NATIONAL RESEARCH COUNCIL ANNUAL REPORT 1932-33

DOMINION OF CANADA

SIXTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

AND

FINANCIAL STATEMENT

1932 - 1933

OTTAWA, CANADA

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1935 - 1936

The Hon. H. H. Stevens,

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

Sir:

I have the honor of presenting to you herewith the Sixteenth Annual Report of the National Research Council, for the fiscal year 1932-1933.

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

Your obedient servant,

H. M. TORY,
President, National Research Council.

73504—1½

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MINISTER OF FINANCE
MINISTER OF MINES
MINISTER OF AGRICULTURE
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NATIONAL RESEARCH COUNCIL
1932-33

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SIXTEENTH ANNUAL REPORT
OF THE
NATIONAL RESEARCH COUNCIL

REVIEW OF THE ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL

Introduction

On March 31, 1933, the National Research Council completed the sixteenth year of its existence. The year was one of unusual significance in the Council's history, for, notwithstanding the economic difficulties of the times, the Council realized certain of the major plans to which it had devoted many years of thought and effort. The reference is to the establishment of National Research Laboratories.

The condition of the national finances during the year made necessary a postponement of certain of the developments originally projected by the Council, and a restriction of numerous parts of the program; nevertheless notable progress was made in a considerable number of investigations proceeding under its auspices and some of these were brought to a satisfactory conclusion. The major part of the work of the Council is now being carried on in the Council's own laboratories at Ottawa, but the program developed under its associate committees, assisted researches and scholarships was continued during the year as effectively as the available resources permitted.

A detailed account of the Council's work during the year under review is to be found in later sections of this report, beginning on page 24.

During the year the association of private enterprise with the Council has been extended, and financial contributions to the support of the work of the Council were received from this source. In two cases investigations of specific problems were undertaken on the understanding that the Council would be recompensed for services rendered. Both the magnesian products industry and the laundry industry made contributions to support work proceeding in these fields.

In the last annual report attention was called to the growing demand for extension of the Council's services. This demand increased during the year under review, and at the time of writing the officers of the Council are planning a study of a program of research to be undertaken when finances permit. A careful assessment of Canadian needs and the part science can take in meeting them is being made.

The problem of staff is a pressing one as the year closes. Without question, fifty additional investigators could be put to work in the Council's laboratories on investigations already undertaken. It has been one of the tragedies of the present depression that a method has not been found of meeting this need by the employment of the highly trained investigators whose services are now being lost to Canada. A distressing feature of the year under review has been the number of these who have unsuccessfully sought employment under the auspices of the Council.

The following events of the year seem to warrant special mention:—

Opening of the Laboratories

The most significant event of the year under review was the formal opening of the National Research Laboratories. It is hardly necessary to say that an effort has been made to plan a laboratory system of the most modern type. Before the building was planned an intensive study was made of the corresponding institutions in the major industrial countries of the world. The importance of the event in our national life was recognized by a formal opening ceremony in which His Excellency the Earl of Bessborough, Governor General of Canada, the Right Honorable R. B. Bennett, Prime Minister, and the Honorable H. H. Stevens, Chairman of the Committee of the Privy Council on Scientific and Industrial Research, participated.

Referring to the special position of Canada as a place for scientific endeavor, His Excellency stated: "There are two outstanding facts concerning Canada which I am sure everyone will have recognized—we have in our possession an extensive and almost untouched area of the world containing enormous natural resources awaiting development; we are also happily linked by an unbroken tradition to the great past of two of the oldest and most progressive countries of Europe—countries which have held a place of intellectual leadership for centuries. If we bring to the solution of our problems that type of scientifically guided intellectual effort which is ours by tradition and inheritance, no one can predict how great our future may be. A glance at the past history of Canada gives assurance that Canadian men of science will justify the confidence of those who have placed at their disposal this splendid equipment and opportunity for service."

In referring to the same subject, the Prime Minister said: "It is the Government's very earnest hope that the laboratories will be equal to the demands made upon them in the discharge of their function. To determine how industry and mankind can best be served is the purpose of this building. It is amazing what scientific research has done. I am confident that the work of these laboratories will become increasingly effective."

The Honorable Mr. Stevens, in a short address, made this statement: "This event brings to fruition work begun in 1916. The character of a nation today is measured by the degree of its interest in scientific affairs and the manner in which it applies science to industry and business."

In brief reply, the President of the Council completed his remarks with the following statement: "May I say to the Government of Canada and to the people of Canada that we of the National Research Council are grateful for the opportunity that these laboratories will give us to do our share in the future development of our country, and will you believe me when I add that we shall regard them as a sacred trust given to us to be utilized for the upbuilding and the strengthening of the nation."

Following the ceremony a reception was tendered by the Government of Canada to the delegates of the British Commonwealth of Nations to the Imperial Economic Conference then in Ottawa, and the building was opened for inspection by the guests.

The day following the formal opening, the Right Honorable Stanley Baldwin, President of the Council of His Majesty's Government in the United Kingdom, presented, on behalf of Surgeon-Captain R. J. E. Hanson, M.A., O.B.E., of Fowey, England, a number of pictures of distinguished scientific men to hang in the halls and offices of the building. Included among the gifts was a beautiful painting of Faraday, certified by no less a personage than the late King Edward VII as being an excellent likeness.

Mr. Baldwin, referring to the National Research Laboratories as representing science, said that science knew no bounds of race or religion; that it was universal: "And if there is one study more than any other for which the right spirit is reverence and humility, that is it. And I will tell you why.

"Reverence, because your work lies all the time in the region of the profound mysteries of the universe. For even when the so-called discoveries are made they remain mysteries, and will, so far as the human brain can penetrate.

"And humility, because the greater the man the more he realizes how limited is the sphere in which he can work in the vastness of infinity. And he knows that great as his genius may be it would be nothing but for the work of those who had gone before him. The greatest man in science today is dependent upon the work of his predecessors. The search for truth is eternal and will last as long as the world. It was Sir Isaac Newton who declared: 'If I have seen farther, it has been by standing on the shoulders of giants.'

"It is not the calling of every man to pursue science or research. But may it be your fortune to find here the man who is born for research, that something may be accomplished in this building, or may be discovered, which will run round the world and make his name famous. He will not then want material rewards. They can come to the exploiters. But long after we have mouldered into dust the name of such a man, as of those attached to these pictures, will be handed down from generation to generation as among the benefactors of mankind."

Division of Biology and Agriculture

Another important event during the year was the establishment on a permanent basis of the Division of Biology and Agriculture. This division was previously directed by an acting director from one of the university centres in western Canada. Dr. Robert Newton, B.S.A., D.Sc., Ph.D., F.R.S.C., formerly head of the Department of Field Crops and Professor of Plant Biochemistry at the University of Alberta, was appointed director. Dr. Newton comes to the national science services after years of intensive training, possessing an international reputation in research.

Four active divisions are now in operation in the National Research Laboratories: the Division of Physics and Engineering (under which is included an Aeronautics Branch); the Division of Chemistry; the Division of Biology and Agriculture and the Division of Research Information.

Fire Hazard Laboratory

During the year the fire hazard testing laboratory, referred to in the report of last year, commenced operation, a beginning having been made with facilities for the testing of oil burners. A conference called by the Council and participated in by representatives of various organizations concerned with problems of fire hazard testing strongly urged the adoption of uniformity in provincial and municipal fire hazard regulations, and urged the Council, in co-operation with the Canadian Engineering Standards Association, to take the lead in effecting it. Since the close of the year, at the suggestion of the Council, the Canadian Engineering Standards Association has commenced the preparation of standards which it is hoped will be adopted by the provinces and municipalities as was the Canadian Electrical Code. The fire hazard laboratory is operating under the direction of the assistant director of the Division of Physics and Engineering.

Regulations for Testing Meters

Under the Gas and Electricity Inspection Act, the Council was made responsible for determining the types and standards of electrical measuring instruments to be used for the sale of electricity in Canada.

During the year a prolonged and arduous task in this connection was undertaken, namely, the preparation of regulations to govern the approval of the following types of meters: (a) watthour and ampere meters; (b) electric demand meters; (c) electric graphic meters; (d) instrument transformers and phase shifters.

Aeronautical Laboratories

The aeronautical laboratories which are housed in what is now known as the National Research Laboratories Annex were completed except for minor details of equipment, and the first researches and tests undertaken.

At the request of the Canadian National Railways a study of locomotive design was undertaken and completed. The results of the investigation were published in the January, 1933, number of the Canadian Journal of Research. A radically new streamlined design of locomotive was evolved, which complies with statutory and operation requirements and, it is believed, achieves the two objectives sought,—reduced air resistance and deflection of the smoke from the engineer's cab. It is calculated that the design reduces air resistance by twenty-five per cent. Patents on the design developed have been secured in Canada and France and have been applied for in other countries.

Ten studies in aeronautics were undertaken for the Department of National Defence and tests were made on ventilators and motor car models at the request of commercial interests. The first official type test of an aircraft engine upon which to base an airworthiness certificate for export was made on the dynamometer. Canada, by subscribing to the International Convention for Air Navigation, undertook to certify to the airworthiness of all aircraft engines exported. Until the establishment by the National Research Council of the aeronautical laboratories, the necessary tests could not be made in Canada.

Institute of Parasitology

The negotiations for the establishment of an Institute of Parasitology at Macdonald College were reported upon in the last annual report; the arrangements were completed and work was begun during the year under review.

Until recent years the study of plant and animal diseases has concentrated upon the study of the diseases that are caused by bacteria and fungi, and laws against the importation of diseased plants and animals have been in operation in most countries. Only recently has it come to be realized that the loss due to parasites, especially in the animal industry, is probably greater than that due to any other cause. Development of the Institute of Parasitology at Macdonald College was a consequence of the recognition of this fact. The Institute is directed by the Associate Committee on Parasitology, on which the following are represented: McGill University, the Federal Department of Agriculture, the Imperial Institute of Parasitology, the Quebec Department of Agriculture, and the National Research Council. Dr. T. W. M. Cameron, M.A., B.Sc., D.Sc., Ph.D., M.R.C.V.S., a distinguished parasitologist from the University of Edinburgh, has been appointed Director of the

Institute and Professor of Parasitology at McGill University. It is hoped to make the Institute an effective instrument for the training of parasitologists and for the development of means by which the very considerable losses caused by parasites may be lessened or eliminated. Work of interest in several parts of Canada is already under way.

Report on the Drying of Grain

The Council published during the year its second report on the artificial drying of grain. This study by the Council, carried on through its Associate Committee on Grain Research, is recognized as effecting a possible saving to Canada of many millions of dollars. Canadian grain need not again be damaged in artificial drying. The conditions of drying without doing damage have been scientifically determined and reported. In the three crop years 1925-26-27 the amount of tough and damp wheat in the Canadian crop was estimated at approximately 450,000,000 bushels. Numerous complaints were received that it was damaged in being dried. The investigation of this problem became the first large co-operative effort of the Associate Committee on Grain Research. The first report was published in 1929 and the second, clearing up a number of remaining points, has now appeared.

Field Crop Diseases

The most important announcement from the Council's associate committees since the last report was written is that of the Associate Committee on Field Crop Diseases, to the effect that strains of wheat have now been developed which are resistant to rust and other diseases and are of high milling and baking quality. This result must be regarded as a victory of the first magnitude for Canadian energy and skill. The effort has been a co-operative one by the Experimental Farms Branch of the Federal Department of Agriculture, the universities of the prairie provinces and the National Research Council. The Council stimulated the organization of the undertaking, provided the machinery for co-operation and assisted the work in the universities under its assisted researches program.

The loss to Canada from cereal rust in the last twenty-five years has been estimated at more than $600,000,000. In two years' time there will be two or three new strains of wheat, resistant to rust, available for distribution to the prairie farmers. The new strains are being subjected to thousands of tests to provide against all possibility of serious defect.

Asbestos Research

A study of the standard testing machine used by the Quebec asbestos industry was completed and new specifications accepted by the industry. It has been stated that at one period lack of confidence in the machine was costing the producers $500,000 a year. A thorough study has been made of the conditions of test, including the effects of humidity, moisture content and temperature. Approximately 2,000 tests of the standard machine were required. Other studies are proceeding at the request of the industry.

Magnesian Products

In the magnesian products investigation, a result secured during the year was the development of a new process for making refractory bricks. Patents have been obtained in various countries and early commercial appli-

cation is anticipated. In this investigation, which was the first to be undertaken in the Council's own laboratories, the following additional products and methods have been developed: improved refractory for steel furnaces, a chemically bonded refractory for general use in metallurgy, a special refractory for copper smelting furnaces, a basic refractory cement, a plastic magnesia for composition floors and a method of using magnesian rock in towers for the manufacture of bisulphite liquor.

Canadian Journal of Research

The Canadian Journal of Research, established by the Council in 1929 as a medium for the publication of the results of Canadian research, was noted widely in the scientific press of other countries during the year. Particularly great interest was aroused in papers on fundamental studies on grain problems made under the auspices of the Associate Committee on Grain Research. The journal is now circulated to twenty-nine countries. Since the establishment of the journal a total of 355 scientific papers have been published in it. Sixty-five of these have reported results obtained by the staff of the National Research Council and 190 have reported results obtained with the financial assistance of the Council under its assisted research program.

Assistance in General Administration

During the year the staff of the Council has rendered some direct service to nearly every department of the Federal Government, and to certain provincial governments as well. The arrangement whereby the Council's laboratories serve as the laboratories of the Department of National Defence and the Canadian Radio Broadcasting Commission was continued. At the request of the Department of Trade and Commerce an investigation of the condition of meters used in the measurement of electricity throughout Canada was undertaken, the contention having been made to the Department that the law requiring all meters to be examined and re-sealed every six years by the Gas and Electricity Inspection Service was too stringent. At the request of the governments of British Columbia, Manitoba and Ontario, the Council made an investigation of safety standards for theatre projection room operation, and prepared a report. An investigation of the quality of certain insulating materials, undertaken at the request of the Tariff Board, was completed.

An increasing number of calls are being received for the assistance or advice of the Council's trained personnel in the solution of special problems arising in various government departments, and the prospect is that this service will become increasingly valuable. Such calls were received when preparations for the Imperial Economic Conference were being made and since the close of the year the temporary location of the Tariff Board in the National Research Laboratories has assisted the development of a close liaison between the two organizations and the rendering of a number of services similar to those rendered at the time of the Imperial Economic Conference.

Standardization

Officers of the Council participated in the work of the standardization committee of the Imperial Economic Conference, the report of which—

(a) emphasized the necessity of the judicious development of national standard specifications, and the importance of buying on nationally recognized specifications, as safeguarding purchasing and ensuring quality and performance;

(b) welcomed the advance being made in the various parts of the Commonwealth in the co-ordination of industrial standardization activities into central national bodies, representative of all parties concerned;

(c) urged that the central standardizing body in each part of the Commonwealth should be accorded active support by the Government, by way of financial and technical assistance and by the co-operation of the Government purchasing departments and otherwise.

The following more specific recommendations were made:—

"As an immediate step towards the promotion of intra-Commonwealth trade through the adoption of commercial standard specifications, the Conference recommends that, in respect of steel, timber, industrial chemical products and replaceable parts of agricultural implements and machinery, immediate steps be taken by the central standardizing bodies in those parts of the Commonwealth affected to secure a greater degree of uniformity in standard specifications and trade practices."

"In order to provide the various parts of the Commonwealth with an accurate means of exchange of colour information and to secure a basic standard in trade practice, the Conference recommends that each central standardizing body should at an early date consider the issue of a standard of colours."

"With a view to the employment of common standard specifications for aircraft materials and component parts, and particularly the method of testing therein specified, the Conference recommends that the national standardizing bodies in those parts of the Commonwealth particularly concerned, should co-operate directly with this object in view."

The Council continued its financial support of the Canadian Engineering Standards Association.

A special committee appointed by the National Research Council in 1932 to study the general Canadian standardization situation advised the Council as follows:—

(a) that the work of the Canadian Engineering Standards Association should continue on its present basis;

(b) that the Main Committee of that association should continue to act as an Associate Committee on Engineering Standards of the Council;

(c) that the Council should be left entirely free to organize other fields of standardization under committees or associations similar to the Canadian Engineering Standards Association.

Facilities for Testing, Standardization and Approval

It is estimated that more than 3,000 tests were performed in the Council's laboratories during the year under review. At the time of writing a revised schedule of charges to be made for tests when requested by the public and departments of government is being prepared and will become effective at the beginning of the year 1934-35.

Wool

The protracted task of developing a type or types of sheep better suited to Canadian conditions than present types, and producing a higher grade of wool, has been carried a step further during the year. Tribute to the work that has been done was paid by the President of the Canadian Woollen and Knit Goods Manufacturers' Association in his presidential address, as follows:

"I am glad to be able to report that the use of Canadian wool is increasing in the mills in Canada, partly because we are now producing goods of a kind formerly imported for which Canadian wool is the best procurable, and partly because one of our industries is combing Canadian wools of a class formerly exported. Such wools are now being combed into tops for use in Canada at the rate of 2,000,000 lb. per year, and the rate is increasing. If nothing prevents this development proceeding it is expected that all wool produced in Canada will in the near future be used in Canada. Through the good work of the National Research Council at Ottawa we were able to obtain for the first time last year a complete report of the sources and handlers of Canadian wool, and who buys it. This report for 1931, compiled by the Dominion Bureau of Statistics, showed that of the total wool produced by Canadian farmers and sold for further manufacture in 1931, the Canadian mills purchased 60.3% and 39.7% was sold for export. I would like here to pay a tribute to the sound, useful and necessary research work on the production of wool in Canada which is being done under the National Research Council. This research work is basic and its results will be cumulative, and will grow more valuable as time passes."

As a demonstration of the quality of the wool already produced in Canada, certain fleeces from sheep in Alberta were carried through the manufacturing processes under the auspices of the Council's Associate Committee on Wool. Recipients of the finished product have paid tribute to its high quality. Samples may be inspected at the offices of the Council or obtained on application by mail from the Canadian Co-operative Wool Growers' Association at Toronto.

Hospitality to Science Associations

The National Research Council had the privilege during the year of making its facilities available to a number of scientific organizations. The Fiftieth Anniversary meeting of the Royal Society of Canada was held under the chairmanship of Sir Robert Falconer in the assembly hall of the new building in May, 1932. In June, 1932, the tenth meeting of the Annual Colloid Symposium, sponsored by the Committee on the Chemistry of Colloids of the National Research Council of the United States and by the Division of Colloid Chemistry of the American Chemical Society, was held in the same hall. Dr. G. S. Whitby, Director of the Council's Division of Chemistry, acted as chairman, and Dr. W. Gallay, of the same division, as secretary. Dr. Emil Hatschek, of London, England, came to Canada as guest of honor. Other organizations which used the new facilities of the Council in a similar way were the College of Physicians and Surgeons, the Engineering Institute of Canada, the Professional Institute of the Civil Service of Canada, and the Ottawa Branch of the Society of Chemical Industry. During the year the preparations for the Fifth Pacific Science Congress, scheduled to be held in June, 1933, in Victoria and Vancouver, were carried forward under the auspices of the Council.

Associate Committees

At the present time there are thirty-three associate committees co-operating with the Council in directing its work. Four hundred and two individuals, professors of universities and technical officers of industry, are giving their time and thought free in helping to organize and direct important researches. Much of the work done under the Council could not have been accomplished but for the cordial co-operation and assistance of these groups

Four new associate committees were organized during the year: the Associate Committee on Agriculture, the Associate Committee on Chemical Standards, the Associate Committee on Forest Research, and the Associate Committee on Survey Research.

The Associate Committee on Agriculture consists of the deans of all the Canadian university agricultural faculties and agricultural colleges, and representatives of the Federal Department of Agriculture, the Canadian Society of Technical Agriculturists and the National Research Council. Its object is to present the problems of agriculture requiring the application of science to the National Research Council and advise on the organization of investigations and projects. The Council, in creating it, had as one aim the prevention of overlapping in science services and the development of common scientific programs.

The Associate Committee on Chemical Standards was formed as a result of inquiries made by the Council and of the recommendations of the Imperial Economic Conference of 1932. (For details see page 61.)

The Associate Committee on Forest Research was appointed as a result of representations made by the Forestry Department of the University of British Columbia and others, and with the approval of the Dominion Forest Service of the Department of the Interior. The purpose of the committee is to co-ordinate as far as possible and direct research work on forestry problems in Canada. The committee is under the chairmanship of Dean C. D. Howe of the Faculty of Forestry of the University of Toronto. On the committee are representatives of the Department of the Interior, the National Research Council, and certain of the provincial governments and the forest industries.

The Associate Committee on Survey Research was appointed as a result of a conference, called at the suggestion of the Department of National Defence, of the various departments of government conducting survey work. In addition to representatives of the National Research Council it consists of representatives of the Departments of National Defence, Interior, Marine and Mines. The functions of the committee have been described as follows:—

(a) To examine Canadian problems relating to survey, including the interpretation and application of air photographs.

(b) To organize research and experiment on such problems, and to set up subcommittees of interested parties for the study of special subjects, as may be found advisable.

(c) To make recommendations to the federal departments possessing the required facilities for carrying out research.

(d) To correlate the experimental work in this sphere being done in the various federal departments, with a view to avoiding overlapping and waste of effort.

(e) To co-operate with the Air Survey Committee of the British War Office, to study developments abroad and pass information so obtained to interested departments, maintaining indexed records of available information and sources thereof.

(f) To issue reports on the research and experimental work performed, and to arrange for the interchange of information on the subject between all departments and parties concerned.

Grants in Aid of Research

From its inception, the Council has recognized the importance of stimulating research in the universities, colleges and research institutions of the country. This has been done in two ways: (1) through a system of postgraduate scholarships granted to the most promising young graduates in pure and applied science from Canadian universities; (2) by grants in aid of research to distinguished university professors and other research workers, who desire to conduct researches of which the Council approves.

Over a period of years a substantial volume of research was built up by these methods and, what was of equal importance, a number of the universities greatly improved their facilities for both research and postgraduate training. It is regrettable that during the past year great reductions have had to be made in the amounts available for these two phases of the Council's activities. In 1930-31, the grant to scholarships was $59,335; for 1932-33 this was reduced to $17,605. The corresponding amounts expended from parliamentary appropriation for assisted researches for the same years were $129,000 and $16,000, respectively. These reductions were unavoidable, for two causes: (1) a substantial reduction in the parliamentary appropriation for the year; (2) the increased obligations which the Council had to assume in connection with the new National Research Laboratories.

The condition stated in the foregoing paragraph must be regarded as only temporary; if scientific research is to achieve anything like the maximum benefit, it must be so regarded. It has been the aim of the Research Council from the beginning to make sure that a succession of trained men capable of dealing with the scientific problems of the country is provided, and to assist the universities in maintaining a standard of graduate training which will make such a succession possible. No matter what the economic and political future, nationally and internationally, it is absolutely necessary for the security of our industry and agriculture, if a reasonable standard of living is to be attained and made permanent, that vital, constant and efficient contact be established with research agencies designed to solve our problems. This is especially true in a country like Canada, where our comparatively small industrial organizations scattered over a large area cannot possibly maintain research facilities on a scale commensurate with the larger industries of more highly developed countries. Hence the need for co-operation between industry and national research agencies. History and experience alike demonstrate that if we fail to make provision for the training of the best minds among the youth of our country and to make use of them when trained, the products and profits of our industry will pass into other hands than ours and our intellectual guidance come from without our borders. This is surely a contingency which no self-respecting people can contemplate with satisfaction, especially as it can be demonstrated that it is economically advantageous for us to be masters in our own house and that it is within our power so to be.

Membership of the Council

The term of appointment of the following four members of the National Research Council expired on March 31, 1932, in accordance with the provision in the Research Council Act requiring that appointments be for a period of three years:—

J. T. Foster, Vice-President, Trades and Labor Congress of Canada, and President, Montreal Trades and Labor Council, 747 Stuart Avenue, Outremont, Quebec.

Sir J. George Garneau, B.A.Sc., LL.D., 71 St. Peter Street, Quebec, P.Q.

J. H. Grisdale, B.Agr., D.Sc.A., Deputy Minister, Department of Agriculture, Ottawa, Ontario.

J. W. Shipley, B.A., A.M., Ph.D., F.C.I.C., F.R.S.C., University of Alberta, Edmonton, Alberta.

These vacancies were filled by the appointment of the following persons for a period of three years ending March 31, 1935:—

A. S. Mackenzie, Ph.D., D.C.L., LL.D., F.R.S.C., formerly President of Dalhousie University, 25 Kent Street, Halifax, N.S.

Abbé Alexandre Vachon, M.A., L. en Ph. and Th., Director, Ecole Supérieure de Chimie, Laval University, Quebec, P.Q.

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.

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

In addition to these appointments Mr. J. T. Foster, Vice-President, Trades and Labor Congress of Canada, and President, Montreal Trades and Labor Council, 747 Stuart Avenue, Outremont, Quebec, was appointed to a vacancy which had occurred in the membership of the Council in the preceding fiscal year, his appointment to expire March 31, 1934.

Sir George Garneau served for a number of years upon the Council and was one of its most effective and helpful members. He brought to the Council a wealth of experience and understanding of industrial problems in addition to a wide scientific knowledge. His retirement from the Council because of the pressure of other duties was greatly regretted by his colleagues.

Dr. Grisdale was appointed a member of the Council in 1923, and served three terms. His retirement followed upon his retirement from the position of Deputy Minister of the Federal Department of Agriculture. He served on many important committees of the Council and was joint chairman of the Associate Committee on Field Crop Diseases, with which was merged the original Associate Committee on Cereal Rusts, and also of the Associate Committee on Tuberculosis.

Dr. Shipley was appointed to the Council in 1929 and served one term. At the time of his appointment he was Professor of Chemistry in the University of Manitoba, and later was appointed head of the Department of Chemistry in the University of Alberta. His place was taken on the Council by the appointment of Dr. Wallace, President of the University of Alberta.

Staff

Appointments

At the end of the year under review the professional staff of the National Research Laboratories totalled 57; of these, 28 are holders of the doctor's degree in science. Every appointment on the Council's professional staff has been made after a thorough inquiry as to technical qualifications, experience and fitness for the particular task to which the individual was to be assigned.

The following appointments were made during the year:—

Robert Newton, B.S.A., 1912, McGill University; M.Sc., 1921; Ph.D., 1923, University of Minnesota; F.R.S.C., 1930; D.Sc., 1933, University of

Alberta, has been appointed Director of the Division of Biology and Agriculture. Dr. Newton has had the following experience since graduation: 1912-13, District Agricultural Representative, Macdonald College; 1913-14, Chief Assistant Cerealist, Dominion Experimental Farms; 1914-15, Director of Agricultural Instruction, New Brunswick; 1915-19, war service, field artillery, wounded 1916, M.C., 1917; 1919-20, Assistant Professor of Field Husbandry, University of Alberta; 1920-22, Shevlin Postgraduate Fellow, University of Minnesota; 1922-24, Professor of Plant Biochemistry, University of Alberta; 1924-32, Head of Department of Field Crops, University of Alberta; 1928-32, Acting Director, Division of Biology and Agriculture, National Research Council; 1928, commissioned by International Education Board to make survey and report on postgraduate instruction and research in agriculture in Canada; 1929, commissioned by National Research Council to make survey and report on marketing wheat by protein content in the United States, and survey and report on feasibility of using protein content in marketing Canadian wheat in Europe. His principal researches have been on the nature of frost, drought and disease resistance in plants; the quality of wheat in relation to variety, soil and climate; effect of frost, stage of maturity and artificial drying on the quality of wheat. He has published 30 scientific papers in the above field of research, and various reports.

J. G. Malloch, B.Sc., 1924, M.Sc., 1926, University of Alberta; Ph.D., 1928, University of Minnesota, has been appointed Assistant Research Biologist. He has had research experience in cereal chemistry, the effect of irrigation on the quality of wheat, the milling and baking quality of dried wheat and frozen wheat, and factors affecting gas production in bread doughs. He has published 15 scientific papers. Dr. Malloch served as the Secretary of the National Research Council's Associate Committee on Grain Research from 1930 until his transfer to Ottawa and played a leading part in the development of the program of that committee, among the more important accomplishments of which have been researches on the drying of grain, the relative merits of varieties of wheat and the testing of new disease-resistant strains developed by the plant breeders of the Associate Committee on Field Crop Diseases. Prior to his appointment to the laboratory staff of the Council, Dr. Malloch was a member of the staff of the Council's Associate Committee on Grain Research. He collaborated with Dr. Newton in the investigation of the feasibility of using protein content in the marketing of wheat.

J. W. Hopkins, B.Sc., 1929, M.Sc., 1930, University of Alberta, has been appointed Junior Research Biologist. His duties will be to assist as an expert statistician in planning experiments and analyzing results obtained in the laboratories of the Council and co-operating institutions, and to be available for consultation by research workers throughout Canada who may desire to avail themselves of such a service. Mr. Hopkins received training in statistical mathematics under Dr. R. A. Fisher, of the Rothamsted Experimental Station and London University, a world authority on the application of statistical methods to biological and agricultural problems. Previous to his appointment to the staff of the Council's laboratories, he was employed by the Council's Associate Committee on Grain Research. In studies of experimental data which Mr. Hopkins has made, not only have hitherto unsuspected conclusions of great value been reached when the results of many experiments at different stations have been considered together, but shortcomings in the planning of experiments, rectifiable in future work, have been disclosed.

