NATIONAL RESEARCH COUNCIL ANNUAL REPORT 1934-35.

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National Research Council
OTTAWA
CANADA
Division of Mechanical Engineering

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DOMINION OF CANADA

EIGHTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

AND

FINANCIAL STATEMENT

1934 - 1935

OTTAWA, CANADA

NATIONAL RESEARCH COUNCIL

OF THE

EIGHTEENTH ANNUAL REPORT

DOMINION OF CANADA

AND

REPORT OF THE PRESIDENT

CONTAINING THE

OTTAWA, CANADA

1931-1932

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 Eighteenth Annual Report of the National Research Council, for the fiscal year 1934-35.

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.

During the period in question the Presidency of the Council was held by Dr. H. M. Tory, and the first section, which comprises the President's report, was prepared by him.

Your obedient servant,

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

6542—1½

THE COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

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

NATIONAL RESEARCH COUNCIL
1934-1935

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Secretary-Treasurer:

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

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CHARLES CAMSELL, B.Sc., LL.D., F.R.S.C., Deputy Minister, Department of Mines, Ottawa, Ont.

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A. FRIGON, B.Sc., D.Sc., A.M.A.I.E.E., A.M.E.I.C., Dean, Ecole Polytechnique and General Director for Technical Education in the Province of Quebec, 1430 St. Denis Street, Montreal, Que.

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OSKAR KLOTZ, M.B., M.D., C.M., F.R.S.C., F.R.C.P., Professor of Pathology and Bacteriology, University of Toronto, Toronto, Ont.

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JOHN STEPHENS, M.A., M.A.I., D.Sc., M.E.I.C., Professor of Mechanical Engineering and Drawing, University of New Brunswick, Fredericton, N.B.

M. L'ABBÉ ALEXANDRE VACHON, M.A., S.T.D., Lic. Ph., F.R.S.C., F.C.I.C., Director Ecole Supérieure de Chimie, Université Laval, Quebec, Que.

R. C. WALLACE, M.A., Ph.D., D.Sc., LL.D., F.G.S., F.R.S.C., President, University of Alberta, Edmonton, Alta.

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EIGHTEENTH ANNUAL REPORT
OF THE
NATIONAL RESEARCH COUNCIL

REVIEW OF THE ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL 1934-35

On March 31, 1935, the National Research Council of Canada completed the eighteenth year of its existence. For seven years it operated under the original act passed in 1916; for eleven years under the Research Council Act passed in 1924. By this act the activities of the Council were enlarged and its responsibility more clearly defined. For the first eight years the Council was wholly without laboratory facilities and was dependent for all research work undertaken upon the good will and co-operation of the universities of Canada and other public institutions. For the next seven years temporary laboratory accommodation on a small scale was available, sufficient only to give opportunity for very limited investigations of a specific character. It was not until near the end of 1932 that the National Research Laboratories situated on Sussex Street became available. While some equipment had been purchased and was ready for installation, and the nucleus of a research staff gathered together previous to 1932, it was not until 1933 that the new laboratories could be considered a going concern and the plan of operation previously worked out began definitely to function.

The total public expenditure during the eighteen years has been approximately $8,000,000. Of this amount more than half has been for permanent work, expressed in building and equipment, and remains a permanent investment for the country. The balance has been for current expenditure during the eighteen years.

During the period 152 researches have been completed, some of major economic importance. Approximately 100 are now being carried on, some of which are nearing completion, while others will extend over a considerable period of time.

Over 500 scientific papers have been published in Canadian and foreign journals as the result of the work of the staff of the Council and subventions granted to university laboratories. In addition, 382 men have been trained or are training under the scholarship system inaugurated by the Council. Further, every university in Canada where facilities for research exist has been stimulated to participate actively in the study of the scientific problems related to the development of our natural resources.

It can be said without fear of contradiction that the National Research Council has already returned to the people of Canada in economic benefits far more than the total expenditure, both current and capital, made to date, and this with the current expenditure reduced to such an extent that if further reductions were made the laboratories would of necessity in part cease to function.

In the meantime the growth of research has gone on at an increasing pace in other industrial countries with which we must compete in the markets of the world. Japan has 45 research institutes, supported by the government, reaching into every phase of national industry. In these institutes 3500 men

are employed, of whom over 1000 are scientific experts. In addition, 1000 men are employed in the electrotechnical laboratories dealing with problems presented by this special industry. Recently a new organization has been called into being, by the combined efforts of the government and industry, in which over 500 are engaged in research in chemistry and physics. The official description of this institute states, "The Institute conducts investigations in the pure sciences of physics and chemistry aiming at their industrial development, and at the same time engaging in applying research. No undertaking whether it be in industry or agriculture can be built upon a sound foundation unless it be based on physics and chemistry." Here is a major reason for the phenomenal industrial rise of Japan.

Russia, which in 1930 had 400 research institutes, has now 840 in which 47,900 trained men are at work. Their universities last year turned out 8400 men to add to their corps of scientific workers. The annual expenditure on research in Russia now amounts to approximately $500,000,000 and they are planning by the end of 1937 to have a capital expenditure in these institutes of $2,000,000,000. Under one organization dealing with the production of wheat and allied botanical problems 1000 trained men are employed. This is suggested as something upon which Canadian industrialists and agriculturalists should meditate profoundly if they hope to maintain their place in world trade.

A slower but equally sure development is taking place in Great Britain. When Britain created her industrial research organization she started with a straight gift of £1,000,000. Last year she spent, independent of work done in the army and navy, £655,000. Of this, £42,000 was spent on building research; £20,000 on chemical research; £195,000 on the National Physical Laboratories, which correspond to just one section of the work undertaken in the National Research Laboratories of Canada; £44,500 on food research; £98,000 on grants in aid of research (the National Research Council of Canada spent approximately $17,000 last year for the same purpose); and £92,000 on fuel research. These figures show that Great Britain recognizes that the future of industry rests upon science.

Meetings of Council

During the year five meetings of the Council were held. At these meetings the work being carried on under the direction of the Council in the National Research Laboratories and under associate committees was brought under intimate review.

At the second meeting of the year, held on September 19, the Council appointed a special committee with the president and the chief technical officers of the Council to review and report on all phases of the activities of the Council. The committee was specially instructed (1) to review the work of the Council to date and (2) to make recommendations with respect to policy and program for future work.

This committee consisted of:—

Dr. A. S. Mackenzie, Chairman

Dr. Frank Allen, Head of the Department of Physics, University of Manitoba

Dr. A. L. Clark, Dean, Faculty of Applied Science, Queen's University

Dr. F. M. G. Johnson, Dean, Faculty of Science, McGill University

M. l'Abbé Alexandre Vachon, Université Laval, Director, Ecole Supérieure de Chemie.

Tom Moore, Esq., President, Trades and Labor Congress of Canada.

The full report of the committee, which is a comprehensive statement of the position of the Council, contains the following items which seem worthy of special mention:

"They (the committee) had before them not only the statement of itemized receipts and expenditures for the present fiscal year and that of 1933–34 for comparison, but also classified statements of revenue and expenditure incurred from 1916–17 to 1933–34. They had also for study a statement of the grants in aid of research as at January 23, 1935; also of the standing of sub-grants made by associate committees as at that time; also a list of the revenues received from industry, etc., during the years 1927 to 1934 inclusive. These tables gave the committee a comprehensive picture of the financial side of the Council's working from its inception:

"1. (*a*) The committee desires to report that the funds of the Council have been expended economically and wisely and in accordance with the budget authorized by the Council. . . . . .

"(*d*) On account of the need for an adequate supply of trained research men for science and the industries it is recommended that for the coming year the amount allocated for scholarships should if possible be $20,000. The committee felt that recent reductions in the grants for this purpose . . . . might react adversely in the future development of the activities of the Council. . . . . .

"4. The committee notes with interest that the volume of work which is being pressed on the laboratories by government departments, industrial organizations, etc., is steadily increasing. The committee realizes that such work is one of the important functions of the Council, but would call attention to the fact that the constant increase in this type of work without simultaneous increase in staff and appropriation has resulted in a corresponding decrease in the normal research program laid out by the laboratories. . . . . .

"The committee would strongly recommend that as soon as financial conditions permit of the appointment of additional staff, increased attention should be given to the normal research program of the laboratories. . . . . .

"7. The committee was also strongly impressed with the necessity of having and retaining on the laboratory staff at least a few men of the highest scientific capacity. The committee is convinced that if such men were appointed and given reasonable freedom to conduct independent research work, the result would more than justify the salaries it would be necessary to pay them.

"The committee was somewhat concerned by the fact that three members of the scientific staff of the Council have recently been offered positions in industrial organizations at greatly increased salaries over those received from the Council. The committee strongly recommends that in such cases reasonable inducements should be offered the employees concerned to remain on the staff of the Council. . . . . .

"9. The committee also desires to report that there is pressing need for additional staff. As a result of its investigations and its discussions with the directors of the various divisions the committee found that at the present time senior laboratory men are spending time on work which could be done equally well, and should be done, by juniors. The committee believes that the addition of a reasonable number of trained and untrained laboratory assistants would not only facilitate but greatly expedite the work of the laboratories. . . . . .

"14. The committee desires to record that space in the buildings provided and designed for use of the Council is at present being occupied by certain organizations which obviously are not engaged in work of the nature for which the building was constructed and intended and whose activities are not scientific and not associated with the work of the Council. The committee is strongly of the opinion that these organizations should be required to vacate the space occupied as soon as such space is required by the Council."

When the report was submitted to the Council the findings were unanimously approved.

Membership of the Council

The term of appointment of the following members of the National Research Council expired on March 31, 1934, in accordance with the provisions of the Research Council Act requiring that appointments be for three years:

Prof. Oskar Klotz, M.B., M.D., C.M., F.R.S.C., F.R.C.P.
Prof. Frank Allen, M.A., Ph.D., LL.D., F.R.S.C.
Prof. H. R. Christie, B.Sc.F.
Dean F. M. G. Johnson, M.Sc., Ph.D., F.I.C., F.R.S.C.
J. T. Foster, Esq.

Prof. Allen, Prof. Klotz, and Dean Johnson were reappointed for another term of three years. The two additional vacancies were filled by the appointment of the following:

Prof. R. W. Brock, M.A., LL.D., F.G.S., F.R.S.C., Head of the Department of Geology, University of British Columbia;
Tom Moore, Esq., President of the Trades and Labor Congress of Canada.

At the meeting of the Research Council held on March 28, 1934, the following resolution regarding the death of Dr. A. B. Macallum was unanimously passed:

"That the National Research Council very deeply regrets the death of Dr. A. B. Macallum, who was its first administrative chairman and who, in addition to being a distinguished scientist and teacher, had been an honored colleague. The Council remembers that his high standing in the field of science, his industry and interest in the work of the Council, and his wide experience enabled him to render very great service to the Council during the early years of its existence."

At the same meeting the attention of the Council was called to the death of Mr. J. T. Foster, whose term of office as a member of the Council had expired only a few days prior to his death. The Council recorded its deep regret in the following resolution unanimously passed:

"Resolved that the National Research Council of Canada learned with deepest regret of the untimely death of Mr. J. T. Foster, a colleague who had always had the interest of the Council at heart and had done his utmost to further those interests."

Staff

Professional Staff Appointment

Dr. F. H. Sanders—Appointed May 28, 1934.

Frederick Henry Sanders, B.A., 1928, University of British Columbia; M.A., 1930, Ph.D., 1932, University of California. Winner of the Governor-General's medal and a scholarship to the University of British Columbia; teaching fellowship in physics at the University of California, 1928–32; Research Associate, University of California, 1932–34.

Retirement

Dr. O. M. Morgan retired from the staff of the Division of Chemistry of the National Research Council on June 22, 1934, to accept a position with the National Aniline and Chemical Company, Buffalo, U.S.A.

Relation of the Council to Industry

This would seem a fitting place to refer once again to the policy of the Council with regard to industry. Generally speaking, problems for solution have reached the Council by one of the following methods:

1. Problems originating from the work of the technical officers of the Council, the solution of which would render industrial development possible. In all such cases the Council retains full right to patents and royalties and, subject to the final decision of the Governor in Council, the right to make such provision for production, in the public interest, as may seem advisable.

2. Problems brought by private individuals or industrial organizations to the Council for solution and for which the persons concerned wish to pay the total cost of the necessary investigations. In such cases, if a solution of commercial significance is found it becomes the property of the person submitting the problem.

3. Problems brought by private individuals or industrial organizations to the Council for solution, the parties concerned being able to pay only part of the cost of the necessary investigation. In such cases the solution is considered the joint property of the Council and the persons submitting the problem, in proportion to the share each has borne of the cost of the necessary investigation.

4. In addition, where the Council undertakes on its own behalf the solution of problems of broad general interest such, for example, as the drying of tough and damp wheat, fruit and vegetable processing, cold storage research, research under the associate committees on Field Crop Diseases, Coal Classification and Analysis, Electrical Measuring Instruments, Grain Research, etc., all information obtained is made immediately available to the public. This policy was adopted after full discussion by the Council and with the approval of the Committee of the Privy Council.

Pacific Science Congress

During the year under review the work of publishing the Proceedings of the Fifth Pacific Science Congress was concluded. The Proceedings consist of five volumes totalling 4,227 pages. The papers constitute a comprehensive presentation of scientific research, with special reference to economic development, carried out in the Pacific area during the period 1929–33.

It is a pleasure to report that of the $70,000 voted by Parliament for this project $15,000 was returned to the Receiver General of Canada as the result of economies effected by the Executive Committee. At the close of the fiscal year there was an unexpended balance on hand of $10,937.11, and when the affairs of the Congress have been brought to a final conclusion some further refund to the public treasury will probably be possible. The special thanks of the Council are due to three of its officers, Mr. S. J. Cook, who acted as Secretary of the Congress, Mr. S. P. Eagleson, the Secretary-Treasurer, and Mr. F. E. Lathe, the Director of the Division of Research Information; and also to the Executive Committee, made up of Canadian scientists who gave unsparingly of their time in maturing the plans which made the Congress such a success. It is respectfully suggested that Canada may well be proud of this splendid achievement carried out under the auspices of the National Research Council.

Associate Committees

Your attention is again respectfully called to the important work carried on under the auspices of the associate committees organized by the Council. Under these committees, upon which serve representatives of nearly all the scientific institutions of the country (see page 10, Annual Report of the National Research Council of Canada, 1933–34) large researches are undertaken which would not be possible for a single individual or for a group representing a single science. For a full report of their work see pages 72–115 of this report. The work of these committees, carried out with a minimum of cost to the public, would not be possible but for the hearty co-operation of the universities of the country.

During the year two committees which had become inactive were reorganized because of new demands for work.

1. The Associate Committee on Aeronautical Research was reorganized for the following reasons:

(*a*) The increased activity in aviation in Canada, including aircraft construction, air transport and airway construction.

(*b*) Probable developments in the future in the operation of the trans-Canada air service.

(*c*) To enable urgently needed assistance to be obtained in the laboratories, particularly to cope with the instrument work for the Royal Canadian Air Force.

The committee appointed under the chairmanship of Group Captain E. W. Stedman, chief aeronautical engineer, Department of National Defence, was made representative of all the interests concerned, the Research Council, the industry, the operators, Dominion Government departments and the universities. The work being done under the committee has grown rapidly. For a full description see page 130.

2. At the request of the Department of External Affairs the Associate Committee on Trail Smelter Smoke was also reconstituted. This was made necessary because, under the proposed terms of settlement between the governments of Canada and the United States, evidence of damage done in the Northport area since 1932 would have to be considered. A re-study, therefore, of the technical problems became necessary. A staff of eight men under the direction of Dr. Katz of the Research Council staff was organized and will be in the field during the summer of 1935 and possibly 1936. The Department of Agriculture is co-operating. The cost is not being borne out of public funds.

Another important departure during the year was the organization of the Canadian Government Purchasing Standards Committee. This committee was formed following a conference of representatives of various Government departments in Ottawa. The primary object of the committee is the preparation of commodity specifications applicable to the purchase of equipment and supplies for Government departments. All the departments of the Government are co-operating. Technical subcommittees have been at work for some time and a number of specifications have been prepared and tentatively approved, for one year. These are now being used in making purchases. It is already apparent that a considerable saving will be effected.

The Associate Committee on Fire Hazard Testing was especially active during the year. The significance of the work done under the committee is

shown in the following resolution passed at the Convention of the Dominion Fire Prevention Association which met in Toronto in August:

"With the confident belief that this work is of unparalleled importance to the public welfare and essential to the establishment of uniformity throughout the Dominion we hereby call upon each provincial government to embody in legislation the requirement that National Research standards shall constitute the recognized authority in all matters pertinent thereto, and

"We especially recommend that provincial fire marshals, or other authorities having jurisdiction, establish the standards of the National Research Council as an authoritative reference in all regulations promulgated under their respective acts, and require that all affected devices and materials be submitted to the National Research Council for approval before their use is authorized."

During the year several important conferences were held between the officers of the National Research Council and those of the Department of Agriculture with a view to the better co-ordination of research in the agricultural field. After a full discussion of the whole situation it was recommended, and later approved by the National Research Council and the Department of Agriculture, that certain associate committees of the Council should become joint committees of both organizations. These reorganized committees are as follows:

(*a*) Associate Committee on Agriculture of the National Research Council and the Dominion Department of Agriculture.

(*b*) Associate Committee on Field Crop Diseases of the National Research Council and the Dominion Department of Agriculture.

(*c*) Associate Committee on Grain Research of the National Research Council and the Dominion Department of Agriculture.

(*d*) Associate Committee on Wool Research of the National Research Council and the Dominion Department of Agriculture.

(*e*) Associate Committee on Weed Research of the Dominion Department of Agriculture and the National Research Council.

The membership of these committees was revised so as to make them representative of all the interests concerned.

The Canadian Journal of Research

During 1929 the National Research Council, after a full discussion, decided that the time had come to begin the publication of a journal of research under its auspices. The reasons for this action were briefly set out in a foreword to the first volume by the President of the Council in the following terms:

"In the last few years scientific papers resulting from the activities of the universities, the National Research Council and other research agencies in Canada have become so numerous as to cause difficulty in securing prompt publication. This is largely due to the fact that there has been in Canada no national periodical devoted to research. Canadians have consequently been largely dependent upon foreign journals, already overcrowded as a result of the activities of their own scientific men. It has therefore been decided to publish under the auspices of the National Research Council a Canadian Journal of Research.

"While the journal is intended primarily for the publication of the results of work carried out under the auspices of the Council, it will also be open for suitable papers from Canadian research workers not connected with this organization. Material is already in sight to guarantee its publication bi-monthly. Moreover, it is expected that within a short period of time there will be available a volume of scientific papers sufficient for monthly issues. In its future development the Canadian Journal of Research can be depended upon to keep pace with the progress of scientific and industrial research throughout Canada, and the Council hopes that it may make a material contribution toward that progress."

Beginning as a bi-monthly the journal soon became a monthly. Later the size of the monthly issue was greatly increased. Finally the subdivision of the journal into separate publications for the several branches of science had to be considered. During the year under review this separation was authorized by the Council and will be in operation after July 1, 1935. Under the plan the journal will be published in two parts, each part in two sections. One part will be devoted to A, Physical Sciences; B, Chemical Sciences. The other part will be devoted to C, Botanical Sciences; D, Zoological Sciences. It is hoped that in this way the Journal will be more acceptable not only to its readers but also to those who desire to use it as a medium of publication.

Since its inception 610 papers have been published in the journal, 131 by members of the staff of the Council and 479 by other contributors, mainly those working under grants from the Council. During the past year the corresponding figures have been 135 papers published, 32 by members of the staff and 103 by other contributors.

Canadian Engineering Standards Association

A new departure was made during the year in connection with the work of the Canadian Engineering Standards Association. It will be recalled that the Main Committee of the Association functions as an associate committee of the National Research Council. Its chief function is to establish engineering standards applicable to industry. To a limited extent it has also been functioning in the field of safety standards. At a recent meeting the Association decided to withdraw from this field leaving it to the National Research Council, since the Council was in a better position to secure the necessary governmental co-operation from the provinces. Following this action on the part of the Association, the Council decided to take the necessary step looking to the establishment of national safety code standards in co-operation with provincial government departments.

Conferences

Three important conferences were held during the year under review.

1. *Honey.*—On the request of the Associate Committee on Agriculture a conference on the problems of the honey industry was called. There were in attendance representatives of the Federal Department of Agriculture, the Ontario Agricultural College, the University of Saskatchewan, the Ontario Honey Producers Co-operative, the Montreal Beekeepers' Association and members of the staff of the National Research Council. The chief problems confronting the industry were brought under review as well as the scientific work being done by the various agencies for the improvement of Canadian honey. A further program of research was outlined in which the National Research Council and the Federal Department of Agriculture are co-operating. The work is going steadily forward.

2. *Cold Storage.*—On the recommendation of the Associate Committee on Agriculture a conference was called for the purpose of formulating a comprehensive program of cold storage investigations. Brief statements outlining the progress in cold storage research in other countries were submitted, indicating specific problems in railway and ocean transportation, biochemistry and mycology as related to the cold storage of meat, fish and dairy products, and the storage and refrigeration of fruits and vegetables. Representatives of the Dominion Department of Agriculture, the railroad and steamship companies, the universities and agricultural colleges, the Biological Board and other interested parties were present. As a result a scheme dealing with immediate problems of direct interest to Canada was drawn up, the work being undertaken jointly by the Research Council and the Department of Agriculture, the other bodies interested co-operating where co-operation was found possible and useful. A committee consisting of Dr. Newton and Dr. Boyle of the National Research Council and Dr. Swaine of the Department of Agriculture was named to give general direction to the work.

3. *Potatoes.*—Early in the autumn the attention of the Council was called to the fact that owing to the loss of markets a considerable portion of the potato crop in Prince Edward Island and New Brunswick would be a total loss if some use could not be found for it. Appeals having been made to the Council for assistance a conference was convened to which representatives of the growers, the manufacturers of potato starch, the Departments of Trade and Commerce and Agriculture and the National Research Council were called. A complete statistical study of the situation having been made it appeared that the manufacture of starch and starch products offered the most hopeful solution of the problem. At the conference it was decided that a special research committee should be established under the direction of Dr. Whitby, Director of the Division of Chemistry, to make an exhaustive study of the whole subject. Dr. Whitby was sent to Europe accompanied by a representative of one of the starch companies to secure information on methods already in use in countries such as Germany and Holland. On Dr. Whitby's return a further conference was called followed by an active program of research under the committee. This work will be continued intensively during the year 1935–36.

Canadian Research Institute of Launderers and Cleaners

Since 1930 the National Research Council has conducted a laboratory for laundry research in conjunction with the Eastern Canadian Laundry-owners Association (E.C.L.A.). Following the usual practice the Council placed in charge a highly trained research chemist on the understanding that should the work prove beneficial to the industry in due course provision would be made by the industry to maintain the laboratory. For some time the E.C.L.A. has maintained an assistant in the laboratory. The work having grown very rapidly and having proved of great service, certain leaders in the industry decided to undertake the formation of a research institute for the purpose of supporting and extending the work already being done. This organization was completed during the year. Articles of association were drawn up and approved by the industry and the National Research Council. Membership is open to all launderers and cleaners in Canada desiring to join. The membership fee is based on the volume of business of the individual or company joining, and is designed to furnish an amount sufficient to maintain the laboratory, apart from the salary of the technical expert. The articles of association and the by-laws were carefully drawn so as to be a model for other industries desiring to take similar action.

The objects as set forth in the articles of association show so clearly what the industry has in mind that it seems fitting to set them forth in this report as a suggestion to others.

"The objects of the Institute shall be:

"(*a*) To promote scientific research and technical work in connection with the laundry and cleaning industries.

"(*b*) To provide funds through fees, or such other means as may be from time to time determined, for the purpose of payment of such skilled professional, technical, or other officers as may be agreed upon between the Institute and the National Research Council and for other purposes consistent with these articles of association.

"(*c*) To co-operate with the National Research Council in equipping and maintaining such laboratories as shall be found necessary.

"(*d*) To accept grants of money and other assistance from any source whatsoever for the purposes of the object of the Institute and to invest the money of the Institute not immediately required in any one or more of the modes of investment for the time being authorized by law for the investment of trust money and in such manner as may be from time to time determined.

"(*e*) And generally to undertake in co-operation with the National Research Council any work of a scientific or technical nature as shall be agreed upon as being in the interest of the laundry and cleaning industries and conducive to an improved service to the public served by the industries."

The Association is now a going concern.

Assisted Researches

During the year grants in aid of research were made to six professors, who applied for assistance in connection with researches which were being conducted in their own laboratories. The subject of research in each instance was approved by the Council. The total amount of these grants was less than $4,000. The Council deeply regrets that because of the state of the finances of the Council other worthy applications had to be refused. The significance of this statement will be seen when it is recalled that during the same year grants made in Great Britain for similar purposes amounted to £98,000.

A statement of the work done under these grants will be found on page 116 of this report.

Scholarships

During the year 26 students held scholarships under the Council. Of these scholarships, 18 were bursaries, six studentships and two fellowships. Not only has the number of these scholarships been greatly reduced in recent years, but the amount payable to each student has been greatly reduced. Because of the necessity of maintaining a sufficient body of trained men for the public service as well as for the assistance of industry and agriculture, it is hoped that a return to normal in this field of effort may not be long delayed.

Researches Conducted in the National Research Laboratories

Last year in this section of the annual report special attention was called to the work being done in the National Research Laboratories. It is hardly necessary, therefore, again to specially emphasize this phase of the activities of the Council. Suffice to say that activity has been intensified in every laboratory division. The requests for assistance which have grown year by year were

in the year under review greater than ever. The need for more assistants, especially junior help for the senior staff, is urgent. Attention is again called to the fact that the Council had its staff only partially organized when the economic depression began and it has been carrying on with increased demands in every branch of its activities with $125,000 less than was available before the new laboratories were opened. The full benefit of the work which the Council is striving to do cannot be realized until a much enlarged staff is available.

Particulars of the work in the laboratory divisions will be found beginning on page 23 of this report.

Financial Statement for the Fiscal Year 1934-1935

S. P. EAGLESON, *Secretary-Treasurer*

Revenue

A. *Parliamentary Appropriation*			
Voted by Parliament	$ 392,000.00		
Less Unexpended Balance	46.52		
			$ 391,953.48
B. *Special Fund*			
Laboratory Fees	$ 7,258.43		
Assisted Researches	8,266.81		
Publications	1,814.43		
Miscellaneous	278,83		
			$ 17,618.50
C. *Trust Fund*			
Amount in Trust Account April 1, 1934	$ 43,060.48		
Grain Research Trust Fund	30,331.66		
From Industries, etc., in Trust	39,485.56		
			$ 112,877.70
			$ 522,449.68

Expenditure

A. *Parliamentary Appropriation*			
Salaries	$ 263,128.48		
Laboratory Expense	57,497.15		
General Expense	6,574.01		
Scholarships	11,825.00		
Travelling	12,778.90		
Contingencies	645.97		
International Affiliations	6,560.26		
Assisted Research Advances	32,943.71		
			$ 391,953.48
B. *Special Fund*			
Assisted Research Advances	$ 14,649.02		
Publications	2,969.48		
			$ 17,618.50

C. *Trust Fund*

Aeronautical Committee	$ 735.73	
Asbestos Committee	100.00	
Coal Classification Com.	1,620.00	
Food Storage and Transport Committee	163.21	
Field Crop Diseases Com.	1,350.36	
Fire Hazards Committee	2,200.50	
Gas Research Committee	1,248.83	
Grain Research Committee	24,772.69	
Laundry Research Committee	1,170.00	
Magnesian Products Com.	5,939.95	
Parasitology Committee	20,833.33	
Smelter Smoke Committee	25,783.93	
Survey Research Committee	1,257.21	
Radio Research Committee	267.73	
Radiology Committee	1,202.23	
Tuberculosis Committee	11,282.08	
Weed Control Committee	3,400.00	
Wool Committee	897.22	
Soil Studies	1,000.00	
C.E.S.A.	12,430.35	
Surpluses Recalled to Special Fund	8,019.85	
		$ 125,675.20
Less Amounts Provided from Parliamentary Appropriation and Special Fund	45,537.34	
Net Expenditure from Trust Fund	80,137.86	
Balance in Trust Account March 31, 1935	32,739.84	
		$ 112,877.70
		$ 522,449.68

REPORTS OF LABORATORY DIVISIONS

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

Continuing the policy inaugurated a year ago, work on projects of a pure science character has been gradually reduced in order that the small staff available in this division might devote itself to practical problems of urgent importance. This is an emergency policy to tide over the difficult times. It is hoped that a resumption of more fundamental research may soon be possible, as a proper balance between pure and applied science is necessary to the life of a research institution.

No expansion of staff has been possible, and an attack on many important problems has still to be deferred, *e.g.*, vitamin research, and research on the utilization of agricultural wastes. Other large projects we have had to be content to begin in a very small way. Investigations on the storage and transport of food products and research on barley are examples of two such projects undertaken during the year. Thanks to the industry and faithfulness of an efficient, if small, staff, good progress has been made in several lines.

During the year it has fortunately been possible to make certain important improvements to the physical equipment of the laboratory. The control of growth conditions in the plant house has been improved by the installation of sensitive temperature regulators connected with both the heating units and the ventilation system. In two of the rooms this equipment may be set to give any desired variations in night and day temperatures. A spray cooling system has been installed over the roof of the whole house to permit more successful operation in the summer months. The cold storage plant has been extended to include five rooms cooled by brine, one by direct expansion ammonia, and one by direct expansion carbon dioxide, giving a combined range from $-40°$ to $+55°$ F. The carbon dioxide room cannot be brought into use, however, until carbon dioxide compressors are installed. It is hoped that this may be done in the forthcoming year.

As usual, the staff has been called upon quite frequently to render services to other government departments. With the Department of Agriculture a number of co-operative projects are under way. It is a pleasure to record the increasingly close and harmonious integration of our work with that of this department, due in no small measure to the convenience of consultation made possible by the appointment of Dr. J. M. Swaine as its Director of Research.

Services to other institutions and to the country at large, by answering technical inquiries on a wide variety of topics, have continued to occupy a substantial proportion of the time and energy of the staff.

The following brief progress reports on work carried on in the divisional laboratories have been prepared by the individuals concerned.

Biochemistry of Rust Resistance

J. ANSEL ANDERSON

Investigations designed to elucidate the nature of resistance and susceptibility to stem rust in wheat have been continued. A series of twelve hybrid lines from a Marquis × H-44-24 cross were grouped, according to their rust reactions, into four classes representing the four possible combina-

tions of seedling and mature-plant reaction to rust. Quintuplicate plots of each class were grown in the field and leaves were collected at the three-leaf stage and after heading. The material was dried, ground and analyzed for total ash, nitrogen, and fat; hot- and cold-water-soluble organic matter, ash, nitrogen, reducing compounds, reducing sugars and invert sugar; alcohol-soluble matter; reducing compounds (from hemicellulose) and nitrogen compounds made soluble by hydrochloric acid; reducing compounds (from cellulose) and nitrogen compounds made soluble by sulphuric acid; and for ash, nitrogen and lignin in the remaining residue. The material was also subjected to quantitative extraction by the following solvents successively: ligroin, ether, chloroform, ethyl acetate, acetone, and alcohol.

Small but significant differences were found between classes with respect to certain fractions. There was no evidence, however, that these differences were related to rust reaction.

These investigations and those reported in past years, though now being temporarily discontinued while still falling short of their ultimate objective, have served to indicate some profitable lines of attack upon the problems of disease resistance in plants. Their main value lies in their contributions to the knowledge of plant chemistry, lack of which still remains the greatest stumbling block in the path of those who would investigate problems of immediate practical importance. During the year, one paper was published in the Canadian Journal of Research, Vol. 11, and another is in preparation.

Organic Constituents of Wheat Leaves

J. Ansel Anderson

Research on the nature of the less common organic constituents of wheat leaves was undertaken as a necessary adjunct to studies of the biochemistry of rust resistance and as a contribution to our knowledge of the chemistry of plants. During the past year, owing to limitations of time and staff, the work has been confined to the partial isolation of considerable quantities of the water-soluble yellow coloring matter of Khapli wheat leaves. It is interesting to note that the isolation and identification of the flavone pigments of wheat leaves, now promises to find practical application in the study of the relation of the pigments of wheat kernels to quality for macaroni production.

Apparatus for Plant Growth under Controlled Conditions

W. H. Cook

Further tests of this equipment, which has been described in previous reports, have been made. It was found that increasing the rate of air flow by means of recirculating fans reduced the space variations of temperature to about 0.1° F., or less, and that plants grown in the cabinets under these conditions were much less variable in weight than those studied in previous experiments. The wet weights of the plants from the two cabinets, however, still differed by about 4%, and a study of the light intensity was then undertaken in an effort to explain this variance, since the temperature and humidity conditions were identical. This study led to the conclusion that the light intensity was at such a low level that variation in this quantity, owing to voltage fluctuations, was probably affecting the results. The light intensity was therefore increased and further experiments are under way.

Chemical Weed Killers

W. H. Cook

The laboratory investigations carried out during the year under review have been confined to tests on the toxicity of selected chemicals on perennial sow thistle. The chemicals employed were those previously found most toxic to annual weeds, namely: ammonium thiocyanate, arsenic pentoxide, chloric acid, copper nitrate, formic acid, phenol, sodium arsenite, sodium bichromate, sodium chlorate, sodium cyanide, sodium selenite and sodium sulphide.

