NATIONAL RESEARCH COUNCIL ANNUAL REPORT 1929-30

Division of Chemistry,
National Research Laboratories,
Ottawa.

118

Dominion of Canada

THIRTEENTH ANNUAL REPORT

of the

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

and

FINANCIAL STATEMENT

1929-1930

Ottawa, Canada

OTTAWA, January 24, 1931.

The HON. H. H. STEVENS,

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

Ottawa, Ont.

SIR:

I have the honor of presenting to you herewith the Thirteenth Annual Report of the National Research Council, for the fiscal year 1929-1930.

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.

THE SUBCOMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH, 1929-1930.

Minister of Trade and Commerce, Chairman.

Minister of Finance

Minister of the Interior and Mines

Minister of Agriculture

Minister of Pensions and National Health.

Minister of Labour.

Minister of National Defence.

NATIONAL RESEARCH COUNCIL

1929-1930

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Hume Cronyn, B.A., LL.B., General Manager, Huron and Erie Mortgage Corp., London, Ont.

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H. M. MacKay, B.A., B.A.Sc., M.Am.Soc.C.E., Dean of the Faculty of Applied Science and Professor of Civil Engineering, McGill University, Montreal, Que.

A. S. Mackenzie, Ph.D., D.C.L., LL.D., F.R.S.C., President, Dalhousie University, Halifax, N.S.

J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S., Professor of Physics and Director of the Physics Laboratory, University of Toronto, Toronto, Ont.

W. C. Murray, M.A., LL.D., F.R.S.C., President, University of Saskatchewan, Saskatoon, Sask.

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

Julian C. Smith, M.E., LL.D., M.E.I.C., Shawinigan Water and Power Company, Montreal, Que.

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THIRTEENTH ANNUAL REPORT
of the
NATIONAL RESEARCH COUNCIL

REPORT OF THE PRESIDENT

I. REVIEW OF ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL

Introduction

During the period covered by this annual report the National Research Council has completed the thirteenth year of its existence. At the present time it may fairly be described as entering upon a new phase of its activities.

Established in December, 1916, by the Dominion Government, the Honorary Advisory Council for Scientific and Industrial Research, as it was then called, found itself greatly handicapped during its early years by the lack of laboratory facilities. The only research laboratories of any consequence existing in Canada at that time were those of the universities, where many valuable researches were even then under way, but where the work was often seriously limited by lack of funds. This deficiency the National Research Council undertook to remedy, in especially urgent cases, by the provision of special equipment or much-needed technical assistance. The serious shortage of scientifically trained men which the country was then experiencing led to the establishment of postgraduate research scholarships in the universities. Advisory committees were also created in some of the more important branches of science and technology, in order that the Council might have the benefit of the advice of specialists in extending its various activities.

Since 1924 the work of the National Research Council has expanded considerably through the establishment of a number of research committees to undertake investigations on major problems, some of them of national importance. Amongst these may be mentioned black stem rust of wheat, tuberculosis in man and animals, wool growing and manufacture, house insulation, and the utilization of Canadian deposits of dolomitic magnesite. Arrangements were made for co-operative researches in the laboratories of federal and provincial government departments and the universities. The establishment of a small research laboratory in connection with the magnesite investigation foreshadowed the day when national research laboratories, on a scale called for by the number and magnitude of our problems, should be built and equipped by the Dominion Government. That day, ushering in a period of rapid expansion in scientific and industrial research, is now at hand.

The Council

At the end of the fiscal year 1928-1929 there occurred the retirement of three members of the National Research Council, Dr. A. B. Macallum, Dr. R. F. Ruttan (since deceased) and Mr. J. A. McClelland.

Upon the establishment of the Council in 1916 Dr. Macallum was appointed its first administrative chairman. Under his direction the Council was organized, and a nation-wide survey was carried out to ascertain the extent of the scientific man-power of Canada and the country's laboratory facilities for scientific and industrial research. This led to the establishment of the systems of postgraduate scholarships and assisted researches already referred to above. In 1920 Dr. Macallum resigned from the chairmanship of the Council to become Professor of Biochemistry at McGill University, but he continued to serve as a member of the Council and of several of its most important committees. In his retirement the Council loses the services of one whose name will always be associated with the early years of the Council's activities.

Dr. Ruttan was one of the original members of the National Research Council, and upon the resignation of Dr. Macallum as administrative chairman he was appointed to this position, in which he continued for six months. He then resigned, owing to the pressure of his duties as Director of the Department of Chemistry at McGill, but continued to give freely of his time and energy as a member of the Council, as Chairman of the Associate Committee of Chemists, and as a member of several other committees. His recent death removes one who has made a large contribution to the cause of research in Canada, both directly through the Council and indirectly as a teacher and as Dean of the Faculty of Graduate Studies at McGill.

Mr. J. A. McClelland was for three years the representative on the Council of the Trades and Labor Congress of Canada. His special interest in the Council was as its work affected, directly or indirectly, the welfare of the laboring man, and in this field he made a valuable contribution.

To the vacancies created by the above retirements, the Government appointed Dr. J. W. Shipley, Associate Professor of Chemistry at the University of Manitoba, H. M. MacKay, Dean of the Faculty of Applied Science, McGill University, and Mr. J. T. Foster, Vice-president, Trades and Labor Congress of Canada. Sir George Garneau and Dr. J. H. Grisdale, whose terms expired on March 31, 1929, were reappointed for a further term of three years.

During the year under review five meetings of the National Research Council were held, all in the city of Ottawa. The pages which follow outline the action taken by the Council during this period.

Organization and Staff

As soon as the Government announced its intention of establishing National Research Laboratories under the auspices of the National Research Council, as mentioned in the last annual report, the Council gave consideration to the form of organization required to carry out the various phases of the work authorized under the Research Council Act. It was decided to recommend to the Government the creation of a number of laboratory divisions, each under a director, who should be responsible to the president of the Council for carrying out the duties assigned.

About this time the Beatty Commission was appointed to report on the salaries of all technical employees, and the Government decided to refer to this commission the whole question of the salaries of the Council's professional staff.

NATIONAL RESEARCH COUNCIL ORGANIZATION CHART

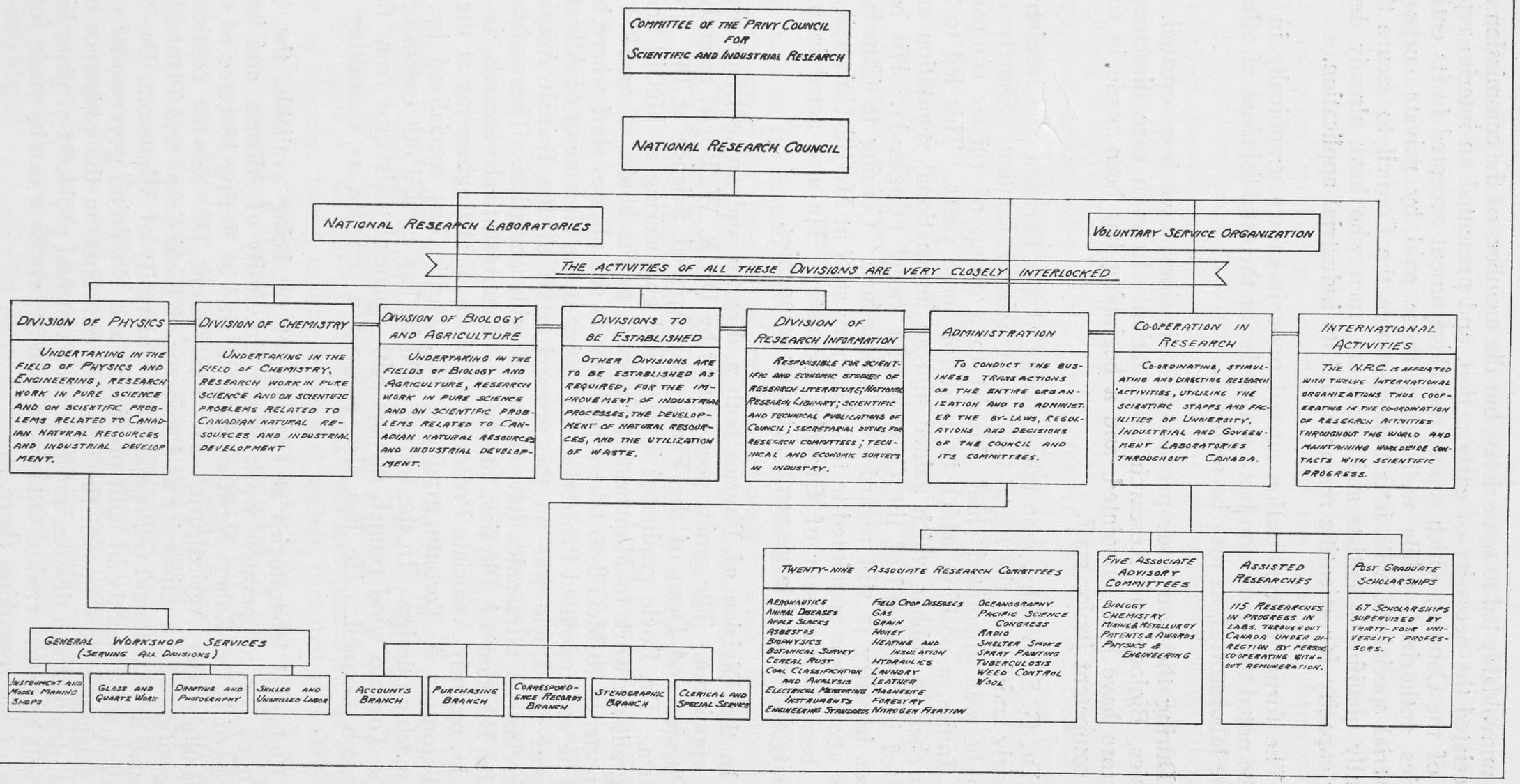

Fig. 1.

This unavoidably led to some delay, but the members of the commission fortunately appreciated the necessity of early action, and presented an interim report on the staff of the Council, which report the Government accepted in its entirety. The salaries authorized, while well below those paid by private corporations for industrial specialists, will, it is hoped, enable the Council to secure the services of fully qualified scientists and engineers, men who have already demonstrated their capacity for scientific research and its industrial application.

The form of organization agreed upon is shown graphically in Fig. 1. It will be noted that provision has been made for the establishment of other divisions of the laboratories, as may be required.

During the year four professional divisions have been created, Chemistry, Physics, Biology and Research Information. In each case directors or acting directors have been appointed, and a beginning has been made in the selection of a competent junior staff.

Dr. G. S. Whitby, who takes charge of the Division of Chemistry, received his early training in the Royal College of Science, London. Shortly after graduation he was appointed chief chemist to a group of rubber companies in the East Indies, a position which he held for some years. This led to a series of researches on rubber which gained him an international reputation and recently resulted in the award of the Colwyn gold medal (England). His book on the rubber industry is still regarded as a standard. Coming to Canada about ten years ago he was appointed to the chemistry staff at McGill University, where he soon became Professor of Organic Chemistry. He also acted in a consulting capacity for several large manufacturing companies.

In the Division of Physics both a director and an assistant director have been appointed. The senior post is held by Dr. R. W. Boyle, recently Professor of Physics and Dean of the Faculty of Applied Science at the University of Alberta. Dr. Boyle graduated in electrical engineering at McGill and went for postgraduate work to Manchester, England, as the holder of an 1851 exhibition. He returned to McGill to take a position on the physics staff where he remained until he was appointed Professor of Physics at the University of Alberta. During the war Dr. Boyle was on the research staff of the British Admiralty. His researches on ultrasonics have attracted wide attention. The assistant director of the Division of Physics, in charge of aeronautical research, is Mr. J. H. Parkin, recently Associate Professor of Mechanical Engineering at the University of Toronto. A Toronto graduate, Mr. Parkin has specialized in aeronautics and machine design. In the former field he has carried out extensive researches in the Toronto wind tunnel, in part with financial assistance from the National Research Council. He has also enjoyed a practice as consulting mechanical engineer.

Biological laboratories at Ottawa not yet being available, the Council has arranged for co-operative work at the University of Alberta, and has placed in charge of it Dr. Robert Newton, with the title of Acting Director of the Division of Biology and Agriculture. For the present Dr. Newton continues to hold his position at the university as Professor of Field Crops and Plant Biochemistry. Trained at Macdonald College and the University of Minnesota, Dr. Newton was engaged subsequently in both provincial and Dominion government service. He has become widely known through his researches on the resistance of plants to frost, drought and disease, and other fundamental problems of plant biochemistry. He will be transferred to Ottawa as soon as provision can be made for a continuation of his researches there.

A Division of Research Information has been created to include those technical branches of the Council's work closely related to the laboratory investigations. These are: the research library, which is intended to serve not only the staff of the Council but also research workers elsewhere; the Council's publications, including the recently established Canadian Journal of Research; a bibliographic and abstracting service and technical enquiries of all kinds; economic studies. In addition, the staff of the division will be responsible for secretarial and other services in connection with the Council's research committees. In charge of the division will be Mr. F. E. Lathe, who has for five years been on the Council's staff as technical assistant to the president. A graduate of McGill in both chemistry and metallurgy, Mr. Lathe for twelve years held positions as chief chemist and metallurgist with Canadian and foreign companies. He has from the beginning directed the Council's magnesite investigations, and will continue in charge of this work.

In addition to the organization of the professional divisions, there has been an accompanying development of the administrative staff of the Council under Mr. S. P. Eagleson. This has been made necessary, not only by the increasing work of administration in connection with the establishment of National Research Laboratories at Ottawa, but also by that relating to the Council's important external activities. Mr. Eagleson, who was formerly on the staff of the Department of the Interior, has been with the National Research Council since its inception. He was appointed secretary in 1922, and three years later was promoted to the position of secretary-treasurer, which he now holds.

Buildings and Equipment

As forecast in the last annual report, some of the old mill buildings on the Edwards property have been fitted up for laboratory work in physics and chemistry. During the year, however, the work has proceeded on a much larger scale than originally anticipated. The buildings on this site will in future be known as the John Street Laboratories of the National Research Council.

The laboratories for chemistry and physics are being fitted up as originally intended. Each has the equivalent of about twelve laboratory units 16 by 30 feet. Permanent installations are being made of water, gas, steam and electricity. Other equipment is being installed of a temporary character, as it is anticipated that when the new building is ready these units will be used for investigations on a semi-commercial scale. Researches in both physics and chemistry are already under way.

In addition, it has been decided that in view of the rapid development of aviation in Canada immediate provision should be made for aeronautical research on an adequate scale. The only wind tunnel in Canada is a small one at the University of Toronto. In spite of the fact that hydroaeroplanes are of particular importance in Canada, owing to our great and widely distributed water areas, there is as yet no water channel to provide for research on this type of machine. The Council has therefore decided, with the approval of the Government, to immediately fit up laboratories on the Edwards property for aeronautical research. Fortunately this can be done at comparatively small expense, for two of the old buildings are almost as well fitted to house a wind tunnel and a water channel as if they had been designed for that purpose, requiring only minor modifications and the installation of the special equipment necessary in any case. Provision is thus being made for a wind tunnel with a nine-foot nozzle and for a water channel about 410 feet long. An extensive machine shop, so necessary for the construction of models and miscellaneous equipment, is being fitted up in one of the other buildings.

Excavations were recently begun for the National Research Laboratories on a ten-acre site near the confluence of the Ottawa and Rideau rivers. It is hoped that the building will be ready for occupation before the end of 1931. A view of the architects' model of the building which will face on Sussex Street, is shown in Fig. 2.

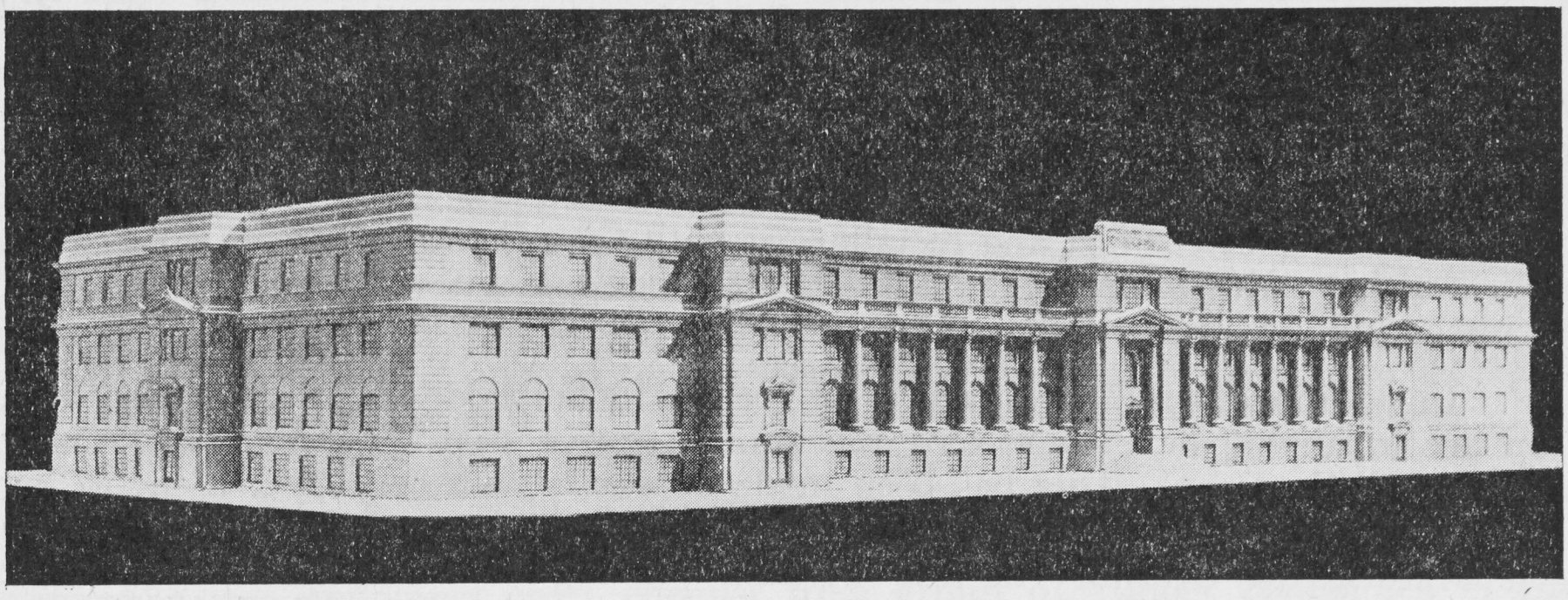

Fig. 2. View of Architects' Model of the National Research Laboratories.

The contract calls for a four-storey building approximately 418 ft. long, 176 ft. wide and 60 ft. high. There will be two large interior courts, on either side of a central library and assembly room, so that the whole building will be amply provided with exterior light.

The building will be of steel frame construction, faced with Wallace sandstone brought from quarries in Nova Scotia. It will be practically fire-proof throughout. Corridor walls are to be of face brick, and interior partitions of steel and plaster, so constructed that they can be removed readily in case of need.

The building is being erected for purposes of research, and is consequently in the main a system of laboratory units. There will, however, be office accommodation for the staff of the Council on the first floor, at the front of the building. On the same floor will be the entrance to the main assembly room, centrally located, and designed for general meetings of the staff as well as for scientific and technical conventions, if desired for that purpose. Immediately above and at the rear of the assembly room will be the research library, with accommodation for some 300,000 volumes. Beneath each central court will be a large exhibition hall, where it is intended to set up exhibits showing the progress of scientific and industrial research. Provision is being made for small committee rooms at convenient points throughout the building. With these exceptions the whole of the structure will be given over to research laboratories.

It is not yet possible to assign definitely all the laboratory space, but it may be said in general that the northeast end of the building will be given over to researches in electricity and other branches of physics, while in the opposite end will be located laboratories for biology and chemistry. Each will be provided with special equipment, according to its needs; the details are now being worked out. At the rear of the building will be placed the engineering laboratories, carried through both the basement and first floor in order to secure room for large testing machines and other similar equipment. Between these and the small electrical laboratories, and also carried through two stories, a high-tension electrical laboratory will be provided, where researches will be carried on at voltages up to about 750,000. This has been decided upon in view of the enormous hydro-electric development in Canada and the corresponding need for research in elec-

trical transmission. Higher voltages, up to possibly 3,000,000, are also desirable, but it is not feasible to install the necessary equipment in a building for general researches.

Finances

As will be seen from the treasurer's report, which appears on page 92, the Council has received from all sources during the present year the sum of $464,-382.75, and has expended practically an equal amount. This does not include the expenditures on capital account, which are handled through the Department of Public Works.