George A. Ledingham, B.Sc., 1927, M.Sc., 1928, University of Saskatchewan; Ph.D. (plant pathology), 1932, University of Toronto; holder National

Research Council scholarships, 1929-30, and 1930-31; winner of Elizabeth Anne Wintercorbyn award (University of Toronto), 1931, and of a Teaching Fellowship (Harvard University), 1932, has been appointed Junior Research Biologist, to assist in the editorial services of the National Research Council. Dr. Ledingham was employed in the summers of 1930 and 1931 by the Council's Associate Committee on Trail Smelter Smoke, investigating and assessing sulphur dioxide damage in the valley of the Columbia River in British Columbia and the State of Washington, U.S.A. Dr. Ledingham's research results have been recorded in scientific papers on sedge rust, browning root rot and crown rust of oats.

K. A. MacKinnon, B.Sc. (electrical engineering), 1926, B.Sc. (physics), 1928, M.Sc. (physics), 1929, Queen's University; holder National Research Council bursary, 1928; postgraduate student, Harvard University, 1929-30, has been appointed Junior Research Physicist. His duties will be to assist in the examination of types of electric meters submitted for the approval of the National Research Council, to assist in electrical precision standardization and other related tasks. Mr. MacKinnon assisted Mr. A. J. Grant in the investigation of meters in use in Canada as requested by the Minister of Trade and Commerce, and as referred to elsewhere in this report.

T. H. Doherty, B.Sc. (mechanical engineering), 1929, McGill University, has been appointed Junior Research Engineer. He will be required to assist in the direction and operation of the fire hazard laboratory, the planning and organization of which are reported upon elsewhere in this report.

Resignations

During the year the Council lost the services of two members of the professional staff. Lieut.-Col. W. A. Steel, Research Physicist in charge of radio research in the Division of Physics and Engineering, resigned to become a member of the Canadian Radio Broadcasting Commission. Lieut.-Col. Steel, however, undertook to continue supervision of the Council's work in radio until his successor could be appointed.

The second member of the professional staff whose services were lost to the Council was Dr. J. Stanley, Junior Research Investigator, in the Division of Research Information, who resigned to become Assistant Professor of Biology at Queen's University.

Summary of Financial Statement for 1932-33

During the year under review a parliamentary appropriation of $410,000 was provided for the work of the National Research Council, of which $408,829.91 was expended. Revenue received during the year from various other sources totalled $44,518. The total amount received by the Council during the year was therefore $453,347.91. The corresponding figure during the preceding year was $556,832.41.

The revenue of the Council received from sources other than a parliamentary appropriation consisted mainly of trust funds held by the Council, contributions made by industrial organizations toward work carried on by the Council, fees for tests carried out in the National Research Laboratories, sales of publications, and unexpended grants in aid of research. The sum of $19,032.80 was received by the Associate Committee on Grain Research from a trust fund established in 1928 for this work. Various industrial organizations contributed to the Canadian Engineering Standards Association, which

operates as an Associate Committee of the National Research Council, the sum of $6,790.55, and the sum of $6,161.25 was received from the Empire Marketing Board as a contribution toward the work of the Institute of Parasitology at Macdonald College, the work of which Institute is directed by an Associate Committee of the National Research Council.

During the year under review the gross expenditure of the Council totalled $453,347.91. The sum of $269,429.91 or considerably more than one-half of the entire expenditure was required to provide for the salaries of the professional, sub-professional and administrative staffs of the Council. The sum of $61,062.47 was expended on grants in aid of research, of which only $15,820.90 was from parliamentary appropriation, the balance being from the special revenues indicated in the preceding paragraph. The corresponding figure for grants in aid of research for the previous year was $166,-898.05. This expenditure included grants to associate committees directing large co-operative investigations, grants to aid individual investigators in carrying out approved researches by furnishing them with either special apparatus required for the investigations or junior assistants, and other direct contributions toward the promotion and co-ordination of research work in Canada.

The Council expended the sum of $17,605 on postgraduate scholarships as compared with $38,490 during the preceding year, and $59,335 in the year prior to that. The sum of $15,921.84 was expended on the publication of scientific information, including the Canadian Journal of Research, and $52,932.09 was expended on the operation of the National Research Laboratories.

The total travelling expenses of members of the Research Council, the staff of the Council, and members of all committees of the Council amounted to $16,498.54, and the sum of $18,723.73 was expended on the administration of the entire organization and on contingencies.

Financial Statement for the Fiscal Year Ending March 31, 1933

S. P. EAGLESON, *Secretary-Treasurer*

Revenue

A. *Parliamentary Appropriation*			
Vote	$ 410,000.00		
Unexpended Balance	1,170.09		
			$ 408,829.91
B. *Special Fund*			
Publications	$ 1,825.96		
Assisted Researches, Refunds	4,050.20		
Miscellaneous	5,298.17		
			$ 11,174.33
C. *Trust and Indirect Revenue*			
Received from Industries	$ 7,690.55		
Grain Research Trust Fund	19,032.80		
Empire Marketing Board	6,161.25		
Miscellaneous	459.07		
			$ 33,343.67
Total revenue			$ 453,347.91

Expenditure

A. *Parliamentary Appropriation*

Scholarships	$ 17,605.00	
Grants in aid of Research	15,820.90	
International Affiliations	1,897.90	
Publications	15,921.84	
Operation of Laboratories	52,932.09	
Salaries	269,429.91	
Travelling	16,498.54	
Administration and Contingencies	18,723.73	
		$ 408,829.91

B. *Special Fund*

Grants in aid of Research	$ 10,000.00	
Unexpended Balance	1,174.33	
		$ 11,174.33

C. *Expenditure Incurred from Trust and Indirect Revenue*

Canadian Engineering Standards Association	$ 6,790.55	
Grain Research Committee	19,032.80	
Parasitology Committee	6,161.25	
Weed Control Committee	425.00	
Magnesian Products Committee	700.00	
Laundry Research Committee	200.00	
Miscellaneous	34.07	
		$ 33,343.67
Total Expenditure		$ 453,347.91

Detailed reports of the work of the National Research Council follow.

REPORTS OF LABORATORY DIVISIONS

The following reports of the laboratory divisions have been prepared by the directors of those divisions to indicate the character of the investigations now in progress in the National Research Laboratories.

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

With the completion of the new laboratory building, the work of the Division of Biology and Agriculture, which for four years had been carried on at the University of Alberta under a co-operative arrangement, was transferred to Ottawa. Owing to the financial conditions resulting from the world-wide economic depression, it was not possible to expand the staff and program as originally planned for this occasion. However, a nucleus of the prospective staff has been established, and satisfactory progress has been made in developing a carefully planned program of research. During the year this program was submitted for criticism to the Associate Committee on Agriculture.

Naturally the first important task was to equip the laboratories allotted to this division, within the limits made possible by restricted financial resources, and all members of the divisional staff devoted a large part of their time to this. Not only had standard laboratory equipment to be selected, ordered and installed, but a number of special installations were made which required a large amount of preliminary study and consideration before specifications could be prepared. The largest of these include a plant house on the roof of the laboratory, a refrigeration plant on the ground floor, chambers for growing plants under controlled conditions in the basement, and equipment for experimental baking.

The parts of the refrigeration plant so far installed include two ammonia compressors, each of a capacity of ten tons. One of these cools two cold storage rooms at present, and has additional capacity to carry part of the load of other projected rooms when these are built. A special system of temperature control, devised for these rooms, depends upon thermostatically controlled fans circulating the air over brine coils enclosed in an insulated bunker; this system is entirely free from the lag associated with the direct introduction of cold brine into exposed coils in the room, and gives simple and precise control. The other ammonia compressor is capable of serving five pairs of controlled plant growth chambers in the basement, though only two of these chambers have so far been constructed. The refrigeration plant is entirely automatic, and the two compressors are cross-connected to provide a stand-by service for either the cold storage rooms or the plant growth chambers, so that service can be maintained in either of these installations should a machine fail while important experiments are in progress.

Owing to the large number of requests for research on vitamins, the equipment of laboratory and animal house units for such work has been undertaken, to be in readiness for the time when a moderate expansion of staff will make its active prosecution possible. Other new projects which are particularly pressing include fermentation studies with agricultural wastes (straw, etc.), and studies on the utilization of barley.

In addition to carrying on the research projects reported herein, members of the staff have given a significant amount of time to the answering of technical inquiries. Special mention may be made of the assistance given by

Dr. J. G. Malloch to the Commercial Intelligence Service on wheat and flour matters, and by Mr. J. W. Hopkins to various investigators seeking expert advice on the statistical analysis of experimental data.

Apparatus for Plant Growth under Controlled Conditions

R. Newton and W. H. Cook

Plant physiologists have long cherished the ideal of constructing equipment for growing plants under conditions controlled with respect to the chief factors of the environment, in which it would be possible to study the effect of a given factor while holding the others constant, as well as the threshold values and complex interactions of temperature, humidity and light. After two years' study of the problem, during which specifications were gradually developed in the effort to combine the best features of such apparatus installed in various institutions in the United States and Europe and to avoid the rocks upon which some of them had foundered, the first pair of chambers was constructed during the year under review.

An air-conditioning unit, served by steam and refrigerating lines in the balance desired, stands just outside a room enclosing the two plant chambers. In the air conditioner, fresh air is drawn through a fine water spray at some selected temperature, thus saturating it with moisture at that temperature and setting the absolute humidity of the air in both plant chambers. The relative humidity in the plant chambers depends, however, on the temperature to which the air is raised after leaving the conditioner, and this can be controlled independently in the two chambers by heating appliances in the flues leading from the conditioner to the chambers. The stream of air, thus conditioned in two stages with respect to moisture and temperature, enters the chambers through the bottom and passes out at the top, at such a rate that no appreciable change takes place while it is in contact with the growing plants. The composition of the air can be altered, if desired, by introducing carbon dioxide or other gases into the stream before it enters the chambers. Artificial light shines through a distilled water screen at the top of each chamber, and the chambers are completely lined with polished Monel metal to insure good reflection and diffusion. This first pair of chambers is being used for preliminary tests which will be made the basis for modifying, as may seem desirable, the design and construction of further pairs to be built later.

Standardization of Experimental Baking Test

J. G. Malloch

In preparation for further experiments looking to the development of apparatus for the complete mechanization and standardization of experimental baking, the basic equipment of the baking laboratory has been built to specification and installed. The dough-punching machine previously devised and built in the laboratory has now been tested by the laboratories co-operating with the Associate Committee on Grain Research and has been found satisfactory.

Comparison of Diastase from Wheat and Barley

J. G. Malloch and A. M. Torrie

Results indicate that there is no important difference in the properties of the diastase from wheat and barley. The method of preparation, however, markedly influences the characteristics of the enzymes. There is no evidence to show that wheat malt preparations would have any advantage over those made from barley for use as diastatic supplements in baking.

Studies on the Gluten Proteins

W. H. Cook

Studies of the effect of heat denaturation on the viscosity of gluten dispersed in urea solutions have been continued. Most of the work performed during the past year has been concerned with the effect of the age of the dispersion and the hydrogen ion concentration on the viscosity, with the object of sorting out these effects from that of heat treatment. These studies are of practical importance in relation both to methods for improving flour quality by heat and to the injury of wheat by improper drying methods.

When a gluten dispersion is prepared in a 30% urea solution, the viscosity falls with increasing time of storage at either 0° or 25° C., but much more rapidly at the latter temperature. By a combination of storage for eight hours at 25° and subsequent storage at 0° C. it was possible to obtain viscosity values that remained constant for a period of 18 days. With these dispersions it was possible to study the effect of hydrogen ion concentration and heat treatment.

It was found that the viscosity was constant over the pH range from 6.0 to 8.0, and this range was selected for the initial study of heat treatment.

Gluten dispersions, containing 5 mgm. of protein nitrogen per gram of dispersion in 30% urea solution, were heat treated for various periods of time at 40, 60, 70, 80, 90 and 100° C. The viscosity was found to decrease with time of treatment at all temperatures, the rate and degree of fall being inversely related to the temperature. A dispersion, containing 10 mgm. of protein nitrogen per gram of dispersion in 30% urea solution, showed only a slight decrease in viscosity at the lower temperatures, and a decided increase in viscosity at the higher temperatures. This behavior is still unexplained, but it is probably due to the difference in the proportions of urea and protein in the concentrated dispersion.

Chemical Weed Killers

W. H. Cook

The toxicity of a number of chemicals has been tested by spraying them on four annual weeds. This phase of the investigation was completed during the past year and will be published in the near future in the Canadian Journal of Research. Of the 80 chemicals tested the following were most effective in killing annuals:—ammonium thiocyanate, sodium cyanide, sodium dichromate, phenol, arsenic pentoxide, selenic acid, sodium selenite, formic acid and chloric acid. Many of the other chemicals tested, however, are sufficiently toxic to merit further experiments.

New work has been initiated with a view to developing shorter and simpler methods of evaluating the effectiveness of chemicals of which it is desired to test the herbicidal power. The addition of the chemicals to water-culture solutions, using wheat as a standard test plant, has proved as effective and much speedier than spraying the foliage of weeds directly. Experiments have now been started on a conductivity method, based on the high electrical resistance of living as compared with dead plant tissue.

The investigation of fire hazards in the use of oxidizing agents as herbicides, described in last year's report, has been completed and published (Can. J. Research, 8 : 509-544. 1933).

Experiments on Weeds and Weed Seeds

J. M. Manson and P. Garrow

Eleven selected chemicals were tested for the control of perennial weeds, particularly couch grass and Canada thistle, under field conditions. Of these, sodium chlorate and ammonium thiocyanate appear to have produced the greatest kill and the most lasting effect. Sodium hydroxide, sodium cyanide and sodium dichromate caused rapid discoloration of the foliage but, at the concentrations used, did not suppress regrowth. All the substances used were capable of killing annual weeds, acid sludge and creosote being least efficient.

Germination studies on wild oats indicate that dehulling may not necessarily induce germination and that when such germination does occur it is the result of mechanical damage to the seed coat. Germination and developmental vigor may be markedly influenced by the season in which the seed is produced. Increasing the depth of burial of wild oat seeds in soil decreases germination and also the proportion of germinated seeds resulting in established plants. There appears to be a distinct tendency for dormancy to be more strictly imposed on the secondary and tertiary seeds than on the primary in the same spikelet.

The optimum temperature for germination of wild oats seems to be in the neighborhood of 60° F. Lower temperatures reduce the rapidity of germination but not necessarily the total germination obtained. Stubble burning reduced the subsequent germination of wild oat seeds on the surface, but those slightly covered with soil germinated better after the burning than before.

The practice of cutting couch grass for hay involves the danger of spreading the weed by seed. Germination studies with seed from heads harvested at various dates after the onset of flowering suggest that there is some risk if the grass is allowed to stand more than a week after flowering starts.

Biochemistry of Rust Resistance

J. A. Anderson

The effect of diluted press-juice of Khapli, Vernal, Marquis and Little Club wheats on the germination and growth of germ tubes of urediniospores of wheat stem rust, form 21, has been studied. The varieties fall into two groups, the press-juices of Khapli and Little Club reduce the percentage germination and retard growth to a greater extent than those of Vernal and Marquis. It is concluded that no relation exists between the inhibitory effect of host extracts on spore germination or on the growth of germ tubes and the rust resistance of the host.

A study of the effect of hydrogen ion concentration on the germination of urediniospores of form 21, carried out as part of this investigation, shows that the range of maximum germination extends from pH 5.8 to 6.2. The percentage germination decreases rapidly on both sides of this narrow range.

A study of the organic constituents of wheat plants is being continued, both for its scientific interest and in the hope of isolating compounds of importance in resisting disease.

Influence of Weather Conditions on the Growth and Yield of Wheat

J. W. HOPKINS

The influence of weather conditions upon the yield of wheat in any particular season is to be regarded as the resultant of a number of separate effects, harmful or beneficial, exerted from time to time throughout the growing season. Furthermore, the requirements of the plant are not the same at all stages of growth, so that weather conditions favorable to one phase of development may actually be inimical to another.

In order to distinguish by statistical methods these interacting effects it is necessary to have a fairly long series of crop yields which can be correlated with the prevailing weather conditions. Observational material for the present study has been obtained by combining the experience, over a period of years, of seven experimental stations at different places in Saskatchewan and Alberta. Yields of Marquis wheat, grown in test plots on well-prepared summer-fallowed land, are available for 10 years at each station.

Analysis reveals a significant relation between rainfall and temperature conditions prevailing during the growing season, and the resultant crop yield. Above average rainfall in the early part of the growing season appears to result in increased yields. From 30 to 90 days after seeding the beneficial effect, as measured by the increase in yield due to each additional inch of rain, shows a progressive diminution. Rain falling in the period 95 to 110 days after seeding seems to be definitely detrimental. Higher than average temperatures at the time of seeding and during the first month of the growing season are associated with increased yields. During the period 30 to 85 days after seeding, however, high temperatures appear to be unfavorable, the maximum detrimental effect being experienced approximately 60 days after seeding. Subsequent (85 to 110 days after seeding) above average temperatures are again beneficial. A study of the relation between weather conditions and the relative yield of early and later-maturing wheat varieties is in progress, and a comparison of the response to weather conditions of wheat grown on summerfallowed and stubble land is also being undertaken.

The Effect of Aging and Temperature on the Mutation Rate in Cereals

F. H. PETO

The recent discovery by a Russian worker, that the chromosomal mutation rate in a species of hawk's beard *(Crepis tectorum* L.*)* was influenced by aging of the seed, has been corroborated by observations on the mutation rate in corn plants grown from seed of various ages. On the theory that aging involves fundamentally a gradual coagulation of the nuclear proteins, experiments have been carried out with heat treatments of fresh seeds of barley. Reduction in germinability comparable to that found in old seeds was accompanied by a rapid rise in the number of chromosomal mutations, as evidenced by an abnormal chromosome number, fragmentation, translocation and other phenomena. A considerable number of these mutations have been shown to be eliminated during growth of the plant. Therefore the principle that *only the fittest survive* seems equally true of cells as of individuals and groups of plants or animals. Subsequent breeding work on this material should show whether these mutations express themselves in new heritable plant characters or new recombinations of the original characters. If even a small proportion of them are inherited, the discovery of

this fact will increase our knowledge of the fundamental causes of evolution, as well as provide a new tool in the hands of the practical plant breeder for inducing new combinations of useful characters.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

As was the case last year, it has not been possible to proceed with building up the staff of the division, and hence the number of workers engaged in most of the major fields of activity is far less than could be desired. In view of the limited staff of workers available, however, very gratifying progress has been made and results of industrial interest secured on a considerable number of lines of investigation.

Adsorption of Vapors and Gases on Solids

L. M. PIDGEON

An apparatus has been developed to measure this property. In the year under review some work on the adsorption of benzene, alcohol and water on silica gel, and a new form of active silica, developed in these laboratories, was completed, and results of practical and theoretical interest obtained. An investigation on adsorption by asbestos and rubber is under way.

Aluminium from Clay

A. F. GILL

Frequent inquiries are received at the laboratories relative to possible methods of obtaining aluminium oxide or other compounds from clays. While this is a subject of undoubted interest because, among other reasons, the crude aluminium oxide used for the manufacture of aluminium in Canada is now all imported, it is one which has been covered thoroughly in numerous investigations, both in private laboratories and in those of certain corporations. Technically feasible methods for the recovery of aluminium oxide do exist. Numerous difficulties of an engineering nature render such proposals unattractive in the face of the present ample supplies of bauxite ore.

Recent laboratory work which is of interest in this connection has involved the determination of the thermal decomposition point of hydrous aluminium chloride ($AlCl_3.6H_2O$). This compound decomposes on heating, leaving a residue of aluminium oxide. The temperature of decomposition was found to be 182° C., the same, it may be noted, as the boiling point of the anhydrous salt, $AlCl_3$.

Asbestos

D. WOLOCHOW, A. VAN WINSEN

The process mentioned in the last report for the economic utilization of low grade fibre and asbestos tailings has been carried through to the semi-commercial stage. Results obtained both in the manufacture and use of the products seem to warrant the development of this process on a commercial scale and steps are being taken to that end.

The properties of the new moulded asbestos compositions which have been developed in the laboratory, and were also mentioned in the last report, are being studied further.

At the request of the asbestos producers a comprehensive study has been undertaken of the properties of asbestos cements, large quantities of which are used for thermal insulation. The covering capacity, shrinkage, density and thermal conductivity of the various grades of asbestos cements produced are being determined, and the relation of these properties to the screen analysis is being studied. Considerable experimental data have already been obtained; further work is under way and the results are being studied.

The screening action of perforated plates, with particular reference to their possible use in the Quebec standard testing machine, has been made a subject of investigation, also at the request of the asbestos companies.

Further work on several other projects, which were mentioned in the previous report, has been carried on as time permitted.

Work has been continued on the standardization of the Quebec standard testing machine. It was found that the testing machines of the various asbestos producers varied with respect to structural details. After considerable study, plans were drawn for a standard machine and these have now been adopted by the asbestos producers in Quebec. Complete working drawings and specifications are nearing completion. The screens for this testing machine also were thoroughly studied and standard specifications with regard to type of weave, tolerances and kind of metal for the wire were drawn up and have been adopted by the asbestos producers in Quebec.

Experiments are being made to determine the effect of variation in the moisture content of the fibre, due to changes in atmospheric conditions, on the screen test and the physical characteristics of the fibre.

The use of asbestos fibre as a filler for plastics is being studied and in this connection some microscopic work has been done and wet screening tests made.

Carbon Black

D. F. STEDMAN

The photometer constructed for the purpose has now been used for the examination of 16 typical samples of commercial carbon blacks, covering practically the whole range of types available. The correlation of these optical data with physical tests has not yet been undertaken, but it would appear that such optical tests would be a very useful basis for classifying blacks, as the transmission of light is very closely related to the fineness of the black, and the reflection coefficient is related to both fineness and the physical condition of the surface of the particles. While the reflection coefficient varies from only .2 to .65%, it is a highly specific property of a black and is probably very closely connected with such properties as the stiffening of rubber. Its correlation with physical tests will be undertaken as soon as possible.

Colloids

W. GALLAY

Certain starches, starch derivatives, and the hemi-cellulose of refuse grain screenings were investigated as possible agents in the rapid tanning of leather.

Various methods of determining the "spreading power" of liquids on solids have been investigated. Such a classification would be of value in conjunction with insecticides and fungicides applied by spraying, and is also an important factor in determining the lubricity of "oiliness" of a lubricant

Solutions of gelatin, agar and rubber were studied from a viscometric point of view and the results published in the Canadian Journal of Research. Studies which were made of the material effect of gelatin and agar solutions when mixed may, when pursued further, reveal points of practical significance in regard to the creaming of emulsions.

Distillation

D. F. STEDMAN

Attention has been concentrated largely on assembling the necessary equipment for a very close examination of naphtha from the Turner Valley, Alberta. It is hoped to separate all isomers present up to and including the nonanes, which will be accomplished mainly by close fractional distillation. The apparatus has required the very careful design of many details, including the fractionating columns themselves, which will separate compounds boiling only .25° apart with comparative ease, reflux dividers capable of operating at ratios as high as 6000 : 1, a complete voltage regulator and safety system, barometric pressure regulator, camera for recording temperatures continuously, etc., so that stills may be operated for months at a time without interruption.

A 50-gal. sample of naphtha from the Turner Valley has been separated into fractions boiling over a range of only a few degrees each, operating under 25 lb. per sq. in. up to the end of the butanes.

Biochemistry

I.—R. H. F. MANSKE

The program of investigating plants which are known to be poisonous or suspected of being physiologically active was started in these laboratories in 1930 and has been continued and extended without interruption. Some of the alkaloids isolated are being examined pharmacologically, thanks to the able co-operation of pharmacologists at several universities. One of the alkaloids has shown some promise as a medicinal agent and is being tested clinically.

A wide diversity of plants has been examined in whole or in part, but those which belong to the natural order Fumariaceae have thus far yielded the most decisive and complete results. The work on the following plants may be regarded as practically complete as far as the identification and isolation of the alkaloids are concerned. The figures in parentheses give the number of alkaloids isolated from the various species. *Dicentra canadensis* (squirrel corn) (5); *D. cucullaria* (Dutchman's breeches) (8); *D. eximia* (wild bleeding-heart) (6); *Corydalis sempervirens* (pale corydalis) (6); C. *aurea* (golden corydalis) (6); *Adlumia fungosa* (climbing fumitory) (6). Work on the following plants is only in the preliminary stages: *Zygadenus venenosus* (death camas); *Lobelia cardinalis* (cardinal flower); *Delphinium brownii* (tall larkspur). Still others have been collected for examination, so that the total list to date includes more than 15 species.

The constitution of several of the new alkaloids has been elucidated. As examples it may be mentioned that bicuculline and adlumine proved to be analogues of hydrastine. Many other new alkaloids have become available and work on their constitution is being actively pursued.

A further feature of this work has been the finding of some hitherto very rare alkaloids in large quantity, so that a thorough pharmacological study is possible for the first time.

Some of the results on Fumariaceous plants have been published in a series of seven papers in the Canadian Journal of Research.

II.—L. MARION

Various plants, known for their poisonous properties or belonging to families containing species utilized as sources of pharmacologically interesting glucosides, were collected in the summer of 1932, and studied during the year.

The investigation of the corms of *Arisaema triphyllum* (Jack-in-the-pulpit) is now completed. A glucoside has been isolated together with numerous substances of interest. *Mimulus ringens* (Monkey flower), belonging to the Scrophulariaceae, has been found to contain a saponin and also a crystalline glucoside together with a substance belonging to the class of saccharides.

Gas Research

A. CAMBRON, C. H. BAYLEY

The main objects of this investigation are the production by thermal treatment of *(a)* liquid hydrocarbons suitable as motor fuel, and *(b)* olefines such as ethylene and propylene, which are becoming more and more important as raw materials for the synthesis of common alcohol, higher alcohols and glycol (an antifreeze and basis for explosives). The subject is important because large amounts of the lower open-chain paraffins are at present available from stabilizing units at petroleum refineries, or in natural gas such as is going to waste in the Turner Valley, Alberta. The investigation of the possible utilization of these paraffins, initiated last year, has been continued.

Largely on account of the high temperature required, which has led to expensive and fragile refractory tubes being used, little or no commercial application has hitherto been made of the possibility of producing valuable products by thermal treatment of the gas. As a result of the present investigation, however, it has been found possible, by using a reaction tube of new design, to reduce the temperature required to within the range where tubes of heat-resistant alloy steels can be employed. The conversion of propane to olefines, for instance, can be satisfactorily carried out in chromium alloy steel tubes at temperatures around 800° C., the yield of olefines based on theory being of the order of 70-75%. Heat-resistant alloys of the 18/8 type have been found unsuitable for this purpose, because the nickel present catalyzes the formation of carbon, but nickel-free alloys containing over 20% chromium have been found satisfactory. After preliminary experiments in silica tubes, it was found possible to carry out the conversion of paraffins, such as propane, to liquid hydrocarbons in tubes of the same material and same design as used for the production of olefines. The yield of liquid products obtained from propane, for instance, is over three gallons per 1,000 cu. ft. of gas, 80% of these products consisting of hydrocarbons boiling in the gasoline range. This represents a conversion of propane to liquids of 21.4% by weight, 34% of the propane used being recoverable in the off-gas in the form of olefines, the total conversion to useful products being consequently over 55%. A very important feature of the new type of reaction tube used in the present experiments is that carbon deposition in the tube is almost entirely suppressed even at relatively high temperatures.

Honey

MISS H. D. CHATAWAY

Following up previous work on the subject, a simple procedure was established whereby the hydrometer can be used to measure accurately the moisture content of honeys, a matter of much importance in avoiding the spoilage of honey by fermentation and in producing granulated honey of uniform consistency adapted to the domestic and export trade. In November an address was given at the Ontario Beekeepers' Convention in Toronto, and in May, 1933, a paper appeared in the Canadian Journal of Research. The investigation may now be considered substantially completed.

Considerable work has been carried out on the clarification of buckwheat honey. Success hinges on the possibility of rapid efficient filtration. The problem has therefore been merged with that of the utilization of Canadian diatomites as filter aids, and work on the two problems is being carried out together,—a typical example of the value of co-ordinated research.

Dried Apples

N. H. GRACE

It is a general characteristic of dried apples that their flavor and attractiveness are somewhat less than those of fresh apples. Work has been under way which had as its aim methods which would raise the quality of dried apples. A general method of flavor improvement has been developed. This enables production of a dried apple which is practically indistinguishable from the fresh. Related problems have been considered, such as a critical study of the conditions for the most suitable pretreatment of apples. A quantitative study of Canadian dried apples indicates that prevailing pretreatment technique requires modification. A paper was read at the convention of the Canned Foods Association of Canada, meeting at Belleville.

Laundering

O. M. MORGAN

The laundry research program has consisted of two parts: (1) fundamental research, and (2) service work for the industry.

In the former branch of the work a laboratory comparison of the detergent efficiencies of the common alkaline soap builders has been completed and the results published. The work was carried out in a small laboratory wash wheel. It was found that efficiency differences did exist and could be measured. Definite optimum concentrations of soap builders also existed at which point maximum detergent efficiency was obtained.

