following table summarizes the oil burner work:—

ATMOSPHERIC OIL BURNERS

——	Manufacturers submitting burners	Models submitted	Models listed	Models rejected	Under test
Year 1935-36.....	5	12	6	1	5
Total to date.....	20	65	55	5	5

AUTOMATIC OIL BURNERS

Year 1935-36.....	—	—	—	—	—
Total to date.....	8	12	7	5	—

In addition, several manufacturers of accessories for oil burners have submitted parts for listing. Two manufacturers submitted a total of four sets of shells for atmospheric burners and one manufacturer submitted a metal bottle for atmospheric burners, all of which were found to meet requirements.

Practically all atmospheric oil burners now being submitted to the laboratory are incorporated in domestic heating equipment, such as ranges, space heaters or water heaters. A number of such units are now in the laboratory under test. An investigation has been conducted of the hazards involved in the operation of an atmospheric oil burner, installed in a warm air furnace and connected to an oil tank of fifty gallons' capacity. Report No. PFO-M1019 was issued describing this work.

Fire Extinguishers

The design and construction of the equipment for the testing of fire extinguishers was completed and test work, for laboratory purposes, on different extinguishers has been commenced and is still in progress.

Other Devices

One manufacturer has submitted several gasoline safety cans for test, but listing of these has not, as yet, been granted. A gasoline stove has been under test and a special investigation of flash arrestors was made in this connection. Plans have been laid for a more complete investigation of flash arrestors, but this work has been suspended. One manufacturer submitted three models of gasoline-burning devices.

Other devices received for test and listing include an automatic fire alarm, for which test equipment has been designed and constructed, and an automatic draft regulator, which has been tested but has failed, as yet, to meet requirements.

Three Safety Standards have been drafted as follows:—

No. NRC–13–1935. Safety Standard for Gasoline Safety Cans.

No. NRC–14–1935. Safety Standard for the Design and Construction of Automatic Draft Regulators.

No. NRC–15–1935. Safety Standard for the Design and Construction of Gate Valves of the Inside Screw Type.

Safety Standard for Dry Cleaning Solvents, No. NRC–10–1935, has been revised.

Regulations governing the testing, examination and listing of fire detection, control and suppression equipment, and hazardous devices and materials have also been revised.

Labelling and Inspection Service

The work of this service was continued throughout the year. Thirty-four factory inspections were made, of which 25 were conducted in British Columbia by an officer of the Fire Marshal's department; four were conducted in Toronto, Ont., two in Waterloo, Que., and three in Montreal, Que.; the nine last mentioned were conducted by the laboratory staff.

The total number of labels issued was 4,016 as compared with 7,450 in the preceding year. Of the labels issued during the last year, 500 were for automatic oil burners and 3,516 were for atmospheric oil burners.

Safety Codes

No safety codes have been drafted, but the laboratory has been represented on various committees of the National Conference called to discuss and formulate recommended regulations governing the handling and storage of flammable liquids.

Heat

C. D. NIVEN, J. D. BABBITT

House Insulation

The work of testing various kinds of house insulation for commercial firms has been continued throughout the year as samples were submitted. The "Hot-box" apparatus constructed about a year ago is now in operation and is yielding satisfactory results, so that the heat transmission of samples of walls can now be determined.

Thermal Insulation of Refractories

The work of testing the heat transmission of insulators up to a mean temperature of 1500° C. has also been carried on as samples were submitted.

Temperature Control in Railway Refrigerator Cars

The heater which was referred to in the preceding annual report was remodelled and the newly designed apparatus was installed in a car which crossed the continent several times during the winter. The railway operators were very well pleased with the results and contemplate equipping several cars during the coming summer for operation next winter. The Canadian Pacific Railway Company, who have been watching the development, decided to build a heater of this design last winter, but unfortunately the advent of spring prevented them from giving the system a thorough trial. Considerable interest has been shown in this development by some of the United States railways. An application for a U.S. patent has been filed.

Use of the Eupatheoscope in Canada

It was found that, while the eupatheoscope did not give an altogether satisfactory indication of comfort conditions in Canada, owing to the fact that no allowance was made for the effect of humidity, the real reason for the disagreement between the feeling of comfort and the reading on the instrument was usually due to the enormous temperature gradient in houses during very severe cold weather. The results will be published.

Humidification and Deodorizing of Rooms

A system now on the market is being investigated with a view to ascertaining the scientific principles on which it depends.

Cold Storage of Celery

An investigation was carried out in the Harbor Cold Storage Warehouse in Montreal to determine the temperatures in the storage rooms and in the celery during the first few weeks of storage, and the results were compiled in a confidential report to the Quebec Federal-Provincial Committee on Cold Storage.

Temperature Standardization

Work is being undertaken to standardize temperature between 660° C. and 1063° C. This consists of measuring the e.m.f. of a Pt —, Pt — Rh thermocouple at the melting point of various pure metals.

Thermal Conductivity of Metals

Work has been begun in connection with the thermal conductivity at liquid air temperatures of metals and alloys. The investigation is mainly of interest from the theoretical point of view.

Heat Transmission of Fabrics

An investigation is in progress to determine the efficiency of various cloths and combinations of cloths in insulating the human body. The problem is of importance from several standpoints. First, the economic aspect in connection with the house heating problem; second, the development of more healthful and comfortable living conditions; and third, the purely commercial aspect in connection with the development of a winter overcoat cloth or combination of cloths giving maximum protection in cold windy weather with minimum weight. The results obtained so far are very interesting; the cloths are being tested on two different types of apparatus, on one of which the cloth lies tightly against a warm cylinder and on the other of which it lies in contact with only part of the hot body.

Light

L. E. Howlett

Spectrophotometry

During the year a considerable amount of work has been done on developing the facilities for spectrophotometric tests on transparent samples. Two pieces of equipment have been procured: *(a)* a visible spectrophotometer; *(b)* an ultra-violet spectrophotometer. These are in process of being set up and adjusted. The laboratory will now be in a position to accept requests for tests of the spectral transmission of transparent samples either in the visible or ultra-violet regions of the spectrum.

Spectroscopy

A reflection grating has been procured. This is a three-meter concave grating, ruled on a four-inch spectrum disc with 30,000 lines per inch. The mounting of this is being undertaken.

Spectroscopic tests have been made for various applicants, using existing equipment. Appreciation of the utility of spectrum analysis in industry is growing, and an increase in this type of work may be expected.

Photoelectric Photometer

Considerable work has been done in applying the photoelectric cell to photometry. A spectrophotometer of this type has been constructed and is used for certain types of routine work. A photoelectric absorption meter of compact design and of high sensitivity has been developed and adapted to several purposes, notably asbestos grading.

Variation of North Sky Light

A continuous series of readings on the intensity of north sky light and its rate of variation has been taken to secure information for architectural and building projects.

Life Tests on Lamps

Permanent apparatus for life testing of lamps has been designed and is under construction to replace the temporary test racks now in use.

Miscellaneous

Projects of various kinds have been undertaken which can be summarized in the following way: *(a)* standardizing lamps; *(b)* adjustment work on various optical instruments; *(c)* possibility of using the photoelectric cell in certain biological tests; *(d)* development work on the grading of sugar by color; and *(e)* routine tests.

Metrology and Allied Measurements

R. H. FIELD, W. J. LINFORD

Metrology

Further measurements were made on the 24-metre invar tapes belonging to the National Bureau of Standards. The tapes were afterwards returned to the Bureau, where they are again under investigation.

Measurements of a steel tape made before and after the removal of rust by means of emery cloth showed a definite increase in length. The growth was greatest immediately after cleaning, and the tape gradually shortened throughout some three weeks, when it appeared to assume a steady length of about one part in 50,000 greater than the length before cleaning.

Optical and Allied Instruments

Some improvements were devised for the high oblique plotter for air photographs and incorporated into the machine. In its improved form the plotter is being given a further trial in the Geographical Section, Department of National Defence. The construction of the radial-stereoplotter proceeded through the year, and is now nearing completion.

Information was acquired with a view to the equipment of the laboratory with means for measuring block gauges by interference methods. These gauges are important as they form the fundamental reference standards in many industrial shops.

A laboratory method was devised for the adjustment and measurement of the relative angular positions of the cameras in the new tri-camera mount designed by the Royal Canadian Air Force for multi-camera oblique photography.

Routine Work

Owing to increased activity on the part of the land survey branches of the Government service, more time was spent in routine work on instruments and tapes than during the past few years. In addition some modifications and improvements were made in some of the optical instruments used in control surveys.

Five gas meters were examined for approval under the Council's regulations for approval of type, five pressure gauges for pressures up to 900 lb. per sq. in., and a variety of thermometers, hydrometers, length measures and other types of instruments were verified or adjusted.

LIST OF INSTRUMENTS VERIFIED, 1935-36

—	For Government Services	Others
Thermometers, various	343	9
Clinical thermometers	1440	6
Hydrometers	250	5
Metal tapes	74	7
Sieves	—	2
Analytical weights (sets)	—	2
Hydraulic pressure gauges	5	—
Transits	29	2
Levels	10	—
Air cameras	29	—
Surveying cameras	2	—

Radio

J. T. HENDERSON

Atmospherics

During the summer of 1935 the cathode ray direction-finding apparatus was moved to a more suitable location near Britannia Heights. Some preliminary observations were made there and it is considered to be a more suitable observing site than the former one.

In September instructions were received to proceed with a second direction-finding station, to be established in western Canada, and much of the winter was taken up with the design and construction of the equipment. It is hoped to have the second station established at Forrest, Manitoba, in the early part of the summer.

Receiver Tests

Much of the laboratory time has been spent on the measurement of the performance of radio receivers and in the construction of the necessary testing apparatus. The existing arrangements have been altered somewhat to facilitate routine work. New equipment, which requires some modification, has been added to measure the response of loud speakers, but no such measurements were made until after the fiscal year ended. Ninety-four receivers were tested during the period under review.

Radium and X-rays

G. C. LAURENCE

During the year 211 radium preparations were measured and certified. These had a total content of 9982 mg. radium element, almost entirely of Canadian origin, having a value of about $450,000.

A new standard X-ray ionization chamber was constructed and set up in the laboratory. This instrument is used for the calibration of medical X-ray dosage meters. It was found to agree closely with a portable instrument previously used as a standard that had been calibrated by comparison with national standards of other countries.

At the instigation of the Associate Committee on Radiology six portable ionization chambers were constructed in the laboratory shops, calibrated, and placed temporarily in physics laboratories conveniently situated near cancer clinics in different provinces. After a few months experience in using the instruments they were returned to the laboratory for changes to overcome difficulties encountered in use in the clinics.

An investigation was begun with the purpose of finding a suitable method of measuring the intensity of very hard X-rays and radium gamma rays in the practical units that have been adopted for medical use with ordinary X-rays. Part of the experimental work was done in collaboration with Dr. P. Lowe, Royal Military College, Kingston, Ont.

Ultrasonics

F. H. SANDERS

Scattering of Light by High-frequency Sound Waves in Liquids

The work commenced last year on the study of the various physical properties of liquids by the use of high-frequency sound waves, with a view to determining their value for technical and industrial purposes, has been continued, as time permitted, with very satisfactory results. By making use of a very long tank in which standing waves were eliminated, results have been obtained in the liquids xylol and petroleum ether, which are in excellent agreement with recent theoretical analyses. Comparison of earlier data obtained in a standing wave field with the theoretical treatment for the standing wave case gave similarly good agreement. A number of different frequencies have been employed using the light from a sodium arc. Further investigations with light of different wave-lengths are in progress.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

The Division of Research Information has two main functions: *(a)* to assist in the co-ordination of research projects carried on both within the laboratories and under the direction of associate committees, or in the universities with the assistance of financial grants from the National Research Council; *(b)* to serve the laboratory divisions and research workers throughout Canada by means of library services, the preparation of bibliographies, searches of scientific literature, patent investigations, and translations. Additional functions include the provision of secretarial services for associate committees, the editing and publication of reports on the work of the Council, including the Annual Report, and the issuance of the Canadian Journal of Research. A voluminous correspondence is carried on each year, largely in reply to technical inquiries from manufacturers and others seeking advice on special problems or information regarding sources of data on scientific matters.

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Following work done by the Division of Chemistry for the Commission on Price Spreads, the National Research Council decided to make inquiries in various government departments as to the extent to which use was made of standard specifications in the placing of orders for supplies. Specifications that were in use were also examined with a view to determining how effective they were for the purpose intended. Following this a meeting of representatives of government departments was held on May 31, 1934, and consideration was given to the proposal that an interdepartmental committee be formed for the purpose of preparing commodity specifications suitable for use by any departments concerned. Accordingly, the Canadian Government Purchasing Standards Committee was formed. During the year this committee, of which Mr. A. F. Gill is the secretary, was placed under the direction of the Division of Research Information.

Associate committees and assisted researches continue to form an important part of the Council's activities, as may be seen from the detailed accounts given in the sections devoted to their work in this report. Co-ordination of the work done by most of the associate committees with that carried on in the laboratories is effected through the Division of Research Information.

The usefulness of literature searches as a preliminary step to laboratory investigations has long been recognized, and, with the tremendous increase in the volume of published papers in almost every branch of science in recent years, it is becoming more and more difficult for an individual to keep informed as to the progress in those sciences in which he himself is not intimately engaged. When a research worker undertakes a problem, it is essential to a proper understanding of the subject that he obtain a conspectus of the work that has been done along similar lines, and this can be accomplished only by an intensive study of the literature. The two requisites are competent abstractors and a well-stocked library. Several members of the staff of the Division of Research Information, each trained in a specific branch of science, devote almost their entire time to this work.

As opportunity offers, original work is undertaken along lines intended to develop profitable avenues for further research, particularly on subjects relating to industrial and commercial undertakings in Canada. Before a new enterprise is launched, it is important to know something of its possibilities for success, if failure and financial losses are to be avoided. An economic study of the situation should be made; availability of raw materials, the principal factors entering into the costs of production, markets and prices for the finished products, are all data of prime importance.

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

National Research Library

Misses M. S. Gill, E. Twohey, D. Y. Willoughby

Fewer books were added to the library than during the previous fiscal year, bound volumes totalling only 1175. Periodicals and other occasional publications are now received by subscription or exchange from forty countries and are in many languages, English and German predominating, with French and Russian next in order. The total number of accessions in the library at the close of the fiscal year was 16,855, in addition to pamphlets, scientific periodicals and other serial publications. Patent specifications to the number of 265 were also added during the year.

Arrangements have been completed for transferring the scientific and technical material in the library of the Royal Society of Canada to the

National Research Library where it will gradually be bound and catalogued and made more readily available to research workers. Some volumes belonging to the Ottawa Branch of the Engineering Institute of Canada have also been transferred to the National Research Library where members of the Institute and others find their use greatly facilitated.

Loans for use outside the library were approximately 3,900, including over 600 to institutions and individuals not on the Research Council staff.

Publications

W. W. Thomson, J. M. Manson, Miss D. DesBarres

The increasing popularity of the Canadian Journal of Research as a medium for the presentation of results obtained by Canadian investigators is indicated by the fact that in 1931–2, out of the 109 papers published, only 22 were contributed by Canadian scientists not associated in some way with the National Research Council, while during the last four years, from 1932–3 to 1935–6, the corresponding numbers of papers received from outside sources and the total number of papers published in the Journal have been as follows: 47 out of 120; 57 out of 121; 78 out of 135; and 76 out of 167. The number of papers written for the Journal by members of the National Research Council staff during the last five years rose from 19 in 1931-2 to 32 in the following year, and during the last three years the numbers have been successively 31, 32, and 33. Papers prepared by investigators working with financial assistance from the National Research Council have shown greater variation in numbers possibly because of the decreased appropriations available for scholarships and grants in aid of research at the universities. In 1931–2 the number published was 67; in the four following years the numbers were, respectively, 40, 33, 25, and for the current year, 58.

During the year two volumes of the Canadian Journal of Research were published. Beginning with Volume 13, July 1935, a change was made in the form of the Journal. It is now issued monthly in four sections:—Section A—Physical Sciences; Section B—Chemical Sciences; Section C—Botanical Sciences; Section D—Zoological Sciences. Sections A and B appear under one cover, as also do Sections C and D. Each section is paged separately.

Of the 167 papers (1842 pages) published in the Journal during the year, 31 dealt with physics and engineering; 62 with chemistry; 47 with botany; 25 with zoology; and 2 with geology.

In addition to the Journal and indexes to Volumes 12 and 13 (35 pages), the following publications were issued during the year: Bulletin No. 16, Health Hazards in the Radium Industry—19 pages; Bulletin No. 17, Radium Dosage—50 pages; Specification NRC–5–1936, Western Red Cedar Shingles —6 pages; The Use of Wax in the Plucking of Poultry (issued in collaboration with the Dominion Department of Agriculture)—19 pages; Eighteenth Annual Report of the National Research Council—158 pages.

Work has been started on the preparation of a collective index for Volumes 1 to 12 inclusive of the Canadian Journal of Research.

Press statements regarding the work of the Council are issued from time to time as required, in order to give the public information regarding features of the Council's work which are considered to be of general interest. The service was reorganized in October, 1935, and in the interval from that time until the end of the fiscal year, eight statements were released for publication. The co-operation of Canadian Press and of the daily and weekly newspapers of Canada in bringing the work of the laboratories to the attention of the reading public is gratefully acknowledged.

Research Information Service

F. E. Lathe, S. J. Cook, A. C. Halferdahl, C. A. MacConkey, R. Ruedy, Miss M. E. Whalley

The services rendered by this branch vary widely in character. A large number of the inquiries received involve only minor questions in science and technology and are readily answered without any special study of the literature. Frequently, however, an inquiry concerns a research problem of some member of the Council's own staff or a research committee, a university worker or an industrial investigator, and involves a thorough study of the scientific and technical literature of all important countries. In such cases exhaustive studies are made involving subsequently the preparation of comprehensive reports. The largest of these reports as a rule contain extensive bibliographies.

In doing this work, however, care is taken not to encroach upon the field of consulting chemists or engineers, and many requests for routine tests and information are referred to consulting firms or to some other branch of the government service.

Further, while inquiries regarding research always receive careful attention, many inquiries refer to matters upon which the Council does not attempt to prepare reports. Of such a character are requests from individuals for full information regarding the technical processes of a whole industry, or letters from students desiring information regarding historical and other events as assistance in the preparation of essays. In such cases nothing more is done than to refer inquirers to sources of general information such as technical books and encyclopedias.

By far the most important of the questions directed to the division are those which involve searches of the literature. Some of the examinations made during the year by certain members of the staff may be noted.

Mr. A. C. Halferdahl continued to devote a considerable part of his time to work in the field of patents, including searches of the literature on subjects in which members of the laboratory staff had developed new or improved processes, and correspondence in connection with the many patent applications placed. Searches and other studies were made in connection with patents on carbon black, heating refrigerator cars, asbestos, active silica, starch, distillation, wax plucking of poultry, alcohol, hydrocarbons, indolyl-3-acetic acid, and magnesite.

Continuing work begun in previous years in co-operation with the Division of Biology and Agriculture, Mr. Halferdahl made a thorough search of the literature on chemical herbicides, for the information of the Division of Biology and Agriculture in connection with experimental work in progress on this subject. The results of the scientific investigation and of the literature search have been consolidated in a report which is being prepared for publication.

In connection with the investigation of the Trail Smelter Smoke problem, Mr. Halferdahl made a survey of the literature on the sulphur dioxide content of city air in Canada, the United Kingdom, Germany, and the United States. It was found that the sulphur dioxide content of city air varies from traces in suburban districts to approximately two parts per million in the downtown and manufacturing sections of large cities.

In co-operation with members of the staff of the Division of Chemistry and the Division of Physics and Engineering, Mr. Halferdahl conducted an inquiry into the causes of an unusually severe type of corrosion which occurred

on a special aluminium alloy exposed to sea water. This problem was solved, but the information obtained in the course of the work pointed to the need for a further investigation on the relative values of certain aluminium alloys for sea-water service in direct comparison with steel. Work on this project is proceeding.

Dr. C. A. MacConkey completed extensive surveys of the literature: (i) as a preliminary to an extended program of research by the Division of Biology and Agriculture on the development in Canada of barley and malt rich in diastase; and (ii) on the possibilities for the industrial use of molasses slop, the residue from the alcoholic fermentation of molasses, which is at present largely a waste product. Work on soybeans was continued so that all published scientific information on this subject might be readily available.

The technical literature was searched to provide answers to a considerable number of minor inquiries, including the possible use of trisodium phosphate in sugar refining; the preparation of catalytic nickel; the use of pyroligneous acid for bleaching textiles; the industrial use of calcium acetate; wood and tar oils in the creosoting industry; naphthenic acids; manufacture of synthetic methyl alcohol; refining of cod liver oil; prevention of crystallization in honey; plating of aluminium alloys; toxicity of cadmium sulphide; the acidity of mine waters; fish poisons; the manufacture of matches; paper for interleaving postage stamps; shower-proofing men's coating; manufacture of sugars from sulphite liquor; uses of lactic acid and glycerophosphates; manufacture of grape sugar; manufacture of dipped rubber goods; uses for waste leather; corrosion inhibitors for automobile cooling systems; and other subjects.

Dr. MacConkey also prepared an analysis of replies to a questionnaire sent out to users of suits made from Canadian wool; a history of the International Electrotechnical Commission in its connection with the National Research Council; and a report on Canadian patents on the manufacture of maple syrup. Translations were made of a number of French and German letters and scientific articles.