Grateful acknowledgment is made of the receipt of the sum of $10,000 from the Sun Life Assurance Company of Canada, towards the work of the Associate Committee on Tuberculosis.

The Council's external activities still account for the chief expenditures. Of these the assisted researches amounted to $220,442.60, and scholarships involved an expenditure of $49,990. Library expenditures—chiefly for standard sets of scientific periodicals—amounted to $30,202.96. Salaries, owing to increases in the professional staff, have risen to $83,419.12 but still form only a small proportion of the total.

The total expenditures of the National Research Council since its establishment more than thirteen years ago amount to $2,080,505.87. This amount may be compared with the sum of $2,709,495.01, spent by the American Bureau of Standards during the single year 1929-30.

With the construction and equipment of National Research Laboratories already under way, it is obvious that the Council's expenditures must increase over a period of years, in order to provide an adequate scientific staff and the special apparatus necessary for their investigations. This is of special significance at a time like the present, when the country is passing through a period of depression, and is quite in keeping with the policy of some of our largest industrial corporations, which, profiting by their past experience, have largely increased their appropriations for research in order to find a solution for their present economic problems. There may also be noted at this point the statement of T. S. Harding that every dollar spent to date on research by the United States Department of Agriculture has returned at least five hundred dollars to the nation. An estimate of President Hoover's quoted in a previous report, is to the effect that the work of the Bureau of Standards up to that time was worth to the United States some $600,000,000 a year.

Associate Committees

The National Research Council again acknowledges its deep indebtedness to those who, without remuneration, have given freely through another year of their time and energy to the work of the Council and its associate committees. Acknowledgment for this co-operation is extended, not only to those individuals whose services have been sought, and to whom the greater debt is due, but also to those federal and provincial government departments, universities, private corporations and others which have permitted them to make their personal contribution. In the past the activities of its committees have played a very large part in the Council's work, and while with the establishment of large laboratories at Ottawa this part may become relatively less prominent, it may be expected to continue as one of the important features of the Council's activities.

In the section of this report dealing with the associate committees there will be found summary reports of their work and lists of co-operating organizations. In Appendix J all the associate committees and their members have been listed in detail.

The continued expansion of the Council's external activities is evident in the fact that there were formed during the year under review committees on Biophysics, Fifth Pacific Science Congress, Gas Research, Honey, Leather, Trail Smelter Smoke, and Weed Control. In practically every case the Council has been requested to take such a step by some organization representing either a specific industry or a branch of agriculture. As far as possible the work to be carried out will be done in the National Research Laboratories, but the Council has also been offered the use of other laboratories and of industrial plants, and will carry out its investigations where this can be done to best advantage.

In addition to the projects enumerated above, which have been assigned to special committees, preliminary conferences have been held during the year on animal diseases, a Canadian botanical survey and laundry research. If it is decided to proceed with investigations on these subjects special committees will be appointed for that purpose.

Assisted Researches

Beginning on page 67 of this report will be found abstracts of researches in progress during the past year with financial assistance from the National Research Council. This system, providing as it does special apparatus and technical assistance, but no remuneration to the director of the research, has been exceedingly fruitful. Important contributions have thus been made to science and industry, and this at a very minimum of expense to the Government.

On page 111 will be found a list of the 111 assisted researches in progress during the year, either under committees or individuals. Of these, many were a continuation of researches previously begun. The 21 new projects for which grants were made during the year are as follows:

Grantee	Subject
Committee on Trail Smelter Smoke	Damage to vegetation by smelter smoke.
Dr. E. H. Boomer, University of Alberta	The chemical utilization of natural gas.
Prof. E. Stansfield, University of Alberta	A chemical survey of Alberta coals.
Father Leopold, Oka Agricultural College	Mastitis in cows.
Dr. A. G. Lochhead, Central Experimental Farm	The fermentation of honey.
Dr. Robert Newton, University of Alberta	The use of chemicals in the destruction of weeds.
Dr. A. W. Henry, University of Alberta	Plant parasites of weeds.
Dr. J. D. Newton, University of Alberta	Effect of chemical herbicides on the soil.

Grantee	Subject
Dr. L. E. Kirk, University of Saskatchewan	Botanical studies of weeds, and effect of cultural treatments on food reserves and viability.
Prof A. M. Shaw, University of Saskatchewan	Cross-breeding of sheep.
Prof. J. P. Sackville, University of Alberta	Effect of environmental factors on wool quality.
Associate Committee on Wool	Crossing of Corriedale and Rambouillet sheep.
Prof. J. C. McLennan, University of Toronto	Emission and absorption spectra.
Dr. W. Lash Miller, University of Toronto	Yeast spores.
Dr. A. L. Clark, Queen's University	Measurement of the Joule effect.
Prof. C. R. Young, University of Toronto	The lateral support of steel columns and struts.
Prof. O. S. Gibbs, Dalhousie University	Cause of the reversed blood pressure of fowls.
Profs. H. M. King and W. Sadler, University of British Columbia	Relation of bacteria to feed flavors and stable odors in milk.
Dr. A. Savage, University of Manitoba	The uses of the photo-electric cell.
Dr. G. S. Whitby, (at McGill University	Catalysts.
Dr. H. Hibbert, McGill University	Action of bacteria and enzymes on carbohydrates.

Scholarships

Scholarships are dealt with in some detail in the section of this report beginning on page 96; there need be noted in this brief summary only certain items of special interest.

There have been awarded by the Council and held during the past year one Ramsay Memorial fellowship of $1,750; three foreign travelling fellowships of $1,500; six fellowships of $1,200; eighteen studentships of $1,000 and twenty-six bursaries of $750 each. These have been awarded to the graduates of thirteen Canadian universities and have been held at seven Canadian and four British and foreign universities.

For award in the spring of 1930 there have been offered by the Wheat Pool three fellowships of $1,200 each. The awards will be made by the National Research Council.

II. SUMMARY OF ACTIVITIES OF ASSOCIATE COMMITTEES

Twenty-eight associate committees were in operation under the auspices of the National Research Council at the close of the year under review, with a total membership of 449 persons, who, without remuneration, gave freely of their time and experience in furthering this phase of the activities of the Council.

Twenty-three of these were research committees charged by the Council with responsibility for the organization and direction of co-operative investigations in connection with the following major research problems: grain researches; cereal rust; field crop diseases; animal diseases; aeronautics; heating and insulation of buildings; Canadian helium resources; the utilization of Canadian magnesite; wool production and manufacture; the classification of Canadian coals; tuberculosis in man and animals; the reseeding of certain burnt-over and cut-over forest areas; spray painting; oceanography; slack barrels in exported apples; engineering standardization; biophysics; electrical measuring instruments; utilization of natural gas; honey research; damage caused by smelter fumes; control of weeds; leather research.

Five associate committees, whose main function is to keep the Council constantly in touch with important research problems requiring attention, and with advances made from time to time in the particular departments of science which they represent, were also in existence at the close of the year under review. These committees provide the Council with a valuable source of scientific advice in each of the sciences which they represent. Research work is occasionally carried on under the auspices and direction of advisory committees, but research is not their main function.

Such committees ordinarily meet once a year to discuss problems relating to the work of the Council, to consider the manner in which the committee can most effectively co-operate and assist in such work, and to make such recommendations to the Council regarding new problems requiring attention as in the judgment of the committee may be advisable. Such an advisory committee has been established in each of the following fields: chemistry; physics and engineering physics; mining and metallurgy; nitrogen fixation; patents.

Summaries of the activities of these research and advisory committees, given in this section of this report, will indicate the scope and volume of the activities carried on under this phase of the work of the Council.

A complete list of the committees, with the names of members, will be found in Appendix J, page 135.

Associate Committee on Aeronautical Research

Co-operating organizations

Royal Canadian Air Force

University of Toronto

The expansion in civil aviation proceeded at an increased rate in Canada during the year under review, and was exceeded in only one other country. While flying on regular air routes continued its steady increase, the expansion was most marked in other flying operations. This expansion was attended by a marked increase in the number of aircraft and personnel employed and by increases in the number of firms building aircraft, operating aircraft or employing aircraft as auxiliary service, while there was a large increase in the number of civil aerodromes.

In view of this rapid expansion of the industry, the committee, recognizing the importance of adequate research facilities in the development of an independent Canadian aircraft industry, recommended that the National Research Council make provision for aeronautical research in the National Research Laboratories now being established in Ottawa. It was further recommended that two suitable buildings on the government property at John and Sussex Streets, Ottawa, be reserved for housing a test tank and a wind tunnel and that a directing officer for the aeronautical work of the Council should be appointed at an early date.

Three firms are now assembling aircraft engines in Canada, primarily to supply the Canadian demand, but already engines assembled in this country are being exported. Under the air regulations of 1920, the Dominion Government is required to make tests to establish the airworthiness of aircraft engines for export. There being no equipment for this purpose in the country at the present time, the committee recommended the provision and installation of suitable dynamometer equipment in the Ottawa laboratories.

In July 1929, an assistant director in the Division of Physics was appointed to the staff of the laboratories to have charge of aeronautical research. Work was immediately started on the design of a tank 400 x 9 x 6 ft. and its equipment, and on the design of a wind tunnel 9 ft. in diameter. Consideration was also given to the engine testing equipment, and a suitable dynamometer was selected and ordered from a firm in England. This dynamometer will be capable of testing aircraft engines of any type up to 1000 horsepower.

Remodelling of the building and construction of the tank were commenced November 14, 1929, and by March 31, 1930 the building was practically finished and the concrete portion of the tank nearly completed. Considerable progress had also been made on the design of the carriage drive, and most of the necessary machinery for the drive had been ordered.

Work was commenced on the wind tunnel late in November 1929, and the construction proceeded throughout the winter. By the end of March about 75 per cent of the concrete part of the tunnel had been completed. The electrical drive and control for the tunnel were designed and ordered about the end of 1929 and this equipment was about 60 per cent completed by the end of March.

A small engine and other equipment were also purchased for testing gasolines for detonation characteristics.

Stability of Flying Boats

Work was continued until July, 1929, on this investigation which had for some time been in progress in the wind tunnel of the University of Toronto (see annual reports for 1927-28 and 1928-29).

A study of the theory of the methods for the determination of the rotary derivatives was completed early in the present year and a comparison of the forced and free oscillatic hods was made for the model in yaw, and a certain amount of work was dc pitch and roll. The work was interrupted in July 1929, and will be continued later in the laboratory at Ottawa.

(*Investigation under the direction of Prof. J. H. Parkin, University of Toronto.*)

Water Channel

A study was commenced in the mechanical building, University of Toronto, during the summer of 1928, of the feasibility of a testing tank for aircraft floats and hulls, in which, instead of drawing the model through still water, water is moved past a stationary model.

Experiments were made on a one-sixteenth scale model, using a glass trough. Efforts were directed toward securing a stream of water of as uniform a velocity throughout as possible, having a smooth surface and a velocity of 20 ft. per sec. The attainment of these objectives presented many difficulties, but, by use of special devices, considerable progress was made.

Work was interrupted during the winter of 1928 by pressure of teaching duties, but was recommenced in the spring of 1929 and further progress was made. Unfortunately, it became necessary to dismantle the equipment during the summer of 1929 before the work could be brought to a definite conclusion.

(*Investigation under the direction of Prof. A. Taylor, University of Toronto.*)

Windmills for Power Generation

To supplement full-scale work on windmills for the generation of power for farms, being carried on by Prof. A. R. Greig, of the University of Saskatchewan, work was commenced in the wind tunnel of the University of Toronto in May, 1929, with the object of developing a windmill capable of operating in very light winds.

A basis for the design of a suitable windmill was arrived at by analyzing wind records of the Meteorological Service.

A special dynamometer was designed and constructed for testing in the wind tunnel model windmills of 18 in. diameter. Windmill blades were designed, on a theoretical basis, and constructed of cast aluminum. The hub employed was so constructed as to enable from two to eight blades to be used. Blades without twist were first tested. Tests planned with blades with varying degrees of twist could not be made owing to transfer of the personnel to the laboratories at Ottawa in September 1929. This work will probably be continued in the wind tunnel at Ottawa.

Such work as was completed at Toronto indicated the feasibility of constructing a windmill capable of generating one kilowatt in a wind of eight miles per hour.

(*Investigation under the direction of Prof. J. H. Parkin, University of Toronto.*)

Associate Committee on Apple Slacks

Co-operating organizations

Dominion Department of Agriculture

Nova Scotia Department of Agriculture

For years shippers of apples from the Maritime Provinces to Great Britain have experienced serious losses due to reductions in price on account of a condition of slackness in barrels of apples, known as "apple slacks." Fruit shipped from Nova Scotia, apparently in excellent condition, often does not completely fill the

barrels upon arrival in England, and accordingly brings a much lower price. The observed slackness has variously been ascribed to poor condition of the fruit, poor packing and other causes. A committee was therefore appointed by the Council, under the chairmanship of Dr. J. H. Grisdale, to study the causes and endeavor to devise methods of overcoming the difficulty.

The investigation has been under way for some time, but the final report of the committee has not yet been received.

Associate Committee on Biophysics

For several years the National Research Council has had under consideration the advisability of organizing in Canada researches in radiology and other problems involving both the physical and medical sciences. An invitation was received to send a delegate to the International Congress on Radiology, held in Stockholm in July 1928. It was not found possible to accept this invitation, but the voluminous proceedings of that Congress were studied with the object of determining what should be the position of Canada in regard to researches going on in this field.

It was very evident that, on the one hand, few highly trained physicists were undertaking radiological work, while, on the other, the radiologists had in general been trained in medical sciences rather than in the fundamental physical laws so necessary to the proper understanding of radiological problems. While the therapeutical use of radiology was rapidly increasing there was little precise knowledge as to the proper wave-lengths to use or the optimum time and intensity of treatment. There were not even any accepted standards for ultra-violet lamps, and their haphazard use by people unfamiliar with their limitations was recognized as sometimes of doubtful value, if not of real danger. At the same time, the use of radiation had in many cases been attended with such success as to indicate that when thoroughly understood from both the physical and biological points of view it might prove to be of very great therapeutic value.

After careful consideration the Council authorized the appointment of an Associate Committee on Biophysics to deal with these and related problems. As a result, a conference on this subject was held in Toronto in February 1930. There were in attendance eminent physicists, biologists, radiologists and biochemists, and a great number of problems were suggested for discussion. It was evident that many of these were very large problems, involving for their solution the close co-operation of men trained in different branches of science, and probably years of intensive study. The conference unanimously agreed, however, that the field was likely to prove a very fruitful one, of great practical value from a medical point of view.

As a first step a subcommittee was appointed to go carefully over the whole list of problems suggested, consider the advisability of undertaking researches upon them in Canadian laboratories, and report back to the main committee.

Associate Committee on Cereal Rust

Co-operating organizations

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

The losses due to cereal rusts were again relatively small in 1929. The dry season was unfavorable for the development of rust in epidemic form in the field. Fundamental investigations carried on primarily in laboratories and greenhouses, where conditions are partially controlled, progressed satisfactorily. Artificial epidemics were developed in the field with sufficient intensity to score the new hybrid material being developed.

At the conclusion of its annual meeting in the spring of 1930, the committee drafted and released to the press the following statement summarizing progress to date in the practical solution of the wheat stem rust problem: "Several of the new wheat hybrids in preliminary tests have shown high rust resistance and satisfactory yield and quality. These are now being subjected to severe tests at various points throughout the Prairie Provinces to ascertain their resistance to other diseases such as smuts and root-rots. Such of these new wheat varieties as give a good account of themselves in this regard and also in regard to yield, quality, strength of straw, and so forth, will be multiplied for eventual distribution to farmers. It is hoped that such distribution may not be delayed more than three or four years."

Research at the Dominion Rust Laboratory, Winnipeg

At this centre a number of investigations have been carried on without financial assistance from the National Research Council.

A study of the probable origin of spores causing incipient infections of black stem rust has been under way for several years. Exposure of slides in spore-traps before any local infections have occurred has demonstrated that the spore showers precede the early infections. Meteorological conditions associated with these spore showers, such as an area of low pressure over Manitoba with a general movement of air from Texas northward through the Central States into Western Canada, indicate that the West-Central States are the probable sources of inoculum. Exposure of slides on aeroplanes has substantiated the findings of the stationary slide exposures.

It has long been recognized that environmental conditions, especially temperature and light, exert considerable influence on rust development. Temperature has now been shown to affect the identification of physiologic forms, the same rust on the same host reacting differently at different temperatures. Wheat varieties having only partial resistance may vary in their reaction in the field in accordance with weather conditions when certain rust forms are present.

A study has been made of the inheritance of color and pathogenicity in crosses between physiologic forms of *Puccinia graminis tritici.* A definite factorial basis for the inheritance of pathogenicity cannot be established at present, owing to the complexity of the problem. For instance, the inheritance of color in one cross appeared to be governed by two pairs of genetic factors and in another by three pairs. The second generation segregated into four distinct color classes. Some of the hybrid forms are new, others are identical with previously known forms. There is evidence that cultures of the same physiologic form, obtained from different sources, may be genotypically different. In selfing experiments only one form proved to be homozygous. Approximately five per cent of the aecia showed mixture of forms.

Seven distinct physiologic forms of crown rust (*Puccinia coronata*) have been isolated. The collections to date indicate that some of the forms are apparently of common occurrence while others are quite rare. Form I, the most virulent and also the most common, has been collected from Saskatchewan to Prince Edward Island.

The results from sulphur-dusting experiments in 1929 continue to demonstrate that relatively small amounts of suitable dusts properly applied will protect wheat against destructive epidemics of stem rust. The amount of rust was controlled on a series of sulphur-dusted plots and studies made on the correlation between yield and a given percentage of rust. When the growth on the plots was light to medium there was a reduction in yield of approximately 7 per cent for each 10 per cent of rust. When the plant growth was heavy there was a reduction in yield of approximately 9 per cent for each 10 per cent of rust.

The breeding work the past two seasons has yielded results which point definitely toward success in the production of satisfactory rust-resistant varieties of wheat. With respect to quality, some of the hybrid strains have given a good account of themselves in laboratory baking tests, and the indications are that they will be just as satisfactory in baking tests conducted on a large scale.

The genetic factors in oat and wheat varieties which are responsible for resistance to a given physiologic form of rust may be concerned with the reaction to numerous forms. All forms falling into one group may be considered by the plant breeder as one unit in inheritance. Several such groups have been demonstrated. This considerably simplifies the breeding problem.

Abnormal chromosomal behavior has been found in certain varieties of wheat. It does not appear to be due entirely to non-conjunction, since the latter is no more frequent in Marquillo, in which abnormalities are common, than in Marquis and Red Fife. Crosses between Marquillo and other varieties have resulted in very complex segregations in the second generation, as would be expected if the genes in question are carried on chromosomes which frequently fail to pair.

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

Rust Research at the University of Alberta

Cytological studies of Marquis wheat leaves, which had been injected with various substances in an effort to modify the severity of rust infection, showed: (1) That the method of injection was satisfactory, since there was no injury to the cell contents from the injection of distilled water or wheat juice. (2) That the injection of resistant juice did not necessarily injure the rust parasite growing in a susceptible variety. (3) That the injection of dilute phenolic solutions killed or injured both cell contents and parasite, without necessarily producing any external symptoms on the leaf. The second of these findings does not agree with the results of earlier experiments, in which the severity of infection was reduced by injection of resistant juices; this point therefore requires further investigation. The third finding is, however, in accordance with the theory that rust resistance may be due to phenolic compounds set free in the cell on the entrance of the fungus, which kill the cell and inhibit the growth of the parasite.

Studies have been continued on the cell contents of rust-resistant wheat varieties, in a search for substances which may be toxic to the fungus. Various phenolic compounds have been isolated, and their identity is now being investigated.

(*Investigations under the direction of Dr. Robert Newton.*)

Two wild species of wheat, *Aegilops cylindrica* and *A. triuncialis,* both commonly referred to as "goat grass," are found in practically all the important grain-growing regions of the world, except Canada. They are already found in the western part of the United States. One of their most undesirable features

is their susceptibility to diseases common on cultivated wheat. When inoculated in the greenhouse with five physiologic forms of stem rust (*Puccinia graminis tritici*) found in western Canada, they proved to be completely susceptible to all of them. They are also severely infected with some of the root-rotting fungi. Consequently they must be regarded as potential carriers of cereal diseases.

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

Rust Research at the University of Manitoba

The persistence of the bi-nucleate condition in the diploid mycelia of the Basidiomycetes has been shown by experiment to confer upon this group of fungi certain pronounced advantages in ensuring reproduction in nature.

(*Investigation under the direction of Dr. A. H. R. Buller.*)

From 115 rust-resistant hybrid strains derived from a Khapli emmer x *vulgare* cross, 52 have a red *vulgare* type of kernel. The apparently resistant or slightly susceptible lines are being subjected to rigid rust-nursery tests.