Benefitting from the knowledge thus obtained, full scale power laundry tests to compare the efficiencies of these alkaline soap builders were carried out in Vail's Laundry, Ottawa. It was found that efficiency differences existed but these were not so pronounced as in the laboratory work. When optimum amounts of alkaline builder and soap were added to a wash wheel, the quality of the work turned out was constant. Hence the final criterion is cost, since the amount of builder and soap necessary in each case is specific.

An investigation has been started on the effect of sulphur dioxide on cotton fabrics. The concentrations of gas used are comparable with those found in manufacturing cities. This work is still in progress.

In connection with the service work for the industry, 271 reports have been issued covering new and damaged fabrics, soaps, alkalies, water problems, etc. A trip was made through the Canadian west for the purpose of inspecting the laundries and arranging for co-operative work with them.

Under the auspices of the Eastern Canadian Laundryowners' Association there has been organized a Canadian National Laundry Research Fund for the purpose of financially supporting the work of the laboratory.

Magnesian Products

A. F. GILL, N. P. PITT

The co-operative investigation on behalf of the Canadian Refractories Limited was continued during the year.

Work in this laboratory has been centered more on the immediate problems arising from the diversification of this company's output of magnesitic dolomite refractories and the extension of their use into fields other than ferrous metallurgy.

Following removal of the laboratory to the permanent building several fuel-fired laboratory furnaces were constructed, including a steel-melting furnace intended to reproduce the effect on refractories of basic open-hearth practice.

Investigation of the factors attendant on the expansion during drying of certain rammed refractories disclosed that this was primarily due to hydration of the magnesium or calcium oxides by the water of tempering solutions. A laboratory test was devised to indicate the relative susceptibility of various materials to hydration under these conditions. In addition to determining the mixing procedure least likely to result in hydration, clinkered products of increased stability were later developed. The problem of control of disintegration of fired refractories of this type due to their dicalcium silicate content was also investigated. Control was effected readily by additions of small proportions of certain chemical compounds. As a result of these improvements several successful installations have been made of the "ramming-mix" both in metallurgical furnaces and in boiler settings. The product "Magnifrit cement" is now finding a steady market.

The frequent conferences of laboratory workers and other members of the technical staffs of the Research Council and of Canadian Refractories Limited have continued to be a feature of this investigation. With the work on brick and other special investigations, reported under the Associate Committee on Magnesian Products (p. 83), the group is rendering a considerable service to the users of basic refractories in Canada.

In view of the depressed state of the construction industry less attention has been given in the laboratory to the plastic magnesia, Grenite, which is used largely in building products. Manufacture of this material was carried on, however, during the year and further installations were made.

Leather

W. E. GRAHAM

During the year under review further inspections have been made of Canadian tanneries, so that the visits have now included tanneries making all the principal kinds of leather tanned in Canada.

Examination has been made of many tanning materials, of leathers exhibiting defects and of leathers from experimental tanning processes.

Some study of salt stain on resalted hides has been made, bacteriological examinations having been kindly undertaken by Dr. A. G. Lochhead, Dominion bacteriologist. Wear tests have been made on samples of sole leather. Work has been done on methods of analysis to meet requirements of some experimental tanning processes.

Laboratory studies, not yet completed, on the dechroming of chrome leather waste have met with considerable promise of success.

Considerable attention has been given to the selection and design of apparatus with particular reference to equipment for a small experimental tannery. Apparatus for carrying out analyses by official methods and for duplicating the processes of the tannery, as far as can be done on a small scale, has now been installed and tanning experiments carried out. A wear test machine for sole leather is under construction and will be installed in the near future.

Many inquiries for information on methods of home tanning and on the operation of a small but fairly complete tannery to serve the needs of a small community have been answered. To facilitate the giving of information to such inquirers the preparation of two bulletins, suitable for these two groups, describing methods of making leather has been undertaken, and they will shortly be ready for distribution.

Lime Products

A. F. Gill

Some short investigations have been made on behalf of lime producers in connection with the plasticity and other properties of this product, chiefly in connection with lime of higher magnesia content. The problem of plasticity in hydrated lime is a very live question and at the present time the desirability of undertaking systematic work in this field is under consideration.

Maple Products

L. Skazin

Further experiments on the process developed in the laboratories for the production of super-flavored maple syrup were conducted throughout the course of the 1932 sap season. The development of this new process is necessarily slow due to the shortness of the maple sap season. The experiments confirmed the findings of the previous years and also have established the optimum conditions for preparation of super-flavored syrup.

An investigation was started to determine the conditions of formation in maple products of invert sugar, the presence of which lowers the market value of the product.

Further work has been done on two new maple products to which reference was made in the last report, namely, concentrate of true maple flavor, and, a non-hardening and non-mottling form of molded maple sugar. The processes for production of these two products, it is believed, are now ready for commercial exploitation.

McMurray Bitumen

M. Katz, T. R. Griffith

Various experiments were carried out on the effect of blowing bitumen from the Alberta tar sands with air under definite conditions of temperature and rate of blowing. This operation which converts the soft bitumen into

products of heavier consistencies, was carried on in three different types of apparatus, using charges of 0.4, 1.5 and 4.5 kilograms respectively. New uses for these products are being investigated. A quantity of this bitumen was converted, at the request of an asphalt company, into a product suitable for use in flooring compositions, and weathering tests will be carried out in this connection.

Mineral rubbers prepared from Alberta bitumen gave quite satisfactory tests when compounded with rubber in comparison with a standard mineral rubber used by the rubber industry. Samples of the material prepared in the laboratory were sent to a Canadian rubber company who reported that they could use this product.

Investigations of the use of Alberta bitumen in various emulsions indicated that, although the soft raw material extracted from the sand could be emulsified readily by the use of recognized emulsifying agents, this did not apply to the harder, blown products. Special technique appears to be required in the latter case. The subject will be further investigated. Some work was carried out on the utilization of eel grass in the preparation of an insulating board using bitumen as a binder. The product could not, however, compete in price with the various fibre board products now on the market.

A large quantity of bitumen was separated into its component parts, consisting of asphaltenes, resins and oily constituents. The constitution of those fractions is being investigated, and also their influence on the properties of mineral rubber.

Milkweed

L. Marion

The milkweed is of possible economic significance and deserving investigation because it offers three products—*(a)* seed oil, apparently similar to cottonseed oil, *(b)* seed fibres, comparable, at all events at first sight, with cotton, *(c)* bast fibres, comparable roughly with flax.

A large quantity of this plant has been collected and the stalks, seeds and floss separated. Retting experiments have shown the existence of bast fibres removable from the stalks and the best method of isolating these fibres is being studied. The seeds contain from 17 to 18% of oil and at least 1% of sucrose. The plant has been stated to contain a glucoside, asclepiadin, and a chemical investigation of the seeds is under way to ascertain whether they contain anything which would prevent their possible use as a cattle food.

Oil Refining

W. Gallay

A thorough investigation of Canadian clays as refining agents has been initiated. At present imported clays are used almost exclusively for this purpose, the total value of the imported material being nearly $300,000. Samples have been obtained from all promising deposits and are being tested with regard to decolorizing and filtering power in connection with various mineral oils and gasolines. The calcination and acid activation of these materials are being carried out by numerous methods with a view to the greatest possible increase in decolorizing and filtering efficiency. Direct contact with the industries concerned has been established and in some cases plant practice is being followed on laboratory and somewhat larger scales. This work shows much promise in the development of the clay resources of Canada.

Refuse Screenings

C. Y. Hopkins

The study has been continued of products obtainable from refuse screenings such as accumulate at the head of the lakes to the extent of 80,000 tons or more a year. It has been found that weed seed oil behaves in the same way as rapeseed oil when blown with air at elevated temperatures. The product is an oil of very high viscosity which may be found suitable for special types of lubrication. The oil of hare's-ear mustard seed has been examined separately and the quantitative determination of its fatty acids has been completed.

A study of the bitter principle of hare's-ear mustard reveals that it is a sulphur-containing glycoside. The aglucone has been obtained in pure crystalline form by enzymic hydrolysis.

A series of experiments has been carried out on the briquetting of screenings for use as household fuel. The results have been favorable and indicate that the most suitable binder is concentrated sulphite liquor. This material can be produced at any sulphite mill from the liquor which at present is run to waste.

Rubber

M. Katz, T. R. Griffith

A review paper on synthetic rubber was written by Dr. G. S. Whitby, in collaboration with Dr. M. Katz, and includes work carried out by the authors on synthetic rubbers. In order to continue the work begun last year on synthetic rubber, a quantity of isoprene was prepared and purified by conversion to the tetrabromide. Laboratory tests were made on the behavior of the new chloroprene rubber.

After preliminary work on the production of oils from rubber had indicated that practically quantitative conversion could be secured by distillation of the rubber in an atmosphere of carbon dioxide under certain conditions, experiments were carried out on a larger scale using 10-lb. batches of rubber. By distillation in a vacuum of 0.03 mm. the product was separated into a series of about 20 different fractions. New uses for these oils are being investigated and work is in progress on the constitution of the higher members of this series.

Assistance was given in connection with the manufacture of various Canadian plastic rubber compositions which were not giving satisfactory service in competition with similar products from the United States. The products were improved so as to meet successfully this competition.

Preliminary work has been undertaken on the use of Canadian clays and diatomaceous earth in rubber, which will be investigated fully in the coming year.

Salt-clay Highway Treatments

A. F. Gill

Representations were received from a Canadian producer of salt that favorable results had been obtained in highway tests of a traffic layer consisting of a mixture of salt and clay and the treatment was investigated with a view to elucidating the physical or chemical principle underlying the observed effect.

Chemical considerations were assumed to be of no significance with the materials used. The influence of the salt, as an electrolyte, on the colloidal components of the clay was also found to be of minor importance. The greatest effect observed was in the influence of the salt on the rate of moisture transfer from treated clay. The fact that admixture of salt gave a marked decrease in rate of drying even at comparatively high temperatures was ascribed to the mechanical effect of growing salt crystals on the porosity of the clay as the water content was lowered. In a report covering this work it was recommended that these favorable indications be followed up with further field and laboratory tests with a view towards developing a low priced secondary highway surface.

Smelter Fumes

M. KATZ

Supervision was exercised over the work being carried out on the effect of fumes from the Trail Smelter on vegetation in the state of Washington, relating to the daily readings of sulphur dioxide occurrence by automatic recorders, analyses of foliage, etc. A report on "The Effect of Sulphur Dioxide on Douglas Fir and Yellow Pine" was completed in collaboration with Mr. A. W. McCallum of the Department of Agriculture. A second report on the "Effect of Sulphur Dioxide on Crop Plants" is well in hand and will be completed shortly. Information and advice were tendered to the provincial government of British Columbia in connection with sulphur dioxide damage to vegetation.

Storage Battery Separators

L. M. PIDGEON

Most of the batteries manufactured in Canada are fitted with separators made from Port Orford cedar, a wood native to Oregon. The British Columbia wood yellow cedar is a member of the same family, and has appeared to be suitable for this purpose, but there has been no information available as to the relative merits of the two woods. An extensive research has been completed during which several thousand separators of foreign and domestic origin were examined. A number of tests were devised to determine the electrical resistance, resistance to acid, and the production of organic acids harmful to the battery. It appears that in the first and last of these properties yellow cedar is quite as good as the American wood, while its resistance to acid, although not quite so high, is satisfactory.

Straw

L. MARION

Attempts were made to prepare from wheat straw, after first removing the lignin and hemicelluloses, cellulose having a sufficiently low ash content to make possible its utilization in the manufacture of cellulose acetate. So far, the ash has been brought down from about 7 to 1.5-1.6%. It must still, however, be reduced further, and the task is rendered difficult by the fact that drastic treatments liable to affect the cellulose cannot be used.

A study has been started of the resins and fats present in wheat straw to the extent of about 3%. They are removed from straw with a mixture of methanol and benzene and can then be separated into five fractions, soluble

respectively in petroleum ether, ether, chloroform, ethyl acetate and methanol. So far, it has been possible to ascertain the presence of glycerides, free fatty acids, organic acids, removable with ether, and neutral substances as well as sugars.

Utilization of Canadian Pyrite as a Source of Sulphur

A. F. GILL

So far only preliminary laboratory work has been carried on in connection with this problem—so important because of the fact that practically all the sulphur used in Canada is now imported. This preliminary work dealt with the proposed distillation of pyrite by direct heat in rotary kilns to yield one molecule of free sulphur with a residue of ferrous sulphide. The temperature at which this decomposition occurs was measured in the laboratory. While the results left some uncertainty as to the existence of solid solutions subsequent to decomposition all of the freed sulphur was lost below 700° C. The distillation of pyrite in closed retorts was carried on commercially many years ago. Yields, however, are reported to have been very small. In laboratory tests carried on chiefly with the object of becoming familiar with the rather peculiar technique necessary in handling this material at high temperatures it was found very difficult to avoid comparatively heavy losses.

At the present time the whole question of sulphur is being taken under advisement and several proposed methods of recovery are being considered.

Wool

P. LAROSE, MISS A. S. TWEEDIE

In connection with experiments conducted at the University of Alberta to determine the effect of environmental factors on the quality of wool, more than 200 samples of wool from individual sheep were tested for staple length, fibre length, crimps, tensile strength, fibre diameter, grease, suint, dirt and yield of clean wool. The method used for the determination of grease, suint and dirt was compared with a new one proposed by the British Wool Industries Research Association and was found to be as satisfactory. In order to determine the probable accuracy of the results of these tests, a study of these by statistical methods was made.

A large number of fleeces clipped from sheep used in breeding experiments being carried out at various points in the west were examined while being graded at Weston, Ont., and representative samples were measured for fibre diameters. Using these diameters to obtain the correct yarn count according to the Bradford system, it was possible to show that the grader's classification corresponded closely to that at Bradford.

In order to compare various methods of measuring fibre diameters, a large number of fibres were measured using *(a)* the eriometer, *(b)* the microbalance, *(c)* the microscope with projection screen and *(d)* the weight-length method. In connection with this last method, experiments were carried out to determine the change of length of fibres at different relative humidities.

A trip was made to the lower Quebec district where methods employed by the farmers for treating their wool used in handicrafts were studied.

Cloths woven from Canadian and from Colonial wools were compared for tensile strength and wearing qualities and the tops from which they were made measured for fibre diameters. Popularity tests were also made on samples of the cloths.

Experiments were carried out with a view to controlling and measuring the temperature and humidity in the fugitometer preliminary to fastness tests on dyeings.

An apparatus was built by means of which the moisture absorption by wool under various conditions will be studied and its density determined.

At the request of mills, such tests were made as the determination of the nature of sizing material in a cotton cord, cause of grayish color in washed wool and reason for bad dyeing properties.

Miscellaneous

1. *Linotype Machine Matrices.* Analysis was made of a mixture for cleaning carbon deposits from brass matrices. The original compound has a definite corrosive action which is detrimental to the use of the matrix. A mixture has been developed which is equally effective in removing carbon without any appreciable corrosive action. (C. W. Davis.)

2. *Antifreeze.* A study was made of the value and corrosive action of different antifreeze solutions. (C. W. Davis.)

3. *Hops.* Examination was made of samples of Canadian hops with the kind co-operation of one of the breweries. The method of analysis was revised to conform with that of the brewery. (C. W. Davis.)

4. *Analysis.* Among the analyses carried out during the year were: *(a)* Inorganic analyses of cements, refractories, clays, pigments, metals and solutions (350 samples, 1,500 determinations). *(b)* Analyses of soaps, washing compounds, waxes and disinfectants (30 samples, 100 determinations). *(c)* Water analyses with some study of boiler water treatment. *(d)* Gasoline analyses and testing, including analysis of carbon deposits from motors using fuel containing standard anti-knock compounds. *(e)* Examination of lubricating oils by standard methods including oxidation tests according to British Air Ministry procedure and residual carbon by the Ramesbottom coking apparatus. *(f)* Analyses of organic iodine compounds for animal medication. (C. W. Davis.)

5. *Corrosion.* Continued study of the corrosion of metals and the cleaning of corroded surfaces. (C. W. Davis.)

6. *Effect of Cocoa on Silver.* An investigation of possible effects of cocoa on silver was carried out. (L. Skazin.)

7. *Freezing of Coffee and Chicory Essence.* The effect of freezing of the essence on its flavor and physical appearance was studied. (L. Skazin.)

8. *Electrolysis of Seed Cereals.* In conjunction with the Dominion Experimental Farm a laboratory and field test of the Wolfryn electrochemical process for the treatment of seed cereals prior to sowing has been carried out. The chemical treatment was carried out in these laboratories (L. M. Pidgeon) while field tests were conducted at the experimental stations of the Department of Agriculture at Ottawa, Fredericton and Charlottetown. The process, which has been claimed to give improved germination and to increase the yield of grain, failed to produce the favorable results claimed.

9. *Chicken Incubators.* An examination of the corrosion of copper incubator tanks indicated that excessive overlapping of the joints together with the use of a corrosive flux was the cause of failure. Recommendations were made with regard to humidity problems in incubator construction. (L. M. Pidgeon.)

10. *Utilization of Oak Whisky Casks.* As a result of work undertaken on these casks, suggestions were made for their further utilization after being used for maturing whisky. This involved reconditioning the cask by removing the inside charred surface, and steaming to remove some of the fusel oil and alcohol absorbed by the staves. The treatment was meant to render the cask suitable for the shipping of foodstuffs. The principals concerned did not consider experiments on the aging of whisky in the cleaned casks advisable. (L. Marion.)

11. *Preparation of Special Ethers for Calibration of Fractionating Columns.* (L. Marion.)

12. *Book of Remembrance.* In connection with the Canadian Book of Remembrance the advice of the Council was sought as to the ink to be used. A thorough study of the literature was therefore made, a carbon ink decided upon and finally exhaustive tests were carried out on six specially selected inks. The report on the work was laid before the special committee of the Book of Remembrance in March, 1933. Other technical matters concerning materials for the book were studied and reported upon. (Miss H. D. Chataway.)

13. An increasing number of inquiries, on some of which experimental work was carried out, have been received from governmental and other public bodies, corporations and interested individuals. Apart from those received in connection with laundry research work, 305 inquiries were received and were answered by special reports, letter or by personal interview. Slightly over 50% of these inquiries were from corporations. Special reports were prepared on such subjects as:—*(a)* by-product dry lime hydrate; *(b)* new rubber cements; *(c)* testing of silk samples; *(d)* cedar leaf oil; *(e)* instantaneous liberation of a harmless gas; *(f)* paste for auto polishing; *(g)* suitable disinfectant for bottling equipment and storage tanks; *(h)* utilization of lignite tars; *(i)* carbon remover for internal combustion engines; *(j)* fireproofing of cotton batting; *(k)* cultivation of sumac; *(l)* decolorizing carbon; *(m)* abrasion tests on sole leather; *(n)* the electrodynamic concentration of ores; *(o)* a proposed method for separation of alumina from clay; *(p)* hardening vulcanized rubber; *(q)* adhesives from wheat starch (preliminary); *(r)* tree stump destruction; *(s)* absorbent clays; *(t)* furniture polish; *(u)* a flux for type metal; *(v)* salt clay mixtures for highways (preliminary); *(w)* testing of matches (preliminary).

Inquiries answered more briefly included:—*(a)* use of seal oil in paints; *(b)* bleaching beeswax; *(c)* specific products obtainable from natural gas; *(d)* new maple products; *(e)* manufacture and use of various chemicals such as triethanolamine, lavric acid, cellulose acetate, styrene, etc.; *(f)* home tanning; *(g)* Canadian or Empire sources of materials; *(h)* fruit drying; etc.

DIVISION OF PHYSICS AND ENGINEERING

R. W. Boyle, *Director*

J. H. Parkin, *Assistant Director*

Shortly after the beginning of the year under review much consideration was given to the coming transfer of most of the laboratories from the John Street Annex to the new building. Transfer of the apparatus began in June and was practically completed in August.

The engineering equipment, other than electrical, has been retained in the Annex, where there are laboratories for aeronautics—including the wind tunnel and water channel—fire hazard testing, and instrument and model shops.

Also on that property, but operated by the Department of Public Works, are a hydro-electric power plant and a central heating plant.

During July and August, 1932, preparations were made for the various special investigations undertaken by the Council in connection with the total solar eclipse (August 31). Advantage was taken of this rare event to secure certain important scientific observations on the Kennelly-Heaviside layer.

On direction from the Council a subcommittee, consisting of certain members of the division, with the director as chairman, and Messrs. Stiver and Dupré of the Electricity and Gas Inspection Service, began the work of completely revising the definitions and regulations pertaining to the units and standards employed in the measurement of gas, and the regulations governing the approval of types of gas meters. This work is still in progress. A similar task pertaining to electrical units and the regulations for type approval of electrical meters is nearing completion.

During the year the division has co-operated with officers of the Departments of Agriculture and Mines in carrying out certain physical tests of special concern to those departments.

It is of interest to note that an electric moisture tester for grain, developed in the laboratories of the division by Mr. Chas. Limbrick, in co-operation with the staff, has now been put on the market, and is finding a place in the private use of various grain companies.

Brief accounts of the activities of the division are given below.

Metrology and Related Measurements

R. H. FIELD, W. J. LINFORD

The Physical Testing Laboratory of the Topographical Survey, Department of the Interior, was definitely merged into the division when the new research laboratories were occupied. It was decided at this time to make the aircraft and allied instruments section part of the Aeronautics Branch and the instrument shop equipment and staff were transferred to the main shop of the National Research Laboratories.

This brought to a close the independent existence of the Physical Testing Laboratory, successfully established some twenty years ago by the late Dr. Deville and afterwards further developed by his successor, Mr. F. H. Peters, the present Surveyor General.

Metrology

Two new 42% nickel steel one-metre rules and a one-metre rule of Fixinvar were received from the International Bureau of Weights and Measures in April. Unfortunately, corrosion marks developed on the speculum surface of the nickel steel rules, which are to be replaced by the makers. The Fixinvar rule has a coefficient of expansion of approximately 1×10^{-6} per degree Centigrade, which will make it valuable for length measurements conducted in air.

A redetermination was begun of the equation of the four-metre Invar rule used as a standard in tape verifications.

Optical Instruments

At the time of the installation of the equipment in the new laboratories, the apparatus for calibrating aerial cameras was completely redesigned. With the new equipment more precise measurements of the camera constants can be made with less labor.

The use of the equipment was extended to the Geodetic Survey, so that laboratory measurements could be made in connection with the research being conducted by the Survey on the precision of direction measurements. Assistance was rendered to the Topographical Survey in diagnosing trouble experienced with a prismatic astrolabe.

Tests Made in the Year 1932-33

	Government	Commercial
Lengths determined	28	28
Hydrometers verified	342	1
Watches rated	59	—
Thermometers verified	517	80
Clinical thermometers	3,882	—
Temperature indicators	—	115

Ballistics

D. C. Rose

In connection with investigations in ballistics a short rifle range is being prepared in the sub-basement of the National Research Laboratories. A new method of measuring velocities of bullets of ultra-high velocity has been developed, in which the bullet interrupts beams of light shining on photo-electric cells, the current through the cells being recorded by means of an Einthonen galvanometer. This ballistics laboratory is almost ready for use.

The Elimination of Static Electricity in Aerial Cameras

D. C. Rose

The problem of the elimination of static markings in aerial films has been carried over from the previous year. A study of the electrostatic charging of celluloid films when rubbed by wool felt and by brass has been made under varying atmospheric conditions of the type prevailing in aeroplane flights. The experiments were performed in a tank in which pressure, temperature and humidity could be controlled.

Experimental results have been obtained which will be useful in designing static elimination devices and alterations in camera design which should reduce electrostatic effects.

A comprehensive report on the subject has been prepared covering the work in these laboratories, with a discussion of the merits and demerits of various static elimination devices on the market. The report includes suggestions for further devices for reducing static which can be tested when sufficient photographic work is undertaken to justify further tests in the field.

Radio Observations at the Time of the Total Solar Eclipse

D. C. Rose

A station was established at Kingston, Ont., for a study of the upper Appleton layer in the upper atmosphere on the occasion of the total eclipse of the sun, which occurred on August 31, 1932. An outline of the experiment and findings will be found on page 88, under the report of the Associate Committee on Radio Research.

Electric Meters

A. J. GRANT, K. A. MACKINNON

Approval of Meters

Eleven types of meters or meter attachments were submitted to the Council for approval of type to enable them to be used in Canada. The Council approved ten of these and rejected one because of the feature that it could not be sealed. In addition, one meter in a preliminary state of development was submitted for suggestions as to its suitability. Tests were made on this meter but to date it has not been resubmitted in final form.

Specifications for Approval of Type

The following four specifications for the approval of type of apparatus used for determining charges for electricity were completed and adopted by the Council:—

1. Specifications for electricity meters.
2. Specifications for electricity demand meters.
3. Specifications for curve drawing instruments.
4. Specifications for instrument transformers.

Apparatus

The following important pieces of apparatus were received during the year: one Kelvin double bridge, three portable test meters, four standard cells from the N.P.L., four standard resistors and a current source for current transformer testing.

The Kelvin double bridge, the standard cells, and resistors were necessary to do standardizing work for outside firms. The portable test meters were used in the field investigation of watthour meter accuracy. The current source is necessary to enable the Council to test current transformers for approval of type.

Field Investigation of Watthour Meter Accuracy in Connection with an Extension of the Re-seal Period

Canadian utility companies have periodically requested the Minister of Trade and Commerce to extend the re-seal period of electricity meters from its present length of six years to a longer period. Conflict between data submitted by the utilities, and admittedly inadequate data supplied by the Electricity Inspection Department indicated that a field investigation was desirable. The Minister of Trade and Commerce requested the Council to undertake this Dominion wide investigation.

The field tests in connection with this investigation were carried out between September, 1932, and April, 1933. These tests involved the examination of nearly 3,000 meters. A detailed report is in preparation.

Work for Outside Firms or Individuals

1. Investigations of a proposed form of aluminium solder.
2. Standardization of standard cell voltages.
3. Tests of conductivity of standard copper bars.
4. Test of a potentiometer for the Central Experimental Farm.
5. Initiation of tests on electrolysis of seaplane float plating and bolts.

Testing Facilities

The additional space and power sources of the new building, together with the new apparatus listed elsewhere, enables the Council to do almost any kind of precision measurement in the commercial frequency or direct current field. Some additional apparatus is desirable but most measurements can be made with present equipment to the degree of accuracy required.

Electrical Engineering

B. G. Ballard

Practically the entire year has been devoted to work incidental to the establishment of the laboratories in the new building on Sussex Street. While many of the electrical installations required in various laboratories were of a minor character, the large number of them precluded the possibility of undertaking any extensive work in electrical engineering, particularly with the limited staff available.

In some cases, however, the installations required considerable time, but where possible the major ones were done under contract to definite specifications. Maintenance of the electrical equipment of the laboratories is becoming an increasingly important item and occupies the time of one man continuously.

The major undertaking of the staff was the equipment of the electrical engineering laboratory proper. While adequate switching equipment has not yet been installed, the design has been completed and much of the apparatus is available for erection.

Two motor generators have been installed and the services from these units are in almost continuous demand. One set is a synchronous frequency changer unit supplying 3-phase power at 25 cycles per second. Particular care was taken to secure a good wave form on this 25-cycle machine. The other motor generator consists of two 120-volt direct current machines and one 550-volt, 3-phase, 60-cycle synchronous machine. Dry type transformers make it possible to secure any voltage up to 2200 at either 25 or 60 cycles, single or three phase. The direct current drive on the 60-cycle machine makes it possible to vary the frequency, and by driving the frequency changer set from the other motor generator the 25-cycle frequency may be varied. Where studies require particularly steady conditions the sets may be driven from a battery system so as to be independent of variations on the local electric supply. The 60-cycle machine has also a very pure wave form so that a close approach to a pure sine wave is available for both frequencies.

The laboratory is now in a position to undertake practically any oscillographic studies of wave form or transient phenomena within the range of the Duddell type of instrument. An arc light has been procured for use with the oscillograph which makes it possible to secure high-speed records.

A Tesla coil has been constructed to provide a source of high-voltage, high-frequency current. This is fed from a 50,000-volt testing transformer which is available for test work in its sphere at a frequency of 60 cycles per second.

Vibrations in Rods and Disks

G. S. Field

A new method of examining vibrations in solids has been devised and a great deal of experimental work has been done with metal rods and disks of a variety of sizes. The different types of vibration which occur have been

carefully analyzed, so that a considerable amount of information has been obtained. It is hoped that the experimental data will be of considerable value in connection with the use of vibrating rods and disks for radio frequency standardization. A complete report is being published in the Canadian Journal of Research.

Acoustics

G. S. FIELD

With a view to the establishment of a laboratory for testing the acoustic properties of various kinds of building materials, a survey was made of a number of acoustical laboratories in the United States. Complete plans and specifications for a suitable sound chamber have been drawn up, and a start has been made in getting together the necessary equipment.

New Type Electrostatic Voltmeter

G. S. FIELD

This meter was received from the workshop and a number of tests were carried out on it. Several changes were found to be necessary, following which the instrument was calibrated. A report is being published in the Canadian Journal of Research.

Light

L. E. HOWLETT

Photometry

A complete photometric laboratory is being equipped. The basic parts, optical lens, integrating sphere and necessary electrical equipment are well on the way to completion. Primary standards of candle power are held by the Council. These consist of lamps calibrated by the National Physical Laboratory and the Bureau of Standards. The lamps from the latter body were supplied and calibrated free of charge as a gift to the organization. A member of the Research Council's staff took part in the calibration.