When applied as a spray, the heavier dosages of all these chemicals killed the above-ground parts of the plants in a few days. Many of the chemicals, however, had little effect on the roots, and the plants recovered within a few weeks. When judged by the permanent effect, the chlorate ion, as represented by sodium chlorate and chloric acid, was found to be much more toxic than any of the others. Sodium selenite, ammonium thiocyanate, sodium arsenite and sodium bichromate were found to be slightly toxic, but these appear not to be effective enough to be considered good perennial herbicides. No other chemicals tested were sufficiently toxic to be of any value for eradicating perennials, although they might be useful for delaying maturity, seed-setting, etc.

In these experiments the chemicals were applied as a spray to the aerial parts of the plant and soil, to the aerial parts of the plant only, and to the soil only. It was found that in the case of chlorates, which represent the most toxic class, there was no significant difference in the results obtained from applications to the soil only, as compared with applications to both the aerial parts of the plant and the soil. This is an important result since it indicates that, for perennials, no practical advantage is gained from the use of the expensive spraying and dusting equipment commonly employed to apply the toxin to the leaves and stems in a finely divided state. Similar results were obtained with the other chemicals, except arsenic pentoxide, but as these are all much less toxic than the chlorates they will not be discussed further.

There is considerable information in the scientific literature on the toxicity of chemicals to plants but this has never been adequately reviewed and compiled. In co-operation with the Division of Research Information a comprehensive review of the literature has been undertaken. (See page 70).

Temperature, Relative Humidity and Air Movement in Celery Storage Rooms

W. H. Cook

The Quebec Federal-Provincial Committee on Cold Storage has initiated an extensive investigation into the storage of celery, with the object of supplying the domestic market for a longer period with the home-grown product. In connection with these investigations the Council was requested to make a study of the storage conditions in certain commercial cold storage warehouses in Montreal.

It was found that although the operators attempted to maintain the air temperature at 32° F., the average temperature was, in general, about 1° F. higher. The celery near the outside of the crate usually had about the same temperature as the ambient air but was from 1° to 2° F. higher in the centre of the crate. The maximum variation of the air temperature, including both

the variation between days and between different parts of the room, was usually less than 3° F. which may be regarded as quite good control. It is possible, however, that this variation could be reduced still further by a continuous positive air circulation, which would reduce the temperature variations between different parts of the room. The relative humidity ranged from 92 to 98%, being on the average about 95%, a condition which is quite satisfactory. A still higher average humidity might be beneficial but this cannot be employed unless the temperature variations are reduced to prevent the formation of condensate in local areas. In most cases the air movement is inadequate. In certain warehouses fans are installed but are only operated intermittently, and even in rooms where they are operated continuously the arrangement of the air ducts is such that most of the air passes over rather than through the stack.

In a report submitted to the Quebec committee, the desirability of a positive, continuous air movement is pointed out. Certain other practices, such as precooling the product, are recommended, and suggestions are given regarding the selection of rooms for celery storage, and the arrangement of the product in the rooms.

Poultry Storage Experiments

W. H. Cook, G. A. Ledingham

In co-operation with the Department of Agriculture, a preliminary study was made of the safe holding period for chilled poultry, a problem of great importance in relation to the export of this product to Great Britain. Freshly killed poultry required 24 hr. to reach approximately air temperature in a room at 30° F. Cooling could be speeded up by using an initially lower temperature, without risk of freezing. It was found that at 30° F. the poultry kept in good condition about five weeks, as judged by bacteriological and chemical analyses, while at 32° F. the safe period was about four weeks. Several species of moulds which developed on this poultry in more prolonged storage were isolated for studies of the conditions which favor or inhibit their growth. The storage experiments are being continued.

Determination of the Freezing Point of Certain Canned Food Products and the Disintegrating Effect of Frost

W. H. Cook

At the request of a commercial firm the freezing point of certain canned food products was determined and the information supplied to the company. The disintegrating effect of frost on canned beans shipped to northern points was also studied. It was found that intermittent freezing and thawing caused more disintegration than continuous frost.

Studies on the Gluten Proteins

W. H. Cook, R. C. Rose

This investigation was undertaken to study the properties of the gluten proteins in relation to wheat quality as affected by various factors, primarily by heat as used in commercial drying. The results have been published in a letter to Nature (Sept. 8, 1934) and in three papers in the Canadian Journal of Research (Vol. 12). It was found that the classical solvents, dilute alkali

and acid, alter the protein and also cause considerable hydrolysis. In a search for neutral solvents capable of dispersing gluten it was found that 12% sodium salicylate and 30% urea solution could be used. These solvents caused less serious changes in the gluten than alkali or acid. In urea solution gluten appears to have a definite coagulation point, as judged by viscosity measurements, in the region of 70° C. This harmonizes with previous work on flour and wheat, which showed that the greatest change takes place at temperatures higher than this.

Investigations on the chemical nature of gluten extracted with the neutral solvent, sodium salicylate, are described in the report of the Associate Committee on Grain Research, on page 77.

Standardization of Experimental Baking Test

J. G. Malloch

Reduction of the variability in the results of experimental baking tests, in order to reduce the time and expense involved in the extensive replication required to obtain reliable results, is still a pressing problem. Substantial progress has been made during the year. It has been shown conclusively that the use of the punching and moulding machine gives more constant results than the manipulation of the dough by hand. The variability, using the machine, is considerably less than that of the ordinary routine tests. Even with this improvement the variability is still too high to be considered completely satisfactory. In an attempt to effect further improvement, certain changes have been made in the design of the moulder and a new model is now under construction. The oven is also being remodelled in the light of the results of a study of oven design conducted at the University of Saskatchewan. Two papers were published during the year (Cereal Chem. 12 : 57-61; 130-132. 1935).

Denaturation of Wheat

J. G. Malloch

At the request of the Department of External Affairs and the Department of Trade and Commerce possible methods for rendering wheat unfit for human consumption without affecting its value for stock feeding were examined. It was found that the addition of small quantities of fish oil is the cheapest and most practical method under Canadian conditions.

Cleaning and Handling of Barley

J. G. Malloch

With the prospect of increased production of barley in Canada an extension of our markets for this grain is necessary. In bringing this about, the quality of the product which we offer for sale will be an important factor. Cleanliness and freedom from mechanical damage are aspects of quality which must be considered. Last summer the National Barley Committee appointed a Committee on Cleaning and Handling, on which the Council is represented, to investigate the adequacy and suitability of our present handling machinery and methods. The actual work of investigation was undertaken by Council officers on behalf of the committee.

A survey of the machinery and methods now in use was made and some laboratory experiments have been conducted, using a specially designed

damaging machine, to aid in the interpretation of the information gathered during the survey. The main conclusions from this investigation are as follows:

1. Machinery is available which will clean feed barley to any desired degree of purity.
2. Under the conditions prevailing during the past season, more damage through peeling occurred during threshing than at any other single stage of handling.
3. The danger of damage to the grain by cleaning machinery is slight.
4. Rough handling during any operation increases the susceptibility to damage in subsequent operations.
5. Susceptibility to damage decreases with increase in moisture content.
6. Varieties differ in their susceptibility to damage. A complete report has been prepared for publication.

Barley Research

J. Ansel Anderson

Research on the nature of quality in barley, on methods of measuring quality, on the effects of variety and environment on, and the relation of malting methods to, quality, is being undertaken with the object of applying the knowledge thus gained to the improvement of Canadian barley.

Visits were made to laboratories in the British Isles and Denmark in order to study the research and analytical methods, which have been developed in these countries, for the study of barleys and malts.

Since the malting quality of barley cannot be determined without malting it, experimental malting equipment for 1-lb. samples is being developed. The equipment is required as a tool for both research and routine investigations.

During the visit to the British Isles many users of Canadian malting barley were visited. Information was collected on the chemical and malting characteristics required in Canadian barley by each of the several industries in which it is used; on the improvements which are desirable in order that the present market may be held; and on the prospects for increasing the sale of Canadian barley in the British Isles. The information obtained was made available to members of the Canadian grain trade both by reports and during a subsequent visit to Winnipeg. It is hoped that the interest aroused and the recommendations made, may result in immediate practical steps being taken to improve Canada's position in the British market for malting barleys.

Barley Proteins

R. C. Rose

The development of barleys of superior quality is hindered by lack of knowledge of the nature of malting quality. In an endeavor to elucidate the problem, a study of the barley proteins is being made. These proteins are classified according to their solubility in salt and alcohol solutions, but their nature is not well understood. An investigation is under way to determine whether solubility in a new protein solvent, sodium salicylate solution, substantiates the present classification, and also to determine the changes in the proteins which take place during malting.

The results indicate that about 30% of the protein in barley is a glutelin, *i.e.*, insoluble in salt and alcohol solutions, and that this protein is not changed during malting. It probably originates in the outer layers of the barley kernel. The main endosperm protein, amounting to about 40% of the total protein, is alcohol-soluble. Attempts to fractionate it are under way. There is also about 20% water-soluble protein, and about 10% which is neither water- nor alcohol-soluble but which is soluble in salt solutions. Probably all of these fractions but the glutelin are changed during malting and therefore influence the malting quality of the barley.

Effect of Fertilizers on Yield and Composition of Manitoba Barley

J. W. Hopkins

Experimental results obtained by Professor T. J. Harrison at Manitoba Agricultural College in 1926 and 1927 were analyzed statistically. Six fertilizers, phosphate, potash, nitrate, ammonium sulphate, cyanamide and sulphur, applied at heavy rates, were studied in 1926 and five in 1927, when sulphur was omitted. In both years the fertilizers were applied to plots summerfallowed the year before. In 1927, the residual effect of the manures also was investigated by growing a second crop of barley on the plots fertilized in 1926.

Weather conditions differed appreciably in the two years, and this apparently affected the response to fertilizers. Of the direct applications to the summerfallowed plots, phosphate increased the yield of straw, presumably by increasing tillering, since the length of straw was little affected. A high percentage of lodging resulted from any form of nitrogen, either alone or in combination with phosphate and potash, applied at seeding. The nitrogen fertilizers had no significantly beneficial effect on yield, but caused pronounced increases in the protein content of the grain in 1926 and smaller increases in 1927. Phosphate and potash in combination at seeding increased both weight and volume per 1000 kernels by about 5%. The coefficient of mealiness of the grain was reduced by all the nitrogenous manures, whether applied at seeding or at heading in 1926, but not in 1927.

Residual effects were confined to the nitrogenous group, especially sulphate of ammonia and cyanamide, which gave pronounced increases in yield of both grain and straw over the unmanured. Although yield of grain was thus increased, the protein content did not exceed that of the unmanured plots. Both weight and volume per 1000 kernels were also slightly higher on the residual nitrogen plots.

Agricultural Meterological Studies

J. W. Hopkins

The object of these studies is (1) to investigate the influence of weather conditions on the growth and yield of crops, and (2) by statistical examination of meteorological records to accumulate information respecting the average weather conditions in selected districts and the extent to which these vary from year to year.

Weather and Wheat Yield in Western Canada

In the course of the year a paper describing studies on the influence of rainfall and temperature during the growing season on the yield of wheat from experimental plots in Saskatchewan and Alberta was published (Can.

J. Research, 12 : 306-334. 1935). The investigation was later extended to include the effect of pre-seasonal precipitation (between August 1 of the preceding year and the sowing of the crop in the spring). After allowing for the effect of rainfall during the growing season it was found that, on the more fertile soil of variety test plots, the correlation between pre-seasonal precipitation and yield was not statistically significant; the requirements for significance were somewhat high owing to the variation introduced by growing the plots on different soil each year. There was likewise no consistent relation between pre-seasonal precipitation and the relative yield of the four early- and late-maturing wheat varieties studied. On both the stubble and fallow plots of the fallow–wheat–wheat rotation, however, a significant effect was demonstrable, increased precipitation during the autumn, winter and spring months being associated with increased yield.

Following this the correlation between annual precipitation and commercial wheat yields in six crop districts in central and southern Alberta and Saskatchewan was investigated. Homogeneous yield data from 1916 to 1930 and precipitation records from two meteorological stations in each area were available. In general the results obtained were in agreement with the plot findings, the maximum effect of additional rain occurring during the month of June. The southern districts showed a greater response to pre-seasonal precipitation than the central ones. Formulation of accurate yield prediction equations must await the accumulation of more extended series of annual yields. Meanwhile, the question of the number of meteorological stations required to provide a reliable estimate of the rainfall over a given area requires further study.

Weather and Protein Content of Wheat

A statistical study of observations accumulated over some 17 years by Dr. F. T. Shutt, former Dominion Chemist, Department of Agriculture, revealed a significant negative correlation between amount of rainfall during the growing season and the nitrogen content of Marquis wheat grown annually in experimental plots at five points in Alberta and Saskatchewan. The main effect was exerted during May and June, and it seems probable that additional moisture at this time stimulates vegetative growth, thus leading to an increased production of carbohydrates. Above-average temperatures during July and August were associated with a higher nitrogen content. The nature of the relation suggests that the effect of elevated temperatures is to increase the loss of carbohydrates from the developing grain by respiration. One paper has been published (Can. J. Research, 12 : 228-237. 1935) and another has been prepared.

Study of Evaporation Measurements

With a view to determining the extent to which evaporation is affected by intra- and inter-seasonal variations in atmospheric temperature, wind and humidity, a statistical study was made of observations of these quantities accumulated by the United States Department of Agriculture over a period of some 20 years at each of two stations, situated in Montana and New Mexico respectively. Evaporation records are not yet available in Canada.

At both stations July was the month of maximum average temperature, evaporation and vapor pressure. Average wind velocity was greatest at both stations in May, decreasing progressively throughout the summer. In general the amount of evaporation was markedly influenced by wind and humidity as well as by temperature. Annual variations in the evaporation during a specified calendar month were found to be correlated with temperature differences, but here also there was a significant additional effect of wind and humidity. Evaporation measurements should therefore supplement temperature records in agricultural meteorological studies.

Statistical Studies of Routine Co-operative Experimental Baking Tests

J. W. HOPKINS

Results of baking tests on the same series of flours in the three laboratories in the prairie universities co-operating with the Associate Committee on Grain Research, were examined statistically.

Within laboratories, consistent day-to-day differences in the loaf volume of duplicate samples appeared in this, as in all other extensive series of baking results so far examined. Experimental errors, as determined through deviations between duplicates, were, in two of the three laboratories, somewhat higher than anticipated. The frequency distribution of differences between duplicates within laboratories was determined. After eliminating consistent differences between days the distributions for two of the laboratories did not depart significantly from the requirements of the normal law of errors. They provided, therefore, no theoretical justification for the rejection of results, and increased accuracy must be sought through additional replication or improvements in general technique. In the third laboratory, however, the error distribution was such as to suggest that the elimination of a few outstanding discrepancies might result in a normal distribution of significantly increased precision.

Three comparisons were possible between laboratories. In each case there were found to be large irregular deviations between parallel samples, superimposed upon systematic differences in average loaf volume and range of volume over the series. The proportionality between the volumes in different laboratories was also found to differ somewhat between groups of samples baked on different dates. These results indicate some directions in which improvements in experimental methods should be sought.

Variation in Weight of Some Internal Organs of the Domestic Fowl

J. W. HOPKINS

In collaboration with Mr. J. Biely, Department of Poultry Husbandry, University of British Columbia, a statistical study was made of the weights of internal organs of 100 apparently normal yearling single-comb White Leghorn hens. The average weight of the liver, kidneys and spleen constituted 1.89, 0.64 and 0.12% of the average total live weight. Single organs, particularly the spleen, were relatively more variable than total body weight.

The weight of the organs from individuals of similar total live weight varied markedly, but on the whole the larger birds had somewhat larger organs. As the size of bird increased, however, the average percentage of the total weight due to liver, kidneys or spleen decreased. There was a moderate but significant correlation between the weights of liver and kidneys from birds of a specified total weight, but no evidence of association between kidneys weight and spleen weight. A full account of the results has been published (Can. J. Research, 12 : 651-656. 1935).

These biometrical data should provide standards of reference for anatomical comparisons between healthy and diseased birds.

Effect of Temperature on Mutation Rates in Cereals

F. H. PETO

Experiments conducted during the past year indicate that abnormally high temperature treatment of seeds or young plants may cause new heritable characters to appear which may be of considerable practical and theoretical significance. For example, a barley plant with double the usual chromosome number was obtained by germinating and growing the plants for seven days at 35° C. Attempts are now being made to duplicate this experiment and to develop a technique whereby the plant breeder may be able to produce new fertile and stable strains of plants by doubling the chromosome number in sterile first generation hybrids.

It is frequently very difficult for the plant breeder to break an association (linkage) between certain desirable and undesirable characters. Cytological studies have shown that certain of the heat treatments may be successful in breaking this association by causing an interchange of chromosome parts.

Hybridization of Wheats and Wheat Grasses

F. H. PETO

There is great need of a forage crop for western Canada which possesses drought resistance, soil-binding properties and large seeds. Certain Russian researches have indicated that perennial wheats produced by crossing wheat and wheat grass (*Triticum* × *Agropyron*) may have these characteristics. Consequently a project has been undertaken co-operatively between the National Research Council and the Dominion Experimental Farms whereby the latter are responsible for the plant breeding, genetical and agronomic phases of the study and the former for cytological studies and experiments designed to bring about fertility and stability in the hybrid progeny. The parental material is now being grown in preparation for hybridization during the summer of 1935. The F_1 hybrid seed will be used in experiments to induce chromosome doubling in an effort to produce fertile and stable lines.

Obligate Root Parasites of Higher Plants

G. A. LEDINGHAM

One of the major plant-disease problems in Canada today is the root rot diseases of cereal and garden crops. The importance of this problem and the necessity for further studies have been stressed at the meetings of the Associate Committee on Field Crop Diseases for a number of years. Since little fundamental knowledge was available concerning the obligate root parasites of plants it seemed well worth while for the National Research Council to carry on work on this phase of the problem.

During the past year studies have been made on *Rhizophidium graminis* and *Polymyxa graminis*, two new root parasites of wheat. The life histories of these with details of morphology and cytology are now ready for publication in the Canadian Journal of Research. *Polymyxa graminis* was found to be closely related to two other common parasites, one of which causes the club root disease of cabbages, the other the powdery scab disease of potatoes. The new knowledge obtained from the study of *Polymyxa* has cleared certain

obscure points in the life histories of these fungi and whereas only part of the life cycle had been previously described for the powdery scab organism it was now possible to complete the remainder (Nature, 135 : 394, March 9, 1935).

Very little work has been done in Canada on these fungi and no doubt many new parasites of this kind still await discovery. It is intended to investigate further more of these undescribed root parasites.

Fermentation of Agricultural Wastes

G. A. LEDINGHAM

Possibly wheat straw is the largest agricultural waste product produced in Canada. In its natural state straw has a very limited use in industry, but there are some possibilities of converting it into other useful compounds. Since the process of disintegration in nature is carried out by micro-organisms it seemed advisable to culture the more promising of these and study the compounds produced when grown on straw. A number of fungi were isolated from rotting stacks in western Canada. Twelve different species have been obtained in pure culture. Active work on this project has had to be suspended until an increase of staff becomes possible.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

While the following pages outline in fairly full detail the various projects under study in this division during the past year, a few introductory paragraphs will serve to explain their practical value to the country as a whole.

Problems of every province are represented in the work done during the year. The fishing industry of the Atlantic and Pacific coasts brought problems in the utilization of stearine from pilchard oils in the rubber and leather industries, the preservation of fish nets, and the grinding to a very fine powder of fish by-products of supposed dietetic value. The prairie provinces are interested in industrial uses for grain surpluses and certain mineral resources. The report on the utilization of grain for the production of power alcohol has received exceptionally wide distribution both in Canada and abroad. Since the starch content of the grain is of special interest in regard to the industrial use of cereal grains, the development of a convenient method for its estimation is of distinct importance. Work on the utilization of waste natural gas, which occurs plentifully in Alberta, has been continued, and very good progress made. The process previously developed for the production of liquid motor fuel from part of the gas has been improved, and a new process, with interesting commercial possibilities, for the manufacture of carbon black from the gas is being developed. Work on the bitumen of Alberta has gone forward, and the majority of the clay deposits which have shown promise for the manufacture of activated bleaching and refining clays are located in the western provinces. Samples from several silica sand deposits have been examined for specific industrial purposes. The increasing herds of buffalo promise to afford a supply of hides, and work on the tanning of these hides has been continued.

The central provinces, being more highly industrialized, have more interest in specific industrial problems than have other parts of the country. Therefore, while questions concerning natural resources and agricultural products

are still prominent, these provinces are also to be considered as markets for the industrial utilization of the products of the more basic industries of the country as a whole. For this reason they are the ones chiefly interested in any efforts towards industrial standardization and in being informed of developments of this nature in other countries. Lest the idea be given that basic developments are not being sufficiently stressed, however, it may be pointed out that the investigations of these laboratories on asbestos, magnesian products, maple products, etc., are essentially of primary interest to the central provinces.

The major problem of maritime interest is, perhaps, the work recently initiated on the industrial utilization of surplus potatoes. While this work was initiated too late in the year under consideration to allow any extended laboratory studies to be undertaken and reported, a plan of research was formulated and is now being energetically carried out. The plant erected in Nova Scotia for the production of dried apples treated by a process in the investigation of which these laboratories were concerned has been in regular operation and has aided in the solution of several operating problems which have arisen. A number of deposits of diatomaceous earth are found in New Brunswick and Nova Scotia. While the diatom structure has been found to be broken down to an appreciable extent, work has been done in an endeavor to develop means of their utilization as rubber fillers, filter aids, etc.

Some remarks concerning the advantages of centralized research facilities should be of timely interest. In addition to the advantages in cost and convenience of centralized direction, library facilities, and common stores of chemicals and equipment, and the readinesss with which experts in different fields can be consulted, the field of one research project frequently or eventually is found to enter upon that of another. This statement can be illustrated most clearly by a specific example. Our facilities for work on rubber are quite extensive, and in the past year our rubber work has embraced the testing of such compounding ingredients as pilchard oil stearine from British Columbia, carbon black from Turner Valley gas, mineral rubber made from Alberta tar sand bitumen, clays from the western provinces, silica sand from the central provinces, and diatomaceous earth from the maritime provinces. This same example also emphasizes the truth of the statement made earlier in this review concerning the value of the industrialized areas as purchasers of materials of basic origin, for while the rubber industry is almost wholly centralized in Ontario and Quebec, the compounding ingredients given above represent products of the entire Dominion from the Atlantic to the Pacific.

Other phases of the work are of direct interest to all parts of the country. The work on the wax plucking of poultry, initiated in co-operation with the Livestock Branch of the Department of Agriculture, has seen the development of a wax which is much superior to that originally hoped for. Demonstrations held in Ontario and Quebec have led to requests for similar demonstrations across Canada. Alkaloids from one of the plants under study in the laboratories have shown promise as the toxic ingredient of a spray to use against insects attacking fruit trees, and through the interest and co-operation of the Department of Agriculture further tests are being made, limited only by the quantity of the alkaloids immediately available. The work of the laundering department has made great progress during the year, and by the organization of the Canadian Institute of Laundering and Dry Cleaning is now soundly established as a national laboratory of the trade. The program of wool research has included studies of interest to the wool grower, the manufacturer and the consumer.

During the year under consideration the members of the professional staff of the division contributed 14 papers for publication in the Canadian Journal of Research and 7 papers in other publications. Several lectures were given by members of the division before outside associations and before the Science Association of the National Research Laboratories. The weekly meeting of the staff for the purpose of keeping one another informed of world progress in chemical research as reported in the technological and scientific journals has been continued. The general discussion which follows the presentation of these reports is of at least the same degree of interest as the reports themselves.

Dr. R. H. Manske was elected a Fellow of the Royal Society of Canada during the year. Dr. L. Marion was granted leave of absence to do advanced study at the University of Vienna on problems connected with his work in the laboratories. Dr. O. M. Morgan resigned to undertake the development of a research project for one of the larger United States chemical companies. A number of the members of the staff have taken part in the work of the committees and subcommittees organized to draw up specifications for government purchases. This work has made very gratifying progress. In some instances provincial governments have desired to adopt certain of these specifications, and there is every reason to believe that this trend will continue.

As in previous years, the direction of the work on magnesian products has been in the hands of Mr. F. E. Lathe, Director of the Division of Research Information. At the last meeting of the Engineering Institute of Canada Mr. Lathe was awarded the Plummer Medal for his paper on "The Utilization of Magnesian Carbonates."

Alberta Bitumen

A. Cambron, T. R. Griffith

In order to obtain larger quantities of processed bitumen for commercial trials, a still of 10 gallons capacity and capable of operating under closely controlled conditions was designed in the division and built towards the end of the last fiscal year. This still has since been installed in one of the industrial chemistry laboratories and is being used as planned.

Asbestos Research

D. Wolochow, A. van Winsen

The template, mentioned in the previous report, for checking the Quebec standard testing machine, has been adopted by the Quebec Asbestos Producers' Association and is being used. Further, in connection with the standardization of the Quebec testing machine, standard conditioned samples of asbestos fibre have been supplied at regular intervals.

A special apparatus for determining the apparent density of absestos fibre has been designed and built. Various new lines of investigation, designed to secure a better understanding of the qualities of milled asbestos fibres and to evaluate such fibres on the basis of their physical properties have been pursued during the year. The settling rate of various grades of asbestos fibre in water has been studied, and the effects of certain dispersing agents which retard this rate have been observed. An adsorption test for determining the degree of milling, or the "fibration index", of asbestos fibres has been developed; the industrial application of this test will be studied. Alternative

methods devised by two of the asbestos producers were studied and reports submitted. At the request of the Quebec Asbestos Producers' Association, a series of factory tests was made to determine the relative values of open and crudy milled asbestos spinning fibres. The data obtained were analyzed and discussed in two reports submitted to the Association.

The leaching of asbestos fibre with distilled water, free from, and in the presence of, carbon dioxide, is being studied.

Work on various projects outlined in the previous report has been continued.

Bituminized Portland Cement

D. Wolochow, N. H. Grace, A. F. Gill

With the kind co-operation of the Testing Laboratories of the Department of Public Works, a comprehensive series of tests was carried out on bituminized portland cement. This material, in which the cement particles are partially covered with bitumen, is being employed in Europe for road construction and is claimed to possess certain advantages over ordinary cement, such as greater resistance to low temperatures. Tests made included strength tests, heat of hydration, and linear change measurements. For purposes of comparison, the portland cement from which the bituminized cement was made, and a second portland cement, were included in these tests which were carried on up to a period of one year. The work has been completed and a report submitted.

Carbon Black

L. M. Pidgeon

Carbon black continues to be the most important reinforcing material used in the rubber industry, and is being employed in increasing proportions in tire treads. Practically all the black used in Canada is imported, despite the availability in Canada of large quantities of natural gas, the raw material for carbon black production. In the gas-oil field of the Turner Valley, Alberta, gas to the extent of about 200 million cu. ft. a day is now going to waste.

The object of the present researches is to study the production of carbon black from natural gases, especially from those available in the Turner Valley, and if possible to develop a method of production capable of yielding carbon black at a cost which will enable it to compete with black produced in the southern states, which, on account of the shorter haul to the consuming centres in central Canada, enjoys an advantage in the matter of freight charges. Very satisfactory progress has been made in pursuit of this object during the year.

A large number of samples of carbon black have been made in the experimental channel plant described in the last report. It has been found that from the waste "dry" natural gas of the Turner Valley there may be produced good yields of a black which exhibits excellent properties in rubber. The effect of varying certain known factors of production has been examined. An economic handicap on successful commercial operation continues to be the high sulphur content of this gas, which necessitates purification before use in the standard channel system.

Extensive experiments have been made on the use for carbon black production of another gas available in the Turner Valley, *viz.*, "Stabilizer" gas, *i.e.*, the gaseous or highly volatile material which is contained in the

gasoline as first secured from the wells and which it is necessary to remove before the gasoline can be shipped. In most of the experiments this gas was subjected to preliminary processing before being used for carbon black production. Yields of channel black up to 7 lb. per thousand cubic feet of gas have been secured, as compared with about 1½ lb. usually obtained from "dry" gas. The effect on the yield and quality of the black of gas composition, channel height, draft control, rate of gas flow, and other variable factors has been worked out.

A series of rubber tests has been carried out relating the controllable variables of production with rubber reinforcement. These blacks were compared with commercial blacks as to their resistance to abrasion, aging, and tensile properties, with results which show that the new blacks are as good as, and frequently superior to, the commercial blacks.

Research has been carried out on improved methods of evaluating carbon black for rubber reinforcement. Sorption of iodine, benzene, and vapor and methylene blue, have been correlated with rubber reinforcement and the factors of production. Optical methods have been further examined with less success in the case of channel blacks, but this method seems to be useful for thermal process blacks. (This work will, it is expected, be published in a series of scientific papers in the near future.)

During the latter part of the period covered by this report a new method of producing black from hydrocarbon gases has been evolved and very high yields have been obtained by means of it. In the case of propane the yield is approximately ten times that obtainable in the channel process. The new black appears to have better reinforcing power than the thermal process blacks at present on the market and is in many respects similar to the channel black, which is at present the standard of the rubber industry.

Chemistry of Plant Products

R. H. MANSKE

The isolation of alkaloids from fumariaceous plants and their chemical and pharmacological investigation have been continued. A number of new species (*Corydalis cheilanthifolia*, *C. ophio carpa*, *C. sibirica*) have been examined and a total of some fifteen new alkaloids obtained.

Among plants of the orders which were examined, special interest attaches to one grown in western Canada, the alkaloids from which seem to be of value as an insecticide. They have been tested by Mr. A. Kelsall of the laboratories at Annapolis Royal. In a preliminary trial, the toxicity was found to be appreciably greater than that of nicotine to two insect species. Experiments on a larger scale are in progress.

Other plants in the course of investigation include *Menispermum canadense*, *Lobelia cardinalis*, *Coptis trifolia*, *Hypecoum leptocarpum*, and *H. procumbens*.

Diatomaceous Earth

MISS H. D. CHATAWAY

Renewed attention is being given to the investigation of specialized uses for Canadian diatomaceous earths. The Canadian materials differ appreciably from those of foreign origin. Research into their inherent qualities and the special uses to which, after the application of suitable refining processes,

they can be most advantageously put, are giving encouraging results. In particular, their use in both the paint and the rubber industries is being further investigated.

These studies have been facilitated by the Mines Branch which has already done extensive mapping of the Canadian deposits and has kindly supplied samples and information.

Distillation

D. F. STEDMAN

Owing to the great interest at present shown in the separation of isotopes, the 16-ft. column erected at the beginning of this year for work on this subject has been in constant use. Repeated tests have been made by various procedures attempting to concentrate the heavy hydrogen isotope by distillation of water, but these have been largely unsuccessful, both at atmospheric pressure and under vacuum. These distillations, however, have given quite considerable separations of the oxygen isotopes and efforts have been concentrated on getting pure O^{16}. In this work, 30% of the heavy oxygen isotopes have been removed, but, as this indicates an excessively small boiling-point difference for the various forms of water, attention is now being directed to the fractionation of liquid oxygen by means of this column, and for this purpose a vacuum jacket for the column is being constructed.

Owing to the difficulty of concentrating "deuterium" by distillation, a test was made by long continued electrolysis of a small sample of water, but no change in density occurred. From this, it would appear that electrolysis does not produce the heavy hydrogen, but merely concentrates it.

A further test was made of the possibility of utilizing Turner Valley methane as a source of deuterium. A sample of mono-deuterio-methane was prepared, and its boiling point proved to be 0.5° (± 0.1°) lower than the normal gas. If adequate uses for deuterium develop, there is little doubt that it could be obtained fairly readily from the methane of natural gas fields.

Food Products—General

The Vitamin C Potency of Apples and Dried Fruit

A literature survey was prepared on the vitamin C potency of apples and dried fruit with particular reference to the effect of sulphur dioxide treatment. (N. H. Grace.)

Tin in Food Products

A report was prepared on tin in food products. This dealt with the subject primarily from the standpoint of public health. The heating of various foodstuffs in tinned containers is being studied in the laboratory. (N. H. Grace, A. van Winsen.)

Apple Taint

On the request of the transportation companies, a conference was held, in which the Department of Agriculture, the Division of Biology and Agriculture, and the Division of Chemistry joined, to discuss means of preventing the flavor or taint imparted to certain food products carried in box-cars which had previously been used for shipping apples. A committee was formed to study the problem and some work on the chemical aspects of taint has been started. (N. H. Grace.)

Sugar Beet Table Syrup

Three methods for the home preparation of table syrup from sugar beets were tested. Taking all factors into consideration, one method could be recommended in preference to the others. Direct decolorization of beet syrup with decolorizing carbon does not improve the syrup to such an extent as to justify an additional complication of the existing processes. However, an adjustment of the acidity of the syrup (to about pH 4.0) before the application of the decolorizing carbon seems to improve the syrup as to flavor, color, and brilliancy. The speed of filtration is also greater. It appears that more work in this direction is justified before final recommendations can be made. (L. Skazin.)

More extended reference to other food products will be found elsewhere in the report of the division, under headings, as Honey, Maple Products.

Gas Research

A. CAMBRON

Work on the vapor-phase cracking of heavy petroleum fractions has been continued and means have been established whereby the composition of the liquid products can be varied in marked degree. The value of this work lies in the increase in the amount of aromatics (components of high anti-knock value) which can be produced. At 800° C., for example, about 23% of the gas oil sample treated is converted by one passage through the cracking apparatus to 205° end-point gasoline. Under normal treating conditions this gasoline contains about 20% of benzene and toluene. Under the conditions established in these laboratories, however, the benzene and toluene content of this gasoline has been increased to 60%.

Work on a protective coating for preventing the carburization of heat-resistant alloys under pyrolysis and vapor-phase cracking conditions has been completed and a coating has been developed which provides effective protection.

The rate of deposition of carbon on a coated 28%-chromium alloy, for instance, was found to be of the order of 0.08 mm. in 100 hours under pyrolysis conditions. This is about a third of the rate of deposition of carbon on a 28%-chromium alloy surface under the same conditions, before the metal has become carburized; and when the unprotected alloy has been subjected to an oxidizing atmosphere after it has become carburized, carbon forms on the surface at a considerably higher rate, blocking the tube after a few hours.