(*Investigation under the direction of Prof. H. F. Roberts.*)

Intensive studies were made on 180 F_6 hybrid lines. These consisted of 13 Kanred x Ruby, 58 Kota x Marquis, 13 Kanred x Kota, 16 Kota x Ruby, 10 Emmer x Marquis, 34 Iumillo x Marquis, and 37 Pentad x Marquis. Some strains both rust-resistant and desirable in milling and baking quality were isolated from all of the crosses except Kanred x Ruby.

(*Investigation under the direction of Prof. A. T. Elders.*)

Rust Research at the University of Saskatchewan

Eight lines from a Marquillo x Marquis cross are outstanding for their rust resistance, root-rot resistance, baking quality and various other important agronomic characters. Several other crosses are being studied intensively in the F_3 and F_4 generations. These are Iumillo x Marquis; (H-44-24 x Double Cross) F_1 x Marquis; (H-44-24 x Iumillo) F_1 x Marquis; H-44-24 x Early Triumph. Bulk or mass-selected lots were grown from all crosses.

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

Cytological behavior of non-viable types and the mating capabilities of chromosomes in F_2 plants of species crosses as reported by Kihara have been confirmed in all essentials. There were some exceptional plants as is to be expected in such material.

In a systematic examination of many hundreds of cells it was found that in pure lines of common wheats about 5 per cent of the pollen-mother cells showed chromosome irregularities while in durums and emmers the percentage was lower. These irregularities may be responsible for some of the complex breeding results.

A cytological and genetical study of F_2 and F_3 of crosses between 7- and 14-chromosome species is nearly complete. The 7-chromosome condition is never recovered. Nearly all plants have as many as or more than the parent with the larger number. Lines with 21 chromosomes have been obtained by chromosome doubling. Although these have the same number as *vulgare* wheats they have no *vulgare* characters.

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

Associate Committee of Chemists

The first meeting of the committee under the chairmanship of Dr. G. S. Whitby was held on January 4, 1930, in the board room of the National Research Council, at Ottawa.

The chairman expressed the hope that the committee might in future act in an advisory capacity to the Division of Chemistry in the National Research Laboratories. By so doing he felt that it might enter a new and important field of usefulness.

At the chairman's request, Dr. Tory briefly outlined the progress which had been made by the National Research Council since the last meeting of the committee. He explained in particular the steps which had been taken for the construction of new laboratories, in which ample provision was being made for chemical research. He described the form of organization which was being created, and its relation to other research bodies, in England and elsewhere.

The committee briefly discussed the Canadian Journal of Research being issued monthly by the Council, and expressed the hope that it would receive the enthusiastic support of all Canadian chemists. It was pointed out that the Journal could usually offer very prompt publication, and in this respect presents a marked advantage over most other mediums of publication. Its articles were being abstracted regularly by the principal abstracting agencies.

Messrs. B. L. Emslie and R. J. Walley, of Canadian Industries, Ltd., presented papers on the Outlook for Artificial Fertilizers in Canada, Treating of Superphosphate with Ammonia, and Experimental Tests with Superphosphate. In their opinion, although the immediate market for artificial fertilizers in Canada would not take care of even the present production, the future was bright. Both their own company and the Consolidated Mining and Smelting Company were doing much to educate the farmers of Canada to the value of fertilizers, and both of these companies were constructing plants for fertilizer manufacture. The committee discussed the new intensive system of grassland management which was coming into use in England, the difficulties in the way of utilizing Canadian apatite for the production of phosphatic fertilizers, the relation of sulphuric acid production in Canada to the manufacture of fertilizers, the effect of various fertilizers on the soil and their relation to soil moisture.

A demonstration of the use of the Stevens consistometer for the testing of lubricating oils was given by Mr. W. A. P. Schorman, of the British American Oil Company. He described various tests which he had carried out, showing the methods of determining the actual lubricating value of oils under conditions of both low and high temperature. By this instrument one could satisfactorily investigate the properties of oils as affected by dewaxing or other treatment. It was evident to the committee that the information given by the methods shown would be more useful in some respects than ordinary tests for viscosity.

Dr. A. Bruce Macallum introduced a discussion on recent advances in our knowledge of vitamines. He briefly reviewed the history of vitamines and dwelt in particular upon cod liver oil, irradiated ergosterol, and other sources of vitamine C. It appeared that the cod liver oil from Newfoundland and northern Europe was more potent than that from southern latitudes. The effect of sunlight was dealt with, as also the use of glass permeable to ultra-violet light, and sheets of cellulose nitrate. A color test which appeared to be specific for vitamine A and could be used for assaying it was described. In spite of the enormous amount of research under way on the vitamines none of them had yet been isolated or fully identified chemically.

The relation of agriculture to the chemical industries was the subject of discussion introduced by Dr. Harold Hibbert. He dealt with it in a broad way, pointing out the need for a study of soil, climate, markets and employment. Upon all of these chemistry had a definite bearing. As chemical products developed from agricultural raw materials he cited corn starch, and casein and lactose from skim milk. Mr. Wardleworth showed how chemistry could be of service to agriculture in the development of efficient insecticides and fungicides. Dr. Tory called the attention of the committee to the fact that the Council already had a considerable number of agricultural problems under investigation. The chairman assured those present that agricultural problems would be given his most careful consideration in planning the work of the Division of Chemistry.

The chairman outlined the character of the chemical researches now under way in the National Research Laboratories. He asked that the members of the committee should give the question of additional researches some thought and bring forward any suggestions they might have at the next meeting of the committee, which it was proposed to hold in Ottawa at the time of the Chemical Convention.

Associate Committee on Coal Classification and Analysis

Co-operating organizations

Alberta Research Council

American Engineering Standards Sectional Committee

Dominion Department of Mines

The second general meeting of the committee was held in Edmonton, Alberta, in October 1929, at the time of the annual western meeting of the Canadian Institute of Mining and Metallurgy. In Dr. Tory's absence, through illness, the chair was taken by Dr. Chas. Camsell, joint chairman.

The committee was fortunate in having present at this meeting Mr. A. C. Fieldner, Chairman of the American Engineering Standards Sectional Committee on Coal Classification. Mr. Fieldner expressed his pleasure at the close co-operation of the two committees, which had a great deal in common in endeavoring to classify the coals of their respective countries. He then outlined the form of organization which they had adopted, and explained the work of each of their subcommittees. Considerable laboratory experimentation had been found necessary. They were thus studying the physical properties of coal as affecting classification, and were attempting to determine whether they should use corrected or uncorrected analytical values in coal classification. A preliminary grouping of coals according to various methods of classification was being made, although the task was a very difficult one and the end was not yet in sight.

Mr. R. E. Gilmore submitted to the committee reports of the meetings of the American committee which he had attended as the Canadian committee's representative.

The report of the subcommittee on the Origin, Constitution, Location and Occurrence of Coal was presented by its chairman, Dr. B. R. MacKay. He stated that the subcommittee was collecting all possible data regarding Canadian coals and checking these up with field observations. It had also been hoped to have laboratory work started on a microscopical examination of twenty complete cross-sectional samples which had been taken of coals in the Cape Breton field. Arrangements for this had not yet been completed. Maps were exhibited showing the coal areas of Canada, and the classifications which had been temporarily assigned to them. It was found that these differed somewhat in the western fields from the corresponding coals in the United States, although the coals appeared to be essentially the same.

Mr. Gilmore presented the report of the Subcommittee on the Sampling, Analysis and General Uses of Coal. A series of standard coal samples comprising different classes of coals was being prepared for distribution to the principal Canadian laboratories equipped for coal analysis, to be analyzed by their regular methods. This was being done to determine the uniformity of the methods now employed in analysis, and the reliability of the results. Methods of sampling would later receive the attention of the committee. By means of a questionnaire they had endeavored to find out what methods of sampling and analysis were already in use, and whether the regular A.S.T.M. methods were considered satisfactory. It appeared that some modifications were desirable. In regard to use classification, this question was being studied by assigning to specialists on the committee certain classes of coals for intensive study.

The report of the Subcommittee on the Applicability of the Proposed Scientific Classification Schemes to Canadian Coals was presented by its chairman, Prof. E. Stansfield. The committee had found that most of the analyses given in the literature were unsuitable for scientific classification purposes, since it was often quite uncertain what methods had been used in sampling and analysis. Mr. J. W. Sutherland had prepared a paper dealing with this question at some length. The paper discussed the methods of eliminating mineral matter from an analysis. He had found that western coals could not be properly classified on a dry coal basis, since this would sometimes completely change their rank. The opinion had been formed that the coals of higher rank could best be differentiated by volatile matter, while for coals of low rank calorific value was a better guide for classification purposes. He suggested certain new names for coals for which previous classifications were unsatisfactory.

Prof. Stansfield recommended that a chemical survey of the coals of Canada should be carried out by the committee, each important deposit being sampled according to standard methods previously agreed upon, and then analyzed by uniform methods, in order that the results might be fully comparable. This suggestion was discussed at some length, and the committee decided that to attempt a survey of all Canadian coals in this way was too great a task for the committee to attempt at once, but it was agreed that a start should be made in the province of Alberta as soon as arrangements could be made.

At the close of the sessions most of the members of the committee improved the opportunity to visit Prof. Stansfield's laboratories at the University, where extensive coal research was being carried out under the auspices of the Research Council of Alberta. Particular attention was paid to recent improvements in apparatus and methods for the determination of carbon, hydrogen, volatile matter, calorific value, fusibility of coal ash, and for the cleaning and air-drying of coal.

At the annual meeting of the Canadian Institute of Mining and Metallurgy, held in Toronto in March 1930, those members of the Coal Classification Committee in attendance held a special meeting, under the chairmanship of Mr. Lathe, the secretary. Dr. MacKay, Prof. Stansfield and the secretary reported having attended the Philadelphia meeting of the American committee, where they secured much information. Mr. Gilmore presented the results of analysis of a number of standard samples of coal in different laboratories. These only emphasized former statements that coal analyses were often not sufficiently comparable for classification purposes, although entirely satisfactory for ordinary commercial purposes. Prof. Stansfield reported that arrangements were being made, in co-operation with the Mines Branch, for the proposed survey of the coals of Alberta.

Associate Committee on Electrical Measuring Instruments

Co-operating organization

Gas and Electricity Inspection Service

The second meeting of the committee was held in Ottawa on February 8, 1930, to receive reports on the various questions assigned to members for study.

Mr. E. Holder presented a report on methods of measuring and billing for power, considered from the point of view of the power companies. He took up the questions of domestic lighting, domestic heating, commercial lighting, small power users, large power users, bulk supply, off-peak rates, demand measurements, power factor charges, and K.V.A. measurement, and outlined the special features of each. The wide variation of conditions under which electricity was used made it difficult to arrive at any system of measuring and billing which could be considered satisfactory under all conditions.

Mr. D. A. McKenzie considered the same question as it affected the various publicly owned power organizations in Canada. He took up various meters and their characteristics and outlined the practice of the larger organizations in measuring and billing for power. He pointed out that the generally accepted basis of rate making was that the charge for power should be composed of two elements, one based on capacity of the equipment required for the service and the other on the energy used.

Professors Price and Wallace reported in a preliminary way on the work assigned to them—that of describing the various types of meters and their principles of operation.

The evolution of central electrical stations and its bearing on power supply systems and methods of charging was dealt with in a report by Mr. H. A. Dupré. He traced the development of the electrical industry from the early days when its chief load was a local one for the supply of direct current lamps, through the higher voltage direct current systems to modern alternating current distribution over very large areas. He pointed out the possibility that the development of cheap and satisfactory methods of converting from alternating to direct current without the use of rotating machinery might under some conditions lead to an increased use of direct current. He considered the various factors entering into the cost of producing electrical power on a large scale and pointed out the influence of these on methods of measuring and billing for electricity.

The committee noted a definite tendency towards the negotiation of large power contracts on the basis of assuring an income on which to finance the development project, rather than on technical considerations.

It was agreed that the various questions before the committee should be given further study and that supplementary reports should be presented at a future meeting of the committee.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association, though an incorporated body, operates as an associate committee of the National Research Council, and receives a large part of its financial support from that organization. Important contributions are also received from industrial firms, many of which take out one or more sustaining memberships at fifty dollars each. Sixty-eight Canadian firms contribute in this way.

The Main Committee of the Association has now 53 members, who represent the technical associations, industrial organizations, universities, government departments, railways and large industrial firms. Including the various sectional and other committees the total number co-operating in the work of the Association is now 550, all of whom serve gratuitously.

Since 1919 the Association has published 28 standard specifications, two revisions of the specification for Steel Railway Bridges, and revised specifications for Portland Cement, Steel Highway Bridges, Steel Structures for Buildings, Single-phase Distribution Transformers, and Canadian Electrical Code. The C.E.S.A. specifications are not in any way compulsory, but they are nevertheless being very widely adopted throughout Canada. They are used as standards in most Dominion Government departments and also in many departments of the provincial governments. The specification for Steel Railway Bridges has been officially adopted by the Board of Railway Commissioners. Complete sets of C.E.S.A. specifications are on file in most of the leading public and technical libraries in the United States.

Civil Engineering and Construction

Reinforcing Materials for Concrete.—A revised edition of the specification for Reinforcing Materials for Concrete has been in preparation and it is expected that this will constitute three booklets. each dealing with one type of reinforcing material, and that the specifications will be classified under Ferrous Metals instead of under Civil Engineering and Construction.

Wood Piling.—A committee has been formed to consider specifications for wood piles and wood pile driving, which will include physical characteristics, classification of timber and preservative treatment, and bearing values.

Mechanical

Cast Iron Pipe.—No further progress can be reported on this project as the final results of experimental work which has been done by different standardizing bodies is not yet available.

Sheet Metal Gauges.—A petition has been presented by the sheet metal interests to the Minister of Trade and Commerce, asking for official recognition of the proposed Canadian gauge, but no definite decision has yet been made.

Screw Products.—The Committee on Machine Screws has been reorganized to consider screw products generally and under the direction of this committee Established Lists of Dimensional Standards will be issued.

Stove Bolts.—A second edition of specification B18-1925, Standard Specification for Stove Bolts, will shortly be issued as an established list, similar to that adopted for Machine Screws. No radical revision will be made, but it will be issued in pamphlet form to be inserted in the binder under the general title of Established Lists of Dimensional Standards.

Standard Color Scheme for Identification of Piping Systems.—It is expected that some work will be done shortly on the above project, as there seems to be a feeling in many quarters that such a color scheme would be useful.

Electrical

Power Transformers.—A second draft of the proposed specification for power transformers has been prepared and comments have been received from members of the committee. A summary of these comments will be sent to the committee, together with a report from the special panel which prepared the draft, and it is hoped to issue this specification during the year 1930.

Transformer and Switch Oil.—A committee has been organized to consider specifications for this material and one meeting has been held. A questionnaire was sent out to the committee, asking for a statement as to the necessity for such a specification, also for information on specifications now in use and the results obtained. This material has been collated and a memorandum sent out to the committee.

Canadian Electrical Code, Part II.—This covers specifications for electrical apparatus. A draft form of specification has been sent out to the Panel on Specifications, and also a draft dealing with radio apparatus. It is proposed to issue these specifications in the form of pamphlets, each one dealing with some particular type of electrical apparatus.

Canadian Electrical Code, Part III, Outside Wiring Rules.—A general panel has been organized to consider this project and in order to facilitate the work, it has been divided into four sections, as follows, each section being assigned to a sub-panel:

1. Overhead Systems
2. Underground Systems
3. Inductive Co-ordination
4. Grounding and Conductive Co-ordination

Publications

During the year four new specifications have been published and revised editions of three, including the Canadian Electrical Code.

The following new specifications have been issued:

A23-1929. Standard Specification for Concrete and Reinforced Concrete

This is a very complete specification for constructors and designers, outlining the best construction practice and methods of design, supplemented by appendices giving tests for material. The book has been in preparation since 1921 and was issued in May 1929.

G25-1929. Standard Specification for Carbon Steel Billets and Bars of Forging Quality

This book has been published at the suggestion of steel manufacturers and it is felt that it will clear up much of the misunderstanding which has existed between the producer and the consumer. It is quite general in its purport and is not intended to cover specialized requirements. It is hoped that this specification, together with No. G24-1929 covering Sampling for Check Analysis of Steel Billets, Bars and Shapes, and Nos. G26 and G27-1929 covering Commercial Bar Steels, will constitute a group of publications which will be of practical service.

G28-1929. Standard Specification for Carbon Steel Castings

This book is the result of a careful study of the situation with respect to steel castings and its chief feature is a special section dealing with castings for heavy duty such as rotors, housings, etc., in which information is given on heat treatment and methods of taking specimens. The taking of hollow drill tests is strongly recommended by the committee and it is hoped that the educational features alone will prove useful. The book covers castings for general service, castings for ships, and castings for heavy duty, as above stated.

B29-1929. Established List of Machine Screws

This publication is something of a departure from previous publications and it is proposed to prepare similar lists under the general title of Established Lists of Dimensional Standards. These will cover mainly mechanical products and will be published in pamphlet form for insertion in a special binder. This first pamphlet provides for a list of 21 varieties of machine screws, covering 11 sizes and, with one exception, a two-thread series. The establishment of this list will effect a very useful reduction in the number of sizes, as records show that 43 different sizes were on the market, some of which were subject to infrequent call —in some cases only one gross per annum.

The following revised editions of specifications have been issued:

C2-1929. Standards for Single-phase Distribution Transformers

This constitutes the second edition of a specification which was issued in 1920. The title has been changed to read "Standards" instead of "Standard Requirements" and some revision has been made in the capacity limit and rated voltages, this being made necessary by the result of experience in the operation of the first edition.

C22-1930. Canadian Electrical Code, Part I

This constitutes the second edition of the Canadian Electrical Code, Part I, published in November 1927. The book contains about 50 per cent more material than the first edition and many radical revisions have been made as the result of meetings of the committee and correspondence with the various committee members. It is felt that this second edition is a considerable improvement on the first edition and many favorable comments have been received on material which it contains. This code has now been officially adopted in the Provinces of Nova Scotia, Quebec, Ontario, Saskatchewan, Alberta and British Columbia, and there is every indication that in the Provinces of Manitoba and New Brunswick it will shortly be adopted. It has also been adopted by many cities throughout Canada and also by the Western Canada Fire Underwriters Association. New provincial editions have been issued for the Provinces of Nova Scotia, Quebec, Ontario, Saskatchewan and British Columbia.

A16-1930. Standard Specification for Steel Structure for Buildings

This constitutes the second edition of the specification issued in 1924. The chief item is the raising of the allowable unit stress for axial tension from 16,000 to 18,000 lb. per sq. in. The column formula has also been revised. Certain other revisions have been made to conform with the latest editions of the specifications for Steel Railway and Steel Highway Bridges.

In addition to the specifications above described, the Association has continued the publication of the Year Book. It has proved a most useful medium for giving information on the Association and many requests for copies of it have been received.

The C.E.S.A. Bulletin, which is issued quarterly, has completed its third year of publication. As it constitutes a quarterly progress report, it has been found very useful in keeping the members of the Association advised as to the status of the different projects and many new names have been added to the mailing list for each number issued.

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 Associate Committee on Field Crop Diseases, at its organization meeting in the spring of 1928, laid out a program designed to co-ordinate and promote investigations into diseases other than rusts. The first general meeting to review progress was held in the spring of 1930. Owing, however, to the immediate need of more complete information on the distribution and prevalence of important diseases and their causal organisms, a subcommittee on plant-disease survey in the Prairie Provinces met in June 1928, to work out a uniform method of procedure. The survey report card drawn up at that time was revised, at the 1930 meeting, in the light of two years' experience, to make it dominion-wide in its applicability. This will both facilitate the recording of data and secure uniformity in observations.

The reports and discussions at the second meeting brought out again the destructiveness of the foot-rot diseases and our meagre knowledge of them as compared with other better known diseases, such as rusts and smuts. The increasing prevalence of the smuts, however, was one of the striking facts revealed by the plant disease survey. Bunt of wheat had in some sections increased as much as three-fold. This emphasizes the need of varieties that are more resistant and of better methods of seed treatment to control smut diseases.

Research at the Dominion Rust Research Laboratory, Winnipeg

During 1929, 230 collections of plants, all apparently with root- and foot-rotting organisms, were made in 108 localities within the province. Most of the collections were obtained from wheat and barley, but a few from oats and rye. The prevalence of infection varied from a mere trace to almost 100 per cent of the plants. Approximately 25 per cent of the fields of wheat and barley showed infection of 50 per cent or more of the plants. Infected plants generally appeared to be more prevalent on the lighter soils.