Book of Remembrance

An investigation has been completed on the selection of leathers and vellums for the Book of Remembrance. The purpose was to find which ones would stand up best to aging. A complete report was furnished to Mr. J. Purvis, the artist in charge of the compilation of the book.

Grading of Eggs

Work has been initiated in co-operation with the Poultry Division of the Live Stock Branch, Department of Agriculture, to improve the facilities and methods of egg candling. Considerable progress has been made and a full report is under way.

Cold Storage Research

L. E. HOWLETT

In co-operation with the Poultry Division of the Live Stock Branch of the Dominion Department of Agriculture, a research was undertaken in an effort to avoid the excessive condensation which occurs on food products when brought out of cold storage. The urgency of the problem was indicated by the severe loss which occurred on Canadian poultry shipped to England from Canada in the autumn and winter of 1932-33. This loss, it is believed, was largely due to condensation of moisture on the birds. The elimination

of condensation has been demonstrated in the laboratory and on a small scale at the Rail and Harbor Terminal cold storage at Toronto. These preliminary results have been successful and have met with a good reception from the trade.

The problem is still in hand and the development of methods for large-scale operations is being undertaken. A brief synopsis of the work has been compiled and copies sent to the members of the produce trade who are interested.

Radiology

G. C. LAURENCE

X-rays

Preparation is being made for testing all kinds of equipment used in medical radiology, for the conservation of standards of radiation, and for investigations concerning the equipment and physical methods of radiotherapy, particularly as applied to cancer.

The economic depression has delayed this work considerably; however, X-ray equipment has been installed during the year and is now in operation. Potentials up to 220,000 volts, valve rectified and filtered, are available. A standard ionization chamber with its accessory equipment has been built. This is for use in the calibration of dosage meters and similar equipment used in radiotherapy. A high tension voltmeter, which will give a continuous reading of the X-ray tube potential, is being built. A large precision X-ray spectrograph, suitable for calibration work, will shortly be added to the equipment.

The X-ray equipment is also to be used in the investigation of other problems which have arisen in this laboratory.

Radium

The laboratory possesses a primary radium standard of 24.5 milligrams, which has been compared directly with the international radium standard. It has also six secondary standards of 10, 5, 5, 2, 1 and 0.5 milligrams. These have been carefully compared with one another and with the primary standard, and are used in routine tests.

At the beginning of the year a new standard gamma ray ionization chamber was completed. This is used for the measurement of radium and employs a null method. Since that time many measurements have been made with this instrument. Some of these have been tests of radium preparations which have been submitted to the National Research Laboratories for that purpose. Others comprise a careful test of the instrument with regard to the linear relation between ionization current and gamma ray intensity, and the variation of ionization current with filtration.

The laboratories undertake to measure radium preparations as well as to test them for leakage of emanation and for mesothorium impurity.

A small radon collecting apparatus has been built and about fifty milligrams of radon are available as a source of emanation.

Heat

C. D. NIVEN

House Insulation

The work of testing certain building boards and blankets was completed and the official report was presented to the Associate Committee on Heating and Insulation. This report has been transmitted to the Tariff Board and

to the Canadian Manufacturers' Association. Several routine tests for commercial firms have been carried out during the year; samples for such tests have included fibre board, Gyproc, cinder and cement block, plaster and brick.

High Temperature Insulation

A great amount of work has been devoted during the year to the construction of an apparatus suitable for testing heat insulation up to a mean temperature of 1550° F. Judging from tests on material which had already been examined in the United States this apparatus gives correct results. It is ready for the systematic testing of diatomite and asbestos products, which are being submitted for test respectively by the Mines Branch and by the Division of Chemistry in the National Research Council.

Temperature Standardization

Apparatus for standardizing thermocouples at several fixed points on the temperature scale has been installed. Considerable trouble was experienced with the sulphur point, and as the literature revealed that other experimenters had met with difficulties in this determination a systematic investigation of the discrepancies in precision results is being undertaken.

Railway Refrigerator Car Temperature Device

Recently a research has been undertaken in co-operation with the Live Stock Branch, Department of Agriculture, in order to find a suitable and economical design of resistance thermometer and Wheatstone Bridge for determining the temperature in a refrigerator car at divisional points on the line.

Aeronautics

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

The equipment of these laboratories is largely of a special nature and must be designed and made in the laboratories and workshops. Owing to the lack of staff in the shops, progress has been necessarily slow. Pressure of work has necessitated carrying on tests and investigations, with improvised equipment in many cases, while proceeding with the completion of the laboratories and the design, construction and installation of the equipment. At the present time, none of these laboratories are completely finished and equipped.

Practically all of the work done during the past year has been for various departments of, or organizations connected with, the Federal Government, particularly the Department of National Defence. It is desired again to acknowledge the very cordial co-operation of the Department of National Defence in this work.

The arrangement providing for the sending of officers of the Royal Canadian Air Force to the laboratories for periods to acquire experience in aeronautical testing and research has been in operation during the year. This arrangement has been a very satisfactory one from the standpoint of the Council and when the laboratories are in full operation, will, it is hoped, be found of great value to the department and its officers. Likewise, the placing of two aircraftsmen in the engine laboratory has proved most satisfactory.

The fact should also be emphasized that much of the work of the aeronautical laboratories is of a non-aeronautical character. The equipment is proving valuable for general engineering tests and investigations.

A study has been made of the possible use of the model testing basin for work on vessels. The combined shipbuilding and boatbuilding industries of Canada include about 150 plants, with an invested capital of between 30 and 40 million dollars, employing over 5,000 persons with an annual wage of over $7,000,000 and with a production valued at nearly $20,000,000 in 1930 (the last year for which complete figures were available). During 1926-30, from 70-100 steel and wood vessels and 250-400 motor boats were built annually.

The Ottawa basin is capable of testing models of hulls of ships up to 150 ft. long with accuracy, and of models of much longer hulls with useful accuracy. The basin is particularly suitable for the testing of small high-speed craft such as patrol boats.

Aerodynamic Laboratory

The wind tunnel, although not fully completed, has continued in use throughout the year practically unchanged, with the exception of the completion of the balance and pit platforms and pit trolley. The automatic speed control (with the exception of the micromanometer) was placed in operation in May and has since then functioned satisfactorily. The design of the aerodynamic balances was completed and their construction continued. The balances are now possibly two-thirds completed. Certain necessary instruments and equipment have been designed, or, where available, purchased. The propeller has been inspected, balanced and checked by the A.I.D.

Hydrodynamic Laboratory

Further improvements have been made in the equipment of the model testing basin. The automatic control gear of the carriage drive, including emergency stopping mechanism and footage indicator, but excluding the automatic starting control, was completed and has been in satisfactory use during the year. The indicating towing dynamometer has also been used throughout the year, and the construction of the recording elements practically completed. A machine to facilitate analysis of the automatic records has been designed.

Urgent test work has prevented any very serious study of the characteristics of this equipment but some work has been done.

The basin was out of commission for about three months while the rails were being machined, levelled and aligned.

Engine Laboratory

(1) *Dynamometer laboratory.* This laboratory was practically completed during the year. The structural work done included the underpinning of one of the walls and provision of a small workshop. Certain additional equipment has been installed, including pyrometer, thermometers, gasoline storage tanks, air and gas systems.

The first official type test of an aircraft engine was made during the year and the equipment was found to function satisfactorily.

(2) *Detonation laboratory.* The installation of the single cylinder variable compression unit, and of a constant speed, high temperature unit was completed and after some adjustment and alterations, the units were placed in successful operation. These two units supplement each other in such a way as to enable a wide range of conditions to be covered. A good deal of routine test work has been done with this equipment (see following). Additional equipment for the testing of engine accessories, etc., such as spark plugs, and lubricating oils, has been provided.

(3) *Museum.* On the advice of the Associate Committee on Aeronautical Research, the upper floor of the engine laboratory building is being arranged as an aeronautical museum. In this, the Department of National Defence is heartily co-operating. The museum should, in the future, provide not only an interesting history of the development of aviation, particularly in Canada, but should serve a very useful purpose as a guide to designers, constructors and operators.

Instrument Laboratory

During the year under review, this laboratory, formerly a part of the Physical Testing Laboratory of the Department of the Interior, was moved to the John Street property and installed on the ground floor of the Annex Building.

To accomplish the moving, it was necessary to dismantle most of the equipment and this presented an opportunity to secure a re-design of some of its details. The experience gained during several years' operation of the laboratory at the old location has permitted full advantage being taken of this opportunity and the new layout is such as to permit maximum efficiency in operation.

For the testing of tachometers, a stroboscopic disk, driven by a variable speed motor, which also drives the tachometer under test, is illuminated by a flashing neon lamp. The period between flashes is controlled by an electrically maintained tuning fork. A variation in speed of two or three revolutions per minute at speeds up to 2,600 r.p.m. can be readily detected. Air speed indicators are checked against a Wright calibrator. A standard manometer is available for the standardizing of the Wright calibrator and for the test of open-scale manometers up to a maximum of 48 in. of water.

Aneroid barometers, altimeters, altigraphs and allied instruments are tested against cistern type mercury barometers of about one-inch bore. Various glass covered chambers and central supply pressure and vacuum systems with needle valve controls are available to meet all the various requirements of these tests.

Pressure gauges of low capacity are tested against mercury manometers and those of higher capacity up to a maximum of 200 lb. per square inch are tested against a dead weight calibrator.

A turntable, capable of various rates of turn, has been provided for the test of gyroscopic turn indicators.

All of the tests provided for can be carried out at the various temperatures likely to be encountered by the instruments when in actual use. For this purpose, a special refrigerator chamber has been installed having a clear space of 4 × 4 × 5 ft. available for test purposes. This chamber can be readily cooled to temperatures as low as −40° F. and easily maintained at the required temperature during test work.

Locomotive Research

This work was undertaken at the request of the Canadian National Railways. The primary object of the tests was to develop an improved external form for locomotives such that the smoke from the stack would be carried clear of the cab and would not tend to blow down and obscure the view of the engine crew, as happens with existing locomotives. As a secondary consideration, an attempt was to be made to reduce the air resistance of the locomotive for the sake of fuel economy on high-speed runs. The work was considerably accelerated by the construction and use of a drag balance of the subframe type for measuring directly the air resistance of the model

locomotive and tender. A dummy ground was suspended beneath the model and the effects of a large number of modifications of the model both on its air resistance and on the air flow around it were examined. The air flow was investigated by a number of silk streamers attached to the model at various critical positions.

As a result of the tests, a new external form has been developed for steam locomotives whereby the air flow, as exhibited by the streamers, is such that the smoke would be lifted clear of the upper surface of the locomotive and cab windows kept positively free from obstruction. The locomotive has 35% less air resistance than the original unmodified type and complies with statutory and operational requirements. Patents have been applied for covering the new form of locomotive. (J. J. Green.)

Windmill Research

For several years, Prof. A. R. Greig, at the University of Saskatchewan, has been operating an experimental windmill for the generation of electricity for farm use. His tests show that the windmill he has been using requires a relatively high wind to operate it and therefore a relatively large storage battery to carry the load during periods of little or no wind. At the request of Prof. Greig, and with the assistance of the National Research Council, the development of a more efficient windmill capable of operating in lower winds was undertaken in the aerodynamic laboratory of the University of Toronto. Considerable preliminary work was done at Toronto, but, owing to the resignation of the personnel of the Toronto laboratory, the research was suspended to await the completion of the National Research Council wind tunnel.

The work has now been taken up at Ottawa. All existing theory on windmills and airscrews has been reviewed and developed, so that it can be applied to the design of windmills. A model windmill based on theory has been designed and has been built in the workshop. This model will be tested in the wind tunnel to see how accurate the assumptions made in the theory are. If necessary, modifications will be made in the theory (such as the value of certain factors, etc.) until a reasonable basis for windmill design is developed. From this it should be possible to design a practical windmill of reasonably high efficiency but of simple construction so that its initial cost may be low. It is then hoped that a full-scale windmill may be constructed and sent to Prof. Greig to be tested in Saskatchewan. (G. J. Klein.)

Aircraft Skis

To balance the large aerodynamic pitching moments on skis attached to high performance aircraft, it is proposed to use a trimming leg in conjunction with an auxiliary stabilizing surface of aerofoil shape attached to the after end of the ski. Wind tunnel tests are required to determine the size and location of this aerodynamic balancing surface to minimize the loads on the trimming leg. (J. J. Green.)

Pressure Distribution over Tail Units of Aircraft

Information is required concerning the loads on the tail unit of Bellanca aircraft in level flight and manoeuvres and an investigation of the longitudinal and lateral stability of the aircraft is requested with a view to removing the existing instability. Complete drawings have been prepared for a one-eighth scale model of the aircraft which is now being made and arranged so that pressure distribution on the tail surfaces can be measured. The model will house in its fuselage an electric motor driving a scale model propeller for the purpose of giving correct slipstream effect. The steel propeller and the

wooden floats have been completed and work on the fuselage and wings is progressing. A great many researches have been planned which will require the use of this model. (J. J. Green.)

Aircraft Float Research

An extensive research was carried out on models of an aircraft float which had been found to behave badly on the water. The unmodified float was tested at three tracks differing from that normally used to see if that would effect a cure. No improvement was found and so four modifications of the shape were tried. One of these was sufficiently beneficial to the performance of the model and has been recommended for trial full scale.

A research is in progress to find an aircraft float suitable for a photographic aeroplane, which demands a wider track than normally used. Three commercial types are being tested and also models of a new design. (K. F. Tupper.)

Strength of Flat Rectangular Plates with Clamped Edges

A research has been undertaken to determine safe loads on flat plates, such as the plating on aircraft floats, ship bottoms and tanks. This is a matter of fundamental importance and of wide application. The method used consists in clamping the plate rigidly at its edges and applying hydrostatic pressure to one side. The deflection is measured to determine the elastic limit. Much difficulty has been found in securing the required rigidity of clamping. The plates being tested are of two shapes,—squares and rectangles having sides of 1 : 2 ratio. The ratio of plate thickness to short side varies from 1 : 125 to 1 : 500. (K. F. Tupper.)

Aircraft Engine Exhaust Tail Pipe

A short investigation of the influence on the exhaust back pressure of variation in design of the exhaust tail pipe was undertaken. The tests were made on a 300-h.p. radial air-cooled aircraft engine. As a result of the study, a new tail pipe was designed and tested, which considerably reduced the back pressure on the engine. While the resulting increase in power was negligible, there should be a considerable saving in expensive exhaust valves through the use of the new tail pipe. (M. S. Kuhring.)

Effect of Lowering the Air Intake of a Radial Air-cooled Aircraft Engine

A study was undertaken with the object of determining the effect on the power developed of lowering the carburetor air intake different distances below its normal position. As the intake is lowered, cooler air is drawn into the carburetor. By lowering the intake some $4\frac{1}{4}$ in. an additional 10 h.p. was developed in an engine of 300 nominal horsepower. (M. S. Kuhring.)

Effect of Humidity on the Operation of Internal Combustion Engines

There is considerable difference of opinion on the influence of moisture on the performance of gasoline motor cars and aircraft engines. An investigation has been commenced with the object of determining the effect of moisture, admitted to the cylinder in different ways and under different conditions, on the power developed, carbon formation, etc. (M. S. Kuhring.)

Formation of Gum in Gasoline

A study is being commenced of the factors influencing the formation of gum in gasoline in storage. (M. S. Kuhring.)

Tests Completed or in Progress

Aircraft windmill	Aircraft floats
Motor car models	Windmill
Mechanical transmission	Anemometer
Aircraft engine type test	Gasoline tests
Spark plug	Lubricating oils

Tests Made of Aircraft and Allied Instruments

	Government	Commercial	Total
Height instruments	21	5	26
Airspeed instruments	8	14	22
Tachometers	30	8	38
Directional instruments	18	3	21
Engine gauges	48	3	51
Barometers and barographs	75	—	75
Hygrographs	7	1	8
Manometer	—	1	1
	207	35	242

Inquiries

Sixty-three technical inquiries have been dealt with during the year, including the examination of 23 inventions.

Fire Hazard Laboratory

J. H. PARKIN, T. H. DOHERTY

On April 14 the fixed equipment of this laboratory, including four house-heating furnaces of Canadian manufacture and different types and capacities, heat dissipating equipment, flues, oil, electric and water services, was reported completely installed.

The literature and patents were studied, accessory apparatus and equipment were designed, constructed, or where available, were purchased, and in September the laboratory was placed in operation as a working unit.

Domestic oil burners of both the pressure type and natural draft vaporization type (gravity) are being tested for safe and proper operation. The first burner was placed under official test on September 26 and the first certificate of listing was issued on February 25, 1933.

This work is under the general direction of a small committee of the laboratory personnel, under the chairmanship of the President of the Council.

A general conference of representatives of interested organizations and officials was held in Ottawa on March 27 to discuss the general question of the testing and approval of equipment and materials involving a fire hazard, and to endeavor to clarify the complex and involved situation now existing.

Many requests are being received from manufacturers both in Canada and Great Britain for the testing of different kinds of equipment, such as hydrants, valves, sprinklers, extinguishers and safes. Consideration is being given to the provision of equipment and staff for testing of this kind to obviate the necessity of Canadian manufacturers having to secure approval of a foreign laboratory.

Instrument and Model Shops

J. H. PARKIN

The shops are engaged in the construction and modification of instruments, apparatus and equipment of a kind not available on the market, and which experience has demonstrated it is unsatisfactory to have made in out-

side shops. In addition, installation, repair and maintenance of equipment, both mechanical and electrical, and the construction of accurate scale models are done by the shop staff.

During the year the shop staff and equipment of the Physical Testing Laboratory of the Department of the Interior were transferred to the shops of the Council. A rearrangement of the shops has been effected to accommodate the additional tools and provide a better layout. An instrument shop for precision work and a stock-room and tool-crib have been provided.

During the year over 500 jobs were completed in the shop. Nevertheless, owing to shortage of staff, the shop has been unable to handle all requisitions promptly and researches have as a result frequently been unavoidably delayed through lack of equipment.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

For more detailed information regarding the work of the division the reader is referred to the annual report for 1931-32, pages 57 to 61. In the following report will be found only a brief statement regarding each of the principal activities of the division.

National Research Library

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

The library was moved in July, 1932, to the new building, in which there is accommodation for more than 400,000 books. In its new quarters the library has proved increasingly useful, although its growth has again been hampered by the need for economy.

During the year under review the number of loans made was 2,939 and the use of books and journals in the reading room increased correspondingly. The number of new books added to the library decreased from 2,551 to 816 owing to the restrictions placed on purchases. There were added 67 new periodical subscriptions, while five periodicals of little value have been dropped, bringing the present total of regular and irregular publications to 786. The number of volumes bound during the year was 751. Copies of 795 patent specifications have been obtained.

The resources of the library have been supplemented by loans from 23 libraries in Canada and seven in the United States. In addition, photostat copies have been obtained of many short articles in periodicals not available in Ottawa. In return, loans have been made to eight libraries and photostat copies of a number of articles have been supplied.

Co-operative arrangements with the Royal Society of Canada and the Library of Parliament have been continued throughout the year and are proving entirely satisfactory.

Research Information Service

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

The work of this branch has been continued throughout the year along the lines previously laid down, including searches of the literature on a wide variety of subjects, the preparation of reports and bibliographies, the answering of inquiries and the translation of many technical articles from foreign languages.

The following is a partial list of reports prepared in connection with current or proposed investigations of the National Research Council, or in response to inquiries from other Canadian research workers.

Abstract of a Report on the Permanence of Papers, Prepared by the League of Nations, by M. E. Whalley.
Combustion and Decomposition of Nitrocellulose Films, by R. Ruedy.
The Effect of Using Aluminium Cooking Utensils on Food, by M. E. Whalley.
Fowl Paralysis, by M. E. Whalley.
Frosting of Electric Lamp Bulbs, by A. C. Halferdahl.
Fuel Oil as an Antifreeze, by C. A. MacConkey.
Glyoxal, by C. A. MacConkey.
Health Hazards in the Aluminium Industry, by A. C. Halferdahl.
Manufacture of Matches (a list of references), by R. Ruedy.
Mastitis in Cows, by M. E. Whalley.
Nature of Watery Whites in Eggs, by M. E. Whalley.
On the Sterilization of Fabrics, by R. Ruedy.
The Preparation of Transparent Metal Films, by R. Ruedy.
Problem of Helium Production in Canada, by R. Ruedy.
Production of Yeast from Waste Sulphite Liquor, by M. E. Whalley.
Recent Work on Frequency Regulation in Power Systems, by R. Ruedy.
Reduction of Iron Oxides by Natural Gas, by A. C. Halferdahl.
Removal of Iron and Magnetite from Asbestos, by A. C. Halferdahl.
Review of Literature on Magnesite for 1931, by A. C. Halferdahl.
The Separation of Gases by Centrifugal Methods, by R. Ruedy.
Simple Methods for the Detection and Measurement of Alpha and Gamma Rays, by R. Ruedy.
Soluble Starch, by C. A. MacConkey.
The Spahlinger Vaccines, by M. E. Whalley.
The Spontaneous Combustion of Hay, by R. Ruedy.
Sulphurized Asphalt and Inhibitors in Pickling Baths, by C. A. MacConkey.
Summaries of Recent Papers on B.C.G., by M. E. Whalley.
Titaniferous Ores and Processes, by A. C. Halferdahl.
Utilization of Wastes from Potato-starch Factories, by M. E. Whalley.
The Vapor Pressure of Dissolved Benzene in Wash-oils (Absorbent Oils), by R. Ruedy.
Virus Diseases, by M. E. Whalley.

Publications

W. W. Thomson, J. Stanley, Miss D. DesBarres

The following publications have been issued during the year:—

Canadian Journal of Research (12 issues, two volumes)	1,319 pages
Fifteenth Annual Report of the National Research Council	169 pages
Report No. 25, The Drying of Wheat (Second Report)	104 pages
Report No. 26, Weed Survey of the Prairie Provinces	34 pages
Report No. 27, Weeds and Their Control	15 pages

At the close of the year one additional technical report was in press. Further, various publications are being issued by the Division of Research Information for the Fifth Pacific Science Congress. References to these will be found on page 100 of this report.

The Canadian Journal of Research serves as a medium for the publication of results of research work done under the auspices of the Council or

obtained by any Canadian investigator. The 12 monthly issues contained a total of 120 papers, 45 of which dealt with biology and agriculture, 54 with chemistry, 20 with physics, and one with geology. Thirty-two papers were written by members of the staff, 40 by investigators who received financial assistance from the Council, and 47 by other Canadian workers.

Editorial work has also been done on a large number of reports prepared in other branches of the Council's work and issued in typewritten or mimeographed form.

Outside Research Activities

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

Members of the staff have again given assistance in connection with the activities of research committees, necessitating considerable work outside of Ottawa. One of the largest of these tasks has been in connection with preparations for the Fifth Pacific Science Congress, a more complete statement regarding which appears elsewhere in this report. In addition a large number of miscellaneous tasks have been undertaken in connection with other activities of the Council. These are reported elsewhere.

SUMMARY OF ACTIVITIES OF ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

Co-operating organization:

Department of National Defence

In the absence of matters requiring the urgent attention of the committee and in view of the general financial outlook no meeting has been convened during the past year.

A number of suggestions and recommendations which were advanced at the last meeting of the committee have been acted upon and adopted. These, including the establishment of an aeronautical museum, the calibration of an anemometer for the Dominion Meteorological Service and an arrangement whereby officers of the Royal Canadian Air Force are sent to the aeronautical laboratories for periods of duty, have been dealt with under the report of the Aeronautics Branch, on page 48.

Associate Committee on Agriculture

Co-operating organizations:

Canadian Society of Technical Agriculturists
Federal 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

On consideration of the many requests which were being received by the National Research Council for assistance in connection with research work on problems in the field of agriculture, and in view of the fact that this work was scattered over a wide area in Canada and was in many cases being carried on by comparatively isolated individuals or groups without easy contacts with one another, the Council decided to establish an Associate Committee on Agriculture with the object of co-ordinating and stimulating work in this field.

While there are some scientific research workers who have their own problems at which they wish to work independently, and this type of worker ought to be encouraged, there are many large problems which require the co-operation of a group of investigators, sometimes trained in several different departments of science, in order to make possible the successful solution of the problem.

It was apparent to the Research Council that on the prairies there are three great provinces with problems which are so much alike that it is easy to find common ground. In the maritime provinces, however, the problems are different. The agricultural problems in the province of Ontario and Quebec are to some extent common to both provinces, but British Columbia stands to a considerable extent by itself in this field. Consequently, when

considering the problems of agriculture in Canada, there are four distinct divisions imposed by geographical location and distance: the central east; the central west; the maritimes; British Columbia. It was the purpose of the National Research Council therefore in appointing an Associate Committee on Agriculture to have a committee representative of all sections of the country, in order that it might advise the Council as to the special problems in each of the four major divisions referred to above. The Council, consequently, appointed as members of the committee the deans of each of the agricultural colleges in Canada, the Chairman of the Research Committee of the Canadian Society of Technical Agriculturists, and three representatives of the Federal Department of Agriculture.

There is no wish on the part of the Council to control in any way research work which is being carried on in the agricultural colleges, nor to curtail its own assistance to such work. On the contrary, it is to encourage and expand this work in so far as may be feasible, and to help men who are capable of undertaking research, in order that the efficiency of the research machinery existing in these institutions may be increased, if possible. The Council is, however, convinced that the committee can be of very considerable service in the co-ordination of such work and in the prevention of unnecessary duplication of expense and effort. It is felt that the committee can present a picture of the agricultural problems of Canada as a whole and can aid both the Council and the agricultural research organizations of Canada in the reviewing and co-ordination of research programs in this field, in avoiding duplication, and in stimulating interest in the local centres where such work is carried on.

The first meeting of the committee was held early in the year under review. At this meeting the previous work of importance to agriculture either done or assisted by the National Research Council was briefly reviewed. This included work carried on through associate committees, under grants in aid of research, and by the staff of the National Research Laboratories. The projected research program of the Division of Biology and Agriculture was also submitted for discussion and constructive criticism, and other proposals for increasing the usefulness of the National Research Laboratories to agriculture or for improving co-operation with other institutions were discussed. General discussion also took place regarding the organization of the committee and the manner in which it might function most effectively.

A second meeting of the committee was held in the fall of the year under review. During the course of this meeting the committee met in joint session with an agricultural conference called by the Canadian Chamber of Commerce, at which questions of common interest were discussed.

Further constructive criticism and suggestions were invited and received in connection with the tentative research program of the Division of Biology and Agriculture, and the general relation of the work of the Council in the field of agricultural research to work carried on under the auspices of various agricultural colleges was discussed. Attention was called to the fact that it is the policy of the Research Council to aid in the stimulation of research work in this field in every feasible way and that opportunities are available for assisting other institutions by providing laboratory facilities and technical advice to workers who wish to pursue their problems for a time in the National Research Laboratories at Ottawa, by carrying out special investigations or parts of investigations, on request, and by maintaining a statistical section available for consultation in regard to the planning of experiments and the methods of analyzing results.

A report on the research activities of the Canadian Society of Technical Agriculturists was presented and discussed by the committee and a formal

resolution was passed commending very highly the work of the C.S.T.A. in compiling valuable information regarding the nature, scope, and present status of agricultural research work in progress in Canada.

Various members of the committee submitted for discussion important regional or other research problems in the field of agriculture which had come to their attention and which they considered of sufficient importance to be added to the research program.

This committee serves in an advisory capacity to the National Research Council and in this respect differs from the committees which are directing active research work in their field.

Associate Committee on Animal Diseases

Co-operating organizations:

Federal Department of Agriculture
Macdonald College
Oka Agricultural Institute
University of British Columbia

In the interests of economy no meeting has been held during the fiscal year 1932-33. Certain of the investigations being carried out with financial support from the committee have nevertheless been continued.

As anticipated in the last annual report, there has been founded during the year at Macdonald College, Que., an Institute of Parasitology, and all the work of the committee on animal parasites has now been transferred to this Institute.

The standardization of the agglutination test for bacillary white diarrhoea of poultry has been before a subcommittee under the chairmanship of Dr. E. A. Watson of the Federal Department of Agriculture. This work has now been practically completed and it is expected that a final report will be submitted at the next meeting of the committee.

At the last meeting there was appointed a subcommittee, consisting of Dr. Tory, Dr. Harris and Dr. Klotz, to study the question of research on virus diseases and to recommend what action, if any, should be taken by the committee in regard to this problem. A review of the literature and a survey of the work going on in Canada were first made by the Council's Division of Research Information, and a report was prepared covering the findings. After a study of this report by members of the committee, a meeting was held and it was agreed that while it is not possible to recommend any investigation at the present time, the situation should be watched closely and an effort should be made to secure, if possible, first-hand information regarding research under way on virus diseases in both Great Britain and the United States.

During the year a review of the literature has been prepared by the Division of Research Information on the subject of mastitis in cattle, on which research has been under way for some years at the Oka Agricultural Institute. This investigation is now being carried on at the Institute without further financial support by the committee.

Research on Poultry Paralysis at the University of British Columbia

The committee has continued, during the great part of the year under review, financial assistance to an investigation of poultry paralysis at the

University of British Columbia. This disease, regarding the fundamental nature of which little is yet known, is causing serious losses to flocks throughout Canada, particularly in British Columbia.