Dr. R. Ruedy completed a number of investigations, mostly in the field of the physical sciences. He reports that developments in the design of electricity meters, watthour meters, in particular, have left the lubrication of the lower bearing as probably the one remaining weak spot in the meter. In response to an inquiry from an industrial concern, he reviewed a report on the investigations carried out on this subject in various countries and the problems involved in the standardization of lubricating oils for meters and watches.

In an effort to assist power companies in dealing with the failure of transmission lines owing to vibrations caused by the wind, which is a major problem, Dr. Ruedy reviewed the literature on this subject. In studying remedies, the power line has hitherto been considered as a string without weight stretched by external tension. With strings, vibrations set up by the wind can be prevented only by suspending dampers on the line. The equations relating to dampers were deduced so as to allow their correct design. It was also shown that, since in reality a power line has considerable mass, the line differs from a string, and that it is also possible to prevent vibrations by suitably adjusting the tension, or by increasing the diameter of the conductor towards the points of suspension.

Hydraulic undertakings, such as canals, dams and harbors, often assume such proportions that the known laws of hydraulics no longer suffice for their design. In other cases the theories developed are too complicated for practical

purposes. One method of avoiding failure is to make tests on small models, suitably designed, and to draw conclusions from these observations. It may be said that no hydraulic work of any importance is begun today without a previous test in the laboratory. Even small countries, such as Belgium, Czechoslovakia, Holland, and Switzerland, have been led in recent years to establish, at considerable expense, national hydraulic laboratories. Descriptions of all the new laboratories and the problems they study were secured during the year and translated by Dr. Ruedy for ready reference.

At the request of the Director of the Topographical Survey, a service involving abstracts and translations from certain foreign periodicals dealing with various branches of surveying was started by Dr. Ruedy. Shorter reports prepared dealt with recent literature on lithium, melting of ice, and phosphorescence.

Miss M. E. Whalley made a study of the literature relating to the methods of making biological and chemical assays of vitamins and compiled a report of 118 pages on this subject. From the earliest years of vitamin research, the biochemist has had difficulty in isolating vitamins and determining their chemical character and the nature of their physiological action. The survey of the literature completed by Miss Whalley indicates that the situation is not yet entirely clear. Nevertheless, the bibliography and summary of the methods employed in vitamin assays given in this report constitute a useful reference on this important subject.

One of the subjects discussed at the meeting of the Associate Committee on Potato Research was the nutritive value of potatoes, and on inquiry it was found that the literature on this subject was scattered through a great many journals. At the request of the associate committee, Miss Whalley undertook the compilation of a report on the chemical composition and nutritive value of potatoes. A report, of 81 pages, was issued in June, 1935. Copies of the report were sent to the members of the associate committee for reference in connection with the investigations in progress.

Other reports of a less extensive nature were prepared on the literature dealing with the following: tellurium as a health hazard; iodine content of apples; effect of frost on milling of oats; permissible fluorine content of foods; methods of converting angora wool to yarn; homogenization of milk; electrocution of animals; micro-organisms in peat; harvesting of kelp; and a bibliography on waxing fruit and vegetables.

Outside Research Activities

F. E. Lathe, S. J. Cook, A. C. Halferdahl, A. F. Gill, J. M. Manson

Full particulars regarding the Council's outside research activities are given in other sections of this report, but it may be observed here that a large part of the secretarial and executive work pertaining to the functions of no fewer than 18 associate committees and three conferences has been carried on by officials of this division. Work of this character varies according to the nature of the investigations, but the several committees are of considerable importance in that they provide an effective and valuable means of contact between the Council, the industries, and universities co-operating in research projects. The committees served by officials of this division during the year included the following: asbestos, chemical standards, coal classification, Canadian government purchasing standards, electrical measuring instruments, field crops, forestry, gas research, helium, iron ore, leather, magnesium products, patents and awards, potato research, Trail smelter smoke, tuberculosis, weed control and wool.

Close liaison, maintained during the year with the American Society for Testing Materials, proved valuable in view of the Society's position in the testing field throughout the world.

REPORTS OF ACTIVITIES OF COMMITTEES

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 eighth meeting of the Associate Committee was held at Winnipeg, April 6–9, 1936. The following summaries indicate the progress made in plant disease surveys, 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 77.

The Canadian Plant Disease Survey for 1935

The most destructive epidemic of stem rust in the history of western Canada occurred in 1935. It was no more severe than the 1916 epidemic but a much greater acreage was involved. The severity of the epidemic was due to (1) early arrival of inoculum, (2) retardation of crop development by unseasonable weather, (3) heavy rains in June and July. Reward wheat withstood the attack of rust better than Thatcher or Ceres, while Renown and Thatcher, under experimental conditions, produced good yields in spite of the epidemic. Durum wheat was less affected than common wheat. Oats and barley were damaged slightly by stem rust but considerably by crown rust, which was prevalent in Manitoba and particularly severe on oats.

Wheat smut was more prevalent than in the previous three years, particularly in Alberta red winter wheat. Of the cars graded from August 1 to October 1, 1935, 39.4% were graded smutty.

Take-all is expected to become more troublesome in 1936. Common foot rot was less prevalent and less injurious in 1935, probably as a result of the cool, rainy spring. Browning root rot was very widespread in Saskatchewan.

Beet rust, a new disease in Canada, was found in British Columbia and may have arrived in seed from Europe. Downy mildew was reported on soybeans in Ontario for the first time. A downy mildew was also found on sweet clover at Edmonton for the first time.

Gray bulb rot, a very destructive, but fortunately, unusual disease, was observed in Rockcliffe, Ontario. A heavy outbreak of apple scab occurred in the interior of British Columbia. Leaf curl of peaches and powdery mildew of raspberries were prevalent in Ontario.

(Survey compiled by I. L. Connors.)

Research in Alberta

Dominion Laboratory of Plant Pathology, Edmonton

Continued studies have confirmed and extended previous observations of the effect of deficiencies and excesses of certain mineral elements on the development of root rots of wheat. The test of about 90 varieties of wheat for

resistance to root rot has been continued with encouraging results as have studies of fungi associated with winter killing of clover and alfalfa. Progress has been made in the study of antagonism among pathogenic and other micro-organisms.

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

University of Alberta

In an investigation of two diseases of flax, anthracnose and browning, it was found that when heavily inoculated seed was used, the percentage of diseased seedlings was much greater in sterilized than in unsterilized soil. This was also true when seed was sterilized to remove surface inoculum. These results indicate the possibility that the organisms responsible for these diseases are adversely affected by other micro-organisms in the soil.

Four strains of *Ophiobolus graminis*, differing in virulence, were used singly and in combination to inoculate soils in which wheat was grown. The results show that pathogenicity was not reduced by using mixtures of strains and that pathogenic strains tend to dominate. Pathogenic strains should, therefore, be used in variety testing.

Formaldehyde has never been popular as a treatment for flax seed because the mucilaginous substances in the seed coat cause caking of the seed in the presence of moisture. For this reason dry or dust treatments have been tested. Some organic mercury dusts have given good results, causing marked increases in germination and significant increases in yield. The dusts appear to act not only by destroying pathogenic organisms on the seed, but also by protecting the seed and the young seedling from various soil-borne organisms.

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

Sixty hybrids and eight parent varieties of wheat were tested for their resistance to drought under natural conditions and also by means of the "Chinook machine". No data were obtained under natural conditions at Brooks, Alberta, on account of extreme drought, but data from other stations and from experimental work showed that Milturum was definitely the most resistant wheat tested. Reward was susceptible to drought injury and no hybrid was as resistant as the Milturum parent.

Genetic studies of the progeny of crosses of Selection I-28-60 × Milturum, Reward × Caesium and Caesium × Marquis have been made. A large number of wheat varieties have been tested on naturally infested soil to determine their reaction to take-all.

In order to develop barleys for feeding and malting, crosses have been made involving seven varieties. The first two generations have been grown and selection from the third generation will be done in 1936. As an aid to plant breeding and taxonomy, 235 barleys have been classified according to their reaction to covered smut. Similar classification will be made for reaction to other pathogens. On the gray soils of Alberta covered smut produced a greater proportion of infected plants than on the black soil. Experiments indicate that the pathogen is assisted by the slower emergence of seedlings on the gray soil. Thirteen collections of the covered smut pathogen were tested to determine whether they were equally pathogenic to all varieties. As a result it is now possible to differentiate between collections on the basis of their pathogenicity to specific varieties.

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

Research in Manitoba

Dominion Rust Research Laboratory, Winnipeg

The resistance of Thatcher wheat in the field in 1935 raised the question whether resistance in this case might be due to the absence of certain physiologic forms. The survey for that season showed that relatively few forms were present. Accordingly this wheat was exposed to 30 forms in the rust nursery and to a number in the greenhouse and proved to be resistant to the forms to which Kanred is immune. It has approximately the same degree of resistance as Hope and Renown to the forms to which Kanred is susceptible.

Recent work has shown that environment has a marked effect on resistance in plants. Among the environmental factors most likely to produce this effect is the intensity of light. The effects of this factor on resistance are now being studied.

Two fungi, species of *Alternaria* and *Cladosporum* have been found associated with spikelet sterility in wheat but whether these cause the condition or are merely invaders is not yet known. *Alternaria* is capable of considerable development at high temperatures and humidities and it may be found that the disease occurs from the interaction of these factors in the presence of these organisms.

Genetic studies of the infection capabilities of physiologic forms of *Puccinia graminis tritici* indicate that repeated selfing may result in the production of abnormalities, probably as a result of bringing together lethal factors. A recent selfing has given rise to several distinct physiologic forms and mutations have been induced by a long period of storage.

The effects of treatment of smutty wheat were tested at eight stations in 1934 and 1935. Formaldehyde, copper carbonate, copper chloride and New Improved Ceresan were used on wheat, and formaldehyde and New Improved Ceresan on oats and barley. Results show that (i) treatment of smut-free seed of wheat, oats and barley with a good copper or organic mercury dust will, on the average, give only a small increase in yield, (ii) the use of seed of high quality is necessary if maximum yields are to be obtained, (iii) the treatment of moderately good seed with these materials may improve the yield slightly but will not bring it up to that from high-quality seed, (iv) treatment with a good organic mercury dust should result in maximum yield and in freedom from smut infection.

The testing of varieties of wheat and oats for resistance to root-rot caused by *Helminthosporium sativum* and *Fusarium* spp. has been continued since 1930. Supplementary objects of the work have been (i) to develop efficient practical methods of creating artificial attacks of root-rot on cereals, (ii) to develop reliable methods of recording and analyzing the experimental data. The results now obtained should be of considerable value in future co-operative experiments. Testing results indicate that the development of resistant varieties offers a favorable method of controlling the loss due to these parasites.

Investigations have been conducted to determine the relation between soil salinity and the severity of infection by *Fusarium culmorum*. When the seed of wheat, oats or barley was infested with this organism, the presence in the nutrient solution of a considerable quantity of magnesium sulphate increased the disease rating. Soil experiments produced similar results. It appears that any condition that removed soluble salts from the region of the root crown provides for normal growth of the plant. When salts accumulate at the root crown the plant does not flourish and the root-rot organisms become much more injurious.

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

The co-operative variety tests of wheat were carried out at 13 points in western Canada. Susceptible varieties suffered heavy damage from rust. A number of the new rust-resistant varieties, seed of which has been considerably increased, appear to be satisfactory from the agronomic standpoint. Tests on these varieties for milling and baking quality are referred to in the Report of the Associate Committee on Grain Research, page 77.

Sixteen varieties of durum wheat were grown at Brandon, Morden and Winnipeg. The effect of rust on yield was less marked at Brandon than at Winnipeg, possibly on account of earlier seeding and ripening.

Thirteen oat varieties and strains were tested at seven points in Manitoba and Saskatchewan. All new strains outyielded standard varieties and four of them were consistently high in yield at all stations. One strain which is as good as any of the standard varieties under normal conditions outyields them all when rust is a factor.

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

Research in Ontario

Central Experimental Farm, Ottawa

Of 40 varieties of winter wheat inoculated with bunt collected in western Ontario all commonly grown varieties were susceptible even though all physiologic forms were not present. It is believed that Hussar, Ridit, Hohenheimer and Oro offer possibilities as breeding material carrying resistance. Twenty-five varieties of spring wheat, including new rust-resistant strains, were tested for resistance to bunt collected from Red Fife, Garnet and Reward. Some of the new wheat will require more testing for bunt resistance before they are distributed. A number of strains descended from Garnet appear to have inherited the Garnet resistance.

The meiotic-chromosome behavior of the wheat varieties included in the co-operative tests has been investigated. While it was possible to test only a small number of plants of each variety, the results clearly show great differences among varieties and strains, the oldest varieties being, as a rule, the most stable. These cytological studies show that care should be exercised in increasing certain strains and that some strains require still further selection.

It has been found that light and moisture supply are important factors in the development of blast in oats and that late seeding increases blast development. The period during which light and moisture have their most important effect is from six to eight weeks after seeding. Eagle, Lasalle and Alaska showed reasonably low proportions of blasted florets under test. One of the new rust-resistant strains also showed a high degree of resistance to blast.

Two oat varieties, Victoria and Bond, apparently are resistant to crown rust and six others have shown considerable resistance, as have some hybrid lines from Victoria, although all lines have been discarded on account of susceptibility. Four resistant lines yielded as well as Alaska. In a bunt-resistance test, no standard variety had less than 48% smutted heads but one new strain was smut-free and bond was almost free of smut.

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

Research in Saskatchewan

Dominion Laboratory of Plant Pathology, Saskatoon

Studies of the take-all disease of wheat have been continued, an effort being made to determine how the temperature at which the organism is grown affects the pathogenicity.

Histological studies were made to determine whether there are differences in the mode of infection of wheat, oats and barley which would explain why wheat is susceptible, barley somewhat resistant and oats quite resistant to *Ophiobolus graminis*.

Helminthosporium sativum produced more damage in deeply sown grain. Listed in order of greatest injury from this organism the varieties tested were Reward, Reliance, Early Triumph, Pelissier, Garnet, Marquis and Mindum. Reductions in yield were from 24.3% (Reward) down to 13.3% (Mindum).

Fungi were isolated from different levels in the root system of Marquis wheat. In the upper foot, *Fusarium*, *H. sativum* and *Alternaria* were prevalent. Below this *Fusarium* was rarely isolated. Fungi from pieces from the lower depths grew very slowly. The purpose of this investigation is to determine the importance of fungi from the lower levels in causing plant diseases.

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

University of Saskatchewan

The frost resistance of 332 F_6 lines of the cross H-44-24 × Reliance and of 227 F_5 lines of Reliance × Reward has been determined in a nursery test. Eighty of the former and 56 of the latter showed the desirable Reliance resistance. The genetic nature of resistance has been clearly indicated and the utility of a nursery test for separating resistant from susceptible lines has been demonstrated.

The risk of spreading rust from an artificially produced epidemic to farmers' fields has forced the development of a method of studying rust reaction in the field on late seeded crops, the forms present in the natural epidemic providing inoculum. The satisfactory results that have been obtained in separating resistant and susceptible lines will be checked in 1936 at the Dominion Rust Research Laboratory. If the check agrees with previous results an inexpensive and risk-free method of testing will be available.

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

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

Ten Years Progress, 1926–36

In January 1926 a conference was called by the President of the National Research Council to draw up a program of research on grain problems and particularly those of wheat production and grading. On the recommendation of this conference the Associate Committee on Grain Research was formed to co-ordinate the work. It has now been active for ten years and it seems fitting to review the progress made during that period.

At the committee's inception, the Board of Grain Commissioners and the western universities were represented and later the Dominion Cerealist and the Dominion Chemist were added to the membership. As the scope of the committee's work was enlarged, subcommittees on soft wheat, barley

research, and oil seeds, were appointed and through representation on them a number of other organizations, including the University of British Columbia, McGill University, the Dominion Seed Branch, the Canada and Dominion Malting Companies became connected with the work. In the investigation of specific problems the committee has sought and obtained the collaboration of other laboratories, both university and commercial. There is not a single laboratory in Canada, concerned in any way with the quality of our grain, that has not at some time co-operated with the committee, and cordial relations have been developed with several laboratories in other countries. The commercial grain-handling organizations have been of very great assistance through the facilities they have granted for the collection of samples and in many other ways. On several occasions the Dominion Bureau of Statistics and the Commercial Intelligence Service have supplied valuable information.

Through the independence and special qualifications of its personnel and the wide scope of its co-operative facilities, the committee has gained recognition as an authoritative body to which problems involving the quality of Canadian grain can be referred for opinion or investigation. Several of the major projects of the committee have been initiated in this way, by references from the Dominion Government, the Board of Grain Commissioners, the National Barley Committee, the Northwest Grain Dealers' Association, the Wheat Pools and other organizations. Several investigations have been initiated by the committee itself or by individual members, and others have arisen from the original program set out in 1926. The National Barley Committee has named the Associate Committee on Grain Research as its technical committee and similar action has been taken recently by the newly formed Canadian Flax Association.

Throughout, the committee has maintained flexibility in the organization of its investigations. The nature of the problem and the special facilities of the co-operating laboratories have always been considered in choosing the method of approach. In several instances the investigations have taken the form of committee projects, with the various laboratories working as one unit, each carrying out a share assigned to it by common consent and with mutual checking of the analytical results. Others have been referred to subcommittees while still others have been assigned to individual laboratories. The bulk of the fundamental work in cereal chemistry has been initiated and carried out independently by the co-operating laboratories but with full and frank discussion of the plans and results with other members. In this way the committee has made the fullest use of the facilities available. It has achieved co-ordination without restriction of initiative, and organization without hampering individual freedom.

The committee has an outstanding record of accomplishment in the solution of problems relating to bread wheat. It studied the drying of tough and damp wheat and found the conditions under which this could be done without injury to the milling and baking quality of the grain. The limits of safety specified by the committee are now being observed by all the commercial drier operators in Canada. The saving to Canadian farmers from this alone would be more than sufficient to pay the entire cost of all the committee's investigations. The feasibility of using protein content as a factor in wheat grading was carefully studied and authoritative information made available to Parliament. The evaluation of the relative quality of the varieties of wheat grown in western Canada and the subsequent elimination of inferior ones from the higher grades have helped to maintain the good reputation of Canadian wheat. The testing of new strains originated by plant breeders will prevent the future distribution of inferior varieties. The study of frost

injury has proved the essential soundness of the present methods of grading frosted wheat. Comments in English trade papers on the report of this investigation show that it enhanced the confidence of importers in our grading system. The committee's work on methods of harvesting has shown the areas in which combines may be safely used and has thrown new light on the storage of high-moisture grain.

As a result of the growing importance of durum wheat, the committee established a special laboratory, located in the Laboratory of the Board of Grain Commissioners, for the study of this grain. Last year, for the first time, the Grain Standards Committee had available the results of quality tests to aid in the setting of the grades. Studies of the relative quality of durum varieties and the effect of various forms of damage on quality are under way and the information gained will be of great importance as a basis for the sound grading of this class of wheat.

With the restriction of the market for Canadian wheat, improvements in the quality and marketability of possible substitute crops became a matter of first importance and work on barley and flax was initiated in June 1934. Subcommittees were formed to co-ordinate the new investigations with those previously started independently by the members.

The facilities for the testing of malting quality of barley have been improved and arrangements made to ensure their efficient use in conjunction with breeding and field investigations. The technical requirements of the overseas and domestic markets have been studied, giving a sound basis for the improvement program. An extensive investigation of cleaning and handling is being conducted and the main sources of peeling damage have already been determined. This information is being used in an educational campaign for the elimination of the difficulty. The report on the comparative feeding value of barley, oats, wheat, rye, and corn, prepared at the request of the committee by Prof. E. W. Crampton, was described by the Imperial Bureau of Animal Nutrition as "the most comprehensive report on the subject."

The discovery of the high quality of northern-grown flax and the introduction of varieties suited to the high-quality areas by members of the Subcommittee on Oil Seeds should lead to the conversion of some of the low-quality wheat acreage to the growing of high-quality flax. This work has been greatly facilitated by the development of new, accurate, and rapid methods for the determination of oil quantity and quality, by the Laboratory of the Board of Grain Commissioners. These methods may also find an application in grading.

Among the more important investigations initiated and conducted independently by the co-operating laboratories, in most cases with the financial assistance of the committee, are: drought hardiness of cereals; quality of wheat grown on wooded soils; seed injury by fungicidal treatments; prevention of heating of damp grain in storage; proteins and diastase of barley; influence of weather conditions on growth and yield of wheat; factors influencing the carotene content of wheat.

Early in the history of the committee a Subcommittee on Methods was appointed and the co-operating laboratories are continually striving to improve methods of analysis and testing. The initial stages of any investigation of this kind are usually conducted independently, but with collaboration before any changes are finally adopted. The milling and baking tests, determination of diastatic activity, determination of carotene, yeast and gas production tests, determination of moisture, and several other methods have received

attention. The members of the committee have co-operated in the preparation of a book of methods for use in their laboratories and have adopted a high standard of accuracy as a prerequisite for final acceptance of any method.

The following list gives the main projects of the committee since its inception. It includes all the projects initiated by the committee but not those started independently by its members.