Isolations were made on artificial culture media from the discolored basal part of the stem and from the roots. *Helminthosporium* was this year more frequently isolated than *Fusarium*, although the latter was also common. "Take-all" (*Ophiobolus graminis*) which occurred frequently in 1928, was not found this year. The severe drought during the summer may have retarded its development. Bunt of wheat was found to be about three times as common as in 1928.

(*Investigation under the direction of Dr. J. H. Craigie.*)

Disease Survey in Alberta

A joint report on the plant disease survey in the Province of Alberta was made by the Dominion Laboratory of Plant Pathology at Edmonton and the University of Alberta. Damage from foot- and root-rots was difficult to distinguish from drought injury in many cases. Typical take-all (*Ophiobolus graminis*) was not nearly as easy to find as in 1928. Foot-rots caused by *Helminthosporium sativum, Fusarium* spp., *Wojnowicia graminis* and *Leptosphaeria herpetricoides* were general over the province. Bunt of wheat (*Tilletia*) was more common than usual and caused considerable damage. The smuts of oats (*Ustilago levis* and *U. avenae*) and the covered smut of barley (*U. hordei*) were common and caused serious losses.

(*Survey under the direction of Dr. A. W. Henry and Dr. G. B. Sanford.*)

Research at the University of Alberta

In studying the occurrence and growth of foot-rotting fungi in the soil, both *Helminthosporium sativum* and *Fusarium* spp. were isolated late in the fall from summer-fallow soil. The former was as virulent as any cultures of this organism isolated directly from wheat plants. Four of the foot-rotting fungi were grown successfully on all Alberta soil types and on water extracts of these soils. Apparently no substances very toxic to these fungi are present in these soils.

Desiccation at room-temperature for eleven months indicated that these fungi are not killed readily in this way. At higher temperatures *Helminthosporium* showed a greater resistance than *Fusarium*. Continuous freezing killed all of the spores of *Helminthosporium sativum* in two months, while alternate freezing and thawing killed them in three weeks. Germinated spores survived several freezings.

Application of sulphuric acid to the growing wheat crop, sufficient to control annual weeds, gave no practical control of foot-rots. A large number of dust disinfectants applied to the seed failed to have any appreciable effect in reducing foot-rot damage. Barley stripe was, however, completely controlled by Ceresan. A mixed mercuric dust prepared in the laboratory controlled the oat smuts completely, while Ceresan and Smuttox did not.

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

Considerable agitation is apparent in the Prairie Provinces over the widespread increase in the amount of loose smut of wheat caused by *Ustilago tritici*. Artificial inoculation of forty varieties of wheat seemed to indicate that the greater percentage of diseased plants in some varieties was not necessarily due to a greater susceptibility but rather to differences in exposure to inoculum and natural infection.

Progress is being made in the selection and purification of hybrid material which is commercially desirable and showing some resistance to the more common and destructive diseases. Knowledge regarding the mode of inheritance of reaction to some of the more common disease organisms is being accumulated.

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

Research at the Dominion Laboratory of Plant Pathology, University of Alberta

In addition to the plant disease survey, investigations are in progress on the pathogenicity of fungi isolated from wheat plants damaged by root-rots; the effect of crop sequence on the development of foot-rots of wheat; the effect on foot- and root-rots of chemicals applied to the soil; historical studies, and the effect of stage of development on the susceptibility of the wheat plant to these diseases.

A fungus which has been constantly associated with root-rot of sweet clover and related crops has been isolated, described, and named *Plenodomus meliloti.*

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

Research at the University of Saskatchewan

Numerous strains of *Pythium* species have been secured from infected roots of wheat seedlings grown in soil collected from "browning" root-rot fields. One form showing vigorous parasitism on wheat has been obtained repeatedly. Another form is strongly parasitic on both oats and wheat. Laboratory and greenhouse investigations indicate that the wheat *Pythium* is closely allied to the species causing root-rot of corn and sugar-cane in the United States. Wheat plants artificially inoculated developed the lesions characteristic of browning root-rot in the field. It is concluded that the disease known as browning root-rot is caused primarily by *Pythium* species.

Asterocystis radicis, which is associated with the foot- and root-rot disease of cereals, has been reported here for the first time on this continent. Of itself it need hardly be regarded as a parasite of economic importance, but in some seasons it may be an important factor in paving the way for more vigorous parasites.

(*Investigation under the direction of Prof. W. P. Fraser.*)

Research at the Dominion Laboratory of Plant Pathology, University of Saskatchewan

In 1929 a total of 666 grain fields were visited and reports made on foot- and root-rot diseases. The outstanding difference noted from the previous season was the predominance of the *Helminthosporium-Fusarium* type of foot-rot. Take-all appeared to be less prevalent, but in all probability the symptoms were masked by lack of rain.

A study of the fungous flora of wheat crowns and roots in the seedling stage at Saskatoon showed a predominance of *Fusarium* spp. over *Helminthosporium sativum.* Later in the season, *H. sativum* isolations showed a marked increase with a large number coming from the stubble. Similar seasonal variations were obtained at other stations. A small number of *Rhizoctonia* spp. were isolated from all locations. A *Botrytis* was isolated from roots of Kubanka wheat grown at Indian Head.

A systematic survey of 26 fields carried on since 1925 shows that the take-all disease can be satisfactorily controlled by the judicious use of simple crop rotations. Garnet wheat was more susceptible to the disease than Marquis.

In pathogenicity tests with *Alternaria,* very few lesions were produced and in no case were these definitely attributable to the organism used. Leaf inoculations were all negative, but head inoculations gave some evidence that *Alternaria* can produce discoloration of wheat kernels.

(*Investigation under the direction of Dr. P. M. Simmonds.*)

Associate Committee on Gas Research

Co-operating organizations

Alberta Research Council
Dominion Department of Mines
University of Alberta

Large supplies of natural gas are available in several places in the province of Alberta. In most cases the gas has been carefully conserved for domestic and commercial utilization. When, however, the Turner Valley field was developed, the problem of utilization became a serious one, since the producing companies wished to secure a large flow for the sake of the contained naphtha, and the amount available was much more than could be used locally. As a result much gas, stripped of its valuable liquid hydrocarbons, has been burned in that field, the recent wastage probably amounting to 300,000,000 cu. ft. or more daily.

Early in 1927 the Alberta Research Council undertook research work in an effort to develop methods of utilization of this gas. About a year later the work had expanded to such an extent that the support of the National Research Council was sought, and since that time the research has been carried on as a joint project. As the wastage of gas became more serious the National Research Council decided to appoint an Associate Committee on Gas Research, whose major task it would be to investigate the possibility of developing new methods of utilization. Known commercial processes were already being studied by commissions appointed by the federal and provincial governments.

The first meeting of the Associate Committee on Gas Research was held in Edmonton in October 1929, under the chairmanship of Dr. G. S. Whitby. At that meeting Dr. E. H. Boomer, who had been directing the local researches on natural gas, presented a report of the results obtained. Representatives of the Dominion Department of Mines described their work in the analysis of gas from many different wells, the method used being to freeze out the constituents one by one and determine their nature and percentage. Helium, if present, is the final gas remaining. The results of these analyses indicated that the proportion of methane in the waste gas of the Turner valley was higher than generally supposed, and that of the more valuable hydrocarbons correspondingly lower. The latter were present, however, in larger amount than in most of the other supplies of natural gas in Alberta.

Dr. Boomer's preliminary work has been to study the reactions of natural gas, with and without catalysts. A number of possibilities were tried, in order to eliminate those which did not give promise of a reasonable chance of success, and to permit concentration upon those which appeared encouraging from a commercial point of view.

Partial oxidation to formaldehyde and methyl alcohol was carried out in the presence of many different catalysts, but the average yield obtained was small, and this phase of the work has been discontinued.

A process was developed for the partial oxidation of methane to carbon monoxide and hydrogen, from which it is easy to produce methyl alcohol. A nickel catalyst was used, and its action may be considered very satisfactory. If the gas used contains much sulphur, as does that from the Turner valley, it will require preliminary separation, since it combines with the catalyst to form nickel sulphide.

The decomposition of the gas to carbon and hydrogen was found to be feasible over metallic catalysts. The carbon produced is not of sufficiently high quality for general use as carbon black, but might be satisfactory for rubber compounding. The hydrogen can be obtained at a purity of 98 per cent. This gas is of special interest in view of its large-scale use in the synthesis of ammonia from hydrogen and the nitrogen of the atmosphere.

The Fischer process of producing oils and other organic compounds intended for use as motor fuel was investigated, but showed little promise.

Conditions for the catalytic production of alcohol were sought by passing alcohol vapor over various catalysts, the idea being that any catalyst found to promote the decomposition of alcohol would, under suitable conditions, also promote the formation of alcohol from the products of that decomposition, which it was hoped might be obtained from natural gas. This work is still under way.

A further possibility is the use of natural gas in the hydrogenation of bitumen from the tar sands of the McMurray district in Alberta, either directly through hydrogen, or one of its decomposition products. The preliminary experiments have shown some promise, a fair yield of gasoline being secured with only a small production of coke. This phase of the investigation will be pursued.

Another interesting possibility is the production of benzene, valuable as a motor fuel, along with naphthalene and tar, by a simple heat treatment of natural gas. The yields obtained in the preliminary experiments are not high, but are regarded as sufficiently encouraging to justify a continuation of the work.

Since the meeting of the committee provision has been made for chemical work in the National Research Laboratories at Ottawa. Since natural gas is not available there except in cylinders it is planned to carry out a series of experiments on a small scale and to transfer elsewhere such phases of the work as may show sufficient promise. Experimental work will be done on the various constituents of natural gas individually as well as on the mixtures ordinarily found in nature. Special attention will be paid to the production of unsaturated hydrocarbons, which are frequently of value as a source of other chemical compounds.

In view of the rapid development of airships, additional sources of helium are urgently required. Up to the present no sources of this gas have been found in Canada comparable with those of the United States. Arrangements have been made, however, through the Department of Mines, to have analyzed for helium all the present sources of natural gas and other new wells as brought in.

Associate Committee on Grain Research

Co-operating organizations

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

The work of the committee on the large co-operative projects reported last year has been continued in the three university laboratories. The Dominion Grain Research Laboratory has been carrying on the work assigned to it in the original research program of the committee (Report for 1927-28, Appendix B). The Dominion Cerealist has given facilities for the growing of experimental material on the Dominion Experimental Farms and has acted in a consultative capacity.

In addition, the university laboratories have been continuing the investigation of problems fundamental to the co-operative projects of the committee. The results of these investigations, together with the scientific reports of the committee, are published in a single series of numbered papers. During the year thirteen papers were approved for publication in this series.

Co-operative Investigations

The Drying of Wheat

The investigations covered by the published report of the committee on the drying of wheat showed that further work on a number of points was desirable. During the year a new experimental drier was constructed at Edmonton. With this it was possible to control still more closely and record more completely the conditions of drying than could be done with the first experimental drier. With the new drier the following points were studied:

1. Factors involved in continuous drying.
2. Drying very damp wheat in two stages.
3. Recirculation of air from cooler to heater.
4. Operation when air entering the drier is very cold and dry.
5. Drying with moderately humid air.
6. Over-drying.
7. Batch drying.
8. Invisible loss.

Samples of the wheat used in these experiments were sent to the co-operating laboratories for milling and baking tests. When these are completed a full report of the investigation will be published.

Frost Injury of Wheat

A comprehensive statistical study has been undertaken with the data obtained from the samples collected from the frosted crop of 1928. Though the appearance of samples is not an infallible index of milling and baking quality, the grading of the 1928 crop was found to be, on the average, reasonably satisfactory from this point of view. The weight per measured bushel and the percentage of sound kernels appear to be valuable indices of quality in frozen samples.

A series of artificially frozen samples of known history was produced in the fall of 1929 with the refrigeration plant installed at Edmonton. More extended experiments, modified in the light of this year's experience, are projected for next season.

Protein Content as a Factor in Grading Wheat

Following the presentation of the interim report of this committee on protein content as a factor in grading wheat, a further reference was received by the National Research Council from the House of Commons, asking that the inquiry be extended to the principal wheat-importing countries of Europe. Accordingly, Dr. Robert Newton, a member of the committee, visited the principal grain markets and milling centres in that continent, and concluded as a result of his inquiries that there seemed to be at present no practical way in which protein content could be used effectively in the marketing of Canadian wheat. A full report of the survey has been published.

Quality of Wheat Varieties Grown in Canada

Although there is a considerable amount of information available on the milling and baking quality of most wheat varieties commonly grown in Canada, their systematic evaluation on a comprehensive scale has not previously been attempted. The committee has for the past two years obtained samples of over twenty varieties of wheat grown at widely scattered points in the Prairie Provinces, chiefly in the trial plots of the universities and the Dominion Experimental Farms. These samples have been subdivided, as usual, for milling and baking tests in the three university laboratories. At the end of another season's work it should be possible to classify these varieties satisfactorily, and use them as a basis of comparison in the classification of new varieties.

Spring vs. Fall Threshing

In the fall of 1927, adverse weather conditions prevented the completion of threshing before winter set in, and a considerable quantity of grain was threshed the following spring. The spring-threshed grain was badly bleached and the question of possible damage to milling and baking quality was referred to the committee. Each season since that time arrangements have been made to obtain a series of fall- and spring-threshed samples comparable in all respects except that of the exposure of one member of each pair to winter weathering. In 1928-29 the damage due to standing in the stook all winter was not serious. The weather conditions, however, did not approximate those of a winter in which any considerable proportion of the crop would be left in the stook.

Independent Researches at the Universities

Grain Research at the University of Alberta

Further proof that soil as well as climate plays an important part in controlling the quality of wheat was afforded by variations found in the quality of wheat grown in a single field. In one experiment the protein content of twelve varieties grown in quadruplicate plots showed a spread between replicates ranging from 2.2 to 4.9 per cent in individual varieties. There did not appear to be any simple relation between variation in yield and variation in quality . The latter aspect of the problem will be the subject of experiments during 1930.

A number of crop rotations are being studied with reference to their effect on wheat yield and quality, but it will be some years before definite results can be obtained in this project. In an experiment on the effect of alfalfa,

brome, timothy and western rye grass on the yield and quality of the succeeding wheat crops, the largest yields of both grain and straw were obtained after alfalfa, with the grasses coming in the order: western rye, brome, timothy. In yield of protein per acre, the same order was maintained and the spreads increased. The differences in baking quality, however, were not significant, as, owing to the character of the season, all samples were uniformly good. The adverse effect of timothy cannot be explained by the relative drain on soil moisture and nutrients made by the forage crops. Timothy roots and stubble, however, contain a higher ratio of carbohydrates to protein than do those of the other grasses. This would tend to retard decomposition, a view which is supported by measurements of oxidation-reduction potentials in the water extracts of the crop residues.

In experiments on the effect of crop association, it was found that the admixture of flax did not reduce either the yield or quality of wheat in 1928 or 1929. The presence of sweet clover improved both the yield and quality of wheat in 1928 and slightly improved the quality without depressing the yield in 1929.

In connection with the studies on the nature of heat damage to wheat, a new method for preparing glutenin has been developed, which depends on its dispersion in concentrated urea solutions. The nitrogen distribution of glutenin so prepared is different from that of glutenin prepared by the alkali method. Gliadin has been prepared by several methods and the effect of heat on its properties is now being studied.

In continuation of studies on methods for the estimation of gluten quality, it was found that the maximum loaf volumes which a series of flours was capable of attaining, when all had been brought to the same protein content by starch dilution, were in the same order as, though not necessarily proportional to, gluten quality, provided the degree of dilution was not too high. The rate of decrease of loaf volume with increasing dilution, however, had no general application as a measure of gluten quality, whether the baking was performed with or without the stimulation of gas production. Takadiastase and malt diastase were unsatisfactory as gas stimulants, because as obtained commercially they contained proteolytic enzymes. Maltose and potassium bromate were better for this purpose.

To supplement the information obtained in the co-operative project on frost injury in wheat, biochemical studies of the changes in composition incident to maturing and freezing have been undertaken. The preliminary work has been done with a selected series of samples from the artificially frosted material produced in 1929.

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

Chemical and microbiological investigations of the soil in the plots used for the studies of the sequence effects of alfalfa, brome, western rye grass, and timothy have been carried on by the Department of Soils. It was found that the alfalfa plots had a higher nitrate content and a greater biological activity than the grass plots, and that this relation was maintained for at least a year after the sods were broken. The differences in microbiological activity under the grasses as measured by nitrate content, rate of nitrification, and plate counts of micro-organisms, were insufficient to account for the varying sequence effects.

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

Grain Research at the University of Manitoba

The following problems were under investigation at the University of Manitoba:

1. Influence of heating germ at different moisture contents and temperatures, for various times, on the deleterious effect of germ added to a highly purified mill stream.
2. The cause of reaction of bread dough to bromate.
3. The changes in flour incident to aging. Flours of different grades with varying protein content and percentage ether extract were stored with different moisture contents and at two different temperatures.
4. The utility of protein peptization by inorganic salt solutions as a means of predicting baking quality. A statistical study of the data obtained shows that this method is practically valueless.
5. The utility of honey as a source of sugar in bread making.
6. The heat of hydration of wheat flours of various protein contents at different moisture levels.
7. The relation between carotin content and protein content of flours milled from the same variety.

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

Grain Research at the University of Saskatchewan

A preliminary investigation of means for bleaching experimentally milled flour was carried out. Color of flour has become an important factor in testing wheat. This is especially true in respect to new varieties, many of which have been bred from highly colored parent stock. Methods for bleaching on a laboratory scale have been very time-consuming and it was necessary to develop a method combining ease and speed of applicability with a reasonable degree of accuracy. The apparatus devised permits a continuous flow of flour to be exposed to a continuous stream of air-chlorine mixture, thus approximating commercial practice. This apparatus can be used for all gaseous bleaching agents. For bleaching with powdered reagents such as Novadel, a special type of jar, designed to give very thorough mixing of the ingredients, was constructed.

A large number of tests were made using different varieties of hard spring wheat flours of different strengths, and various concentrations and combinations of two commonly used bleaching agents, namely Beta-chlor and Novadel. Beta-chlor was found to have both maturing and bleaching effect while Novadel showed only a bleaching effect, results in agreement with those of other investigators. Particular attention was given to the maturing effect of Beta-chlor. It was observed that in general the dosage necessary to cause over-bleaching is directly related to the protein content of the flour. Some of the flours with protein of over 16 per cent, subjected to three times the normal commercial dosage, showed no signs of over-bleaching, as determined by baking behavior, whereas the very low protein flours showed evidence of damage from the normal dosage. There is some indication that a flour apparently undamaged for straight baking, may have been reduced in value for blending with very soft flours, but this point requires fuller investigation.

A moderately small dosage of Beta-chlor or chlorine, at the rate of ½ oz. per bbl. of flour, followed by Novadel at the rate of 1 lb. per 40 bbl., seems to be indicated as a good bleaching procedure for routine laboratory work where it is desired to compare flours with some accepted standard, as, for example, in testing selections for the plant breeder.

Incorporation of bleaching as part of the laboratory routine will enable the cerealist to obtain a more accurate estimate of flour quality and to predict with greater confidence the commercial utility of new varieties of wheat.

An improved constant-temperature fermentation cabinet has been designed and constructed. Tests of this equipment have shown that low variability in loaf volume is obtained by its use. This has led to the construction of similar cabinets in the Alberta and Manitoba laboratories.

(*Investigation 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

The committee has during the year continued its study of heat insulation along the lines previously laid down. In addition, work has been undertaken for the Advisory Board on Tariff and Taxation, which required information in connection with its inquiries as to the comparative value of heat insulating materials manufactured in this country and those imported.

The committee first met and discussed the methods which should be used in carrying out these tests. They were considered to be of sufficient importance to justify duplication of the determinations in different laboratories. This would not only provide a check on the results but would also give valuable scientific information as to the procedure to be followed.

It was arranged that all the samples for test should be secured on the open market, and from a single source in the case of each material, in order that all the laboratories might be working on material as nearly alike as possible. Three insulating boards were first secured and tested by methods tentatively agreed upon. The committee then met to compare results and consider whether modifications in procedure were desirable. The results obtained were considered entirely satisfactory for ordinary purposes, but in view of the unusual importance of the samples it was agreed that minor modifications should be made and the work should be repeated, the other samples also being tested by the improved methods. This work is now in progress.

Associate Committee on Honey

Co-operating organizations

Dominion Department of Agriculture
Manitoba Agricultural College
Montreal District Beekeepers Association

Complying with requests received from different honey producers' organizations the National Research Council has appointed an Associate Committee on Honey, which held its first meeting in Ottawa in August 1929. At that meeting consideration was given to a list of problems suggested by the Montreal District Beekeepers Association and others.