Considerable attention has been given to a study of the possible inheritance of resistance to fowl paralysis. The evidence obtained, while not conclusive, indicates a marked difference in susceptibility in different families of birds, and possibly also a variation in resistance in different varieties. This is of special interest in view of the possibility of breeding strains resistant to paralysis. The relation of lymphomatous tumors to poultry paralysis has been studied but no close correlation between them has been observed. An effort has also been made to effect artificial inoculation of birds with poultry paralysis, but owing to the uncertainty connected with the question of susceptibility and resistance, it has been impossible to interpret quantitatively the results obtained. Fowl paralysis has been found to develop in chicks at an age as early as 37 days.

A number of scientific papers have been published giving detailed results of this investigation, including the following:—

Biely, J., Palmer, E. and Asmundson, V. S. Inheritance of Resistance to Fowl Paralysis. II. On a Significant Difference in the Incidence of Fowl Paralysis in two Groups of Chicks. Can. J. Research, 6 : 374-380. 1932.

Biely, J. and Palmer, V. E. Observations on the Gonads of Male Birds Affected with Fowl Paralysis. Can. J. Research, 7 : 293-299. 1932.

Biely, J., Palmer, V. E. and Lerner, M. Fowl Paralysis in Chicks under three Months of Age. Can. J. Research, 8 : 305-311. 1933.

(Investigation under the direction of Dr. H. W. Hill.)

Associate Committee on Asbestos

Co-operating organizations:

Canadian asbestos producers and manufacturers
Federal Department of Mines
Quebec Bureau of Mines
Quebec Committee on Asbestos Standardization

Throughout the year the committee has been active in the various projects before it, including the standardization of the Quebec testing machine, the conditioning of asbestos previous to test, the development of new uses for asbestos, and the utilization of asbestos tailings. The necessity for research has increased rather than decreased during the year, as the depression has lessened the demand for asbestos, and the competition from sources outside Canada has been increasingly severe. Asbestos research in the National Research Laboratories has been pressed as much as has been possible with the rather limited facilities available. This work is described under the report of the Division of Chemistry, page 29.

Since the last report was issued the fifth and sixth meetings of the committee have been held, the former in Montreal on August 23, 1932, and the latter in Sherbrooke on January 5, 1933. In the unavoidable absence of Dr. Tory, chairman of the committee, the chair was taken at these meetings by Mr. F. E. Lathe and Dr. G. S. Whitby, respectively.

The committee has given special consideration to the standardization of the Quebec testing machine, as this project is regarded by the industrialists on the committee as that of most immediate concern. In the past there have been frequent disagreements between seller and purchaser due to differences in the tests obtained and the standardization of that test is therefore of the

greatest importance. Gratifying progress has been made, largely through the activities of a special subcommittee, and complete agreement has now been reached regarding all details of the testing machine, including the screen cloth to be used and the tolerances to be permitted. Through the use of blueprints, obtained as a result of the committee's work, it will now be possible for producer and consumer to secure machines identical in every respect.

It is recognized that the condition of asbestos samples in regard to their moisture content, the pressure to which they have been subjected, and other factors, may have an important bearing upon the results obtained in tests, even with a standard machine. These matters are therefore receiving careful study in the National Research Laboratories.

Other projects discussed by the committee, and which are receiving attention in the laboratories at Ottawa, are the use of asbestos in asphalt pavements and road tars, the use of ground tailings as a mineral filler in asphalt pavements, the development of products containing Portland and oxychloride cements and asbestos, plastics containing asbestos, and the utilization of tailings for the production of active silica and magnesium salts. Details of these investigations will be found in the report of the Division of Chemistry.

A report on iron in asbestos has been prepared for the committee by Mr. A. C. Halferdahl of the Division of Research Information. It does not appear, however, that there is any cheap and satisfactory method of reducing appreciably the iron content of asbestos.

Associate Committee on Chemical Standards

Interest in the subject of standardization was stimulated as a result of the general discussion on this subject at the Imperial Economic Conference held in Ottawa in 1932. At that time Mr. leMaistre of the British Standards Institution visited Canada in the course of an Empire tour designed to promote co-operation in the field of standards throughout the Empire. He explained that the British Standards Institution had been organized in four main divisions, namely; chemicals, textiles, building materials and engineering. He urged that consideration be given to the establishment in Canada of similar facilities for the development of Canadian standards in these fields.

Later at a meeting of the National Research Council the need of establishing an Associate Committee on Chemical Standards was considered. The Council first appointed a Special Committee on Chemical Standards to investigate and report back on the desirability of creating a permanent organization to deal with this subject and to indicate the nature and extent of any work of this kind that, in their opinion, should be undertaken.

Consideration was given by this committee to the development of standards in Canada. It was observed that several departments of the government were charged with the administration of acts which necessitated the establishment of standards, and that the practice had grown up of fixing standards for commodities by legislation. When this was done it was very difficult, as need arose, to modify the standards established. As recommended by the Imperial Conference, the committee thought it would be advisable to confine legislation to general principles and merely refer to established standards, which might be changed as found necessary by changing conditions.

The purpose of chemical standards, in the opinion of the committee, was to set up reasonable commercial specifications that would be acceptable as working guides in industrial plants. Such commercial standards would be quite distinct from fundamental standards. In the United Kingdom, it was observed, the British Standards Institution had established a number of committees to study and report on specific fields of work, and the recommendations of these committees, when approved by the British Standards Institution, become known as national standards.

British and United States standards were available for many chemical products made in Canada, but it was thought Canadian standards should be established in a much wider field than at present, although in many cases after study it might be found that either the British or American practice would be applicable to Canada and might be adopted as the Canadian standard. If a central organization were set up, Canadian manufacturers could present their views and the interested government departments could also be heard, so that an impartial decision might be obtained.

At the conclusion of the discussion the committee recommended to the National Research Council that an Associate Committee on Chemical Standards be established, that the personnel of the associate committee be the same as the personnel of the Special Committee on Chemical Standards, that provision be made for the establishment of subcommittees to study specific problems and to make recommendations to the main committee, and that on these subcommittees representation be given to the industries concerned. At a later meeting of the National Research Council, an Associate Committee on Chemical Standards was appointed, as recommended.

One of the first tasks to be undertaken by the associate committee will be to assemble data on chemical specifications in general use in this country. To this end the committee proposes to send a letter to each of the leading representatives of the chemical industry in Canada, asking for a list of the commodities produced or purchased according to chemical specifications, the source of the specifications used and an expression of opinion as to the products for which it would be desirable to develop national standards. It is not the intention of the committee to recommend the establishment of compulsory standards; in this work in Canada, as in Great Britain, the plan is co-operative and the wish of the committee is to indicate, as national standards, only those specifications or requirements that meet with general approval throughout the trade. It is thought that the adoption of national standards of this kind will do much to simplify practice and to improve the specifications used in the manufacture and sale of materials in which chemical composition is significant in the establishment of quality or grade.

Associate Committee of Chemists

The fifteenth meeting of the Associate Committee of Chemists was held in Hamilton on May 31, 1932, with 17 persons in attendance, including Dr. W. F. Geddes, Dr. D. U. Hill and Dr. R. K. Stratford as new members.

Consideration was given to the various questions which had arisen at the previous meeting of the committee, and changes in the industrial chemical situation were noted.

The committee received a report from a subcommittee appointed at the previous meeting to consider how the usefulness of the committee could be extended. It was recommended that the committee should pay increasing attention to industrial developments bearing on Canadian problems, to a survey of Canadian chemical industries, to chemical standardization and to

problems which might be made the subject of investigations in the National Research Laboratories. Dr. Whitby, chairman of the committee, expressed his desire to carry out as fully as possible the wishes of the members in regard to the committee's activities.

Mr. S. J. Cook informed the committee that a report on "Chemicals and Allied Products in Canada, 1928-1930" had been issued by the Dominion Bureau of Statistics and that a "Directory of Chemical Industries in Canada" was in preparation. These reports, prepared largely on the recommendation of the committee, were commended as being very useful compilations.

Dr. Whitby called attention to a considerable number of reports being prepared by the Council's Division of Research Information. A large proportion of these reports deal with chemical subjects and all of them can be made available to members of the committee.

The committee discussed at some length the question of chemical standardization and reviewed such standardizing activities involving chemistry as are now being practiced in Canada. There was finally appointed a subcommittee consisting of Messrs. Whitby, Lathe and Cook to consider the present status of chemical standardization in Canada and the interprovincial relations in this field.

A subcommittee consisting of Messrs. Lathe, Tomlinson and Matheson was appointed to investigate and report on the possibility of replacing imported sulphur by domestic supplies. This question the committee regarded as of some importance in view of the fact that considerable quantities of sulphur are imported by Canadian industries while several possible sources of sulphur already exist in this country.

The chairman briefly reviewed work being carried on in the Division of Chemistry in the National Research Laboratories on asbestos, battery separators, effect of electrolysis on germination and yield of wheat, Alberta bitumen, leather, straw, alkaloids, honey, maple syrup, magnesian products, corrosion by gasoline, laundering, apple utilization, weed seeds, carbon black, pyrolysis of natural gas, wool, colloids and synthetic rubber.

There had previously been distributed to members of the committee a report on Agricultural Surpluses and Wastes, prepared by Mr. S. J. Cook. Mr. Cook's recommendations were considered at some length and members of the committee were invited to submit in writing their comments and suggestions on specific questions raised in the report.

When a report of this meeting of the Associate Committee of Chemists was submitted to the National Research Council consideration was immediately given to the question of chemical standards and it was decided that the Council should proceed to organize this work in Canada. Additional details are given in this report on page 61.

As a first step in the study of the sulphur problem in Canada a report on the recovery of sulphur has been prepared by Mr. A. C. Halferdahl of the Division of Research Information. This document is being studied by the subcommittee appointed for the purpose and it is anticipated that a report will be prepared for the next meeting of the associate committee.

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
Federal Department of Mines

The Associate Committee on Coal Classification and Analysis, working in close co-operation with the American committee, has continued its laboratory researches on those phases of coal composition and testing which are most closely related to the classification of coal. Definite progress towards the adoption of a system of coal classification may now be recorded.

In October, 1932, a meeting of the American Subcommittee on Tentative Classification of Coals was held in Washington and this subcommittee reported a few days later at Atlantic City to the American Committee on Scientific Classification. Prof. E. Stansfield is a member of both of these committees, but in his absence the Canadian group was represented by Mr. F. E. Lathe, secretary of the associate committee. At these meetings substantial agreement was reached on important questions, including the status of weathered coals, the condition in regard to moisture of coals being tested, and the calculation of pure coal material. Tentative main groups and classes of coals were agreed upon and the boundary lines between these groups and classes were indicated. The proposed classification will be given careful consideration by the general committees and further tests will be carried out before a definite scheme of classification is adopted.

This year, for the first time, the associate committee met in two sections. Taking advantage of the presence in western Canada of several members of the committee, a meeting of the western section was held in Edmonton on January 18, 1933, followed by a meeting of the eastern section a month later.

In the absence of Dr. Tory and Dr. Camsell, joint chairmen of the committee, the chair at the Edmonton meeting was taken by Dr. R. C. Wallace. Mr. J. McLeish presented a report prepared by Dr. B. R. MacKay, chairman of the Subcommittee on Origin, Constitution, Location and Occurrence of Coal. This report reviewed the coal investigations of the Geological Survey in Nova Scotia, Alberta and British Columbia and microscopic work carried out for the purpose of determining the constitution of certain Nova Scotia coals. A special study has been made of the deposits at Michel, where there is an exceptionally complete series of coals of Lower Cretaceous age, there being 11 commercial seams in a thickness of 1,600 feet. A part of this work has been carried out for other purposes than those of the committee.

A resolution drawn up by Dr. J. A. Allan urging that the microscopic work of the Geological Survey be continued with the most qualified man obtainable was unanimously passed by the meeting.

Messrs. Lang and Gilbart reported on the work of Prof. Stansfield, who was absent on account of illness. These reports covered analyses made in connection with the chemical survey of coal in Alberta, methods of drying preliminary to analysis, the conditioning of coals in a standard atmosphere, and friability experiments.

Mr. Gilbart also reported for Prof. Stansfield as chairman of the Subcommittee on the Applicability of the Proposed Scientific Classification Schemes to Canadian Coals. They had determined how most of the important Alberta coals would fit into the proposed classification scheme of the American committee.

At the February meeting, held in Ottawa, Mr. R. E. Gilmore reported as chairman of the Subcommittee on Sampling, Analysis and General Uses of Coal. He described in particular tests made under his direction by the Fuel Research Laboratories on the agglutination and agglomeration of coals. By the use of electrode carbon and various percentages of dextrin he had endeavored to set up standards on agglomeration which could be duplicated by other laboratories.

The committee discussed briefly the question of Ontario lignite, upon which Mr. C. Tasker presented a verbal report covering his experiments at the Ontario Research Foundation. Much interest was shown in the results obtained.

Dr. MacKay presented a report supplementing that submitted in Edmonton and including charts showing the structure of the areas in which chemical surveys had been made.

Prof. Stansfield described his experiments on the accelerated weathering and oxidation of coal. In laboratory work for the Alberta Research Council he had paid special attention to the boundaries between the main groups of coal, as suggested by the American committee. He had found marked variations in the results of weathering with differences in the humidity of the air in which the samples were dried. He presented suggestions for standardizing the test by carrying it out in a narrow range of humidity. The committee discussed in detail Prof. Stansfield's work and urged that it be continued.

Mr. J. H. H. Nicolls presented an arrangement of Canadian and foreign coals illustrating how they would be classified according to the tentative scheme proposed. Such studies were necessary in order to determine the practical value of any system of classification.

Messrs. Gilmore, Stansfield and Lathe were sent by the committee to New York in February, 1933, to attend the annual meeting of the American Institute of Mining and Metallurgical Engineers, at which sessions were devoted to coal classification, and also meetings of the American Sectional Committee held at that time. At these meetings further consideration was given to the tentative classification previously proposed. A special committee was appointed to study the boundaries between groups and also a committee on nomenclature, which is regarded as important in that certain names tend to suggest definite boundaries. There is Canadian representation upon both of these committees.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association operates as an associate committee of the National Research Council, from which it receives about half of its funds. Contributions from manufacturers total about an equal amount. In 1932 subscriptions were received from 67 firms.

The main committee of the association is now composed of 54 members, of which five are representatives of the National Research Council. The total membership of all committees of the C.E.S.A. as at March 31, 1933, was 639.

The primary object of the committee's work is to set up standards for the guidance of Canadian industry. These standards, the observance of which is purely voluntary, are nevertheless being widely adopted by provincial and municipal governments and industrial firms throughout the Dominion. In the establishment of standards, manufacturers and consumers are called together in conference and jointly agree upon such standards as are believed to represent the best practice in the particular industry concerned. Usually the recommendations of the committee include a very great reduction in the number of sizes manufactured. By confining themselves to these sizes, manufacturers are able to reduce production costs, middlemen to reduce stocks and increase turnover, and consumers to purchase standard goods at lower prices.

New Publications

B 24–1932 (November 1932)—Established Lists of Machine Screws and Square and Hexagon Machine Screw Nuts. (Second edition).

B 33–1932 (August 1932)—Established Lists of Cap Screws (Hexagon, Flat, Oval Fillister, and Button Heads); Set Screws and Studs; Common and Semi-finished, Slotted and Castellated Hexagon Nuts.

B 37–1932 (August 1932)—Standard Blade Punching for Road Grading Machinery.

Under Part II of the Canadian Electrical Code, approval specifications as follows:—

C 22.22 No. 0–1932 (December 1932)—Definitions and General Requirements.

C 22.2 No. 2-1933 (January 1933)—Construction and Test of Electric Signs.

C 22.2 No. 3–1933 (February 1933)—Construction and Test of Electrical Equipment for Oil-burning Apparatus.

Civil Engineering and Construction

Building Materials. The panel dealing with brick sizes held an organization meeting on January 17, 1933, and a small sub-panel was appointed to prepare a questionnaire to be sent out to architects, contractors, engineers, brick manufacturers, and different government departments of public works, boards of education, and city architects or engineers, with the idea of obtaining first-hand information on the sizes of brick now being manufactured and used and to ascertain the reaction to the adoption of a standard size for Canada. When all replies are in, a special report will be prepared and submitted by the panel to the Committee on Building Materials.

Mechanical Engineering

Screw Products. Two standards have been published during the year, as noted above. The standard for machine, carriage and plough bolts has been held up owing to proposed changes in manufacturing practice, but data for heavy bolts and nuts as used by the railways have been incorporated. Panels to discuss standards for wood screws and small rivets have been appointed.

Bar Size Tolerances for Bolts. Preliminary information on these tolerances has been prepared and is under consideration by the panel.

Blade Punching or Road Grading Machinery. This standard has now been published.

Elevator Safety Code. A committee has been organized to discuss the preparation of a Canadian safety code for passenger and freight elevators, and the committee held its first meeting on January 17. A preliminary draft has been sent out for comment.

Electrical Work

Canadian Electrical Code, Part I. A Special Committee on Code Revisions, preparing material for the third edition of the code, has been continuing operations. The code was adopted by the province of Prince Edward Island on April 13, and a Provincial Code Committee has been organized in that province. The province of Manitoba officially adopted the code on September 7, 1932, so that the code is now officially adopted in the nine provinces of Canada.

Work on Part II of the Canadian Electrical Code, which covers essential requirements and minimum standards for electrical equipment, has been very active, particularly as the Underwriters' Laboratories of Chicago have practically withdrawn from the Canadian field, an announcement having been made that this would take effect on January 1, 1933. It is therefore required to prepare the necessary approval specifications under which testing and approval may be carried on by the testing laboratory. The C.E.S.A. Panel on Specifications has held numerous meetings. In April, 1932, meetings were held to discuss specifications for service entrance and branch circuit breakers, and electric clocks. In November, 1932, the panel discussed specifications for portable electric displays and incandescent lamp signs, capacitors (electrical condensers), electric fixtures, and electric floor surfacing and cleaning machines, and in March, 1933, specifications for electrical equipment used in hazardous locations, fractional horsepower motors, and a second draft for capacitors. Twenty-two specifications in all are being considered, of which three have been published.

Work on Part III of the Canadian Electrical Code, covering outside wiring rules, has been mainly confined to inductive co-ordination, and a preliminary draft of definitions and principles has been sent out to the panel for approval.

Electricity Meters. The revised draft specification for a.c. watthour meters and a new specification for demand meters have been considered, and meetings of the committee were held in April, 1932, to discuss these drafts. Revised drafts will be sent out to the committee for final approval.

Insulated Power Cable. The report on lead-covered paper-insulated cable is still under discussion and it has not yet been possible to proceed with the other types.

Enameled Magnet Wire. It is proposed to consider standards for this material and a committee will be appointed shortly.

Oil Circuit-breakers. A committee has been formed to consider tests covering the rupturing capacity of oil circuit-breakers and preliminary meetings were held in October 1932, and February, 1933.

Ferrous Metals

Heavy Steel Shaft Forgings. The committee which has been organized has not been able to hold a meeting as yet, but it is planned to take this matter up actively in the near future.

Imperial Economic Conference

Mr. C. leMaistre, Director of the British Standards Institution, was present at a meeting of the Main Committee of the Association which was held at Ottawa on April 25, 1932, and gave an account of his visit to the other standardizing bodies in the different dominions. He discussed also the proposed economic conference to be held in Ottawa during the summer.

The Imperial Economic Conference was duly held in July, 1932, and the Association was represented on the Subcommittee on Standardization by the secretary. As a result it was decided to encourage closer co-operation among the dominion standardizing bodies, and in accordance with this, the chairmen of the different sectional committees of the C.E.S.A. are now comparing Canadian and the corresponding British specifications, with the idea of securing harmony if possible. In the meantime, draft specifications pre-

pared by the Association are freely interchanged with the British Standards Institution, and close contact is also kept with the Standards Association of Australia, the South African Branch of the B.S.I., and the New Zealand Standards Institution. A full report of the Conference appeared in the C.E.S.A. Bulletin for September 30, 1932.

Sale of Publications

The sale of publications has kept up well during the year, and the demand for specifications issued by the British Standards Institution has also been quite active.

Associate Committee on Field Crop Diseases

(Western Section)

Co-operating organizations:

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

The object of this committee is to secure effective collaboration between the various departments and institutions interested in promoting the warfare against plant disease enemies, the ravages of which both increase the cost of crop production and reduce the quality of the product. The scope of the committee's activities covers surveys of the prevalence of and injury caused by various diseases, the life history of the causal organisms, and the best means of combatting them, whether by special treatments of soil or seed, or by resistant varieties produced by plant breeding.

At the fifth meeting of the Associate Committee on Field Crop Diseases, held in the Dominion Rust Laboratory, Winnipeg, April 5 to 7, 1933, each of the subcommittees reviewed the progress on the various projects under investigation and outlined the direction in which future research should proceed. All were of the opinion that the present division of work among the laboratories in the prairie provinces was very satisfactory.

The Plant Disease Survey Subcommittee suggested that more attention be given to collecting and reporting saprophytic as well as parasitic fungi, that a more intensive survey of the distribution of "browning root rot" of cereals be made in Manitoba and Alberta, and that the report contain meteorological data from the districts covered by the survey.

The Rust Subcommittee approved of further field survey work and the continuation of slide exposures. Meteorological surveys of small areas to determine more precisely the effect of weather factors on rust development and the exact relation of temperature and moisture conditions to infection in nature were considered desirable. The advisability of obtaining data on periods of dew formation and on the germinability of early arriving wind-blown spores was stressed.

The Subcommittee on Foot and Root Rots was concerned largely with consideration of practical measures of recording the degree of infection. Real progress has been made during the past year in regard to this. The effect of fertilizers, particularly phosphates, on foot and root rots was discussed. It was agreed that experimental work along this line should be continued and that soil chemists be asked to collaborate with the committee in this matter.

The most important of the activities of the Subcommittee on Plant Breeding during 1932 was the operation of a co-operative variety test of all promising varieties at 12 different points in the west. The varieties were compared with each other and also with a set of standard varieties. In addition to the agronomic data, comprehensive milling and baking data were obtained through the co-operation of the Associate Committee on Grain Research.

For 1933 the subcommittee recommended: (1) testing all varieties at all stations; (2) adding to the existing 12 stations one at Fallis, Alberta, on gray wooded soil where wheat protein is usually low; (3) using Marquis, Reward, Ceres and Huron as check varieties; (4) making cytological studies on new varieties; (5) attempting to evaluate threshing characters, shattering and seed appearance at more stations than in the past year.

The Subcommittee on Plant Breeding now feels safe in saying that varieties of wheat highly resistant to disease and very satisfactory from the standpoint of quality and agronomic behavior have been produced.

The Canadian Plant Disease Survey for 1932

The twelfth report of the Canadian plant disease survey was tabled at the opening session of the Subcommittee on Field Crop Diseases.

Stem rust, according to the report, caused less than 2% damage to wheat in the Red River valley. In the remainder of Manitoba, damage was very slight. In Saskatchewan no damage was observed except in a few late fields in the east and southeast. Only late fields of oats were seriously rusted and damage was slight. In Ontario, crown rust was destructive to oats between Merrickville and Burritt's Rapids on both sides of the Rideau river.

Smut diseases were much less prevalent in 1932 in the west than a few years ago. The average infection for all fields in the three prairie provinces was less than 1%.

Foot rots appeared to be about as prevalent as in 1931. Take-all was found in 33% of the fields examined in Alberta, 18% in Saskatchewan and none in Manitoba. Foot rot attributed to *Helminthosporium sativum* and *Fusarium* spp. was observed in 49% of the fields in Alberta, 96% in Saskatchewan and 87% in Manitoba. Damage ranged from a trace to slight. Browning root rot was reported from one field in Alberta and 10% of the fields examined in Saskatchewan.

There was a considerable increase in the number of fields of potatoes rejected by the Dominion Potato Inspection Service over the previous year.

Many diseases of bulbs and ornamentals new to Canada are being reported each year, chiefly from British Columbia.

(Survey compiled by I. L. Conners, Central Experimental Farm, Ottawa.)

Research in Alberta

1. *Dominion Laboratory of Plant Pathology, Edmonton*

Studies of foot and root rots of cereals were concerned with the fungi *Helminthosporium sativum*, *Fusarium* spp., *Ophiobolus graminis* and *Wojnowicia graminis*. In tests with the first three of these no satisfactory evidence of any resistance was found in 140 varieties and strains of wheat. Of 36 isolates of *Wojnowicia graminis* tested none was found to be parasitic. In pathogenicity studies on *Helminthosporium sativum* and *Fusarium* spp. the

virulence was found to range from zero in some strains, to a degree equivalent to that of the most pathogenic of *Ophiobolus graminis* strains in others. A greater number of strains of *Helminthosporium sativum* than of *Fusarium* spp. were very virulent on wheat. Saprophytic strains of *Fusarium* were more common than pathogenic types.

Results obtained during the past five years indicate that environmental factors have greater effect than variety of crop on the prevalence of either *Fusarium* spp. or *Helminthosporium sativum*.

The effect of fertilizers on the development of "take-all" disease of wheat was studied. While the results obtained were conflicting, there were indications that nitrate fertilizers favored development of the fungus.

Studies on the pentosans of wheat in relation to root rot do not suggest that greater susceptibility is associated with increased pentosan content in so far as *Ophiobolus graminis* is concerned.

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

2. *University of Alberta*

Six different projects were carried out on the saprophytism of cereal foot-rotting fungi. The fungi used were *Helminthosporium sativum*, *Ophiobolus graminis* and *Fusarium graminearum*. When cultures of these were placed in soil, marked decrease in all except *Fusarium graminearum* occurred after two weeks in bare unsterilized soil. All were found highly resistant to desiccation. The greatest sporulation of *Helminthosporium sativum* and *Fusarium graminearum* took place at a temperature of 25° C. No change in pathogenicity of either fungus was found after prolonged growth in soil.

Tests on the influence of products of *Ophiobolus graminis* on wheat seedlings gave no evidence that toxins are produced.

Studies on the relation of Alberta grasses to the foot-rot problem of wheat indicated that in both sterilized and unsterilized soil wheat following grasses showed significantly heavier infection with *Ophiobolus graminis* than wheat grown on soil that had been unplanted the previous year, suggesting that grasses encouraged the survival and multiplication of the causal fungus.

In experiments on covered smut of oats it was found that the bulk of the inoculum producing infection was not lodged under the pericarp or in the interior of the grain.

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

In 1932, 119 spring wheat varieties and hybrid strains with Marquis checks were tested at the University of Alberta for reaction to bunt. Tests were also made on 88 varieties of winter wheat, in addition to 140 varieties and strains of wheat for other investigators. Four bunt-resistant hybrid selections of superior yielding ability and other desirable agronomic characters continued to show a very high degree of resistance to bunt in tests at Edmonton. Tests on commercial samples of bunted wheats showed Red Bobs, Marquis and Garnet to rank in the order named for both number of samples graded smutty and percentage of infection when grown in their naturally infested condition.

Studies were made upon F_3 lines of reciprocal crosses between Trebi and Glabron barley in regard to barbing of awn, earliness of heading, height of plant and reaction to the pathogenes *Helminthosporium sativum* and *Ustilago hordei* (covered smut of barley). Correlation studies showed significant positive correlation between height of plant and covered smut reaction, also between earliness of heading and covered smut reaction.

When the seed of certain wheat varieties was artificially inoculated with bunt chlamydospores, marked differences in the percentage of infection occurred, depending on whether the seed was sown in fall or spring. Such differences were not entirely due to differences in temperature. Apparently length of day was a contributing factor.

Data were reported on the inheritance of certain characters in several oat crosses. Lemma color was found to be inherited on a two-factor basis; awn development was probably due to two factors, while rachilla pubescence was found to be controlled by one main factor and at least one supplementary factor. Smut reaction appeared to be dependent on one main factor and two supplementary factors, resistance being clearly dominant.

In tests on 15 varieties of winter wheat and 20 varieties of spring wheat for reaction to "take-all" disease the spring wheat varieties showed lower average infection than the winter wheats.

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

Research in Manitoba

1. *Dominion Rust Laboratory, Winnipeg*

The work of this laboratory, as well as other projects under the Dominion Department of Agriculture, is carried on without financial assistance from the National Research Council.

Since the discovery in 1927 of the important role played in the life cycle of rust by the pycnia, studies have been directed to a better understanding of the morphology and function of these bodies. By means of sections of haploid pustules of *Puccinia helianthi* and *P. graminis* two types of hyphae have been found protruding through the ostiole of the pycnium. Pycniospores were found connected to the flexuous type of hyphae by means of short hyphal tubes. The pycniospore nucleus very probably passes down the hypha and associates itself with a nucleus of the haploid mycelium, thus initiating the diploid phase and the production of aecia.

Fusions apparently also occur between hyphae in rusts, as well as in the Hymenomycetes. This was demonstrated by sowing urediniospores (diploid spores) of *Puccinia helianthi* on sunflower leaves in close proximity to haploid pustules. Several days later aecia began to appear among the haploid pustules, indicating that hyphal fusions had occurred.

A number of color mutations varying from light red to yellow have occurred in a physiologic form that was subjected to irradiation by ultraviolet light. The fact that the mutations were not accompanied by any changes in pathogenicity supports the conclusion that color and pathogenicity are inherited independently.