The permanency of the above coating under operating conditions was determined in the course of three series of experiments during which the coated alloy was subjected to (*i*) alternate heating and cooling; (*ii*) heating alternately under carburizing and oxidizing conditions; and (*iii*) prolonged heating under pyrolysis conditions.

The first series of experiments showed that, when applied to high-chromium alloys, the coating does not peel or break off when the alloy is repeatedly subjected to reaction temperature and cooled to room temperature. When the coating is applied to heat-resistant alloys of the 18%-chromium-8%-nickel type, which have a thermal coefficient of expansion almost twice as high as that of the 28%-chromium alloy, the coating tends to crack and break off under alternate heating and cooling. High-chromium alloys, however, have a greater heat resistance and have been found more suitable for

pyrolysis than the nickel alloys. The second series of experiments showed that the coating does not lose its protective action when it is repeatedly heated in an oxidizing atmosphere after being subjected for long periods to pyrolysis conditions. The third series of experiments, one of which consisted of a continuous run of three weeks' duration, showed that the coating is still effective in preventing the carburization and the consequent failure of high-chromium alloys when these are subjected to pyrolysis conditions for long periods of time.

Honey

Miss H. D. Chataway

In order to enable a cheap honey grader to be put on the market for the use of honey producers and of inspectors in administering the new grading provisions in the Fruit and Honey Act, specifications for a series of standard colors were drawn up at the request of the Dominion Department of Agriculture. Subsequently, 200 graders were constructed by a firm of consulting chemists in accordance with these specifications, in time for the 1934 crop.

Following a request made at a meeting of the Conference on Honey held during the year, a table was prepared showing the relation to moisture content of the numerous scales (Brix, Baumé, and such various ones as specific gravity, viscosity, and refractive index) that may be used in connection with the determination of moisture content in honey.

Detailed specifications for a special honey hydrometer were prepared and supplied to the Dominion Department of Agriculture.

Some experiments have been made on the use of activated bleaching clays for the bleaching of beeswax. Reasonably good results were secured. Although the bleached samples had a slight yellowish tint, it is thought that a short supplementary sun bleaching would give a white product. (Dr. W. Gallay collaborating.)

Industrial Uses for Grain

C. Y. Hopkins

Starch Content of Wheat

Since the ordinary industrial uses for wheat are based on the starchy portion of the grain, it was considered desirable to determine the content of starch in the lower grades of Canadian wheat. A convenient polarimetric method for estimating starch was developed for this work. The details of the method and proof of its accuracy have been published in the Canadian Journal of Research. Average samples of seven grades of Canadian wheat were analyzed for starch and showed but little variation from the higher to the lower grades. This is in contrast to the protein content which in general decreases with grade. The results indicate that the lower grades will be found particularly suitable for such industrial purposes as fermentation to alcohol or to organic solvents, or for the manufacture of wheat starch.

Power Alcohol

It was found necessary to issue a second report on the subject of grain alcohol for motor fuel, copies of the 1933 report having been exhausted. The opportunity was taken to add new material and make necessary revisions.

Industrial Uses for Minerals

The Physical Chemistry and Practical Applications of Clays and other Fillers

The value of clays as fillers *e.g.*, in rubber, depends upon the fineness of division or state of dispersion of the clay and the force of attraction between the clay and the other constituents of the mixture. The particle size ranges of several clays and silicas were measured and fractionations carried out in some instances. Various physico-chemical properties such as dye adsorption, liquid absorption, light extinction, etc., were measured in relation to particle size. (W. Gallay.)

Silica

(1) A large number of determinations of particle sizes have been made on silicas, flints and clays for various commercial purposes and Canadian producers have been aided in ascertaining the value of their products. In one instance alone, it has been estimated that about $20,000 was saved for one firm through determinations of degree of dispersion on certain fillers. (W. Gallay.)

(2) Several samples of silica sand from widely separated deposits were examined for their industrial value in such projects as the manufacture of sodium silicate, floor detergents, etc. (C. W. Davis, F. G. Green, D. Wolochow.)

Marl

Experiments were carried out on the feasibility of bleaching, by various calcining methods, marl containing organic impurities. (W. Gallay.)

Iron Pigments

Several samples of natural pigments were examined to determine their suitability for use in paints, but none of them was found to be of specification grade. (C. Y. Hopkins, C. W. Davis.)

Lithopone

A study was made of the possibility of developing an indigenous lithopone industry, a review being prepared on the subject. This survey of the field considers certain of the chemical phases of the question and also deals with some of the more important sources of the raw materials, possible economic location for manufacture, and rough costs of production. Since Canadian imports of lithopone amount to about 8,000 tons annually, and all the raw materials are native, there is justification for giving careful consideration to the possibility of establishing in Canada the manufacture of this important white paint pigment. (N. H. Grace.)

Other Industrial Minerals

More extended reference to studies relating to other aspects of the industrial uses of mineral products will be found elsewhere in the report of the division under the headings—Diatomaceous Earth, Magnesian Products, and Mineral Fillers for Rubber.

Industrial Utilization of Potatoes

W. GALLAY

Investigation has been initiated on the comparative values for various purposes of starches including chiefly those from potato, corn, wheat, and cassava; and the fundamental differences in these starches are being studied. The use of edible starches as fillers, for culinary and confectionery purposes, baking powder, and icing sugar, and in the manufacture of confectioners' glucose, syrup, and grape sugar will be investigated. Further, it is planned

to carry out work on starches for such industrial uses as in laundries, foundries, the preparation of vegetable glues and other adhesives, the finishing of paper and textiles, and the manufacture of asbestos products, explosives and linoleum. In all cases comparison will be made of the value of the different types of starch and starch products, special attention being given to studies of acid modification, oxidation, gelatinization, dextrinization, and other starch conversions.

Laundering and Dry Cleaning

C. H. Bayley, B. J. Kenalty

The "test bundle" service initiated by the laboratory has been greatly extended and during the year 397 bundles for white work and 89 bundles for colored work have been issued. Laundries using this service have maintained a high degree of efficiency in such factors as detergency, whiteness retention, and low tensile strength loss. This service has proved to be of definite value in enabling laundries to keep a close check on the efficiency of their operations.

Experiments carried out in conjunction with the Department of Household Science, University of Toronto, for the purpose of comparing the efficiency of washing done by power laundries with that done in small domestic washing machines are being continued. The scope of this investigation has been extended to include all of the present types of domestic machines.

In connection with the establishment of the Canadian Research Institute of Launderers and Cleaners, the laboratory has prepared standards of plant efficiency for use by the Intsitute. All of the technical and research work of the Institute will be carried out by the laundry laboratory.

The work of the laboratory has been extended to include the problems of the dry-cleaning industry. A program of research on the efficiency of the various dry-cleaning solvents and soaps, together with a study of the fundamentals of the dry-cleaning process, is being followed.

The investigation on the production of a cheap water softener made from Canadian raw material from the asbestos mines is being continued. It has been found possible to prepare synthetic base exchange material having high capacities for water of low calcium and magnesium hardness. The capacity of these synthetic materials towards waters of hardness ranging from 4 to 26 grains is being investigated.

A systematic study of the detergency efficiency of the soaps of the various fatty acids has been begun. Preliminary experiments have been carried out on four commercial soaps prepared from various commercial fatty bases. The effect of temperature and of concentration of sodium carbonate (builder) has been studied. It has been found ncessary to make certain modifications in the type of standard soil used in these experiments. It is proposed to determine the detergency efficiency of the soaps prepared from the individual fatty acids present in commercial soaps and to carry out a number of other measurements on the physical properties of solutions of these soaps.

Service work for the industry included 367 reports covering the investigation of new and damaged fabrics, soaps, alkalies, water problems, and miscellaneous analyses.

In connection with the work of the Canadian Government Purchasing Standards Committee, the laboratory has collaborated in the preparation of the following specifications for the Subcommittee on Soap and Detergent Specifications; Liquid Toilet Soap, Household Bar Soap, Laundry Chip Soap and Laundry Powdered Soap, Soft Soap, Milled Toilet Soap, White Floating Soap and Liquid Household Soap.

Leather

W. E. GRAHAM

Considerable attention has been given during the year to matters relating to the composition and useful physical properties of leathers with a view to establishing criteria of quality. Apparatus for measuring permeability of leather to air and water, the apparent density, and the strength and elastic properties of shoe upper leathers, has been installed in the laboratory during the past year. This apparatus and equipment for the testing of resistance to abrasion previously constructed in the laboratory shops are being used in studies of the physical properties of Canadian leathers. With the co-operation of members of the tanning industry who are particularly interested in tests of water permeability and abrasion resistance, investigations on these subjects have been carried out or are in progress.

Research on the utilization of waste products of the leather industry, has yielded a convenient method for recovering wool from alum- and vegetable-tanned sheep skin scrap from skins tanned in the wool. Further work has also been done on the recovery of glue from waste chrome leather.

As part of a program embracing the use of Canadian materials in the tanning industry, studies are in progress on the utilization of Canadian fish oils.

Studies have also been made on a number of service problems submitted by the industry. Among the more important of these was the further examination of deteriorated chrome uppers as a result of which methods of preventing these losses were developed and are now being investigated. Deterioration of upholstery leathers in industrial atmospheres and methods for its prevention have been studied.

Several examinations of leathers, leather goods, materials used in treating leather or in the manufacture of leather goods, have been made for other branches of the government service.

Magnesian Products

N. P. PITT, L. HODNETT, E. G. BAKER

The major projects under way during the year have been the development of new and improved refractory clinkers and an extension of the field in which these can be supplied.

In this work, to which Canadian Refractories, Limited, have made a substantial financial contribution, the staff has enjoyed the close co-operation of that company. Since the work is entirely of a commercial character, attention has been paid throughout to the economic factors involved.

Some hundreds of refractory clinkers have been made on a small scale in the laboratory of compositions not previously tried, so far as is known. Of these a large number have exhibited a high degree of refractoriness and exceptional stability to the action of water or steam. A few of the best of these

clinkers have been made on a larger scale in commercial kilns and their properties have been studied in some detail. Much time has been spent in the development of suitable tests for their capacity to bond under the action of heat alone, their resistance to the action of slags, and other properties desired in commercial products. This work is now nearing completion and it is hoped that it will shortly be possible to determine the broad fields in which these new refractories are most likely to find commercial application.

While many refractory clinkers have been bonded satisfactorily by the application of heat alone, there is a great demand for materials which, at ordinary temperatures, can be molded in place with chemical bonds. This field has been very actively explored during the year in respect to both physical and chemical composition of the aggregates and bonds. So many elements play a part in determining the success of any material or application that such investigations must proceed rather slowly in order to ensure that no important factor is overlooked. Substantial progress has nevertheless been made. Very definite improvements are being effected in the products already in commercial use. Bonds of an entirely different type, radically modifying the characteristics of the refractories, have been found applicable to such products, and the scope of their application is now being determined.

The report of the Associate Committee on Magnesian Products, under whose auspices the above work is carried on, appears at page 99.

Maple Products

L. SKAZIN

A considerable amount of study has been devoted to certain questions relating to the process described in the last report for the production of maple syrup of intense flavor. The process depends on the fact that maple sap lacks maple flavor and that the flavoring principle is produced only while the sap is being boiled down to syrup or sugar. The process involves two steps: (1) the concentration of the sap to syrup in such a way that no flavor develops; (2) heating the flavorless syrup in a closed pressure vessel at a temperature above its boiling point. In this way a more intense maple flavor is developed than when sap is boiled down to syrup in an open vessel, as in the ordinary production of maple syrup.

During the year the conditions which determine the development of flavor during the ordinary boiling down of sap to syrup have been studied, and some interesting discoveries have been made in connection therewith. The possibility of making practical application of these observations will be explored during the next maple sap season. As to the actual development of intense flavor in flavorless syrups, it may be noted that experiments made during the year have established the exact relation between flavor on the one hand and temperature and time of autoclaving on the other.

Referring to the process, developed in the laboratories and mentioned in the last report, for the production of a concentrated extract of natural maple flavor, it may be mentioned that, since numerous requests for samples of the concentrate have been received, a crystallizer for the small-scale operation of the process has been designed in the division and constructed.

A new form of maple sugar block developed in the laboratories has clear advantages over the ordinary, cast blocks, in that the sugar does not harden and become mottled when kept. Merchants, however, objected that the color of the first samples distributed was so pale that consumers, accustomed to

the deeper color of the usual blocks, would find difficulty in believing the product pure. Non-mottling and non-hardening blocks have now been made much darker in color than formerly, but it cannot, at this time, be said whether the marketing difficulties have yet been overcome.

A sample of maple sugar made in Manitoba was analyzed and suggestions were made for improving the product.

Milkweed

N. H. Grace

An experimental study has been undertaken on the retting of milkweed stalks by fermentation and chemical methods. While encouraging progress has been made, milkweed fibre differs considerably from flax and hemp and, quite apart from technical considerations, the abundance and low price of both flax and hemp are adverse economic factors which indicate that development of milkweed as a source of bast fibre for textiles is open to serious question.

Chemical treatment of the floss (seed fibre) was investigated to some extent in an endeavor to overcome some of the difficulties encountered in a commercial spinning and weaving test. This work is still in progress. Study of the compressibility or resilience of the floss in comparison with other filling materials such as kapok gave rather favorable results.

A fairly large supply of roots has been obtained and stored for future investigation.

Mineral Fillers for Rubber

W. Gallay, T. R. Griffith

A number of clays were tested as fillers in rubber stocks. Direct relations between the value of the filler and its particle size were found in testing clay fractions, particularly when the total surface area per unit weight of different clays was measured. These data should prove important in the evaluation of clay fillers. This work was extended also to silicas and it was found that within each type of filler, particle size is the criterion of value, but that the types vary in the nature of their attraction for rubber.

Experiments were carried out with an air-separated fraction of diatomaceous earth supplied by Dr. H. D. Chataway. The particle-size range was determined and tests were made in a rubber stock. The material shows promise as a filler in rubber.

Experiments have been carried out with various materials in attempts to increase the force of attraction or bonding between certain fillers and rubber. Various "wetting agents" have been included. This work is still in progress.

Most of the above work will be described fully in forthcoming articles in the Canadian Journal of Research.

Paints

C. Y. Hopkins

A program of research on paints has been undertaken with a view to fostering the use of Canadian materials and developing improved durability tests for protective coatings. A series of outdoor and accelerated weathering tests on standard paint formulas was begun. Laboratory examinations and analyses of a number of commercial paints and of putty were made at the request of the Commission on Price Spreads.

In collaboration with a committee, representative of various government departments interested in the purchase of paints, standard specifications were drawn up for the following paint materials: raw linseed oil, boiled linseed oil, turpentine, petroleum thinner (Types I and II), liquid paint drier, and putty for glazing. The specified requirements and methods of testing were based on actual laboratory examination and tests of these materials.

Plasticity of Hydrated Lime

A. F. GILL

The superior "workability" of undried lime putties over dry hydrates on the one hand and of magnesian or dolomitic hydrates over those high in calcium, on the other, is well recognized. The difference becomes important when the materials are used as finishing plaster which it is necessary to trowel to a smooth continuous surface. The accepted explanation for this behavior is that the workability of a lime depends upon the presence in it of a major proportion of particles of colloidal size surrounded by a lubricating layer of adsorbed water. The limitations inherent in the commercial preparations of dry hydrates have prevented, in large measure, any marked improvement in the properties of high-calcium products.

With the idea of supplying an artificial gel to replace the colloid component in non-plastic hydrates, laboratory tests were made of the addition of aluminium sulphate to commercial products. It was recognized that on subsequent tempering with water the material would react with the calcium hydroxide to yield gelatinous aluminium hydroxide, which in turn would tend to coat the particles and supply a lubricating film.

The effect of the aluminium sulphate additions was observed quantitatively by means of a flow-table plasticimeter. Favorable laboratory indications were followed by practical trials which demonstrated that high-calcium hydrates could be rendered as valuable as high-priced dolomitic finishing hydrates. Subsequent to publication of the results two large lime producers indicated their intention of making commercial trials of the treatment.

Refining and Bleaching Clays

W. GALLAY

The investigation of Canadian refining and bleaching clays begun last year has been extended. A study of samples taken from various parts of one Manitoba deposit has shown the material to be of excellent value. The economical removal of certain impurities, and the comparative efficiencies of the materials, were studied, and as a result the mining costs have been greatly decreased. It has been reported that plans are in progress for the erection of two plants. The optimum conditions for activation have been determined.

In co-operation with Prof. W. G. Worcester of the University of Saskatchewan, who carried out the field work and preliminary laboratory work under the auspices of the province of Saskatchewan, an extended laboratory examination has been made of a number of bentonites from various deposits in that province. Activation experiments were carried out and the activated products evaluated for mineral oil refining. The unactivated materials were tested mainly in the bleaching of vegetable oils. A number of deposits were shown to possess good efficiency for the latter purpose. One bentonite in particular was shown to be readily susceptible to activation yielding a highly efficient product for the refining of lubricating distillates.

Miscellaneous clays and volcanic ash were tested for the refining of various oils.

Rubber

T. R. Griffith

During the past year the rubber laboratory has given technical advice in regard to manufacturing and related problems and has answered a number of inquiries on such topics as the following: preservation and manufacture of rubber gloves, latex adhesives, rubber cements, rubber compounding ingredients, manufacture of rubber articles directly from latex, and bonding of rubber to metal.

The article entitled "A Mathematical Treatment of a Theory of Rubber Structure," published in the May 1934 issue of the Canadian Journal of Research, has been well received; many requests for reprints have come from Canada and abroad.

The work on the bonding of rubber to metal was further pursued. Samples were prepared for examination by interested companies.

Some study was given to the commercial possibilities of a newly-introduced form of crude rubber.

An investigation was carried out on the behavior at Canadian winter temperatures of aeroplane shock-absorber cord, which causes difficulty owing to its change of elastic modulus at low temperatures. During this investigation certain unsuspected characteristics of the behavior of rubber at low temperatures were observed. It is proposed to study these further during the coming winter.

At the request of the Department of Naval Service, a preliminary draft was made of specifications for the various rubber articles used on naval vessels.

In conjunction with the Prince Rupert (B.C.) Experimental Station of the Biological Board of Canada, experiments have been made which have demonstrated the possibility of producing from Canadian raw materials fatty acids suitable for use in rubber compounding.

Sorption

L. M. Pidgeon

Reduction of Vapor Pressure by Rubber and Similar Polymers

The relation between concentration and vapor pressure in the rubber-benzene system has been investigated. It has been found that mechanical and extractive treatments are without effect in this relation, although they appear to affect the degree of polymerization of the rubber. The work has been extended to polystyrenes and to poly-acrylic esters of known molecular weight. The molecular weight of a long-chain polymer has little effect on the vapor-pressure relation so that measurements of this kind do not indicate the molecular weight of the polymer as has been supposed.

The vapor-pressure relations of rubber-carbon black mixtures have been examined and this work is to be extended, as it appears to offer a means of evaluating the bond between the pigment and the rubber which is responsible for reinforcement.

Sorption of Vapors

Papers covering work on sorption of vapors by active silica and silica gel have appeared in the Canadian Journal of Research during the period covered by this report.

Survey of Consumer Commodities

In connection with the Price Spreads Investigation a survey was made of various commodities in common use to explore in a preliminary way the possibilities of establishing national standardization of quality and grades. The survey included cotton, wool, silk and rayon textiles in piece goods and manufactured articles, soaps of all grades, rubber hot water bottles, dry-cleaning solvents, insecticides, silver-plated ware, aluminium ware, paints and putties, leather soles. In addition reports were prepared at the request of the Commission or its staff on such specific points as use of shoddy in woollen cloth, quality of dyes used in Canada, examination of samples of jam, etc. (A Cambron, P. Larose, W. E. Graham, C. Y. Hopkins, C. H. Bayley, L. Skazin, C. W. Davis, T. R. Griffith.)

Wax for Poultry Plucking

N. H. Grace

In co-operation with the Department of Agriculture, a study of the use of "wax" in poultry plucking has been carried to successful completion. A simple, inexpensive wax has been developed; this can be used with very primitive equipment and the method of use requires little control and lends itself to use by the farmer as well as the packing plant. By means of this "wax" most classes of poultry can be plucked simply by dipping the bird, after dry-roughing, in the molten wax at a suitable temperature, allowing the wax to set and then stripping it. The wax carries with it all feathers and down, and leaves the bird with an excellent finish. The pinny broiler, or moulting bird, is preferably semi-scalded before being wax-plucked in order to secure the best results.

In all, considerably more than 140 different compositions were made up and studied, and a large number of different methods of application were tried before the process and the wax were finally approved.

Wool

P. Larose, Miss A. S. Tweedie

The Animal Husbandry Department of the University of Alberta, which is proceeding with experiments on the influence of environmental factors on the quality of wool, has continued to send to these laboratories samples taken from the fleeces of the animals used in the experiments. Determinations of staple length, fibre length, crimp, tensile strength, fibre diameter, grease, suint, dirt, and yield of clean wool were made on these samples, which included those clipped in the spring of 1934 as well as a large number clipped in the fall of 1933. The tests also included the washing of ten whole fleeces in order to compare the yield with that of the smaller samples.

The sulphur content of a number of Canadian wools is being determined by a new method which has been found well adapted for this purpose.

A machine has been redesigned and constructed for testing the resistance to wear of cloth. This machine is similar in principle to the laboratory device previously developed. A number of tests have been made with it to determine the effect of various factors which may influence the results of tests.

Tests on the fastness to light of fabric dyed with a wide range of dyes were conducted on the roof of the laboratories during the summer of 1934, in connection with the establishment of standards of light fastness. Tests were

also made in the "Fugitometer" to determine the best conditions for rapid fading in this instrument and the relation between the results of accelerated and natural fading tests.

Resiliency tests on four samples of yarn were completed and a paper was published on the subject in the June number of the Canadian Journal of Research.

A number of experiments on the determination of regain of raw wool were carried out.

The absorption of sulphur compounds from benzene when the latter is used to wash wool was also investigated.

Government Standards

Thirteen specifications covering methods of test for textiles were prepared. A specification for a wool and cotton flannel was also prepared. In this connection a complete analysis was made of flannel supplied by one of the departments interested.

Miscellaneous

1. Analyses. Among the analyses carried out during the year were:

(a) Inorganic analyses of asbestos, cements, clays, refractories, pigments, metals and solutions. (950 samples, 1650 determinations.)

(b) Analyses of soaps, washing compounds, oils, fats, waxes and textiles. (135 samples, 400 determinations.)

(c) Water analyses—twenty-six samples were examined (7 for the Tidal Survey for chlorine, 14 for the Biological Board for copper, 5 complete analyses re corrosion problems).

(d) Continued study and analysis of anti-freeze solutions to determine the merits of different types and co-operation with Dr. C. Y. Hopkins in developing standard tests.

(e) Miscellaneous analyses—rubber samples for ash, corrosion products, strawberry jam, varnish driers. (C. W. Davis.)

2. Pitchblende. A sample from the Hottah Lake deposit was analyzed for uranium, lead, thorium and the rare earth metals. Special attention was given to the thorium determination since mesothorium can be considered an impurity in commercial radium salts. (C. W. Davis.)

3. Motor Fuels and Lubricants. Chemical analyses were made for sulphur, anti-knock compounds and iodine numbers on 29 samples of aviation gasoline, 62 samples of motor gasoline, and for sulphur only, on 44 samples of benzol.

Standard tests including oxidation and coke numbers were made on 11 samples of lubricating oils. (C. W. Davis.)

4. Matches and Spontaneous Combustion. In co-operation with the Department of Insurance and the match manufacturers, 15 samples of matches were tested. A revision of the splint test was suggested. A special investigation as to the likelihood of oil-impregnated mops causing spontaneous combustion was reported. (C. W. Davis.)

5. Floor Detergents. A study was made of the literature dealing with floor detergents, and a brief report was prepared. Some experimental work was carried out and is being continued. (N. H. Grace, A. van Winsen.)

6. Preservation of Fish Nets. A literature review was prepared on the preservation of fish nets. Special note was made of the most important factors affecting deterioration and the precautions necessary to minimize the unduly rapid failure in service. (N. H. Grace.)

7. Adhesive for Postage Stamps. At the request of the Postmaster General, the efficiency of the adhesive now in use on Canadian postage stamps was investigated. Comparative experiments were carried out on adhesives in use in other countries and the conclusions reported to the Post Office Department. (W. Gallay.)

8. Permanence of Documents. The work on this subject referred to in the previous report was completed. Based in part upon it, government specifications for the purchase of fine papers are now being prepared. (H. D. Chataway.)

9. Photo-gelatine Engraving. Various problems of importance in regard to the quality of the print produced by the photo-gelatine engraving process were given consideration, and as a result it was possible to make recommendations which enabled the firm bringing forward the problems to secure a large measure of improvement in its product. (W. Gallay.)

10. Carbon Monoxide Hazard in Aeroplanes. The concentration of carbon monoxide in the cabin and in the cockpit of closed and open aircraft while the motor was being warmed on the ground, and at intervals during flight, was determined in several types of planes. (A. Cambron.)

11. Inquiries. As in previous reports, an increase in the number of inquiries received has been recorded. The increase over the previous year was approximately 50%. Nearly all this gain was in inquiries from firms or corporations and government bodies, and the nature of the inquiries received indicated a clearer conception on the part of the public of the nature of the work being undertaken in the division. Inquiries were answered by special reports, letters, or personal interviews, but in many instances some experimental work was required. Special reports were issued on such subjects as the following: *(a)* identification and source of supply of special wax; *(b)* decolorizing carbons; *(c)* treatment of cigarettes; *(d)* chrome steel for burner parts; *(e)* lacquer for illuminated signs; *(f)* toughened glass for railway service; *(g)* examination of projected industrial processes; *(h)* gasoline-air gas machine; *(i)* paper for cheque forms; *(j)* hempseed oil for cooking purposes; *(k)* type-metal analysis; *(l)* effect of water on strength of Hessian; *(m)* examination of sole-attaching cement; *(n)* corrosion of tanks; *(o)* analysis of fish nets for composition and filling material; *(p)* fine pulverizing of fish by-products. Other special reports were prepared on subjects having reference to major research problems under consideration, and are not given in the above list.

Inquiries answered more briefly included: (*a*) paints for special purposes; *(b)* sources of supply of chemicals; *(c)* particle size determination; *(d)* laboratory equipment design; *(e)* application of metal spray process; *(f)* skin dermatitis; *(g)* special chemical test methods; *(h)* dyeing from natural barks, etc.; *(i)* alcohol from potatoes, sugar beets and wood waste; *(j)* water treatment; *(k)* electrolytic cells; *(l)* trade or manufacturing possibilities; *(m)* viscosity of glues; *(n)* action of salt water on vitrified clay pipe; *(o)* cleaning agents for cooking utensils, dairy containers, etc.; *(p)* method for freezing sera; *(q)* re-conditioning bleached shellac; *(r)* use of soy-bean oil in paints.

DIVISION OF PHYSICS AND ENGINEERING

R. W. BOYLE, *Director*

J. H. PARKIN, *Assistant Director*

During the past year, the Division of Physics and Engineering has been called upon to perform a greater number of tests and examinations and to standardize a larger number of instruments than in the preceding year. The facilities of the laboratories have been considerably extended by the addition of: (*a*) a reverberation chamber for the determination of the sound absorption coefficient of all types of wall board and sound absorption value of partitions; (*b*) a hot box apparatus for the testing of thermal conductivity and the heat insulating value of large samples of various walls or wall boards which, heretofore, it has not been possible to test with existing equipment; this apparatus has been completed and preliminary measurements and calibration are in progress; *(c)* a plant for the production of liquid air; this is of extreme value in all work requiring high vacua and where very low temperatures are required; *(d)* apparatus for the testing of color sensitivity and other characteristics of photographic emulsions.

A long series of tests of commercial radio receivers has been carried out for the Canadian Radio Broadcasting Commission and a large amount of new apparatus constructed to facilitate this type of work. The atmospherics recording and direction finding apparatus set up at the Rockcliffe Air Station with the co-operation of the Department of National Defence was operated very successfully until August, 1934, and a large number of records of the direction of approaching atmospheric disturbances obtained. This work has been discontinued pending the construction of a western station of a similar kind without which the actual position of a centre of disturbance cannot be determined. This work has been carried on under the Associate Committee on Radio Research.

Since Canada has at present no absolute standards for the measurement of electrical inductance and capacity, work has been commenced on an absolute standard of mutual inductance of the type similar to that used by the National Physical Laboratory in England. Used in conjunction with existing apparatus this will provide an absolute standard for the measurement of capacity as well as of inductance.

A considerable amount of assistance has been given other government departments, as, for example, in the solution of physical problems relating to cold storage and to the transport of food stuffs, both by rail and water.

Acoustics

G. S. FIELD

Acoustic Testing Laboratory

During the past year a reverberation chamber was built on the annex property. In this chamber numerous measurements have been made for commercial firms on the sound-absorptive properties of various kinds of building material. Experiments are also under way to determine the best method of using certain of the materials.

The laboratory is also equipped to make measurements on the sound-insulative value of partitions. It is expected that several of these tests will be made in the coming year.

Vibrations in Rods and Discs

A paper was published in the Canadian Journal of Research discussing some of the theoretical questions involved in previous studies on the mechanical vibrations that occur in rods and discs.

Radio Receiver Tests

Apparatus is being set up to measure the acoustic output of radio receiving sets. When this is completed, it will be possible to determine the "over-all" efficiency of radio sets, that is, to include the loud-speaker as well as the electrical circuit of a given set in the measurements.

Miscellaneous

Blue-prints of the new Royal Canadian Air Force Station at Trenton were examined, and suggestions were made for an acoustic treatment of the main lecture hall.

A loudness test for the Testing Laboratories, Department of Public Works, was conducted to determine the noise-level originating in their stone-sieving machine, located under one of the offices in the West Block.

Work in Progress

1. Testing of building materials and research in connection therewith.
2. Microphone calibration.
3. Acoustic testing of radio receivers.

Aeronautics

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

The work in the aeronautical laboratories during the year has consisted of tests, calibrations and investigations directed to the solution of specific problems submitted. The urgency of this work and existing staff limitations have precluded any possibility of doing work on several researches of a more general character, which it was planned to undertake. For the same reasons, certain other investigations have been suspended.

It will be apparent from the following paragraphs, that much of the work done in these laboratories has been of a non-aeronautical character and that the laboratories are proving of value in other fields. Further, it will be seen that most of the work has been for departments of the federal government and, in particular, for the Department of National Defence.

Co-operation with the Department of National Defence in the work of the laboratories has been close and cordial. The department has generously assisted by supplying material, equipment and services and the laboratories have made every effort to solve the problems submitted.

While the laboratories are now reasonably well equipped, in certain cases work is being carried on with improvised equipment and in others, the nature of the work required has indicated the need for certain additional apparatus. The demands upon the laboratories have rendered it practically impossible to proceed with the design of permanent apparatus to replace improvised equipment and have further prevented any thorough and consistent calibration of the major equipment.

The wind tunnel and equipment, including the aerodynamic balances, of the aerodynamic laboratory have functioned satisfactorily. A micromanometer for the measurement of low air speeds, as in anemometer calibration, has been provided and better illumination for the wind tunnel jet installed.

In the hydrodynamic laboratory some time has been devoted to the design of a permanent towing dynamometer for the model-testing basin. The improvised dynamometer in use is unsatisfactory for certain work. The testing of the 1/12-scale model of the hull of the Singapore IIC flying boat, loaned for comparative tests by the Air Ministry, cannot be done with the present dynamometer.

Accurate one-second time signals are now received from the radio laboratory over a special line and are proving very useful.

Some studies have been made of the rate of decay of waves in the basin.

The installation of the main gasoline-storage tanks in the engine laboratory was completed, and the water and electrical services were improved. A refrigerator has been provided. Certain modifications and improvements have been made in the test equipment and additional apparatus provided.

A vibration stand was completed and placed in service in the aircraft and allied instrument laboratory.

Aerodynamic Laboratory

Aircraft Skis

(a) Aerodynamics. As a development of the work already done in the laboratories on aircraft skis, (see last annual report), a comprehensive investigation was made with the object of developing a ski of improved aerodynamic design to meet the requirements of high-speed service aircraft and of commercial aircraft, the speeds of which are continually increasing. The improvements aimed at were reduction in air resistance and reduction in pitching moment about the axle. The first part of the investigation comprised the measurement in the wind tunnel of the characteristics of some nine* full-scale service and commercial skis and of the drag of the trimming cables and pedestal and of a wheel. This was followed by the development, by successive modifications of a normal service ski, using a half-scale model in the wind tunnel, of an improved ski.

It was found that the normal ski had about three times the drag of the unfaired wheel and that the ski, pedestal and trimming cables each contributed about one-third to the total drag. The pitching moment of the improved ski developed in the laboratories averages only about one-third of that of the normal ski, and is very small at negative incidences. This reduction in moment permits use of internal trimming instead of external cables. The drag of the new ski is only some 16% of that of the normal ski installation and 57% of that of a wheel. The performance of an aircraft should thus be improved, instead of impaired, in changing from wheels to skis.

Late in the winter, skis of the new design were constructed for flight testing by the Royal Canadian Air force. (J. J. Green and G. J. Klein.)

(b) Snow Performance. To complete the work on skis and secure information now lacking, an investigation has been commenced to determine the resistance and bearing power of skis on snow and the influence thereon of such factors as snow condition, speed, form and proportions of ski bottom. A towing dynamometer has been constructed, enabling resistance, attitude

**One of these was a half-scale model.*

and speed to be measured for two skis. Several half-scale models have been made and provision has been made for loading these up to a maximum of about 250 lb./sq. ft. The early advent of spring interrupted the tests after only a few preliminary runs had been made. (G. J. Klein.)