The most important single problem appeared to be that of fermentation, from which serious losses are being suffered. A study of a large number of analyses available showed a close correlation between fermentation and moisture content. It was also noted that those sections of the country where the climate was very dry, as the Prairie Provinces, had a much lower percentage of fermentation. Fermentation is especially liable to occur in honey which has crystallized due probably to the consequent increase in moisture content of the uncrystallized portion.

Dr. Lochhead of the Central Experimental Farm presented to the committee the results of studies carried out under his direction on fermentation in honey. A study was first made of the organisms causing fermentation and of their distribution. From thirty-four species of flowers examined eleven types of yeasts capable of causing fermentation in honey were isolated. Of these, two were types which had been found to occur in honey. A study was also being made of the soil as a source of infection. The biochemistry of honey fermentation was being investigated in the hope that this might throw some further light upon the cause of fermentation and indicate methods of preservation.

The crystallization of honey was regarded as of some importance, since the European market preferred honey which had crystallized, but which was nevertheless smooth in texture and very fine-grained. Some markets, on the other hand, demanded uncrystallized honey, and methods of keeping it liquid were desirable.

Bee diseases were given some consideration, but were regarded as not constituting an urgent problem. In the same category was put the production of a honey-yielding flora. It was agreed that work on the development of new uses for honey was desirable.

In order to enable Dr. Lochhead to make more rapid progress in his investigations the committee agreed to provide him with an assistant to carry out bacteriological studies. Arrangements were also made for experiments on the use of honey in bread making to be carried out under the direction of Dr. W. F. Geddes at the Manitoba Agricultural College.

It is contemplated that chemical work on honey will be carried out in the National Research Laboratories as soon as the necessary arrangements can be made.

Associate Committee on Leather

Co-operating organizations

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

Late in 1929, at the request of the Tanners' Section of the Toronto Board of Trade, the president of the National Research Council conferred with a group of their members regarding a possible co-operative investigation of the problems of the leather industry. At this conference several of the outstanding problems of the industry were discussed, and the definite request was made that the Council establish an Associate Committee on Leather. Such a committee was authorized by the Council at its meeting on December 16. To it were appointed members of the technical staff of the Council and representatives of the Tanners' Section of the Toronto Board of Trade and of the Technical Association of Canadian Leather Belting Manufacturers, this latter organization having also

expressed a wish to co-operate in the work of the committee. Steps were immediately taken with the object of securing for the committee all reports of researches carried out in England by the British Leather Manufacturers' Research Association, and satisfactory arrangements were completed.

Following a number of preliminary conferences to discuss plans for a co-operative investigation a full meeting of the committee was held in Toronto on February 24, 1930.

At this meeting the leather manufacturers stated that their problems of most immediate concern were those relating to damage to hides, by various causes. Losses from damage by the warble fly, it was estimated, would amount to several million dollars a year, while those from branding and accidental injuries were also serious. It was brought out that the life history of the warble fly had already been worked out, but that control was difficult, requiring the co-operation of all cattle men in a district in order to be really effective. In Denmark the destruction of the grubs before emergence had been made compulsory, and losses sustained had as a result been reduced to a very low figure. The situation in Canada was so serious, however, that during certain months of the year many tanners would not purchase Canadian hides. It was arranged to communicate with other organizations in this matter with the object of having a serious effort made to destroy this parasite.

On consideration of problems in tanning, there was presented a letter from the American Leather Chemists Association outlining the nature of the work being done by that organization. There appeared to be several problems upon which researches should be carried out in Canada.

In regard to belting manufacture, practices differed widely. Some firms tanned their own leather, while others imported their whole supply. The advisability of preparing standard tests for leather belting was discussed, and it was arranged that there should be submitted to the committee a list of the problems peculiar to that section of the industry.

The utilization of waste products of the tanning industry, and of waste bark which might be used by the tanners, was considered by the committee. It was reported that in British Columbia a large amount of hemlock bark was being burned, although some of the tanners of Ontario were importing their bark from the United States. The secretary was instructed to investigate this matter. It was decided to look into the question of the utilization of waste Canadian sulphite liquor in the tanning industry. The committee agreed that the wastes of the tanning and belting industries were being fairly well taken care of by the manufacturers themselves, although other uses for their by-products were desirable.

After considerable discussion it was agreed that research on leather problems should be undertaken in the Division of Chemistry of the National Research Laboratories at Ottawa as soon as arrangements could be completed The decision was also made to circularize the industry in regard to the work of the committee.

Associate Committee on Magnesite

Co-operating organizations

Dominion Department of Mines
North American Magnesite Company
Scottish Canadian Magnesite Company

The present year is the fifth since the magnesite investigation was begun; it may be of interest, therefore, to review the progress which has been made in the laboratory in that time, and to note the commercial bearing of the results obtained.

Five years ago the co-operating magnesite companies were making a careful selection of all rock quarried, and, in order to reduce the silica and lime content to the point required by the trade, found it necessary to discard some 70 per cent of the total material handled. It was discovered in the laboratory that, provided the different constituents of the rock were properly proportioned, it was unnecessary to do more than ensure that the silica was kept down to a reasonable figure, a change which made it possible to utilize practically all the rock mined. The resulting product, lower in magnesia than formerly and somewhat higher in the other constituents, possesses the property of setting more rapidly when exposed to a high temperature, such as that prevailing in an open-hearth steel furnace, without losing its refractoriness. It thus constitutes a more satisfactory material for that purpose. Its quality has been reflected in very largely increased sales, in Canada, Great Britain and the United States, and this in spite of the depression in the steel industry, in which the greater part of it is used.

Another possible outlet for the material is in the manufacture of magnesium bisulphite liquor for use in the pulp and paper industry, provided that this can be done in the ordinary towers designed for limestone. A process was worked out in the laboratory whereby the rock could be calcined, ground or otherwise reduced in size, and admitted with water to the top of a tower filled with limestone. Under these conditions its rate of solution was so increased as to make possible the easy introduction of magnesian liquor into the system, at the same time giving better control of the proportions of free and combined acid in the liquor. Negotiations are now under way for a commercial trial of the method.

As outlined in the last annual report, laboratory tests indicated that if the calcination of the rock were carefully controlled it could be used for the production of plastic magnesia, and semi-commercial trials fully confirmed the smaller tests. It was found that the product was suitable as stucco for houses, and, combined with wood flour and other materials, as a resilient, fire-resistant and attractive floor. During the past year such a plastic magnesia has been produced on a commercial scale. The material has already been used for a floor put down in the John Street laboratories of the National Research Council. Laboratory work is now under way which it is expected will result in a further improvement of this product and lead to its commercial use in other fields.

Further progress has been made in the development of a satisfactory brick in the ceramic laboratories of the Department of Mines. This work was begun more than four years ago, and at times it appeared that the difficulties encountered were almost insuperable. One by one, however, these have been overcome, and recent trials in commercial furnaces of the experimental brick produced indicate that they will be as satisfactory in practical use as the laboratory tests had indicated. They are sufficiently refractory, are practically neutral in character, so that they can be used in contact with either acid or basic brick, and possess remarkable spalling resistance, that is, they can be repeatedly heated to a high temperature and cooled rapidly without fracture. Before commercial manufacture is begun further furnace trials will be made under widely varying conditions.

Two patents have been obtained upon the processes developed and others will be applied for in due course.

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

Associate Committee on Mining and Metallurgy

The twelfth annual meeting of the Associate Committee on Mining and Metallurgy was held in Toronto on March 5, 1930, under the chairmanship of Dr. Frank D. Adams. Nineteen persons attended the meeting, and a number of important questions in the fields of mining and metallurgy were discussed.

In order that the committee might be kept thoroughly posted on all developments in the iron and steel industry, which might offer any prospect for the utilization of Canadian iron ore resources, the known deposits of which are of lower grade than certain iron ore deposits in other countries, the committee some time ago established a Subcommittee on Iron Ores. The report of the above subcommittee was presented at the meeting under review by Mr. J. G. Morrow, chairman of the subcommittee. This report covered such questions as the Lake Superior iron ore reserves, beneficiation, sintering, the use of Canadian iron ores, blast furnace operation, iron pyrites and sponge iron.

The committee also had under consideration the question of acoustic plasters and the use of asbestos in their manufacture. The Canadian asbestos mines have been used for some fifty years and the high-grade material has been greatly depleted. The attention of the committee was called to the fact that it is extremely important to find new uses for the low-grade asbestos fibres which are now being produced from the Canadian asbestos mines. The various important phases of this problem were discussed at length by the committee, and arrangements made for rendering such scientific assistance to the asbestos industry of Canada as may be found necessary.

The committee also had under consideration the question of the production of iron and steel by processes involving the preparation of sponge iron which may then be melted in electric furnaces or in open-hearth furnaces, or alternatively the production of pig iron or steel in one process by apparatus in which the sponge iron is produced electrically and melted before cooling.

The advisability of the National Research Council undertaking research work on certain problems relating to the mining resources of New Brunswick was also considered by the committee. In this connection, Dr. W. J. Wright, Provincial Mineralogist, presented for consideration a paper covering the following problems:

1. Anhydrite and spent shale, to yield sulphuric acid and cement.
2. Anhydrite and coal, to yield coke and ammonium sulphate.
3. Artificial seasoning of pulpstone.

The possibility of utilizing sand tailings separated from Northern Alberta bituminous sands, for moulding sand, sand-blasting, in glass making and for sand-lime bricks, was introduced by Professor Edgar Stansfield and fully discussed by the members of the committee.

The question of the advisability of a geological or other survey of the Burmis iron fields being undertaken, and if found worth while, the study of the titanium content of these ores and methods of beneficiation, was discussed by the committee. During the course of the discussion on this subject, it was pointed out that it has been shown that good pig iron can be made from such ores, but that there is some question as to the cost involved. It was the concensus of opinion of the committee that in the absence of a market, it would not seem possible to economically develop these deposits at the present time.

Associate Committee on Nitrogen Fixation

A meeting of the committee was held in Ottawa on December 16, 1929. At this meeting the situation in regard to nitrogen fixation and the manufacture and use of fertilizers was reviewed, and it was decided to continue the issue of an annual report covering these subjects in some detail. The preparation of such a report was undertaken by the staff of the newly organized Division of Research Information of the National Research Council, under the general direction of the chairman of the committee. The committee wishes to express its indebtedness to all who, by supplying information, have assisted in the collection of material for this report.

A review of the world situation during the year under review reveals the fact that the very rapid expansion in the fixation of nitrogen has continued. Most of the increase is accounted for by developments in Great Britain, the United States, Canada and Belgium. Chile, by a marked increase in the production of sodium nitrate, has contributed largely to the abundance of nitrogenous fertilizers. The situation may be summed up in the statement that world production has doubled in the last five years, and that production is likely to considerably outrun consumption in the near future.

The failure of consumption to fully keep pace with production is no doubt due in large part to the present world-wide depression in agriculture. Under the circumstances, however, consumption must be regarded as fairly satisfactory, the year 1929 having shown an increase over 1928 of more than 200,000 tons of nitrogen. This increased consumption has been made possible only by an intensive educational campaign and the stimulation of low prices.

Some time ago the I. G. Farbenindustrie announced the conclusion of a sales agreement with the Chilean Government and with the principal British producer. It is significant of the policy of this cartel, however, that coincident with its formation a reduction in the price of fixed nitrogen was announced.

The world situation in regard to potash and phosphoric acid is not radically different from that of nitrogen, although in recent years the world production of nitrogen has increased relatively faster than either of these other two important plant foods. In potash production Germany continues to occupy first place, and France the second. These two countries continue to dominate the world market, although production in the United States is increasing rapidly. The production of phosphate rock from French dependencies in northern Africa has shown a remarkable increase in recent years, while the very large production of the United States has remained approximately stationary.

Technically, the nitrogen and fertilizer industries have made further progress, although new developments of the first magnitude have been lacking. In nitrogen fixation, interest continues to centre in the production of hydrogen, the cost of which is still the largest single item of expense in the synthesis of ammonia. Coke-oven gas is becoming more and more important as a source of hydrogen, due both to the ever-increasing volume of this gas available and to improvements in methods of recovery and purification. Other cheap sources of hydrogen are being sought.

The catalytic oxidation of ammonia to nitric acid is taking place on an increasing scale, and costs are being reduced to such a level that synthetic sodium nitrate is now being produced in competition with the natural product. Further developments in this direction may be expected.

Cheap nitric acid immediately suggests its substitution for sulphuric acid in the decomposition of phosphate rock, and experimental work in the development of such a process is actively under way. Decomposition by nitric acid, followed by neutralization with ammonia, offers very attractive possibilities. Commercial developments along this line would constitute an important step in the production of concentrated fertilizers.

The great effort to cut production costs in order to supply cheap fertilizers and thereby increase consumption has been accompanied, at least in Germany, by a corresponding attempt to reduce transportation charges per unit of plant food. So far have some manufacturers gone in this direction that fertilizers containing 75 per cent or more of plant food are now on the market in Europe. In America consumers still show a marked preference for the mixed fertilizers of lower grade.

An interesting development which promises to become of importance is the new system of grassland management in which close grazing or frequent cutting and the intensive application of nitrogenous fertilizers are combined to produce crops containing an amount of protein hitherto thought impossible of attainment. It has been demonstrated that under favorable climatic conditions the stock-carrying capacity of land can by this system be greatly increased.

Developments of some importance are under way in Canada. Not long ago the American Cyanamide Company completed a large addition to its nitrogen fixation plant at Niagara Falls, Ont., and the total capacity is now said to be 355,000 tons of cyanamide per year. This product is being shipped to the United States for use in the manufacture of fertilizers.

Canadian Industries, Ltd., is building a small synthetic ammonia plant near Windsor, Ont., to utilize by-product hydrogen from the chlorine cells of its electrolytic soda plant. The ammonia produced will be oxidized to nitric acid at Beloeil, Que. A fertilizer plant will be built at Hamilton, Ont., and one already in operation at New Westminster, B.C., will be enlarged.

The Consolidated Mining and Smelting Company of Canada is building at Trail, B.C., a contact sulphuric acid plant which will utilize a large part of the sulphur dioxide now going to waste in the smelter gases. (See report of Committee on Trail Smelter Smoke Investigation, page 62.) The acid produced will be used in the manufacture of triple superphosphate and ammonium sulphate. The ammonia required for the latter will be produced in a 40-ton Claude plant using electrolytic hydrogen. Incidentally, the installation of mercury-arc rectifiers required for the production of the necessary direct current will be the largest in the world. The construction of the acid and fertilizer plants, exclusive of the necessary hydroelectric developments, involves a total expenditure of more than ten million dollars. Production is expected to begin early in 1931.

The erection of this company's large fertilizer plant is being accompanied by an educational campaign in the use of fertilizers, particularly in the Prairie Provinces. A large number of experimental plots have been established under the supervision of the provincial departments of agriculture, and results are being watched with the greatest interest. The first season's trials indicate that under favorable conditions sufficiently large increases in yield can be secured to more than pay for the additional cost involved in the use of fertilizer.

Associate Committee on Oceanography

Co-operating organizations

Biological Board of Canada
University of British Columbia

Several meetings of the committee have been held during the year under review. At these meetings consideration has been given to problems arising out of the two main branches of the committee's work, which are:—First, co-operation with the Biological Board of Canada in planning an oceanographic investigation of that region of the Pacific in proximity to the Biological Station at Nanaimo. Second, co-operation with other countries bordering on the Pacific, especially in the standardization of methods of obtaining material and data, so that a more direct comparison of results may be made than has been possible in the past.

Members of the committee, as well as investigators working at the Nanaimo Station under the auspices of the Biological Board, have kept in close touch with investigations of a similar nature under way along the Pacific coast of the United States. Several groups of individuals have conferred on problems of mutual interest, and it is planned to have a general conference in the near future.

Dr. W. A. Clemens has brought up to date the list of papers published in Canada on Pacific oceanography, and mimeographed copies of this list have been sent to the other national committees in countries bordering on the Pacific. The committee is also preparing to take an active part in the work of the Fifth Pacific Science Congress, to be held in Vancouver and Victoria in 1932.

An important contribution to co-operation in Pacific oceanography was made in connection with the Fourth Pacific Science Congress, held in Java in 1921. The chairman of the committee attended this congress and presented at its sessions seven papers prepared for the occasion by men engaged in various phases of the general field of oceanography in Canada. In accordance with a resolution passed at that congress the chairman of the Associate Committee on Oceanography automatically becomes vice-chairman of the International Committee of the Oceanography of the Pacific, and will continue to hold this position until the adjournment of the Fifth Pacific Science Congress.

Associate Committee on Physics and Engineering Physics

A two-day meeting of the committee was held in Ottawa on October 28 and 29, 1929, under the chairmanship of Prof. J. C. McLennan. Nineteen members were in attendance.

The chairman outlined the work which the National Research Council had carried out since the previous meeting of the committee, and informed the committee that a decision had been reached to establish National Research Laboratories at Ottawa, under the auspices of the Council.

A discussion took place on the desirability of securing a source of helium in Canada. The chairman read correspondence which he had had with the Helium Company of the United States, stating that they had found gas wells in Utah and Colorado containing over seven per cent of helium, and from which 12,000,000 cu. ft. of this gas could be produced annually. It was evident that low-grade gases could not be treated for helium in competition with these

sources, but the committee agreed that the possibility of a source of helium in Western Canada should nevertheless be investigated, particularly on the slopes of the Rocky Mountains.

Researches on the upper atmosphere were also considered by the committee especially in relation to radio transmission. Attention was called to the particularly favorable location of Canada for researches on the aurora. Representatives of the Department of National Defence and the Meteorological Service offered their hearty co-operation in any work which the committee might undertake on this subject. It was agreed that the National Research Council be asked to make arrangements for a comprehensive series of researches on the upper atmosphere and related problems.

Dr. A. S. Eve called attention to the growing demand for young physicists, and expressed the fear that the universities might not be able to supply the required number of trained men. A subcommittee was appointed to give further consideration to this question.

Mr. Keay brought up the question of the utilization of Saskatchewan lignites, and urged that either the Dominion Government or that of the province should determine the value of this fuel in pulverized form; several plants using pulverized lignite had been abandoned. Mr. McLeish stated that the Mines Branch was preparing to carry out a systematic series of tests on Canadian coals to determine their suitability for use in this way. He also informed the committee that the briquetting plant of the Lignite Utilization Board had been taken over by a commercial firm, which was marketing briquettes.

Consideration was given to the question of the relation of lightning to high-tension electrical transmission, a question of peculiar importance to Canada. It was recommended that the National Research Council appoint a committee to deal with this question.

Mr. Clark pointed out the need for reliable information as to what constitutes a satisfactory artificial electrical ground under varying conditions of weather, soil, etc. Mr. Dobson urged the collection of data on actual ground resistances over a wide area. A number of difficult problems in this field were outlined, and it was agreed that the matter should be given further study.

Dr. Eve reviewed for the committee the various methods of geophysical prospecting which had been developed in recent years. He pointed out that the Dominion Observatory and the Geological Survey were doing work with the gravitational method, and that electrical methods were being tried in Canada. He thought that the seismic method should also be applied in this country. Prof. Gilchrist outlined the work on electrical prospecting being done co-operatively by his department and the Geological Survey. After considerable discussion it was agreed that Dr. Tory and Dr. Collins should discuss further the possibility of a co-operative program of research.

Great regret was expressed by the committee at the untimely death in Australia of Dr. E. S. Bieler, while engaged in work on electrical prospecting.

Other subjects discussed by the committee included the standardization of lubricating oils, and researches on alloys, corrosion, radio interference, fatigue of metals, and physical therapy.

Associate Committee on Spray Painting

The question of the health hazard connected with the spraying of paint was referred to the National Research Council by the Federal Department of Health late in 1926. Prior to this, discussions on this subject had taken place

in labor organizations with the result that the whole question was discussed in Montreal at a general labor assembly, by which it was referred to the Dominion Council of Health. The latter body in turn referred the matter to the Federal Department of Health, which department passed the problem on to the National Research Council.

In referring the matter to the Council, the opinion was expressed that the use of the paint spraying machine must, in all probability, be considered as permanently established, but that there is a menace to the health of the operators in the improper application of this device; this menace is due to the pigments and insoluble ingredients used, such as lead, silica, etc., and to the inhalation and local irritative action of solvents and driers used in the material sprayed.

The National Research Council, on consideration of this question, appointed an Associate Committee on Spray Painting and assigned to the committee the task of considering all phases of the question and recommending the action which, in the opinion of the committee, should be taken by the Council.

The first act of the committee was to distribute a questionnaire for the purpose of ascertaining what definite information is available in the files of the health departments and labor organizations with respect to the health hazard connected with the use of the spray painting machine. The replies to the questionnaire clearly indicated that there was no definite information on this question available in Canada.