PROJECTS OF THE ASSOCIATE COMMITTEE ON GRAIN RESEARCH

Project	Subject	Assigned to
1	Drying of wheat	
1A	Experimental drier	Stansfield
1B	Commercial driers	Committee
1C	Drying of wheat of known history (University series)	Committee
1D	Bin drying	Cook
1E	Lethbridge drier	Stansfield and Malloch
2	Protein grading of wheat	Newton and Malloch
3	Fall *vs.* spring threshing	Committee
4	Wheat variety tests	
4A	Varieties grown in western Canada	Committee
4B	Reaction to bleaching	Committee
4C	Garnet	Committee
4D	New hybrids	Committee
4E	Standard varieties	Committee
5	Frosted wheat	
5A	Crop of 1928	Committee
5B	Artificially frozen wheat	Newton and McCalla
5C	Annual survey	Committee
6	Moisture meters	
6A	Preliminary tests	Birchard
6B	Extensive tests	Cook, Hopkins and Geddes
7	Equipment, development and testing	
7A	Thomson molder	Committee
7B	Baking ovens	Larmour
8	Methods of harvesting	
8A	Grade and moisture survey	Committee
8B	Moisture in standing grain	Committee
8C	Barge harvesting	McCalla
8D	Heating and respiration of wheat	Larmour
9	Drought-resistant wheats	Aamodt (later Neatby)
10	Durum research	Geddes
11	Grain rations	
11A	Rations for cattle, sheep, horses and swine	Crampton
11B	Rations for poultry	Crampton
12	Soft wheat research	Soft Wheat Subcommittee
13	Flax research	Oil Seeds Subcommittee
13A	Development of improved refractometric method for determining oil content of flaxseed.	Grain Research Laboratory
13B	Effect of storage on chemical and physical characteristics of flax and linseed oil.	Grain Research Laboratory

PROJECTS OF THE ASSOCIATE COMMITTEE ON GRAIN RESEARCH—*Concluded*

Project	Subject	Assigned to
13C	Relation between refractive index of linseed obtained by cold pressing and iodine value.	Grain Research Laboratory
13D	Oil content, iodine values and carotene content of different varieties of flaxseed grown at Dominion Experimental Farms.	Grain Research Laboratory
13E	Relation between oil content, weight per 1000 kernels and weight per bushel.	Grain Research Laboratory
13F	Variety testing	Oil Seeds Subcommittee
13G	Dates of harvesting studies	Oil Seeds Subcommittee
14	Barley research	
14A	Effect of cleaning and handling on malting quality	Malloch
14B	Barley and malt proteins	National Research Laboratories
14C	Development of malting test	Anderson and subcommittee
14D	Methods for malt analysis	Anderson and subcommittee
14E	Diastase in barley and malt	National Research Council
14F	Effect of environment on malting quality: materials produced by the Dom. Exptl. Farms and in university projects supported by the Wheat Pools, U.G.G., etc.	McRostie and subcommittee
14G	Malting quality of varieties. Study of uniform series grown at the Dom. Exptl. Farms and of new varieties produced by Canadian plant breeders.	McRostie and subcommittee

The results of all the committee projects and of most of the independent researches in the co-operating laboratories, whether financed by the committee or not, are published as papers of the committee's series. So far 93 such papers have been published, 25 during 1935–36. Three volumes of Collected Papers with a total of 1,621 pages and containing the papers up to Number 75 have been issued.

The contributions of the committee to our knowledge of Canadian grain have been substantial. The body of information now in the hands of the members is probably sufficient to enable them to make at least a preliminary appraisal of most of the problems which may arise in the future. Not less important is the experience which has been gained in the organization and technique of large-scale co-operative research. The success which has been achieved through the whole-hearted collaboration of the members has been the inspiration for the application of similar methods in other fields. The committee has effectively prevented wasteful duplication of effort and by the interchange of information and mutual criticism the reliability of the results obtained has been greatly enhanced. The words of the concluding paragraph of the Foreword to the first volume of the Collected Papers of the Associate Committee on Grain Research are as true today as when they were written five years ago:

> "The existence of a unified organization covering the whole of the great grain-producing area of western Canada, ready at short notice to bring to bear on important problems of the grain industry as they arise, its combined technical resources . . . . is a matter of no little significance at a time when it is becoming clearer that to maintain her place in the markets of the world, Canada has need of all legitimate aids, not least of those afforded by science."

Progress in 1935–36

The committee has completed its work on methods of harvesting and on the determination of moisture. It has continued work on its other joint projects during the past year and a considerable volume of independent research has been carried on by the co-operating laboratories. Reports of these investigations follow:

Joint Investigations

Frost Injury of Wheat

The annual survey of the quality of frosted wheat has now been conducted for six years. The report on the first three years, 1930–32, has been completed. In the special investigation of 1928, No. 4 wheat was found to be of better quality than No. 3 Northern. The results of the survey show that this anomaly has been corrected by the revision of the grade specifications in 1930. Variations in the baking quality within each grade can now be attributed mainly to variation in protein content.

Quality of New Wheat Varieties

The testing of new strains of wheat originated by the plant breeders working with the Joint Associate Committee on Field Crop Diseases is an important part of the committee's work. Samples of promising new wheats grown at 13 stations scattered over western Canada are submitted annually for quality tests. The individual samples are tested by the Cereal Division and composites of each variety by the three western co-operating laboratories. After careful consideration of the results, the varieties are classified as "satisfactory" if they are fully equal to Marquis in quality, or "unsatisfactory" if they have marked defects. The remainder are classed as "doubtful" and reserved for further testing. This classification, together with the results of the agronomic tests, is discussed each year in a joint conference of the plant breeders and cereal chemists, which decides on the general merits of the varieties. Several of the new strains show excellent milling and baking quality and a few that were found to be deficient in this respect have been discarded by the plant breeders.

The committee is also called upon to advise the Board of Grain Commissioners on the quality of new varieties from various sources which make their appearance from time to time in shipments of commercial grain.

Subcommittee Projects

Soft Wheat Research

There is a considerable demand in British Columbia for soft wheat flour for the pastry and biscuit trade, but the varieties grown at present are better adapted to the production of flour suitable for bread-making. Dr. G. G. Moe of the University of British Columbia has been conducting tests of a series of varieties at different points in the province, but the results indicate that only the coast regions are satisfactory for the production of soft wheat. Varietal differences have been found, but environmental factors are more important in controlling the protein content of the wheat.

Barley Research

During the year the committee greatly expanded its activities in barley research and adopted plans for mobilizing all facilities in Canada and co-ordinating the efforts of those working in this field.

The experimental malting laboratory at the University of Manitoba has been added to the group co-operating with the committee, and is being developed as a service laboratory for testing new varieties of barley for plant breeders throughout the country, and samples produced in investigations of the effect of environment and other factors on malting quality. The financial assistance given to this laboratory for some years by the Cereal Division of the Department of Agriculture has now been substantially augmented by grants from the National Research Council; the staff has been increased, and new analytical equipment is being installed. A second malting laboratory has been set up in the National Research Laboratories and this will be used for developing and standardizing the experimental malting test and as an aid to fundamental investigations of malting quality.

In order to provide contacts between these two laboratories and experienced practical maltsters, a Subcommittee on Methods of Experimental Malting and Malt Analysis was set up with representatives of the Canada and Dominion Malting Companies, the University of Manitoba and the National Research Council. The subcommittee is responsible for the adoption of standard methods of malt analysis, for periodic checking of the uniformity of results obtained in the co-operating laboratories and for specifying the methods to be used in the malting laboratory at the University of Manitoba. During the development of new malting equipment and methods in the National Research Laboratories, the subcommittee will act in an advisory capacity and it will subsequently have the duty of deciding upon standard equipment and methods.

A Subcommittee on Malting Barley Research was also set up with representatives from the three prairie universities, the Dominion Department of Agriculture and the National Research Laboratories. The subcommittee is responsible for reviewing the plans of all investigations which require the services of the Winnipeg malting laboratory, and was set up in order that the number of available malting tests may be distributed to the best advantage, that the investigations may be co-ordinated, and that data obtained throughout Canada may be comparable and thus suitable for collective analysis. Machinery is being set up that will enable the subcommittee to keep in touch with all investigations and variety tests from the time that seeding plans are first drawn up, until the projects are completed. The subcommittee will also be available in an advisory capacity to aid in planning investigations, interpreting results of malting tests, and in preparing reports.

The subcommittee projects include a study of the malting quality of barley varieties. New varieties will be tested for Canadian plant breeders and when these show promise they will be included in uniform, annual variety tests carried out by the Dominion Department of Agriculture at their various experimental stations. Zonation studies and investigations of the effect of environment in malting quality are being carried out by the three western universities. The laboratory of the Board of Grain Commissioners is making an annual survey of the protein content of Canadian barley and is also making proximate feeding stuff analyses. The National Research Council is continuing the survey of cleaning and handling of barley, developing equipment and methods for malting small samples, studying methods of estimating the quality of malt, and, in co-operation with the research station of an English company, initiating investigations of the development of diastatic enzymes in barley and malt. These projects are discussed more fully in the reports of the various institutions concerned.

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Oil Seeds Research

The Subcommittee on Oil Seeds has devoted most of its attention to flax, but the work has also included a comparison of Canadian and Hungarian sunflower seeds. Extensive joint investigations of the effect of time of harvesting on the quantity and quality of oil in flax is under way. With uniform time of cutting there seems to be a tendency for late seeded flax to give oil with a high iodine value. Surveys have shown that the flax produced in irrigated areas is definitely higher in oil content and iodine number than that grown in the drier areas. The testing of standard varieties and new hybrids is being continued. Laboratory investigations in connection with the work of this subcommittee are reported by the Laboratory of the Board of Grain Commissioners. (See below).

Grain Research in the Laboratory of the Board of Grain Commissioners

The work of the Durum Wheat Laboratory during the year has resulted in standardization of the experimental milling and macaroni processing technique, and an extensive series of technological studies has been carried out. These include the effect of various forms of damaged kernels, quality of new and standard varieties, and a study of 1935 tentative durum wheat standards and averages. A new color comparator has been secured and an extensive study conducted upon the various methods of color analysis, as applied to cereal products, including wheat, semolina and flour. The effect of drying conditions and of pH on macaroni color have also been investigated. The study of the effects of aging upon the pigment content of durum wheat and its products has been completed and it has been found that, unlike most cereal products, macaroni becomes more highly colored on storage. A similar study employing "bronze green" Reward wheat kernels is in progress.

Experiments with a Brabender Farinograph, acquired during the latter part of 1934, have been concerned chiefly with the accuracy of the instrument and details of technique as a preliminary to studying its value for indicating baking strength. The flour-water dough curves may be accurately reproduced, employing either the small or large mixer; a dough consistency level of 600 Brabender units appears the most satisfactory for hard red spring wheat flours.

An investigation of the accuracy and efficiency of the semi-automatic forçed air draught moisture oven and the magnetic grain grinder manufactured by the Brabender Corporation of Duisburg, Germany, as compared with the standard vacuum oven, air oven and Brown-Duvel procedures, and the Wiley and Hobart grinders, for determining the moisture content of wheat, has been completed. The moisture loss during grinding was highest in the Hobart and lowest in the Brabender magnetic grinder, while the mean moisture contents, as determined by the various analytical procedures, were in fairly close agreement.

The laboratory was one of eight organizations which collaborated with the Methods Committee of the American Association of Cereal Chemists in a study of the Blish and Sandstedt, Schoorl and Bertrand procedures for determining reducing sugars in flour extracts. The Schoorl method gave the best agreement between laboratories, the greatest differentiation between flours and the lowest interaction for flours by collaborators, while the Blish and Sandstedt procedure gave the lowest difference between replicates.

A comparison of various methods for measuring flour-gassing power is in progress. The gas production of yeast-flour-water doughs is being deter-

mined by volumetric and manometric methods and the results related to the diastatic activity of the flours.

Tests are in progress to determine whether variations in the baking strength of flours milled from different world wheats are due chiefly to differences in protein quantity or protein quality. Finely pulverized dried gluten, which, when mixed with water, yields gluten of similar physical properties to freshly washed gluten, has been prepared from flours of varying strength, and its effect on baking behavior of different flours is being investigated.

A comparative study of the utility of the Brabender automatic and Allis-Chalmers experimental mills for estimating flour yield and the suitability of the flour for baking and other quality tests, has been undertaken.

During the year the laboratory has continued and extended previous studies of flaxseed. Rapid refractometric methods for determining the oil content of flaxseed and the iodine value of the oil have been developed, which rendered it possible to carry out large numbers of routine tests at small cost. These included a survey of the oil content and iodine value of flaxseed produced in the prairie provinces in 1935, tests on standard varieties, and also on hybrids produced by the Cereal Division. In co-operation with the Sub-committee on Oil Seeds, laboratory studies have been carried out on samples from the dates of harvesting experiment. Tests of false flax (*Gamelina sativa*) reveal that its oil content is appreciably lower than that of flaxseed and that the oil is also very much lower in iodine value. Tests on different varieties of sunflower seed grown in Canada by the Dominion Forage Crops Division, reveal that their oil contents and the iodine value of the oils compare favorably with Hungarian grown seed.

As in previous years, the laboratory has carried out surveys on the protein content of hard red spring wheat, durum wheat and barley produced in western Canada, and the results were published in the form of maps and mimeographed reports. Proximate feeding stuff analyses of the various feed grades of western Canadian wheat, oats and barley have also been conducted and published in mimeographed form.

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

Grain Research by the Cereal Division, Dominion Experimental Farms

The quality of a large number of varieties developed at the Dominion Rust Research Laboratory, and at the Brandon Experimental Farm, and possessing a high degree of rust resistance, was investigated for the 1935 crop. Another group of 25 varieties, 18 of which were rust resistant sorts, were tested co-operatively, as already noted, from samples grown at 10 different points in western Canada. Wheats bred at Ottawa, and at certain of the Branch Farms, and possessing early maturing properties were studied, and in addition a uniform series of 28 sorts known as the early wheat group were investigated from samples grown at three stations in western Canada, as well as at Ottawa.

The effect of stem rust on the quality of Marquis wheat is being investigated in a co-operative experiment between the Divisions of Botany, Cereals and Chemistry. The wheat is being grown at Winnipeg in a plot arrangement with sulphur dust treatments, thus affording a wide range of stem rust effects. In 1934, reductions in weight per bushel, protein content and flour yield, and an increase in the yellow pigments of the flours were accompanied with increases in the percentage infection of rust. In 1935, these effects were very much more pronounced and in addition, the commercial grade and baking strength qualities were reduced appreciably.

In 1935, a statistical study of the significance of wheat protein differences in varietal trials was made. A uniform series of 28 varieties was grown in four plots at each of three stations, Swift Current, Scott and Lacombe. The plots were arranged in a randomized block plan at each station, and the protein determinations were made in duplicate for each sample. The necessary differences between varieties at each station varied from .41 to .74 in percentage protein, and between varieties for the three stations was calculated to be .64. Covariance analysis between yield and percentage protein revealed a high negative correlation for between stations, and within stations, indicating that when the yield of wheat increased, its protein content decreased. The study further revealed that a composite sample made up from all the wheat produced by the four plots was essentially the same in protein percentage as the average determined on the wheat from each of the four plots for each variety. The ability of certain varieties to produce higher protein percentages than others was again demonstrated. A report on this study is being prepared for publication.

A number of spring and winter varieties grown in localities known to produce low protein wheat, were studied for their suitability for the soft wheat flour trade. On the basis of tests for wheat protein, kernel texture and milling and baking tests, the varieties were classified into three categories, namely, characteristically soft wheats of low gluten strength, characteristically soft wheats of medium gluten strength, and varieties not considered suitable for the soft wheat trade. Of the spring wheat varieties studied, Onas, Dicklow, Federation × Dicklow and Pacific Bluestem were considered the best, and of the winter wheat varieties, Junior No. 6, Dawson's Golden Chaff and American Banner.

Five commercial soft wheat flours comprising two well-known commercial brands milled from Ontario winter wheat, one milled from a soft spring wheat grown in Alberta, and two imported Australian wheat flours were compared. Chemical, physical and baking tests indicated that all five flours were satisfactory for general soft wheat flour purposes.

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

A uniform series of the important and promising varieties of flax are being grown at seven stations in the prairie provinces, and the quantity and quality of the oil expressed from these samples are being investigated in co-operation with the Dominion Grain Research Laboratory.

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

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

GRAIN RESEARCH AT THE UNIVERSITY OF ALBERTA

Studies on the relation between potassium nutrition and the composition and quality of wheat were completed and the results published. (Can. J. Research C, 13 : 339-354. 1935).

Similar studies on phosphorus nutrition were begun with the object of obtaining confirmation of the conclusions reached as a result of the studies of wheat grown on the black and gray soils of Alberta.

The previous year's results showed that nitrogen and sulphur were limiting factors under the gray soil conditions, and that abnormally large

quantities of phosphorus were absorbed. Fractionation of the phosphorus and nitrogen in wheat grown on the black and gray soils was carried out during the summer of 1935. There was no indication that the high phosphorus content of the wheat grown on the gray soil was responsible for the poor keeping quality discussed in the last report.

Studies of the chemical and physical changes involved in the deterioration of flour were continued. The earlier conclusion that deterioration was related to the lipoidal constituents was substantiated. While the presence of germ in flour reduces its quality, it apparently does not hasten deterioration. Fatty acids added to flour alter the physical properties of the gluten, but apparently do not impair the baking quality.

Quality studies on wheat samples supplied from the rotations maintained by the Pathology Division of the Department of Field Crops were continued. No analysis of the data collected has yet been made.

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

The field tests of strains of drought resistant wheat in 1935 were a complete failure owing to extreme severity of the drought at Brooks. Since increase plots of all material were grown at Edmonton, ample material for extensive trials in 1936 is available.

During the past year attention has been concentrated upon the development of laboratory methods for the selection of drought resistant strains of wheat. The purpose is not to replace the field tests, but to devise a laboratory method of selection which will result in an improvement of the general level of material subjected to field tests. The chinook machine has been remodelled and several improvements have been effected. As a result the accuracy of tests and economy of operation are enhanced. A study of the relation between drought resistance and the ability of plants to recover after the seedling roots have been immersed in two-molar sugar solutions for various periods of time is in progress. Evidence of a certain degree of differential ability of strains to recover has been obtained. The extent to which this ability is associated with drought resistance cannot be determined until the results of extensive field trials are available. For the purpose of studying differences in the nature and extent of root systems of wheat varieties and strains, special galvanized iron containers with glass fronts have been constructed. Striking differences in the extent and intensity of the root systems of different varieties are evident. The significance of such differences in relation to drought resistance can only be determined by means of comparison with the results of extensive field trials.

Since no material was harvested at Brooks, and since all the Edmonton material was severely damaged by frost, milling and baking tests could not be made.

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

Field experiments in the summer of 1935 demonstrated the influence of formaldehyde seed injury on increasing the severity of damage from seed-born inoculum of *Helminthosporium sativum* and *Fusarium graminearum*, and also on the incidence of smut (*Tilletia tritici*). The damage from the two former organisms was significantly greater on seedlings from formaldehyde-treated seed than on those from water-treated seed. As a result of reinfestation of seed treated with the two formaldehyde concentrations, 1–400 and 1–360, the incidence of smut was significantly higher than that occurring

on water-treated reinfested seed. Higher concentrations of formaldehyde reduced the amount of smut resulting from reinfestation, but these concentrations were obviously more injurious to the seed.

Investigations were conducted on formaldehyde solutions to determine whether any impurities contained therein might be partially responsible for seed injury. The commercial or 40% formaldehyde gave a pH reading of 3.3, and it was thought that this might be due to formic acid present in the solution. Further experiments showed that formaldehyde solutions (1–400, 1–360 and 1–320) deteriorated rapidly on standing and this deterioration was accompanied by a lowering of the pH. Results with seeds treated with solutions buffered to various pH's indicated that the low pH of certain formaldehyde solutions may be partially responsible for some seed injury. The possibility of the methyl alcohol in the solution being a factor responsible for seed injury has been recognized, and experiments have been undertaken in this connection, but the work has not progressed far enough to warrant a definite statement.

Experiments are being conducted in the greenhouse to observe the effect of formaldehyde seed treatment on root development. The results indicate that formaldehyde definitely retards the development of primary roots. Ceresan in comparison increased root development even over that resulting from water-treated seed.

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

Accurate yield comparisons could not be obtained from the plot tests of the fertilizer requirements of Alberta peats for barley production, as the heavy frost of August 16 stopped grain development. Notes taken while the crop was growing showed that O.A.C. 21 reached the shot-blade stage and headed out a few days before Peatland, but that the former lodged more. At Duffield, the plots fertilized with nitrogen, phosphorus, and potassium were observed to head out first and were evidently ripest when frozen. At Edmonton, the combined nitrogen and phosphorus, and especially the combined nitrogen, phosphorus and potassium fertilizers, were apparently beneficial.

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

Grain Research at the University of Manitoba

Owing to lack of adequate staff the number of tests carried out in the malting laboratory was limited to 270 and these were not completed until the end of March. About 50 varieties grown at the university were malted and the remaining 220 samples were drawn from the smooth-awn series grown at the Dominion Experimental Farms.

None of the smooth-awn varieties tested appear to be equal in general malting quality to O.A.C. 21, as each variety shows a defect in one or more of the characteristics necessary to a good malting barley. Newal, however, might find some use for the production of high diastatic malts as it is superior to O.A.C. 21 in this respect. Byng and York produced malts of higher extract than O.A.C. 21 but less satisfactory in other characters.