Cup Anemometer

At the request of the director of the Meteorological Service of Canada, the characteristics of the standard service three-cup anemometer head, when fitted with flanged and with beaded cups, are being determined in the wind tunnel. (J. J. Green.)

Development of New Aircraft

The extensive model tests on a new Canadian freight aircraft, which were referred to in last year's report, have been continued. A new wing was tested, but was found to be inferior to the original wing as regards maximum lift. These tests opened up the question of the effect of wind-tunnel turbulence on maximum lift and some time was spent in investigating this problem. The results obtained in the Ottawa tunnel are in good agreement with the best results obtained in other wind tunnels.

The first aircraft of this type has since been flight-tested and is now in service. Satisfactory agreement between the predicted and actual performance figures was secured. The machine has been fitted with an engine exhaust tail pipe of the type developed in the laboratories (see report for 1932–33) with satisfactory results. (J. J. Green and G. J. Klein.)

Farm Windmill

The experimental model windmill to be used in securing information on which to base the design of a windmill capable of operating in light winds has been ready for some time. Work in the shops on the dynamometer has proceeded as opportunity offered. Pressure of other work has prevented progress with this study, but it is expected that active work will begin in the summer of 1935. (G. J. Klein.)

Locomotive

Although the external form for steam locomotives, developed in the wind tunnel to reduce the smoke hazard and air resistance, at the request of the Canadian National Railways (see report for 1932–33), has not as yet been applied to a Canadian locomotive, it is gratifying to note that the fundamental principles laid down in the design have appeared in recent streamlined locomotives built in other countries.

Reduction of Drag of Cameras in Photographic Aircraft

At the request of the Department of National Defence, an attempt was made to reduce the drag of the three exposed cameras as mounted in an aircraft on the "three-camera mount" recently introduced for use in aerial photographic operations. The drag of the cameras was found to have an adverse effect on the performance of the aircraft, particularly the climb. Using a one-third-scale model of the aircraft fuselage and cameras, different fairings and arrangements were tested in the wind tunnel. A reduction of 80% in the drag of the cameras was finally achieved by withdrawing the cameras slightly and fairing the exposed portions. (G. J. Klein.)

Model-testing Basin

Current-meter Rating

The equipment and facilities of the model-testing basin render it particularly useful for the accurate rating of current meters. As the basin is housed in a heated building, meters may be rated during the winter when they are not normally in use.

A number of meters have been rated during the past year, most of them for the Interdepartmental Water Levels Board.

In connection with this work, in addition to precise checking of the autographic recording and timing apparatus, studies have been made of the influence of wake, turbulence, setting, etc., on the meter operation. (K. F. Tupper.)

Oil Barge

Stability tests on the model of this barge were made in the model-testing basin last year. Subsequently it was proposed to install engines in the barge and further tests were made on the model in the basin to determine its resistance and check the calculations of the required power in addition to further stability tests. (K. F. Tupper.)

R.C.M.P. Patrol Boat

Tank tests for resistance were made on a model of the "Improved Acadian" type hull for a patrol boat for the Royal Canadian Mounted Police. The time between receipt of the lines of the hull and the delivery of the test results was six days, during which the model was constructed and tested and results were calculated from the observations. (K. F. Tupper.)

Singapore IIC Hull (1/16-scale model)

Tests have been made in the model-testing basin on this model, kindly loaned by the Air Ministry, to check the equipment and technique of the Ottawa basin against those of British basins in which the model had been previously tested. (K. F. Tupper.)

Stop Logs for Emergency Dams

At the request of the Engineer in Charge, St. Lawrence Waterways, measurements were made in the model-testing basin of the hydrodynamic forces on log models. Owing to the size of the logs (80 ft. × 6 ft.) to be used, and lack of real knowledge of the forces involved, information was desired for use in the design of a dam. Models of round and square logs (1/24-scale) were towed in the basin and the forces measured. Unexpected results were obtained and further work is to be done. (K. F. Tupper.)

Engine Laboratory

Carbon Monoxide in Aircraft Cockpits

At the request of the Department of National Defence, samples of air in the cockpits and cabins of several types of aircraft in flight were taken and tested for the presence of carbon monoxide from the engine exhaust. (M. S. Kuhring.)

Gasoline

1. Standardization. Requests have been made to the Council at different times for suggestions and advice relative to gasoline and its measurement, grading, and standardization. In connection with this work and particularly

the drafting of standards for gasoline, a number of investigations have been initiated to obtain information on different phases of the subject. These include:

(a) A study of the effect of long exposure of doped gasoline to sunlight and electric light, as in the container of a visible dispenser. (In progress since October 1934.)

(b) A study of the seasonal variation in the characteristics of commercial gasolines as sold to the public. Samples are being collected in Ottawa and tested each month.

(c) Determination of characteristics of gasolines on the market in certain sections of eastern Canada.

(d) Deterioration and loss in gasolines during long periods in storage.

(e) Miscibility of gasoline and water. In progress. (M. S. Kuhring.)

2. Aviation Gasoline. A comprehensive investigation is in progress in the United States, under the auspices of the Aviation Gasoline Detonation Subcommittee of the Co-operative Fuel Research Committee of the Society of Automotive Engineers and participated in by the United States Army Air Corps, National Bureau of Standards, aircraft engine builders, and fuel producers, in an attempt to develop a method of testing aviation gasoline for detonation characteristics showing satisfactory agreement with results secured in engines in service. Owing to the possible bearing of the results of the investigation on practice in Canada and possibly in Europe, it was considered desirable that Canada should take part in this work. Participation was welcomed by the American committee and preparations are now in progress for certain tests in the Council's laboratories.

Indicating Engine Lubrication

Functioning of the lubrication of aircraft and motor-car engines is now commonly indicated by a pressure gauge showing the pressure in the system. This method is not entirely satisfactory since the system may be blocked, no oil reaching the engine, while the gauge still shows satisfactory pressure. The Department of National Defence requested that an endeavor be made to devise a means for indicating the flow and, if possible, the viscosity of the oil. It was also requested that an instrument now on the market be investigated to determine its usefulness. The work has been in progress some time. (M. S. Kuhring.)

Pumping Cold Oil in Starting Aircraft Engines at Low Temperatures

At the request of the Department of National Defence, a study was undertaken with the object of determining the feasibility of warming the oil in an aircraft engine, as a preliminary to starting the engine in low temperatures, by circulating a portion of the oil through a heater. The present practice is to draw off the oil while still warm, immediately the engine is stopped. Before starting, the oil is heated and poured into the previously warmed engine. The feasibility of the suggested method depended on the possibility of pumping the oil, and this question was accordingly investigated. A method permitting the oil to be circulated successfully was devised. (M. S. Kuhring.)

Aircraft and Allied Instrument Laboratory

Altigraph for Aerial Survey Use

Under the auspices of the Associate Committee on Air Survey Research, a sensitive limited-range altigraph has been developed in the laboratories. The instrument has a range of 7,000 to 10,000 feet, with a duration of 7 to 8

hours at a chart speed of one-quarter inch per minute. The instrument records also the time of tripping the shutter by the intervalometer. The instrument has been laboratory-tested and is now ready for flight-testing. (S. J. Murphy.)

Intervalometer

Intervalometers are being studied in the laboratories, under the auspices of the Associate Committee on Air Survey Research, to determine the factors which govern their accuracy. (S. J. Murphy.)

Auxiliary Recording Camera

Under the auspices of the Associate Committee on Air Survey Research and in co-operation with the Department of National Defence, a design has been developed for a camera to record the necessary information to fix the position of the aerial photograph at the time of exposure. A mock-up of the proposed design has been made and tested, and drawings and specifications prepared. (R. H. Field and S. J. Murphy.)

Miscellaneous Investigations

Bearings

To obtain information to serve as a guide in the use of small ball-bearings in the construction of instruments for use in the laboratories and elsewhere, a study of the characteristics of small ball-bearings on the market is being made. (G. J. Klein.)

Prevention of Formation of Ice on Aircraft Propellers

Investigation of a suggested method of preventing the formation of ice on aircraft propellers, primarily from the standpoint of the operation of trans-Atlantic air services, has been initiated in the engine laboratory and wind tunnel.

Strength of Flat Rectangular Plates

This investigation was undertaken at the request of the Department of National Defence to determine the strength characteristics of thin flat plates under pressure as in aircraft floats and hulls. Owing to pressure of other work, the equipment has been handed over to a graduate student at the University of Saskatchewan and he is continuing the investigation.

Strength Tests of Aircraft Wing Ribs

The Department of National Defence requested that the National Research Council undertake the testing of wing ribs of aircraft for airworthiness requirements. The department transferred the testing equipment to the laboratories. The first of these tests was carried out for the new freight aircraft mentioned elsewhere in the report. Full-sized ribs supplied for the tests were modified to bring their strength up to Empire standard requirements. (J. J. Green.)

Investigations suspended owing to pressure of more urgent work include: Slot research; float research, pressure distribution on aircraft tail units; gum in gasoline; effect of humidity on operation of internal combustion engines; boat appendage resistance; effective life of radium luminous compounds; ground effect; turbulence investigation.

Tests

Tests Completed or in Progress

In addition to the tests mentioned in the foregoing, numerous routine tests have been or are being made on aviation gasoline, and lubricating oils, and preparations are being made for the testing of aircraft dope. The wind tunnel has been used frequently for anemometer calibration.

Tests Made of Aircraft and Allied Instruments

	Government	Commercial	Total
Airspeed instruments	43	13	56
Attitude instruments	20	0	20
Anemometers	2	3	5
Barometers and barographs	121	18	139
Directional instruments	68	8	76
Engine instruments	55	7	62
Height instruments	68	4	72
Hygrometers	5	0	5
Tachometers	57	7	64
	439	60	499

Inquiries

During the year, 269 technical inquiries were answered, including the examination of some 29 inventions.

Atmospheric Electricity

D. C. Rose

A study of atmospheric electrical effects has been started with the intention of studying particularly the electric charges built up in thunderstorms and the physical process involved in the building up of such charges. As a preliminary step, apparatus has been set up to study the atmospheric potential gradients. Continuous potential-gradient records have been taken since about the first of December, 1934, and an analysis of the records shows a relation between variations in the regular diurnal potential-gradient curves and general local weather conditions which do not seem to have been studied in this manner before. Plans are also being made for a study of atmospheric ionization.

Some preliminary work is being done on the development of portable apparatus which can be used in aeroplanes for measuring atmospheric conductivity, potential gradient, etc. Such information should be of great value in explaining phenomena, hitherto only partially explained, such as the separation of electric charges in thunder clouds.

Ballistics

D. C. Rose

A new method of measuring the velocity of projectiles, developed in the laboratory, has been improved. The method consists of an arrangement whereby a succession of beams of light placed along the trajectory are interrupted by the bullet. The beams of light shine on photo-electric cells and

the time of the interruptions is recorded by an oscillograph. Considerable improvement has been made in the method of recording the time of interruption of the light by the bullet. A special grid-controlled discharge tube was constructed, which emits a flash of light each time the bullet interrupts a beam of light. The flash of light makes a record on a moving photographic film, and with suitable timing apparatus the velocity can be measured to an accuracy of one part in a thousand or better. This new discharge tube eliminates the necessity of an oscillograph, thereby simplifying the apparatus considerably. The discharge tube also has many other applications where the accurate recording of short intervals of time is required.

The velocity-measuring apparatus is being developed further so that it can be used with artillery. This makes a complete alteration in design necessary in order that it may be used outside and made semi-portable.

The work on ballistics was undertaken at the request of the Department of National Defence.

Electrical Engineering

B. G. BALLARD

Electrical Laboratories Equipment

A distribution panel was built and installed in the electrical engineering laboratory to interconnect circuits and to feed the available electrical services to practically all points in the physics and electrical laboratories. Owing to the necessity of providing a limited stand-by service for certain important loads in case of power failure, a group of storage cells has been arranged to pick up the load automatically and automatic charging circuits have been installed.

Voltage Regulation

Work has been continued on a precision voltage regulator. Several schemes have been investigated and it is now possible to control voltage well within one-tenth of one per cent. In all cases final control has been effected by means of hot cathode vapor discharge tubes. As the demand for a regulated voltage in the laboratory, principally for lamp tests and X-ray investigations, has impeded this development somewhat, a study has been made to secure a special service with precise regulation for such work so that progress in the electrical engineering laboratory will not be hindered. Work is proceeding on an improved reference standard so that the disadvantage of batteries, now used so frequently for regulators of this nature, may be overcome.

Electrical Accessories of Oil Burners

During the year a number of oil burners were submitted for approval listing, and the electrical features were inspected and tested in accordance with the specifications of the Canadian Engineering Standards Association. In some cases points arose, which were not covered by the specifications, and special investigations were necessary.

Special Problems

Special problems investigated during the year included: the elimination of static charges of electricity which were resulting in shocks; dielectric tests on equipment submitted to the laboratory; testing of an electric water heater employing water as the resistance element; investigation of vapor-type rectifiers which employ the heat generated by the arc to heat the cathode.

In addition to the above, the facilities and co-operation of the laboratory were extended for the development of a remote water-level indicator and a traffic-control signal.

Electrical Measurements Laboratory

A. J. Grant, J. S. Johnson

Meter Approval

Forty-four types of meters or meter attachments were tested for approval of type, one being rejected. The characteristics of all instrument transformers now sold in Canada have been examined or are under examination with a view to determining their suitability for use with measuring instruments.

Temperature characteristics of all meters used in Canada on single-phase, 60-cycle lines have been obtained. This work will be continued to include 25-cycle and polyphase meters and a study of the effect of temperature on the various lubricants.

Routine Electrical Tests

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

Sixteen resistances were adjusted and certified in order to enable the radio section to make the tests of radio receivers requested by the Canadian Radio Broadcasting Commission.

Fire Hazard Testing Laboratory

J. H. Parkin, T. H. Doherty

A large part of the work in this laboratory during the past year has been in connection with the testing and listing of domestic oil burners for safety. There has been, however, a decrease in the number of burners submitted to the laboratory for approval.

Since the establishment of the laboratory, eight manufacturers have submitted 12 models of automatic burners. Seven of these models have been approved and listed, three did not meet requirements, and two are under test. Fifteen manufacturers have submitted atmospheric burners, 13 of which have received listing, one did not satisfy requirements, and one is under test. A certain number of manufacturers of listed burners have from time to time modified the design of the listed burners, which, in some cases, necessitated the testing in the laboratory of the newly-designed parts and which, in all cases, necessitated revising the listed records.

The factory labelling and inspection system, inaugurated by the laboratory last year, has been continued. During the past year 6,250 labels were issued for attachment to listed atmospheric burners, and 1,200 labels were issued for attachment to automatic burners. Thirty factory inspections were conducted. Six of these were conducted in British Columbia by the provincial fire marshal's office; the remainder were carried out by the laboratory staff and covered factories or agencies in Toronto, Montreal, Sarnia, and Waterloo, Que.

British Columbia and Manitoba have enacted legislation requiring that domestic oil burners carry listing by the National Research Council, and it is expected that Ontario will do so in the near future.

At the last meeting of the main committee of the Canadian Engineering Standards Association (September 29, 1934), it was suggested that the drafting of safety codes might be conducted by the National Research Council. Since that date the drafting of the oil burner safety code has been taken over by

the National Research Council. Three sections of the code have been completed, covering design and construction requirements of atmospheric and automatic oil burners and fuel oil. These sections have been discussed with oil-burner manufacturers and have received the approval of the Council. Work is now in progress on installation and operation requirements for atmospheric and automatic burners.

The Associate Committee on Fire Hazard Testing has rendered valuable assistance. Details of the work of this committee are contained in the annual report of the committee, page 96.

In addition to the testing and listing of oil burners, one gasoline engine for fire-pump drive was tested *in situ* and listed. Specifications covering requirements for this type of equipment have been drafted. Specifications covering requirements for dry-cleaning solvents, fire extinguishers, gasoline-vapor machines, stoves and lamps have also been drafted. One sample of dry-cleaning solvent and one gasoline-vapor machine have been tested, but have not as yet received listing. Test work on a gasoline safety can is now in progress, and also the design and construction of equipment for the testing of fire extinguishers. Three extinguishers have been submitted to the laboratory for test and listing, and work on these is in progress.

Heat

C. D. Niven

House Insulation

The work of testing various kinds of house insulation for commercial firms has been continued throughout the year as samples were submitted. Such tests have included work on glass wool, corrugated cardboard, rock wool, sphagnum moss, ground wood fibre, lamp black, zonolite, and others.

Owing to some unavoidable delays, the construction of the "hot-box" apparatus which was begun over a year ago has been completed only recently. Considerable difficulties are being encountered in securing uniform temperature throughout the heated box, and until this is overcome the apparatus cannot be considered reliable.

Temperature Control in Railway Refrigerator Cars

The results obtained last year in testing refrigerator cars for heat loss led to the conclusion that, while the heat loss from the latest models of cars was less than from the older ones, the difference was not very great; and, on the whole, there was not much to complain about in this regard. The work clearly showed that the protection of perishable freight against frost damage in sub-zero weather could be effected, not by insulating the car more efficiently, but by providing a suitable method of getting heat into the car. The Canadian National Railways kindly consented to build and test a system of heating, designed in these laboratories, which it was thought would give the desired results. On two trial runs, this system proved very satisfactory and arrangements are now being made to improve the design of the heater with a view to simplification in its construction. The new heater, it is hoped, will be ready for trial in December; it is expected that it will have a larger capacity and certain other advantages over the original experimental design. If the improved model gives the expected results, it is understood the railway companies will equip a fairly large fleet of refrigerator cars with the system.

On the Use of the Eupatheoscope in Canada

In view of the severity and length of the winter in Canada, a "eupatheoscope", as designed by Dufton in England, was purchased to see if it could be relied upon to indicate whether a house was satisfactorily heated. In spite of the fact that in England this instrument has been accepted as a standard one, the results obtained to date rather indicate that it will not be satisfactory in Canada during the winter.

Temperature Standardization

Some work to determine the optimum operating conditions in calibrating a platinum thermometer at the boiling point of sulphur has been completed and will be published in the near future.

Instrument and Model Shops

J. H. PARKIN

The shops have been fully engaged throughout the year. It has been barely possible to keep up with the current work required and quite impossible to overtake the jobs, numbering more than one hundred, in arrears. During the year some 655 jobs were completed, varying from those requiring an hour or so to those involving the construction of intricate apparatus requiring many weeks or months.

The character of the work required of the shops is undergoing a gradual change. In the early days, when the laboratories were being equipped, the work was largely heavy construction and installation. Most of the work now is on fine instruments and apparatus with a considerable amount of maintenance work on apparatus and equipment.

The construction, repair, and adjustment of instruments for other government departments is continually increasing. In particular, a large number of aircraft instruments have been reconditioned for the Department of National Defence. The following list of instruments overhauled or repaired during the year indicates the scope of this work:

Aircraft Instruments	
Airspeed instruments	34
Attitude instruments	20
Directional instruments	53
Engine instruments	50
Height instruments	55
Tachometers	37
Binoculars, Field glasses, Telescopes	23
Cameras and Accessories	3
Hygrometers	4
Surveying Instruments	
Alidades	9
Barometers and barographs	55
Compasses	7
Levels	8
Transits and theodolites	21
Miscellaneous	10
	389

The list given below of some of the instruments and apparatus constructed in the shops during the year will give some indication of the range of work done:

Aircraft ski dynamometer and model skis
Apparatus for determination of gum in gasoline
Apparent density apparatus for asbestos fibre
Camera for radio research
Cloth-testing machine
Crimping press
Oil-burner valve-testing equipment
Precision X-ray spectrometer
Radial stereo plotter (air survey)
Radio direction finder (Canadian Radio Broadcasting Commission)
Recording camera (ballistics)
Recording dough mixer
R.C.M.P. patrol boat model
Sensitive limited-range altigraph (air survey)
Stiffness-measuring apparatus
Switchboard for electrical laboratory
Vibration stand for aircraft instruments
Voltage divider
Overhaul and installation of tensile-testing machine.

During the year, the electrical shop has been fitted up, partially equipped with tools and instruments, and is now engaged on electrical construction, installation, repair and maintenance work for the laboratories. Besides the electrical shop, the central shops now comprise machine, fine instrument, welding and forge, sheet metal and cabinet shops, tool crib and stores, together with facilities for blueprinting, photostating, and drafting.

Certain necessary new tools and equipment were provided during the year and the recording, control, and stores systems improved.

The shops function under the direction of a Workshops Supervisory Committee, comprising members of the laboratories' staff under the chairmanship of the president of the Council, through a technical officer in charge of the shops. An Advisory Committee on Design is organized to advise and assist the research staff in the design of apparatus or equipment.

Light

L. E. Howlett

Sugar Testing

At the request of the Department of Customs and Excise, work was carried out on the development of a mechanical apparatus involving a photocell for the grading of sugar solutions according to their ability to transmit light. An apparatus was devised and is now being tested in practice.

Spectroscopic Tests

Several spectroscopic tests have been performed during the year.

Tests on Photographic Films

Pursuant to a request for this type of work from the Topographical and Air Survey Bureau, equipment has been designed and built to determine the characteristic curves of photographic emulsions. Complete tests on two types of films for aerial survey work have been made and the results reported. Some of the apparatus used was of a temporary nature, but this is being replaced by permanent equipment. (Dr. F. H. Sanders collaborating.)

Photometry

Standardization—The equipment for standardizing lamps has been supplemented and improved. Routine tests of calibration of incandescent lamps have been performed.

Life Testing—A beginning has been made on equipping the laboratory for life tests on incandescent lamps. Some temporary equipment has been installed. Permanent apparatus is in the course of preparation.

Between 300 and 400 lamps have been tested for the Department of Trade and Commerce.

North Sky Illumination—Photoelectric continuous recording of the fluctuations of north sky light were taken at the winter solstice in connection with a scheme for the improved illumination of picture galleries, workshops, etc., by natural light.

Miscellaneous Photometric Tests—A number of photometric tests, not of a routine nature, have been carried out in response to special requests.

Metrology and Allied Measurements

R. H. Field, W. J. Linford

Metrology

The four 24-metre invar wires being circulated by the International Bureau of Weights and Measures were verified for length and thermal coefficient. These wires had already been verified at the National Bureaux of Great Britain, Germany, Poland, and the United States, as well as at the International Bureau at Sèvres, France. It was hoped that the Canadian measurements would serve as a means for the comparison of the lengths as measured by the different laboratories. The results, however, while indicating systematic differences between some of the institutes to the order of one or two parts in a million, were complicated by definite changes in the wires themselves. It was found necessary to send these wires again to the National Bureau of Standards at Washington, together with two invar tapes, which were subsequently checked again at Ottawa. The subject is an important one, and international effort is being continued towards a satisfactory solution.

To carry out the provisions of the Weights and Measures Act, a comparison was made between the two surviving platinum-iridium legal standards of the pound. At present there is a lack of precision balances, and recourse had to be made to a balance of an older type which was first adjusted as accurately as possible. The final difference between the two standards varied by about one part in four millions from that found in 1874, when they were compared in London with the Imperial pound standard. At the same time the legal departmental standards, comprising various sets of weights ranging from 0.01 grain to 50 pounds, were verified in terms of the one-pound standards. A further comparison was made between the two platinum-iridium troy ounce standards which are in excellent condition and were found to agree to one part in ten millions with the difference determined in 1874. The departmental troy standards, from 0.001 ounce to 500 ounces were also verified from the platinum-iridium standard weights.

Optical and Allied Instruments

The plotting instrument for high oblique air photographs, mentioned last year, was constructed on behalf of the Associate Committee on Survey Research, and is now undergoing trial in the office of the Geographical Section, Department of National Defence. A full design and working drawings of a

machine based on the radial line method of plotting map positions were prepared for a stereoscopic plotter for vertical air photographs, following the scheme proposed by Major E. L. M. Burns, Department of National Defence. The construction of this plotter is now being commenced. Further work on behalf of the committee included the preparation of the preliminary design of an instrument-recording camera for air photography, the completion of the investigation of the influence of temperature on the principal distance of an air camera, and the examination of a number of proposals relating to survey and plotting purposes.

Routine Work

Many routine standardization and allied tests were made, mostly on behalf of government services. For the first time analytical weights were verified, four sets being received. Instruments tested also comprised thermometers, hydrometers, tapes, transits, levels, air cameras, and photographic shutters, besides which the usual work of maintaining the accuracy of the laboratory standards was carried on.

A commencement was made in the equipment of a laboratory to test new and altered gas meters for approval by the Council under the Gas Inspection Act. A rebuilt meter prover has been set up in the laboratory by the Gas and Electricity Inspection Service and the Dominion standard cubic foot bottle has been given a complete overhaul in the Council's instrument and model shop and will be re-calibrated as soon as time permits.

Strength of Materials

A series of tests was carried out to determine the deformation and recovery of various samples of wallboard under pressures up to 1700 lb. per sq. in. (F. H. Sanders and G. J. Klein.)

Radio

J. T. HENDERSON

Atmospherics

A series of measurements on the direction of arrival of atmospherics, using a cathode-ray direction finder and an automatic recorder, made during the months of May to August, showed that a close correlation apparently existed between the directions of sources of atmospherics and meteorological conditions. If this is so, and independent work in other countries strongly substantiates this view, then routine observations should provide a valuable aid to the collection of meteorological data for weather forecasting. The method would be particularly applicable in Canada with its large virtually uninhabited areas. The results should be of value not only to the Meteorological Service but also to aviation services, both civil and those of the Department of National Defence.

To carry out the preliminary experimental work, it will be necessary to establish a second observing station somewhere in the vicinity of Winnipeg. The Associate Committee on Radio Research, sponsoring this investigation, was unanimously of the opinion that this action should be taken as soon as the necessary funds become available.

Ionosphere

Some measurements of heights and ionization of the ionosphere were made, but owing to lack of staff the work has proceeded spasmodically. Efforts have been confined to attempts to make the instruments self-recording and it is expected that automatic routine measurements will be made throughout the coming year.

Receiver Measurements

Equipment for measuring the sensitivity, selectivity, and fidelity of broadcast receivers has been set up. Thirty-two different models were tested during the period under review.

Standards

In conjunction with the Electrical Standards Laboratory, considerable work has been done on a primary standard of mutual inductance of the Campbell type. When completed this will serve as an ultimate reference standard for many A.C. measurements. (See also the report of the Associate Committee on Radio Research, page 106.)

Radium

G. C. LAURENCE

Measurement and Certification of Radium Preparations

During the year 201 units were measured and certified. These contained a total of 1.526 gm. of radium prepared from Canadian ore.

Several changes were made in the measuring equipment which considerably reduced the hazards of handling the preparations, and the time required for measurements. Some improvement in accuracy was effected also. A new method of radon leakage testing has been developed.

Many measurements of absorption coefficients and of the effects of ionization-chamber walls on the apparent values of these were made in connection with the preparation of a brochure on radium dosage sponsored by the Associate Committee on Radiology.

X-rays

The standard X-ray ionization chamber was compared directly with the American standard, thereby obtaining correlation with other national standards. Another standard chamber, desirable as a check on the first, and of greater precision and wider quality range was designed and is now in construction. The laboratory is now fully prepared for the usual types of test on X-ray equipment and the calibration of dosage meters. Six portable standards for distribution in physics laboratories throughout Canada were built. A number of radiological clinics, etc., were visited to obtain information for a report on the hazards of X-ray exposure from present-day installations. (See also the report of the Associate Committee on Radiology, page 106.)

Ultrasonics

F. H. SANDERS

Diffraction of Light by Ultrasonic Waves in Liquids

In the study of the physical characteristics of liquids and the consequent determination of their value for various industrial and technical purposes, the manner in which they transmit sonic and ultrasonic waves is of extreme value. The phenomenon whereby liquids, subjected to a high-frequency vibrational disturbance, act as an optical diffraction grating and produce scattering of light passing through them, provides a very simple means of determining their various characteristics. An investigation to determine the relation between the ultrasonic energy transmitted by a liquid and the degree of scattering has been carried out and compared with theory. Further investigations, as time from other duties permits, of the effect of frequency and optical wave-length are in progress with a view to determining the optimum conditions for the study of different liquids.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

A steady growth in the services rendered to members of the staff in the Council's laboratories and to other scientific workers, both in Ottawa and elsewhere throughout the Dominion, is reflected in the records of the Division of Research Information for the year under review.

Loans from the library rose by about 30% over the total for the preceding year, and replies to technical inquiries and requests for information, involving searches of the literature, increased by upwards of 50% in the same period. The Canadian Journal of Research showed a gain in both the number and volume of papers published. Further, the issue of the proceedings of the Fifth Pacific Science Congress involved a great increase in editorial work. There was no expansion in outside activities however, as the necessity for economy restricted the Council's work in this field.

National Research Library

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

Library loans increased in the year under review from 3,248 to 4,201, including loans to 22 libraries and organizations other than individuals. Books were borrowed from 11 other libraries in Ottawa and 15 elsewhere, including five in the United States, and photostat copies of scientific articles were also obtained as required.

New volumes added during the year totalled 1,414, or 355 fewer than in the preceding year, and the purchases made were almost entirely limited to those books which were urgently needed for reference in connection with work already in progress in the Council's laboratories. Twenty-three carefully selected new titles were added to the subscription list, and numerous journals and publications were received through memberships, by gift, or in exchange for the Canadian Journal of Research and other National Research Council publications. As yet, however, only a beginning has been made in filling the shelves that have been designed to house upwards of 400,000 volumes. Expansion of the library facilities is largely dependent on the availability of funds for this purpose.

Patent specifications added to the library during the year numbered 239, these being required not only in connection with industrial researches being carried on in the Council's laboratories, but also for the great amount of technical information contained in them.

At March 31, 1935, the total number of accessions was 15,680, in addition to about 14,000 pamphlets; the library also receives some 600 scientific periodicals and about 270 other serial publications. Under a co-operative arrangement, the value of which is gratefully acknowledged, the library of the Royal Society of Canada and certain scientific sets belonging to the Library of Parliament have been placed on the shelves and so made available for reference. These resources, supplemented when necessary by loans from the more specialized libraries maintained by each of several government departments at Ottawa, and the science libraries of the universities throughout Canada, enable the Council's library to render a much more comprehensive

service than might at first be supposed. Appreciative responses from those who have taken advantage of the opportunities thus offered give ample proof that real service is being provided.

For the convenience of those using the National Research Library, a photostat service is maintained. Translations of articles appearing in foreign journals can also be made within the Division of Research Information.

Publications

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

Publications issued during the year include: two volumes of the Canadian Journal of Research containing 12 monthly issues (1528 pages), and a special issue (100 pages) dealing with the beech bark disease and published in collaboration with the Arnold Arboretum, Harvard University; indexes to the two volumes (31 pages); the seventeenth annual report of the National Research Council (149 pages); and a number of reports which were issued in typewritten or mimeographed form. At the close of the year one specification and one bulletin were in press.

The Canadian Journal of Research continues to provide an outlet for papers reporting the results of researches carried on in the National Research Laboratories or with financial assistance from the Council, and also, to an increasing extent, those presenting the findings of other investigators working in the laboratories of the universities in Canada. Of the 135 papers published in the Journal during the year, 32 were written by members of the staff of the Council, 25 by authors who received financial assistance from the Council and 78 by other Canadian investigators. Sixty-three papers recorded the results of investigations in the fields of biology and agriculture, 30 in physics and engineering, and 42 in the field of chemistry.

An important change in the form of the Journal was decided upon towards the end of the year. Beginning with Volume XIII (July, 1935), the Canadian Journal of Research will be published monthly in four sections, as follows:— Section A—Physical Sciences; Section B—Chemical Sciences; Section C—Botanical Sciences; Section D—Zoological Sciences. Sections A and B will appear under a single cover, as will also Sections C and D. Each section will be paged separately. It has been evident for some time that this division of the Journal will appeal to both contributors and subscribers.

Completion of the proceedings of the Fifth Pacific Science Congress, a task carried out under the supervision of Mr. S. J. Cook, but not by the regular editorial staff, marked the conclusion of an important piece of work under the auspices of the Council. The proceedings comprise five volumes, a total of 4,227 pages. A complete account of the congress is given at page 112.

Research Information Service

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

Inquiries received in this division cover a wide range of subjects. Some letters, of course, ask for assistance that cannot be granted, as for example, the chemical examination of samples which should properly be sent to a commercial laboratory; in such cases the writers are usually referred to the various testing laboratories specializing in this type of work. Inquiries which relate specifically to the work of a provincial or federal department are forwarded to the respective officers in charge for attention and reply.

Many requests for recipes or formulas are received from prospective manufacturers of polishes, waxes, and similar preparations for which there is a widespread demand. As far as possible suggestions are given to the writers of these letters indicating the usual sources of information of this kind, or copies of well known recipes are given. This type of inquiry, however, as well as those which are outside the scope of the division's normal activities, are usually dealt with as briefly as possible.

Technical inquiries may be grouped in two main classes: (1) general questions on scientific matters which can be answered with little, if any, reference to the literature; (2) requests for searches of the literature which may require the time of experienced abstractors for days or weeks to complete. 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, as time goes on, 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 before along similar lines, and this can only be accomplished 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 their entire time to this work. For the most part, the searches made by the division are used as a guide to work in the laboratory divisions but, to an increasing extent, such services are also being performed for outside workers who do not have, readily accessible to them, scientific libraries where hundreds of journals and technical treatises may be consulted.

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.

Work of this kind is of great value, since it serves to bring the scientific problems of industry and commerce under examination by skilled scientists, whose training and experience often enable them to contribute valuable suggestions regarding methods of procedure in industrial operations. Similar problems are presented when a new process is developed in the laboratories. Many commodities in common use to-day were but laboratory curiosities a few years ago. Expansion in this branch of research information seems likely to yield results of considerable commercial value.