In addition to the distribution of the questionnaire, the committee proceeded to gather all available literature on the subject, including reports and papers which have been published in connection with researches already carried out, and to collate this information and arrange the material in a form which would make it available to all organizations, industries, and persons concerned with this problem.

In the course of its work, the committee visited twelve industrial plants using paint spraying equipment, in the Montreal and Toronto districts, in order that the members of the committee might become personally familiar with the conditions under which paint spraying operations are carried out in Canada. The plants visited employed from two or three to more than sixty operators each, and were spraying lacquer, enamel, varnish or paint on such articles as automobiles, stoves, pianos, radio cabinets, aeroplanes, ships, furniture, household utensils, street cars, motor buses, and machinery. From the foregoing, it will be obvious that the committee had accurate knowledge of the general conditions under which Canadian industries carried out paint spraying operations.

As a result of its activities, the committee prepared a report which was issued during the year under review and published as Bulletin No. 15 of the National Research Council under the title, "Review of Literature Dealing with Health Hazards in Spray Painting." This report is divided into three main sections. Section I deals with the physiological effects of a number of the more common substances used in spray painting. Section II deals with the reported results of tests of equipment and recommendations suggested for the control of the hazards of spray painting, and Section III contains a summary of existing and tentative legislation on this problem. An extensive bibliography on this subject is also given as an appendix to the report.

The conclusions reached by the committee as a result of its deliberations are stated as follows:

"After a careful study of all the information found in the accompanying report, the committee is of the opinion that there are certain definite health hazards connected with spray painting, and the committee offers the following conclusions and recommendations for the consideration of the constituted public authorities who are responsible for dealing with such matters.

(1) The more toxic or pathogenic ingredients in the material to be sprayed should be reduced to a concentration below that which constitutes a health hazard. This will involve especially lead (which present knowledge would indicate should not exceed in concentration one per cent of the material used for spraying), benzol, turpentine, and silica, and certain alcohols (methyl, butyl, allyl and amyl), benzine, gasoline, toluol (toluene) xylol (xylene) tetralin and tetrachlorethane. When a satisfactory painted surface can be produced otherwise, a number of these ingredients should be eliminated altogether from the material used for spraying. All paints containing lead, benzol, turpentine and free silica for use in spray painting, should be labelled in such manner as clearly to indicate the percentage of each such substance on the container. Whether other ingredients now used, or other compounds which may in the future be so used, should be included in the foregoing list, can only be determined after careful investigations have been made as to the possibility of their constituting more or less serious health hazards in spray painting.

(2) The spray booth and its equipment should be such as to provide the maximum safety possible for the spray operator. The exhaust fan should provide a sufficient current of air, varying according to the size of the booth, but adequate to exhaust the fumes. To prevent the exit of the fumes or air charged with the ingredients of the sprayed material other than through or by the exhaust fan, the air entering the room in which the booth is located should not exceed the supply of air removed from the booth by the exhaust. The face of the booth should be provided with doors capable of being adjusted to reduce the open face of the booth according to the size of the object to be sprayed.

Where spray painting is done within buildings, it should be carried on only in a part of the building set aside exclusively for such work. Objects freshly sprayed should be immediately removed for drying to special apartments not used for other purposes, and proper equipment for exhausting the fumes from such apartments should be provided.

(3) The air pressure used in the spray machine should be as low as will provide a satisfactory painted surface. The nozzle of the spray machine should be held at least one foot distant from the object sprayed, in order to avoid unnecessary rebound (beat back) of the spray.

(4) The operator should, and, when he is engaged in interior spray painting, must, wear a mask into which uncontaminated air under pressure is supplied.

(5) No one should be engaged as an operator who is under twenty years of age, and before beginning employment as such, each applicant should undergo a medical examination to determine whether he is in proper condition to serve as an operator. Thereafter, where possible, every three months he should be examined medically to determine whether he has been affected in any way by the material used in spraying, and if found affected, should only continue as operator on medical advice and under medical supervision. No woman should be employed in spray painting during pregnancy.

(6) Provision should be made requiring spray operators personally to observe regulations intended to minimize the health hazard."

Associate Committee on Tuberculosis

Co-operating organizations

Dominion Department of Agriculture
Fort Qu'Appelle Sanatorium
McGill University
Queen Alexandra Sanatorium
Queen's University
Sun Life Assurance Company of Canada
University of Alberta
University of Montreal
University of Toronto

In addition to the use of curative measures in the treatment of disease at least two methods of control are in common use. The first of these is based upon the principle of preventing infection by the destruction of diseased animals, as is done with rabies in dogs, and in the accredited-herd plan for tuberculosis in cows. This method is reasonably effective, but is frequently very expensive, involving as it does the loss of animals which may be of considerable value. Another important method of control is immunization against disease, which has accomplished so much in reducing the prevalence of small-pox and diphtheria in humans. It is this method for the control of tuberculosis which has been adopted on a large scale in France and other European countries, where the vaccination of children and calves with B.C.G. (bacillus Calmette-Guérin) has become fairly common. Much has been claimed for this vaccine, and the Associate Committee on Tuberculosis has therefore made a serious effort to determine the advisability of its use in Canada. The question has proved to be of such magnitude and difficulty that it has not yet been possible to reach a unanimous conclusion. Its importance, however, both from the human and animal standpoint, is such as to more than justify the work which is being done.

The continued financial support of the Sun Life Assurance Company of Canada, which has contributed a further sum of ten thousand dollars towards the work of the committee, is gratefully acknowledged.

At the Hull Research Station of the Dominion Department of Agriculture and at the University of Alberta investigations have continued on the effect of vaccination of calves with B.C.G. The nature of cultures of B.C.G. from various sources has been studied at Queen's University. Progress has been made at the University of Montreal on the vaccination of children with B.C.G. and observation of the results obtained. At the University of Toronto the incidence of tuberculous infection has been studied, and detailed microscopic examinations have been made of cattle which react to tuberculin but do not possess visible lesions. Researches at the Queen Alexandra Sanatorium have had as their objects the determination of the nature of immunity to tuberculosis, and an improved technique in X-ray photography and the interpretation of photographs of tubercular lungs. At the Fort Qu'Appelle Sanatorium additional work has been done on tuberculosis amongst the Indians.

There follows a brief outline of the work under way at each of these centres.

Tuberculosis Research of the Dominion Department of Agriculture

Further work has been done on the effect of vaccination of calves with B.C.G., the animals being kept for various lengths of time before slaughtering; this phase of the investigation will be continued, since it is believed that time is

one of the most important factors in determining both the innocuity or otherwise of the vaccine and its value in increasing resistance to tuberculosis. A special study has been made of vaccination nodules. It has been found that such nodules, even on an animal which shows no tuberculous lesions, still give a positive reaction for tuberculosis in guinea pigs as much as 18 months after vaccination.

A laboratory investigation is also being made on the possibility of the dissociation of B.C.G. into strains of varying virulence.

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

Tuberculosis Research at the Fort Qu'Appelle Sanatorium

A report on the survey of the tuberculosis epidemic amongst the Indians of Fort Qu'Appelle, which had been in progress for some time, was given in the last annual report. The results of this investigation form a background for future work.

Because of a decline in the cases of glandular tuberculosis amongst the children on the reserve, material used in the investigation to discover the nature of the germ responsible for the infection has decreased. Thirty-two of 35 specimens taken were found to be tuberculous, and of the many strains isolated from these not one was found to be of bovine origin. With the co-operation of a full-time physician, appointed as the Medical Superintendent of the Qu'Appelle Indian Health Unit, more work will be done on this as well as other phases of the investigation.

Attention has been directed particularly to the problem of prevention. This involves elimination of the source of infection, observation and treatment of the school-age child, and protection of the pre-school-age child against the disease, which entails the general improvement of sanitary conditions on the reserve.

During the year 329 school children and 32 pre-school children were examined. This work included the taking of radiographs, laboratory investigations of the blood, urine and expectoration, and examination of the teeth, tonsils and general nourishment of the children. Twenty-eight children were kept under observation, some being latent cases, others with recently healed lesions, and three with active tuberculosis. Regular dental attention has been given for three years, with the result that the teeth of these children now compare favorably with those of white children. According to ordinary standards, the tonsils of one-third of the children should be removed, but since the usual unhealthy conditions caused by diseased tonsils are very rare, no definite action is being taken at present. In general, the Indian is found to be better nourished than the average white child.

Cattle were tested to determine the prevalence of tuberculosis, with the result that 7.0 per cent of those tested at the File Hills reserve reacted, as did 2.8 per cent of those at Fort Qu'Appelle. Families are being encouraged to obtain healthy cattle and so provide non-tuberculous milk for their children.

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

Tuberculosis Research at the Queen Alexandra Sanatorium

It is commonly known that humoral antibodies have some part in the production of resistance to tuberculosis, but exactly what their function is remains a matter of conjecture. To investigate this question a definite plan of procedure

has been drawn up. First, there is being undertaken the isolation of types of tuberculosis antibodies in as pure a state as possible and in high concentration. This is purely a problem in biochemical technique. The second step is the administration of such antibodies to animals in good health and in various states of tuberculosis for the purpose of studying their biological effects.

The procedure has been as follows: (1) To dry blood serum containing the desired substances in an inert medium. (2) To extract with various reagents, using a reflux condenser under diminished pressure, in order to extract below the thermal death point of the antisubstances. (3) To concentrate, and further fractionate by precipitation, the extracts containing antibodies. (4) To serologically identify and measure the antibody content of the various chemical fractions. (5) To study the biological effects of the various fractions, by inoculation into healthy and tuberculous animals. The technical difficulties are very great, but definite progress is being made.

Pathological studies have been carried on, the aim of which is the precise identification of lung structures, primarily by means of X-rays. The method has been as follows: (1) To secure stereoscopic radiographs before death. (2) To radiograph the cadaver before autopsy. (3) To remove the lungs, inflate them and radiograph them in as nearly the normal positions as possible. (4) To freeze the lungs in an inflated state. (5) To cut the frozen lungs into slices from one-sixteenth to one-half inch in thickness and radiograph them while frozen. (6) To cut from the frozen slices those structures found to cast shadows. (7) To carry out microscopic studies of the slices.

By the above method it has been found possible to select the exact tissue, no matter how small, responsible for a given radiographic shadow, and to study it microscopically. Several hundred lungs have already been studied by these methods.

For the purpose of carrying out such radiographic studies it has been necessary to develop a special technique. In so doing observations believed to be entirely new have been made on the character of penumbral shadows.

(*Investigation under the direction of Dr. F. H. Pratten.*)

Tuberculosis Research at Queen's University

For some time work has been under way on the dissociation of strains of tubercle bacilli into forms of different appearance and virulence. Strikingly different results were obtained on cultures from different sources. During the past year studies have been made on the following B.C.G. cultures: (1) That used by Dr. Watson in the work of the Department of Agriculture. (2) That of Dr. Rankin, at the University of Alberta. (3) One from Dr. Petroff, who had previously made dissociation experiments, and who stated that it had originally come from the Pasteur Institute. (4) One obtained directly from the Pasteur Institute in Paris.

All four of these cultures were plated from the original media on which they were growing when received. Those from Watson, Rankin and Paris yielded only rough or avirulent colonies, while that from Petroff showed two distinct colony types, rough and smooth, the latter proving virulent to guinea pigs. It was found possible by repeated cultures on special media to convert the rough Petroff colonies into those of the smooth type. The Rankin and Watson colonies were similarly converted, although no smooth colonies were found in them originally. To date it has not been found possible to so convert the Paris culture, but the time of cultivation given it is not up to the present as great as that required for the dissociation of the Rankin and Watson strains. These observations are being continued.

Another series of experiments has been started using cultures from active cases of tuberculosis in man, to discover whether it is possible to dissociate these also into two different types. It appears probable from the work already done that the avirulent rough forms can be obtained.

Experiments have been initiated with the object of developing methods of distinguishing readily the two principal types noted above from the confusing intermediate forms. It appears that they behave differently in acid agglutination, and that there is also a correlation between virulence and cataphoretic potential. Several straining procedures are being tried with the object of differentiating the granular forms. This work will be continued.

Further experiments have been carried out on the stimulation or retardation of growth of tubercle bacilli by particular chemicals. Ferric iron, as previously reported, has a marked stimulating effect. Ferrous iron has not. Strong oxidizing agents like potassium permanganate and potassium chromate greatly stimulate growth, even when present in minute amounts. Reducing agents such as sodium thiosulphate, on the other hand, retard growth.

(Investigation under the direction of Dr. G. B. Reed.)

Tuberculosis Research at the University of Alberta

Since the previous report to the committee there has been started an experiment designed to determine both the innocuity of B.C.G. to calves and the degree of resistance conferred, when vaccination has been performed by the oral method. Seventy-six new-born calves were purchased and half of these were vaccinated. Both vaccinated and unvaccinated animals were then divided into two groups, the first being kept as free as possible from all sources of infection, and the latter being kept free for six months and then being placed in contact with tuberculous animals and fed on tuberculous milk for a further period of six months, after which they were again removed from sources of infection. Both vaccinated animals and controls at present appear to be in good health. They will be slaughtered and the carcasses examined later.

Continuing a previous experiment, there is being kept a herd of 152 cows, of which 99 were vaccinated as soon as possible after birth. Of these, 24 are young animals which have been vaccinated only once, 24 have been vaccinated two years in succession and the remaining 51 for three successive years. The 53 unvaccinated animals are old cows forming a tuberculous herd.

In another herd are 59 cows, of which 21 have not been vaccinated, nine have been vaccinated once, 13 twice and 16 three times.

In a herd of 180 cows systematic tests are being made of the milk to determine whether it contains tubercle bacilli. Of these animals 38 have given a positive test for tuberculosis in the milk when the latter was fed to guinea pigs. Four of 29 vaccinated cows in this group have given milk containing tubercle bacilli, and it is interesting to note that, of the four, one was vaccinated just over a year previously and the other three between one and two years before. No animal has secreted tubercle bacilli in its milk within a year of vaccination with B.C.G. All of these animals had been fed on tuberculous milk and had been in continuous contact with a tuberculous herd.

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

Tuberculosis Research at the University of Montreal

From June 23, 1926, to December 31, 1929, 1092 new-born babies were vaccinated with B.C.G., the vaccine being administered by mouth shortly after birth. The number of vaccinated children is now increasing rapidly, as physicians and parents are favoring vaccination as a means of protection against tuberculosis.

The fact that no reaction has ever been observed following the administration of the vaccine may be taken as evidence of its complete harmlessness.

Statistics are now available for 544 vaccinated and 1995 unvaccinated children within one district. Of these there has been a total mortality during the first year of 4.8 per cent amongst the vaccinated and of 17.6 per cent amongst those not vaccinated. It is also important to obtain a comparison between the vaccinated and unvaccinated living in contact with open cases of tuberculosis. Of 20 such vaccinated children 15 are in good health, three are dead from causes other than tuberculosis and the remaining two are suspected cases of tuberculosis. While there is no local group of unvaccinated children living under similar conditions the above may be compared with a mortality rate of 25 per cent found in France and Roumania where controls have been kept under observation.

The follow-up work has been carried on according to the plan adopted at the conference for the study of vaccination against tuberculosis by means of B.C.G., convened by the League of Nations in 1928. This important part of the work has been made possible by the services of a public health nurse. It is hoped that greater attention may be given this phase of the work, as it is only through careful observation and comparison of the vaccinated cases and control groups that it is possible to estimate the results.

An investigation is also being made to determine the origin of tuberculosis infection amongst children in Montreal. Of 23 cases the study of which has been completed to date 21 proved to be of human and only two of bovine origin.

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

Tuberculosis Research at the University of Toronto

It is now a matter of common knowledge that bovine tuberculosis may be transmitted to children through milk; unpasteurized milk, as sold on the ordinary market, contains tubercle bacilli in 3 to 15 per cent of the samples examined.

That the pasteurization of milk is a satisfactory safe-guard against this infection is illustrated by the results of a recent investigation in Toronto, where the pasteurization of milk has been compulsory since 1915 . Of tubercle bacilli recovered from children with non-pulmonary infection, not a single strain was found to be of bovine origin. Those patients in whom bacilli of bovine origin have been recognized have, in every case, come from districts outside Toronto, where the milk supply is not pasteurized.

There are three ways in which milk can be infected by tubercle bacilli. They may enter it: (1) Directly, from cows having generalized tuberculosis. (2) Indirectly, by the contamination of the milk from the excrement of cows having pulmonary tuberculosis. (3) By the mixing of milk from tuberculous animals with uninfected milk.

The most serious source of tuberculous infection in milk is tuberculosis of the udder, and great numbers of bacilli appear in the milk of cows with such an infection. Young of London demonstrated that 29.1 per cent of cows with

generalized tuberculosis showed tuberculous udders. On the other hand, there is evidence that cows without udder infection may excrete tubercle bacilli. Of specimens from 16 apparently normal udders four per cent showed the presence of tubercle bacilli.

Raw milk from herds not tuberculin tested, secured from a representative milk route outside Toronto, was examined for the presence of tubercle bacilli. Of 189 samples of milk 3.7 per cent yielded tubercle bacilli on guinea-pig inoculation. This seems a low percentage when compared with results obtained from analysis of milk from tuberculin-positive cows. Thirty per cent of samples of this milk yielded tubercle bacilli on guinea-pig inoculation. This is indicative of conditions in Canada. Less than five per cent of all cattle tested have been reactors, which is a lower rate than prevails in Europe or in the United States. Accordingly, the incidence of bovine infection in children is less here than elsewhere reported.

The determination of the incidence of bovine infection in children in Toronto has, in this investigation, been given a great deal of attention. Now the scope has been broadened to include a study of adult infection. Although enquiries elsewhere show that about 10 per cent of tuberculosis in adults is of the bovine variety, not a single typical bovine bacillus has been recognized so far in this study.

Attention was confined as far as possible to surgical cases showing no evidence of active pulmonary tuberculosis and 53 such adult cases were examined. Of the 41 which were identified, 39 proved to be typical human tubercle bacilli. Two strains were found to be atypical, being neither human nor bovine in all characteristics.

The results of a study of a group of children are quite different. From 193 cases of both medical and surgical tuberculosis in children under 14 years of age, 237 strains were identified; 197 strains recovered from 167 children proved of human origin and 40 strains recovered from 26 children were of bovine type.

The histories of most of the children with tuberculosis of human origin show a previous contact with open pulmonary tuberculosis, and a great many of these children themselves revealed pulmonary or tracheo-bronchial infection.

On the other hand the 26 children from whom the 40 strains of tuberculosis of bovine origin were recovered showed no evidence of pulmonary or tracheo-bronchial disease, except one child, 15 months old, which had a generalized infection. In no case did there appear to have been previous contact with open tuberculosis, but in every case the child, during some period of its life, had been fed on raw cow's milk. Further support for the theory that bacilli are transmitted to man from cows by milk is found in the fact that the majority of the infections in these 26 children were located in the alimentary canal, lymph nodes in the neck, and tonsils. Every one of these 26 children came from districts outside Toronto, where the milk supply is not pasteurized. In the city of Toronto the cases of tuberculosis in children were of human origin. It is estimated from this study that 13.4 per cent of surgical tuberculosis in children is due to infection with the bovine tubercle bacillus and can be traced in infected milk.

The reaction of cattle to tuberculin is ascribed to a tuberculous infection. The fact that many positive reactors fail, at autopsy, to show evidence of gross tuberculosis has therefore been a disturbing factor in the process of eradicat-

ing bovine tuberculosis. For instance, in a condemned herd of 54 animals a post-mortem examination revealed 20 which failed to show any microscopic lesions. Such animals are designated "no-lesion reactors." This investigation has therefore been undertaken in an effort to discover why cattle which react positively to tuberculin should on autopsy show no tuberculous infection.

The tuberculin reaction is merely an index of tuberculous infection, and does not indicate the extent of the lesion or the virulence of the organism. The length of the incubation period of tuberculosis is not definitely known, therefore some no-lesion reactors may have been too recently infected to show any evidence of disease, that is, the disease may exist in an undeveloped or latent state.

Material for examination was collected at the autopsy of a number of no-lesion reactors. Glands showing no signs of infection were removed and parts of them were ground up with sand. Normal saline was then added and the resulting emulsion was inoculated subcutaneously into guinea pigs. The latter were killed from two to three months after inoculation, autopsied, and carefully examined for evidence of tuberculosis. Cultures were made from the glands and spleen of the positive animals. Of the total of 57 animals studied some one gland from 10 such animals proved infectious for guinea pigs. This is not a large proportion of the total number, but it is felt that if it were possible to examine the whole of the lymphoid tissue in a bovine animal, a tuberculous focus, responsible for the sensitization of the animal to tuberculosis, could be demonstrated. In only one of the 10 animals noted above was it possible to find microscopic evidence of tuberculosis.