During the 1935 season an investigation designed to test the effect on malting quality of fertilizer treatment, dates and rates of seeding, and rotation, was undertaken and this will be carried on for several years. Variety testing and breeding work is being continued and the most promising lines will be submitted for malting tests.

(Investigations under the direction of Dr. G. P. McRostie.)

Grain Research at the University of Saskatchewan

A study has been made of the effect on gluten of dilute sodium hydroxide solutions ranging in concentration from 0.0125 *N* to 0.6 *N*. Ammonia nitrogen and amino nitrogen were determined. It was found that the amide hydrolysis is dependent on both time and concentration of the alkaline solution. With solutions of 0.4 *N* and lower, amide hydrolysis was incomplete at the end of 21 days, but at the end of six days all the ammonia nitrogen (as determined by acid hydrolysis on another sample) was liberated in a 0.6 *N* solution. In a 0.0125 *N* solution of alkali only 5% of the available ammonia nitrogen was liberated at the end of six days. With concentrations of 0.025 *N* and lower there was no evidence of peptide hydrolysis after the gluten had been in solution 31 days. Even with the highest concentration, namely 0.6 *N*, only 24% of the total amino nitrogen was available. It is quite evident from this study that the amide and peptide hydrolysis of gluten in cold alkaline solutions are independent of each other, and that low concentrations of sodium hydroxide in the cold have very little hydrolytic effect on either the amide or peptide linkage.

A series of hot alkaline hydrolyses of gluten were also made using various concentrations of sodium hydroxide. An apparatus was constructed with provision for collecting the ammonia which is vaporized off under these conditions. After 24 hr. hydrolysis in boiling 0.025 *N* sodium hydroxide, the total ammonia determined was 22% and the amino nitrogen, only 7% of that obtained in the acid hydrolysate. It seems evident that the hydrolytic effect of dilute solutions of sodium hydroxide on gluten has been somewhat over-estimated.

Continuing the study of experimental baking formulas, it was found that sucrose, glucose and fructose in moderate dosages with 3% yeast always gave fermentation rate curves having two maxima, whereas maltose always gave single maximum curves. The first maximum with sucrose is attained in about 80 min. after fermentation begins and the character of the maxima seems to be fairly independent of the kind of salt used, provided the salt has no deterrent effect on the yeast. It seems evident that with a plentiful supply of readily assimilable sugar the yeast is the limiting factor during the first 80 min.; during the next 40 min. or so the available sugar becomes the limiting factor; thereafter the fermentation rate curves are very susceptible to the influence of the specific salt used in the formula. It has not yet been decided whether the added salts affect the enzymes of the flour or the activity of the yeast during the latter part of the fermentation period; the evidence available at present is somewhat conflicting.

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

Grain Research at McGill University

A comprehensive review of the literature on the relative feeding value of cereal grains for poultry is now in press and will be issued as National Research Council Report 29. Wheat, barley, and corn appear to be superior to oats or rye for the feeding of any class of poultry. There are only minor differences in the value of the three better grains when they are fed as part of a properly balanced ration.

(Investigation under the direction of Professor E. W. Crampton.)

Among the impurities arising in cultivated oats, which constitute a serious problem in the production of pure seed, are the so-called false wild oats which are very similar in appearance to common wild oats. Less frequently there arise forms like the Mediterranean wild oat *(A. sterilis)*. In

common wheat, forms arise which are like the primitive Spelt and others which are like the club wheats. In addition to these two major off-types of oats and wheat respectively, many forms arise which are intermediate between them and the normal cultivated types of grain.

It has been found that these forms all arise through quantitative changes in the chromosomes which carry the hereditary factors determining them. In some cases there have been losses of whole chromosomes; in others losses of small parts; in others reduplication of certain parts and losses of others. The chromosomes particularly concerned, besides carrying factors which determine the external appearance of the plants, also carry factors affecting fertility and the hereditary transmission of other chromosomes. They appear to be the most important chromosomes of the cultivated cereals. The analysis made of these chromosomes, by means of correlated microscopic and breeding studies, will therefore be of value in general cereal breeding, as well as in the immediate objective of discovering the origin and nature of these troublesome impurities of seed grain. A series of technical papers is now being prepared which will embody the results of thirteen years' work on these problems.

(Investigation under the direction of Dr. C. L. Huskins.)

NOTE.—Grain researches in the National Research Laboratories are summarized in the Report of the Division of Biology and Agriculture, page 23.

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

The annual meeting of this committee was attended by about one hundred and fifty representatives of the market poultry industry in Canada. During this conference and subsequent group meetings, members reported on results and trends of recent research work carried on in various institutional and trade agencies.

From the discussions there has been evolved a program of research relating to the poultry industry of the Dominion. Efforts are being made to secure the active co-operation of all research agencies in the development of a larger volume of commercial product, that will compare favorably on the British market with that sent from foreign countries.

It is proposed to issue shortly a brief statement of results obtained and the projects under investigation at the various Canadian institutions.

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

On the return of Dr. G. S. Whitby, Director of the Division of Chemistry, from a European tour in which he investigated the possibilities of using potatoes for the manufacture of starch and other products, a second conference on potatoes was held in Ottawa on May 10, 1935, to discuss his report and to consider a program of research.

Dr. Whitby stated that he had visited England, France, Germany and Holland, and that during most of his visits he was accompanied by a representative of one of the Canadian starch manufacturing companies. As a result of his tour, Dr. Whitby expressed the opinion that the building of a plant in Canada for the manufacture of potato starch and potato dextrin on a commercial basis might well be given consideration. On the technical side most of the factors were favorable, but the economic and engineering features

of making potato starch in Canada presented certain difficulties. While potato dextrin might possibly be produced to advantage, it would be necessary to carry on a great deal of educational work before such a product could be marketed successfully.

The reports presented at the conference were fully discussed, with special reference to marketing, the manufacture of potato flakes, ensilage, feeding of potatoes to stock, technical and economic factors in the manufacture of potato starch, potato prices, and the possibility of increasing consumption of potato starch in Canada.

The Associate Committee on Potato Research, appointed by the National Research Council in March 1935, held its first meeting on January 20, 1936, under the joint chairmanship of Dr. H. T. Güssow, Dominion Botanist, Department of Agriculture, and Dr. G. S. Whitby, Director, Division of Chemistry, National Research Laboratories. Prior to the meeting, members of the committee had been invited to prepare brief reports on the work being carried on under their direction, and these reports had been duplicated and distributed for the information of the members. The papers were then presented by their respective authors, who merely outlined the contents of their manuscripts. In this way most of the day was spent in the discussion of the material that had been compiled in the contributed papers.

A program of research was prepared and approved. Among other things, it included provision for work in the following fields: *(a)* experiments in feeding potatoes to livestock and poultry; *(b)* a survey of the literature on the nutritional value of potatoes; *(c)* investigations regarding the starch content of potatoes by the Division of Chemistry at the Experimental Farm; *(d)* the drying of potatoes for feeding, with special reference to dehydration methods; *(e)* potato breeding experiments in order to obtain precise scientific information on the genetics of potato propagation; *(f)* chemical research on the utilization of potato starch.

All this work is now in progress.

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

This committee, the organization of which was reported last year, consisted at the outset of only a small executive, set up to act until time should show what form of organization was best to cover the diversity of interests. This group, with additional *ad hoc* members, held meetings in Ottawa on May 9 and July 24, 1935. The executive committee held an additional meeting in Ottawa on November 15, 1935, when it was decided to reorganize the committee on a sectional basis. As poultry cold storage and taints in stored and transported food products were the main problems occupying the attention of the committee, sections covering these problems were organized. The first meeting of the newly organized poultry section was held in Ottawa on February 28, 1936, and at this meeting a research group, consisting of the research workers, was named for the purpose of holding more frequent meetings and thus keeping one another informed of the work under way in the various co-operating laboratories.

National Research Laboratories

The work of the National Research Laboratories for the poultry section of the committee consisted of investigations into: defrosting and dechilling of poultry; dechilling of eggs; transport and storage of chilled poultry under

commercial conditions; and frozen storage of poultry. Reports by Dr. W. H. Cook and Dr. Ledingham covering these investigations appear in the report of the Division of Biology and Agriculture on pages 25 to 27. The Dominion Department of Agriculture co-operated in these investigations by supplying the produce, and the Department's graders and inspectors assisted in making the examinations.

Owing to pressure of other work it has been impossible to proceed very far with the program prepared last year, following a conference with representatives of the shipping interests, of research into the tainting of certain foodstuffs by other odoriferous commodities. A survey of present shipping practice to determine the link in the transportation system which is the chief offender was considered of immediate importance, and a group named by the committee met and planned a method of procedure. This was approved by the committee but no work has yet been possible.

Certain measurements on the nasal threshold of apple taint have been made prior to the development of methods for the quantitative estimation of such small amounts of this material in air. A summary of this work by Dr. N. H. Grace is included in the report of the Division of Chemistry on page 33.

The Quebec Federal-Provincial Committee on Cold Storage again requested the National Research Council to undertake a study of the rate of cooling of celery and the temperature variations in the cold rooms in certain Montreal warehouses. This study was made by Dr. C. D. Niven, whose statement will be found in the report of the Division of Physics and Engineering on page 64.

The committee received a report that the new heater developed by Dr. Niven for warming refrigerator cars during cold weather had been found extremely satisfactory in tests made by the railway companies and packers.

Poultry, Bacteriology, and Chemistry Divisions, Central Experimental Farm

In an effort to prolong the safe storage period of chilled poultry, a number of experiments were made on the reduction of the initial surface-contamination, and subsequent growth rate of micro-organisms by treatment with various materials. Several kinds of light mineral oils, chemical antiseptics, brine solutions, and wax coatings were tested, using various methods of application. Coating with wax appears to be the most satisfactory, although certain of the oil treatments may also be satisfactory. The experiments are being continued.

The susceptibility of cold stored poultry to decomposition on removal from the refrigerated storage room, as compared with the freshly killed product, is exceedingly important. Certain preliminary experiments were made with various lots of fresh, chilled and frozen birds. Bacterial decomposition appears to be most rapid in poultry that have been frozen, while the decomposition of poultry that have been chilled is intermediate between that of the frozen and freshly killed product. Purely autolytic decomposition appears if anything to be most pronounced in poultry that have been held in chill, less in the poultry held in the frozen condition, and least in the freshly killed product. It is suggested that bacterial decomposition in poultry removed from chilled storage is aided by the autolysis during storage, while the increased rate in the product removed from frozen storage is probably due to the physico-chemical effects of freezing.

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

Co-operating organizations:

Alberta Department of Agriculture
British Columbia Department of Agriculture
Manitoba Department of Agriculture
Saskatchewan Department of Agriculture
University of Alberta
University of Manitoba
University of Saskatchewan

No meeting of the committee was held in 1934, but in 1935 the committee met on July 19, at the University of Saskatchewan. The extensive weed experiments at that institution were inspected and reports from co-operating organizations were presented. Brief summaries of these reports follow.

Weed Investigations of the Federal Department of Agriculture

The weed surveys of the Dominion Division of Botany occupy a month or more of each year and have now extended into almost every agricultural region in Canada. A primary aim is to detect new invasions as early as possible and to investigate those reported. The charting of plague centres becomes easier as more data are acquired. Fairly complete data are being acquired on many of the newer weeds, but continuous effort is required to keep information up to date, as each year provides more information on new and potentially dangerous weeds.

Other important botanical work on weeds includes study of the germinating behavior of many species, a study of the hydrogen ion tolerance of several weeds with a view to their removal from lawns, determination of flowering and fruiting periods of many plants in Canada, the dissemination among the public of dependable information on poisonous plants, their identification and control, and the application to practical problems of information gained in the course of the weed surveys. Further details are given in the Annual Report of the Division of Botany, Dominion Department of Agriculture.

(Investigation under the direction of Dr. H. T. Güssow.)

At the Brandon Experimental Farm it has been found that neither deep plowing nor black fallow will effectively control wild oats. Cultivation to a depth of two to three inches gave better results than deeper cultivation, and this was most successful when the weeds were less than four inches high. The most effective means of control was crop rotation. A six-year rotation consisting of fallow, wheat, seed down; hay; hay, break in midsummer; wheat; oats; has given good results in controlling wild oats.

Variations in germination of wild oats in the fall which may be attributed to differences in maturity are being investigated.

Almost complete destruction of stinkweed in small plots was accomplished by spraying with 4% or 5% sulphuric acid at the rate of 100 gallons per acre. Increased amounts per acre gave no better results. Clipping was ineffectual as a method of restraining the flowering of this weed. A heavy stand of alfalfa and brome grass competed effectively with stinkweed, choking it out except where the fodder crop was thin.

Experiments with hoary cress showed that the main root penetrated downwards at least six feet and that new growth could be produced by parts of the upper 30 inches. Every 1½-inch portion of a running root 36 inches long was able to initiate new vegetative growth. Sulphuric acid sprays did not kill this weed nor was it possible to kill it out by fall plowing, ten inches deep, or by constant cultivation with cultivator and rod weeder for one season.

Work at the Regina sub-station was concentrated on control by cultural methods of wild mustard, stinkweed, Canada thistle and poverty weed. Results obtained from 1931 to 1934 are, of course, affected by the fact that moisture was scarce throughout the period. Wheat yields were reduced on the average 28% and 54% by light and heavy infestations of poverty weed and 18% and 65% by light and heavy infestations of Canada thistle.

Dormancy in the seeds of Canada thistle, stinkweed and wild mustard was most persistent in fully mature seeds. No seeds of poverty weed were found during the years 1931–1934, this weed spreading almost wholly by running rootstocks.

The effectiveness of shallow surface tillage in reducing the weed seed content of the soil was determined by counts. Stinkweed was reduced 51% by shallow-worked fallow and 30% by plowed fallow; wild mustard was reduced 52% and 35% by shallow and plowed fallow, respectively, in 1934. The degree of reduction by a given method of cultivation varies from year to year, depending on the moisture content of the soil. Shallow tillage with the rod weeder or duckfoot cultivator is superior to tillage with implements of the disc type. The weed seed content of the soil is decreased when crops are cut for green feed, but it is increased by all grain crops, including fall rye.

Increased rates of seeding have assisted in the control of weeds and their effect has been accentuated by the addition of superphosphate in years when moisture is available. In very dry years the use of the fertilizer is unprofitable.

Black fallow begun as late as July 15 or 20 was fully as effective as fallow started earlier in eradicating Canada thistle and was much less expensive as fewer operations were required. If the thistles are not allowed to produce top growth between the above dates and September 15, complete eradication may be achieved. Fall plowing is less effective and aggravates soil drifting. Summerfallow operations for control of this weed should occur every seven to ten days in the early part of the work and from eleven to fourteen days towards the end of the season. It is necessary that all plants be cut off underground at each operation. Successful control was also obtained by black fallow worked from June 10 to August 5, and then seeded to a cover crop to control soil drifting. Three years of testing indicate that soil drifting may be controlled and eradication of Canada thistle achieved by growing early harvested crops and following with a surface-worked black fallow, keeping the stubble and trash on the surface.

Poverty weed was not eradicated by two years of black fallow, and one year of fallow had very little effect on it. However, it has a slow rate of regrowth when cut off underground even though regrowth may take place from 22 inches underground. Taking advantage of this characteristic a successful method of obtaining good crops on infested land was devised. The method consists of deep plowing of the standard summerfallow about the end of August, and thorough working both before and after that date to conserve moisture for the following year's crop. In the following year the land is cultivated with the duckfoot cultivator as early as possible and then seeded heavily. Good crops have been obtained by this system.

Additional details of this work are given in the Annual Report of the Division of Field Husbandry, Dominion Department of Agriculture.

(Investigations under the direction of Dr. E. S. Hopkins.)

Weed Investigations at the University of Alberta

The role of weeds in harboring and encouraging the parasites of cereal crops has been under investigation and it has been shown that couch grass, as well as western rye grass, crested wheat grass, and awnless brome grass, enables the take-all fungus to spread in the soil. This indicates the importance of the study of other weeds in relation to other plant parasites.

Special study will be given to the control of dandelions in lawns and hay and pasture fields. It has been noticed at Edmonton that some sharply defined spots on otherwise badly infested lawns remain free of dandelions. This suggests some condition of the soil unfavorable for the weed. Some of these spots are undoubtedly connected with the presence of snow mold, and it is proposed to investigate whether toxic products of the fungus may be responsible for keeping the dandelions in check.

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

The effects of herbicides on three types of Alberta soils have been investigated. Copper sulphate applied to summerfallow did not affect the yield of wheat in the following year or the yield of wheat, oats, rye and flax in the second year after application. Sodium dichromate when applied directly to growing wheat reduced the yield but had no effect on the following year's crop when it was applied either to a growing crop or to summerfallow. Heavy applications of sodium chlorate to either a growing crop or a summerfallow affected the soil for three years but did not affect the yields of crops for more than two years. Ammonium thiocyanate when applied directly to growing wheat reduced the yield more than did sodium dichromate but its toxic effect disappeared early in the second season. Annual weeds increased in the two years following the application of this nitrogenous herbicide. It was found by laboratory experiments that ammonium thiocyanate readily leaches out of the soil with water, that it decomposes fairly rapidly under favorable conditions of moisture and temperature, and that it reduces nitrification in soils for a time after application.

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

Weed Investigations at the University of Manitoba

Studies are being made on wild oats to determine the length of the resting period, the order of maturity of the parts of the panicle, and whether color in the wild oat is associated with difference in ripening period. The dark yellow wild oats appeared to be earlier than the others. Fodder crops being tested as means of controlling wild oats are: Early Fortune, Siberian, and Hungarian millet, Sudan grass and sorghum.

Leafy spurge is becoming more prevalent in Manitoba and methods for its control are becoming important. Experiments carried out in 1934 and 1935 showed that one-year's cultivation was not effective, as sufficient rootstalks remained alive to reinfest the whole area. A heavy smother crop of barley was insufficient to check the spurge in the season after cultivation.

A commercial herbicide, depending for its killing action on copper nitrate, was tested for its effect on dandelions in lawn grass. Twenty minutes after spraying, shriveling of the dandelion leaves was noticed. A few days later the grass showed similar effects which, however, did not persist, and at the end of the season the grass on the treated plots was healthier in color than that in the untreated plots. No definite results may be given until the effects of the winter on both grass and dandelions are ascertained.

During the winter of 1934, some 40 weeds were analyzed for fibre, reducing sugars, ash and protein. This work was continued in 1935.

(Investigations under the direction of Dr. G. P. McRostie.)

Weed Investigations at the University of Saskatchewan

Studies of those plant characters which may be important in the competition between weeds and crop plants have been continued. It was shown that there are marked differences in assimilating surfaces which have no relation to relative leaf area. For instance, a wild mustard plant had 79,800 stomata as compared with 64,300 in a Hannchen barley plant, despite the fact that the latter had seven times the leaf area of the former.

Previous work showing that damaged wild oat plants are able to produce new roots and stems was checked under different environmental conditions, the results indicating the practical importance of cultivation at the proper stage of plant growth and under desirable weather conditions.

The optimum depth for germination of many weed seeds was found to be from one to three inches. Russian thistle seeds were a notable exception, as they germinated most readily in the top half-inch of soil. Wild oat seeds, buried from one to seven inches in the soil, germinated in about a month, although some remained dormant. Dormant seeds that had been buried for 35 months germinated about 1%. It is therefore obvious that, under dry-farming conditions, deep plowing to control this weed is not justifiable. Preliminary studies of the dormancy of these seeds indicate that control may best be achieved by shallow after-harvest cultivation followed by packing. Seeds of weeds do not germinate as rapidly as those of crop varieties under the conditions studied. Heavy seeding is therefore recommended. Such a practice allows the crop to become thickly established in time to choke back the weeds.

In the study of root systems it was found that soil moisture had an important effect on growth. In 1933, a dry year following a dry autumn and winter, no crop roots reached a depth greater than 30 inches. In 1934, soil moisture was plentiful and roots of wheat, oats and barley penetrated to depths of more than five feet. The lateral spread of roots was also studied; one Russian thistle plant, grown without competition, occupied an area whose diameter was 17.2 feet. One plant of crested wheat grass, three years old, had a total length of all roots of 317 miles. These results coupled with information on the distribution of the roots below the surface, on storage of food and so on, provide a means of interpreting what happens when the plants are competing for a limited supply of moisture and nutrients in the soil.

Data obtained in the study of root systems of grain plants have been collected and are under examination in order to determine whether they may be of use to cereal breeding work.

In the practical field of agronomy methods have been devised for the control of large infestations of annual weeds and of such perennials as perennial sow thistle, Canada thistle and couch grass.

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

Investigation by the Saskatchewan Department of Agriculture

Investigation to control annual weeds by spraying in growing crops is now at a standstill because a suitable sprayer is not available. Spraying had been found effective in severe infestations of wild mustard, stinkweed and wild buckwheat. However, a method has been found which gives every indication of providing successful control over annual weeds. This method, which has now been tested for three years, consists in seeding early and shallow and using a rate of seeding much heavier than the usual. The method is based on the fact that grain thus seeded germinates soon and fills the top soil with

a layer of roots, thus preventing the young weeds from developing. It is becoming apparent that the rates of seeding previously used in Saskatchewan are no longer satisfactory, since the land is now less fertile and much more heavily populated with weeds.