When a group of wheats resistant in the adult stage to all physiologic forms of wheat-stem rust were found, it was no longer necessary to carry on the previous extensive collecting program. Until these new wheats are ready for distribution it seems probable that 50 to 100 collections of wheat-stem rust will have to be made yearly in order to detect any radical changes which might occur in the number or kinds of forms present in the country.

Since the discovery of *regional* resistance in 1930 a new interest has been stimulated in the problem of resistance. Experiments have been made on regional resistance in varieties whose general resistance or susceptibility does not vary appreciably from seedling to adult stage and on varieties that are susceptible in the seedling but resistant in the adult stage. It was found possible to develop susceptible areas on cereals that are not natural hosts for certain rusts, *e.g.*, oat-stem rust on wheat varieties.

Attempts were made to discover to what extent mature plant resistance could be broken down by a manipulation of certain environmental conditions such as temperature and soil nutrients. These factors seemed to have little effect on this type of resistance. There was no evidence that the extract from plants showing mature plant resistance increased in toxicity to germinating rust spores during the growing period of the plants.

The method of estimating loss in yield from cereal rusts, developed in connection with the sulphur dusting tests, has been applied to the whole wheat crop of Manitoba and Saskatchewan. Estimates based on acreage, yield and price statistics, for the past eight years, indicate annual loss for wheat was $35,438,000; for oats in the past three years the annual loss was $2,624,000.

During the past three years considerable attention has been given to the problem of devising satisfactory and efficient methods of carrying out field tests to differentiate between cereal varieties for resistance and susceptibility to foot rots. The problem involves the determination of efficient methods for infesting soil with foot-rotting organisms and the development of reliable methods of recording and analyzing foot-rot experimental data. In 1932 significant increases in disease and significant decreases in yield were obtained when field plots were inoculated with *Fusarium culmorum* but none of the methods used were entirely satisfactory for *Helminthosporium sativum*.

Taxonomic studies of *Helminthosporium* and *Fusarium* species are being made. During the summer of 1932, 700 isolations of species and strains of *Fusarium* were made from diseased cereal roots. A large number of these have been identified.

In the plant breeding projects several strains of wheat have been developed from the original crosses that appear to combine disease resistance, high yield and quality. In disease resistance especially, these strains are distinctly superior to any of the standard varieties.

Yield data show that all strains are considerably higher in yield than Marquis and three of them are higher than Ceres. Future work is being directed particularly towards the development of wheats of higher quality.

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

2. *Dominion Experimental Farm, Brandon*

Experiments on resistance to black chaff, of all varieties in the co-operative variety tests, were made at Brandon, since a heavy infestation of this disease is often obtained there. In general, the infection on neck and rachis was rather light while the infection on glumes and culms varied from very light to very heavy. It was considered that culm infection lowered the yield to a greater extent than infection on other parts of the plant. None of the varieties tested were entirely immune, though a few showed very slight infection.

A preliminary test in 1930 and 1931 showed that many of the Brandon wheat strains possessed a high degree of resistance to loose smut. A number of individual head selections were made in the hope of obtaining homozygous lines with a high degree of smut resistance. These re-selections from the parent strains, as well as all varieties included in the co-operative test, were artificially inoculated with loose smut. Two heads from each variety were inoculated and seeds from these heads were sown in the greenhouse in the fall of 1932. Smut counts made when all plants were headed out indicated infection on different varieties to vary from 0 to 91.7%.

All varieties grown in the co-operative test in 1932 were subjected to a weathering test to determine the effect of this on grade. On the average all varieties lost one grade through being exposed, but there was not a great deal of difference between varieties. It would seem that varieties with a vitreous berry are better able to withstand exposure in the stook, than varieties possessing thick porous bran.

(Investigation under the direction of Mr. S. T. Vigfusson.)

3. *University of Manitoba*

Certain soils upon which cereals have been grown were found to contain an average of about 90,000 viable spores or bits of mycelium of fungi per gram of surface soil. No more than 1% of these fungi were parasitic species, but even 1% indicates a population of nearly 1,000 parasitic fungi per gram. Evidence from plate cultures and pot experiments indicate that *Trichoderma lignorum* is one fungus which helps to hold in check the numerous pathogenic fungi which accumulate in soils planted to cereals. (See Can. J. Research, March, 1933, for complete report.)

(Investigation under the direction of Prof. G. R. Bisby.)

For determination of quality requirements of malting barley, a comparative study was made of O.A.C. 21, Californian, Roumanian and Russian barleys. In regard to physical appearance the results show that Canadian barley is equal in bushel weight, is smaller in kernel size, is often weathered, is not quite so mellow and is often badly threshed, resulting in a high percentage of skinned kernels. O.A.C. 21 has a quicker, stronger, more even germination than any other barley tested and gave as high an extract of malt in brewers' pounds per quarter as Californian barleys, and gave twice the amount of diastase.

(Investigation under the direction of Dr. G. R. McRostie.)

Research in Ontario

1. *Central Experimental Farm, Ottawa*

Breeding work aiming at the development of an early smut resistant variety of oats for eastern Canada was started in 1930. Crosses were made between Markton and Alaska. Inoculations with loose smut spores were made on 410 F_3 lines developed from this cross in 1932, and on 250 of these lines no infection was found. Further studies are being made on these selections.

In 200 varieties and strains of oats examined for the presence of halo blight in 1932, 30 were found free from the disease. Greenhouse inoculations were made during the winter and field data will be collected in 1933 on resistance and susceptibility of oats to the causal organism.

Hybrids resistant to crown rust in eastern Canada are being developed at the Experimental Farm. In 1932, 175 lines of F_3 material from the cross Alaska × Red Rustproof were tested for resistance to three physiologic forms of the rust. None of these were totally resistant to all strains. In 1933, F_3 lines of several other crosses will be tested to all physiologic forms of crown rust known to be present in eastern Canada.

Flax wilt first appeared at Ottawa in 1923 on the flax variety test plots. Since 1925 a plot showing heavy wilt damage has been used for testing varieties and hybrid selections. Crosses have been made using as parents, several resistant varieties obtained from North Dakota. Both greenhouse and field tests have been made on many lines for several years.

(Investigation under the direction of Mr. L. H. Newman.)

In order to determine to what extent rust was a limiting factor in the growing of oats and other cereals, it was decided to make a preliminary survey in eastern Ontario. A careful survey was made around Antrim in Carleton county, to determine the number of buckthorn hedges and, if possible, estimate the number of wild bushes. Oat fields adjacent to hedges were heavily rusted, the crop being worthless in some cases. It is doubtful whether eradication of the buckthorn is feasible in this area and there is therefore a distinct need for varieties of oats resistent to crown rust.

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

2. *National Research Laboratories*

For reports on investigations on the effect of hydrogen ion concentration and of host extracts on the germination of urediniospores of wheat stem rust *(Puccinia graminis tritici*, form 21), see the report under the Division of Biology and Agriculture, page 18.

Research in Saskatchewan

1. *Dominion Laboratory of Plant Pathology, Saskatoon*

In 1932 the laboratory and greenhouse work on take-all disease of wheat, caused by *Ophiobolus graminis*, dealt almost entirely with a study of the influence of soil temperature and moisture on the development of the disease. In unsterilized soil, artificially inoculated, it was found that a comparatively high temperature with a low soil moisture content gave the highest disease rating. In the field rod-row tests were used to study: (1) the influence of fertilizers on the development of disease; (2) the pathogenicity of various isolates of the fungus; and (3) the effect of date of seeding. Good results were obtained in the pathogenicity tests but in the other two experiments, results were inconclusive.

Tests on the pathogenicity of 106 isolations and strains of *Helminthosporium sativum* obtained from wheat and barley grown in Saskatchewan were made. In the field the investigation was directed towards an analysis of root-rot symptoms in terms of yield. In spite of severe drought suffered by the field plots at Indian Head a small positive correlation was found between low yields and severe lesions on the subcrown internodes.

In the project on seed diseases the effect of *Helminthosporium sativum* on plants grown from abnormal seeds was tested. Types of seed used were frosted, immature, shriveled, sprouted, and seed injured by formalin treatment. It was found that the use of sound seed resulted in much lower infection than the use of unsound types. Infection was increased when the seed was injured by formalin treatment.

Continuing the studies on the development of Marquis wheat special attention was directed toward root growth. The maximum seminal root penetration obtained at Indian Head was 38 in. The outstanding feature of this work was the demonstration of the exceedingly well developed primary root system in Marquis wheat.

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

2. *University of Saskatchewan*

Browning root rot is most severe as a seedling disease on wheat following fallow. From meteorological data examined for the ten-year period 1923 to 1932, at various points in Saskatchewan, it appears that a warm, bright May of low rainfall, following a warm and very wet September, are conditions which favor the disease. There is some evidence that unbalanced soil nutrients, possibly a surplus of nitrate nitrogen and a deficiency of available phosphorus,

predispose the seedlings to fungus attack at this time. To test this hypothesis soil samples were collected from spots infested with browning root rot, and spots apparently healthy, in the same field, and analyzed for nitrate nitrogen and available phosphorus. It was found that with only two exceptions out of 22 typical browning fields, nitrate nitrogen was greater than in healthy areas, while the available phosphorus was less. It appears that a narrow ratio of phosphorus to nitrate allows the disease to become manifest whereas a wide ratio maintains the crop in a healthy condition.

The effects of nitrogenous and phosphate fertilizers on wheat seedlings grown in crocks in the greenhouse was also tested. In diseased soil phosphorus applications may give an increase in dry weight of wheat seedlings of over 100% compared with seedlings grown in untreated diseased soil, whereas nitrate applications gave only a slight increase or none whatever. On the healthy soil, phosphorus resulted in an increase of 33% over the untreated, and nitrate showed little or no increase. It appeared that the beneficial effects of the phosphorus applications were due primarily to the encouragement of a more vigorous root system and only secondarily to increased resistance of the roots to fungus invasion.

In conclusion, the results of the soil tests for nitrate and phosphorus, and the fertilizer experiments on soil from infested fields, suggest possible control measures from the use of fertilizers and certain crop and cultural procedures.

(Investigation under the direction of Prof. T. C. Vanterpool, with financial assistance from the Saskatchewan Research Foundation.)

For a number of years research has been directed toward an explanation of the abnormal breeding results obtained in crossing common wheat with emmer types. They have been proved to be due to the fact that many germ cells, particularly those of certain chromosome types, fail to produce offspring. There are several possible reasons for this failure, and several stages in the life cycle at which they may act. The first which might possibly be the cause is a pre-gametic effect. Examination of chromosomes in young F_1 pollen grains showed that grains of all chromosome numbers were formed in the theoretical proportions. This possible cause is therefore ruled out. There was also the possibility that although pollen grains were formed they might not function. Such was actually found to be the case, non-functioning being chiefly due to the death of 5% of the gametes, and the retardation and non-germination of 25 or 30%. There is in addition to the non-functioning of many male gametes a large effect from endospermic abnormalities, particularly in relation to female gametes, because of abnormal chromosome numbers. This unbalanced chromosome condition which injuriously affects the endosperm, resulting in small wrinkled or shriveled seed, may also affect the embryo. While any such adverse change in the condition of the embryo may be due to the abnormal endosperm, there is the possibility of a direct effect of chromosome unbalance on the zygote. Evidence for this may be seen in plants which survive the embryonic stage, but perish during seedling development.

Stable hybrid lines from crosses of common wheat with durum or emmer have either 14 or 21 chromosomes, the former resembling the durum and the latter the common wheat parent. Substitution of a durum character for one of common wheat in a hybrid of the common wheat type depends on whether the genes responsible for the common wheat character are in the primary 14 chromosomes, which mate with those of the durum, or in the secondary seven chromosomes.

Studies of common wheat characters appearing in 14-chromosome hybrid lines and emmer characters appearing in 21-chromosome hybrids show that the genes for certain common wheat characters are located in the primary 14, and those for other characters in the secondary seven chromosomes. Confirmatory evidence was obtained by determining the common wheat characters occurring in 15-chromosome plants but not in those with 14 chromosomes. From such studies the plant breeder may determine which characters of the durum and emmer wheat may be transferred to hybrids of the common wheat type.

Means of distinguishing the different chromosomes of a plant are valuable in making thorough genetic analyses. A technique has been evolved and successfully applied using the chromosome divisions in the pollen grains of rye and a primitive wheat.

Preliminary work of a similar nature has been done on some common wheat species.

(Investigation under the direction of Dr. W. P. Thompson.)

In order to provide rust-resistant wheat varieties, which are also adapted to Saskatchewan conditions in other respects, 47 rust-resistant lines from a cross H44 double cross × Marquis were tested in 1931. After elimination of the least satisfactory on the basis of yield, earliness, strength of straw, resistance to rust and bunt, appearance of seed, plumpness, weight per bushel, commercial grade and milling and baking quality, 23 lines were continued in 1932 and 16 will be grown in 1933.

In addition to their rust resistance the chosen lines compared favorably with Marquis in yield in the dry seasons of 1931 and 1932. In a co-operative test at a number of experimental stations some lines exhibited distinct local adaptation. They have shown superior resistance to bunt, though not enough to permit dispensing with formalin seed treatment, and they appear to be at least as resistant as Marquis to loose smut. Foot-rot resistance has not been definitely determined because of unsatisfactory weather conditions.

In height, strength of straw and resistance to shattering these lines are satisfactory, and in seed characters—plumpness and weight per bushel—they should surpass Marquis under rust-epidemic conditions. As a group they averaged about the same as Marquis in protein content and loaf volume, and slightly higher in computed baking score, although a few lines were unsatisfactory in these qualities. A promising line from a Marquillo × Marquis cross was included in these tests.

Other breeding projects involving Vernal, Marquis, Iumillo, Hope, H44, Reward, Quality, Ceres, Reliance and Garnet are designed to produce suitable recombinations of the outstanding qualities of these varieties. Several hundred progenies from crosses and back-crosses, some of which have reached the fourth generation, are being studied. In addition to the economic phases of the work, fundamental investigation of the inheritance of certain characters are being made.

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

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
Calgary Institute of Technology
Federal Department of Mines
University of Alberta

The sixth meeting of the committee was held in Edmonton on January 21, 1933. In the absence of Dr. Tory the chair was taken by Dr. R. C. Wallace.

Mr. P. V. Rosewarne of the Dominion Department of Mines reported on the analysis of gas samples from the Fort Norman and Peace River districts, on losses in weathering of gases in the Turner Valley, on variations in composition of waste gas from the separators over a period of years and also on the total production of certain wells in the Turner Valley. The last investigation, as yet incomplete, has for its object the securing of information regarding the nature of the hydrocarbons underground. The committee was of the opinion that these experiments should, if possible, be continued in the summer of 1933 with lowering pressure in the wells and with continuous metering. The information obtained should indicate how the field will behave at lower pressures.

The work at the University of Alberta, jointly supported by the Alberta Research Council and the National Research Council, was outlined by Dr. E. H. Boomer. Hydrogenation experiments had been continued on bitumen in a continuous autoclave to determine the possibility of commercial operation. Under more favorable conditions this work was considered to have commercial possibilities. The production of alcohols from water gas with various catalysts was investigated and it was found that methyl alcohol could readily be produced. Solubility studies on the methane-benzene system had been continued. In the previous work there were found large deviations from the accepted gas laws and these results have now been fully confirmed. The information gained may throw much light on the behavior of the gas fields over a period of years. Pyrolysis experiments in the laboratory of the Calgary Institute of Technology have now been discontinued, at least temporarily. It is proposed to make a detailed estimate of costs and to supply these with technical details to the companies interested. The major difficulty in the way of commercial operation is that the length of life of the field is uncertain.

Dr. G. S. Whitby outlined experiments being carried out under his direction in the National Research Laboratories. These are described on page 32, under the report of the Division of Chemistry.

Associate Committee on Grain Research

Co-operating organizations:

Board of Grain Commissioners for Canada
Dominion Department of Agriculture
Macdonald College
University of Alberta
University of Manitoba
University of Saskatchewan

In view of the increasing importance of durum wheat in western Canada the committee established a durum research laboratory at the Manitoba Agricultural College under the direction of Dr. W. F. Geddes. The equipment already installed includes a special experimental mill and purifier for the manufacture of semolina, and an experimental macaroni unit comprising a mixer, kneader and press. A special drying cabinet has been devised and constructed which renders it possible to maintain control over the velocity, temperature and humidity of the drying air.

As color is an important criterion of durum quality, a spectrophotometer has also been included in the new equipment acquired by the committee.

The use of this instrument is not confined to durum wheat studies, and it has already been of great service in determining accurately the carotin content (yellow pigmentation) of new rust-resistant varieties of common wheat submitted to the committee for testing.

The committee has continued to sponsor co-operative investigations on factors affecting the milling and baking quality of Canadian wheat. The problems being actively investigated are as follows:

1. Frost injury
2. Methods of harvesting
3. Quality of new wheat varieties.

Fundamental research on special problems arising out of the co-operative program is carried on independently by the universities.

Three papers were published during the year, making a total number of 34 in the committee's series.

Co-operative Investigations

Frost Injury of Wheat

The results of the annual survey of the quality of frosted wheat in 1930-31-32 are now being studied and a report will be issued shortly.

Methods of Harvesting

A survey of the moisture and grade of grain harvested by different methods was conducted in the three prairie provinces. The percentages of samples grading tough or damp were: combine samples, 25; swathe and combine, 9; binder, 3 (tough only). The stook-threshed grain graded higher on the average than grain harvested by the other methods. A full report of this survey is now in press. (Can. J. Research.)

Studies of the rate of ripening of wheat and barley under field conditions, and of the header-barge method of harvesting were also made.

Quality of New Wheat Varieties

The committee tested 259 samples of 36 new varieties of wheat originated by members of the Associate Committee on Field Crop Diseases. The results of the extensive tests to which these samples were submitted enable the plant breeders to discard varieties of inferior quality, and ensure that the high standard of excellence of Canadian wheat will be sustained by the rust-resistant varieties offered to the farming public.

Independent Researches at the Universities

Grain Research at the University of Alberta

In view of the close relation between baking quality and the proteins of wheat it is important that precise information on the elaboration of these compounds in the plant should be obtained. Work on this problem has shown that the uptake and reduction of nitrate continues for some time after heading. The organic compounds produced in vegetative parts are not synthesized to proteins after heading, but accumulate in the form of non-protein compounds. The nitrogen reserves built up in the developing plant are largely translocated to the kernels during the time of filling. A large supply of nitrate available to the plant during the later stages of growth results in a very high total nitrogen content of the grain.

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

The study of the effect of timothy, brome, western rye grass and alfalfa on the yield and quality of succeeding crops has been continued. In 1932 the last grass plots were plowed, but wheat will be grown for two more years. The most striking feature of this year's results was that the yields of grain and protein from the plots which had been sown to timothy were greater than the yields following any of the other crops. This probably indicates that the slower decomposition of timothy sod is now making itself felt while the effect of the earlier decomposition of the other sods is disappearing.

The rotation studies mentioned in earlier reports are being continued.

Frost injury in commercial wheat is estimated by the degree of wrinkling and blistering of the bran, and samples are de-graded by the inspectors accordingly. Experiments with Marquis, Red Bobs, Reward and Garnet wheat last year indicated that Marquis is not as resistant as the others to this form of damage, as shown by the change in the official grade of the grain brought about by exposure of the freshly cut, unthreshed plants, at various stages of maturity, to 22° F. for four hours.

(Investigations under the direction of Dr. R. Newton and Dr. J. G. Malloch.)

With a view to originating a variety of wheat adapted to the semi-arid areas of the prairie provinces crosses were made between high quality, non-drought-resistant varieties and drought-resistant Russian varieties. The progeny of these crosses is under test at Brooks on brown soil in the dry area, at Edmonton on black soil in the park belt, and at Fallis on the gray wooded soil, in order to study the effects of different environments.

A machine for reproducing drought conditions has been constructed to enable tests of drought-resistance to be made at any time. An experiment to determine the comparative resistance of wheat to both atmospheric and soil drought, at the periods of stooling, shooting or early heading, soft dough and hard dough, is in progress. Results to date show that all varieties are more susceptible to both soil drought and windburn in the shooting stage than in the stooling stage. Windburn produced much greater injury than did soil drought.

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

The plots under alfalfa, timothy, western rye grass, brome grass, and wheat following these crops (and a fallow plot in another part of the field) were sampled throughout the season of 1932, as in previous seasons. The samples were analyzed for nitrates and numbers of bacteria and fungi.

The nitrates in the sod plots, up to the time when these plots were plowed, were considerably lower than those under wheat. Under the second crop of wheat following sods in sub-block II (broken in 1930) the alfalfa plots were highest in nitrates and the brome plots lowest, thus corroborating results previously obtained. Under the fourth crop of wheat in sub-block I (sods broken in 1928) the differences were smaller, but the alfalfa plots still contained most nitrate. In the latter half of the season the nitrates were, as usual, higher in the supplementary fallow plot than in any other plot.

Generally speaking the difference between the bacterial numbers in the different plots were not very significant.

The counts of fungi in the sod plots of sub-block III, up to the time when these plots were plowed, were highest under alfalfa, as in previous years. Following the breaking up of the sods it was again observed that large mucor colonies predominated in the alfalfa plots.

A supplementary experiment was conducted to determine the numbers of bacteria and fungi at different depths in two nearby plots, one cultivated and the other under grass. The numbers were determined at monthly intervals at six different depths, down to a total depth of approximately three feet. Broadly speaking, the numbers decreased with depth, but nearly all samples contained both bacteria and fungi, and the soil was by no means sterile even at the greatest depth.

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

Grain Research at Macdonald College

A comprehensive review of the literature on feeding experiments with farm livestock has been completed. Data covering about 1,700 comparisons have been assembled and analyzed. A report (National Research Council (Can.) Rep. No. 28) entitled, "The Comparative Feeding Values for Livestock of Barley, Oats, Wheat, Rye and Corn," has been issued.

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

Grain Research at the University of Manitoba

The study of the influence of commercial fertilizers on the protein, ash and phosphorus content and milling and baking quality of Manitoba grown red spring wheat, begun in 1929, has been completed. The results on the 1931 crop support the general conclusions arrived at from a consideration of the previous years' data. Nitrogenous fertilizers drilled in just below the seed at the time of planting raise the protein content of the wheat slightly, while phosphates, either alone or in combination with other fertilizers, tend to have a slightly depressing effect. Milling and baking tests show that the large increases in yield resulting particularly from phosphatic fertilization do not result in lower quality.

A further study has been undertaken to determine whether variations in the quantity of protein extractable from different wheat flours by various inorganic salt solutions can be used as an index of baking quality. The relation between ash content and the percentage of salt-soluble proteins is being included in this study.

Studies on the chemical changes in the wheat lipoids incidental to aging have been continued and the effect of these changes on the baking behavior of flour investigated. The iodine numbers of fatty acids prepared from the lipoids extracted from wheat germ, aged under different conditions, varied only slightly. On the other hand, the lipoid nitrogen and lipoid phosphorus markedly decreased upon aging, particularly at the higher moistures, these changes being accompanied by an increase in iodine number and acid value. The constancy of the iodine number of the fatty acids upon aging, considered in conjunction with the increased iodine number and acid value of the lipoids from which they were prepared, indicated that hydrolysis rather than oxidation was responsible for the decrease in phosphatide content observed upon aging.

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

Grain Research at the University of Saskatchewan

The study of effect of environmental influences on the quality of wheat is being continued for the eighth year with the support of the Saskatchewan Agricultural Research Foundation. Another investigation along similar lines has been made possible through the co-operation of Professor M. Champ-

lin, Field Husbandry Department, University of Saskatchewan, who has made available wheat samples grown in his rotation tests. These samples, numbering about 80, are all of the same variety grown on an area of less than 20 acres, and are particularly interesting for the study of effect of soil variation on quality.

Mr. S. F. Brockington has made an extensive investigation of experimental baking formulas, using in all some 160 modifications, in order to find, if possible, one or more that may be used to give more complete information regarding quality than can be obtained by those in use at present. While it is very difficult to choose a definite formula, since the baking test itself is the criterion of quality it appears that there are several formulas which when used together and properly interpreted will give much more information than is obtainable by the present procedure. In conjunction with these studies there has been carried on an investigation of various diastatic preparations such as malted wheat and barley flours and diastatic malt extracts. The optimum quantities were ascertained and comparisons were made of the effects of the different preparations in respect to their effect on tolerance to oxidizers. No evidence of reduction of tolerance to oxidizers, even with fairly high dosages of these preparations, was obtained.

During the year a laboratory study of respiration and heating of damp wheat was carried on with financial assistance from the Board of Grain Commissioners of Canada. The most important result of this was the discovery of a treatment which effectively prevents heating of wheat of moisture content as high as 25%. This has been applied to laboratory tests only but it is hoped that it may be possible to try it with commercial lots of wheat in the fall of 1933.

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

Associate Committee on Heating and Insulation

Co-operating organizations:

Dominion Fuel Board
McGill University
Queen's University
University of Saskatchewan
University of Toronto

A meeting of the committee was held in Ottawa on March 4, 1933. No meeting had been called for some time previously, as it was felt wise to clear up first certain questions which had arisen in connection with heat conductivity tests made in several laboratories.

At this meeting Dr. C. D. Niven reported on a large number of Canadian and imported low-temperature insulating materials tested in the National Research Laboratories and also in a number of cases in the laboratories of the Universities of McGill, Queen's, Saskatchewan and Toronto. The tests showed the Canadian materials to be fully equal in insulating value to those imported.

Mr. James Govan, a Toronto architect, raised the question as to the utility of the heating formulas of the American Society of Heating and Ventilating Engineers when applied to well insulated buildings. He expressed the opinion that the heat savings to be effected by adequate heat insulation were so great as to reduce the required capacity of heating plants and radi-

ating surfaces in buildings so insulated far below the figures specified by the society. In support of his opinion Mr. Govan cited the case of an unheated Ontario storage plant where outside temperatures had fallen as low as 17° below zero, while the inside temperature had never been below 30° F. Insulated buildings had been found to require in some cases only 30% of the radiating surface necessary for similar uninsulated buildings. This question is being given further study.

Prof. Angus stated that he had under way at the University of Toronto a series of investigations on the construction of radiators and the rate of heat flow through laminated boards made of several different insulating materials.

The committee recommended to the Council that the work of the committee be reorganized and that it be related to other problems common to the construction industry. This recommendation is now being considered by the National Research Council.

Associate Committee on Helium

Co-operating organizations:

Department of Mines
Department of National Defence

With a rapid increase in air travel there is renewed interest in sources of helium gas. Unfortunately, however, no commercial source of helium has yet been found in the British Empire and the committee has therefore been considering possible methods of discovering sources of this gas. The committee felt that commercial sources might be possible through the discovery of gases richer in helium than those yet found, or through improved methods of concentrating in large quantities the helium in gases now available but known to contain only very small percentages of helium.

Two meetings have been held during the year of the reorganized Committee on Helium under the chairmanship of Dr. Charles Camsell. At each of these meetings Mr. P. V. Rosewarne of the Dominion Department of Mines reported on the analysis of many samples of natural gas found in areas widely distributed throughout Canada. None of these were comparable in helium content with gases found in different parts of the United States, although a few wells contained enough helium to make them of interest if very cheap methods of concentration could be worked out.

Dr. R. Ruedy of the Division of Research Information gave the committee the results of his studies on the geology of areas in which helium exists in commercial quantities and also on possible means for its recovery through cheap methods of concentration. Dr. Ruedy pointed out that a source of helium existed in the igneous rocks found at depth all over the world. Unfortunately, however, in most areas so much fracturing had taken place in the overlying rocks that the helium formed through geological ages has had ample opportunity to escape. Only where severe fracturing was absent and dome-shaped structures existed could helium accumulate in commercial quantities. There are few districts in Canada where such conditions prevail. Many possible methods of recovering helium from dilute gases were studied by Dr. Ruedy but none had been found commercially feasible. The usual method of liquefaction of gases offered greatest promise, as operating costs did not appear prohibitive even when the helium was present in low concentration. The cost of equipment was so high, however, that overhead charges would raise the total cost to a high figure unless the percentage of helium was considerably greater than any so far found in natural gas available in large quantity anywhere in Canada.

While it appeared that there was not much the committee could do in the immediate future, it was agreed that it would be desirable for the Dominion Department of Mines to continue its analyses for helium of natural gas from all new wells brought in and that the committee should also keep in close touch with progress in methods of separation.

Associate Committee on Laundry Research

Co-operating organization:

Eastern Canadian Laundryowners' Association

A meeting of the committee was held in Toronto on October 21, 1932, in connection with the annual meeting of the Laundryowners' National Association of the United States and Canada. At this meeting Dr. O. M. Morgan reported on his work carried out in the National Research Laboratories at Ottawa. An outline of these investigations will be found on page 33 of this report under the Division of Chemistry.

The committee discussed Dr. Morgan's program of work and approved his plan to send to a number of Canadian laundries test bundles of cloth soiled in a standard manner and of cloth of standard weave to be handled in the regular way and later returned for examination in the National Research Laboratories. This, it was agreed, would enable him effectively to advise the laundries on the efficiency of their laundering methods.

The Eastern Canadian Laundryowners' Association appointed a Canadian Laundryowners' Research Fund Committee to consider methods of raising money to finance the work being carried out in the National Research Laboratories. Arrangements were made by this committee whereby subscriptions were received from the industry for this purpose.

Following a recommendation of the committee, Dr. Morgan extended to western Canada his service to the laundry industry. Meetings were held and illustrated addresses given at Winnipeg and Vancouver. Practically all steam laundries in western Canada were visited by Dr. Morgan, thus affording an opportunity for a discussion of practical problems.