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

Associate Committee on Weed Control

Co-operating organizations

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

In response to requests from numerous organizations, a conference on the destruction of weeds by means of chemicals was called in Edmonton on October 4, 1929. This conference asked the National Research Council to undertake a program of research with reference to the destruction of weeds, and recommended strongly that the program should not be limited to the use of chemical weed eradicators. The Council followed its usual course in an investigation involving several different organizations, by appointing an Associate Committee on Weed Control with representatives from the organizations concerned. This committee was left free to develop a program co-ordinating as far as possible all activities in the entire field of weed control investigations in this country.

The committee held its first meeting on December 30, 1929, when the chief aspects of the problem were considered and a program adopted. It was felt that this should be nation-wide in scope, but having regard to the practicability of getting investigations under way immediately, and since the problem was possibly more urgent in the Prairie Provinces, it was agreed that the initial activities should have more particular reference to this area.

A qualified man was appointed to make during the summer of 1930 a reconnaissance survey of the Prairie Provinces, to get a general view of the weed situation in this area, and to co-ordinate the survey results obtained by the provincial departments of agriculture.

Subcommittees were appointed to plan the details of field-plot experiments with chemicals and to devise a uniform method of survey and reporting, including mapping. Both of these aspects are to be developed along similar lines in all three provinces.

The Federal Department of Agriculture is carrying on, through the Experimental Farms Branch, cultural experiments on weed control and, through the Seed Branch, seed-drill surveys. The committee asked that these be extended, in the one case to include studies of the identity and percentage of weeds in the various rotations, and the crop losses and extra cost of cultivation due to weeds; and in the other case to include studies of the conditions affecting the germination of weed seeds in the soil.

The National Research Council undertook to carry on fundamental investigations on the effects of chemicals on plants, with special reference to weed control. Grants were made in aid of researches in the universities on the botanical characteristics of weeds, the fungal parasites of weeds, and the effects on the soil of chemicals applied for weed control.

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)

Good progress has been made during the year under review in all the projects previously approved by the committee. This has been provided for at three meetings; first, a meeting of the Section on Wool Growing, held in Ottawa in August, 1929; second, a conference on sheep grazing lands, held in Edmonton in October; third, a full meeting of the committee, held in Toronto in November, just previous to the Royal Winter Fair in that city.

In co-operation with the committee Prof. J. P. Sackville, of the University of Alberta, Edmonton, who had already done considerable work on the relation between wool quality and environmental conditions, undertook to greatly extend his experiments, covering variations in temperature, humidity and feed, and using sufficient animals to reduce, as far as possible, errors due to individual variations. The wool on each sheep was sampled previous to and at the completion of experimental periods, and all samples were subjected to intensive study in the National Research Laboratories at Ottawa. It will be necessary to carry on this work over a period of several years before definite conclusions can be reached on the effect of the various factors mentioned.

Prof. A. M. Shaw, of the University of Saskatchewan, Saskatoon, has offered the use of 200 fine-wooled ewes of the Rambouillet type at the university in connection with cross-breeding experiments designed to produce the best possible combination of wool and mutton growth for use under prairie condi-

tions. He visited England and purchased sheep of several of the most promising breeds, including Leicester, Cheviot, Corriedale and Ryeland. The shipment of these sheep was delayed owing to an outbreak of foot-and-mouth disease, and as a consequence one breeding season was lost, but local Romney Marsh, Corriedale and Rambouillet rams were used in the meantime on the flocks, and a careful record of the progeny will be kept. The breeding experiments originally planned will be started in the next breeding season.

At the Lethbridge Experimental Farm in Alberta Dr. Fairfield is continuing, without financial aid from the Council but in close co-operation with the committee, experiments which he has had under way for some years designed to determine the value of Corriedale sheep under Canadian range conditions. Stock has been obtained directly from New Zealand as well as from the United States, and is being used as a stud flock for the production of rams to be used on Rambouillet ewes, as well as to determine the hardiness and adaptability to Canadian conditions of the breed, when kept pure.

Under the committee a co-operative experiment was arranged in the fall of 1929 with Mr. Glen Neilson, a successful sheep farmer of Cardston, Alberta. Six hundred fine-wooled ewes, very uniform in type, were carefully selected from his large flock by a subcommittee of the Association Committee on Wool. Of these ewes, half were bred to high-class Rambouillet rams and half to Corriedale rams imported for that purpose, and the same plan will be used in the next breeding season. A detailed record of each ewe and lamb will be kept, and it is planned to use some of the latter in due course for further breeding experiments.

As reported a year ago, the committee had hoped to carry out a survey of the pure-bred flocks in eastern Canada, but did not find it possible to make the necessary arrangements. It is therefore gratifying to be able to report that such a survey has now been undertaken by the Livestock Branch of the Dominion Department of Agriculture. In 1929 some 250 breeders forwarded fleeces for grading by a special expert, and records are now available for over 5,000 pure-bred ewes and rams. These records should be of great assistance to the breeders in improving the quality of their flocks.

The conference on sheep grazing lands, held at the suggestion of the committee to discuss the possibility of the better utilization of western lands suitable for sheep grazing, was attended by representatives of the Dominion Departments of Agriculture and the Interior, of the provincial governments of Alberta, British Columbia and Saskatchewan, of the Canadian National and Canadian Pacific railways and of the loan and trust companies with interests in the districts affected.

The British Columbia Government had already formulated a definite plan for handling sheep grazing lands, which are leased for twenty-one years. Every encouragement is being offered to sheep ranchers. In Alberta the question had apparently not been given serious consideration previous to this conference. In Saskatchewan there are no great grazing problems, since the range flocks are confined to the extreme southwest corner of that province. The Canadian Pacific Railway grants leases for fifteen years on reasonable terms. Lands under the control of the Dominion Government are leased for twenty-one years. In some districts of the West there appears to be a need for the consolidation of small abandoned areas, as also of areas held by individual trust and mortgage companies, which are more anxious to sell than to lease, and which would not offer terms acceptable to sheep ranchers.

A verbatim report of the proceedings of the conference has been sent to each of the organizations represented, and it is hoped that the record of the candid discussion which took place may be of value in pointing out the needs of the sheep ranchers and the steps which may be taken to improve the situation. The problem now appears to be essentially one for the provinces to deal with, and the matter will be left in their hands.

In the laboratories of the National Research Council at Ottawa extensive tests have been undertaken in connection with the investigations of Prof. Sackville. Determinations on a large number of samples have been made for moisture content, clean weight after scouring, percentage of grease, fibre diameter, staple length, ratio of fibre length to staple length, and the number of crimps per inch. Not less than fifty measurements have been made on each sample.

The problems of wool manufacture are also being given attention by the committee. Arrangements have been completed with the Wool Industries Research Association of Great Britain whereby for an annual contribution the results of all the research of that organization are made available to the committee. Representatives of the committee have visited the research laboratories at Torridon, England, and laboratories for research in wool manufacture are now being fitted up at Ottawa. In the National Research Laboratories at present in course of construction adequate provision is being made for wool researches on a considerable scale. These will be carried out under the direction of Dr. G. S. Whitby, Director of the Division of Chemistry.

III. SPECIAL COMMITTEES AND CONFERENCES

Executive Committee on Fifth Pacific Science Congress

Pacific Congresses are held at intervals of not less than three years "to initiate and promote co-operation in the study of scientific problems relating to the Pacific region, more particularly those affecting the prosperity and well-being of Pacific peoples," and "to strengthen the bonds of peace by promoting a feeling of brotherhood among the scientists of all Pacific countries."

As the next congress is to be held in Canada in 1932, it is of interest to trace the events leading to the organization of the Pacific Science Association, the parent of the triennial series of Pacific Science Congresses.

While scientific exploration of the Pacific has been carried on intermittently for a hundred years or more, it is only within the present century that such work has been co-ordinated and directed towards the solution of the many interesting scientific problems that confront the countries of the Pacific basin. One of the leaders in this field was Charles R. Bishop, the founder of the Bernice P. Bishop Museum in Honolulu, who in 1900 arranged for a scientific expedition to the Marianas Islands and, in 1903, to the southern Pacific. Largely as a result of this work, the Pacific Scientific Institution was incorporated in 1907 under the laws of Hawaii "to encourage, in the broadest sense and most liberal manner, investigation, research and discovery in the Pacific ocean, and to make application of knowledge thereof to the improvement of mankind."

Scientific organizations, such as the British Association for the Advancement of Science, its American counterpart, the American Association for the Advancement of Science, and others, recognizing the need for co-operative effort in matters relating to the Pacific area, have given this subject a place in their programs from time to time during recent years. At the British Association meeting in 1914 informal discussions pointed to the need for international co-operation in the study of Pacific problems, and in the program for the meeting of the American Association at San Francisco in 1915 there were a number of papers on Pacific topics. In 1916 the presentation of a "Symposium on Pacific Exploration" before the National Academy of Sciences in Washington led to the appointment of a Committee on Pacific Exploration, which met several times during the next three years.

At the close of the war projects for Pacific work again came up for serious discussion. In the United States, with a view to uniting all interests in a single organization, the Committee on Pacific Explorations was transferred to the National Research Council at Washington and combined with the interests of western groups. The deliberations of this committee brought out clearly the size and complexity of some scientific problems centering in the Pacific, and indicated the extent of the work then being carried on by individuals, institutions and governments.

It became evident as a result of this work that the ultimate value of research relating to Pacific problems would depend very largely on the degree of co-ordination of effort attained among the workers.

As a means of promoting the desired co-operation, the committee undertook to arrange for a conference. A place of meeting was provided by the citizens of Hawaii, who invited the representatives to meet under the auspices of the Pan-Pacific Union, a Hawaiian organization devoted to developing friendly relations among the different nationalities of the Pacific. Very satisfactory progress was made at this meeting in a consideration of the subjects on which international studies would be likely to yield valuable results.

At the invitation of the Australian Government, extended through the Australian Research Council, a second Pan-Pacific Science Conference was held three years later in Sydney and Melbourne. During these sessions it was decided to organize the work on a permanent basis. Accordingly a committee was appointed to draft a constitution, and to report at the next gathering. An invitation from the Japanese government to meet in Tokyo in 1926 was accepted.

Delegates to the Tokyo conference were most enthusiastic in their appreciation of the magnificent reception accorded them and of the splendid program of research problems presented for study on this occasion. A large number of scientists from many countries participated. Among the Canadian delegates was Dr. H. M. Tory, President of the National Research Council, who attended as official representative of the Dominion Government.

The draft constitution, accepted at the Tokyo meeting, provided for a Pacific Science Association of the interested countries, with a Pacific Science Council not to exceed fifteen in number, as the executive body. On this council no country has more than one representative, and each has one vote, irrespective of the population in the country represented. Members of the first council comprised nominees from Australia, Canada, China, France, Great Britain, Hawaii, Japan, Netherlands, Netherlands Indies, New Zealand, the Philippine Islands, Russia and the United States. English was accepted as the usual language of the Congress, and the name of the triennial meeting was changed to "Pacific Science Congress." It was provided that the National Research Council, or the corresponding organization, should be the representative institution in each country, with authority to name its country's official delegates to each Congress.

The first meeting under the new constitution was held in 1929 in Java, the number attending being about 450 persons. Canada's invitation to hold the next meeting in the Dominion, extended by the Canadian delegation at Java on behalf of the Canadian Government, was accepted with acclaim.

The decision to hold the Fifth Congress in Canada gives to the Dominion the distinction of being the first country on the eastern side of the Pacific ocean privileged to entertain the brilliant assembly of scientists who are devoting their talents to the investigation of problems bearing on the well-being of Pacific peoples. It provides a unique opportunity for the leaders in Canada to promote international goodwill among the peoples of Pacific countries and to stimulate the co-operative movement in research that is destined to be one of the strongest ties binding these nations together for the promotion of their common interests and the maintenance of peace.

The National Research Council of Canada has been appointed by the Dominion Government to organize and direct all arrangements for the Fifth Pacific Science Congress. Since Canada's scientific interests in the Pacific are largely confined to problems affecting the Province of British Columbia, the congress sessions will be held in the cities of Victoria and Vancouver.

Following the practice in previous congresses, it has been agreed to group the scientific studies in two main divisions. Biological sciences will include agriculture, anthropology and ethnology, animal diseases, botany and plant pathology, entomology, fisheries, forestry, public health and zoology. Physical sciences include astronomy, geodesy and geography, geology and mineral resources, oceanography, meteorology and terrestrial magnetism, radio, and seismology and volcanology.

It is expected that the papers and discussions at the Fifth Pacific Science Congress will prove of great practical value, particularly to Canada, as a

majority of the papers will bear especially on Canadian problems, and the speakers will include many who enjoy world-wide reputations for their achievements in science.

Committee on Trail Smelter Smoke Investigation

Co-operating organizations

British Columbia Department of Agriculture

Dominion Department of Agriculture

Dominion Forest Service

An international problem of some importance has arisen through the proximity to the Washington state line of the smelting and refining plants of the Consolidated Mining and Smelting Company of Canada, situated at Trail, B.C., in the Columbia river valley. It has been alleged by residents of the valley immediately south of the international boundary that smoke from the smelter is blown down into that territory, and that it has caused serious damage to forests, farm crops, livestock, exposed metal, and even to the soils of that area. The question was brought to the attention of the respective federal governments, which asked the International Joint Commission to investigate and recommend a basis upon which settlement should be effected. The Dominion Government instructed the National Research Council to make a scientific investigation of the effect of smelter smoke in that area, and field studies were accordingly begun in the spring of 1929. Obviously, no detailed report of that investigation can be issued until a settlement has been made, but something may nevertheless be said as to the method followed in the scientific studies.

The works of the Consolidated Mining and Smelting Company at Trail constitute one of the most important metallurgical plants in the world, one which, from the point of view of tonnage of metal produced, actually occupies the leading position. The company has some thousands of employees, both at Trail and at the principal mine and concentrator at Kimberley, B.C., and many more thousands are indirectly dependent upon the operations of this company for a livelihood. Its continued operation is therefore a matter of great importance, not only locally but also to the industrial life of the Dominion. During the last six years the operations of this company have been greatly expanded, and improvements in metallurgical practice have been effected which not only have resulted in marked economies in operation but also have reduced, in some cases practically to the point of complete elimination, those constituents of the smelter gases which might have an adverse effect upon animal or plant life. In this respect, also, the company has kept well in advance of the usual metallurgical practice. This has been fully borne out by an independent report made by G. L. Oldright, metallurgist of the U.S. Bureau of Mines.

Unfortunately, sulphur dioxide, which is one of the constituents of smelter smoke, is not readily eliminated from it, and has passed into the atmosphere in quantity up to 600 tons per day. This gas, in sufficient concentration, is harmful to vegetation, and its action has therefore been the subject of the most careful study. Pursuing its established policy of advanced practice, the company has taken steps to convert a large part of this gas into sulphuric acid, which it proposes to use in the manufacture of super-phosphate and other fertilizers. This development will require an expenditure in excess of $10,000,000 for the first unit, which it is expected will be brought to completion in 1931, and the operation of which will, it is hoped, greatly reduce any present effect of the smelter smoke upon vegetation in the vicinity.

Field crop studies in the Northport district have been carried out for the National Research Council by Dr. G. H. Duff, of the University of Toronto. Careful observations have been made both within and without the area in which it is claimed that damage has been caused by smelter smoke. A study has been made of farming practice, including the need for and use of fertilizers, irrigation, the prevalence of plant diseases, and other related questions. A similar study of orchards in the district has been made by M. S. Middleton, horticulturist of the B.C. Department of Agriculture. Soil conditions have been investigated by Dr. F. A. Wyatt, of the University of Alberta, who has determined the amount of plant food available, the activity of those micro-organisms necessary to plant life, the acidity of the soil and its content of soluble sulphate, a possible source of which might be the sulphur dioxide of the Trail plant.

Dr. S. Hadwen, recently of the University of Saskatchewan, and now in charge of veterinary research for the Ontario Research Foundation, has made a careful study of livestock in the district. Many animals found to be diseased or in poor condition were slaughtered and examined to determine the cause. Stock was inspected at points outside the area and where kept in immediate proximity to the smelter, and the condition of stock, fed on hay grown in the area where sulphur dioxide was frequently observed, was noted.

An extensive study of forests in the Northport district was made by A. W. McCallum, forest pathologist, and R. Hopping, entomologist, both of the Dominion Department of Agriculture. In addition to the careful examination of the forests over a large area for evidences of sulphur dioxide markings, plots were selected both within and without the district and a census was made to determine not only the condition of every living tree, but also, where dead trees were found, the cause of death. In this way a reliable comparison was secured between conditions prevailing in the zone of damage and those where sulphur dioxide is never found. In addition, some 3,600 trees were bored, and the cores obtained were measured for annual growth by the Dominion Forest Service. The detailed study and interpretation of these measurements was undertaken by F. E. Lathe of the National Research Council. This study was somewhat complicated by the fact that for years there was operated in the town of Northport itself a smelter which was the source of a considerable quantity of sulphur dioxide. A second factor of importance was that in the Northport area the precipitation is so low that under ordinary conditions it is the controlling factor in forest growth. In spite of these difficulties it nevertheless proved possible to determine the area within which retardation of growth has occurred, due to the operation of the two smelters, and to form an approximate estimate of the amount of retardation.

As a further check on the effect of sulphur dioxide in the district the percentage of this gas present in the atmosphere was accurately determined, both by the extensive use of a portable apparatus, with which a large territory could be readily covered, and by the installation of automatic recorders at two points where determinations were made every twenty minutes over a period of many months. Observations were made of the prevailing conditions of humidity, temperature, sunlight, wind direction and other known factors affecting sulphur dioxide presence and damage. In addition, the sulphur content of the vegetation was determined by analysis of samples obtained over a wide area, in order to detect any abnormal conditions. This chemical investigation was carried out by Dr. G. S. Whitby, Director of the Division of Chemistry in the National Research Laboratories and by Dr. Morris Katz of his staff.

The results of these investigations to date have been presented to the Dominion Government in the form of a report prepared by the President of the National Research Council, and also in testimony given by the scientific

staff before the International Joint Commission in session in Washington, D.C., in January and February, 1930. It is proposed to continue the field investigations until a settlement of the case has been effected.

Conference on Animal Diseases

This conference was held in Ottawa in February, 1930, under the chairmanship of Dr. H. M. Tory. It was called, as stated by the chairman, in order that general consideration might be given to the whole question of animal diseases, and that the Council might be advised by specialists in animal pathology as to those diseases which most urgently required investigation. The Council had in the past supported several researches on animal diseases, in addition to its heavy program of work on tuberculosis, but an increasing number of applications for assistance was being received, and it was desirable that a brief survey be made of the whole field, both to insure that all major problems were receiving attention and in order to avoid duplication of effort.

Those present, who included representatives of Dominion and provincial research organizations, veterinary colleges and the universities, as well as several specialists in human pathology, were asked by the chairman to outline the situation in their own particular districts, indicating those diseases which they considered of major significance.

It was agreed that of the diseases of cattle those affecting the reproductive processes were the source of the greatest losses. Amongst these the Ontario Research Foundation was investigating the problem of contagious abortion, which also has some relation to human disease. In view, however, of the little exact knowledge possessed about this and other reproductive diseases it was recommended that a survey be made to determine the extent and nature of the loss from these causes.

Mastitis of cows, investigations on which were being made at the Oka Agricultural College, with financial assistance from the National Research Council, was also classed as a serious disease, and it was considered that a small technical committee should be appointed to report upon it. Red water of cattle was stated to be very prevalent in certain districts of British Columbia, and was also found, though perhaps in modified form, in other provinces. Some work had been done on this problem by Dr. Hadwen, but a further study was urged. Other diseases of cattle discussed were malignant catarrh, hemorrhagic septicemia and sweet-clover disease. Measures were also discussed for the control of the warble fly, which causes very severe damage to hides and results in reduced milk production.

Swamp fever of horses was stated to be a disease of particular concern to Alberta and Saskatchewan. Losses were also experienced from botulism, horse cholera and hypertrophic cirrhosis of the liver.

It was believed that the principal losses in sheep raising were due to various internal parasites, of which special mention was made of stomach and tape worms. Septic pneumonia was also noted as of some significance.

Swine in Alberta and Saskatchewan were stated to suffer considerably from the plague. Another disease causing concern, especially in Ontario, was anaemia of sucking pigs. Influenza and parasites were very prevalent.

Poultry diseases were regarded as of particular concern in British Columbia, where Dr. Hill, with assistance from the Council, has already investigated bacillary white diarrhoea. Fowl paralysis was very prevalent, and an investigation was recommended. Losses were experienced from infectious bronchitis, cholera and tuberculosis.