The Lockwood farm of the Saskatchewan Department of Agriculture has illustrated that black fallow, or fall rye with fallow, will eradicate perennials, and grasses and legumes will control soil drifting on the light soil. Good clean crops of cereals have been raised on a soil heavily polluted with stinkweed, Russian thistle, wild buckwheat, lamb's quarters and other annual weeds. This is accomplished chiefly by using the tiller combine, seeding early, heavy, and shallow, and by the application of commercial fertilizers.

(Investigations under the direction of S. H. Vigor and G. L. Godel.)

Weed Investigations in the National Research Laboratories

Investigations carried out in the National Research Laboratories under the direction of Dr. R. Newton are outlined in the report of the Division of Biology and Agriculture, page 22. Work on the determination of the alkaloids in Canadian plants will be found in the report of the Division of Chemistry, page 35.

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

Co-operating organizations:

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

As in previous years, two meetings have been held of the Wool Growing Section of the committee. For the convenience of members the first of these was held in Saskatoon. This meeting also afforded an opportunity to inspect experimental flocks in that province. The second meeting was held in Toronto in November 1935 at the time of the Royal Winter Fair.

At these meetings, Dr. W. H. Fairfield, of the Experimental Farms Branch, reported upon experiments at the Dominion Experimental Station at Lethbridge, and those in co-operation with a rancher at Skiff, Alberta, on crosses between Rambouillet and Corriedale sheep. The favorable results previously reported had been confirmed, and the meeting recommended that Dr. Fairfield should make a definite attempt to standardize this cross, with the object of combining the best qualities of the two breeds in respect to both wool and mutton.

The committee commended the action of the Dominion Department of Agriculture in importing purebred Rambouillet rams for distribution amongst ranchers in western Canada, and strongly favored the continuance of this practice.

The results of Professor J. P. Sackville's four years of work at Edmonton, on the effect of environmental and nutritional factors on wool production and quality, were being studied with a view to reaching as definite conclusions as possible. A comprehensive report was in preparation. A new series of

nutritional experiments had been started, with the object of discovering the cause and possible methods of preventing what appears to be a deficiency disease of sheep observed when they are maintained for long periods on dry feed.

Further results were presented by Dean A. M. Shaw on a Ryeland-Rambouillet cross made at the University of Saskatchewan. The results obtained were regarded by the committee as promising, particularly from the point of view of mutton, and it was recommended that an effort be made to establish a new breed of sheep combining to the maximum extent possible the wool quality and hardiness of the Rambouillet and the mutton quality of the Ryeland breed. The Department of Agriculture advanced a sum sufficient to purchase animals for this cross, and the National Research Council undertook to meet extra expenditures involved in the care of the flock.

Consideration was also given to a proposal by Dean Shaw that a stud flock of purebred Rambouillet sheep be established by the University of Saskatchewan, for the purpose of providing high-grade rams for sale to western ranchers, and thus obviating the necessity of making further importations. The proposal was regarded favorably by the committee, and arrangements were made by the President of the Council for the use by Dean Shaw for grazing purposes of a large area on the Dundurn Military Reserve adjoining that on which the university flocks have been kept. An effort will be made to secure funds for the purchase of the purebred stock required.

Following the Saskatchewan meeting, members of the committee inspected the university's flock and also visited the Matador ranch in southwestern Saskatchewan. At these points sheep of a number of pure breeds and various crosses were seen. As most of these sheep were kept under strictly range conditions, the results obtained were of particular interest from the point of view of the suitability of these breeds and crosses for use in western Canada. The committee is now fully convinced that range conditions require either a fine-wooled sheep, such as the Rambouillet, or such a cross with this breed as will permit the retention of its hardiness and other desirable characteristics.

The usual special wool grading was carried out in the early fall at the Weston warehouse of the Canadian Co-operative Wool Growers and the results were embodied in reports presented by Mr. W. H. J. Tisdale at the November meeting of the committee. A shipment of experimental fleeces was also made to England, and the detailed comments of one of the large wool dealers was obtained upon it. In this dealer's report, the committee was congratulated upon the progress made and advice was given as to the type of wool which should be produced to satisfy the British market. The special grading at Weston and in England was regarded by the committee as of the utmost value.

The committee was also much gratified at a report presented by Mr. Tisdale, showing the improvement observed in wool from western Canada over a period of fifteen years. This improvement was remarkable in respect to both fineness and fibre length.

At the November meeting, Dr. H. B. Speakman, of the Ontario Research Foundation, and Dr. P. Larose, of the National Research Council, outlined to the committee their laboratory investigations on wool. These two laboratories are co-operating fully, each making available to the other the results of its studies.

The secretary presented at the November meeting a report on goods which had been made up two years previously from experimental and other

wool from western Canada, with a view to determining its value for the manufacture of fine wool cloth. About 200 yeards had been manufactured and sold for men's suits, and a questionnaire had been sent to all purchasers of suit lengths. While the comments of individuals varied considerably, the suits were in general reported as being satisfactory in both appearance and wearing quality, and fully equal to the suits ordinarily worn by the purchasers. The chief complaint was that the wool was rather too fine and soft for the purpose, but this comment was regarded by the committee as conclusive evidence that the Canadian climatic and other conditions were not unfavorable to the production of wool of high quality.

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 Marine
Dominion Department of National Defence
Fairchild Aircraft Ltd.
Imperial Oil Ltd.

One meeting of the reorganized Associate Committee on Aeronautical Research was held during the past year.

The committee reviewed the work which had been done in the aeronautical laboratories of the Council during the past six years. The special problems suggested by the committee for investigation were as follows:—

1. Research work on the strength of stressed skin structures. This is a type of construction of growing importance in the aeronautical industry. The Department of National Defence have a number of discarded floats which would be very useful in this connection and it was felt that it would be a valuable contribution to the subject if the strength of various types of float construction were investigated.
2. The behavior and strength of aircraft structures under vibration. The committee urged that the instrument laboratory should develop the necessary equipment and apparatus to investigate this subject. Preliminary work elsewhere had shown the importance of this question of vibration on which very little work has been done.
3. The effect of engine and propeller vibration.
4. Cause of structural failure in fuel tanks.
5. Aircraft engine performance with low viscosity oils and the effect of wearing of the parts.

The committee considered ways and means of disseminating, to the aircraft operators and manufacturers throughout the Dominion, information on the tests and researches carried out in the aeronautical laboratories. It was decided that summaries of all reports for general issue should be sent to the operators and manufacturers and that the complete reports should be made available to them at a nominal charge.

In connection with the aircraft museum, the committee is in favor of finding better and more permanent space both for the exhibits already in the possession of the Council and others that are expected to be placed in the keeping of the Council by the War Trophies Disposal Board.

The committee strongly urged the acquisition (permanent or on loan) of the very historic collection at Baddeck, Nova Scotia, dealing with the first flights within the British Empire, which were made in Nova Scotia. These exhibits are at the moment very poorly housed and, in view of their important historic value, they are well worthy of being placed in a national aeronautical museum, the formation of which the committee strongly favors.

Associate Committee on Asbestos

Co-operating organizations:

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

As anticipated in the last annual report, a meeting of the committee was held in Ottawa in June, 1935, and the whole research program was carefully reviewed. An opportunity was also afforded members of the committee to inspect the National Research Laboratories and to familiarize themselves with the character of the work under way. The asbestos investigations are described in the report of the Division of Chemistry on page 34 of this report.

Throughout the year the research staff has worked in close co-operation with industry. Not only has the committee given advice in respect to the conduct of investigations but a member of the research staff has attended each of the monthly meetings of the Quebec Asbestos Producers Association. It is hoped to establish still closer industrial contacts in order that the work done in the laboratories may be of as practical a character as possible.

Associate Committee on Chemical Standards

Since its formation the Associate Committee on Chemical Standards has received from the British Standards Institution copies of draft specifications on chemical products. These specifications have been distributed to interested manufacturers in Canada for their comment and criticism, and their views have been communicated to the British Standards Institution for consideration before the final specifications were made. The advantage of this connection with the British Standards Institution is that Canadian manufacturers, through the Associate Committee on Chemical Standards, are being afforded an opportunity to assist in the shaping of the standards in the United Kingdom.

To March 31, 1936, there had been received 109 chemical specifications for circulation in Canada under this plan. During the year just closed, the following specifications were distributed:—

Chemical Glassware: ampoules for biological products; bolthead flasks; conical flasks; density hydrometers; extraction flasks; haemocytometer; Kjeldahl flasks; maximum clinical thermometer; meteorological thermometers; round bottom flasks; straight pipettes; volumetric glassware.

Methods of Testing: chemical analysis of butter; coal sampling; flow and drop point of fats; gelatins; sampling and analysis of cheese; viscosity; washing soda.

Pigments: black (bone, carbon, lamp, mineral, vegetable); black oxides; natural siennas.

Standards of Quality: chromic acid; joiner's glue; paper quality; paper sizes; sesame oil; vegetable tanned sole leather.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association, as at March 31, 1936, had a total membership of 711. This includes members of the main committee, sectional committees and all working committees.

The main committee has been reorganized and the new committee, which started to function on April 1, 1936, consists of 70 members. Under the new arrangement, the National Research Council is represented by the President, but further representatives from the Council will be co-opted if necessary. It is proposed also to enlarge the executive committee.

All work of the Association is carried forward by various working committees the members of which 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:—

A36–1935—Standard Dimensions for Building Brick.

G38–1935—Standard Specification 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.

Under the Canadian Electrical Code, Part II, the following approval specifications have been issued during the year:—

C22.2 No. 4–1935—Construction and Test of Enclosed Switches.

C22.2 No. 13–1935—Construction and Test of Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment.

C22.2 No. 14–1935—Construction and Test of Industrial Control Equipment in Ordinary (*i.e.*, Non-hazardous) Locations.

C22.2 No. 16–1935—Construction and Test of Insulated Conductors for Power-operated Radio Devices.

C22.2 No. 17–1935—Construction and Test of Cable for Luminous-tube Signs and for Oil-burner Ignition Equipment.

C22.2 No. 19–1935—Construction and Test of Soldering Lugs.

C22.2 No. 24–1935—Construction and Test of Automatic Motor-control Devices of Small Capacity.

C22.2 No. 26–1935—Construction and Test of Auxiliary Gutters, Junction-boxes and Pull-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.

Civil Engineering and Construction

Brick Dimensions. The report on the standard sizes for brick has now been published, as indicated above.

Structural Timber. The panel dealing with this subject held its first meeting in January and discussed the first draft, and a revised draft is now being issued involving considerable rearrangement. It is hoped, however, that it will now be acceptable to the panel.

Mechanical Engineering

Binder Head Screws. Suggestions have been received that a new size be added to this specification and the proper dimensions for the size are now being discussed by the committee.

Oil Burner Regulations. This work has been taken over by the National Research Council, and the C.E.S.A. committee has therefore been discharged.

Elevator Safety Code. A special panel of the committee has been doing considerable work on the revisions to the first draft and it is hoped that a second draft will shortly be available.

Electrical Work

Canadian Electrical Code. The third edition of Part I of the Code, issued in 1935, has been widely distributed. The latest authority to adopt the Code has been the City of Winnipeg, which has incorporated it in their city by-laws. A supply of the Code has also been secured by the Manitoba Power Commission.

Under Part II of the Code, covering essential requirements and minimum standards for electrical equipment, approval specifications are prepared by a special panel on specifications, which co-operates with industrial representatives. The work has been unusually active during the year and up to date there have been 47 specifications under consideration, of which 24 have been published, including the eight indicated above. During the year the panel has held 13 meetings, at which the following specifications have been discussed: enclosures for use in hazardous locations, panelboards, enclosed branch-circuit cutouts, switchboards, electrically-operated refrigerating machines, electric cranes and hoists, electrode receptacles for luminous-tube signs, electric appliances for hair dressing, etc., Christmas-tree and other decorative lighting outfits, rubber-covered wires and cables, cutout bases, cabinets and cutout boxes, and ground clamps.

Consideration has also been given to the following specifications, which are in draft form: electrically heated warming pads, oil circuit-breakers, wireways and busways, asbestos-insulated stove wire, low-voltage control-circuit wire and cable, receptacle plugs and similar devices, lamp-holders having socket screw-shells, flexible tubing (non-metallic), electric air-heaters and knife switches. The specification for electrically heated warming pads has been on trial for two years and plans are now being made to have it printed. The specification for oil circuit-breakers has been given very careful

consideration and it is now suggested that this be published as a general specification and not under Part II of the Code. If this meets with the approval of the Code Committee this action will be taken.

It has been decided to change the title of Part II of the Code to cover standards for outside wiring.

Under Section 1 of Part III of the Code, covering overhead systems, a revised draft of the crossing specification was issued on February 15, 1936, and a time limit for the receipt of comments was set at March 31. This was later extended to April 30, and comments which have been received to date are now under consideration by a special panel. No definite report is as yet available.

It was decided not to issue a report on Section 2, dealing with underground systems, until the results of the work on overhead systems had been approved.

Under Section 3, dealing with inductive co-ordination, a report covering definitions and principles has now been prepared and is being issued in mimeograph form. A draft covering principles and practices for the prevention of radio interference is still under consideration.

Under Section 4, on conductive co-ordination, a report has been prepared on "Principles and Practices for Protecting Underground Structures from the Effects of Stray Currents Originating in Direct Current Electric Railway Systems," and is being issued in mimeograph form.

Insulated Power Cable. It has been found impossible as yet to get full agreement on the first draft of this specification and the latest information on the insulation tables has been sent to the committee for consideration. Nothing further has been done with respect to the report on armoring for cables.

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

Oil Circuit Breakers. This is referred to under the report on Part II of the Code, but the special committee dealing with this specification is now preparing a final draft which will be sent out for approval as soon as possible.

Galvanized Telegraph and Telephone Wires. It has been decided that this specification should be revised, especially to include copper-bearing wire. The specification has passed through three drafts and the final draft is now before the committee for approval.

Bulletins to Electrical Manufacturers. These bulletins are still being issued to manufacturers in order to give advance information on prospective changes in test requirements or proposed revisions to the Canadian Electrical Code. Seven bulletins have been issued during the year and detailed information is given in the C.E.S.A. Quarterly Bulletin.

Ferrous Metals

Heavy Steel Shaft Forgings. The title of this project has been changed to Carbon-steel Forgings, and the specification has now been issued as indicated above.

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

Reinforcing Materials for Concretes. The specifications issued in 1930 will be revised and draft revisions are still under consideration by the committee.

Steel Construction

Four steel specifications have now been issued under the new sectional committee, as indicated above. A preliminary report on structural steel welding is now before the panel for approval and a summary of suggestions for revision to the specification for steel highway bridges is before the committee. Revisions to the specification for steel railway bridges will be held until final decision is reached on the highway bridge specification. This also applies to some extent to proposed revisions to the specification for steel structures for buildings.

Industrial Contacts

The secretary attended meetings of the Canadian Purchasing Agents' Association, Canadian Hospital Council, Dominion Housing Commission, Dominion Fire Prevention Association, Canadian Electrical Association (Engineering Committees), Canadian Lumbermen's Association and the Canadian Institute of Mining and Metallurgy. In many cases meetings of the C.E.S.A. working committees were called at the time of these meetings in order to take advantage of the presence of committee members. In several cases the secretary had the opportunity of delivering short addresses to the different organizations soliciting their co-operation and extending the facilities of the Association.

Sale of Publications

The sale of publications continued to be very active and their general adoption has been a source of great encouragement. There has also been a considerable sale of publications issued by the British Standards Institution.

Industrial Support

There has been a slight improvement in industrial conditions and as a result the receipts from industrial sources have slightly increased. Resignations were received from three sustaining members but this has been offset by two new sustaining members and one renewal. The total number of sustaining members and subscribers is 68. It is hoped that the reorganization of the main committee will stimulate additional interest in the work of the association on the part of industrial interests.

The National Research Council has continued its financial support and the provision of office and mimeographing facilities, and with the support received from industry a successful year's work has been completed.

Associate Committee on Fire Hazard Testing

The third annual meeting of this committee was held in Ottawa on June 20, 1935. This was the only meeting held during the past year.

Three sections of the Safety Code for Oil Burning Equipment, NRC-11-1935, were submitted for discussion and were approved by the committee. Safety Standard for Dry Cleaning Solvents, NRC-10-1935; Safety Standard for Gasoline Engine for Fire Pump Drive, NRC-7-1934; and Safety Standard for Gasoline Safety Cans, NRC-13-1935, were also submitted for discussion. Approval was subsequently given by correspondence.

Six bulletins were issued to the committee for comment and criticism. Two of these were Reports Nos. PFO-M1018 and PFO-M1019, on the basis of which listing of devices tested was recommended. Two were Safety Standards, namely, Safety Standard Covering the Design and Construction of Gate Valves of the Inside Screw Type, NRC-15-1935, and Safety Standard Covering the Design and Construction of Automatic Draft Regulators, NRC-14-1935. One bulletin contained revised regulations and application forms and the sixth bulletin was a report on the further consideration of the use of metal bottles *versus* glass bottles with atmospheric oil burners. In all cases, constructive criticism and comments which were of valuable aid were received.

Two meetings of the executive committee were held in Ottawa. The main business of these meetings was to discuss the expenditure of money from the funds of the associate committee. The executive committee approved of the expenditure of money sufficient to cover the cost of the necessary equipment for the testing of fire extinguishers. Approval was also given for the appointment of a laboratory assistant to replace the present incumbent who had given notice of resignation.

One new appointment was made to the associate committee, namely, Mr. W. J. Scott, the newly appointed Fire Marshal of Ontario, who accepted an invitation to serve on the committee. The resignation of Mr. G. F. Lewis was accepted.

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories, Limited
Dominion Department of Mines

Most of the work done under the committee is now being carried out in the laboratories of the Division of Chemistry, since Mr. J. W. Craig, the ceramic engineer formerly employed by the committee in the laboratories of the Mines Branch, is now on the staff of Canadian Refractories, Limited. Nevertheless, the special facilities of the Mines Branch are still made available to the committee, as also is the advice of the Mines Branch staff, which is gratefully acknowledged. An account of the work done in the Division of Chemistry will be found on page 42 of this report.

In general, it may be said that the co-operation of industry with the National Research Laboratories, as exemplified by this investigation, is working out most satisfactorily. The close contact maintained by the technical and operating staffs with the research men has resulted in the direction of the investigation along thoroughly practical lines and has facilitated the immediate industrial application of the discoveries made and improvements effected.

As regards all inventions made by the laboratory staff, it is the policy of the committee to take out patents both in Canada and the principal foreign countries. In so doing, however, care has been taken to protect the interests of the Canadian public. A substantial revenue to the Council from its interests in such patents is anticipated.

(Investigation under the direction of Mr. F. E. Lathe.)

Associate Committee on Oceanography

Co-operating organizations:

Biological Board of Canada
Hydrographic Service of Canada
Meteorological Service of Canada
Naval Service of Canada
Pacific Committee on Oceanography (U.S.A.)
University of British Columbia

Some changes have been made in the committee during the year. The Subcommittee on Fisheries is now fully organized, with Dr. R. E. Foerster as chairman, the other members of the committee being Professor J. R. Dymond, Dr. J. L. Hart, Dr. A. G. Huntsman and Mr. G. V. Wilby. Dr. R. H. Bedford and Mr. H. H. Beard have been appointed to the Subcommittee on Fisheries Technology to represent two additional phases of technological investigation.

The Oceanographic Society of the Pacific was duly launched at a meeting at Los Angeles in June; President, Dr. T. Wayland Vaughan, Vice-president, Dr. C. McLean Fraser, Secretary, Dr. C. L. Utterbach. Dr. A. H. Hutchinson represented this committee at the meeting and presented a report on the oceanographic progress made in British Columbia during the previous year. This organization provides another avenue for co-operation among those societies throughout the Pacific coastal area of Canada and the United States, who are interested in oceanography.

Fair progress in all the major problems that have been under way has been made during the year, but the handicap of inadequate financial support seriously retards the expansion that should accompany the development of each problem. In almost every instance, serious delay in arriving at satisfactory conclusions is unavoidable because of the lack of a suitable boat to obtain the necessary material or data. The use of a boat, suitably equipped for all phases of oceanographic work, and sturdy enough to stand the open ocean as well as the inner sheltered waters, would permit the prosecution of the work with greatly increased efficiency.

The field for physical and chemical investigation was extended during the year to include the west coast of Queen Charlotte Islands, where facilities for work were provided on the C.G.S. *Wm. J. Stewart.* Largely on account of the unfavorable weather conditions, the work was not as successful as in the previous summer, on the west coast of Vancouver Island, but much information of value was obtained.

The facilities offered by the *Wm. J. Stewart* made it possible to do some exploratory work on the marine fauna of the Queen Charlotte area. Extensive shore collecting in the area from Houston Stewart Channel to Skidegate Channel, along the coast of Moresby Island, made it possible to get a fair idea of the littoral fauna in an area that had been previously untouched. A limited use of the tow-net and the dredge gave some indication of what species one might expect in the adjacent waters.

Work on phases of the life history of oysters, clams, crabs and wood borers has been continued and further progress has been made in listing species in various classes.

In fisheries research, salmon, trout, pilchard, herring and shell fish are still receiving major attention. Some of the prominent aspects are: effect

on the run of sockeye salmon of the destruction of predators; migration of pilchard tested by tagging experiments; existence of several racial populations in the herring; early growth stages in the ling cod; stomach contents of fur seal; stomach contents of marine birds and of fish eaten by some of these.