While, so far, it has not been possible for the division to undertake any very extensive studies in this field, some assistance has been rendered in this direction from time to time, with satisfactory results. For example, during the year a survey was made of the uses and markets for digitalis grown on the Pacific coast for medicinal purposes.

By far the most important and valuable 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 are mentioned in the following paragraphs.

Mr. A. C. Halferdahl carried out a number of patent studies on such varied subjects as ground asbestos tailings, distillation column packing, barge stability, magnesian products, coating asbestos fibres, dolomite refractories, and the thyratron tube as a light source. He also made a review of the literature on chemical herbicides, continuing work begun in the preceding year in co-operation with the Division of Biology and Agriculture. This will form the basis of a report combining library and laboratory research on this important subject. Bibliographies and surveys of the literature were also made on basic Bessemer steel, calendar roll break, sulphur dioxide in the atmosphere of various cities, cold storage, minor forest products, construction of high-temperature furnaces, ozone in ventilation, thermodynamic calculations on the ferrous-sulphide-lime reaction, and various other subjects.

Dr. C. A. MacConkey completed surveys of the literature, of a comparatively extensive nature, on the testing of large volume gas meters, the grading of talc, and the relative merits of wheat, corn, and other starches. Continuing work undertaken in the preceding year, when he made a survey of the literature relating to soybeans, Dr. MacConkey compiled a supplementary report on this subject covering the period 1931–4. Replies to numerous minor inquiries were also prepared.

In response to a request from the Associate Committee on Surveying, Dr. R. Ruedy examined the question whether modern photoelectric cells could be used for the purpose of locating, through smoke, the actual seat of a forest fire. The study showed that, while modern cells are sensitive to a small portion of the infra-red region, their response does not extend into the range and intensity of wave-lengths associated with forest fires, but that thermocouples may offer a sensitive means by which to study the distribution of the fires.

Another problem of interest studied by Dr. Ruedy during the year was suggested in an inquiry from a power company in western Canada. The increase in the diameter of the wires used for transmission lines in the past ten years has created difficulties, owing to premature failure of the lines caused by small vibrations. These vibrations are set up by steady winds of moderate velocity, and increase rapidly in strength with the thickness of the wire. The report prepared contained references to the work carried out in various countries and included a mathematical analysis of the complex conditions. Several means of overcoming the difficulties were suggested.

Shorter reports were prepared by Dr. Ruedy on the preparation of heavy water by electrolysis, the distribution of daylight, the use of electrical power in industry, cold storage and pre-cooling, the prevention of vibration, electrical insulating materials and the insulation of gasoline storage tanks in order to reduce losses due to evaporation.

Miss M. E. Whalley made an extensive examination of the literature relating to bolting or premature seeding of plants, and compiled a report on this subject comprising 162 pages, with 153 references to papers. It was found that the effect of temperature was the dominant factor governing the growing habits of the plants, and this finding was confirmed by experimental work carried out later in the Council's laboratories. Another report, consisting of 126 pages and 195 references, related to the protein and carbohydrate content of alfalfa. This was compiled primarily for the use of the investigators studying the problem of detrimental effects to crops and forests caused by fumes in smelter smoke. Studies on the literature relating to the dietetic

and medicinal uses of honey showed that, while honey has a slightly lower energy value than ordinary cane or beet sugar, its sugars are more easily absorbed by the system.

Less extensive reports were prepared on the literature dealing with the following: poisonous effects of exhaust gases; Canadian patents on the removal of carbon monoxide from the exhaust of motor cars; effect of surface paints on radiator performance; food for beavers; potato flour; sago flour; sources, uses, importation and methods of production of agar; sources and use of pectins and coloring matter in the manufacture of jams and jellies; storage of furs; paints for the interior of water tanks; and a summary of recent papers on B.C.G. (a tuberculosis vaccine), the last-named subject being in continuation of work done in previous years.

Outside Research Activities

F. E. Lathe, S. J. Cook, A. C. Halferdahl

Reference has been made to the work of the associate committees of the Council and the Fifth Pacific Science Congress, in respect to both of which the officials of the division gave largely of their time during the year. Full particulars regarding the activities of these outside organizations are given elsewhere in this report, but it may be noted here that a large part of the secretarial and executive work pertaining to the functions of no fewer than 19 of the associate committees 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 and the industries and universities co-operating in research projects. Committees served by officials of this division during the year, included the following: asbestos, chemical standards, coal classification, electrical measuring instruments, executive committee of the Fifth Pacific Science Congress, forest research, gas research, helium, honey, iodized salt, iron ore, leather, magnesian products, patents and awards, potato research, Trail smelter smoke, tuberculosis, weed control and wool.

REPORTS OF ACTIVITIES OF COMMITTEES

JOINT ASSOCIATE COMMITTEES

As explained on page 17, the committees whose work is reported under this classification were formerly called associate committees of the National Research Council. Under reports of these committees acknowledgment was made to all co-operating organizations. In view of the great interest of the Dominion Department of Agriculture in the work of these committees, however, it has been deemed wise to constitute them joint associate committees of the two organizations. This has been agreed to by officers of both organizations and by the Council itself and the committees have therefore been renamed accordingly. It has been arranged to place first the name of the organization which has a preponderance of interest in the work of the committee or, in marginal cases, that of the National Research Council as the original sponsoring body. Under this arrangement the names of the Department and Council do not appear among the co-operating organizations.

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

Co-operating organizations:

Canadian Society of Technical Agriculturists
Dominion Bureau of Statistics
Dominion Department of Agriculture
Macdonald College
Nova Scotia Agricultural College
Oka Agricultural Institute
Ontario Agricultural College
University of Alberta
University of British Columbia
University of Manitoba
University of Saskatchewan

The fourth meeting of the committee was held in Montreal, June 29, 1934, the place and time having been arranged to suit the convenience of members in attendance at the annual convention of the Canadian Society of Technical Agriculturists. Some time was devoted to a discussion of the relation of this and various other associate committees to the National Advisory Committee set up by the Dominion Department of Agriculture. The chairman foreshadowed the arrangements then under consideration, which led shortly afterwards to all associate committees in the agricultural field being made joint committees of the Council and the Department.

Reports were received on two conferences held since the last meeting at the suggestion of the committee. The conference on honey problems, between technical workers and representatives of the industry, had outlined a program of further research required, part of which had already been put in hand. The conference on cold storage, also attended by representatives of industry, including railroad and steamship companies, formulated a comprehensive program in this field and arrived at an agreement as to an appropriate division of responsibility in carrying it out. The subsequent activities of the Associate Committee on Storage and Transport of Food, set up to implement this program, are reported elsewhere.

A number of special problems, to which members had directed attention as important subjects of research, were discussed. These included mastitis, contagious abortion, pullorum, joint ill, infectious anemia, wireworms, moles, virus diseases, mineral deficiencies, bacon curing, biochemistry of tree saps in relation to insect and disease attacks, seed-setting in alfalfa, pasture and forage problems, use of agricultural machinery, soil and weed problems, adjusting grain acreages in relation to markets. In some cases it was agreed that satisfactory progress was being made at present, while in others it appeared that new or additional researches were required. Where possible, the problems were assigned by agreement for further attention by the appropriate institutions represented on the committee.

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

(Western Section)

Co-operating organizations:

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

The seventh meeting of the Associate Committee on Field Crop Diseases was held in the Dominion Rust Research Laboratory at Winnipeg on April 4, 5 and 6, 1935. Progress on research toward control of diseases of field crops was reported by each of the co-operating organizations. Some appreciation of the scope of this work may be obtained from the following brief summary of plant disease surveys, life history studies of causal organisms, seed and soil treatments, and progress in the breeding of new disease-resistant varieties.

The Co-operative Test of New Wheat Varieties, 1934

During 1934 the Subcommittee on Plant Breeding carried out, at 12 western stations, a co-operative test on the most promising new wheat varieties developed by various institutions. The check varieties were increased to six by adding Garnet and Early Triumph, and by elimination of unsuitable varieties, 19 instead of 32 new ones were tested. The milling and baking data were compiled by the Subcommittee on Methods of the Associate Committee on Grain Research. The agronomic data were compiled by the Subcommittee on Plant Breeding of the Associate Committee on Field Crop Diseases.

As a result of the test, eight varieties were classed as satisfactory in milling and baking quality and it was decided to multiply these as rapidly as possible. It is interesting to note that of these eight varieties, five were new ones not included in the 1933-34 test. Other promising new varieties not ready for the 1934-35 test will be included in the test to be conducted in 1936.

The Canadian Plant Disease Survey for 1934

This report indicates the prevalence of the various diseases being studied throughout Canada and lists any new ones that may have appeared for the first time. The survey is compiled and distributed by the Division of Botany of the Central Experimental Farms.

Stem rust of wheat was more abundant in 1934 than in the two previous years in the prairie provinces. In Manitoba it occurred chiefly in the Red River Valley and northern parts of the province. In southern Saskatchewan infection was slight, but moderate to severe from the central part of the province eastward. Traces only were reported from Alberta.

There was a slight increase in the number of cars of Hard Red Spring wheat grading smutty in 1934. Bunt in winter wheat (Alberta Hard Winter) is still a problem, as 10% of all cars inspected graded smutty.

Root-rot diseases were not more serious than usual. Take-all disease caused slight damage in Alberta and Saskatchewan, and anthracnose, a new foot rot of oats, was reported from these provinces. Browning, Helminthosporium and Fusarium root rots were reported from all three prairie provinces but were not exceptionally severe.

In Ontario a disease on oats, new to Canada, was found to be caused by an eelworm infestation. Previously this disease was known only in Europe.

(Survey compiled by I. L. Conners.)

Research in Alberta

Dominion Laboratory of Plant Pathology, Edmonton

Further work has been carried out in connection with the new root rot of oats caused by *Colletotrichum graminicolum*. The injury to the plant is mainly caused by the destruction of the seminal roots and part of the stem below ground level.

Studies on the effect of fertilizers on root rots of wheat indicate that deficiency of certain elements in the soil results in heavier infections by *Ophiobolus* and *Helminthosporium*.

Three more fungi in addition to two previously described have been found to play an important part in winter-killing of alfalfa and clover under Alberta conditions. Tests for varietal resistance to these organisms are being carried on at the University of Alberta and at the Lacombe Experimental Station.

Under a program of work on the soil-borne diseases of the potato, tests are being conducted on seed treatment for control of the disease caused by *Rhizoctonia* at various stations. Studies are also being made on the organism in culture and the ability of the various strains to cause the disease.

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

University of Alberta

The influence of low temperatures on the survival of *Ophiobolus graminis* in the soil and its subsequent establishment on wheat have been studied recently. It is now clear that low soil temperatures, including freezing temperatures, distinctly favor the survival of this fungus in soil. This may account for the success of this organism in living over from one season to the next and its ability to establish itself on wheat in the spring.

Experiments were also conducted on the best seed treatment of oats for the prevention of smut. In 1934 it was found that whereas formaldehyde, as normally used (1:320 of water) gave poor control, twice this strength gave 100% control but resulted in some seed injury. On the other hand New Improved Ceresan dust used at the rate of one ounce per bushel gave perfect control of smut with no injury to the seed.

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

During the years 1931-4 tests were conducted at the University of Alberta to determine the relative resistance of barley varieties to the covered smut disease. It was found that the varieties used in these investigations differed greatly in their reaction to covered smut. Varieties belonging to the six-rowed hulled types, two-rowed hulled types and hulless types were classified into two groups on the basis of their susceptibility to attack by the fungus.

In 1934 approximately 125 varieties and hybrid selections of spring wheat from various stations were tested in the bunt nursery as well as 600 hybrid selections from crosses made at this station. It was found that order of susceptibility remained the same as in 1933. The new variety Canus was again found to be highly resistant to bunt present in Alberta, though it is susceptible to certain strains present in Montana. Crosses have been made between Reward and the two smut-resistant varieties, Canus and Selection I-18-65. A breeding program has also been started to obtain resistance to the physiologic forms of bunt found in Montana, to which Canus is susceptible.

There is a distinct need for smut-resistant varieties of oats in Alberta which are suitable from the standpoint of yield, maturity and quality of grain. Promising new hybrid lines resistant to smut have been developed.

(Investigation under the direction of Dr. O. S. Aamodt.)

Research in Manitoba

Dominion Rust Laboratory, Winnipeg

The investigations in this laboratory may be classified as follows: (1) rusts, including stem rust of wheat and oats, leaf, stripe and crown rust and sunflower rust; (2) smuts; (3) root rots; (4) stripe diseases of barley; (5) black chaff of wheat; (6) blast of oats; (7) ergot of cereals and grasses; (8) wheat and barley mildew; (9) a comprehensive breeding program carried on to produce cereals resistant to their pathogenes, and possessing suitable agronomic qualities.

The question of the influence of soil nutrients on the reaction of the rusts of their various cereal hosts has been studied. It was found that nitrogen tended to increase susceptibility slightly, potassium to increase resistance. However, the shifting of the reaction types in both leaf and stem rust by application of these elements was definitely less striking than the shifting of reaction types brought about by differences in temperature and by variation in the light intensity during the same period.

Further studies have been carried out on the genetics of *Puccinia graminis*. The object of this work is to disclose as far as possible the mechanism underlying the pathogenic behavior of physiologic forms by means of inheritance studies with forms of known pathogenic behavior. Strains of both wheat and oat stem rust are being studied in this manner.

During the year the survey on the prevalence of various physiologic races of wheat and oat stem rust has been carried on. Some striking changes in the prevalence of the various races has been found. Forms once very common have disappeared and others formerly rare have become dominant.

Crown rust has been investigated in regard to host range on grasses and *Rhamnus* species. The physiologic forms have been studied and many varieties of oats tested for their resistance to the different races.

Tests made during the past five years on the control of cereal smuts with 37 different substances have been completed. In general it was found

that certain of the new dust treatments gave the best control without causing injury to the seed. Seed should not, however, be treated too long before seeding, for germinability may be affected if the moisture content is high.

Considerable progress has been made in the identification and classification of the strains of *Fusarium* and *Helminthosporium* present in Manitoba. Studies on the pathogenicity of many of these have been carried out, as well as many tests on the effects of adding fertilizers, cellulose, cultures of soil fungi or various salts to soils in which root-rot development was being tested. Experiments on root-rot control and the best method of soil inoculation as well as tests for resistance of cereals have been made.

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

Plant-breeding experiments have been carried on with a view to obtaining information on the genetic relation between resistance to different diseases and on the nature of inheritance of resistance to stem rust by certain wheats, and for the purpose of producing disease-resistant strains of wheat and oats.

From the point of view of practical breeding a result of considerable interest has been obtained in a study of the reaction of the wheat H 44-24 to stem rust (*Puccinia graminis*) and stripe rust (*Puccinia glumarum*). There has been found to exist an intimate relation between semi-resistance in the seedling stage to *P. glumarum*, and field resistance to *P. graminis*. This therefore affords a means whereby selection for field resistance to *P. graminis* may be made by seedling tests with *P. glumarum* in the greenhouse.

Ten physiologic forms of oat stem rust are present in the United States and Canada. There are varieties of oats resistant to nine of these forms, though no one variety is resistant to all. However, no varieties are known to be resistant to Form 6. By crossing two resistant varieties it has been possible to select lines possessing some resistance to this strain of rust and there is now a possibility of breeding a strain of oats resistant to all known forms of oat stem rust.

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

Research in Ontario

National Research Laboratories

For reports on chemical investigations on rust resistance and studies on root parasites of plants, see under Division of Biology and Agriculture, page 23.

Research in Saskatchewan

Dominion Laboratory of Plant Pathology, Saskatoon

Investigations at this station are mainly on root rots and seed-borne diseases. Considerable progress has been made in methods of inoculation of *Helminthosporium* for field plot work. If damp seeds are coated with conidia before sowing, higher infection ratings may be obtained than by former methods.

Further studies were made on the root development of wheat plants affected with various root rots. In common root rots the crown and adjacent tissues were the chief centres of infection. The plants were not killed but were noticeably reduced in growth. In take-all disease the seminal root system was usually destroyed in a severe attack, crown roots were invaded later and the plants were frequently killed. In browning root rot the infection involved the entire upper portion of the seminal root system as well as the crown roots, and plants were stunted and delayed in ripening.

University of Saskatchewan

Research in plant pathology has been confined to the browning root rot of wheat. Studies have been completed on the phosphorus-nitrogen relations of infested fields and the effects of fertilizers on the occurrence of the disease.

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

Some interesting results, of value to both plant breeder and farmer, have been obtained concerning the relation of time of sowing to economic characters of different wheat varieties.

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

Joint 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

Since its inception the work of this committee has been concerned chiefly with the maintenance of the high quality of Canada's export wheat. However in view of the critical situation existing in the wheat market, the improvement in the quality and marketability of possible substitute crops has become a problem of the first importance. Accordingly in June 1934, the committee initiated a program of barley research and appointed a subcommittee to work on the improvement of flax. The work on barley has since been co-ordinated with that of the National Barley Committee and the associate committee acts as the research section of that organization.

Investigation of wheat problems still forms a substantial part of the committee's activities, either in the form of joint projects initiated by the committee, or of fundamental researches related to these projects or to methods of testing, initiated independently by the co-operating laboratories.

The papers reporting the results of these investigations are generally included in the committee's series. Twenty-two such papers were published during the year bringing the total number in the series on March 31, 1935, to 70. Several additional papers have been approved and are awaiting publication.

Joint Investigations

Frost Injury of Wheat

The annual survey of the quality of frosted wheat which was started in 1930 (following a special study of frosted wheat of the 1928 crop) has been continued. A paper giving the results for the three years, 1930–32, is now ready for publication. The variability in the relation between damage to the appearance of the kernels (on which grading is chiefly based) and damage to the milling and baking quality, from year to year, is noteworthy.

Methods of Harvesting

The final report on the survey of methods of harvesting in relation to the moisture content and grade of the grain has been issued. Of the samples harvested by the combine 25% were tough or damp, while swath-combining

gave 8%, and stook harvesting, 5.4% of the samples, in this moisture range. Under early season conditions, before rains occur, samples harvested by the swath-combine method have a slight advantage in grade. Later in the season the best quality is obtained by stook harvesting.

An investigation of the barge method has shown it unsuitable for humid areas.

A study of the moisture changes in standing grain has been completed. Grain was found to be fit for binding 4 to 17 days earlier than for straight combining. There was no evidence that fully ripened grain at moisture contents of 11% to 13% can absorb sufficient moisture during the period of high humidity at night to exceed 14.4% and become tough. The rate of moisture loss in wet, mature grain is much faster, through the same range, than in immature grain.

Quality of New Wheat Varieties

The co-operating laboratories tested the quality of 19 new varieties in comparison with six well-known, old varieties of wheat, all grown at 12 places in the prairie provinces. Six different baking methods and a number of other tests of wheat and flour characteristics, were used in this study. Eight of the new varieties were found to be of satisfactory quality.

Under the auspices of the committee, commercial tests of some of the more promising varieties are being conducted.

Methods for Determining Moisture in Grain

This investigation, referred to in the last annual report, has since been completed. It was undertaken jointly by the National Research Laboratories and the Laboratory of the Board of Grain Commissioners, primarily to ascertain the utility and accuracy of certain rapid methods, including five electrical moisture meters. Three papers covering this investigation have been published during the year (Can. J. Research, 11 : 264-289; 409-447; 547-563. 1934), and an additional summary paper (Cereal Chem. 12 : 230-243. 1935). The results obtained show that the Brown-Duvel method, as operated by the Laboratory of the Board of Grain Commissioners, was more accurate than the air oven. Of the five electrical moisture meters, two were found to be too inaccurate to be of any practical value. The motor-operated Tag-Heppenstall, however, proved to be as accurate, for hard red spring wheat, through the moisture range 11.0 to 17.0%, as the Brown-Duvel method, and further field tests of this instrument have been undertaken by the Laboratory of the Board of Grain Commissioners.

Barley Research

The joint investigations of barley problems have been organized on a slightly different basis to those on wheat. For the present, different phases of the investigation have been assigned to the co-operating laboratories. The Laboratory of the Board of Grain Commissioners is making an annual survey of the protein content of Canadian barley. The National Research Laboratories have conducted surveys of the market requirements in Great Britain and of the cleaning and handling of barley. The Dominion Department of Agriculture is conducting extensive field tests, the grain from which will be used for experimental malting. Routine testing of these samples and of plant-breeders' samples for malting quality will be continued in the Barley Laboratory of the University of Manitoba. The development of improved methods and equipment for experimental malting has been assigned to the National Research Laboratories. Reports on these topics will be found under the appropriate headings. (See pages 27–29.)

Flax Research

Under the auspices of the Subcommittee on Flax, field tests are being conducted by the Dominion Department of Agriculture and the University of Alberta. Quality tests on certain of this material are being made by the Laboratory of the Board of Grain Commissioners which is also investigating improved rapid methods of estimating oil content.

Grain Research in the Laboratory of the Board of Grain Commissioners

The work of the durum wheat laboratory during the year has been devoted very largely to standardizing the experimental milling and macaroni processing technique. A spectrophotometric procedure for the measurement of macaroni color, employing discs cut from flat strips of macaroni produced by means of a special die, has been developed and employed as a basis for evaluating the effect of variations in absorption, mixing time, kneading time, rest period and drying conditions. An automatic recording balance has been constructed for the purpose of obtaining a continuous record of the moisture content of the macaroni during the drying period and data have been secured on the equilibrium moisture values at different relative humidity levels. The measurement of physical properties of macaroni, such as transverse and torsional breaking strength and also the development of a test of cooking quality are now under investigation. A study of the effects of aging upon the color characteristics of durum wheat and its products is also under way.

The need, by plant breeders, for early information on the milling and baking quality of promising wheat selections prompted the development of a small scale milling and baking technique requiring 100 grams of wheat. An experimental mill, resembling the regular Allis Chalmers experimental mill, has been constructed and a baking procedure utilizing only 25 grams of flour developed. The high correlations obtained between the results of the small scale tests and those of the standard experimental procedures indicate that the small scale tests will be of considerable value to plant breeders in the selection of promising strains and the elimination of unsatisfactory ones early in the plant-breeding program.

In co-operation with the University of Manitoba, a study of the validity of the "added diastase" method for determining the amyloclastic susceptibility of wheat starches has been undertaken. The total quantity of sugar produced by the action of taka-diastase and wheat-flour diastase acting singly upon wheat starches, closely approximated that produced when these enzyme preparations acted simultaneously, indicating that the relative amyloclastic susceptibility of different wheat starches may be obtained by tests on wheat flour without the actual isolation of the starch.

To assist the National Barley Committee in outlining districts suitable for the production of barley for different purposes, a survey of the nitrogen content of the various grades of barley produced in the prairie provinces in 1934 was undertaken and the results published in mimeographed form. A collection of feed barleys originating in different countries has been made and their analysis is in progress to determine their relative value for feeding purposes.

During the year the laboratory has continued and extended previous studies on flaxseed. An improved refractometric method for the rapid estimation of the oil content of flaxseed has been developed and a survey made of the oil content and iodine value of flaxseed produced in western Canada in 1934. The results showed that the highest quality flax was

produced in the more northerly regions of the prairie provinces. In collaboration with the Subcommittee on Flax, samples of different varieties of flaxseed grown at a number of experimental stations have been analyzed for oil content, iodine value of oil, and pigment content.

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

Grain Research by the Cereal Division, Dominion Experimental Farms

Wheat. The Cereal Division maintains a laboratory chiefly for the evaluation of the quality of different varieties of wheat being grown and developed for different areas in Canada. Modern analytical, milling and baking tests are applied to samples grown in test plots at the central farm and at most of the branch farms and stations scattered throughout the country. This wide range of environment assists in the appraisal of the quality of any variety. It has been demonstrated that some varieties which appear to be relatively high in baking strength under high protein conditions may be relatively low under low protein conditions. Further studies in this connection are under way.

Quality tests of hybrid lines bred for rust resistance occupy quite a large proportion of the work and 149 grown at the Dominion Rust Research Laboratory were investigated from the 1934 crop. Another group of 18 rust-resistant sorts along with seven named varieties were tested from individual samples grown at 12 different points in the three prairie provinces in a co-operative study, as already noted.

The quality behavior of the varieties Marquis, Reward, Ceres, Red Bobs and Garnet is being investigated from plots grown at a number of locations in Manitoba, Saskatchewan and Alberta. Samples from 93 elevator points were harvested and the grades and protein contents secured through the courtesy of the Western Grain Inspection Division and the Dominion Grain Research Laboratory. Milling and baking qualities by districts will be determined co-operatively by members of the Grain Research Committee.

An extended study of the influence of environment on the yellow pigment content of flour milled from samples of hard red spring wheat varieties grown in western Canada in 1933 was published (Cereal Chem. Vol. XI, No. 6). High negative correlations were obtained between test weight per bushel and yellow pigment content and between weight per thousand kernels and yellow pigment content, but no significant correlation was revealed between wheat protein and the quantity of yellow pigments.

Further work on methods for evaluating soft wheat flour has been carried out and a white cake test for experimentally milled flours patterned after the A.A.C.C. method has been developed.

Barley. In addition to varietal tests on the malting qualities of samples grown at the Dominion experimental stations, considerable information was obtained on the suitability of six varieties of barley for certain districts from plots grown at a large number of elevator points in the three prairie provinces. Samples of the 1934 crop demonstrated that some of the varieties would be most useful in certain localized areas and unsuitable in others. A special program of barley breeding is under way at the Brandon farm.

Flax. Investigations in co-operation with the Dominion Grain Research Laboratory on the quantity and quality of the oil expressed from samples of the more important varieties and strains together with their behavior in different environments are being continued.

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

Grain Research at the University of Alberta

Studies on the effects of potassium nutrition on the composition and quality of wheat were continued during the year. The earlier conclusions that potassium limitation reduces the growth, total absorption and quality of the wheat, have been substantiated.

The effects of soil and variety on the physiological development of wheat were studied during the summer of 1934. Reward and Red Bobs 222 were grown on the black and gray soils. Five collections were made during the season and the distribution of nitrogen and minerals determined. The results are being analyzed statistically. Nitrogen was a limiting factor under the gray soil conditions, and both varieties grown on this soil contained much higher proportions of phosphorus than did the same varieties grown on the black soil.

Studies on the quality and keeping properties of flour from wheat grown on the black and gray soils have been continued. The differences in deterioration of flour from varieties grown on the gray soil in 1932 were apparent also in samples grown in 1933. Chemical studies have shown that deterioration in baking quality is accompanied by markedly increased acidity, increased hydrogen ion concentration and deterioration in the gluten quality. The decomposition of lipoidal substances appears to be the important factor in the deterioration. These studies are being continued and extended to include the effect of storage on the quality of wheat.

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

The quality studies on wheat samples supplied from the rotations conducted by the Pathology Division of the Department of Field Crops were continued as usual. The samples this year, unfortunately, were injured by frost.

Field work in connection with studies of the residual effects of timothy, brome, western rye grass and alfalfa on the yield and quality of wheat, was completed during the year. The wheat crop was rather severely injured by frost, but the results for yield and composition were probably but little affected. The percentage of nitrogen in both grain and straw and the total nitrogen removed per acre were highest after alfalfa, differences which persisted through six crops of grain following breaking of the alfalfa sod.

(Investigations under the direction of Dr. R. Newton.)

Throughout the investigations of the residual effect of forage crops, just referred to, the Department of Soils has co-operated by studying the soil composition and microbiology of the experimental plots. During the past season surface, subsurface and subsoil samples taken at monthly intervals from May to September were analyzed for moisture and nitrates. In addition, the total nitrogen was determined in the samples collected in May.

Under the second crop of wheat after breaking five-year-old sods, the former alfalfa plots were decidedly highest in nitrates and the brome plots were lower on the average than the timothy. Under the fourth crop of wheat following three-year-old sods, the former alfalfa plots were decidedly highest in nitrates but the differences between the brome, timothy and western rye grass plots were probably not significant. Under the sixth crop of wheat following one-year-old sods the differences in the nitrate content of the different plots were not significant.

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

The gray wooded soils area at Fallis, Alberta, provides a satisfactory environment for obtaining a differentiation in kernel texture of hard red spring wheats, which can be used as an aid in the selection of high quality strains. The varieties studied behaved more or less similarly from year to year in regard to kernel texture, protein content and loaf volume, but not in regard to partial baking score. The partial baking score could be predicted more closely from kernel texture than from protein content, while the latter was the better index of loaf volume. A close relation was found between the kernel texture of the varieties grown at Fallis and both the partial baking score and loaf volume of the same varieties grown at Edmonton, but when protein content at Fallis was substituted for kernel texture no such relation was found. The wheat-meal fermentation test was found to be of little value in differentiating between the baking quality of hard red spring wheat varieties. A full report on this work has been prepared for publication in the Canadian Journal of Research.

The breeding program and the physiological studies leading to the development of a high quality, hard red spring wheat of desirable agronomic type with superior resistance to drought have been continued. A machine for testing the resistance of plants to drought injury has been described (Can. J. Research, 12 : 788-795. 1935).

The absorptive capacity of wheat grain immersed in 0.3 molar salt (NaCl and KCl) and sugar solutions showed no relation to the drought resistance of the varieties.

In the breeding work, tests of the hybrid selections were replicated on brown soil in the dry area at Brooks, on the black soil of the park belt at Edmonton, and on gray wooded soil at Fallis, in order to study the effects of different environments. The yield tests at Brooks showed that most of the hybrid lines yielded significantly higher than the standard varieties. A number of the hybrid lines showed considerable resistance to bunt at Edmonton. The Fallis kernel texture test indicated that all the hybrid lines possess satisfactory baking quality. The presence of awns was found to be associated with greater kernel plumpness.

(Investigations under the direction of Dr. O. S. Aamodt.)

Formaldehyde is very widely used in western Canada for the treatment of seed for the prevention of smut, and sometimes reduced yields can be traced to its use. Seed injury by formaldehyde is not only a source of loss in itself, but it also may accentuate markedly the damage from foot-rotting organisms. The factors affecting seed injury and methods for reducing the injury have been studied. The injurious effect of low soil temperature was found to be greatest at 59° F. Covering the seed after treatment increases the injury. The efficiency of the treatment is not reduced by decreasing the concentration from 1 : 320 to 1 : 440. There is some indication that some varieties are particularly susceptible to damage. Pre-soaking, and liming after treatment, are recommended.

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

Grain Research at the University of Saskatchewan

The study of the effect of carbon tetrachloride on quality of damp wheat stored with this reagent has been extended to cover longer periods of storage than those first reported on, because, since the first work was done, it has been reported that short term storage with certain fungicides showed little or no damage, whereas long exposure to the same conditions resulted in marked

damage. The experiment was set up to run 40 weeks and is not yet completed. However, milling and baking tests on samples of wheat at 18% and 24% moisture content stored for 10 weeks with various dosages of carbon tetrachloride, showed no evidence of damage to baking quality that could be attributed to the fungus inhibitor.

In continuing the study of experimental baking formulas, the effects of replacing sodium chloride entirely by various salts, on rate of fermentation were investigated. The rate of fermentation of the sucrose added in mixing the dough was not noticeably affected by the character of the salt used, but after this initial sugar was beginning to be exhausted, there occurred a very specific effect of the various salts on the fermentation rate. This was considered to be due to the hydrogen ion effect on diastasis of the starch. No specific effect of the phosphate ion could be observed.

A study of the protein of flour peptized by neutral salt solutions showed that it consisted of three distinct fractions, namely, one which could be removed by the supercentrifuge, one which settled out from the centrifugate after standing for some days, and one which could be obtained only by salting-out. Analyses of these fractions indicated that the first two are similar and by comparison with reported analyses appeared to be albumin or globulin-like in composition. The third fraction was quite different from the other two and its analysis suggested that it contained a fairly large proportion of gliadin. As these results are contrary to the accepted ideas concerning the nature of salt peptization, this work is being carefully repeated.

An experimental oven, having a completely shielded rotor with five enclosed compartments, has been completed. Its chief characteristics are—rapid heating rate, low heat loss and low cost of construction. Temperature ranges inside the oven have yet to be determined. This has been delayed through difficulty in obtaining suitable thermometers.

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

Grain Research at McGill University

A review of the literature on the comparative feeding values of cereal grains for poultry is being made. The available references reported in the abstracting journals, as well as certain unpublished data from the Dominion experimental farms, Ontario Agricultural College, Macdonald College, and other sources, have covered over 175 trials bearing on the subject. About half of these involved laying or breeding stock, one-third concerned chicks and the remainder were about equally distributed among fattening trials and miscellaneous related topics. In general the experiments conducted in the United States involve comparisons of corn and wheat while those conducted in Canada, slightly less than half the total, are mostly concerned with corn-barley studies.

The preliminary analysis of the material has been completed and the work will now be largely that of bringing comparable data together and completing the analysis.

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

Fatuoids or false wild oats occur in practically all varieties of cultivated oats. Other related abnormal types such as Trelle's dwarf oat may be of economic value on account of their stiff straw. It is therefore important that the cause of these aberrations be determined. Attempts are being made to correlate all the genetical and cytological evidence on the mode of origin of

fatuoids, speltoids and other aberrant forms of oats and wheat. The results to date indicate that many of these aberrant types have arisen as mutations involving a duplication or deficiency of a whole or part of a chromosome.

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

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

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

An apparent surplus of approximately seven million bushels of potatoes on the Canadian market during the winter season of 1934–35 presented a problem of major importance to the producers in the maritime provinces. A conference of the growers, starch manufacturers, representatives of the Potato Marketing Board, and government departments was arranged by the National Research Council to consider the factors involved and to formulate plans for the profitable utilization of the potato crop. At this meeting, which was held in Ottawa on December 17, 1934, the surplus was attributed to a number of factors: *(a)* the loss of the Cuban market, formerly one of Canada's largest export potato markets, because of the increased tariff in Cuba against foreign potatoes, invoked as a means of stimulating home production; *(b)* the increased United States tariff against foreign potatoes; *(c)* the current popularity of certain non-starch diets and other factors affecting choice of foods; *(d)* reduced purchasing powers of the people.