Associate Committee on Leather

Co-operating organizations:

British Leather Manufacturers' Research Association
Tanners' Association of Canada
Tanners' Section, Toronto Board of Trade
Technical Association of Canadian Leather Belting Manufacturers

No meeting of the committee has been held during the year under review but work on leather has been continued in the Division of Chemistry of the National Research Laboratories and a brief account of it will be found on page 34 of this report.

Mr. E. J. Davis of the Davis Leather Company, Limited, Newmarket, Ontario, has been appointed to the committee to represent the calfskin tanners.

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories, Limited
Federal Department of Mines

Work under the committee has been somewhat extended during the year, with a concentration of effort on those investigations which gave most

promise of an early and successful conclusion. That part of the work carried out in the National Research Laboratories has already been described on page 34 of this report.

As stated last year, brick made of magnesium clinker and chromite have, by their very unusual properties, given encouragement to commercial manufacture, even at a time when new enterprises are undertaken with considerable hesitation. The ceramic engineer who has carried out the laboratory work on brick for several years was sent to England for some months by Canadian Refractories, Limited, and while there carried the manufacture of these special brick through the semicommercial stage at the brick plant of one of the large British steel manufacturers. Commercial manufacture has now begun and the brick produced are giving excellent satisfaction in a wide variety of applications. While developed primarily to meet the severe requirements of the steel industry, they are proving of merit in smelting and refining furnaces for both copper and nickel. In these applications they have, as expected, shown a great refractoriness at high temperatures, resistance to the action of corrosive slags and oxides, and high resistance to fracture when subjected to sudden heat changes. While these early trials are to a certain extent experimental in character, the quality of the brick is such that wide application is confidently anticipated.

A special study has been made of certain furnaces in which the temperature is so high and the corrosive action of the charge so severe that ordinary refractories are unsatisfactory. Careful observation has revealed in what respects improvements are needed and experiments have been undertaken with a view to fulfilling those requirements. It is possible that new refractories will have to be developed to meet the situation.

Further work is contemplated in the near future on a number of the applications of magnesian products, which for a time had to be held in abeyance. Details in regard to these cannot be given at the present time.

As before, the experimental program of this investigation has been carefully planned by a group of workers who have met at frequent intervals and discussed in detail possible methods of solving the many problems which have confronted the committee. The contact of the staff with the ceramic and metallurgical industries has also been of inestimable value in directing the work towards practical ends.

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

Associate Committee on Oceanography

Co-operating organizations:

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

Under the conditions prevailing during the past year it has not been considered advisable to call a general meeting of the committee, nor have there been the usual opportunities for members of the committee to get together for conference.

Even in such difficult times, however, co-operation amongst the institutions on the Pacific coast is becoming more and more intimate. The interchange of ideas and of information by the Biological Board and the University of British Columbia in Canada and the Oceanographic Laboratories of the

University of Washington at Seattle and Friday Harbor, the Scripps Institution at La Jolla, California, and the Hopkins Marine Station at Pacific Grove has done much to facilitate progress in research along the whole coast.

Dr. A. H. Hutchinson represented the committee at the Oceanographic Conference held in June at Pullman, Washington. Dr. E. G. Moberg of the Scripps Institution visited the University of British Columbia, the Biological Station at Nanaimo and the laboratories at Friday Harbor and conferred with officials at these centres. The staff of the Seattle laboratories made trips to Nanaimo and Vancouver on their new boat the *Catalyst*, built especially for oceanographic work, in order to demonstrate the use of the boat equipment and to visit the Canadian laboratories. President Klinck, Dean Buchanan, Dr. Hutchinson and Dr. McLean Fraser (chairman of the committee) inspected the new oceanographic laboratories of the University of Washington at Seattle and the laboratories of the International Fisheries Commission and became acquainted with the progress being made in the various problems to which the members of the staff in each case are giving attention.

On account of the great reduction in the funds available for research, no new major problems in oceanography have been attacked during the year. Fortunately, it has been possible to carry on, sometimes to a more limited extent, with most of the problems that have been in progress for some time. The general oceanographic survey of the strait of Georgia and the fiord investigations are still receiving the greater amount of attention. The comparison of conditions in different fiords is bringing out many features of great interest, both from a chemical and from a biological standpoint. Statistical and life-history studies of various species of economic importance, salmon, herring, pilchard, oysters, crabs, etc., are being continued. Technological research on fish oils, fish meals, vitamines, refrigeration, etc., is being continued at the Prince Rupert station. The Meteorological Office continues to receive information on temperature, circulation, etc., from trans-Pacific steamships.

Much time has been spent in preparation of the scientific program in oceanography for the Fifth Pacific Science Congress. The Standing Committee of the Pacific Science Association on Oceanography is the only standing committee that has been continuously active since the first congress in Honolulu in 1920. It is natural, therefore, that oceanography should take a prominent position in the scientific program of the fifth congress. The report of the standing committee will, as usual, be an extensive one, and will show much activity throughout nearly all of the Pacific area.

Associate Committee on Parasitology

Co-operating organizations:

Federal Department of Agriculture
Imperial Bureau of Agricultural Parasitology
McGill University
Quebec Department of Agriculture

The importance of parasitology to agriculture and fur farming is well recognized by those who are directing the activities of these industries. Parasitic infestations are responsible for greater losses of sheep and horses than are suffered from any other cause, while pigs and dogs suffer almost as severely. One of the major problems in fur farming is the control of animal parasites, as it must be when animals are kept in a circumscribed

space. The progress of agriculture is continually increasing the danger of parasites, owing to changing conditions. Many of the conditions favorable to parasites are readily avoidable; more will become so when the bionomics of the parasites are better understood. Economically, the diagnosis, control, and treatment of these pests is one of the major problems now confronting the animal industries.

Recognizing the importance and magnitude of this problem, the National Research Council appointed an Associate Committee on Parasitology for the purpose of co-ordinating and directing research work in this field. An Institute of Parasitology has been established by McGill University at Macdonald College, the activities of which are directed by the Associate Committee on Parasitology. During the year under review a building was erected at the expense of the Quebec Department of Agriculture to house the Institute, and Dr. T. W. M. Cameron, M.A., Ph.D., D.Sc., M.R.C.V.S., was appointed Director of the Institute and Research Professor of Animal Parasitology of McGill University, and other necessary appointments to the scientific staff were also made.

In April, 1931, the Empire Marketing Board, which had been approached for financial assistance for research work in the field of parasitology in Canada, had agreed, owing to the Empire significance of work in this field, to contribute the sum of $25,000 toward the maintenance expenses of an Institute of Parasitology in Canada, this amount to be spread over a period of three years, provided the National Research Council of Canada would organize and direct the work and would contribute an equal amount. The Institute was established and the work actually commenced at the beginning of the year under review. The general functions of the Institute may be outlined as follows:—

1. *Informative:*
   - *(a)* Identification of specimens and replies to queries.
   - *(b)* Popular pamphlets and lectures.
2. *Educative:*
   - *(a)* Training of senior and postgraduate students—especially in agriculture and veterinary medicine.
   - *(b)* Establishment of a reference collection of domesticated and fur animals.
3. *Research:*
   - *(a)* Geographical and zoological survey of Canada, *e.g.*, of parasites of different areas and different species of animals—especially domestic, fur and related wild species.
   - *(b)* Bionomics and life cycles of important species.
   - *(c)* Host reactions and therapeutics.
   - *(d)* Practical application of existing and future knowledge to problems of agriculture, fur farming, veterinary medicine, etc.

Regulations have been drawn up by the Faculty of Graduate Studies of McGill University for the degrees of M.Sc., and Ph.D. in parasitology, and already one student has been registered for each. As the importance of this science in connection with agriculture, fur and other economic animals is realized, the demand for workers is bound to increase; even now the greatest difficulty is found in filling research appointments in this subject. Accommodation has accordingly been set aside for this purpose and complete teaching collections and literature arranged. Unfortunately, however, owing to the size of the building, accommodation is at present limited to three students.

The research policy of the Institute has been arranged to enable the Dominion to take advantage of what is already known about animal parasites and to conduct investigations along lines which will, it is hoped, produce results of both economic and scientific importance. The parasitic fauna of Canada is largely unknown, and the first step taken was therefore to inaugurate a survey of the parasites of domestic animals and economically important wild animals. Geographically, the province of Quebec forms the starting point of this survey. It will be extended gradually throughout the Dominion, and from domestic animals of economic importance to related wild species. Many parasites of wild animals are transmissible to domesticated ones, and as a consequence the farming of wild animals or their movement across wide areas make it important that the Institute should be in possession of as much information on their parasites and their bionomics as is possible.

The survey is, of course, merely the first step in the program. It should disclose what species are present, which are common and which are important. Information on their bionomics already available is being collated and, as far as possible, gaps are being filled in. Where information is not available, research is being undertaken to provide it. While the survey will necessarily take many years to complete, the more important species will, it is hoped, be discovered early.

Research on various important problems in parasitology was undertaken during the year under review. One of these investigations was on the life cycle and bionomics of the large liver fluke of ruminants. Not only is this problem of considerable scientific importance and economic significance, but it is desirable that the Institute should be able to advise on the danger or otherwise of transferring carriers of this fluke from one part of the Dominion to another, or from the Dominion to countries abroad. Of purely American origin, this fluke was probably a parasite of wild ruminants before the introduction of domestic cattle, and the available evidence points to the elk as the original host. It is still absent from the eastern provinces, but it was introduced some years ago into Italy.

An investigation on the problem of nodular disease of sheep in Quebec has also been undertaken. This is one of the most serious of sheep diseases in eastern Canada and is responsible for great economic loss. It is a well known fact that the intestines of all sheep over one year old and also of a large percentage of lambs, are useless for making sausage casings, owing to the existence of worm nodules on the intestines. The significance of this fact is revealed by the necessity of importing approximately one million dollars' worth of casings annually. The same parasite is also known to cause the death of young sheep in many cases. The mechanism of this nodule formation is not understood and there is a suspicion that some bacterium is associated with the action of the worm. The special object of this investigation is to determine the relation, if any, between worm and bacterium and to determine if a bacterial vaccine would be practicable. When the bionomics of this worm have been determined in Canada, scientific control measures can be recommended.

Another investigation has been undertaken on the possibility of using various forms of bedding as a means of controlling the very common strongyle worms of horses and ruminants. These experiments so far have been on the horse parasites, which are extremely common and important in Quebec, and preliminary work points to the fact that animal urine may be a very useful agent in killing the free-living larvae. However, these experiments will require considerable extension before any practical recommendations may be made to farmers.

Other investigations undertaken during the year under review include the description of a new genus of trematode causing considerable mortality in wild ducks and a new species of nematode from the proventriculus of ducks in Ottawa, the collation of all the available information on the free-living stages of nematodes of stock animals with a view to their application to local problems, and investigations on the bionomics of the common liver fluke of sheep in the lower St. Lawrence regions, in parts of which it appears to be a very serious parasite.

A report on the internal parasites of land mammals in Scotland has also been completed during the year. This investigation has made possible the development of a cheap and efficient technique, which is being applied to the survey of the internal parasites of Canadian animals.

The necessary library facilities have been made available and other arrangements made whereby the Institute is able to secure early information on all recent developments in parasitology.

During the year under review seven papers were published by the staff of the Institute and six additional papers dealing with various important phases of the work have been prepared.

Associate Committee on Patents and Awards

No meeting of the associate committee has been held during the year but work has been continued under seven subcommittees appointed by the Council on the recommendation of the committee. These subcommittees deal with patents on the following subjects: apple products, asbestos products, gas reactions, magnesian products, maple sugar products, resins and plastics, and physics and engineering.

Eleven patents, all assigned to the National Research Council, have now been granted and 25 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

At a meeting of the executive committee held on January 6, 1932, a tentative program was prepared for the investigation of the effects on radio transmission of the solar eclipse of August 31, 1932. The object of the work was to study further the nature of the reflecting layers of the upper atmosphere which are known to be responsible for making possible radio communication over great distances.

There are two possibilities as to the source of ionization in the regions in the upper atmosphere from which radio waves are reflected,—ultra-violet light from the sun, and neutral particles shot out from the sun at high velocities by radiation pressure. A total solar eclipse is the only occasion on which the two sources of ionization can be distinguished.

The investigations were carried out by the members of the Eclipse Subcommittee, consisting of Lieut.-Col. W. A. Steel, chairman, Dr. A. S. Eve,

Professor V. G. Smith, Mr. H. J. Vennes and Dr. D. C. Rose. Prior to the eclipse, meetings were held at Ottawa and Montreal in order to organize and make preparations for the readings to be taken during the eclipse.

In co-operation with McGill University, there were established, at the time of the eclipse, three stations provided with radio equipment by means of which the height and the intensity of ionization of the reflecting layers in the upper atmosphere could be measured. The first station was located in Kingston, Ontario, with staff from the National Research Laboratories, to study the upper Appleton layer in the upper atmosphere. The second was located at Vankleek Hill, Ontario, with personnel from the Physics Department of McGill University, to study the lower or Kennelly-Heaviside layer. These locations were chosen as they were directly under the band of optical totality for the layer of the atmosphere concerned. The third station, with personnel from the Physics Department of McGill University, was located at Cornerbrook, Newfoundland. This location was chosen because it was in the region of totality of the predicted corpuscular eclipse.

Following the eclipse a meeting was held on September 4, 1932, at Vankleek Hill to discuss the results of the readings at the various stations. Briefly summarized reports of these stations are as follows:

1. Cornerbrook—In the records there was no reflection from the lower Heaviside layer due to the long drawn out impulse of the ground wave. Great upper layer reflection occurred only during the eclipse.
2. Vankleek Hill—There were found a reduction in ionization and a rise in the limits of the wave-lengths which could get through the lower layer.
3. Kingston—Similar results were observed as at Vankleek Hill but reflections were from the upper layer.
4. Northern Electric Company—No effect was found on the intensity of signals between Montreal and Ottawa.
5. Canadian Marconi Company—No effect was obtained on signals received from across the Atlantic.

It will be observed that the results of three of the stations indicate distinct losses in ionization of both the upper and lower reflecting layers during the period of optical eclipse. The other two stations found no change in signal intensity either on the 500-metre wave-length between Ottawa and Montreal or the 23- to 37-meter wave-length across the Atlantic. None of the observations gave evidence of corpuscular eclipse.

On March 1, 1933, some members of the executive committee met to review the papers relating to radio for presentation at the Fifth Pacific Science Congress. A number of valuable papers were available and it was proposed to arrange for an inspection of one of the recently constructed radio stations of the Department of Marine in the vicinity of Vancouver. This station is remotely controlled from the city of Vancouver. It was also proposed to inspect a boat which had been fitted out by the Dominion Hydrographic Survey. The boat has modern equipment and is provided with every technical convenience.

Associate Committee on Survey Research

Co-operating organizations:

Department of the Interior
Department of Marine
Department of Mines
Department of National Defence

Acting on representations made by senior officials of the Federal Government, to the effect that there was need for better co-ordination and promotion of research in the field of survey work, the National Research Council called a conference of the various government services concerned with surveying problems for the purpose of discussing the desirability of establishing a permanent committee. It was suggested that if the departments concerned with this question found it feasible to co-operate in the work of such a committee, it would be mutually advantageous and would stimulate research. It was pointed out to the conference that it is not the desire of the National Research Council to control such work, but merely to assist in the organization of a co-ordinating committee and to co-operate with other organizations in connection with the activities of any committee which might be established.

A tentative statement of the functions which should be assigned to a committee, and a list of important research projects in this field which require attention, was submitted to the conference for consideration by officers of the Department of National Defence and Department of the Interior. When the whole question had been fully discussed, it was unanimously agreed that the National Research Council should be requested to establish an associate committee representative of the following government organizations concerned with survey work: Department of National Defence, Department of the Interior, Department of Marine, Department of Mines and the National Research Council.

This recommendation was considered by the National Research Council, and an Associate Committee on Survey Research was established just prior to the close of the year under review.

Associate Committee on Trail Smelter Smoke

Pending final settlement of the claims for damage, alleged to have been done in the State of Washington by fumes from the Trail smelter in British Columbia, no action has been taken by the committee beyond continuing the automatic record of sulphur dioxide concentration in the atmosphere at different points in the Columbia valley, making observations on the effect of sulphur dioxide on the vegetation in that vicinity, and sampling and analyzing vegetation for its sulphur content. It is hoped eventually to publish a series of papers giving the scientific results of this very comprehensive investigation.

Associate Committee on Tuberculosis

Co-operating organizations:

Federal Department of Agriculture
Fort Qu'Appelle Sanatorium
Queen Alexandra Sanatorium
Queen's University
University of Alberta
University of Montreal
University of Toronto

The work of the committee has been continued as previously, but on account of the need for economy the annual meeting was limited to a conference of the directors of tuberculosis research and executive officers in Ottawa. This meeting was held on March 21, 1933, when reports were presented of which the following are brief summaries. Attention is also called to the very considerable number of papers published during the year by members of the committee.

Tuberculosis Research of the Federal Department of Agriculture, Hull, Quebec

Vaccination trials with B.C.G. and biological studies have now been carried on over a period of eight years. Trials have been completed on 44 vaccinated cattle and 28 controls under conditions of continuous exposure to natural infection through cohabitation with tuberculous animals, with trials varying in length from two months to two-and-a-half years. In the percentage of infection and in the extent of involvement some evidence of greater resistance was found in the vaccinated cattle up to two-and-a-half years, but not beyond that age.

Experiments were carried out with three strains of B.C.G. Each strain was found susceptible to increase of virulence on the one hand and to complete attenuation on the other. In the earlier work in this investigation some of the vaccinated laboratory animals developed tuberculosis, but this has not been the case since 1928. The conclusion has been reached that by continuous culture and reproduction on the special laboratory media prescribed by Calmette, the potential virulence of the original strains has declined and vanished.

Published paper:

Watson, E. A. Studies on Bacillus Calmette-Guérin (B.C.G.) and Vaccination against Tuberculosis. Can. J. Research, 9 : 128-136. 1933.

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

Tuberculosis Research at the Fort Qu'Appelle Sanatorium

Throughout the year all Indians in the Qu'Appelle Indian Health Unit known to have tuberculous lesions have been under the observation of the medical superintendent, Dr. A. B. Simes, and nearly all of these have had hospital treatment. All school children were examined and 381 of them underwent complete examinations, including laboratory investigations and radiographs.

The general death rate was maintained at about 25% lower than it was before the institution of the health unit. Out of 1,109 persons in the unit only three deaths occurred in 1932 from tuberculosis, the lowest rate ever recorded, and less than half the tuberculosis death rate of the Indians of the province as a whole.

During the year 38 strains of tuberculosis have been isolated and typed and all proved to be of human origin. Lack of bovine tuberculosis is due in part to the fact that the Indians as a rule drink little milk.

A study of possible methods of infection of the healthy Indian children has revealed the fact that children with closed pulmonary lesions may nevertheless excrete germs of the disease in a variety of ways. In the File Hills school, where no children were admitted with closed pulmonary lesions, no new cases of tuberculosis have developed within the last four years. Children having calcified lesions have not been found completely immune against attacks of the disease.

(After hearing this report and very carefully considering the advisability of the vaccination of Indian children with B.C.G., the committee unanimously approved of such action being taken in the Indian Health Unit.)

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

Tuberculosis Research at the Queen Alexandra Sanatorium

During the year the new Mara Research Laboratories have been completed and put into operation. These laboratories have been specially equipped for tuberculosis research.

As previously, work has been carried out along two main lines of research, including biochemical investigations and X-ray studies.

The biochemical work to date has consisted in an attempt to isolate and concentrate tuberculosis antibodies in a protein-free medium. Considerable progress has been made and efforts will be continued to push this work to a successful conclusion. It is proposed also to try animal experimentation with fractions rich in antibodies and to extend the work to vaccination experiments. An improved technique has been worked out for concentrating tubercle bacilli and the method has been demonstrated of value in proving the existence of tuberculosis in many doubtful cases.

In the X-ray work much attention has been paid to what may be called the physics of the problem and especially the sharpness of X-ray shadows. It is hoped that it will eventually be possible to lay down the minimal technical requirements necessary to permit reasonably certain identification of disease processes in X-ray films. X-ray work has proved of value in detecting tuberculosis in a relatively early stage. Considerable evidence has been obtained to indicate that the disease does not always, as commonly supposed, begin in a definite focus of infection, but that it may be laid down in a substantial volume of lung tissue.

Published papers:

Hambleton, A. On the Mechanism of True and Non-specific Complement Fixation Reactions. Proc. Soc. Exptl. Biol. Med. 30 : 538-541. 1933.

Andrus, P. M. Chest Radiography and the Practitioner. Can. Med. Assoc. J. 26 : 308-312. 1932.

Andrus, P. M. The Interpretation of Apical Linear Shadows in Roentgenograms of the Thorax. Am. Rev. Tuberculosis, 25 : 89-98. 1932.

Andrus, P. M. and Hambleton, A. The Capacity of X-ray Tubes as Influenced by the Geometric Design of the Focal Spot, Including the Advantages and Limitation of the Line Focus Principle. Radiology, 18 : 521-531. 1932.

Hambleton, A. On the Mechanism of Complement Fixation. Can. J. Research, 7 : 596-605. 1932.

Hambleton, A. An Examination of Immune Serum Lipoids for the Complement Fixing Antibodies of Tuberculosis. Can. J. Research, 8 : 553–562. 1933.

(Investigation under the direction of Dr. P. M. Andrus.)

Tuberculosis Research at Queen's University

Work has been done during the year on complement-fixing antibodies in rabbits treated with S and R (smooth and rough) tubercle bacilli, on S and R type of tubercle bacilli in pulmonary tuberculosis, on oxidation-reduction potentials as a means of differentiation of types of tubercle bacilli, and on deep cultures. Some of these investigations are still in the preliminary stages.

Two series of experiments with rabbits appear to confirm the earlier conclusion that S forms (virulent) of tubercle bacilli contain two antigenic substances and that R forms (avirulent) contain one of these but not the other. It appears further that rabbits treated with heat-killed cultures produce either two specific antibodies or only one, according as the treatment is with S or R types.

In a study of S and R types of tubercle bacilli in pulmonary tuberculosis attention has been paid to the ratios of the complement fixation results in tests of the two types. While no definite relation has been found to exist in different types of the disease, it appears that the results obtained are of some prognostic value.

In the case of certain species of acid-fast bacteria, it has been shown that types of bacteria within the species may be distinguished by oxidation-reduction potentials. In the case of avian tuberculosis such a distinction is clear but the same does not apply to the S and R types of tubercle bacilli.

Preliminary experiments following the procedure of Dryer and Vollum have proved it possible to grow deep cultures of tubercle bacilli, but not to obtain dissociation of cultures as observed by these workers. Longer passages will be tried.

Published papers:

Boyd, E. M. and Reed, G. B. Oxidation-reduction Potentials in Cultures of *Es. coli*. Can. J. Research, 4 : 605-613. 1931.

Reed, G. B. Dissociation of *Microbacterium leprae*. J. Bact. 24 : 357-378. 1932.

Tuberculosis Research at the University of Alberta

Observations have been continued on 173 cattle vaccinated at birth and annually thereafter and kept in tuberculous herds over a period of years. About a year ago the method of vaccination was changed to double vaccination of B.C.G. intravenously into the jugular vein and at the same time subcutaneously into the dewlap in an effort to develop more rapidly the initial resistance to tuberculosis. In all, 34 animals have been subjected to double vaccination.

During the year tests of milk of 17 of these vaccinated cows have been carried out by injection into a total of 54 guinea pigs. These cows had been regularly vaccinated for five or six years. In only one case did the guinea pigs develop tuberculosis.

Double vaccination was carried out on 50 young animals which have since been kept isolated, along with 42 controls, for the purpose of checking up on the innocuity of B.C.G. These animals have been tuberculin tested three times, about two, five and twelve months, respectively, after the time of vaccination. On the first occasion about 25% of the vaccinated animals gave a positive reaction. The remainder gave negative or slight reactions. In the second and third tests all animals gave negative or slight reactions. At one year of age all the animals of both groups were therefore free from tuberculosis as determined by the tuberculin test.

(Investigation under the direction of Dr. A. Rankin.)

Tuberculosis Research at the University of Montreal

The number of newborn babies vaccinated with B.C.G. has now been increased to 2,570. The vaccine continues to show complete innocuity. Of the vaccinated children 402 are living in contact with either positive sputum

cases or clinically diagnosed or suspected cases of tuberculosis. Through the co-operation of the Bruchési Institute it has been possible to secure as controls a group of 623 unvaccinated children living under conditions of similar exposure to tuberculosis. These groups have been compared as to mortality and morbidity.

The general mortality of the vaccinated children from one to 12 months of age has been 80 per thousand as against 114 for the unvaccinated. In the groups one to five years of age the corresponding figures are 46 and 61. Considering all of these children, the difference in favor of the vaccinated group is 28%.

The death rate from tuberculosis alone of the vaccinated children from one to 12 months of age has been 12 per thousand as against 37 for the unvaccinated. In the groups one to five years of age the rates were 16 and 36, respectively. The totals of the two groups show 62% fewer deaths from tuberculosis amongst the vaccinated children. When the positive sputum cases alone are considered the difference is 78%, again in favor of the vaccinated children.

Of the children from one month to five years of age now living in contact with tuberculous cases 19 per thousand of the vaccinated and 49 per thousand of the unvaccinated children are apparently suffering from tuberculosis, a difference of 60% in favor of the former.

Each succeeding year of this investigation has brought new evidence of the complete harmlessness of vaccination with B.C.G., as well as a subsequent lowered general mortality, lowered mortality from tuberculosis, and lowered percentage of living children suffering from tuberculosis.

(Investigation under the direction of Dr. J. A. Baudouin.)

Tuberculosis Research at the University of Toronto

Five hundred and sixty-two cases of clinical tuberculosis have been investigated with a view to ascertaining the types of the infecting organisms. Of the 306 cases of children under 14 years of age, 14.05% were found to be infected with the bovine type of bacillus as against 2.6% of 266 adult cases. In this study it has been demonstrated that bovine tubercle bacilli produce tuberculous lesions in man in all organs and tissues and that these lesions are clinically indistinguishable from those of the human type.

A special study has been made of a case of tuberculosis of the conjunctiva, the mucous membrane of the eye, a type of infection which is very rare. Contrary to expectation, this case proved to be one of bovine tuberculosis. The patient was operated upon and subsequently made a rapid recovery.

Forty cases of active clinical tuberculosis were investigated for the purpose of determining the presence of tubercle bacilli in the blood. The cases comprised 20 children and 20 adults. Various methods were used. Thirty-six patients failed to show tubercle bacilli in the blood either culturally or biologically. In four cases, including three adults and one child, the presence of tubercle bacilli in the blood was demonstrated.

The stability of various types of tuberculosis was investigated by means of animal passage to determine whether there might be mutation of type. Avian, bovine and human types were used, and guinea pigs, rabbits, fowl, cats and dogs were employed for purposes of inoculation. This work is still incomplete, but the results so far obtained indicate that the cultural and biological quality of these three types of bacilli are not easily altered by animal passage.

(Investigation under the direction of Dr. Oskar Klotz.)

Associate Committee on Weed Control

Co-operating organizations:

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

The fourth annual meeting of the Associate Committee on Weed Control was held at Edmonton on January 19 and 20, 1933. Reports then received from the various co-operators are summarized below.

Publications:

Report No. 26—Weed Survey of the Prairie Provinces—J. M. Manson.

Report No. 27—Weeds and their Control—G. P. McRostie, L. E. Kirk, G. Godel, W. C. Smith and J. M. Manson.

Vegetative Propagation of Wild Oats, *Avena fatua*, and other Economically Important Species of *Aveneae* and *Hordeae*—L. E. Kirk and T. K. Pavlychenko, Can. J. Research, 7 : 204-220. 1932.

Some Considerations in Regard to Experiments with Chemical Herbicides—G. L. Godel, Can. J. Research, 7 : 449-519. 1932.

"Smutty" Wheat caused by *Ustilago utriculosa* on Dock-leaved Persicary—O. S. Aamodt and J. G. Malloch, Can. J. Research, 7 : 578-582. 1932.

Decomposition and Movement of Herbicides in Soils, and Effects on Soil Microbiological Activity and Subsequent Crop Growth—W. E. Bowser and J. D. Newton, Can. J. Research, 8 : 73-100. 1933.

The Relation of Species of *Agropyron* and Certain Other Grasses to the Foot-rot Problem of Wheat in Alberta—G. W. Padwick and A. W. Henry, Can. J. Research, 8 : 349-363. 1933.

Fire Hazards in the use of Oxidizing Agents as Herbicides—W. H. Cook, Can. J. Research, 8 : 509-544. 1933.

Weed Investigations by the Federal Department of Agriculture

The Field Husbandry Division of the Central Experimental Farm and a number of branch farms and stations have continued the study of cultural practices, crop rotations, fertilizers, and chemical eradicants for the control of weeds.

Pasture surveys conducted by the Division of Botany indicate that fertilizer applications and regulated grazing affect the proportions of weedy and other constituents of pastures. Other investigations by this Division include the determination of phenological data (range of flowering period, date of seed ripening, etc.), of value in the formulation of control measures, for more than 100 weeds. A systematic survey of wild plants is also being carried on, field work this year extending from the maritime provinces to Scott, Sask.