The following problems deserve early attention: effect on fish stocks of exploiting only selected species; investigation of less important fisheries before exploitation occurs; need for further collecting expeditions in British Columbia waters; museum facilities.

Much progress has been made during the year in the field of fisheries technology, especially at the stations of the Biological Board in connection with investigations in use of fish oils in manufacturing paints, varnishes and resins, fish oils for feeding and medicinal purposes, production of vitamin-potent liver oils, vitamins, chemical tests on "Thalattols," constitution of fish oils, handling of fresh fish, glazes for frozen fish, low temperature storage, canning, wood rot aboard ship, cooling and freezing curves for fish, sea water temperatures.

Several papers have been published during the year, embodying the results obtained by investigations in the various fields mentioned.

Associate Committee on Parasitology

Co-operating organizations:

Dominion Department of Agriculture
Imperial Bureau of Agricultural Parasitology
McGill University
Ontario Department of Agriculture
Quebec Department of Agriculture

Library

The abstract card index is being maintained and now contains some 5,000 card summaries, which comprise an almost complete list of titles since the beginning of 1932. It is proving of invaluable use to the Institute and to outside scientists.

During the past year a card index has been made of the reprints in the library, which number some 4,000 and include the works of parasitologists in every part of the world. In addition, some 250 of the heavier reprints and monographs have been bound in press board to preserve them. These also are catalogued in a card index.

The Imperial Bureau of Agricultural Parasitology is continuing its invaluable assistance and until last fall furnished the Institute with lists of all titles noted by the Bureau. These were of great value in saving time spent in searching current literature, and it is a matter for regret that financial considerations have made a continuation of this service impossible.

Teaching

A short undergraduate course in parasitology as it affects human medicine in Canada was given in the spring to about 45 medical students of McGill University. Lectures were also given to the undergraduate class in plant pathology. Although no occasional students have studied at the Institute, material for studying has been forwarded to a number of students in Canada and the United States, and a collection of teaching specimens is being supplied

to the Public Health Department at Toronto. Two post-graduate students were awarded the degree of M.Sc. and one that of Ph.D. during the year. Two students are at present reading for the degree of M.Sc. and one for the Ph.D.

An exhibit of an educational nature was prepared featuring *Ascaris lumbricoides* of the pig. This exhibit was on view at the Macdonald College booth at Blue Bonnets Agricultural Exhibition last August and at the Canadian Manufacturers Association Exhibition, Montreal, in November. On account of the unusual character of the demonstration, it attracted a good deal of interest from the general public.

The Royal Canadian Mounted Police contingent going to northern posts came out to the Institute and received a day's instruction in the feeding of dogs and their common parasites. Dr. Plummer of the Animal Diseases Research Institute, Hull, gave a short talk on distemper and similar diseases of dogs.

During the year numerous conventions and meetings were attended, and five addresses were given by the Director.

Research

The survey of internal parasites of economically important animals in Canada has been continued.

During the year 858 animals (not including animals partly examined for specific parasites) have been examined for parasites, compared with 243 last year. These are as follows:—

Animals	1934	1935	Parasitized 1935, %
Wild carnivores	42	118	48
Domestic carnivores	2	21	65
Rodents	29	194	68
Wild herbivores	9	24	80
Domestic herbivores	—	10	100
Insectivores and bats	1	7	66
Sea mammals	2	32	66
Fish	114	94	67
Land birds	41	193	64
Water birds	1	125	72
Domestic birds	2	40	70
	243	858	

During the last twelve months considerable progress has been made in determining the proportions of artificial fertilizers or other substances which can be added to manure to sterilize it against the free living stages of sclerostomes, and, in many cases, at the same time to add to its manurial value.

In tests on the comparative values of animal urines, it was found that urine from a few cows has little or no lethal value, but it was not possible to associate this condition with disease. As a general rule 25 cc. of urine is necessary for 100 grams of faeces.

Ammonia water and acetone (constituents of urine) have lethal properties. Most of the work has been to determine the quantities necessary when the faeces are treated with the nematode eggs still unhatched. In the small

cultures which have been used for these tests, paradichlorbenzene is the most lethal substance yet tested, whether mixed with the faeces or used as a gas. Other chemicals which can be used as a gas and have been used in plant nematode control are now being tested.

Of the artificial fertilizers with which cultures have been made, urea is the most lethal, requiring about 0.85% of the weight of the faeces. Calurea also has good lethal properties and should be used at the rate of 1.25% of the weight of the faeces to be tested. Powdered cyanamid has slightly more killing power than granular cyanamid, lethal amounts being just under and over 2.0%, respectively.

Diammonium phosphate, potassium nitrate, calcium nitrate, calnitro, nitro-chalk, sodium nitrate and ammonium sulphate all have lethal properties, but considerably less than the other nitrogenous fertilizers. Ammonium carbonate and ammonium chloride are the most lethal. Of the potassic fertilizers, high-grade kainit is the most lethal, comparing well with some nitrogenous fertilizers. Muriate of potash also has some practical possibilities. Carbonate of potash has a similar value, but sulphate of potash is most irregular in its lethal properties. Basic slag and raw rock phosphate have no lethal value. Twenty per cent superphosphate is much more lethal than 16%, although the former to be of value has to be used at the high rate of 20% of the weight of the faeces.

Ground limestone has no killing power, but quicklime and hydrated lime kill slowly in small cultures if used in considerable quantities. In large cultures, quicklime kills by the heat caused when mixed with faeces, a process which destroys much of the value of the manure.

Bleaching powder is disappointing in its lethal value, and is most unpleasant to use. Salt has a lethal effect on free-living sclerostomes, as it has on free-living hookworms.

Copper sulphate is peculiar in the slowness with which it appears to kill larvae. Iron sulphate is somewhat less lethal. Borax, which is also used in fly control on manure heaps, is lethal, but even in small quantities it is poisonous to plants. Hellebore, which can also be used in fly control, has no lethal value, nor have derris and pyrethrum powders, yet tobacco dust has a little. Flowers of sulphur has no killing power.

An investigation into the life history of *Paramphistomum cervi* of cattle in the upper St. Lawrence Valley was commenced. The districts of severe infestation have been mapped, the bionomics of the egg, miracidium and adult, studied, and life history experiments are being continued.

The Institute has co-operated with the Department of Entomology, Macdonald College, in testing the efficacy of various larvicides in the destruction of warble fly larvae in the backs of cattle. A standard derris wash was shown to be the most efficient for the destruction of the final instar larvae. Alcoholic extracts of pyrethrins I and II in a soap base, having a surface tension of 31 dynes, did not destroy the larvae. The results of the tests to prevent the development of the third instar larvae could not be interpreted owing to the failure of the limited number of control animals to develop visible larvae. Ointments of naphthol compounds, etc., did not give promise of any larvicidal powers.

The most frequently encountered parasite in sheep in eastern Canada is a nematode worm belonging to the genus *Strongyloides*. As this genus occurs in many other hosts, a study of the bionomics of a closely related species found in rodents has been commenced.

The life history of *Tetrameres crami* in domestic and wild ducks has been completely elucidated. This nematode parasite appears to be quite pathogenic in domestic ducks in the province. Preliminary studies have revealed that "duck malaria" is a cause of severe losses in young ducks locally and in other parts of Quebec. Experiments to determine the exact means of transmission are being planned, some doubt having arisen regarding the present belief that *Simulium venustum* is the only vector.

The investigation on schistosome dermatitis was continued. With the co-operation of the National Parks of Canada, Dr. Swales visited Clear Lake, Manitoba, and, following field observations, the material was studied in detail at the University of Michigan Biological Station. For the latter privilege he is indebted to Drs. LaRue, Cort and Talbot. The results of this investigation showed that the previous work in Manitoba could not be accepted and that an entirely different cercaria and snail host were responsible for the dermatitis, and control measures were changed accordingly. It was noted during the investigation that a strigeid cercaria, C. of *Diplostomum flexicaudum* was the most common species in Clear Lake and that it was extremely lethal to fish. A study has been commenced on the cercariae with bifurate tails and their relation to swimmers' itch in eastern Canada. This work, commenced last summer, will be continued next season. It was considerably hampered last year by lack of knowledge of the bionomics of the snails, which could not be maintained alive in the laboratory for any length of time or induced to breed in captivity.

An examination of local cats showed the presence of a heterophyid fluke in those known to have been fed on fish, and a post-mortem examination showed that fluke to be *Apophallus venustus*, a form previously found only in Washington, D.C. A detailed investigation has been made into its life cycle and it has been found to involve two intermediate hosts—an operculate fresh-water snail, *Goniobasis livescens*, and a fresh-water fish. Experiments indicate that while practically any species of fish will serve, black bass and catfish are especially heavily infected. A study into the pathogenicity of the fluke and its possible occurrence in man is being made.

Sheep field trials were continued with the co-operation of the Health of Animals Branch and the assistance of Canadian Industries, Limited (Salt Division). From information obtained from the farmers co-operating, there appears to have been a decided improvement in the wintering of their flocks after applying methods of sanitation and hygiene, supplemented with drenching. Further data have been obtained on salt consumption figures. This work has been supplemented by laboratory trials to test out medicated licks for toxicity to individuals.

The comparative study of the pathology of Fascioloidiasis magna in various ruminants and rodents has been completed and the results are being prepared for immediate publication.

Dr. Parnell, in company with Mr. A. A. MacMillan, of the Dominion Department of Agriculture, made a vacation trip through the west, inspecting sheep farms in various parts of the country and the conditions prevailing at each. Material was collected and arrangements made for further material to be sent in. *Thysanosoma* (the fringed tapeworm) is considered by many ranchers in the west to be their most serious parasite; in the material examined, however, none was found, although *Moniezia* was common. No fluke disease was reported or signs of it noted. Considerable loss is caused on the ranges by a condition of the lungs which is reputed to be caused by sand. Investigation is being made into this problem.

A study of the parasitic development of the important sheep nematode, *Chabertia ovina*, is almost completed.

The Institute has again to acknowledge the assistance it has received in the correct identifications of mammals by Dr. R. M. Anderson, of snails by Mr. A. LaRocque of the National Museum of Canada, of birds by Prof. V. C. Wynne-Edwards of McGill University, and of fish by Mr. B. W. Taylor, Director of Fish Culture in Quebec.

During the past year the following papers have been published:

By T. W. M. CAMERON.—

"Parasites Carried by Wild Animals of Importance to Man and Domestic Animals." Proc. 28th Inter. Assoc. Game, Fish & Conserv. Commissioners. 1935.

"Immunity Against Animal Parasites." Proc. 12th Inter. Vet. Congress, 1934. 3 : 44-65. 1935.

"Parasitology and Its Relation to Public Health in Canada." Can. Pub. Health J. 26 : 541-547. 1935.

"Parasites and the Empire". United Empire, 26 : 111-112. 1935.

"Studies on the Endoparasitic Fauna of Trinidad Mammals. I. Some Internal Parasites of Trinidad Deer." Can. J. Research, 13 : 89-96. 1935.

"Studies on the Endoparasitic Fauna of Trinidad Mammals. II. Additional Parasites from Trinidad Deer." Can. J. Research, D, 14 : 1-5. 1936.

"Studies on the Endoparasitic Fauna of Trinidad Mammals. III. Some Parasites of Trinidad Carnivores." Can. J. Research, D, 14 : 25-38. 1936.

"Parasites of Animals and the Public Health in North America." J. Am. Pub. Health Assoc. 26 : 46-50. 1936.

"Parasites of Importance in Meat Inspection in North America." J. Am. Vet. Med. Assoc. 88 : n.s. 41 : 282-288. 1936.

"Animal Parasites and Wild Life." 21st Am. Game Conf. Trans. 412-417. 1935.

"Parasitology and Agriculture." Agr. Soc. Tobago and Trinidad. Paper No. 817.

By W. E. SWALES.—

"Researches on Liver-fluke in Deer." 21st Am. Game Conf. 406-411. 1935.

"Schistosome Dermatitis in Canada—Notes on Two Causative Agents and Their Snail Hosts in Manitoba." Can. J. Research, D, 14 : 6-10. 1936.

"Two Important Diseases of Ducks in Quebec." J. Agr. 39(11), 13 : 40-43. 1936.

By I. W. PARNELL.—

"On the Control of the Free-living Larvae of Bursate Nematodes of Domestic Animals." Trop. Agr. 12 : 111-113. 1935.

"Fish Parasites and Their Importance." Trans. Am. Fish Soc. 54 : 390-400. 1935.

"Some Methods of Controlling the Spreading of Internal Parasites of the Horse." J. Roy. Army Vet. Corp. 6 : 138-141. 1935.

"Notes on the Survival and Control of the Eggs of Free-living Larvae of Sclerostomes on Pasture." Sci. Agr. 16 : 391-397. 1936.

By T. Lloyd Jones and A. A. Kingscote.—

"Observations on Ascaris Sensitivity in Man." Am. J. Pub. Health, 12 : 406-413. 1935.

By H. V. M. Metivier.—

"Some Worm Parasites of Stock in St. Lucia." Trop. Agr. 13 : 8. 1936.

By M. J. Miller.—

"*Bunoderina eucaliae* gen. et sp. nov., A New Papillose Allocreadiidae from the Stickleback." Can. J. Research, D, 14 : 11-14. 1936.

(Investigations under the direction of Dr. T. W. M. Cameron.)

Associate Committee on Patents and Awards

As in the past, matters relating to patents have been handled by the Associate Committee on Patents and Awards, which, in respect to applications for patents, works through subcommittees in each of the laboratory divisions of the Council.

During the year under review, 10 patents have been granted and 17 additional applications have been placed.

The Council is now beginning to receive a revenue from the sale and licensing of patents. All arrangements of this kind are made under the authority of Section 11 of the Research Council Act. In each case the Council's proposals have been confirmed by the Governor in Council.

Associate Committee on Radio Research

Co-operating organizations:

Canadian Marconi Company
Canadian Radio Broadcasting Commission
Dominion Department of Marine
Northern Electric Company

No meeting of the executive committee or of the full committee was called during the year but a special conference, with representatives from the Department of National Defence and the Canadian Radio Broadcasting Commission, was held on February 10, 1936, to discuss the details of establishing a second direction finding station in western Canada.

Through the co-operation and good offices of the Department of National Defence it was decided that the equipment, after construction by the National Research Council, should be housed in the buildings of the Airway Radio Station at Forrest, Manitoba. The Department offered to defray some of the cost of the experimental work. Radio communication with the Ottawa station was to be arranged, and the Department of National Defence agreed to make one of their transmitters available for use at Forrest and to use their Ottawa transmitter for limited periods of the day for this purpose. The Department further agreed to supply a man to help in the western station.

It was decided to move the equipment west as soon as possible after May 1, 1936.

Associate Committee on Radiology

Co-operating organizations:

Canadian Medical Association
Canadian Universities, Hospitals and Cancer Clinics
Provincial Departments of Health
Radiological Society of North America
Société Canadienne-Française d'Électrologie et de Radiologie Médicales

The committee continued its efforts to provide facilities in Canada for modern methods of dosage control in radiation treatment of cancer and other diseases, and to promote research on the related problems. It has been guided in this purpose by the realization that radiotherapy has been greatly handicapped in the past by unsatisfactory equipment and control, and by the conviction that radiotherapy will prove much more effective when these difficulties are overcome. It has carefully considered these problems and drawn up a program of the most urgent research projects. Only a modest beginning has been possible on this program with the funds at the committee's disposal; one investigation in the University of Manitoba in addition to the work in the National Research Council Laboratory is described under the heading "Radium and X-rays" on page 67.

The committee has been active also in collecting technical information on these problems and other radiological topics and publishing them in a series of bulletins for the information of radiologists. Many requests have been received for the bulletins thus far published. It is placing instruments at suitable centres for testing clinical X-ray equipment. Its activities have been made possible by the ready co-operation of provincial health departments and university departments.

Associate Committee on Survey Research

Co-operating organizations:

Dominion Department of the Interior
Dominion Department of Marine
Dominion Department of Mines
Dominion Department of National Defence

No general meeting of the associate committee was held during the year under review, but, through the efforts of the executive and subcommittees, progress was made in the various investigations and problems affecting survey work.

Work has continued during the year on the design and construction of instrumental plotters. The Subcommittee on Mapping Methods has nearly completed the design for a stereogoniometer plotter, and the Imperial Oil Company have intimated that they will be willing to provide funds for its construction. Experiments are now under way with the high oblique plotter constructed in the workshops of the National Research Council, and a radial stereoplotter is now nearing completion.

Plotting by the Zeiss Company of a strip of air photographs by the use of a multiple aeroprojector was considered so satisfactory that a set of the apparatus has been acquired by the Department of National Defence.

Consideration was given to a proposal for transferring detail from air photographs to maps by the use of a stereoscope, and also to the design of an instrument for mechanically converting polar into Cartesian co-ordinates, but its construction was not undertaken, as it was not applicable to present work.

Further work was done on camera mounts. A new multi-oblique mount was constructed and tried out in a Bellanca aircraft. The final adjustments and calibration were carried out in the National Research Laboratories, and the calibration was checked by field photography. Two similar mounts for installation in Fairchild and Super 71 aircraft will be constructed. A new type of mount for vertical air photography has been built for use in correcting for changes which occur in fore and aft altitude during flight. The design is such that the verticality of the camera axis is not disturbed by the camera rotation introduced to eliminate crab.

Types of air cameras have been further considered. The committee is investigating the merits of the Zeiss air camera equipped with a Topogon lens for wide-angled single lens air photography. Further experimental work with infra-red emulsion indicated that superior results might be obtained by employing a special camera fitted with a fast narrow-angled lens set at the principal distance for infra-red rays. It was felt, however, that wide-angled lenses were more economical. This work will be continued.

Interpretation of forest species by air photography is of considerable interest. The steep oblique air photograph usually used for this purpose, however, shows the trees slightly more in elevation than is desirable. Further, the apparent horizon lies outside the angular field of the camera lens, and the resulting photograph contains no record that will serve to establish the position of the plate plumb point. The Forest Service suggested the use of a mirror attached to the air camera for projecting the image of the apparent horizon through the lens to form a record on the oblique photograph, and consideration is being given to this proposal.

Test work on filters has been carried out in the National Research Laboratories to determine the percentage transmission of the different wavelengths for each filter. Experiments were also carried out in infra-red air photography. Three rolls of infra-red emulsion on film base were exposed. A noticeable increase in speed over that of the 1934 product was observed, but the panchromatic film was found preferable. In view of the possible value of color photographs of forests, some experimental air exposures were made using supersensitive panchromatic film in conjunction with certain green filters. This work is being continued.

An experimental model of an auxiliary camera for recording the readings of certain instruments in the aircraft at the instant of exposure of the main camera has been constructed in the workshops of the National Research Council and is now undergoing tests.

Further progress has been made in the improvement of the altigraph by which the altitude at each exposure of the camera is automatically recorded on a chart.

A large comparator has been secured and is being used regularly in making measurements required for testing the shrinkage and distortion of new films and photographic papers.

Associate Committee on Trail Smelter Smoke

Co-operating organization:

Dominion Department of Agriculture

Following instructions received from the Department of External Affairs, the Council has throughout the year conducted observations of conditions in the Northport area of the State of Washington, and has maintained automatic recorders to determine at critical points the sulphur dioxide content of the atmosphere. Extensive fumigation experiments have also been conducted at the Summerland Experimental Station of the Dominion Department of Agriculture, in order that the effect on vegetation of various concentrations of sulphur dioxide in the atmosphere might be accurately determined under carefully controlled circumstances. The results of all this work are being incorporated in confidential reports to the Dominion government.

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

No general meeting of the committee was held during the year under review, but reports upon work carried out in that period were presented at a meeting held in Ottawa on June 17, 1936, under the chairmanship of Dr. Oskar Klotz.

At this meeting special consideration was given to the possibility of completing certain of the investigations in the near future or of securing support for them from other sources. It has been found possible to reduce substantially the financial requirements of the investigations, but the committee is fully convinced that the progress made is such as to warrant further experiments over a period of some years. The work will continue to be subjected to the strictest possible control and the results will be carefully analyzed with a view to ensuring that they are on a sound statistical basis.

Tuberculosis Research of the Dominion Department of Agriculture

A report was presented covering tuberculosis research carried out by the department's Health of Animals Branch. A comprehensive study has been made of the nature of the so-called skin lesions of tuberculosis of cattle. It is hoped to determine the relation between acid-fast bacilli found in skin lesions, on the one hand, and true tubercle bacilli and the large group of acid-fast soil bacteria on the other. The ability of certain bacilli to call forth the tuberculin reaction, and the significance of skin lesions in the practical control of bovine tuberculosis will also be investigated.

It is hoped that the isolation and preparation of the active principles of acid-fast bacteria related to those of tuberculosis can be accomplished. If so, much fundamental information will be available which may be found useful in a wide field.

(Investigation under the direction of Dr. E. A. Watson.)

Tuberculosis Research at the Qu'Appelle Indian Health Unit

The work of the Qu'Appelle Indian Health Unit on tuberculosis has been supported financially by the Department of Indian Affairs, the Saskatchewan Anti-tuberculosis League and the National Research Council. It has included a general campaign for the control of tuberculosis among the Indians and a thorough trial of B.C.G. (Bacillus Calmette-Guérin), the latter a project of particular interest to the committee.

Tuberculosis has been found to respond to the segregation of spreaders of the disease on the Indian reserves as readily as when applied to white communities. From the rather limited statistics available it appears that the present mortality from tuberculosis among the Indians of the unit is only about one-half that of the Indians of the whole province of Saskatchewan. Such a result is very gratifying, although the death rate is still much above that of the neighboring white communities.