Consideration was given to the various known methods of disposing of potatoes for other than food purposes, as for example, in the manufacture of starch, dextrin, and alcohol, and to the practical and economic factors involved in the use of potatoes in the feeding of stock. Grading, the development of the potato seed industry and of new markets, both domestic and export, for table potatoes, and the possibility of increasing the consumption of potatoes by advertising, were also considered.

At the conclusion of this conference, it was agreed to appoint a committee comprising officials from government departments, and others if required, to prepare a detailed program of inquiry and research on *(a)* new uses for potatoes, *e.g.*, as industrial raw materials; *(b)* the preservation and canning of potatoes; *(c)* breeding of new types with a higher starch content; *(d)* the food value of potatoes, and other related matters.

A meeting of the special committee was held on February 9, 1935. Comprehensive reports on the possibility of using potatoes for industrial purposes, together with statistical information on the Czechoslovakian potato situation, as revealed in data supplied by the consul-general for that country, were studied by the committee. It was agreed that further research work should be carried on, and also that informative bulletins might be prepared for distribution to the growers and the trade. The co-operation of the Department of Agriculture was solicited in this connection, and arrangements were completed for the publication of a pamphlet for distribution to the farmers of the maritime provinces on farm management with special reference to potato-growing. As a part of the investigational work, the Department of Agriculture undertook to study the value of potatoes in the feeding of stock, and to carry out experiments on the preparation of ensilage in which potatoes and green feed would be used.

In the laboratories of the Council, the work undertaken in relation to starch and dextrin products was reviewed, and it was decided to continue these studies, and to investigate the preservation and canning of potatoes. The food value of potatoes and potato products was also to be studied.

The committee was of the opinion that, as the scientific work on potato studies was likely to continue for some time, it would be desirable to have a somewhat more permanent organization in charge. They recommended, therefore, that the National Research Council and the Department of Agriculture be asked to appoint an Associate Committee on Potato Research to function as a joint committee of these two organizations in the direction of the work on potato studies. At a subsequent meeting of the National Research Council this committee was created, consideration being given in the choice of personnel to the three chief branches in which it is expected research on the utilization of potatoes may be directed; namely, *(a)* industrial uses, dependent on means developed through chemical research; *(b)* feeding experiments, including dietary studies and experiments on the use of potatoes in the feeding of livestock; *(c)* plant breeding research, looking to the development of disease-resistant varieties, and also possibly to the production of potatoes having a higher starch content.

Finally, since a study of the literature on the manufacture of starch from potatoes led to the conclusion that valuable time would be saved and considerable experimental work made unnecessary by a first-hand study of potato starch manufacturing processes and laboratory work in Europe, Dr. G. S. Whitby, Director of the Division of Chemistry, left for Europe towards the end of the year to study this problem particularly in Holland, Germany, France, and England. At the same time one of the larger starch companies in Canada sent one of its officials to Europe to collaborate with Dr. Whitby in this study. At the close of the year investigational work, looking to the increased utilization of potatoes in Canada, was being carried on along several different lines.

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

At the request of the Associate Committee on Agriculture of the National Research Council, a conference on cold storage was held in the National Research Laboratories in June, 1934. Representatives of the shipping companies, the Dominion Department of Agriculture, the Department of Trade and Commerce, other government organizations, the universities, and the National Research Council were present. The object of the conference was to consider what investigations might advantageously be made, and where the different parts of such work should be carried out, as the field was obviously a very large one.

It was agreed that since the Dominion Department of Agriculture had a working committee dealing with the transport and storage of horticultural products, problems in this field could be carried out effectively by that body. It was felt that, if any work were undertaken regarding the cold storage and transport of animal products, it would probably be best done under a committee formed by the National Research Council.

At a later date the Quebec Federal-Provincial Committee on Cold Storage requested the National Research Council to study the storage conditions prevailing in the celery storage rooms in certain Montreal warehouses. A

survey of these warehouses was made by Drs. Niven and Cook during the summer months, and it was decided to make a further investigation during the storage season. For a summary of the results of this study see the report of the Division of Biology and Agriculture, page 25.

From time to time the Council has received requests to make an investigation into the tainting of certain food products, such as wheat, flour, cereal products, eggs and meat, by other odoriferous commodities such as apples, pine, citrus fruits, etc. Since requests of this type had become quite numerous, a conference of representatives of the shipping interests, the Dominion Department of Agriculture and the National Research Council was held in the National Research Laboratories in November, 1934. It was agreed at this conference that certain investigations on taint should be undertaken as soon as possible and a comprehensive program of research in this field was prepared.

In view of the numerous problems in cold storage and related fields brought to the attention of the National Research Council, it was decided in January, 1935, to enlarge the scope of the Associate Committee on Cold Storage and to give it a new title, the Associate Committee on the Storage and Transport of Food. This committee, consisting of representatives of the National Research Council and the Dominion Department of Agriculture, held its first meeting in February, 1935, and considered the three classes of problems that had been referred to it, namely: (1) problems in the storage of celery, (2) problems in the transport and storage of poultry, and (3) problems of taint in stored and transported food products. Consideration was given to the phases of the various problems that could be undertaken immediately with the staff and equipment available, and the allocation of the work among the co-operating agencies.

The formation of condensate (sweating) on products brought out of cold storage frequently causes a rapid deterioration of the product, since in addition to the poor salability of the wet material, the excess surface moisture favors the growth of micro-organisms. The committee recommended that there should be made this year an adequate test of the anti-condensation chamber on the London docks. Meanwhile, the study of air velocity, temperature, and humidity, in relation to the dechilling and defrosting of poultry is being continued on a laboratory scale with the object of determining the most suitable and economical conditions. When these studies are complete further consideration will be given to tests on a commercial scale. A summary of the results obtained will be found in the report of the Division of Biology and Agriculture, at page 26.

As a result of the conference on taints, it was decided that, since apple and wood taints appear to be chief offenders, these should be studied first. Methods of estimating these taints, the relative susceptibility of different food products, and absorbing and deodorizing practices are to be given early consideration. Preliminary investigations on certain phases of these projects have been initiated.

The committee also received a report on the work being carried on by Dr. Niven on the heating of railway refrigerator cars. Details of this report will be found at page 61.

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

Co-operating organizations:

Alberta Department of Agriculture
Manitoba Department of Agriculture
Saskatchewan Department of Agriculture
University of Alberta
University of Manitoba
University of Saskatchewan

No general meeting of the associate committee has been held during the year under review, but work has been continued at a number of centres and it is planned to hold a meeting of the reorganized committee in Saskatoon in June, 1935. This will afford members of the committee an opportunity to see the large weed nursery at that point and to secure full information regarding the associated investigations. There follows a summary of a report covering the work at Saskatoon in 1934. Other reports will be presented at the forthcoming meeting.

Weed Investigations at the University of Saskatchewan

Investigations into germination and growth of weeds and crop plants and testing of certain chemicals as weed eradicators were continued in 1934.

Further evidence was produced to show that the seeds on a wild oat plant may be viable as early as five days after heading. Three-year-old seeds of wild oats and wild mustard germinated better than fresh seeds; wild mustard showed a higher proportion of dormant seeds than did wild oats. Attempts to induce germination in a sample from a lot of wild oats which was buried deep in soil in 1930 were unsuccessful. Germination had been obtained in previous years and further tests will be made in 1935.

Wild oats in some cases germinated and emerged from depths of 12-13 in. and cow cockle from 5–6 in., but the majority of the annual weeds tested germinated satisfactorily only in the top four inches of soil. Thorough shallow tillage should therefore be effective in controlling most annual weeds. Experiment has shown that the wild oat population of a field may be decidedly reduced by the so-called green summerfallow method. The land should be harrowed and packed early in spring and cultivated when the wild oats reach five inches in height. Each cultivation should be followed by packing.

Under unfavorable moisture conditions seeds of cereals germinated more rapidly than did weed seeds. Furthermore, the grains, with the exception of flax, increased in dry weight more rapidly than the weeds for at least 22 days after emergence. This indicates that dense and uniform emergence, which results in effective occupation of available space by the crop plants, gives the crop a decided advantage over weeds.

Studies of the underground portions of plants showed that the root development varies with the season, moisture being the important factor. The tremendous development of roots which occurs in the absence of competition is illustrated by the fact that the total measured length of crown and seminal roots of one plant of Marquis wheat, together with their branches of the first and second order, was approximately 43 miles. Plants of prolific spring rye and wild oats produced still greater total lengths of roots. Length of first order branches reached 30–36 in. in wheat, 41 in. in rye, and 51 in. in wild oats. Where competition exists the yield of crop is reduced, the amount of dry matter produced by weeds being attained at the cost of the crop.

Tests have shown that there is a definite relation between crop yield and weed growth. In general, plants with the more extensive root systems produce greater growth above ground. A study of the root systems of wheat varieties in relation to their yielding ability, now under way, will be continued in 1935.

Crested wheat grass proved to be more effective in competing with weeds than either brome or western rye grass. This grass showed remarkable root development. The roots of a single plant which was seeded in 1932 were excavated and measured in 1934. The total length of all roots exceeded 300 miles. Such development has some bearing on its competitive ability, and it also indicates the value of this grass as a soil binder.

Sodium chlorate, arsenic pentoxide, acid sludge, alpha-naphthylamine, aniline, tetralin and creosote were tested as eradicators of Canada thistle in 1933 and 1934, the two first named showing promise for this purpose. Complete killing of the roots was effected to a depth of 10 in. by sodium chlorate, and 4 in. by arsenic pentoxide. Sodium chlorate also produced some injury as far down as 12 in.

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

Joint 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
University of Alberta
University of Saskatchewan
Wool Industries Research Association (Great Britain)

Two meetings of the Wool Growing Section of the committee have been held during the year, in Ottawa on June 23 and in Toronto on November 23, 1934. At both meetings progress reports were presented of investigations under way and plans were formulated for future work.

Work has been continued at the Lethbridge Experimental Station of the Dominion Department of Agriculture under the direction of Dr. W. H. Fairfield. A flock of purebred New Zealand and Australian Corriedales is being maintained and also a flock of grade Corriedales of good quality. The latter are being divided into three groups, according to the character of the wool. This station has also a flock of purebred Rambouillets required for crossbreeding purposes.

Dr. Fairfield reported upon work carried out at Skiff, Alberta, where in co-operation with a prominent rancher an effort is being made to determine the value of the Corriedale × Rambouillet cross for both wool and mutton, and also the suitability of the Corriedale breed for use under range conditions in western Canada. The first Corriedale cross has been found to improve greatly the mutton characteristics of the Rambouillet progeny, and grading tests show that these sheep produce heavy fleeces which command practically the top market price. Additional Corriedale blood has not given equally good results in respect to wool quality.

Acting on a recommendation of the committee made at its June meeting, the Livestock Branch of the Dominion Department of Agriculture imported about 100 registered Rambouillet rams in 1934, and distributed these among the ranchers of western Canada. The committee feels that this is an im-

portant step in the right direction, as it is convinced that Rambouillet blood must be the foundation of sheep ranching under prairie conditions, and there is still room for great improvement within this breed.

The committee has regretfully decided to bring to a close the work at Cardston, Alberta, where extensive crossbreeding experiments have been carried out between the Corriedale and Rambouillet breeds in comparison with straight Rambouillets. While some valuable information has been obtained, these experiments have not been an entire success, owing largely to the failure of crops in this area.

Prof. Sackville reported to the committee the results of his experiments at Edmonton on the effect of climatic and nutritional factors on wool. These experiments, which were followed up by special grading tests under the auspices of the Canadian Co-operative Wool Growers and exhaustive tests in the National Research Laboratories, indicate that temperature and moisture variations have little effect upon wool quality and quantity. The maintenance of sheep on a high plane of nutrition has been found to produce an increased quantity of strong wool, as well as increased body weight, but the fineness of the wool has probably been slightly lowered in comparison with that produced on a medium or low plane of nutrition. It is the opinion of the committee that the results obtained justify the maintenance of a generous plane of nutrition. It was agreed by the committee that the results of Prof. Sackville's experiments should be given detailed study by a special committee appointed for that purpose. Prof. Sackville is carrying on his nutritional and deficiency experiments on a modified basis.

The results of crossbreeding experiments at the University of Saskatchewan were presented by Dean Shaw. After trying a number of breeds in respect to their suitability for crossing with fine-woolled sheep, Prof. Shaw has eliminated all but the Corriedales and Ryelands. Both of these breeds improve the mutton quality of the progeny, the Ryelands excelling in this respect. The Corriedale crosses produce more wool. The committee considers that both breeds are worthy of further experimentation under similar conditions.

Consideration was also given to the advisability of undertaking experiments with the definite objective of developing a new type of sheep for use under range conditions in western Canada. It was agreed that such a project should not be begun before the fall of 1935 when further results of preliminary experiments will be available.

Special grading was carried out at the warehouse of Canadian Co-operative Wool Growers at Weston, Ontario, under the direction of Mr. W. H. J. Tisdale, on fleeces from all experimental flocks. This work has proved very enlightening and is forming a valuable guide to the committee in its effort to improve the quality of Canadian wool. The committee has also been fortunate in that the Canadian Co-operative Wool Growers were able through their London agents to make arrangements for special grading and scouring tests in the Bradford conditioning house on lots of wool from experimental flocks. The comments on quality and condition of the wool have been very helpful. Of one lot the following comment was made, ". . . an exceptionally fine type, mostly 70's, with some finer fleeces running through. This is the finest type of Canadian wool that we have yet seen."

As part of its wool studies the committee secured typical high-grade English fleeces and similar fleeces from the same breeds grown in Canada. These were compared in detail and the Canadian fleeces were found to be fully the equal of those imported.

Since the committee began its work a gratifying improvement in the quality of Canadian wool has been noted, the tendency in western Canada being definitely towards the half-blood and fine wools. This improvement has been recognized by Canadian manufacturers and it is satisfactory to be able to report that they are now obtaining a large portion of their wool requirements in this country. Further improvement in this respect is anticipated as the quality of Canadian wool becomes better known and appreciated.

As previously mentioned, work has been done in the National Research Laboratories on wool from experimental flocks. Reference to this will be found on page 48 of this report.

ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

Co-operating organization:

Department of National Defence

Early in 1935, the Council decided to re-establish the Associate Committee on Aeronautical Research. In choosing the personnel for the newly formed committee, consideration has been given to the various groups and organizations interested in aeronautics, and the membership has been selected with a view to making the committee as representative as possible of the aircraft and engine constructors, operators, motor fuel manufacturers, meteorologists, the Royal Canadian Air Force, and the National Research Council.

Associate Committee on Asbestos

Co-operating organizations:

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

During the year under review the staff of the National Research Council engaged in research on asbestos has worked in very close touch with the industry. A representative of the Council has attended meetings of the Quebec Asbestos Producers' Association and a representative of that organization has attended the Ottawa meetings of an Internal Committee on Asbestos Research which has been set up in the National Research Laboratories. The work of the laboratories is described on page 35 of this report.

No meeting of the associate committee has been held since January, 1934, but it is planned to call a full meeting of the committee in Ottawa in June, 1935, to go over the whole research program and to give members of the committee an opportunity of becoming more familiar with the work going on in the National Research Laboratories.

Associate Committee on Chemical Standards

An Associate Committee on Chemical Standards was formed by the National Research Council, March 30, 1933, on the recommendation of a special committee appointed to explore the possibilities for useful work in this field.

During the past year the committee 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 are 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. About 80 chemical specifications have been received and circulated in Canada under this plan.

Consideration has been given to various recommendations looking to the establishment of specific standards for chemical products in Canada, but the work done during the past year has been of a preliminary character.

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

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

During the year the committee has continued the policy of calling no general meeting but of carrying on as much laboratory work as possible and sending representatives to meetings of the American committee, which has been active. Mr. R. E. Gilmore of the Dominion Department of Mines was sent to the meeting at State College, Pennsylvania, in the fall of 1934, and Mr. F. E. Lathe was sent to the New York meeting in February, 1935.

Evidence that progress is being made by the American committee is given in the statement by the chairman that "For the first time in history, the consumer—large and small—will be able to order coal and know what will be delivered." The recommendations of the American committee, which have reached the tentative stage, were slightly modified during the year as a result of further investigations.

Laboratory and field work have been continued by the Dominion Department of Mines under the direction of Mr. Gilmore, by the Alberta Research Council under the direction of Prof. Edgar Stansfield, and by the Geological Survey under Dr. B. R. MacKay. This work is having an important bearing on the establishment of standard methods of testing and is revealing fundamental information on the nature and properties of coals of various ranks.

Associate Committee on Electrical Measuring Instruments

Co-operating organization:

Electricity and Gas Inspection Service, Department of Trade and Commerce

The seventh meeting of the committee was held in Ottawa on March 9, 1935, with 22 persons in attendance.

At this meeting consideration was given to a report issued by the Council on the re-seal period of meters, based on the inspection by the Council's staff of over 3,000 meters in cities and towns across Canada. An opportunity was thus afforded all those interested to present their views on this important question.

The committee also discussed the question of defining the location of the government seal on electricity meters. This question did not arise until one manufacturer, in designing a meter for use outdoors, placed the seal in a con-

cealed position where it would be protected from the weather. Some objection was taken to this practice, as a hidden seal would seem to afford less protection against tampering. A subcommittee was appointed to inquire further into this matter.

The problem of metering on electric transmission lines operated at exceptionally low load has been discussed and various suggestions made for the consideration of power companies faced with this difficulty.

At a previous meeting the committee had agreed in principle on the fairness of taking reactive power into account in billing for electricity, that is, in billing on the basis of kilovolt-amperes. Certain problems exist in respect to the measurement of these units and in the definition of terms, but a decision was reached to recommend to the National Research Council that steps be taken to make the kilovolt-ampere a legal unit for billing as soon as may be feasible. In these matters the committee will continue to co-operate with a committee of the American Institute of Electrical Engineers, which was appointed to draw up precise definitions of the more important electrical terms, and also with similar committees in England.

At the same meeting a report was presented on Vibration of Transmission Lines, prepared by Dr. R. Ruedy of the Division of Research Information. This is a problem which has been giving some concern to the distributors of electrical power in all countries. It was decided to have the report duplicated for distribution.

Following the meeting of the committee, two conferences have been held to discuss with representatives of the power companies and the manufacturers of electrical instruments certain practical problems faced by these groups.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association, as at March 31, 1935, had a total membership of 716. This includes members of the main committee, sectional committees and all working committees.

The main committee, which is now the Associate Committee on Engineering Standards, is composed of 50 members, of which at present five representatives are from the National Research Council—Dr. H. M. Tory, Dr. A. Frigon and Mr. F. E. Lathe being nominated, and Dr. R. W. Boyle and Mr. J. H. Parkin being co-opted, representatives.

A complete reorganization of the main committee is now under consideration. This was discussed at meetings of the main committee and of the Association, held in September, 1934, and at a special conference of industrial representatives with the executive committee in November, 1934.

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

New Publications

Six publications have been issued during the year, as follows:—

B34–1934 (August 1934)—Established Lists of Non-heat-treated Machine, Carriage and Plough Bolts and Common Square and Hexagon Nuts.

C22.1–1935—Canadian Electrical Code, Part I (Third Edition.)

This third edition of the Code was issued in December, 1934, and special provincial editions have since been prepared for Nova Scotia, Quebec, Ontario, Saskatchewan, Alberta and British Columbia. The Code is now in operation in all of the nine provinces; in many cases under the direction of a provincial inspection department.

Under Part II of the Canadian Electrical Code, four approval specifications have been issued as follows:—

C22.2 No. 8–1934—Construction and Test of Capacitors (electrical condensers) for Use in Suppressing Radio Interference.

C22.2 No. 18–1934—Construction and Test of Outlet Boxes.

C22.2 No. 20–1935—Construction and Test of Motor-operated Blowers and Stokers.

C22.2 No. 22–1935—Construction and Test of Electrical Equipment for Measuring and Discharge Devices for Explosive or Flammable Liquids.

Civil Engineering and Construction

Brick Dimensions. The report prepared by the panel of the general committee on building materials has been finally approved and the standard dimensions for building brick will be published shortly. Copies of this standard will be sent to the technical press for comment.

Structural Timber. A panel has been formed to deal with specifications for structural timber, and the first draft was issued on February 20, 1935, for comment. Representation from interested government departments, railways, technical societies and organizations has been secured and it is hoped that this specification will prove useful, particularly in the preparation of building by-laws.

Mechanical Engineering

Screw Products. The established list of machine, carriage and plough bolts has now been published as indicated above. No progress has been made on standards for wood screws and small rivets as yet, as it has been thought best to wait for developments which have been taking place in the trade.

Oil Burner Regulations. The Association has been advised that this work will be taken over by the National Research Council, and the present C.E.S.A. committee will therefore be discharged.

Fuel Oil. A conference with oil manufacturers was held in March 1934 under C.E.S.A. auspices, but as it has now been decided that this work will be handled by the National Research Council no committee has been organized by the Association.

Elevator Safety Code. A special panel of the committee is considering the first draft of this specification and it is hoped will submit suggested revisions to the committee shortly.

Electrical Work

Canadian Electrical Code. The third edition of Part I of the Code has been published, as indicated above. A definite plan covering procedure for Code revisions has now been worked out; the committee of provincial representatives has been revived and the work of revision will be carried on under their supervision.

Part II of the Code, covering essential requirements and minimum standards for electrical equipment, is prepared by a special panel on specifications in co-operation with industrial representatives. The work continues to be

active and up to date. There have been 37 specifications under consideration, 15 of which have been published including the four indicated above, and others will soon be ready for publication. The panel on specifications held 11 meetings during the year to discuss draft specifications. These included specifications for capacitors (electrical condensers), outlet boxes, motor-operated blowers and stokers, electrical equipment for measuring and discharge devices for explosive or flammable liquids, which have now been published. Consideration was also given to specifications covering enclosed switches, transformers for luminous-tube signs and oil-burner ignition equipment, industrial control equipment, cable for luminous-tube signs and oil-burner ignition equipment, soldering lugs, oil-circuit breakers, automatic controllers of small capacity, dust-tight enclosures, auxiliary gutters, junction boxes and pull boxes, wireways and busways. Other specifications which are in draft form cover asbestos-insulated stove wire, panel-boards, enclosed branch-circuit cutouts, switchboards and switching equipment, electrically-operated refrigerating machines, electric cranes and hoists, electrode receptacles for luminous-tube signs, low-voltage control-circuit wire and cable, and electrical appliances for hair-dressing and hand-drying.

Part III of the Code covers outside wiring rules, and under Section 1, Overhead Systems, a first draft was sent out on July 10, 1934, to the sub-panel for comment, following a special joint report prepared by the railways and communication companies which was sent out on October 10, 1933. This special report from the communication and railway group has now been revised and a second edition will be sent out to the sub-panel for consideration and inclusion, if possible, in the proposed C.E.S.A. rules for overhead systems.

A draft covering definitions and principles for inductive co-ordination, prepared by sub-panel No. 3, has been approved by the panel on outside-wiring rules and is now before the main committee for approval. A draft covering principles and practices for the prevention of radio interference has also been approved by the panel on outside-wiring rules and will shortly be submitted to the main committee. It is proposed to issue these reports in mimeograph form as soon as approval has been secured, but eventually a complete set of rules covering outside-wiring conditions will be printed.

Under Section 4 of Part III of the Code, a draft of principles and practices for the protection of underground structures from the effects of stray currents originating in direct-current electric-railway systems has been approved by the panel on outside-wiring rules and is now before the main committee for final approval.

Insulated Power Cable. The first draft of the specification covering lead-covered paper-insulated cable has been revised and is now awaiting the result of some special investigations. It is hoped to put this specification forward in the fall. Consideration has also been given to a report on armoring for cable.

Enamelled Magnet Wire. Consideration is still being given to the preliminary draft, but no further progress has been made as the committee is waiting for the results of some further investigations.

Oil Circuit Breakers. This committee has been entirely reorganized and has been co-operating with the panel on specifications under Part II of the Canadian Electrical Code. After considerable discussion a fifth draft of the specification has been sent to the committtee and to the panel for letter ballot.

Bulletins to Electrical Manufacturers. These bulletins are issued to interested manufacturers for the purpose of giving advance information on prospective changes in test requirements or proposed revisions to the Canadian

Electrical Code. Three of these bulletins have been issued during the year. Detailed information on these bulletins to electrical manufacturers is published in the C.E.S.A. Quarterly Bulletin.

Ferrous Metals

Heavy Steel Shaft Forgings. It has been decided to change the name of this specification to Carbon-steel Forgings. The final draft of this specification has now been approved by the committee and as soon as approval can be obtained from the main committee the specification will be published.

Commercial Bar Steel. The committee has been considering proposed revisions to the specifications for commercial-quality hot-rolled bar steels and for commercial cold-finished bar steels and cold-finished shafting, and drafts are now before the committee.

Reinforcing Materials for Concrete. It is believed that the specifications issued in 1930 require revision, and drafts showing these revisions are now before the committee for consideration.

Steel Construction

A new sectional committee has been organized to deal with this subject, and the new steel specifications will be issued under the direction of this sectional committee.

Draft specifications covering mild steel, medium steel, silicon steel and rivet steel have now been approved by the sectional committee and specifications for higher strength rivet steel and higher tensile steel will also be considered.

A special panel dealing with structural steel welding is now in operation and it is hoped to issue specifications covering this subject as well.

It will probably be necessary to make certain revisions to existing specifications covering steel railway and steel highway bridges and steel structures for building, with special reference to working stresses.

Industrial Contacts

The secretary attended annual meetings of the Canadian Electrical Association, Dominion Fire Prevention Association, and the Engineering Institute of Canada, during which wherever possible meetings of C.E.S.A. working committees were called to take advantage of the presence of committee members.

A special meeting was held in May, 1934, with the standardization committee of the American Railway Engineering Association, at which exchange of information was made by representatives of the two organizations.

Sale of Publications

The sale of publications has kept up well during the year. There has also been a considerable sale of publications issued by the British Standards Institution.

Industrial Support

During the year resignations have been received from three sustaining members and two subscribers, and two members were compelled to reduce their subscriptions. Six new members were added to the list; an increased

membership was received from one member, and three former members resumed membership. There are now 68 members on the list of sustaining members and subscribers.

The National Research Council has continued its financial assistance, and with the support received from industry a fairly successful year's work has been completed, but with additional funds the work can be extended to great advantage.

Associate Committee on Fire Hazard Testing

The second meeting of the committee, held in Toronto on August 29, 1934, was the only full session held during the year. Following a report on the activities of the Oil Burner Laboratory presented by the secretary, several features in the testing of oil burners were discussed. The testing and listing of dry-cleaning solvents, fire extinguishers, gasoline-vapor machines, gasoline stoves and lamps were also considered.

In accordance with the policy of issuing bulletins and reports to the committee by mail, for comments and suggestions, two reports were mailed to members,—one on dry-cleaning solvents and one on gasoline-vapor machines, stoves and lamps. On the basis of the replies received, the Council decided, on the recommendation of the committee, to test and list both dry-cleaning solvents and gasoline-vapor machines, stoves and lamps.

Three meetings of the executive committee were held in Ottawa to consider financial matters relating to the committee's work. After reviewing the situation carefully, the executive committee authorized the appointment of one laboratory boy and one laboratory assistant, their salaries to be paid out of the funds of the associate committee. The executive committee also authorized the purchase of equipment required for the testing of fire extinguishers.

Two new appointments to the associate committee were made. Mr. E. McGrath, Fire Commissioner of Manitoba and Mr. Tom Moore, Secretary, Trades and Labor Congress, Ottawa, accepted invitations to serve on the committee. Mr. Tom Moore also consented to serve on the executive committee.

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
Dominion Department of Mines
University of Alberta

No meeting of the committee has been called in the year under review, but research on the utilization of natural gas has been continued both in the National Research Laboratories and in the laboratories of the University of Alberta. The work in the former is outlined on page 39 of this report; that of the latter, supported jointly by the Alberta Research Council and the National Research Council, is briefly described below.

Gas Research at the University of Alberta

It has been necessary to operate during the year on a somewhat reduced scale, but work has nevertheless been continued on several investigations, with the assistance of three postgraduate students.

In view of the possibility of shedding light on the underground conditions in the Turner Valley natural gas field much interest has been centered in the solubility of natural gas in various petroleum fractions. An improved apparatus has been designed for the purpose of investigating this question and preliminary experiments have been carried out on three different fractions boiling in the hexane range. The results indicated the necessity of working with single hydrocarbons, and experiments have therefore been started with pure cyclohexane. It is proposed later to carry on experiments with pentane, hexane, heptane, methyl cyclohexane, benzene and toluene.

The experiments on the oxidation of natural gas have been continued with a larger percentage of oxygen in the gas mixtures. The possibility of explosions had to be guarded against by redesigning the apparatus and operating it with the utmost care. The efficiency, as measured by the yield of useful products, was less than that found in previous work with lower concentrations of oxygen. An effort to improve yields will be made by the use of other catalysts and by further modifications in the apparatus.

An associated investigation is one on the corrosion of lead gaskets used in sulphuric acid scrubbers employed to remove sulphur compounds from the natural gas. Lead is normally quite resistant to sulphuric acid, but that in the apparatus in question was rapidly corroded. The cause has been traced directly to products of the reaction between sulphuric acid and the organic sulphur compounds in the gas. Sulphur dioxide is liberated in these reactions and causes comparatively rapid corrosion of the lead. The investigation has covered various concentrations of acid at pressures up to 230 atmospheres, with and without the addition of sulphur dioxide and other compounds of sulphur.

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

Associate Committee on Laundry Research

Early in the year under review the Research Fund Committee, appointed by the Eastern Canadian Laundryowners' Association for the purpose of securing financial support for work in the interests of the laundry industry of Canada, to be carried out in the National Research Laboratories, presented a report to the Eastern Canadian Laundryowners' Association outlining the results of its activities during the preceding year. The report pointed out that while subscriptions had been received from 49 firms located in every province of Canada except one, only $745.00 had been subscribed. The report then stated,— "The question of the future of the laundry laboratory requires careful consideration. Although it would appear clear that this laboratory should be supported adequately by the industry, this support to date has been disappointing, especially in view of the amount of time and effort which has been expended by your committee to ensure that the industry was fully informed on this subject. The committee are therefore forced to the conclusion that an improved basis of organization for associating the laundry industry in Canada with the laundry laboratory established by the National Research Council, is necessary. Consequently, the committee recommend that serious consideration be given to the establishment of a permanent research organization representative of the laundry and dry cleaning industries throughout Canada. Your committee is of the opinion that such an association might establish minimum standards of laundry practice covering such factors as dirt removal efficiency, tensile strength loss efficiency, sanitation, etc."

The recommendation of the Research Fund Committee was approved by the Eastern Canadian Laundryowners' Association, and the National

Research Council was requested by the industry to convene a conference of representative launderers and cleaners in Canada for the purpose of considering whether the establishment of a national research association in this industry was practicable and desirable, and if these questions were answered in the affirmative, to take the necessary action to form such an association. Two preliminary meetings of the Associate Committee on Laundry Research were held, in October 1934 and in January 1935, for the purpose of making adequate preparations for the proposed conference.

A Dominion-wide conference of representative launderers and cleaners was held at Ottawa on January 25, 1935, and the Canadian Research Institute of Launderers and Cleaners was created at this conference. The proposed by-laws for the Institute were carefully considered and adopted by the conference, and it was decided to secure Dominion incorporation. The conference also considered the question of the system to be used for the rating of laundry and cleaning plants and the procedure to be followed in securing members for the new Institute. The nature of service which should be rendered by the Institute to the laundry industry was already well established through past experience, but the requirements of the cleaning industry were discussed by the conference at some length, as no work in this field had previously been undertaken in Canada on a national scale.

The objects of the Institute as stated in the by-laws are as follows:

(a) To promote scientific research and technical work in connection with the laundry and cleaning industries.

(b) To provide funds through fees or such other means as may be from time to time determined for the purpose of payment of such skilled, professional, technical, or other officers as may be agreed upon between the Institute and the National Research Council for other purposes consistent with these by-laws of the Institute.

(c) To co-operate with the National Research Council in equipping and maintaining such laboratories as shall be found necessary.

(d) To accept grants of money and other assistance from any source whatsoever for the purposes of the objects of the Institute, and to invest the money of the Institute not immediately required in any one or more of the modes of investment for the time being authorized by law for investment of trust money and in such a manner as may be from time to time determined.

(e) And generally, to undertake in co-operation with the National Research Council any work of a scientific or technical nature as shall be agreed upon as being in the interest of the laundry and cleaning industries and conducive to an improved service to the public served by these industries.

The by-laws also cover such questions as the conditions of membership, the fees to be paid by member firms, the constitution of the Executive Committee and Board of Management, general questions of administration, the standards of efficiency to be maintained in the plants of members, and such other questions as are required for the effective operation of the Institute.

The Canadian Research Institute of Launderers and Cleaners came into active operation just at the close of the year under review, and it is confidently expected that the laundry and cleaning industries of Canada will take advantage of the facilities available through the Institute to secure accurate scientific information by means of which they may increase the efficiency of their operations both in their own interest and in the interest of the public whom they serve.

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories, Limited
Dominion Department of Mines

As in recent years, most of the research work carried out under the auspices of this committee in the year under review has been done in the National Research Laboratories. An outline of this work will be found in the report of the Division of Chemistry on page 43. The work on refractory brick, by Mr. J. W. Craig, has been continued in the ceramic laboratories of the Mines Branch, where excellent facilities for ceramic research are available. Large-scale experimental and semi-commercial tests have been made in the plant of Canadian Refractories, Limited, at Kilmar, Quebec, and certain high temperature burns of refractory materials have been carried out at the plant of the E. J. Lavino Company at Plymouth Meeting, Pennsylvania, through the courtesy of that company.