The Division of Chemistry is investigating methods of eradicating moss infestations of grass land.

Weed Investigations by the Alberta Department of Agriculture

The herbicidal treatment of perennial weeds has been continued along lines similar to those of previous years. Canada thistle and perennial sow thistle received most attention but preliminary experiments were made for the first time on blue lettuce, wild morning glory, leafy spurge, salt grass, veined dock and hoary cress.

Spraying of sow thistle by sodium chlorate appeared equally effective at all times throughout the summer. Late fall treatments of Canada thistle however were not as effective as those made during mid-season. Treatment of couch grass proved most effective one month after mowing.

Slight or no increases in yield were obtained from wheat treated with sulphuric acid to remove stinkweed.

Application of zinc sulphate at the rate of two gallons of a 27% solution per 10 sq. yd. was not effective in inhibiting the germination of annual weed seeds.

(Investigations under the direction of Messrs. E. L. Gray and W. G. Smith.)

Weed Investigations by the Manitoba Department of Agriculture

Two extensive surveys have been made to determine the distribution of the most important weeds occurring in the province. A definite study of weed losses has been undertaken, and determinations made of the annual losses attributable to weeds in the growing crop.

Two types of rotary tiller and several new types of duckfoot cultivator were tested for the control of perennial and annual weeds. Modifications of the cultivators are being made in order to render them more effective.

The experiments with chemical weed killers now permit definite recommendations to be made with respect to their use.

Investigations covering two years indicate that the great majority of weed seeds lose their power of germination after being ensiled for a period of two weeks or over.

(Investigations under the direction of Mr. Geo. Batho and Dr. G. P. McRostie.)

Weed Investigations by the Saskatchewan Department of Agriculture

Experiments have shown that even a light mustard or stinkweed infestation of wheat causes a significant reduction in yield. For the control of wild mustard in wheat, copper nitrate and copper sulphate are better herbicides than sulphuric acid, but the latter is best for stinkweed. Copper sulphate causes less injury to the crop than sulphuric acid, hence can be used at a later stage of crop development.

Under 1932 conditions partial control of wild oats and wild mustard was obtained by increased rate of seeding wheat. Phosphatic fertilizers drilled in with wheat reduced wild oat infestation and improved crop yield, providing early seeding was practised.

The experiment on control of poverty weed by tillage is continuing at Eston. The weed persisted on all plots in 1932 irrespective of cultural treatment in 1931.

Cultural experiments on the eradication of couch grass have been commenced at the provincial farm, Lockwood.

(Investigations under the direction of Mr. S. H. Vigor.)

Weed Investigations at the University of Alberta

Further studies have been conducted on the decomposition and movement of herbicides in soils and their effect on soil microbiological activity and subsequent crop growth. Applications of sodium chlorate made in 1930 and 1931 are still depressing the yields of wheat, oats and barley. Flax, a shallow-rooted crop, was not affected by the chlorate treatments of the previous year, and as a result of the elimination of weed competition increased yields were obtained. Sodium dichromate and ammonium thiocyanate applied late in June greatly depressed the yield of the growing wheat crop.

Applications of ammonium thiocyanate had no significant effect upon the numbers of fungi found in soils. Bacterial numbers were temporarily stimulated in sandy loam soil, the effect disappearing by the eighth week. Nitrate nitrogen was depressed, soil types showing differences in rate of recovery.

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

A survey has been made to ascertain the extent to which certain wild and cultivated grasses in Alberta are harboring fungi capable of causing foot rots of wheat. Couch grass and western rye grass were both found heavily attacked, under natural conditions, by strains of the take-all fungus and of *Helminthosporium sativum* highly pathogenic to wheat.

Couch grass appears to encourage the survival of the take-all fungus in summerfallow, while in wheat fields infected couch grass was found associated with severe damage to the crop.

Observations indicate that in the moister parts of the province wheat following western rye grass in rotations may be severely injured by take-all.

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

Weed Investigations at the University of Manitoba

Intensive studies have been made of the food reserves and growth characteristics of the underground portions of couch grass and perennial sow thistle. In the case of perennial sow thistle two definite types of root occur: a lateral system, to be found from one to six inches below the surface of the soil, and a vertical system originating from the lateral system and penetrating to any depth up to eight feet. As either root system is capable of producing new growth at any point, the impossibility of control by deep cultivation is obvious. The couch grass studies have revealed wide differences in the growth of old root stocks in different types of soil.

Increasing the rate of seeding of various cereal crops appears to offer promise as a means of controlling weeds. Oats seeded at $7\frac{1}{2}$ bushels per acre proved more efficient than barley, common wheat or durum wheat sown at proportionate rates. Harrowing after weeds and crop had attained three or four inches of growth materially reduced the number of weeds, but not necessarily the proportion of weeds to crop harvested.

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

Weed Investigations at the University of Saskatchewan

Cereals developed more rapidly than weeds in the seedling stage but the reverse was true at later growth stages. This emphasizes the importance of giving cereal crops as good a start as possible.

Observations on the root system of Canada thistle revealed two distinct types of side runners. The first usually produces vertical roots and new shoots close to the parent plant. The second produces no vertical roots but serves the purpose mainly of lateral spread over large distances (31 ft., 6 in., in one case), producing many new shoots, which become independent plants.

Excavation of two-year-old couch grass sod showed that the majority of stolons were confined to the first five inches below the surface. Fibrous roots grew abundantly from every stolon node, approximately 40% penetrating deeper than 42 in. Each fibrous root on its way downward produced side branches, roughly at the rate of 16 per linear inch.

Perennial sow thistle, Canada thistle and couch grass were eradicated by the shallow cultivation method in from 12 to 18 weeks. Chemical analysis of the roots showed that death of the plants was due first to the attenuation of the reserves of soluble carbohydrates stored in the underground organs, and second to the action of bacteria in hastening the decomposition of the root material.

Striking differences existed between various crops in their ability to compete with weeds. Cereals as a group vied quite successfully with weeds as a group. Competing efficiency of cereal and weed species tested was correlated with the length and mode of distribution of their root systems.

A small proportion of plants emerged from wild oat seeds planted at a depth of 12 in. Of the other weed seeds studied, cow cockle alone emerged from any depth (5 in.).

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

Note.—Experiments with chemicals as herbicides, by Dr. W. H. Cook, and various experiments on weeds and weed seeds, by Mr. J. M. Manson, will be found summarized in the Report of the Division of Biology and Agriculture, pages 26 and 27. Experiments on the chemical utilization of refuse screenings, by Dr. C. Y. Hopkins, are summarized in the Report of the Division of Chemistry, page 37.

Associate Committee on Wool

Co-operating organizations:

Canadian Co-operative Wool Growers
Canadian Woollen and Knit Goods Manufacturers' Association
Dominion Department of Agriculture
University of Alberta
University of Saskatchewan
Wool Industries' Research Association (Great Britain)

Another year of continued activity, particularly in regard to wool growing, may be recorded. Two meetings have been held of the Subcommittee on Wool Grading, one each of the Section on Wool Growing and of the Associate Committee, and a conference on problems of wool manufacture. The Subcommittee on Wool Statistics has also been active.

The wool growing program for the winter of 1932-33 was laid out at a meeting of the Wool Growing Section held in Winnipeg on June 16, 1932. Dr. W. H. Fairfield of the Dominion Experimental Station at Lethbridge has been carrying on, without financial assistance from the National Research Council, experiments with Corriedale sheep, building up a purebred flock and crossing these with fine-woolled Rambouillet sheep. This work is to be continued.

A mass-breeding experiment involving the crossing of Corriedale and Rambouillet rams with Rambouillet ewes has been carried out at Cardston in co-operation with Mr. G. Nielson, a prominent farmer. Considerable

improvement in the quality of mutton has been effected by the cross, but more time is required to determine whether the wool can also be improved.

Prof. Sackville has continued his experiments at Edmonton on the influence of moisture, temperature, time of shearing, plane of nutrition, and rate of feeding of protein and mineral matter on the quality of wool. Wool from all the experimental sheep is being tested at Ottawa and is reported under the Division of Chemistry, page 39. Arrangements have been made for greater uniformity in flocks for succeeding experiments.

Dean Shaw at Saskatoon has obtained interesting results by crossing English Leicester, Romney March, Cheviot, Corriedale and Ryeland rams with Rambouillet ewes with a view to the development of sheep suited for ranch conditions in western Canada and combining desirable characteristics in regard to both mutton and wool. The first two of these breeds have now been discarded as unsuitable, but the others have given results which fully warrant the continuation of the experiment.

Dean Shaw's work has raised the question of the advisability of undertaking a more comprehensive breeding program with the object of combining in one breed all the most desirable qualities of several. A subcommittee has been appointed to consider this question.

Arrangements were made by the committee to have special grading tests carried out at the warehouse of Canadian Co-operative Wool Growers at Weston, Ontario, on fleeces from the experimental sheep. This grading was done in September, 1932, and provided a great deal of valuable information by indicating the extent of the progress which had been made. The comparison of results of grading tests and laboratory studies made on the same fleeces has also proved of the greatest interest.

At the time of these grading tests members of the committee had an opportunity to examine a large quantity of Alberta wool and found some of it of such excellent quality that a recommendation was made to the associate committee that some of this fine wool be made up into cloth for men's wear, with a complete record of the behavior of the wool during manufacture. This is now being done and the results will be of great interest in view of the fact that Canadian wool has not previously been regarded as suitable for this purpose.

At the Conference on Problems on Wool Manufacture, held in Toronto in November, 1932, with representatives of the manufacturers and the Ontario Research Foundation, there was a full discussion of the different phases of the committee's work and the relation of provincial and national research bodies in the selection of projects. It was the consensus that standardizing work in connection with the textile industry belonged definitely to the National Research Council. The suggestion was made that the Council could do valuable service in having a survey of the wool industry made by a competent man. It was finally agreed that a small committee give further consideration to this matter, but in view of economic conditions it has not been possible to take any definite action up to the present.

Through a Subcommittee on Wool Statistics arrangements have been made with the Dominion Bureau of Statistics for annual surveys of wool production and consumption in Canada by grades, and the first survey has already been carried out. It is felt that this information will be of the greatest assistance in enabling wool growers to learn the requirements of the industry in this country and to frame their policies accordingly.

During the year Mr. S. Chagnon has retired from the committee and appointments have been made of Mr. A. Morin of the Quebec Department of Agriculture and Dr. P. Larose of the National Research Laboratories.

SPECIAL COMMITTEES

Executive Committee of the Fifth Pacific Science Congress

In November, 1932, the Government decided to proceed with the postponed Fifth Pacific Science Congress in June, 1933, in view of the commitments already made. Fortunately, during the year of postponement, authors had the opportunity to revise and enlarge their papers, and in some cases to carry out additional research.

Meetings of the Executive Committee, convened in Ottawa, December, 1931, and in Vancouver, January, 1932, served to co-ordinate and consolidate the preparatory work that had been undertaken, and enabled plans to be made for the continuance of a skeleton organization so that activities might be resumed with the least possible loss.

Arrangements were completed for the preparation of the necessary publications in connection with the Congress, including a handbook of Canada for the general information of delegates, presentation volumes of a scientific character, guide books for excursions to places of interest during the Congress, for the scientific program and for the printing in advance of abstracts of all papers so that these might be made available during the meetings. A Committee on Publications was appointed to have charge of this work.

A consolidated index to the proceedings of all previous Pacific science congresses was compiled for convenience of reference in the planning of the scientific program for the Fifth Congress, which proved to be so useful that it was thought such an index, complete with reference to the first five congresses, might be published when the proceedings of the Fifth Congress were being issued.

Further meetings of the Executive Committee were held in Ottawa in December, 1932, and in Vancouver during the following month. Consideration was given to the selection of dates so as to avoid conflict with other meetings of similar interest and it was decided to hold the opening meeting in Victoria, on Thursday, June 1. Sessions were arranged to continue in Victoria until Sunday, June 4, when the delegates would be taken by steamer to Nanaimo. Here an inspection would be made of the Biological Station and an opportunity would be afforded the visitors to see the big timber in Cathedral Grove, some 28 miles distant by automobile. Thence the party would proceed to Vancouver for a ten-day period of scientific meetings. It was proposed also to take the delegates on a short tour of the interior after the Congress, so that the foreign members might see something of the forest resources, industrial development and agricultural features of western Canada.

In accordance with a desire expressed in the appointment of a Committee on Organization at the Fourth Congress in Java, to devise means of reducing the host country's expenditures for the entertainment of Congress delegates, the Executive Committee agreed to accept the suggestions put forward by the Committee on Organization, and to notify all participating countries that free entertainment would be provided only for a specified quota of delegates, each of whom should be duly accredited by his own country, as an official representative. Provision was made for the entertainment of all other delegates at such reduced rates as it was possible for the Congress to obtain in Victoria and Vancouver. Arrangements were made for the establishment

of a Congress office in Vancouver for a month preceding the meeting so that the necessary details of organization might be completed.

Most of the important countries with interests in the Pacific area have signified their intention of taking part in the Congress, and a large number of scientific papers have already been received. The character of these contributions is such as to indicate that the Fifth Pacific Science Congress will be notably successful in increasing present scientific knowledge of this region and in co-ordinating plans for research on unsolved problems.

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service

During the year a number of meetings were held to draft specifications for the approval of type of electrical measuring instruments as used for billing purposes. The specifications were prepared after carefully reviewing the regulations in force in other countries and consulting other interested parties in Canada. Moreover, the draft specifications were submitted to these interested parties for comment; the agreement was most gratifying and it is felt that with the exception of a few minor details the specifications have met with complete approval.

The specifications drafted are as follows:

1. Specifications for approval of type of watthour and amperehour meters.
2. Specifications for approval of type of electricity demand meters.
3. Specifications for approval of type of curve-drawing electricity meters. (These specifications apply only to so-called graphic meters which record instantaneous values.)
4. Specifications for approval of type of instrument transformers and phase shifters.

The above specifications were submitted to the National Research Council and officially approved. It should be understood that they apply only to approval of *type* and they should not be confused with regulations for the inspection of meters and auxiliary equipment, with which the committee is not concerned.

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 a number of the summaries.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 57.

Infertility of Some Quebec Soils

Co-operating organization:

Macdonald College

These investigations aim at the discovery of the causes of the relative infertility of some Quebec soils and the determination of means for their improvement. Preliminary study has shown that the two least fertile soil groups resemble one another in that both are badly leached by heavy rainfall and each possesses a distinct ash layer. However, one of these, the Appalachian upland podsol group, which is found at altitudes of 400 ft. or more, is characterized by a great accumulation of organic matter in the surface layer. This organic matter may be inert or may even be detrimental to fertility. It has been shown that its presence is associated with the marked acidity of the soils and the acidity operates in conjunction with the rainfall to remove important fertility elements to lower soil horizons.

In order to decompose the organic matter, or so to change its form that it would increase rather than reduce fertility, and also to counteract the acidity, chemical treatments were applied. This was done under conditions approximating as far as possible field conditions, and the quantities applied were equivalent to the proportions of lime used in farm practice. Water was applied to the treated soils and the solution which was obtained by percolation was analyzed, in order to determine the effects of the treatments on the soil solution. By this means it was shown that calcium oxide and sodium carbonate were most promising as improvers of these soils. Sodium carbonate is a constituent of the "black alkali" soils of arid regions which are opposite in their characteristics to acid soils. Its use as an improver of acid soils therefore has theoretical support.

A number of the treatments brought about desirable changes in the organic matter and provided more suitable conditions for the nutrition of plants and beneficial soil micro-organisms. Since the addition of chemicals may bring about new conditions in addition to the improvement immediately desired, study has been devoted to other phenomena in these treated soils. For example, considerable quantities of iron and aluminium, both of which may be detrimental to plant growth, were removed in the percolate with the humus material. The development of a method for the extraction of these became necessary. Such a method has been devised and studies of the compounds involved are proceeding. Much information of theoretical value in soil improvement work has been compiled in addition to that of a purely practical character.

Published papers:

McKibbin, R. R. Climate and Soil Leaching Variations in Quebec. Sci. Agr. 13 : 413-425. 1933.

McKibbin, R. R. Soil Organic Matter. J. Am. Soc. Agron. 25 : 258-266. 1933.

McKibbin, R. R. and Gray, P. H. H. Chemical and Microbiological Factors in some Quebec Soils. Can. J. Research, 7 : 300-327. 1932.

(Investigation under the direction of Dr. R. R. McKibbin, Macdonald College, McGill University.)

Microbiology of Quebec Soils

Co-operating organization:

Macdonald College

The fertility of soils depends to a great extent on the activity of micro-organisms. For this reason investigations into the causes of the relative infertility of some virgin podsol soils of Quebec included studies of the numbers and activity of their micro-organic populations. The presence, in the surface layer of the soils studied, of large quantities of organic matter which should serve as a source of energy for micro-organisms, would normally produce greater microbiological activity than occurs in these soils. The numbers of micro-organisms are very much greater in the surface layer than in the lower ones. The activity is also greatest in the surface horizon and is apparently determined by the organic matter relations. Experimental evidence suggests that the lower numbers and reduced micro-organic activity are not due to toxic materials leached from the upper layer.

Deep plowing has been suggested as a means of overcoming the infertility of these soils. This would assume that the mixing of the lower and upper horizons would return to the surface layer some important nutrients which had previously been leached out. The effect on the micro-organic population of such mixing of different quantities of soil from the so-called "mineral layers" with the organic matter layer was found to be a reduction of numbers and activity, due, apparently, merely to dilution of the original population of the surface layer. These virgin soils show greater micro-organic activity, as measured by carbon dioxide evolved, than do soils of the same type which have been under cultivation for many years. Bacterial numbers, on the other hand, are considerably higher after cultivation. This is probably explained by the fact that cultivated soils have received organic manures and fertilizers since they were first broken up.

Published paper:

Gray, P. H. H. and McMaster, N. B. A Microbiological Study of Podsol Soil Profiles. Can. J. Research, 8 : 375-389. 1933.

(Investigation under the direction of Dr. P. H. H. Gray, Macdonald College, McGill University.)

The Beech Bark Disease

Co-operating organizations:

Arnold Arboretum, Harvard University
Nova Scotia Department of Lands and Forests

The investigation, begun in 1930, into the cause and possible measures of control of a disease of beech trees in Nova Scotia, has now been completed, and the results will appear shortly in a special number of the Canadian Journal of Research.

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From a careful survey of the forests in Nova Scotia it was estimated that of some 304 million cubic feet of standing beech timber the disease had destroyed at least 100 million cubic feet. Observations on the spread of the disease indicate that there is a possibility that the beech in eastern Canada and the United States may become a commercially extinct species, sharing in this regard the fate of the chestnut in the United States and the larch in Canada.

The disease has been shown to be due to the combined attack of an insect and fungus parasite.

Apparently, the insect has been present in Nova Scotia for many years without causing any serious damage. In an infested area countless numbers of minute yellow larvae secrete a soft fluffy white down in the late autumn. This down persists in crevices of the bark and eventually the trunk and branches of infested trees appear at a distance as though they were coated with driven snow.

The insect paves the way for the attack of a fungus which of itself is unable to gain entrance to the living tissues of the tree. Once the fungus becomes established, interference occurs with the food-conducting and storage system of the trunk and larger branches. Symptoms of moisture deficiency become apparent in the crown of the tree, so that the foliage curls, dries and becomes brown. Many branches fail to produce buds and the tree usually succumbs the following season.

As soon as the trees are weakened or dead many other insects and semi-parasitic fungi can successfully attack them. This process may take a year or more and in the meantime much valuable timber may be salvaged. Attention of foresters and lumber companies is directed toward the possibilities of cutting and marketing much of the dead timber before it is too late. Such operations will be of great help as control measures, since removal of dead trees will give the younger and more vigorous trees a chance to survive.

In an attempt to produce conditions which will restrict the activity of the pathogens, and substitute a younger, less susceptible stand of beech, growth of this species might be encouraged on broad ridge-tops rather than steep slopes, and the larger trees might be culled. Other control measures might aim at the possibility of combatting the insect pathogen with fungus and insect enemies. Such a method would be applicable over wide areas. It has been found quite possible to control the disease on ornamental trees by spraying with an insecticide; early eradication of the insect by this means prevents the fungus from attacking the tree.

Published papers:

Ehrlich, J. Bark Disease of Beech. Prov. Nova Scotia Rept. Dept. Lands and Forests, 1930 : 36-37. 1931.

Ehrlich, J. The Occurrence in the United States of *Cryptococcus fagi* (Baer.) Dougl., the Insect Factor in a Menacing Disease of Beech. J. Arnold Arboretum, 13 : 75-80. 1932.

Ehrlich, J. *Nectria coccinea* on Beech. Phytopathology, 23 : 10. 1933.

(Investigation under the direction of Mr. O. Schierbeck, Nova Scotia Department of Lands and Forests, and Dr. J. H. Faull, Arnold Arboretum.)

Gas and Water Content of Trees and the Sinkage Problem

Co-operating organizations:

Canada Paper Company

McGill University

Continued work on this problem has shown that there is a decrease in the water content of hardwoods during the summer and a corresponding increase in the fall and winter. Large diurnal variations in moisture content have also been demonstrated in the birch, decreases occurring in the morning and increases in the afternoon and evening. The water content of any annual ring at any given time is constant throughout the tree. This is evidence of continuous water columns in the conducting tracts of the tree.

Spruce dried more slowly and less regularly than balsam following girdling. The rapid seasoning of balsam previously reported has been confirmed. Observations of various life processes suggest that a study of soil temperatures may provide further information on the problem. The investigation will be continued.

(Investigation under the direction of Mr. R. D. Gibbs, McGill University.)

A Study of the Structure and Physiology of the Higher Fungi

Co-operating organization:

University of Manitoba

Progress in our understanding of many diseases of plants and animals depends on information on the morphology and physiology of the fungi. Much new information has been made available to workers in these fields through the comprehensive six-volume publication "Researches on Fungi" by Dr. A. H. Reginald Buller.

In a recent study of human skin diseases it was found that hyphal fusions were of importance in determining the identity of the causal organism. Since these fusions play an important role in the life cycle of many fungi, a detailed study of the process in the higher fungi has been made during the past year. The fusions have been grouped in four main classes and a new terminology has been used in describing them.

The formation of clamp connections in certain fungi has been studied for many years but several features have remained obscure. The exact mode of formation has now been described and an explanation offered as to why the hook grows backward instead of forward.

Further work has been done on the genus *Pilobolus*, including studies on spore discharge and germination, and the description of a new species.

The bread-mold fungus, *Rhizopus nigricans*, has been studied with special reference to the evacuation of protoplasm from, and the formation of septa in, the mycelium.

Problems dealing with the nature of protoplasmic streaming and experiments on wounding and regeneration in the septate hyphae of Pyrenomycetes, Discomycetes and Hymenomycetes have been discussed.

(Investigation under the direction of Dr. A. H. R. Buller.)

Parasites of the Gopher in Manitoba

Co-operating organization:

University of Manitoba

A survey of the parasites of gophers in Manitoba was carried out to determine which were potential destroyers of the gopher, or transmitters of disease from gophers to man and the higher animals. In 236 post-mortems 12 parasites were found, all except one previously unrecorded. One of these is known as the transmitter of tularemia and Rocky Mountain spotted fever in other parts of America. The survey indicated that a number of the parasites could produce epidemic mortality of the gophers, and that infestation increases with overcrowding and lowered resistance.

Published paper:

McLeod, J. A. A Parasitological Survey of the Genus *Citellus* in Manitoba. Can. J. Research, 9 : 108-126. 1933.

(Investigation under the direction of Prof. R. A. Wardle, University of Manitoba.)

Laws Governing the Special Senses

Co-operating organization:

University of Manitoba

It has long been noticed that the sense organs of the body do not operate at a perfectly steady rate, but that their activities fluctuate from one state of sensitivity to another. These changes have in late years become of great importance in the industrial world, owing to the advisability of giving suitably arranged rest periods to workmen.

The cause of many fluctuations may be traced to two types of nerve actions, inhibition and facilitation. These factors, formerly studied with regard to the sense of touch, have now been investigated in the sense of vision in the special case of the rivalry of colors in the two eyes.

When a red color is viewed by one eye and a green color simultaneously by the other, sometimes the red color alone is visible, then the green alone, and often the two colors fuse into a yellow sensation. By a suitable recording device the time intervals of seeing each of the colors and the fusion yellow were obtained. The oscillations were very regular, and could be readily explained in terms of the fluctuations of the nervous actions of inhibition and facilitation.

Published paper:

Allen, F. Binocular Oscillation and Fusion of Colors. Can. J. Research, 8 : 390-401. 1933.

(Investigation under the direction of Prof. F. Allen, University of Manitoba.)

Spectroscopy in the Ultra-violet

Co-operating organization:

University of Alberta

There are few methods by which the innermost portion or nucleus of atoms may be studied. One of the methods is to investigate the finest modulations of the wave-lengths emitted by the atoms, the so-called hyperfine structures. These reveal small differences which are believed to be due to the spin of the nuclei.

The nucleus known to spin with the greatest energy is that of bismuth. The changes of wave-length which this motion produces have been checked in the region of those light waves which pass through quartz, but which are held back by glass. Two quartz Lummer plates of thickness 4.49 mm. and 5.83 mm. were used in this work.

The lines investigated are at wave-lengths 5209, 4259, 4301 and 4079 Å. The missing component in 5209 has been found and the radiation at 4259 shown to consist of four components.

(Investigation under the direction of Prof. Stanley Smith, University of Alberta.)

Spectroscopy and Atomic Structure

Co-operating organization:

University of Alberta

The growing complexity of industrial alloys and the importance of small quantities of impurities have led to the adoption of the spectrograph in the metallurgical industry. A rapid analysis, however, is in general possible only if the structure of the arc and the first spark spectrum are fairly well known.

Antimony is often added to metals to increase their hardness. An investigation of the first spark spectrum may therefore prove useful. Several sources of light were used in such a study, the spark in hydrogen, the spark in vacuum and the discharge in a hollow carbon cathode in an atmosphere of helium or neon, the antimony being held in a thin layer around the inside wall of the tube. The spark spectrum extends from the infra-red to the extreme ultra-violet region with strong radiations scattered through most of the entire range. The spectrum is weakest in the near ultra-violet where the strong lines of the arc spectrum fall. The wave-lengths due to the return of the electron from the second deepest energy level to the normal state are found between 1300 and 2000 Å. About 50 more energy levels have been determined, based upon the classification of nearly 200 lines.

Published paper:

Lang, R. J. and Vestine, E. H. First Spark Spectrum of Antimony. Phys. Rev. 42 : 233-241. 1932.

(Investigation under the direction of Prof. R. J. Lang, University of Alberta.)

Kennelly-Heaviside and Appleton Layers

Co-operating organization:

McGill University

The bending of radio waves round the curved surface of the earth, which permits communication to be established between distant countries, is due to the existence of electrically conducting or ionized layers more than 60 miles above the ground. There are at least two different layers, the lower one, or Kennelly-Heaviside layer, at a height of from 60 to 110 miles, and the upper, or Appleton layer, at a height of from 175 to 275 miles. The general behavior of the ionized regions is fairly well known, but their height and reflecting power may vary from day to day, and it is of importance to gather as much information as possible about such zones, whose unforeseen disturbances may disrupt radio contact between continents for hours at a time on certain wave-lengths.

Utilizing apparatus assembled to investigate the height and properties of the ionosphere at the time of the total eclipse of the sun, on August 31, 1932, a program of observation was carried out fitting in as closely as circumstances permitted with the observations made all over the world on what are known as international polar days. The method used was to send a special short radio signal from a transmitter and intercept it on a nearby receiver. The direct signal and the reflected pulses were recorded in such a way that it was possible to measure the time, about one thousandth of a second, which they had taken to complete the journey up and down. As the speed at which radio waves travel is known, the distance covered may be calculated, and this gives the so-called equivalent height of the reflecting layer.

So far as the results go, it will not be possible to reach any definite conclusions until the data which they contain have been compared with reports from meteorological stations concerning magnetic and electric disturbances.

(Investigation under the direction of Dr. A. S. Eve, McGill University.)

The Action of Alkali Water on Cement and Concrete

Co-operating organizations:

Canada Cement Company
University of Saskatchewan

As stated in the fifteenth annual report, the Canada Cement Company has already begun the manufacture of an alkali-resistant cement (Kalicrete) at its plant at Exshaw, Alberta. The cement produced there has now been used in some large structures in districts where alkali action is appreciable.

The laboratory work carried out during the year under review has included further tests of the efficiency of various methods of preventing the deterioration of concrete in alkali soils and also a study of the effect of the chemical nature of aggregates on the properties of concrete.

Laboratory measurements have been continued on test pieces of concrete subjected to sulphate action. Some of these pieces have now been exposed for more than eight years.

A large number of concrete specimens have been made up for experimentation under field conditions. In many of these specimens a product of the National Research Laboratories has been incorporated in order to determine the extent to which it increases the resistance of the concrete to alkali action. Specimens will at first be examined every three months and later semi-annually.

Tests of numerous high-iron cements have been continued. The behavior of these cements has so far been found entirely in agreement with what was to be expected from laboratory experiments on the pure cement constituents.

In the study of aggregates an investigation is being made of the effect of surface area of a silica aggregate on the strength of test pieces. Steam curing of concrete containing fine aggregate is also being studied.

(Investigation under the direction of Dr. T. Thorvaldson.)

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