Vaccination with the B.C.G. was begun in 1933, on the recommendation of the Associate Committee on Tuberculosis. The committee considers that the opportunity for a scientific test of B.C.G. in the Indian Health Unit is unique, in that the Indian race is unusually susceptible to tuberculosis, the situation in the Qu'Appelle Indian Health Unit is such that vaccinated and control groups are exactly alike, and it is possible to secure post-mortem examinations and thus definitely determine the cause of those deaths which occur. A period of some years will be required to determine what degree of resistance is conferred by B.C.G.

(Investigation under the direction of Dr. R. G. Ferguson.)

Tuberculosis Research at Queen's University

At the 1934 meeting of research directors it was suggested that complement fixation reactions should be carried out on sera from Indian children in the Qu'Appelle Indian Health Unit and from University of Alberta cattle, which, though vaccinated, had failed to react to tuberculin. The sera from 11 vaccinated children were tested and positive results were obtained in each case. The sera from 49 vaccinated cattle, on the other hand, gave negative reactions. In both cases these results checked closely with those of the tuberculin tests.

(Investigation under the direction of Dr. G. B. Reed.)

Tuberculosis Research at the University of Alberta

The large-scale experiments in the vaccination of cattle which have been under way for some years are now being completed. B.C.G. has been found entirely innocuous to cattle. Exposure of vaccinated cattle to virulent tuberculosis has shown that vaccination confers a substantial degree of resistance, but not complete immunity to tuberculosis. There still remain for completion histological studies of vaccinated cattle which had been exposed to tuberculosis and subsequently slaughtered, and also observations on a small group of vaccinated animals in a tuberculous herd. An effort is also being made to eliminate tuberculosis from two tuberculous herds by the vaccination of all animals introduced into these herds. Good progress is being made but it is still uncertain whether tuberculosis can be completely eliminated by vaccination alone.

(Investigation under the direction of Dr. A. C. Rankin.)

Tuberculosis Research at the University of Montreal

Ten years have now elapsed since work was begun at Montreal on the vaccination of new-born babies with B.C.G., and a total of 8452 children have been vaccinated. During the past year, as previously, vaccination has been found completely innocuous to children.

Unfortunately, it has not been possible to follow up all the vaccinated children, but a special study has been made of 330 vaccinated children living in contact with open cases of tuberculosis, and thus most liable to contract the disease, as well as of 560 unvaccinated controls living under similar conditions. Careful observations have also been made of a large number of cases in which vaccinated and unvaccinated children have been living together in homes in which there were persons suffering from tuberculosis. The death rate from tuberculosis amongst the vaccinated children was found to be less than half that in a similar unvaccinated group. Vaccination also reduced to some extent the number of deaths from other causes than tuberculosis and the amount of illness amongst children. These results are regarded by the committee as most encouraging, and arrangements are being made for even closer supervision of the vaccinated children and a careful statistical analysis of the results obtained.

(Investigation under the direction of Dr. J. A. Baudouin.)

All the B.C.G. vaccine used in experiments sponsored by the committee is being made at the University of Montreal under the most rigorously controlled conditions. The technique of the Pasteur Institute of Paris, where the vaccine was first developed, is being closely followed. All the vaccine produced is tested by inoculation into guinea pigs, and it is now possible to state definitely that B.C.G. does not produce progressive tuberculosis in these animals even when administered in doses as large as 10 to 20 mg. A study is now being made of the degree of resistance conferred on guinea pigs by repeated vaccinations and on the sensitivity to tuberculin of animals vaccinated with large and repeated doses of B.C.G.

(Investigation under the direction of Dr. J. A. Frappier.)

Tuberculosis Research at the University of Toronto

In this work, which is not now being supported financially by the committee, an attempt has been made to develop cultural methods to supplant the use of guinea pigs for primary isolations. The results have been very encouraging, and it is now proposed to dispense with guinea pigs for ordinary cases, and to limit their use to those cases in which a special check is desired.

(Investigation under the direction of Dr. Oskar Klotz.)

SPECIAL COMMITTEES

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service, Department of Trade and Commerce

The Specifications for Type Approval of the various electricity-measuring devices have now been in force for several years and have been favorably received by both manufacturers and utilities. Requests for the specifications have been received from various countries throughout the world. A few very minor changes have been suggested and are being considered at the present time. If these changes are made and prove satisfactory to all concerned, it is expected that it will be possible very shortly to consider having the specifications printed in final form.

Special Committee on Hydraulic Research

Co-operating organizations:

Dominion Department of the Interior (Water Power and Hydrometric Bureau)

Dominion Department of Marine

Dominion Department of Public Works

Dominion Department of Railways and Canals

In November, 1935, the National Research Council authorized the appointment of a Special Committee on Hydraulic Research. The function of the committee is to consider the requirements of the several departments of the Dominion government and of industry in respect to the provision of laboratory facilities for research and testing in connection with stream flow, power development, harbor works, river control, canals and channels, hydraulic machinery and equipment, etc., and having regard to existing facilities at the Rideau Falls and to the modifications which can be made without undue expenditure, to specify the facilities which the committee recommends should be made available.

The committee's first work has been a survey of the needs of all interested parties with respect to hydraulic laboratory facilities. A large number of organizations outside the Dominion government departments have been communicated with, consisting principally of hydroelectric companies, existing hydraulic laboratories and departments of the provincial governments. In addition to this, the needs of the Dominion government departments, represented on the committee, have been reviewed.

Upon completion of the survey of what is required in the way of hydraulic laboratory facilities, the committee has taken up the study of how these facilities may best be provided. There exists at Ottawa, on the property of the National Research Laboratories, a location which is unique insofar as its suitability for an hydraulic laboratory is concerned. Here the Rideau River flows into the Ottawa River at the Rideau Falls, a drop of some thirty feet, providing, in addition to a splendid natural water supply, a source of hydroelectric power. There are also some mill buildings on the site, so that many of the essentials for a laboratory are already available. The committee is studying the technical questions involved to see how best to provide the laboratory facilities, which are required, by utilizing the advantages which exist.

Canadian Government Purchasing Standards Committee

Two years ago in connection with the work of the Royal Commission on Price Spreads the National Research Council made inquiries in various government departments as to the extent to which use was made of standard specifications in the placing of orders for supplies. Specifications that were in use were also examined with a view to determining how effective they were for the purpose intended. Following this a meeting of representatives of government departments was held on May 31, 1934, and consideration was given to the proposal that an inter-departmental committee be formed for the purpose of preparing commodity specifications suitable for use by any departments concerned. In sponsoring this committee the National Research Council was implementing the clause in its own act empowering it to prepare specifications for the materials used on government undertakings or consumed by departments for their own needs. It was considered that a co-operative committee in which all departments would have equal status, but on a purely voluntary basis, would be the most effective way of accomplishing this end.

As a result of this conference the Canadian Government Purchasing Standards Committee was formed and it has been functioning actively since that time. Subcommittees in existence during the fiscal year have dealt with the following topics:

Paint and Pigment Specifications; Soap and Detergent Specifications; Lubricant and Liquid Fuel Specifications; Textile Specifications; Leather Specifications; Stationery Forms; Editorial Practice; Standard Testing Sieves; Paper Quality; Refractories Specifications; Wood Preservation.

The main committee has held two meetings, the recommendations of the subcommittees latterly having been submitted for formal approval by letter ballot. Specifications promulgated during the fiscal year numbered 31, and to the end of the fiscal year some 3,000 copies in all of specifications were distributed. Although no attempt has been made to publicize the issue of specifications, a considerable number have been supplied upon request to firms and individuals, including not only those interested in government business but also others desirous of making use of the specifications in their own purchases.

The subcommittees on paints, soaps and lubricants have accomplished considerable work. The Subcommittee on Stationery Forms has made some progress although it has been inactive in recent months. Much remains to be done by the subcommittees on paints, textiles and leather.

The Subcommittee on Editorial Practice, which is engaged in the preparation of a government style book, has prosecuted its work actively during the past year and review of the first draft of the proposed publication is now practically complete.

The Subcommittee on Standard Testing Sieves will soon be in a position to make its final recommendation. As there has been no Canadian standard testing sieve series in the past, it is believed that the Government standard will prove to be of considerable use to industry in addition to fulfilling the requirements of government departments.

The Subcommittee on Paper Quality is concerned primarily with the problem of aging bond papers for documentary purposes. After some initial delay, it is now endeavoring to lay the basis for concerted investigation of the factors affecting this quality. In the past the paper industry has paid

little attention to this feature of its product and it is considered that the subcommittee has an opportunity to make a substantial contribution to the general problem.

The Subcommittee on Refractories Specifications has made considerable progress, but future specifications must be predicated upon laboratory investigations. The latter are at present under way.

A number of new projects have been suggested for the committee and it is expected that the necessary subcommittees and panels will be created in the near future. A feature of the work of all the subcommittees has been the wholehearted co-operation of technical officers from all the departments concerned.

British Commonwealth Scientific Conference Preparatory Committee

Following the Imperial Conference held in Canada in 1932, Dr. O. D. Skelton, Under-Secretary of State for External Affairs, was appointed chairman of an Imperial Committee on Economic Consultation and Co-operation "to consider the means of facilitating economic consultation and co-operation between the several governments of the Commonwealth, etc."

A recommendation made in the report of this committee provided that the question of what research activities should in future be carried out co-operatively, should be considered at a conference consisting partly of the administrative and scientific heads of national research organizations and departments, and partly of such other persons as the several governments might select. Following an exchange of correspondence between the Secretary of State for Dominion Affairs in London and the Department of External Affairs at Ottawa, tentative arrangements were made for the holding of a British Commonwealth Scientific Conference in London in 1935, but, as it was found impossible to carry out this plan, the meeting was postponed until 1936. It is now to be held in London, beginning September 21, 1936.

In order to provide for a satisfactory review of the problems to be considered at the conference, a preparatory committee was established under the chairmanship of Major-General A. G. L. McNaughton, President of the National Research Council, and several meetings were held towards the end of the year. As a result of these meetings, plans have been prepared for the guidance of the Canadian delegation.

Briefly, it is proposed to discuss the topics arising out of the Skelton Committee Report and the reports of the Council of the Imperial Agricultural Bureaux with reference to the present status, future financial support, plan of direction, and possible extension of usefulness of the Agricultural Bureaux and the Institutes of Entomology and Mycology. There will also be discussions regarding the time of meetings of these institutes and the nature of the agenda for them. It is hoped also that an opportunity will be afforded for the discussion of the standardization of the services provided, the distribution of literature regarding the work, co-operation between existing laboratories in the exchange of information and staff, and the maintenance of contacts with industrial research associations.

At the close of the year it appeared probable that four delegates would be sent from Canada, including two from the National Research Council and two from the Department of Agriculture.

A Subcommittee on Nutrition was established by the preparatory committee under the chairmanship of Dr. Wodehouse, Deputy Minister, Department of Pensions and National Health, and with members drawn

from the Departments of Agriculture, External Affairs and Labor, the Dominion Bureau of Statistics and the National Research Council, with Mr. S. J. Cook as secretary.

This subcommittee was appointed to collect the available information on nutrition in respect to health in Canada. The reasons for the establishment of the subcommittee were that a request had been received through the Department of External Affairs from the League of Nations for information on this subject, and also that it was thought the topic might be discussed at the scientific conference in London in September, and that, in this event, the Canadian delegation should be informed regarding the situation in the Dominion.

Holdover Committee of the Fifth Pacific Science Congress

No decision has yet been reached regarding the place of meeting of the Sixth Pacific Science Congress. A letter was dispatched to the members of the Holdover Committee on March 7, 1936, with a memorandum in which it was pointed out that a definite invitation had been received from Fiji for the Association to hold its next meeting in that country in 1937, and that a letter had been received from Hawaii indicating that the congress might be held in that territory if the officers of the Association so desired.

An expression of opinion was requested as to both the time and place at which the next congress should be held. Members of the committee were asked to forward their views promptly in order that a decision might be reached, but at the close of the fiscal year the returns from the several countries were still incomplete.

CONFERENCES

Conference on Forestry Research

In July 1935, the Woodlands Section of the Canadian Pulp and Paper Association and the Canadian Society of Forest Engineers held their annual joint meeting at the Petawawa Forest Experimental Station of the Dominion Forest Service, and among their guests were members of the Lumbermen's Association, of the several forest protective associations, and of the provincial forest services. There were also present a number of officers of the Department of National Defence who were concerned in the conduct of the operations on the forestry reserves which had been developed as a means to employ, in a manner non-competitive with industry, the labor of many thousands of men otherwise idle and unemployed. Use of these reserves resulted in the establishment of a great chain of forest experimental stations from the Atlantic to the Pacific.

It was the consensus of opinion of the gathering at Petawawa that a useful purpose would be served through the holding of a conference to consider the problems of forestry research.

Immediately after the summer meeting at Petawawa these considerations were brought formally to the attention of the National Research Council, which was invited to take the initiative in the matter. The suggestion was approved by Council; a preparatory committee was set up, invitations were issued, and basic papers to serve as an introduction to the several aspects of the matter were arranged.

The conference was held in Ottawa on November 26–27, 1935.

Comprehensively representative of all the interests concerned, the conference included delegates from the Dominion and provincial forest services, divisions of botany, plant pathology, and entomology, of the Dominion Department of Agriculture, university departments of forestry, pulp and paper manufacturers, lumbermen's associations, fire protective organizations, societies of forest engineers, and the Canadian Forestry Association.

The conference was opened by the Hon. W. D. Euler, Minister of Trade and Commerce, in an address in which he stressed the importance of the forest industries and forest research in the economic development of Canada. Further official recognition was given at a luncheon tendered by the National Research Council to the delegates on the first day of the conference, when the Hon. T. A. Crerar, Minister of the Interior, discussed the importance to Canada of the wood-using industries and advocated the adoption of a sound forest conservation policy which should take account of proper forestry methods and measures for the prevention of damage by fire, insects, fungi, and destructive lumbering.

The technical papers read at the several sessions provided a cross-section of opinion on problems relating to forest research in Canada and methods which, in the opinion of the speakers, ought to be followed in seeking solutions for the numerous problems.

A special committee, appointed by the conference to summarize the results of the discussion, recommended that the National Research Council be asked to establish an Associate Committee on Forestry in order to provide a permanent organization representative of the government, industrial, technical, and educational interests concerned in the promotion of forestry in all its branches. The committee suggested names for consideration in the choice of personnel of the associate committee.

The report of the conference was considered by the National Research Council at a meeting on January 31, 1936, and the formation of an Associate Committee on Forestry was approved.

Towards the close of the year arrangements were made for the committee to hold its first meeting in April, 1936.

Conference on Fresh Water Fish Culture

On several occasions the National Research Council has been asked to assist in the promotion of research relating to the conservation and development of the fresh water fisheries in Canada, and consideration has been given to certain specific problems. During the year representatives of the Department of Fisheries, the Biological Board and the National Research Council discussed the problems involved and decided to arrange for a conference of those especially interested in this field of work.

Subsequently the necessary arrangements were made and a conference was held in Ottawa on January 3, 1936. The conference was opened by the Hon. J. E. Michaud, Minister of Fisheries. The purpose of this meeting was to obtain a comprehensive view of the problems of fresh water fish culture as presented in the several provinces, to interchange information, and to consider how best, and by whom, the further research required should be carried out.

Prior to the meeting, representative authorities on each of the several branches of fisheries research were invited to prepare statements which would

serve as a basis for discussion at the conference. More than fifty persons, representing practically every province in Canada, were present at the meeting.

At the concluding session, the views of the members were summarized in a series of resolutions, one of which provided for the establishment of a permanent committee to be known as the National Committee on Fish Culture. The duties of this committee were defined as follows:—

1. To act as a clearing house for information and suggestions regarding every branch of fish culture.
2. To promote the co-ordination and development of research and fish cultural technique, to consider what researches ought to be undertaken and to recommend accordingly.
3. To advise such other action in respect to the science and technology of fish culture as may be deemed desirable.

The composition of the National Committee was defined to include one representative from each of the following organizations:—

National Research Council; Biological Board of Canada; Dominion Department of Fisheries; Canadian Travel Bureau; National Parks Branch; each provincial government; Canadian Pacific Railway Company; Canadian National Railways.

The Hon. J. E. Michaud, in his capacity as Minister of Fisheries, extended invitations to all these organizations to nominate their representatives, and at the close of the year the committee was in process of formation.

SUMMARY OF REPORTS ON ASSISTED RESEARCHES

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.

A list of researches in progress during 1935-1936 under associate committees and under grants in aid of research is given in Appendix B, page 128. A list of additional researches carried out in previous years is found in Appendix C, page 130.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 73.

Soil Investigations in Quebec

Co-operating organization:

Macdonald College

A study has been made of the water-soluble organic materials that are removable from the raw humus layers of representative Quebec podsol soils. Mannitol has been isolated in appreciable quantity from all the soils investigated. Because of its high content of hydroxyl groups, this compound is regarded as being significant in soil leaching processes. At present the highly acid definite fraction, free from ash materials, which remains after extraction of mannitol, is being studied. The titration curve of this material indicates the probable presence of free acids. The procedure now being followed is methylation (1) by dimethyl sulphate, (2) by diazomethane, and the separation of the resultant methyl esters by fractional distillation.

(Investigation under the direction of Dr. R. R. McKibbin, Macdonald College, McGill University.)

The Development of the Apple

Co-operating organizations:

Dalhousie University

Kentville Experimental Station

The problem of tracing the development of the apple from the bud to the full fruit is fundamental to a thorough understanding of the many obscure phenomena observed. Such work has been done in England and the United States but has not previously been undertaken in Nova Scotia.

The problem has been divided into four main divisions:—

(1) Life history of the apple with special attention to the time of differentiation of the fruit bud.
(2) Development of the protective layers of the apple.
(3) The nature of russetting, with reference to sprays in the apple.
(4) Technique for sectioning winter buds of the apple.

Through the courtesy of the Laboratory of Plant Pathology at Kentville about 300 collections have been made of apple buds and fruit. The material was killed and then preserved in alcohol for at least two months, this period

being found necessary for successful cutting. It was then embedded in paraffin wax and about 600 microscopic slides were prepared. Special technique was found necessary for the winter buds, owing to the large quantity of hairs surrounding the flowers.

The first growth of McIntosh Red flowers was found to be differentiated on June 8 of the year preceding the bloom. The differentiation of the bud occurs nearly a month earlier in Nova Scotia than in England and the United States.

Several papers are now in preparation covering the results of this work.

(Investigation under the direction of Dr. H. P. Bell, Dalhousie University.)

Frost Resistance in Plants

This problem, one of particular interest to Canada, relates to the mechanism by which plants are able to resist frost. It is hoped that the investigation will result in the development of easy methods for testing hardiness and a better understanding of those cultural conditions which enable plants to resist frost.

Work has been concentrated upon the hardiest types of plants and a study of living cells rather than extracted juices. Two important changes taking place in the living protoplasm during the process of hardening have been discovered, and the probable role of these factors in frost resistance has been considered. It has also been ascertained that in very hardy plants a great increase of hydrophilic colloid takes place in the vacuole, which has been shown to be of great importance. Other supposed changes have been investigated, some with positive and some with negative results. The whole study is being made the basis of a theory of frost resistance. Several papers are in preparation describing the results obtained.

(Investigation under the direction of Dr. G. W. Scarth.)

APPENDICES

APPENDIX A

29 Scholarships Held During the Year 1935-1936

Fellowships

Grantee	Graduated	Where Held	Subject of Research
O. K. Johannson.....	B.A., M.A., University of Saskatchewan.	Department of Physical Chemistry, McGill University, Montreal, Que.	Densities of several gases at different temperatures and pressures.
F. C. MacIntosh.....	B.A., M.A., Dalhousie University.	Department of Physiology, McGill University, Montreal, Que.	Chemical stimulants of gastric secretions.

Studentships

Grantee	Graduated	Where Held	Subject of Research
A. Cohen.....	B.Sc., McGill University.	Department of Zoology, McGill University, Montreal, Que.	Morphogenesis during development and regeneration.
A. L. Geddes.....	B.Sc., M.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of pressure, volume and temperature relations in one component system near the critical temperature.
T. J. G. Henry.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Physics, McGill University, Montreal, Que.	The absorption of light in excited hydrogen.
D. G. Hurst.....	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Study of the optical absorption by the alkali metals in the Schumann region.
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.
Ralph G. D. Moore.....	B.A., M.A., University of British Columbia.	Department of Organic Chemistry, McGill University, Montreal, Que.	Constitution of lignin.
G. N. Patterson.....	B.Sc., University of Alberta; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Photographic method of studying viscosity effects in the transition region between a laminar and a turbulent flow.
S. Rosenberg.....	B.Sc., M.Sc., McGill University.	Department of Chemistry, McGill University, Montreal, Que.	The kinetics of the thermal decomposition of di-ethyl ether at high pressures, and other gas reactions.
D. M. Young.....	B.Sc., McGill University.	Department of Organic Chemistry, McGill University, Montreal, Que.	Dipyrrols.