It is gratifying to be able to report that distinct progress has been made both in the laboratory investigations and in the commercial application of the results obtained. The various products marketed are meeting with increased favor in an ever-widening field, in spite of the relatively depressed condition of the steel industry, in which they find their chief applications. This expansion has taken place not only in Canada but also in the United States and Great Britain.

In the brick investigation particular attention has been paid to the problems of manufacture, and definite improvements have been effected, resulting in more satisfactory conditions of operation and a stronger product. Much work has been done in an effort to develop a brick possessing increased strength at higher temperatures, for which there is a great demand on account of the present tendency to force metallurgical operations as rapidly as possible. The manufacture of an unburned brick is receiving attention, as the elimination of burning will permit more flexible operation and cheaper production. In this ceramic work the committee gratefully acknowledges the valuable assistance of the staff of the Mines Branch, particularly in microscopic work involving the determination of mineral constituents.

There has also been observed a wider application of plastic products, that is, those which contain chemical bonds and which will harden in place without the application of high temperatures. The developments in this branch of the work have been very gratifying. Users of one material developed in the National Research Laboratories claim that its use greatly increases the life of open-hearth furnace tap-holes. Applications of this material are being extended.

During the year a number of additional patents have been obtained and others have been applied for on the newer laboratory developments.

(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
Pacific Committee on Oceanography (U.S.A.)
University of British Columbia

In order to meet the requirements of a resolution passed by the Fifth Pacific Science Congress, a Subcommittee on Fisheries with Dr. R. E. Foerster, Assistant Director of the Pacific Biological Station, Nanaimo, as chairman, has been added to the Associate Committee on Oceanography.

As Dr. D. B. Finn has been transferred from the Fisheries Experimental Station, Prince Rupert, to the similar station at Halifax, Dr. N. M. Carter, who succeeded him as director at Prince Rupert, has been appointed Chairman of the Subcommittee on Fisheries Technology, to take his place on the associate committee.

The co-operation in oceanographic work in the various institutions and among the various scientists along the Pacific coast of Canada and the United States has been highly satisfactory for some years. It appears that it may be possible to make that co-operation even more tangible. At a luncheon meeting of oceanographers, held at Berkeley last summer, during the time of meeting of the American Association for the Advancement of Science, a committee was appointed to study the advisability of organizing an oceanographic society of the Pacific. In response to inquiries sent out, it was reported by the committee at a meeting of the Western Naturalists in La Jolla in December, that enough interest was indicated to go ahead with the organization. The committee was continued as an organization committee and it is intended that the society should be duly established at a meeting called for a date during the meeting of the Pacific Division of the American Association for the Advancement of Science in Los Angeles in June, 1935.

Co-operation in oceanographic work in the departments of the University of British Columbia, which, in the first place, was largely confined to botany, chemistry and zoology, has been gradually extending to other departments—bacteriology, poultry, animal husbandry and now to physics—as a spectrophotometric method for assaying the potency of vitamin A (in connection with the study of vitamins in certain fish oils) is being investigated.

It is gratifying to learn that although the budgets for carrying on oceanographic work have been cut so severely, much progress has been made during the year on the major problems in hand. Certain new minor problems, growing out of these, have received consideration, but it has not been possible to enter upon the investigation of several larger problems, that have been awaiting attention for some time.

Perhaps the most fruitful advance during the year was brought about by the extension of the co-operation between the Biological Board and the Hydrographic Service. Through the courtesy of the Hydrographic Service, accommodation for two members of the staff of the Nanaimo station was provided on board the excellently equipped survey ship, the "Wm. J. Stewart", from April 15 to August 1, to begin a program of oceanographic investigation on the west coast of Vancouver Island. Analyses of the water were made for chlorides, dissolved oxygen, silicates, phosphates and nitrites, and temperatures, densities and pH readings were taken. Particular attention was given to tidal and other currents, and hydrodynamical studies were made.

Through the courtesy of Mr. H. D. Parizeau, officer in charge of ice survey, access was given to the original charts on which soundings were recorded, showing the interpretation of these soundings into contours of the sea bottom, for about 25 miles off shore, for a distance of 125 miles.

Plankton was collected at definite, vertical depth intervals, where the physical and chemical data were also obtained. Several useful modifications

of mechanical devices used in this work were developed. Samples of the bottom fauna were obtained by dredge and beam trawl, and extensive shore collections were made when the state of the tide permitted.

In the field of technology, several matters of long standing investigation have now been definitely brought into the realm of commerce; for example, the efficiency of roof-tank refrigeration, the utilization of fish oils in paints and the vitamin values of certain fish oils.

Other recent investigations which have brought definite results are an extension of the methods for disinfecting halibut vessels to be used in deodorizing refrigerator cars, methods of preventing "rusting" of frozen fish in cold storage and of cracking the ice glaze.

Judging from the number of scientific papers published during the year, to make the results of this research available, even under such financially adverse circumstances, activity in the oceanography of the Pacific coast is worthy of commendation.

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

Building

The Institute building has now been completed on the general plans laid down four years ago. A number of modifications, however, have been made in the internal arrangements—all in the interests of economy and in the light of experience. The new scheme provides laboratory accommodation for the director, technician, biochemist and students, as well as a combined dark-room-studio, aquarium and a store for the collections; extra accommodation is provided for large farm animals in the basement. Benches have been constructed on a new plan, which provides a maximum of cupboard space with special facilities for cleaning.

Library

The abstract card index is being maintained and now contains some 3,500 card summaries—a virtually complete list of titles since the beginning of 1932. It is proving of invaluable use to the Institute and is now being used by outside scientists.

The Imperial Bureau of Agricultural Parasitology is continuing its invaluable assistance and supplies the Institute with lists of all titles seen by it. These are of great value as they save a great deal of time in searching current literature.

Teaching

During the summer a short course in parasitology was given to veterinary surgeons. Owing to the limited accommodation then available only a few could be enrolled.

A short undergraduate course in parasitology as it affects human medicine in Canada was given in the spring to about 50 medical students under the auspices of the Faculty of Medicine, McGill University.

During the year numerous conventions and meetings were attended, and 12 addresses were given by the director and various members of the staff.

Research

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

During October, the R.M.S. "Nascopie" brought back many of the garbage cans which had been taken to the Canadian eastern Arctic in 1933. The method of collection is undoubtedly successful, and the collectors had taken a great amount of trouble. Altogether about a ton of material was received, including the intestines of several dogs, seals, a walrus, white whales, lemmings, weasels, many foxes and two wolves. Many birds—especially ducks—and fish were also received. The usual amount of material was received from other collectors throughout Canada.

During the year 243 animals (not including animals partly examined for specific parasites) have been examined for parasites, compared with 134 last year. These are as follows:

	1933	1934
Wild carnivores	13	42
Domestic carnivores	5	2
Rodents	31	29
Wild herbivores	4	9
Domestic herbivores	4	–
Insectivores and bats	1	1
Sea mammals	1	2
Fish	27	114
Land birds	35	41
Water birds	12	1
Domestic birds	1	2
	134	243

A survey of parasites of sheep in Quebec has been made by Dr. Swales and a complete check list is in manuscript. This will be published in conjunction with Part III of "The Review of Canadian Helminthology."

Samples of human stools are being regularly received by the Institute for examination. The percentage of human beings harboring animal parasites (mostly protozoa) in Canada is high—unofficially it has been placed at 60%. The most important human parasite yet found is the broad tapeworm, and the Institute is assisting Dr. Bacal on an investigation on its distribution.

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

Dr. Parnell has made considerable progress with the investigation on the sterilizing properties of artificial fertilizers against the free-living stages of horse sclerostomes in faeces. No fertilizer has been found to equal urea, which when mixed with the faeces before the eggs hatch, is lethal to the larvae in the proportion of 0.5 gm. to 60 gm. of faeces, which at $65.00 per ton, means a ton of faeces could be sterilized for 65¢ worth of fertilizer, which would also considerably increase the value of the manure. Calurea, while

less powerful than urea, also has great practical possibilities. Kainit is probably the most lethal non-nitrogenous fertilizer. Other fertilizers which have lethal powers are cyanamid, nitro-chalk, calnitro, calcium nitrate, diammonium phosphate, carbonate of potash, and nitrate of soda; sulphate of ammonia and muriate of potash have been mentioned in previous reports; sulphate of potash and superphosphate 20% have some lethal action, while basic slag has none.

Preliminary work was started on the use of fertilizers for sterilizing faeces on grass. Little progress was made as difficulty was experienced in making the larvae reach the infective stage, summer conditions apparently being unsuitable for their development—which suggests that frequent harrowing might be beneficial.

A few tests have been made with disinfectants on larvae in faeces and difficulty will undoubtedly be experienced in finding an efficient disinfectant.

Dr. Swales has completed his work on the life cycle of *Fascioloides magna* and has begun a comparative study of the pathology of this condition in various ruminants and rodents. The following are the more important points brought out:—

(a) Two ecologically dissimilar snails act as intermediate hosts in Canada—*Fossaria parva* and *Stagnicola palustris nuttalliana*. A detailed study was made of the free-living and intra-molluscan larval stages, both morphological and biological.

(b) The adult parasite produces more than 4,000 eggs per day, which are able to develop in *damp faeces* as well as in water.

(c) The infective stage or encysted metacercaria is able to survive in air at a relative humidity of 90–95, and it is believed that hay may be considered as capable of transmitting the parasite.

(d) The snail hosts are readily destroyed by applications of copper sulphate to their habitats. When animal segregation is not possible this procedure is recommended.

(e) The fibrous tissue reaction to the presence of the adult parasite in the liver of large Bovidae, is such that the small bile ducts approximating the cystic cavity of the trematode are completely occluded. Thus cattle, bison and yak are shown to be probably incapable of transmitting the parasite.

(f) Cervidae are shown to be normal definitive hosts of *F. magna*. The eggs pass down the open bile ducts from the cavity and are evacuated with the faeces. It is thus probable that deer must be present on the area if this liver fluke disease is to continue, and that cattle cannot spread the disease.

(g) *F. magna* is a very pathogenic parasite in sheep, being capable of killing these animals even when present in small numbers. In one case, a fluke reached sexual maturity in six months and a few eggs were evacuated in the faeces. Thus sheep may be capable of spreading this parasite.

The *Fasciola hepatica* investigation was continued by Mr. Griffiths throughout the summer. No definite intermediate host was incriminated but a suspicious mollusc of the Lymnaeidae was collected and infestation experiments were carried out but with no definite results. As yet, it has not been possible to raise a second generation of this species. It is hoped that a second generation might be infected. At least ten species of snails in the infected area have been proved non-vectors.

In the fall, sheep experimental trials were inaugurated at a series of farms, some in the Ottawa district, some in the Lennoxville district. The farms, previously selected by Mr. A. A. MacMillan, were visited by Dr. Parnell, Dr. Swales and Mr. Griffiths. The object of the trials was to ascertain some means of reducing parasitic infestation by prevention of development of infective forms on entry to the digestive tract. Medicated licks and methods of sanitation and hygiene were adopted as a working basis, supplemented by drenching. The proposed licks have been prepared by Canadian Industries Limited, and are on trial with laboratory sheep at the moment. As soon as it is definitely seen that they are not toxic to the individual, they will be tested in the field. Post-mortem examinations have been carried out with material received from the trial flocks.

Further laboratory experiments have been conducted by Mr. Griffiths with molasses in the hope of preparing a solid, very palatable lick for sheep. Up to the present time, much difficulty has been experienced in obtaining a hard block. Sugar, however, has been substituted, and some promising blocks have been obtained. Anthelmintics will subsequently be incorporated.

Dr. Swales has begun an experiment to determine the effect of ascarid infestation in young bacon swine, and at the same time to determine an effective sanitation system for use in eastern Canada. This work is being done with the co-operation of Prof. E. W. Crampton of Macdonald College, who is testing the effect of a high quality protein feed upon ascariasis.

Dr. Cameron has also continued his work on *in vitro* experiments on *Ascaris*. So far the single important fact that has come to light is that water-glass appears to definitely increase the life of these worms. Mr. Jones has also been working on the same worm and finds an amylase has been shown to exist in the body fluid. Up to the present attempts to find a protease have been unsuccessful. A lipase has not been looked for. Various fractions of *Ascaris* have been isolated. The temperature reaction upon parenteral introduction of these in the guinea pig has been determined. Mr. Jones has also studied hypersensitiveness due to *A. lumbricoides* and has demonstrated fixation of complement in the serum of a hypersensitive person, using a saline extract of the worm as antigen. Symptoms in this subject have been recorded.

Dr. Swales has made a study of parasites of grouse in Quebec, and a note has been published in the Canadian Journal of Research regarding the morphological features of the Quebec specimens and their bearing upon the classification of the group.

He is also continuing his work on *Tetrameres*, the stomach worm of domestic and wild ducks. It has been found to be an extremely prevalent parasite of ducks throughout the country. Life history experiments have so far been negative but more are in progress.

At the request of the National Research Council and the Parks Branch, Department of the Interior, Ottawa, a study was begun of the etiology and prevention of "swimmers' itch" or "cercarial dermatitis," in Canada.

At least half a dozen schistosome cercariae, having wild animals (birds or mammals) as their definitive hosts, are able to penetrate human skin coming into contact with infected water and cause a dermatitis which can persist for up to two months. Not all species of schistosome cercariae in north temperate climates can penetrate human skin, however, while not every human is susceptible to such species as can penetrate human skin. Only one worker (McLeod) has been able to find holostome cercariae penetrating the human skin: these usually attack fish and amphibians. The

condition in man is not usually serious, at least so far as records are available, but as pathogenic micro-organisms can be introduced by the parasite, it may act as the starting point of other skin conditions.

Inquiries show that the condition is very widespread in Canada and in most localities there are bathing areas where it is well established that a skin disease follows bathing. There is little doubt that in most cases this is cercarial dermatitis, although scientific proof is still lacking; bathers, at present however, often ascribe the condition to poison ivy, sunburn, etc.

The work on this problem was begun rather late in the year but ducks were examined locally before the lakes froze: no bilharzia worms were found in them but work has been commenced on their holostome parasites. This work will be continued in the spring. As some of the causal parasites may live in water mammals, clean muskrats are being bred for next season's work.

During the past year the following papers and book have been published:

By T. W. M. CAMERON.—

"The Internal Parasites of Domestic Animals." xii plus 291 pp. demy 8vo. 144 illustrations, 107 references. A. & C. Black, Ltd., London, 15/-. October, 1934.

"The Importance of Parasitology." Sci. Agr. 14 : 540-546. June, 1934.

"Parasitic Diseases Common to Man and Animals in Canada." Brit. Med. J. pp. 1110-1112. June 23, 1934.

"Common Parasites of Pigs." J. Agr. Hort. 38 : 10-11, 26. September, 1934.

"Heard Over the Radio: Parasites of Domestic Animals." McGill News, 15 : 59-61. September, 1934.

"Common Parasites of Sheep." Pt. I. J. Agr. Hort. 38 : 5, 22., Pt. II: 7, 32-33, October and November, 1934.

"Plant Parasitic Eelworms." Rept. Que. Soc. Prot. Plants, 25th and 26th Annual Report, p. 13, January, 1935.

By I. W. PARNELL.—

"Animal Parasites of Northeast Canada." Can. Field Naturalist, 48: 111-115.

"Some Methods of Controlling the Spreading of Internal Parasites of the Horse." Sci. Agr. 15 : 165-168. November, 1934.

By W. E. SWALES.—

"*Rhabdometra odiosa* (Leidy, 1887) Jones, 1929. A Parasite of *Pedioecetes phasianellus* in Quebec." J. Parasitology, 20 : 313-314.

"The Life Cycle of *Fascioloides magna* (Bassi, 1875) the Large Liver Fluke of Ruminants in Canada. Can. J. Research, 12 : 177-215. March, 1935.

By R. L. CONKLIN.—

"Parasites of Horses in Quebec." Spec. Pubn. in French and English of the Livestock Branch, Department of Agriculture, Quebec. 6 pp.

"Comment detruire les parasites du mouton." Spec. Pubn. in French and English of the Livestock Branch, Department of Agriculture, Quebec. 4 pp.

Associate Committee on Patents and Awards

Under the Research Council Act the ownership of all patents on inventions developed in the laboratories is vested in the Council. The Associate Committee on Patents and Awards was formed to advise the Council in respect to the administration of that section of the Research Council Act dealing with patents. Under this arrangement subcommittees have been established in the laboratory divisions to consider what inventions should be patented and in what countries applications should be placed.

The fifth meeting of the committee was held in Ottawa on April 13, 1934. Questions of general policy regarding the work of the committee were discussed in some detail.

During the year subcommittees were appointed to deal with the questions of distillation equipment and methods of heating refrigerator cars.

In the year under review 10 patents have been granted and 10 additional applications have been filed.

Associate Committee on Radio Research

Co-operating organizations:

Canadian Marconi Company
Canadian Radio Broadcasting Commission
McGill University
Northern Electric Company
Radio Branch, Department of Marine
University of Montreal

The third meeting of the executive committee was held on December 13, 1934. Subjects of discussion included consideration of the continuation of work on atmospherics, and the other researches in progress in the radio section of the National Research Laboratories.

With respect to studies on atmospherics it was decided that a second station should be established in western Canada so that observations could be taken simultaneously at two different points. It is hoped the required funds will be made available for this purpose in the near future. (See also the report on Radio at page 65.)

Associate Committee on Radiology

Co-operating organizations:

Canadian Medical Association
Canadian Universities, Hospitals and Cancer Clinics
Provincial departments of health
Radiological societies

The activities of the committee during the year have been directed towards providing facilities in Canada for modern methods of radiation-dosage control. A national standard of X-ray quantity in roentgen has been established in the National Research Laboratories. This instrument has been compared with those of other nations. A number of portable instruments have been constructed and calibrated in terms of the standard by the National Research Laboratories and these are being placed in physics laboratories at centres conveniently located near cancer clinics throughout Canada.

This is the first step in the committee's efforts to assist medical radiology. Two investigations are progressing on the development of equipment to simplify dosage measurement, and an extensive research program on this and other problems of physical therapy lies before the committee, to be undertaken as funds become available.

The committee is sponsoring the publication of technical brochures for the information of radiologists and others, dealing with radiation and electrical hazards, dosage measurement, radio therapeutic equipment, etc. A report entitled: "Industrial Hazards in the Radium Industries" by J. D. Leitch, of the Ontario Department of Health has been published; two other publications are in preparation by members of the Council staff, namely "Electrical Hazards in X-ray Equipment" by B. G. Ballard, and "Radium Dosage" by G. C. Laurence. Other brochures are being prepared.

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

One meeting of this committee was held during the year, on March 12, 1935, to review the developments resulting from the activities of the various subcommittees and to discuss further investigations to be carried out. It is not intended to report in detail on the many problems which received the attention of the subcommittees but a summary of them can be gathered from the statements which follow:—

An experimental model of an instrument for plotting highly tilted oblique air photography was constructed in the National Research Council workshop and tested on practical work. Certain alterations to this preliminary model of "high oblique plotter" were found advisable to facilitate and broaden its use and it was decided to proceed further with this development. A plotter based on the radial intersection principle for use in plotting stereoscopic vertical air photography was designed and the construction of an experimental model of this radial stereoplotter was undertaken.

To effect further economy and efficiency in mapping by high oblique air photography, investigations were made into the problem of rigidly coupling in an air-craft, by a suitable oblique mounting arrangement, three air cameras of the type in regular use to be exposed simultaneously at regular intervals. A field method for setting and calibrating the assembly was evolved as well as methods of applying the data so derived. After investigation, it was concluded advisable to improve the rigidity of the present multi-camera mount.

Methods were evolved and experimentally applied for approximate contouring, formlining and rapid mapping, and information relating thereto distributed. To obtain first-hand information relating to photogrammetric methods originating in other countries, visits to the United States and Europe were made by officials who submitted reports of their findings and a lecture by a photogrammetric specialist was arranged for and given in Ottawa.

An experimental investigation was made of the possibility of utilizing on air photographic mapping operations infra-red emulsion as recently made available on film base. Notwithstanding the importance of this new development in the field of photographic sensitometry, after consideration of the photographic results obtained, it was concluded that, chiefly from lack of sufficient exposure in its present stage of development, this film did not give results of as high a quality as the panchromatic film now in use.

Air photography for mapping use must be taken in an orderly manner to be applied efficiently, and if full value is to be derived from it a record as to the air positions occupied in successive exposures must be collected during the flight. The importance of auxiliary apparatus such as sensitive camera levels, aneroids, altigraphs, altimeters and intervalometers, and the degree of their dependability in supplying required information, warranted a great deal of investigational work which was carried out and reported upon. During the year constructional changes were made on an altigraph which resulted in its improved performance in recording the altitudes of successive exposures in oblique photography. An exhaustive series of tests was made on intervalometers to discover errors in their performance. The effect of temperature on the principal distance of air cameras was investigated experimentally. The sensitivity of various levels was tested and a modification to an existing level was designed, and as a result of its satisfactory performance it was made standard equipment for photographic aircraft. A type of altimeter recommended as a result of previous investigations was acquired and tested, and was found highly satisfactory in actual use. Tests for determining the shrinkage and distortion in film and photographic paper—both of which affect the extraction of angles from photographs—were carried out, as well as tests for establishing the relative merits of two air photographic films. Specifications and drawings were made of an auxiliary recording camera by which the reading of the various instruments at the camera exposure instant are obtained as required, and plans were made to construct a model of the instrument.

Generally, in air mapping operations, the more numerous the photographs required the greater the cost of the flying and office work involved. One method of effecting economy in this respect is to employ a multi-lens camera and rectifier, by which is produced a composite photograph covering a much larger area from a single air position than is possible with a single lens camera. After investigation of new developments in the multi-lens camera field the committee felt that the British seven-lens camera, as designed, would most nearly meet Canadian requirements, and steps were taken to acquire one of these.

With a view to providing replacement for aircraft about to be written off, exhaustive investigations and studies were made of Canadian, British, and American types of available aircraft. In air photographic survey consideration must be given not only to the flying qualities of the aircraft but also to its adaptability in providing a suitable platform for the air camera or cameras proposed for use in it. That is, the various cameras employed in different types of air photography and the aircraft itself have different requirements which must be served.

After consideration of the individual merits of each aircraft, and the modifications necessary, if any, for camera installation, it was decided to obtain one of each of two types. The experience obtained in a season's work with them will supply definite information as to the type most satisfactory for future replacements.

Associate Committee on Trail Smelter Smoke

Co-operating organization:

Dominion Department of Agriculture

The committee has continued during the year to study the problem of the distribution of fumes from the smelter at Trail, British Columbia, through the valley of the Columbia River into the northern part of the State of Washington. Automatic machines have been used to determine the sulphur dioxide content of the atmosphere at different points in the area affected and observations have been continued on field crops and forests.

Extensive fumigation tests with sulphur dioxide are also being conducted outside the smoke area in order to obtain quantitative information on the influence of climatic and other factors in conjunction with sulphur dioxide on the growth of vegetation. These tests will be continued throughout 1935.

In the meantime, additional steps are being taken by the smelting company to reduce the amount of sulphur dioxide liberated in the atmosphere. These steps have led to heavy expenditures in the erection of large-scale plants which utilize by-product sulphur dioxide as a raw material for the manufacture of chemical products.

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 associate committee has been held for two years, but a meeting of the directors of research was held in Ottawa on May 2, 1935, to hear reports of investigations carried out during the fiscal year immediately preceding. The Queen Alexandra Sanatorium and Queen's University were not represented at this meeting, but representatives were present from all the other co-operating groups. There follow brief summaries of the reports submitted.

Tuberculosis Research of the Dominion Department of Agriculture

Work on B.C.G. (Bacillus Calmette-Guérin) has been carried out by this department at the Animal Diseases Research Institute, Hull, Quebec, for rather more than ten years, with no financial assistance from the committee. The trials of B.C.G. have been made under conditions corresponding to those of a tuberculous herd on an ordinary dairy farm. The results, which were summarized in the seventeenth annual report, indicated that the younger vaccinated cattle show a higher degree of resistance and the maturing vaccinated and revaccinated cattle a lower degree of resistance than the unvaccinated controls.

(Investigations under the direction of Dr. E. A. Watson.)

Tuberculosis Research at the Qu'Appelle Indian Health Unit

Tuberculosis research is being carried on among the Indians in Saskatchewan by the Qu'Appelle Indian Health Unit, which was formed in 1930 and is being assisted financially by the National Research Council, the Department of Indian Affairs and the Saskatchewan Anti-tuberculosis League.

One of the principal problems has been the control of tuberculosis in Indian boarding schools. A demonstration has been made of the effect of removing from schools in the health unit those children who were spreaders of the disease. The result has been that since the plan was put in operation the spread of infection has been practically stopped in these schools.

A study of tuberculosis among the Indians has revealed the fact that the highest death rate from this disease has occurred in the period between birth and four years of age. This rate has been many times as high as that of the neighboring white race. The situation was therefore a particularly favorable one for the application of any prophylactic measure which is safe and at the same time offers some hope of reducing the death rate from this disease.

After very careful consideration, and acting upon the advice of the committee, vaccination of Indian children with B.C.G. was begun in 1933. Two distinct methods were used in the Qu'Appelle Indian Health Unit. Fifty-one infants born on the reserve have been vaccinated by mouth with B.C.G. following the method of Calmette. A second group, consisting of 15 children at the Le Bret Indian Residential School, was vaccinated intracutaneously on March 6, 1934. A third group of 33 Indian boarding-school children was vaccinated on April 26, 1935, by the same method. Since January, 1935, 21 infants have been vaccinated intracutaneously by the method of Park. To date, 120 children have thus been vaccinated. Observations on these cases will be continued and further vaccinations will be carried out in the hope of protecting the children against infection. It may be noted that many of these children are now living in contact with persons suffering from tuberculosis.

(Investigations under the direction of Dr. R. G. Ferguson.)

Tuberculosis Research at the University of Alberta

In previous years considerable attention has been given to the question whether B.C.G. could be regarded as harmless to bovines. Several distinct experiments were conducted, a large number of cattle being used, but in no case did tuberculosis develop in any vaccinated animal kept isolated from possible outside infection. The harmlessness of B.C.G. to bovines having been fully demonstrated, this stage of the investigation was discontinued.

For some years experiments at Ponoka and Oliver have been under way with the object of determining whether it is possible to eliminate tuberculosis from a herd by vaccinating with B.C.G. all calves added to it, but without the isolation or slaughtering of tuberculous animals. Since in these experiments all vaccinated animals have been constantly exposed to those suffering from the disease, the test has been a severe one. Considerable progress is nevertheless being made. The Ponoka herd now contains 108 animals vaccinated at birth and in most cases revaccinated every subsequent year. During the past year 34 animals have been eliminated. None of these died of tuberculosis but six of the animals eliminated showed some evidence of the disease. The Oliver herd contains 75 vaccinated animals. Of 23 animals eliminated during the year only three showed any evidence of tuberculosis.

(Investigations under the direction of Dr. A. C. Rankin.)

Tuberculosis Research at the University of Montreal

The vaccination of infants with B.C.G. has now been carried on for nine years. In that time 5,126 babies have been vaccinated, of whom 1,519 were added in the past year. Wherever possible the histories of these children

have been followed since vaccination. A special study has been made of those known to be living in intimate contact with persons suffering from tuberculosis. Through the co-operation of the Bruchési Anti-tuberculosis Institute a large control group of unvaccinated children has also been studied. Both mortality and morbidity have been recorded, but in accordance with usual practice the deaths of children under one month of age have been disregarded.

The general mortality rate each year has been in favor of the vaccinated group—during 1934 to the extent of 45%. Analyses of these figures according to the cause of death, show that the deaths from diseases other than tuberculosis have been 29% in favor of the vaccinated group, and, in the case of deaths from tuberculosis, 70% in favor of the vaccinated children. This percentage is raised to 78 when only those cases living in contact with tuberculosis are considered.

The health of the vaccinated children living in contact with cases of tuberculosis is also better than that of the control group, 13% of the former and 27.4% of the latter being ill from some disease. In the case of children apparently suffering from tuberculosis, the percentage is 85% in favor of those vaccinated.

The greatest possible care is taken in the preparation and testing of the B.C.G. vaccine used in this work. A special laboratory is maintained for the purpose and the technique of the Pasteur Institute is followed. Every lot of vaccine is tested by inoculation into guinea pigs and in no single instance have the animals developed tuberculosis.

Other experiments have also been undertaken with B.C.G. An effort is being made to fractionate the vaccine with the object of obtaining an active portion, also to isolate from B.C.G. the pigment responsible for the yellow-green color of Sauton's medium after B.C.G. cultivation. The relation between allergy and immunity is also being studied.

Published paper:

Frappier, Armand, and Fredette, Victorien. Some Observations on the Allergy to Tuberculin of Guinea Pigs Vaccinated with B.C.G. Can. J. Research, 12 : 165-176. 1935.

(Investigations under the direction of Dr. J. A. Baudouin.)

Tuberculosis Research at the University of Toronto

Work has been resumed on the bacteriology of tuberculosis in children. In addition to a hospital group of children, studies have been extended to a group of tuberculous children from Windsor and Essex in an attempt to secure a more representative group for Ontario. An attempt is being made to correlate laboratory findings with clinical and X-ray observations.

In the Toronto district, owing to the universal pasteurization of milk, the human tubercle bacillus is the dominating type of infecting organism. This is usually revealed as an infection of the lungs, whereas cases of bovine tuberculosis in children, usually caused by drinking infected and unpasteurized milk, nearly always result in foci in some other part of the system.

A study of tuberculous infection as determined by the tuberculin reaction is also being made. Juvenile and young adult groups have been selected and in both cases an unexpectedly large number of individuals have been found not to give a positive reaction. This work is still in its preliminary stages.

(Investigations 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 approval of type of the various electricity-measuring devices proposed by the committee and officially adopted by the Council, have been very favorably received by the manufacturers and utilities in the past year. In the case of instrument transformers and phase shifters, some minor revisions to the earlier specification were recommended by the committee and approved by the Council early in 1935.

Special Committee on Gas Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Services

During the year the committee drafted regulations and specifications for the approval of type of positive displacement gas meters and sent copies to all Canadian gas meter manufacturers, the Canadian Gas Association, the larger gas companies who repair and rebuild their own meters, and other interested parties, asking for their criticism. The comments and suggestions were very gratifying. The committee revised the regulations and specifications and submitted them to the Council for adoption. The regulations became effective on January 1, 1935. Copies of "Regulations and Specifications for Approval of Type of Positive Displacement Gas Meters, January 1, 1935, NRC-6-1934" may be obtained from the National Research Council.

Executive Committee of the Fifth Pacific Science Congress

Completion and publication in March, 1935, of the proceedings of the Fifth Pacific Science Congress brought to a close most of the activities of the National Research Council in connection with this important congress, which was held in Victoria and Vancouver, June 1–15, 1933. The proceedings comprise 4,227 pages, and make five substantial volumes.

A feature of the index to the proceedings, which appears at the beginning of Volume I, is that it embodies the complete scientific program arranged in chronological order, with the papers in the six congress symposia listed first, followed by those presented in the four division symposium meetings. Papers presented in the seven section meetings in the Division of Physical Sciences are followed by those read before the eight sections of the Division of Biological Sciences. This arrangement enables the reader to obtain a clear idea of the program arrangements at the congress, and also brings together in groups papers on related subjects. Volume I includes all matter of general interest in connection with the congress, while Volumes II and III are devoted to the papers on physical sciences, and Volumes IV and V to the contributions in the biological sciences.

In Volume I, in addition to the index, the history of the Pacific Science Association is traced in detail in an excellent review by Dr. H. M. Tory, president of the congress. Chapters on the organization of the Canadian meeting, with a complete list of the names and addresses of those in attendance, are included, as well as a verbatim account of the proceedings at the inaugural

and general business meetings. These are followed by notes on the entertainment and social functions held in connection with the congress by various organizations in Victoria and Vancouver, supplemented by an account of the post-congress tour through southern British Columbia.

In Volume I are six appendices; four of these contain the reports presented by the chairmen of the standing committees appointed at the Fourth Pacific Science Congress held in Java in 1929; one is devoted to the 25 resolutions passed at the final general meeting in Vancouver, while the remaining appendix contains the list of the ten standing committees appointed at Vancouver.

The distribution of papers by sections in the remaining volumes is as follows, the figures in brackets indicating the total number of papers in each part:

Volume II—Division Symposia (22)
Division of Physical Sciences, including sections on: Astronomy (21), Geodesy and Geography (33), Geology and Mineral Resources (32),

Volume III—Meteorology and Terrestrial Magnetism (51), Oceanography (33), Radio (13), Seismology and Volcanology (45),

Volume IV—Division of Biological Sciences, including sections on: Agriculture (18), Anthropology (24), Animal Diseases (21), Botany (33),

Volume V—Entomology (34), Fisheries (38), Forestry (27), Zoology (27).

Standing committees authorized by the Fifth Pacific Science Congress provide for the continued study of numerous subjects of interest to scientific workers in the Pacific area during the period between the fifth and sixth congresses, which should normally be not less than three, nor more than five years. Committees were established on the following subjects, the name of the chairman and his country being given in brackets following the name of the standing committee:

International Committee on the Oceanography of the Pacific (Dr. T. Wayland Vaughan, United States); Volcanic Rocks (Dr. P. Marshall, New Zealand); Blood Groups (Dr. L. T. Ride, Hong Kong); Protection of Nature (Dr. M. Miyoshi, Japan); Soil Survey and Classification (Professor Boris Polynov, U.S.S.R.); Classification and Utilization of Land (Dr. W. C. Lowdermilk, United States); Forest Resources (Mr. D. Y. Lin, China); Pacific Economic Entomology (Dr. H. S. Smith, United States); Mountain Structures (Dr. H. A. Brouwer, Netherlands); Seismology (Dr. E. A. Hodgson, Canada).

In the congress symposium meetings, the 55 papers were designed to evaluate the recent advances in the application of scientific knowledge to the basic industries of agriculture, fisheries, mining, and forestry, while another series of papers sought to bring under review the work of the meteorologists in all parts of the Pacific on problems of first importance to navigation and communication. Comprehensive studies were made of the fiords of the Pacific and the origin and antiquity of the American aborigines, and, in the concluding congress symposium, the effect of the introduction of exotic plant and animal forms was developed in a series of nine excellent papers.

In the preparation of the scientific program, the executive committee, working from a carefully prepared plan, invited each country to submit papers by its leading authorities on the subjects selected for discussion. The fact that 531 papers were found suitable for inclusion in the proceedings gives some indication of the extent of the international interest in the work of the Pacific Science Association. That the congress movement is growing in im-

portance, is shown by the fact that the number of papers presented at the Canadian meeting was approximately one-half the number contributed to all four preceding congresses.

Copies of the proceedings were sent to the official members appointed by the governments of the several countries adhering to the Pacific Science Association, and also to the representative institutions which appointed the delegates. By a special subscription arrangement, the congress was also enabled to distribute copies of the proceedings to a selected list of the other members and participants who were in attendance at the congress, and to authors of papers. The publishers also sold a considerable number of copies to representative libraries throughout the world.

Acknowledgments received from those who have obtained copies of the proceedings indicate a most favorable response and it may be of interest to quote a few of the comments from outstanding scientists in different countries regarding the proceedings.

Mr. D. Y. Lin, Nanking, China: "Every delegate will be most happy to have the proceedings, not only as reference books for his library, but also as a reminder of that international gathering of scientists at Vancouver, and of the valuable personal contacts which formed so important a part of the gathering."

Dr. C. Gravier, Paris, France: "I congratulate you warmly on having brought to a successful conclusion, and in a relatively short time, the publication of these five books which are so well edited and illustrated."

Dr. Herbert Gregory, Honolulu, Hawaii: "The proceedings contain a wonderful store of valuable material."

Dr. O. de Vries, Holland: "This magnificent piece of work represents a wealth of contributions to our knowledge of the Pacific."

Dr. J. Sakurai, Tokyo, Japan: "These volumes constitute really a monumental work, and, being fully aware of the difficulties attending the publication of such volumes, I particularly wish to tender you most hearty congratulations upon the completion of their publication, and in such a handsome form, too."

Dr. P. S. Smith, Washington, U.S.A.: " . . . a notable record of scientific thought, which will prove a valuable store-house of reference to modern outlooks on many problems."

Abbé Vachon, Quebec, Canada: "The proceedings are a mine of information for those who are interested in general science as well as for specialists."

The proceedings were edited by Mr. S. J. Cook, general secretary of the congress.

A Holdover Committee, appointed at Vancouver, gave careful consideration during the year to the selection of a suitable place for the meeting of the sixth congress. Correspondence was carried on between the members of this committee, and some suggestions were put forward by certain countries. At the close of the year, however, no decision had been reached regarding the place of meeting of the next congress.

CONFERENCES

Conference on Honey Problems

A well attended conference on honey problems was held in Ottawa on June 21, 1934, the meeting having been called at the suggestion of the Associate Committee on Agriculture.

Methods of determining moisture in honey were discussed and it was recommended that further studies be undertaken. Dr. Chataway, of the Division of Chemistry, was requested to prepare a chart showing the relation between readings obtained by different instruments. This action has now been taken.

Dr. Lochhead and Mr. Gooderham of the Central Experimental Farm reported on their work on the bacteriology of honey. It was suggested that Dr. Lochhead should undertake a study of the relation between the yeast content of honey and the temperature and time of the treatment to which it is subjected in the various methods of processing. An investigation of the physics problems associated with the processing of honey, to be undertaken by the Division of Physics on the completion of Dr. Lochhead's work, is also regarded as desirable.

The Division of Research Information was requested to review the literature on the dietetic and medicinal value of honey with the idea that such a review might be made the basis of future work. Such a report has since been prepared by Miss M. E. Whalley and has been distributed in mimeographed form to members of the committee and others.

Difficulty was reported in securing satisfactory standards for grading honey, especially in respect to granulation. It was recommended that work be done on this subject, as it was the opinion of the meeting that it would be of great value to honey inspectors. Other subjects discussed at the meeting included honey candy and other special honey products, beeswax and diseases of bees.

It was agreed that another honey conference should be called when further work has been done on the problems considered.

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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. References to other recently published papers will be found at the end of one of the summaries.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 72.

Study of Soil Acids and Peats in Quebec

Co-operating organization:

Macdonald College

A raw humus collected at Ste. Anne de Bellevue has proved to be excellent material for the study of soil acids. When the percolate from this material was dialyzed, 78.2% of the acidity of the original solution was found in the dialyzate. Analyses were made to determine the total acidity, the amount of free acid, the proportion present as sulphate, and other relevant data. The soils under investigation have shown a higher content of free acid than any other podsol raw humus yet investigated. Further work is planned and some is now under way to determine the nature of the dialyzable acidity not accounted for as sulphuric acid. The work so far has been complicated by the difficulty of removing the color of the dialyzate without affecting the acidity. The nature of this coloring matter and the possibility of separating definite crystalline compounds are being investigated (H. J. Atkinson).

Acetic acid has been identified among the water soluble acids in three different soils. In two of these it appears to constitute about 10% of the total acidity.

A method has been developed for separating the organic acids in a water extract of soil into five fairly well defined fractions as follows:

(A) Acids forming soluble barium salts. 1. Volatile acids. 2. Non-volatile acids soluble in ether. 3. Non-volatile acids insoluble in ether.

(B) Acids forming insoluble barium salts. 4. Water soluble acids. 5. Acids only slightly soluble in water ("Humic acid").

The acidity of the soil has been shown to be caused largely by free sulphuric acid and by Groups 2, 3 and 4 above.

(Investigation under the direction of Dr. R. R. McKibbin, Macdonald College, McGill University.)

The Influence of Defined Cultures on the Making and Ripening of Cheddar Cheese

Co-operating organization:

University of British Columbia

The problem of the constitution of starters for cheese-making resolves itself into a consideration of two fundamentals; the specificity of the organism and the nature of the action of a number of organisms in association.

The work here reported covers the propagation of starters containing one or more types of organism isolated from Kingston cheese, and the application of these to the manufacture of Cheddar. The milk used for carrying the starters was sterilized instead of being steamed as in usual creamery practice, and pasteurized milk was used for the cheese-making.

A study of the chemical changes in the various series of cheese showed that wide deviations from the normal occurred in the experimental lots. The organisms and groups of organisms used showed definite differences in rate of acid production, some mixtures slowing down the process considerably. The same was true in connection with protein breakdown. It is, therefore, evident that for rapid and desirable development of the processes concerned the constitution of the starter is very important.

The most desirable combination of organisms for the making and ripening of Cheddar cheese has not yet been determined. Work is proceeding on various phases of this topic, miniature equipment being used. The effect of yeast extract on the development of the starter organisms is also under study.

Bitterness which developed in the experimental series and in the controls is definitely not due to the pasteurized milk used for cheese-making, but may be traceable to the sterilized milk used for the propagation of the starters.

(Investigation under the direction of Dr. Blythe Eagles.)

Cataract of the Eye

Co-operating organization:

Queen's University

From the practical point of view the injection into the body of an active substance or enzyme capable of attacking and dissolving the protein responsible for cataract of the eye would be an ideal substitute for the present method of complete removal of the lens by surgery.

A special cataract precision syringe, requiring the operator to use one hand only in the injection, and leaving the other hand free to hold the eye in position, proved the feasibility of injecting lenses of rabbits' eyes. The materials used were sterile suspensions of blood enzymes. Definite softening of the cataractous lens material takes place, while the intra-ocular tension is slightly lowered as soon as the disintegration of the lens begins.

Many experiments were made with leucoprotease obtained from dogs, but there appeared to be a great variation in the activity of the substance obtained from different dogs. After some trials with the enzyme contained in a globulin fraction of the serum, procured by precipitation, first with magnesium and then with sodium sulphate, a bacterial enzyme that would digest lens protein under sterile conditions was procured from *Bacterium subtilis*.

Lenses from the eyes of freshly killed pigs were crushed in a sterile grinder and the material obtained thoroughly shaken with distilled water. After centrifuging and decanting, a whitish gray precipitate was formed, considered to be insoluble lens protein. Sodium chloride suspension of the heavy pellicle of a fresh broth culture of *Bacterium subtilis* was added to a sample of diluted protein. The bacterial enzyme was found to digest some of the insoluble lens protein.

It remains to be seen whether the solution is specific in action.

(Investigation under the direction of Dr. H. C. Connell.)

Spectroscopic Research

During the year work has been done on the spectra of two of the more difficult elements, columbium and cerium. Both these elements lie near the middle of the atomic table, and cerium is on the edge of the rare earths. Consequently, the spectra of these elements are very rich in lines in the ultra-violet. It is therefore necessary as a first step to find some means of separating the spectra due to various stages of ionization. Attempts have been made to devise such means, and the so-called pole effect has been tried with considerable success. The spark in nitrogen is used, and when inductance is added to the circuit the radiation representing the higher spark spectra is confined more and more to the region of the tips of the electrodes until it finally disappears. Published papers:

An Analysis of the Spectrum of Trebly-ionized Columbium (Cb. IV). Physica, Jubilee Volume.

The Spectrum of Trebly-ionized Cerium by R. J. Lang. Can. J. Research, 13A : 1-4. 1935.

(Investigation under the direction of Dr. R. J. Lang.)

APPENDICES

APPENDIX A

26 Scholarships Held During the Year 1934-1935

Fellowships

Grantee	Graduated	Where Held	Subject of Research
A. M. Crooker.....	B.A., M.A., McMaster University.	Department of Physics, University of Toronto, Toronto, Ont.	Spectra of lead.
S. M. Dockerty.....	B.A., Dalhousie University.	Department of Physics, University of Toronto, Toronto, Ont.	Specific heat of copper.

Studentships

Grantee	Graduated	Where Held	Subject of Research
E. P. Aikman.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Raman effect.
B. G. Gardiner.....	B.A., M.A., Queen's University.	Department of Bacteriology, Queen's University, Kingston, Ont.	The relation between cohesive force and sensitization phenomena.
D. Gauvin.....	B.A., L.Sc., Laval University.	Department of Organic Chemistry, Laval University, Quebec, Que.	Study of polymerization.
P. E. Gishler.....	B.Sc., M.Sc., University of Alberta.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of the system calcium oxide, sulphur dioxide and water in the presence of pulp.
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.	Local hormones.

Bursaries

Grantee	Graduated	Where Held	Subject of Research
G. H. Argue.....	B.Sc., M.Sc., University of Alberta.	Department of Physical Chemistry, McGill University, Montreal, Que.	The nature of adsorption on cellulosic materials.
Miss Mary C. Baker....	B.A., M.A., Queen's University.	Department of Bacteriology, Queen's University, Kingston, Ont.	Toxin of *Cl. welchii*.
E. M. Campbell.....	B.Sc., M.Sc., University of Manitoba.	Department of Physics, University of Manitoba, Winnipeg, Man.	Quantitative measurements of electro-magnetic radiation.
A. L. Geddes.....	B.Sc., M.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of pressure, volume, and temperature relationships near the critical temperature.
D. G. Hurst.....	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The optical transmission of thin metallic films for short wave-lengths.
D. C. Jones.....	B.A., University of New Brunswick.	Department of Physics, McGill University, Montreal, Que.	On the profiles of Balmer lines in B stars.
L. E. Jones.....	B.Sc., University of Manitoba; M.A.Sc., University of Toronto.	Department of Mechanical Engineering, University of Toronto, Toronto, Ont.	Wave phenomena in open channels as caused by changes in discharge.

BURSARIES—(Concluded)

Grantee	Graduated	Where Held	Subject of Research
G. L. Larocque	B.C.E., M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigations into the cooking of wood with alkaline liquors.
R. M. Love	B.Sc., M.Sc., University of Saskatchewan.	Department of Genetics, McGill University, Montreal, Que.	Steriloid mutation of oats.
J. S. Marshall	B.A., M.A., Queen's University.	Department of Physics, Queen's University, Kingston, Ont.	β-ray scattering by metal foils.
J. W. McCubbin	B.Sc., M.Sc., Queen's University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Decomposition of nitrous oxide on platinum.
T. McKeown	B.A., University of British Columbia.	Department of Biochemistry, McGill University, Montreal, Que.	Studies on the physiology of lactation.
R. 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.	Viscosity effects in air near curved surfaces.
S. Rosenberg	B.Sc., M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The kinetics of the thermal decomposition of ethyl ether at high pressures.
H. A. Showalter	B.A., McMaster University; M.A., University of Toronto.	Department of Physical Chemistry, University of Toronto, Toronto, Ont.	Solubility of carbon dioxide in solutions involving alcohol, water and sugars.
J. W. Speight	B.A., University of Western Ontario.	Department of Mathematical Physics, McGill University, Montreal, Que.	Problems in mathematical physics.
D. M. Young	B.Sc., McGill University.	Department of Chemistry, McGill University, Montreal, Que.	Dipyrrols.

APPENDIX B

Researches in Progress During 1934-1935 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	Dominion Department of Mines; Canadian Refractories, Ltd.
Damage caused by smoke fumes from the Trail smelters	Associate Committee on Trail Smelter Smoke	University of British Columbia; British Columbia Department of Agriculture; Dominion Department of Agriculture; Dominion Forest Service.
Problems of the grain industry.....	Associate Committee on Grain Research	Board of Grain Commissioners, Winnipeg; Dominion Department of Agriculture; University of Manitoba; University of Alberta; University of Saskatchewan; McGill University.
Tuberculosis in man and animals....	Associate Committee on Tuberculosis	Department of Bacteriology, University of Alberta; Department of Pathology and Bacteriology, University of Toronto; Department of Bacteriology, Queen's University; Faculty of Medicine, University of Montreal; Queen Alexandra Sanatorium, London, Ont.; Fort Qu'Appelle Sanatorium, Fort San, Sask.; Dominion Department of Agriculture.
Problems of the wool industry.....	Associate Committee on Wool	Dominion Department of Agriculture; University of Alberta; University of Saskatchewan; Canadian Co-operative Wool Growers; Canadian Woollen and Knit Goods Manufacturers' Association; Wool Industries Research Association (Great Britain).
Chemical control of weeds.....	Associate Committee on Weeds	University of Alberta; University of Saskatchewan; University of Manitoba; Alberta Department of Agriculture; Dominion Department of Agriculture; Manitoba Department of Agriculture; Saskatchewan Department of Agriculture.
Animal parasites	Associate Committee on Parasitology	Dominion Department of Agriculture; Imperial Bureau of Agricultural Parasitology; McGill University; 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	Board of Grain Commissioners for Canada; University of Alberta; University of Manitoba; University of Saskatchewan; Dominion Department of Agriculture
Measurements and tests on radio receivers	Associate Committee on Radio	Canadian Marconi Company; McGill University; Northern Electric Company; Canadian Radio Broadcasting Commission; Radio Branch, Department of Marine; University of Montreal.
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.

Subject of Research	Directed by	Co-operating Organizations
Utilization of Canadian iron ores	Associate Committee on Iron Ores	Steel Company of Canada, Hamilton.
Aircraft instruments	Associate Committee on Aeronautical Research	Department of National Defence.
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 Societies.
Cold storage problems	Associate Committee on Storage and Transport of Food	Dominion Department of Agriculture.
Development of improved methods and instruments for use in survey work	Associate Committee on Survey Research	Department of National Defence; Department of Marine; Dominion Department of Mines; Department of the Interior.
The action of alkali on cement and concrete	Prof. T. Thorvaldson	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.
Ultra-violet spectroscopy with vacuum grating spectrograph	Dr. R. J. Lang and Prof. S. Smith	Department of Physics, University of Alberta, Edmonton, Alta.
Mineral deficiency of Quebec soils	Dr. R. R. McKibbin	Department of Chemistry, Macdonald College, Quebec.
Surface energy of solids	Prof. F. M. G. Johnson and Dr. O. Maass	Department of Chemistry, McGill University, Montreal, Que.
Ripening of cheese	Dr. Blythe Eagles	Department of Dairying, University of British Columbia, Vancouver, B.C.
Removal of cataract by an injection into the crystalline lens	Dr. H. C. Connell	Connell Research Laboratory, Queen's University, Kingston, Ont.

APPENDIX C

Additional Researches Carried Out in Previous Years

Subject of Research	Grantee
The inheritance of earliness and lateness in wheat	Dr. W. P. Thompson.
Water requirements of crops in western soils	E. S. Hopkins.
The relation of bacteria to the quality of graded butter	Prof. W. Sadler.
Fungi	Dr. A. H. R. Buller.
Acidity and lime requirements of soils in Quebec and New Brunswick	Dr. J. F. Snell.
The influence of acid in the soil on useful (nitrogen fixing) bacteria	Dr. F. C. Harrison.
Insulin-like substances in plants	Dr. J. B. Collip.
Action of pure salts on the structure and growth of vegetable cells	Prof. G. W. Scarth.
The influence of diet on the fur and health of captive foxes	Associate Committee on Nutritional Problems of the Fox Industry.
The resistance of plants to low temperatures	Prof. J. F. Lewis.
The biological origin of false wild oats	Prof. J. R. Fryer.
Life history and habits of the Tabanidae (horsefly)	Prof. A. E. Cameron.
Study of the blood chemistry in animals with the super renal glands removed	Prof. J. B. Collip.
Investigation of the life history of the onion maggot	Prof. E. M. DuPorte.
The use of Canadian oils in ore concentration	Dr. J. B. Porter.
The extraction of benzene and toluene (valuable liquids) from coal gas	Dr. H. S. Davis.
De-tarring of gas by electrical precipitation	Dr. J. G. Davidson.
Reduction of iron ores by gases	Dr. A. Stansfield.
A method of smelting titaniferous iron ores	Dr. C. W. Drury and A. F. G. Cadenhead.
The testing of oil shales in the field	Louis Simpson.
The treatment of silver-lead-zinc ores	Horace Freeman.
The preparation (production) of metallic barium	Prof. H. E. Bigelow.
Oil from shales	Prof. A. E. Flynn.
Alberta tar sands	Dr. A. Lehmann.
Lake Agassiz clay deposits	Prof. R. C. Wallace.
The microscopic examination of cement during hardening	F. M. Dawson.
Causation of cracks in concrete protective coating on iron and steel structures	Prof. P. Gillespie.
The corrosion of iron and steel in the soil	Prof. J. W. Shipley.
Investigation on the utilization of the resources of helium in Canada	Associate Committee on Helium.
The properties and liquefaction of helium	Prof. J. C. McLennan.
Canadian waste sulphite liquor as a source of alcohol	Dr. V. K. Krieble.
The discoloration of cured codfish	Dr. F. C. Harrison.
The discoloration of canned lobster	Dr. F. C. Harrison.
Artificial propagation of the sturgeon	Associate Biological Committee.
The food relations of certain minute organisms (Entomostraca) in the cultivation of fresh water fishes	Prof. A. B. Klugh.
Bacteria found in frozen fish	Dr. F. C. Harrison.
Nicotine from tobacco waste	Arthur D. Hone.
Utilization of milkweed	Dr. A. C. Neish.
Problems of industrial fatigue	Associate Committee on Industrial Fatigue.
The utilization of peat	Department of Mines.
Channel interference in wind channel testing	Prof. J. H. Parkin.
Interference in radio broadcast reception	Prof. T. R. Roseburgh.
Fog signalling	Prof. L. V. King.
Vitamines	Food Research Committee.
Surface tension in liquids and emulsions	Prof. J. C. McLennan.
Chemical reactions at high pressures	Prof. J. C. McLennan.
Conductivity and vapor pressure of salt solutions	Prof. A. N. Shaw.
Crystalline shapes of bicarbonate of soda	Prof. Paul Riou.
Investigation of Roentgen rays	Dr. J. A. Gray.
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.
The spectrum of infra-red rays	Prof. J. C. McLennan.
The action of ultra-violet rays	Prof. L. Bourgoin.
Intensity measurements in spectra	Prof. J. K. Robertson.
The spectrum of tin	Prof. J. K. Robertson.
Constitution of rubber	Dr. G. S. Whitby.
Generation of explosive gases in electric water heaters and boilers	Dr. J. W. Shipley.
The breeding efficiency of bulls and horses	Dr. A. Savage.
Experimental study of precipitation of iron and silica	Dr. E. S. Moore.
Cultivation of medicinal plants in British Columbia	Dr. R. H. Clark and Prof. J. Davidson.
Laws governing the screening of crushed ores	Dr. J. B. Porter.
Grinding ore in ball mills and rock crushing by rolls	Prof. H. E. T. Haultain.
Determining the elimination of magneto noises from aircraft receiving sets	Prof. H. Vickers.
Storage of fruit in warehouses	Associate Committee on Fruit.
Use of ultra short waves for direction indicating apparatus	Lt.-Col. W. A. Steel.
Radium emanation	Dr. G. H. Henderson and Dr. D. A. McIntosh.
Dielectric losses in different classes of porcelain	Prof. A. V. Wendling.
Relation of silver ores to diabase	Dr. E. S. Moore.

Subject of Research	Grantee
Magnetic susceptibility of the alkali metals	Dr. A. S. Eve.
Chemical separation, identification and possible synthesis of antipressor substance from hepatic tissue	Dr. A. A. James.
Structure and growth of anchor ice	Dr. H. T. Barnes.
Effects of velocity on re-absorption rates	Prof. O. S. Gibbs.
Effect of ultra-violet rays on eggs, chicks and laying hens	F. C. Elford.
Adhesion of ice to various surfaces of aeroplane structure	Dr. H. T. Barnes.
Sound analysis of carillon on Peace Tower	Prof. E. F. Burton.
The active principle of yeast	Prof. W. L. Miller.
Factors governing the milling and baking quality of wheat	Dr. R. Newton.
Ultrasonics (inaudible sound waves)	Dr. R. W. Boyle.
Bacillary white diarrhoea in poultry	Prof. H. W. Hill and Prof. E. A. Lloyd
Rotary derivatives of a boat type seaplane	Prof. J. H. Parkin.
Fog alarm research	Dr. L. V. King.
Glucosides of plants indigenous to western Canada	Prof. A. T. Cameron.
The habit and life history of the smaller mammals of the prairies	Mr. F. Neave.
Mistletoe, parasitic on jackpine	Miss E. S. Dowding.
Winter hardiness in crop plants	Dr. R. Newton.
The chemistry of fish curing	Dr. A. B. Macallum.
Researches in the field of low temperatures	Prof. J. C. McLennan.
Chlorination of methane gas	Prof. M. C. Boswell.
Designing and testing of a series of windmills for producing electric power on farms	Prof. J. H. Parkin.
Cause of the reversed blood pressure of fowls	Prof. O. S. Gibbs.
Experiments on catalysis	Dr. G. S. Whitby.
Best methods for obtaining accurate results in testing varieties, strains and treatments of grain	Associate Committee on Accurate Plot Work.
Reforestation experiments on cut-over and burnt-over lands	Associate Committee on New Brunswick Forest Problems.
Health hazards in spray painting	Associate Committee on Spray Painting.
The problem of slack barrels in apple exports	Associate Committee on Apple Slacks.
Destruction of wood piling by marine boring animals	Associate Biological Committee.
The inheritance of sugar and starch in Indian corn	Prof. H. F. Roberts.
Generation of electricity using a windmill as the prime mover	Prof. A. R. Greig.
Effects of certain reagents upon plants	Prof. R. O. Earl.
The effects of temperature and fatigue on the strength of castings	Prof. R. W. Moffatt.
The deterioration of rubber	Dr. G. S. Whitby.
Earth's nocturnal radiation in relation to weather	Dr. H. T. Barnes.
Cathode rays	Prof. J. A. Gray.
Development of a rapid electrical method of determining moisture in grain, timber, etc	Prof. E. F. Burton.
Investigation and preparation of yeast spores	Prof. W. L. Miller.
Measurement of the Joule effect of hydrogen, carbon dioxide and other gases	Dr. A. L. Clark.
Wind tunnel automatic speed control equipment	Prof. H. W. Price.
Raman effect	Dr. A. S. Eve.
Pressure variation inside the cylinders of the internal combustion engine	Dr. D. A. Keys.
Emission and absorption spectra in the infra-red and extreme ultra-violet region	Prof. J. C. McLennan.
Studies on humiditv	Prof. A. N. Shaw.
Effects of electric and magnetic fields	Prof. J. S. Foster.
Investigation of gas laws	Dr. O. Maass.
The marine algae of the Canadian Atlantic coast	Prof. H. P. Bell.
The spectrum of the aurora and the light from the sky and its bearing on radio transmission	Prof. J. C. McLennan.
Power loss in dielectrics	Dr. H. J. MacLeod.
Cytological and histological investigation of alfalfa and clover	Prof. W. P. Thompson.
Chemical problems of the maple sugar industry	Dr. J. F. Snell.
Study of short radio waves	Prof. J. C. McLennan.
The conversion of starch to glucose	Prof. E. G. Young.
Unsaturated hydrocarbons as a source of chemical products	Dr. O. Maass.
The life cycle of fish tapeworm	Dr. D. Nicholson.
Relation of bacteria to incidence of feed flavors and stable odors in milk	Profs. H. M. King and W. Sadler.
Mineral constituents of the floral parts and young fruits of the apple	Prof. W. A. DeLong.
Indirect ultra-violet solar radiation and its distribution	Prof. R. C. Dearle.
Status of slough itch in Saskatchewan	Prof. L. G. Saunders.
Design and construction of apparatus for interpreting print, by touch, through the medium of the photo-electric cell	Dr. Frank Allen.
Diseases of animals	Associate Committee on Animal Diseases.
Heating and insulation of buildings	Associate Committee on Heating and Insulation.
Barley *versus* corn as a food for poultry	Prof. M. C. Herner.
Continuity of welded steel beams	Prof. C. R. Young.
Plant resources in Eastern Canada	Prof. Marie-Victorin.
The effect of light on life processes	Drs. A. B. Klugh and W. R. Sawyer.
Experiments on the preparation of anthraquinone vat dyes	Dr. Paul E. Gagnon.
Electrostatic studies on milk and milk products	Prof. H. R. Thornton.
The lateral support of steel columns and struts	Prof. C. R. Young.
Investigations in connection with the total eclipse of the sun in 1932	Associate Committee on Radio.
Wireworms and false wireworms	Prof. E. H. Strickland.
Effect of radiant energy on protoplasm	Prof. A. H. Hutchinson.
1. Physical and chemical oceanography	Dr. C. McLean Fraser.

Subject of Research	Grantee
2. Marine biology	
3. Fish technology	
Fungi	Prof. A. H. R. Buller.
Mechanical properties of metals at low temperatures	Profs. I. F. Morrison and A. E. Cameron.
Nervous actions underlying color vision and all sensory activities	Dr. F. Allen.
Studies of life in the Pacific adjacent to the Fraser River	Prof. A. H. Hutchinson.
Ultra-violet spectroscopy	Prof. S. Smith.
The uses of the photo-electric cell	Prof. A. Savage.
Action of bacteria and enzymes on carbohydrates and products resulting therefrom	Dr. H. Hibbert.
Investigations on gas and water content of trees	Prof. R. D. Gibbs.
Microbiology of soil conditions in eastern Canada	Prof P. H. H. Gray.
Parasites of the snowshoe rabbit	Prof. R. A. Wardle.
The bark disease of the beech	Mr. Otto Schierbeck.
Stellar stark effects	Dr. J. S. Foster and A. V. Douglas.
Heights of Appleton and of Kennelly-Heaviside reflecting layers	Dr. A. S. Eve.

APPENDIX D

Publications of the National Research Council

Annual Reports

Annual Reports for fiscal years 1916–17 to 1934–35.

Canadian Journal of Research

Published monthly. The Journal has been issued since May 1929, and complete sets (Volumes 1–12) are still available at $1.50 per volume, unbound. Single copies, 35¢ each.

Technical Reports

Report Number	Title	Author
1.	The Briquetting of Lignites	R. A. Ross, E.E., D.Sc., 1918.
2.	The Recovering of Vapors from Gases	Harold S. Davis, M.A., Ph.D., and Mary Davidson Davis, B.A., 1918.
3.	The De-tarring of Gas by Electrical Precipitation. (Out of print)	J. G. Davidson, Ph.D., 1918.
4.	Nicotine and Tobacco Waste. (Out of print)	A. D. Hone, M.A., 1919.
5.	Canadian Waste Sulphite Liquor as a Source of Alcohol	V. K. Krieble, 1919.
6.	An Investigation into the Question of Early Putrefaction of Eviscerated Fish in which the Gills have been Left. (Out of print)	L. Gross, M.A., 1919.
7.	Survey of General Conditions of Industrial Hygiene in Toronto	The Associate Committee on Industrial Fatigue of the National Research Council, 1921.
8.	A Method of Smelting Titaniferous Iron Ore. (Out of print)	W. M. Goodwin, 1921.
9.	Food Requirements of the Ranch Fox	G. E. Smith, B.A.Sc., 1921.
10.	Fuel Saving Possibilities in House Heating	L. M. Arkley and James Govan, 1922.
11.	The Red Discoloration of Cured Codfish. (Both English and French editions)	F. C. Harrison, D.Sc., F.R.S.C., and Miss Margaret E. Kennedy, B.A., M.Sc., 1922.
12.	The Discoloration, Smut or Blackening of Canned Lobster. (Out of print)	F. C. Harrison, D.Sc., F.R.S.C., and E. G. Hood, Ph.D., 1923.
13.	Cultural Criteria for the Distinction of Wood-destroying Fungi	Clara W. Fritz, B.A., M.Sc., 1924.
14.	The Utilization of the Low Grade Iron Ores of Canada	Subcommittee on Iron Ores of the National Research Council, J. G. Morrow, Steel Company of Canada, Hamilton, Ontario, Chairman, 1924.
15.	Marine Borers on the Atlantic Coast of Canada	R. H. M'Gonigle, B.A., 1925.
16.	The Relation of Bacteria to the Quality of Graded Butter	Wilfred Sadler, N.D.D., B.S.A., M.Sc., and R. L. Vollum, M.A., 1926.
17.	The Mosquitoes of the Lower Fraser Valley, British Columbia, and their Control	Eric Hearle, M.Sc., 1926.
18.	Investigations on the Treatment of Nova Scotia Oil Shales	A. E. Flynn, A.R.S.M., 1926.
19.	Bacteriology of Certain Sea Fish	F. C. Harrison, D.Sc., F.R.S.C., 1926.
20.	Consideration of the Relation between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment	R. H. M'Gonigle, B.A., 1926.
21.	The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer	J. H. Fox, M.A., 1927.
22.	An Experimental Study of Sieving	J. B. Porter, Ph.D., D.Sc., 1928.
23.	The Storage of Apples in Air-cooled Warehouses in Nova Scotia	S. G. Lipsett, Ph.D., 1928.
24.	The Drying of Wheat	Associate Committee on Grain Research, 1929.
25.	The Drying of Wheat (Second report)	E. Stansfield and W. H. Cook.
26.	Weed Survey of the Prairie Provinces	J. M. Manson.
27.	Weeds and Their Control	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	Professor W. E. Crampton.

BULLETINS

Bulletin Number	Title	Author
1.	The Need of Industrial Research in Canada.....	Frank D. Adams, Sc.D., LL.D., F.R.S., 1918.
2.	Researches on Sound Measurement with Reference to the Testing of Fog Signal Machinery.....	L. V. King, M A , D Sc , F.R S.C., 1918.
3.	Ho wto Handle Frozen Fish. (Out of print).....	E. E. Prince, D.Sc., LL.D., 1918.
4.	Hints on Frozen Fish. (Out of print).....	E. E. Prince, D.Sc, LL.D., 1918.
5.	Science and Industry.....	Prof. J. C. Fields, Ph.D., F.R.S., 1918.
6.	The Heating of Houses, Coal and Electricity Compared (Out of print)	A. S. L. Barnes, 1918.
7.	The Manufacture of Ethyl Alcohol from Wood Waste. (Out of print).....	G. H. Tomlinson, B.A., 1919.
8.	Some of the Problems of the Fox Raising Industry. (English edition out of print).....	Andrew Hunter, M.A., M.B., Ch.B. (Edin.), 1920.
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).....	Frank D. Adams, Sc.D., LL.D., F.R.S., 1921.
10.	A Plan for the Development of Industrial Research in Canada.....	R. F. Ruttan, B.A., M.D., F.R.S.C., 1921.
11.	Nitrogen Fixation. (Out of print).....	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1924.
12.	Nitrogen in Industry.....	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1926.
13.	Interim Report on Protein Content as a Factor in Grading Wheat.....	Associate Committee on Grain Research, 1929.
14.	Report on Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat.....	R. Newton, Ph.D., F.R.S.C.
15.	Review of Literature Dealing with Health Hazards in Spray Painting.....	Prepared under the Auspices of the Associate Committee on Spray Painting.
16.	Health Hazards in the Radium Industry.....	John D. Leitch.

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.
A 5—1927	Standard Specification for Portland Cement (second edition).
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.
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—Approved Specifications
	No. 0—1932 Definitions and General Requirements.
	No. 1—1932 Power-operated Radio Devices.
	No. 2—1933 Electric Signs.
	No. 3—1933 Electrical Equipment for Oil-burning Apparatus.
	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. 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).
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