Bursaries

Grantee	Graduated	Where Held	Subject of Research
Alan Bell.....	B.A., M.A., University of British Columbia.	Department of Organic Chemistry, McGill University, Montreal, Que.	Structure of lignin.
A. G. Brown.....	B.Sc., University of Saskatchewan.	Department of Physical Chemistry, McGill University, Montreal, Que.	The photokinetics of the bromine sensitized decomposition of chlorine monoxide.
R. A. Findlay.....	B.A., M.A., University of British Columbia.	Department of Physical Chemistry, McGill University, Montreal, Que.	The thermal conductivities of cellulose materials.
P. A. Giguere.....	B.A., L.Sc. and Chemist, Laval University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of the properties of pure hydrogen peroxide.
C. A. Herald.....	B.Sc., Dalhousie University.	Department of Physics, University of Toronto, Toronto, Ont.	Zeeman effect of the hyperfine structure of bismuth and thallium.

BURSARIES—(Concluded)

Grantee	Graduated	Where Held	Subject of Research
J. F. Hinds	B.A., Queen's University.	Department of Physics, Queen's University, Kingston, Ont.	The radiations of radium D and radium E.
Miss A. C. Howard	B.Sc., McGill University.	Department of Genetics, McGill University, Montreal, Que.	Cytological effects of X-ray and other agencies on Trillium erectum, also work on mice.
M. W. Johns	B.A., M.A., McMaster University.	Department of Physics, University of Toronto, Toronto, Ont.	A frequency analysis of the high spark spectra of mercury (Hg. III and IV).
J. Levitt	B.Sc., M.Sc., McGill University.	Department of Botany, McGill University, Montreal, Que.	Cellular changes associated with the winter hardiness of plants.
J. Marsden	B.Sc., Mount Allison University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Discontinuity of state at the critical temperature.
A. D. Misener	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Superconductivity of thin metallic films.
A. Nadeau	B.A., M.A., B.Sc., M.Sc., Laval University.	Department of Biochemistry, Laval University, Quebec, Que.	The study of amylolytic enzymes of maple sap.
H. H. Penley	B.Sc., M.Sc., University of Saskatchewan.	Department of Physics, Queen's University, Kingston, Ont.	The 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 fields on the helium spectrum.
H. Rudoff	B.Sc., McGill University.	Department of Chemistry, McGill University, Montreal, Que.	Cyclopentenolones.
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 solution.
L. Walker	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The construction of a high frequency magnetic resonance accelerator for positive lens.
A. Wilson	B.Sc., Dalhousie University.	Department of Physics, Dalhousie University, Halifax, N.S.	Specific heats of metals.

APPENDIX B

Researches in Progress During 1935-1936 Under Associate Committees and Under Grants in Aid of Research

Subject of Research	Directed by	Co-operating Organizations
The utilization of Canadian high magnesium dolomite	Associate Committee on Magnesian Products	Canadian Refractories, Ltd.; Dominion Department of Mines.
Damage caused by smoke fumes from the Trail smelters	Associate Committee on Trail Smelter Smoke	Dominion Department of Agriculture.
Problems of the grain industry.....	Associate Committee on Grain Research of the National Research Council and the Dominion Department of Agriculture.	Board of Grain Commissioners for Canada; McGill University; University of Alberta; University of Manitoba; University of Saskatchewan.
Tuberculosis in man and animals...	Associate Committee on Tuberculosis	Dominion Department of Agriculture; Qu'Appelle Indian Health Unit; Queen Alexandra Sanatorium; Queen's University; University of Alberta; University of Montreal; University of Toronto.
Problems of the wool industry.....	Associate Committee on Wool of the National Research Council and the Dominion Department of Agriculture	Canadian Co-operative Wool Growers, Ltd.; Canadian Woollen and Knit Goods Manufacturers' Association; Ontario Research Foundation; University of Alberta; University of Saskatchewan; Wool Industries Research Association (Great Britain).
Chemical control of weeds.....	Associate Committee on Weeds of the Dominion Department of Agriculture and the National Research Council	Alberta Department of Agriculture; British Columbia Department of Agriculture; Manitoba Department of Agriculture; Saskatchewan Department of Agriculture; University of Alberta; University of Manitoba; University of Saskatchewan.
Animal parasites.....	Associate Committee on Parasitology	Dominion Department of Agriculture; Imperial Bureau of Agricultural Parasitology; McGill University; Ontario Department of Agriculture; Quebec Department of Agriculture;
Engineering standardization.....	Associate Committee on Engineering Standards	
Foot- and root-rot diseases of crop plants	Associate Committee on Field Crop Diseases of the National Research Council and the Dominion Department of Agriculture.	Board of Grain Commissioners of Canada; University of Alberta; University of Manitoba; University of Saskatchewan.
Measurements and tests on radio receivers	Associate Committee on Radio Research	Canadian Marconi Company; Canadian Radio Broadcasting Commission; Dominion Department of Marine; Northern Electric Company.
Standardization of classification and analysis of coal	Associate Committee on Coal Classification and Analysis	Alberta Department of Mines; Alberta Research Council; American Society for Testing Materials; Sectional Committee on the Classification of Coal; Dominion Department of Mines;
Natural gas.....	Associate Committee on Gas Research	Alberta Research Council; Dominion Department of Mines; University of Alberta.
Aircraft instruments.....	Associate Committee on Aeronautical Research	Armstrong-Siddeley Motors, Ltd.; Canadian Airways, Ltd.; Canadian Pratt and Whitney, Ltd.; Canadian Vickers, Ltd.; Dominion Department of Marine; Dominion Department of National Defence; Fairchild Aircraft, Ltd.; Imperial Oil, Ltd.

Subject of Research	Directed by	Co-operating Organizations
Investigations in the field of medical radiology	Associate Committee on Radiology	Canadian Medical Association; Canadian Universities, Hospitals and Cancer Clinics; Provincial Departments of Health; Radiological Society of North America; Société Canadienne-Française d'Electrologie et de Radiologie Médicales.
Cold storage problems.....	Associate Committee on Storage and Transport of Food of the National Research Council and the Dominion Department of Agriculture	
Development of improved methods and instruments for use in survey work	Associate Committee on Survey Research	Dominion Department of the Interior; Dominion Department of Marine; Dominion Department of Mines; Dominion Department of National Defence.
The action of alkali on cement and concrete	Prof. T. Thorvaldson.....	Department of Chemistry, University of Saskatchewan.
Ultra-violet spectroscopy with vacuum grating spectrograph	Dr. R. J. Lang and Prof. S. Smith	Department of Physics, University of Alberta.
Mineral deficiency of Quebec soils...	Dr. R. R. McKibbin.....	Department of Chemistry, Macdonald College.
Ripening of cheese.....	Dr. Blythe Eagles.....	Department of Dairying, University of British Columbia.
Removal of cataract by an injection into the crystalline lens	Dr. H. C. Connell.....	Connell Research Laboratory, Queen's University.
Publication of a catalogue of fungi..	Dr. J. Dearness.....	
Preparation of the general bathymetric chart of the oceans	Dr. T. W. Vaughan.....	
Development of the apple in Nova Scotia	Prof. H. P. Bell.....	Botanical Laboratories, Dalhousie University.
Frost killing and frost resistance in plants	Prof. G. W. Scarth.....	Botanical Laboratory, McGill University.
Study of motion of air in horns of different shapes	Prof. E. F. Burton.....	Department of Physics, University of Toronto.
Plant resources in eastern Canada...	Prof. Marie-Victorin.....	Department of Botany, University of Montreal.
Investigation of the persistence of the liquid state above the critical temperature	Dr. O. Maass.....	Department of Chemistry, McGill University.
Publication of a catalogue of scientific periodicals in the libraries of the Maritime Provinces	Nova Scotia Institute of Science.	

APPENDIX C

Additional Researches Carried Out in Previous Years

Subject of Research	Grantee
Artificial propagation of the sturgeon	Associate Biological Committee.
Destruction of wood piling by marine boring animals	Associate Biological Committee.
Best methods for obtaining accurate results in testing varieties, strains and treatments of grain	Associate Committee on Accurate Plot Work.
Diseases of animals	Associate Committee on Animal Diseases.
The problem of slack barrels in apple exports	Associate Committee on Apple Slacks.
Vitamines	Associate Committee on Food Research.
Storage of fruit in warehouses	Associate Committee on Fruit.
Heating and insulation of buildings	Associate Committee on Heating and Insulation.
Investigation on the utilization of the resources of helium in Canada	Associate Committee on Helium.
Problems of industrial fatigue	Associate Committee on Industrial Fatigue.
Utilization of Canadian iron ores	Associate Committee on Iron Ores.
Reforestation experiments on cut-over and burnt-over lands	Associate Committee on New Brunswick Forest Problems.
The influence of diet on the fur and health of captive foxes	Associate Committee on Nutritional Problems of the Fox Industry.
Investigations in connection with the total eclipse of the sun in 1932	Associate Committee on Radio.
Health hazards in spray painting	Associate Committee on Spray Painting.
Design and construction of apparatus for interpreting print, by touch, through the medium of the photoelectric cell	Dr. Frank Allen.
Nervous actions underlying color vision and all sensory activities	Dr. Frank Allen.
Adhesion of ice to various surfaces of aeroplane structure	Dr. H. T. Barnes.
Earth's nocturnal radiation in relation to weather	Dr. H. T. Barnes.
Structure and growth of anchor ice	Dr. H. T. Barnes.
The marine algae of the Canadian Atlantic coast	Prof. H. P. Bell.
The preparation (production) of metallic barium	Prof. H. E. Bigelow.
Chlorination of methane gas	Prof. M. C. Boswell.
The action of ultra-violet rays	Prof. L. Bourgoin.
Ultrasonics (inaudible sound waves)	Dr. R. W. Boyle.
Fungi	Dr. A. H. R. Buller.
Higher fungi	Dr. A. H. R. Buller.
Development of a rapid electrical method of determining moisture in grain, timber, etc.	Prof. E. F. Burton.
Sound analysis of carillon on Peace Tower	Prof. E. F. Burton.
Life history and habits of the Tabanidae (horsefly)	Prof. A. E. Cameron.
Glucosides of plants indigenous to western Canada	Prof. A. T. Cameron.
Measurement of the Joule effect of hydrogen, carbon dioxide and other gases	Dr. A. L. Clark.
Cultivation of medicinal plants in British Columbia	Dr. R. H. Clark and Prof. J. Davidson.
Insulin-like substances in plants	Dr. J. B. Collip.
Study of the blood chemistry in animals with suprarenal glands removed	Dr. J. B. Collip.
De-tarring of gas by electrical precipitation	Dr. J. G. Davidson.
The extraction of benzene and toluene (valuable liquids) from coal gas	Dr. H. S. Davis.
The microscopic examination of cement during hardening	F. M. Dawson.
Indirect ultra-violet solar radiation and its distribution	Prof. R. C. Dearle.
Mineral constituents of the floral parts and young fruits of the apple	Prof. W. A. De Long.
The utilization of peat	Dominion Department of Mines.
Mistletoe, parasite on jackpine	Miss E. S. Dowding.
A method of smelting titaniferous iron ores	Drs. C. W. Drury and A. F. G. Cadenhead.
Investigation of the life history of the onion maggot	Prof. E. M. Du Porte.
Effects of certain reagents upon plants	Prof. R. O. Earl.
Effect of ultra-violet rays on eggs, chicks and laying hens	F. C. Elford.
Heights of Appleton and of Kennelly—Heaviside reflecting layers	Dr. A. S. Eve.
Magnetic susceptibility of the alkali metals	Dr. A. S. Eve.
Raman effect	Dr. A. S. Eve.
Oil from shales	Prof. A. E. Flynn.
Effects of electric and magnetic fields	Prof. J. S. Foster.
Stellar stark effects	Drs. J. S. Foster and A. V. Douglas.
1. Physical and chemical oceanography	Dr. C. McLean Fraser.
2. Marine biology	
3. Fish technology	
The treatment of silver-lead-zinc ores	Horace Freeman.
The biological origin of false wild oats	Prof. J. R. Fryer.
Experiments on the preparation of anthraquinone vat dyes	Dr. Paul E. Gagnon.
Cause of the reversed blood pressure of fowls	Prof. O. S. Gibbs.
Effects of velocity on re-absorption rates	Prof. O. S. Gibbs.
Investigations on gas and water content of trees	Prof. R. D. Gibbs.
Causation of cracks in concrete protective coating on iron and steel structures	Prof. P. Gillespie.

Subject of Research	Grantee
Cathode rays	Prof. J. A. Gray.
Investigation of Roentgen rays	Prof. J. A. Gray.
Microbiology of soil conditions in eastern Canada	Prof. P. H. H. Gray.
Generation of electricity using a windmill as the prime mover	Prof. A. R. Greig.
Bacteria found in frozen fish	Dr. F. C. Harrison.
The discoloration of canned lobster	Dr. F. C. Harrison.
The discoloration of cured codfish	Dr. F. C. Harrison.
The influence of acid in the soil on useful (nitrogen fixing) bacteria	Dr. F. C. Harrison.
Grinding ore in ball mills and rock crushing by rolls	Prof. H. E. T. Haultain.
Radium emanation	Drs. G. H. Henderson and D. A. McIntosh.
Barley *versus* corn as a food for poultry	Prof. M. C. Herner.
Action of bacteria and enzymes on carbohydrates and products resulting therefrom	Dr. H. Hibbert.
Bacillary white diarrhoea in poultry	Profs. H. W. Hill and E. A. Lloyd.
Nicotine from tobacco waste	Arthur D. Hone.
Water requirements of crops in western soils	E. S. Hopkins.
The bridging of the gap in the ether waves between those produced by the ultra-violet light and the so-called X-rays	Prof. A. L. Hughes.
Effect of radiant energy on protoplasm	Prof. A. H. Hutchinson.
Studies of life in the Pacific adjacent to the Fraser River	Prof. A. H. Hutchinson.
Chemical separation, identification and possible synthesis of antipressor substance from hepatic tissue	Dr. A. A. James.
Surface energy of solids	Prof. F. M. G. Johnson and Dr. O. Maass.
Pressure variation inside the cylinders of the internal combustion engine	Dr. D. A. Keys.
Relation of bacteria to incidence of feed flavors and stable odors in milk	Profs. H. M. King and W. Sadler.
Fog alarm research	Dr. L. V. King.
Fog signalling	Dr. L. V. King.
The food relations of certain minute organisms (Entomostraca) in the cultivation of fresh water fishes	Prof. A. B. Klugh.
The effect of light on life processes	Drs. A. B. Klugh and W. R. Sawyer.
Canadian waste sulphite liquor as a source of alcohol	Dr. V. K. Krieble.
Alberta tar sands	Dr. A. Lehmann.
The resistance of plants to low temperatures	Prof. J. F. Lewis.
Investigation of gas laws	Dr. O. Maass.
Unsaturated hydrocarbons as a source of chemical products	Dr. O. Maass.
The chemistry of fish curing	Dr. A. B. Macallum.
Chemical reactions at high pressures	Prof. J. C. McLennan.
Emission and absorption spectra in the infra-red and extreme ultra-violet regions	Prof. J. C. McLennan.
The properties and liquefaction of helium	Prof. J. C. McLennan.
Researches in the field of low temperatures	Prof. J. C. McLennan.
The spectrum of infra-red rays	Prof. J. C. McLennan.
The spectrum of the aurora and the light from the sky and its bearing on radio transmission	Prof. J. C. McLennan.
Study of short radio waves	Prof. J. C. McLennan.
Surface tension in liquids and emulsions	Prof. J. C. McLennan.
The active principle of yeast	Prof. W. L. Miller.
Investigation and preparation of yeast spores	Prof. W. L. Miller.
Power loss in dielectrics	Prof. H. J. MacLeod.
The effects of temperature and fatigue on the strength of castings	Prof. R. W. Moffatt.
Experimental study of precipitation of iron and silica	Dr. E. S. Moore.
Relation of silver ores to diabase	Dr. E. S. Moore.
Mechanical properties of metals at low temperatures	Profs. I. F. Morrison and A. E. Cameron.
The habits and life history of the smaller mammals of the prairies	F. Neave.
Utilization of milkweed	Dr. A. C. Neish.
Factors governing the milling and baking quality of wheat	Dr. R. Newton.
Winter hardiness in crop plants	Dr. R. Newton.
The life cycle of fish tapeworm	Dr. D. Nicholson.
Channel interference in wind channel testing	Prof. J. H. Parkin.
Designing and testing of a series of windmills for producing electric power on farms	Prof. J. H. Parkin.
Rotary derivatives of a boat type seaplane	Prof. J. H. Parkin.
Laws governing the screening of crushed ores	Dr. J. B. Porter.
The use of Canadian oils in ore concentration	Dr. J. B. Porter.
Wind tunnel automatic speed control equipment	Prof. H. W. Price.
Crystalline shapes of bicarbonate of soda	Prof. Paul Riou.
The inheritance of sugar and starch in Indian corn	Prof. H. F. Roberts.
Intensity measurements in spectra	Prof. J. K. Robertson.
The spectrum of tin	Prof. J. K. Robertson.
Interference in radio broadcast reception	Prof. T. R. Roseburgh.
The relation of bacteria to the quality of graded butter	Prof. W. Sadler.
Status of slough itch in Saskatchewan	Prof. L. G. Saunders.
The breeding efficiency of bulls and horses	Dr. A. Savage.
The uses of the photoelectric cell	Dr. A. Savage.
Action of pure salts on the structure and growth of vegetable cells	Prof. G. W. Scarth.
The bark disease of the beech	Otto Schierbeck.
Conductivity and vapor pressure of salt solutions	Prof. A. N. Shaw.
Studies on humidity	Prof. A. N. Shaw.
The corrosion of iron and steel in the soil	Prof. J. W. Shipley.
Generation of explosive gases in electric water heaters and boilers	Prof. J. W. Shipley.
The testing of oil shales in the field	Louis Simpson.
Ultra-violet spectroscopy	Prof. S. Smith.

Subject of Research	Grantee
Acidity and lime requirements of soils in Quebec and New Brunswick	Dr. J. F. Snell.
Chemical problems of the maple sugar industry	Dr. J. F. Snell.
Reduction of iron ores by gases	Dr. A. Stansfield.
Use of ultra short waves for direction indicating apparatus	Lt.-Col. W. A. Steel.
Wireworms and false wireworms	Prof. E. H. Strickland.
Cytological and histological investigation of alfalfa and clover	Prof. W. P. Thompson.
The inheritance of earliness and lateness in wheat	Prof. W. P. Thompson.
Electrostatic studies on milk and milk products	Prof. H. R. Thornton.
Determining the elimination of magneto noises from aircraft receiving sets	Prof. H. Vickers.
Lake Agassiz clay deposits	Prof. R. C. Wallace.
Parasites of the snowshoe rabbit	Prof. R. A. Wardle.
Dielectric losses in different classes of porcelain	Prof. A. V. Wendling.
Constitution of rubber	Dr. G. S. Whitby.
The deterioration of rubber	Dr. G. S. Whitby.
Experiments on catalysis	Dr. G. S. Whitby.
Continuity of welded steel beams	Prof. C. R. Young.
The lateral support of steel columns and struts	Prof. C. R. Young.
The conversion of starch to glucose	Prof. E. G. Young.

APPENDIX D

Publications of the National Research Council

Annual Reports

Annual Reports for fiscal years 1916-17 to 1935-36.

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 world, 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 Putrefaction 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 Toredo 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.

BULLETINS

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	Associate Committee on Grain Research.
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.

APPENDIX E

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.
A1a—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—1932	Definitions and General Requirements (out of print).
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—1934	Electric Portable Lighting Devices (Portables).
No. 13—1935	Transformers for Luminous-tube Signs and Oil-burner Ignition Equipment.
No. 14—1935	Industrial Control Equipment in Ordinary (*i.e.*, 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. 30—1936	Enclosed Branch-circuit Cutouts.
A23—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.
**In the press.

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 F

LIST OF MEMBERS OF ASSOCIATE COMMITTEES AND CONFERENCES

RESEARCH COMMITTEES

Associate Committee on Aeronautical Research

Group-Captain E. W. Stedman, O.B.E., M.I.C.E., M.E.I.C., F.R.Ae.S., A.R.C.S., Chairman	Chief Aeronautical Engineer, Dept. of National Defence, Ottawa, Ont.
F. P. H. Beadle, F.R.S.A., A.F.R.Ae.S., M.I.Ae.S.	Chief Designer, Fairchild Aircraft, Ltd., Longueuil, Que.
R. W. Boyle, M.Sc., M.A., Ph.D., F.R.S.C.	Director, Division of Physics and Engineering, National Research Council, Ottawa, Ont.
Wing-Commander A. T. N. Cowley, B.Sc., A.M.E.I.C., R.C.A.F.	Superintendent, Air Regulations, Civil Aviation Branch, Dept. of National Defence, Ottawa, Ont.
G. McIntyre, B.Sc., F.C.S., M.I.P.T.	Chief Chemist, Imperial Oil Ltd., Sarnia, Ont.
Major-General A. G. L. McNaughton, C.B., C.M.G., D.S.O., M.Sc., LL.D.	President, National Research Council, Ottawa, Ont.
R. J. Moffett, F.R.S.A., A.M.I.M.E., A.F.R.Ae.S., M.I.Ae.S., M.S.A.E.	Manager and Chief Engineer, Aircraft Dept., Canadian Vickers, Ltd., Montreal, Que.
J. H. Parkin, B.A.Sc., M.E., F.R.Ae.S., M.A.S.M.E., F.R.S.C.	Assistant Director, Division of Physics and Engineering, National Research Council, Ottawa, Ont.
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