Dr. Talbot reported that ruffed grouse were dying in large numbers in Alberta from an unknown cause. Encephalitis in foxes also received consideration.

Two general questions were given special consideration by the committee, that of mineral deficiency in nutrition, which it was thought might have some relation to diseases commonly ascribed to other causes, and animal parasites, upon which a large investigation, with assistance from the National Research Council and the Empire Marketing Board, had been suggested at Macdonald College. This latter was considered to be a matter of such importance that it was decided to call a special meeting of a subcommittee to deal with it.

Conference of Botanists

A conference of representative Canadian Botanists, called by the National Research Council, was held in the Chateau Laurier, Ottawa, on May 24 and 25, 1929. The chair was taken by Dr. H. M. Tory, who explained that the meeting had been called for a general discussion of the botanical problems of the Dominion, especially in relation to their economic significance. A Dominion-wide botanical survey had been suggested as desirable, but before deciding to organize such a work the Council wished to have the considered judgment upon it of the best botanists in Canada. The original suggestion of such a survey had been made by Mr. J. Adams, of the Dominion Department of Agriculture.

Mr. Adams emphasized the importance of having a survey carried out, and expressed the opinion that the task was not too large a one to be undertaken as a co-operative work. He recommended the collection of botanical material, each plant being preserved for study in five different stages of growth.

Dr. F. J. Lewis, of the University of Alberta, pointed out the economic significance of botanical studies. Botanical questions were closely related to the practice of forestry. Grasses should be studied in relation to the requirements of animals; detailed botanical studies might have an important bearing upon the practice of agriculture. He suggested that separate publications should be issued dealing with the various sections of the country.

Mr. Otto Schierbeck, of the Nova Scotia Department of Forestry, stressed the importance of botanical studies in connection with forestry. The regeneration of the forest, everywhere recognized as of great concern to the country, depended to a considerable extent upon the flora of the forest areas. Closely related questions were those of fungi and forest insects, and forest fire hazards.

Dr. R. B. Thomson, of the University of Toronto, pointed out the value of plants as soil indicators, as also in the preservation of wild life. He suggested that there be prepared a master list of all the flora in Canada. Dr. A. H. R. Buller, of the University of Manitoba, supported this suggestion. Dr. M. O. Malte, of the National Museum of Canada, thought that an essential first step was the establishment of a standard nomenclature, which might be handled by a special committee. He already had a botanical catalogue of some 160,000 names. Much discussion followed upon the advisability of undertaking this work, as a result of which it was decided that the matter would have to be given detailed consideration by a small committee.

Mr. W. M. Robertson, of the Dominion Forest Service, suggested that a botanist be attached to each party of foresters. Mr. Schierbeck supported this suggestion.

As a result of this conference the National Research Council has appointed an Associate Committee on Botanical Survey. Until this committee has met and considered the various suggestions no definite decision will be made regarding action to be taken.

Conference on Laundry Research

In the autumn of 1929 the National Research Council was approached by the Eastern Canadian Laundryowners' Association in regard to the possibility of having researches on laundry practice undertaken by the Council. Attention was called to the great service rendered to the laundry industry in the United States by researches carried out at the Mellon Institute, Pittsburgh, and at the Laundry Institute, Joliet, Ill., by the Laundryowners' National Association of the United States. The Canadian industry had also benefited by the researches of the American organization, but the hope was expressed that similar work might be undertaken in Canada by the National Research Council.

This proposal was favorably considered by the National Research Council, and arrangements were made for a conference between senior members of the Council's staff and representatives of the E.C.L.A. This conference was held in Toronto on March 5, 1930. The president and the director of research of the Laundryowners' National Association and a number of prominent members of the Canadian organization were also in attendance.

At this conference Mr. G. H. Johnson, director of research of the L.N.A., outlined the nature of the work carried on in the United States. It included both research and service on washroom and textile problems, as well as the analysis of supplies. Assistance was rendered the industry by the development of a satisfactory accounting system, and an engineer was available to advise members of the association on mechanical problems. This work had proved of the greatest benefit to the industry.

Following a thorough discussion it was recommended to the National Research Council that there be appointed an Associate Committee on Laundry Research. This recommendation was placed before the Council at its first meeting thereafter and authority was given for the appointment of such a committee and for research on laundry problems to be undertaken in the Division of Chemistry of the National Research Laboratories. Preparations were immediately begun for the initiation of this work.

IV. 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, and a fairly complete list of the papers covering researches carried out with assistance from the National Research Council will be found in Appendix I, page 120.

A list of research grants made by the Council from the beginning of its work is given in Appendix F, page 111.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 16.

Regulations governing the award of grants for research will be found in Appendix E, page 109.

Lateral Support of Steel Columns and Struts

Co-operating organization

University of Toronto

In the design of steel columns and struts for buildings and bridges, both safety and economy depend to a considerable extent upon the effectiveness of the lateral support provided by floors or by special stay members inserted for the specific duty of reducing the lengths of the columns over which they may buckle freely sideways. In order to establish, if possible, a logical method of proportioning either incidental or specially provided stay members, an apparatus was designed, built and calibrated, for testing the behavior of pivoted columns 20 feet in length, loaded axially up to as much as 310,000 lb., and transversely, at mid-length, to an amount necessary to prevent increase of buckling at this point. As the available 400,000 lb. Riehle testing machine could accommodate, under direct loading, columns of not over 9.4 feet in length, provision had to be made for loading longer columns typical of those employed in steel buildings, by means of an extension consisting of two built-up loading eye-bars bolted to a loading cap. The necessary pull in these eye-bars was developed by pin-connecting them at the lower end to an end panel point of a loading truss, to the apex joint of which the testing machine applied through a spherical head any load up to the capacity of the machine. Lateral loads were applied to the test column by means of one or other of the gauge-equipped 12-ton Blackhawk horizontally placed hyraulic jacks H_1 or H_2, each of these bearing against a lateral loading beam. In order to reduce the uncertainty that frequently arises with respect to the degree of restraint existing at the ends of a column, the test column was loaded at each end through roller bearings similar to those employed in the tests on steel columns carried out by a special committee of the American Society of Civil Engineers. The test column was relieved of the dead-load tension in the loading eye-bars, the weight of the loading cap and of the roller bearing by means of a counter-balancing steelyard device between an overhead trolley and the lifting eye in the loading cap.

The pilot tests undertaken appear to indicate that comparatively light stay members may be used to give adequate support to columns carrying considerable loads.

(*Investigation under the direction of Prof. C. R. Young, University of Toronto.*)

Continuity of Welded Steel Beams

Co-operating organization

University of Toronto

The weight of steel beams in building floors may be considerably reduced if there be provided at the supports a restraint comparable to that secured as a matter of course in properly constructed reinforced concrete beams resting on several supports. With riveted end constructions it has been difficult to secure the desired continuity on account of the lack of high rigidity in the end connection details. Welded connections, however, appear to be more promising, and in the present investigation a method has been developed by which the degree of restraint existing at the end of a restrained beam can be accurately ascertained experimentally, for various types of welded end connections. It has been found possible to secure a very high degree of end restraint, and indications have been obtained of the possibility of enhancing this restraint by improvements in design of the welded end connections.

The experiments were made on double cantilever specimens which represented the condition in a real floor as accurately as possible and simulated a 14-foot beam designed for a total uniformly distributed load of 24,000 lbs., assuming the ends as perfectly restrained. In order to reveal the distinctive qualities of a welded connection ten double cantilevers cut in two and welded together were tested under exactly the same loading conditions as two continuous or uncut cantilevers, and as ten other continuous or uncut specimens, to which connection details of the same type as employed in the cut beams were welded to the flanges, in order to exclude the effect on distortion of the local enlargement of the cross section by the welds. The merit of a given end connection may be appraised by the relation of the bending moment it develops to the moment developed at the end of a perfectly restrained beam.

(*Investigation under the direction of Prof. C. R. Young, University of Toronto.*)

The Generation of Electricity by Windmills

Co-operating organization

University of Saskatchewan

The daily output of the wind-electric plant described in previous reports was recorded during eight months of the year in order to arrive at an average output per month. This was determined to be 143 kilowatt hours, which is higher than it was in 1928. The plant was loaded to about sixty kilowatt hours per month, as it had been the year before. The load was applied daily by a time-clock to compare with the number of kilowatt hours that would be used in an average farm home. Only by continuing the operation of this plant for some years can its reliability be determined as well as its suitability for use under ordinary farm conditions on the prairie.

(*Investigation under the direction of Prof. A. R. Greig, University of Saskatchewan.*)

The Design of Windmills for Low Wind Velocities

Co-operating organization

University of Toronto

The windmills now on the market for generating electric power to be used on farms require so high a minimum wind velocity that the periods of operation are relatively short. Windmills developed abroad are more efficient and operate

in a relatively low speed wind. The present investigation was undertaken in order to construct a windmill adapted to conditions in Canada. Model windmills 18 inches in diameter were built and tested in the four-foot wind tunnel. By using two split hubs it was possible to arrange models having 2, 3, 4, 6 or 8 blades set at different angles to the plane of rotation, 15°, 20° and 30°. The results indicate that the usual type of windmill used for pumping water has a very low efficiency and that higher speed windmills with fewer blades and of larger diameters should be used. It will be quite possible to design a windmill that will generate 1 k.w. in a wind velocity of eight miles an hour; because of its large diameter, however, about 30 feet, there would be great danger of its being blown down in a strong wind. The diameter could be reduced if twisted blades were used in the windmills.

(*Investigation under the direction of Prof. J. H. Parkin, University of Toronto.*)

Flying-boat Stability

Co-operating organization

University of Toronto

Because of the great water surfaces found in Canada, aircraft are often equipped with floats or hulls. These parts have to be of fairly large dimensions, and change the air resistance of the plane as well as its stability towards forces tending to overturn it or cause it to spin. A complete knowledge of the stability conditions of such flying boats would reduce the number of flying accidents, increase the usefulness of this type of plane, and facilitate the extension of the air service throughout Canada. The study of the stability of such flying boats has therefore been continued (see 1928-1929 report) in order to secure data which would be of value in the design of seaplanes and flying boats.

A complete determination of the static pitching moments of a model of the Vedette, a three-place flying boat designed and built in Canada, was made for the full range of air speeds, the usual flying incidences and a range of tail settings. The spinning characteristics of the model were investigated by measuring the pitching moment at an air speed of 40 feet per second and zero tail setting for incidences up to 90°. Certain of the rotary derivatives were measured for the full range of flying incidences.

(*Investigation under the direction of Prof. J. H. Parkin, University of Toronto.*)

Fog Alarm Research

Co-operating organizations

Dominion Lighthouse, Prescott
McGill University

The development of an efficient source of sound, constant in frequency and strength, and simple to operate, would increase the safety of vessels in regions where heavy fog is of frequent occurrence. A source emitting sound in a horizontal plane is particularly desirable on account of the reduced expenditure of power and greater facility of orientation. As the progress in the design of power sound equipment has been very rapid during the past few years, the different types of sirens available at the Dominion Lighthouse at Prescott were examined as to their efficiency. The total power expended was determined from the pressure, temperature and mass of the air used to drive the piston, the acoustical power from the drop in temperature after sounding of the known

mass of air. This value could be compared with that which would be valid for an ideal siren. The efficiencies observed were in the neighborhood of 10 per cent for diaphones of type B and F (piston diameter respectively 2.1 and 5.0 inches), and were increased to about 20 per cent when a suitable trumpet was added to the source. These figures are relative values, uncorrected for uneven temperature at different points of the diaphone, and the kinetic heating due to the difference in the velocity of the air on high and low pressure sides.

A vertical arrangement of three small diaphones one-half wave-length apart was also tried, with the object of concentrating the sound in a horizontal plane. The three sources, however, were not matched, and the arrangement did not lead to the desired increase in intensity.

A special test was made by using trumpets of different lengths to demonstrate the reliability of the method of measurement.

(*Investigation under the direction of Dr. L. V. King, McGill University.*)

The Determination of Air Humidity

Co-operating organizations

McGill University

Dominion Department of Mines

In previous reports accounts have been given of the development of new or improved hygrometers which make possible a more rigid humidity control in industries, such as the textile industry, where it is necessary to keep the humidity of the air within certain limits in order to maintain the best operating conditions. An additional influence to be considered is the surface temperature. The danger of frost injury to fruits and vegetables, for instance, depends on the humidity of the air and on the surface temperature. So far in this investigation, particular attention has been paid to methods allowing rapid and precise determination of these two values. Data have been accumulated on the calculation of water vapor pressures by means of electrical resistance measurements. Summaries and card indexes of the voluminous current literature on hygrometry have also been prepared as a basis for a general report on hygrometry have also been prepared as a basis for a general report on hygrometrical problems.

(*Investigation under the direction of Dr. A. N. Shaw, McGill University.*)

Sound Reflection and Transmission by the Ultrasonic Method

Co-operating organization

University of Alberta

Knowledge of the transmission and reflection of sound through partitions has become increasingly important of late, and is used to an ever increasing extent in the design of buildings, auditoriums, loud-speakers and musical instruments. Experimental work on the properties of sound is rendered difficult by the fact that the most important sound-waves are of comparatively great length, at least in air as a medium, and require for their study an enormous expenditure of material and of money. For this reason, experiments on very short—or ultrasonic—waves, waves above the audible range, are of great practical value. With their help, theoretical calculations can be tested, and theories developed. In the present investigations frequencies in the range of 60,000 to 300,000 cycles per second were used.

Present theories indicate that for a beam of sound waves striking a plane at right angles, a maximum amount should be transmitted when the thickness of the partition is a multiple of one-half wave-length of the incident wave. The experiments performed in the course of this investigation showed the theory to be accurate for plates as much as one and one-half wave-lengths thick, and for plates as thin as it is possible to machine on an ordinary turning lathe.

For oblique angles of incidence, and partitions of glass, less than one-half wave-length in thickness, transmission of sound is not in agreement with the recognized simple theory of compression waves. Other forms of waves probably enter and transmit appreciable energy across the partition (shear waves and flexural waves, etc.). It was found that the fraction of energy transmitted at angles larger than the critical angle at which total reflection should be produced, was a function of the ratio of thickness of partition to wave-length of incident sound. Each plate showed maximum transmission for a certain angle, the angle being greater, and the peak broader, for the thinner plates. The angle for maximum transmission for a given plate decreased as the thickness and frequency were increased.

That waves of at least one type other than compressional enter into the transmission of sound across partitions was brought to light in experiments on the velocity of sound in bars and sheets. The velocity was found to increase with increasing frequency; theory predicts an increase with frequency only in the case of flexural vibrations. For these measurements one end of a glass rod was sealed to the sound transmitter so that the longitudinal vibrations in the transmitter would set up flexural vibrations in the glass strip.

In the course of this investigation two methods were found useful for rendering visible the properties of wave-motion. A sheet of stiff drawing paper was fastened with sealing wax at one or two points to the face of the transmitting rod, so that the longitudinal vibrations of the rod set up flexural vibrations in the paper. Sand was placed on the surface of the paper, and the standing waves were indicated by the arrangement of the sand.

Published paper:

Boyle, R. W. and Sproule, D. O. Transmission of Sound Energy and Thickness of Plate Transmitter at Normal Incidence. Can. J. Research, 2: 3-13. 1930.

(*Investigation under the direction of Dean R. W. Boyle, Univesity of Alberta.*)

Piezo-electric Pressure Gauge

Co-operating organization

McGill University

Commercial pressure gauges which are at present in use for making a continuous record of pressure during the cycle of an internal-combustion engine, will not record sudden rapid alterations in pressures, owing to the inertia of their moving parts. These gauges give the mean or normal time-pressure curves over a large number of cycles. The present investigation was undertaken in order to develop an instrument which would be free from such shortcomings. With such an improved gauge more exact information regarding the course and results of knocks and other phenomena in internal-combustion engines could be obtained.

Such a gauge was constructed and tried out using a section of a quartz crystal as the element sensitive to pressure. Rapid variations in pressure, acting on sections of quartz suitably cut and mounted, produce a corresponding variation in charge of electricity with no motion of the crystals other than the elastic wave of the pressure impulse itself. The variations in electrical charge were observed, after suitable valve amplification, by the motion of a cathode ray beam in a cathode ray oscillograph having a linear or uniform time scale. The gauge was calibrated so that displacements of the cathode ray beam of the oscillograph could be related to actual pressures in the engine. It was found possible to obtain the time-pressure curve for a Diesel oil engine, running free from load and with load, and photographs were obtained of artificially-made knocks. The gauge should be of great importance in the investigation of different types of detonation, fuels and mixtures.

(*Investigation under the direction of Dr. David A. Keys, McGill University.*)

Spectroscopy and Atomic Structure

Co-operating organization

University of Alberta

The study of atomic structure by means of wave-length measurements has now been extended to elements offering greater difficulties: germanium, (singly, doubly and triply ionized,) gallium (singly ionized) and antimony (doubly ionized). The structure of the spectrum of these elements is found to be in remarkable agreement with Hund's theoretical prediction.

The number and the intensity of intercombination lines in Ge III are greater than those found for the lighter corresponding element Al II, but smaller than those found in Pb III. The intervals separating the three levels which represent the lowest or normal state of the corresponding atoms of same outer structure: C III, Si III, Ge III, Sn III and Pb III, show a progressive increase which is quite marked in the case of Ge III, and indicates a change from the normal Russell-Saunders coupling of the two outer electrons. The change is more marked in the next higher level, that is, in the level in which one of the electrons has been given additional energy. Close to 150 wave-lengths have been measured and classified in the course of this work.

Some 60 lines of the vacuum spark spectrum of antimony Sb III have been measured and classified in the region of wave-lengths 6600 to 600Å.

The spectrum of gallium has been excited in a hollow cathode discharge in helium and photographed in the region from wave-lengths 10,000 to 200Å. About 90 lines so excited have been classified in singlet and triplet series of Ga II.

Published papers:

Lang, R. J. Spark Spectra of Germanium. Phys. Rev. 34: 697-712. 1929.

Lang, R. J. Second Spark Spectrum of Antimony. Phys. Rev. 35: 445-452. 1930.

Lang, R. J. and Sawyer, R. A. Spectrum of Gallium II. Phys. Rev. 34: 712-720. 1929.

(*Investigation under the direction of Prof. R. J. Lang, University of Alberta.*)

The Properties and Use of High Speed Electrons

Co-operating organizations

University of Toronto
The Carnegie Corporation

During recent years the study of the chemical action of cathode rays, or electrons of extremely high velocities, up to 100,000 miles per second, has opened up a new field of research. Four problems were studied in the present investigation: the action of high speed electrons on methane, on a mixture of methane and oxygen, on carbon monoxide and on a mixture of carbon monoxide and oxygen.

Methane is only very slowly attacked by cathode rays.

Methane and oxygen combine when exposed to high speed electrons giving a mixture of carbon monoxide, carbon dioxide, hydrogen, water and formic acid, the latter product being of particular interest. The relative proportions of the different products do not differ widely when pressure, composition of the gas mixture, and speed of the rays are varied. The reaction rate increases linearly with the speed of the electrons up to a certain value, after which it becomes nearly independent of the voltage.

High speed electrons acting on carbon monoxide produce carbon dioxide and a solid brown suboxide soluble in water and of a composition corresponding to the formula $(C_3O)_n$. If the carbon monoxide is moist, less carbon dioxide is produced, and no visible amount of solid or liquid is deposited.

When cathode rays of high speed are allowed to act on mixtures of carbon monoxide and oxygen, carbon dioxide is formed. The amount of carbon dioxide formed in dry mixtures increases with the proportion of carbon monoxide present. The amount of carbon dioxide in moist mixtures is much less, and is independent of the proportion of carbon monoxide. The presence of water vapor has a retarding effect on the reaction, which appears to be independent of its concentration.

Published paper:

McLennan, J. C. and Glass, J. V. S. Action of High Speed Electrons on Methane, Oxygen and Carbon Monoxide. Can. J. Research, 3: 241-252. 1930.

(Investigation under the direction of Prof. J. C. McLennan, University of Toronto.)

High Frequency Research

Co-operating organizations

University of Toronto
Canadian General Electric Co.
General Electric Co. of Schenectady (U.S.A.)

Considerable interest was recently aroused by the discovery that unexpected physiological and biological effects, such as the production of artificial fever in men, were obtainable by the use of short electromagnetic waves of wavelength 50 metres or under. This investigation has been carried out to determine the physical causes of the phenomena. It has been found that the heating by short electromagnetic waves depends on the specific conductivity of the liquid and rises to a maximum for a certain conductivity, whatever the size and shape

of the specimen heated, this maximum being the more marked the higher the frequency. The conductivity at which the maximum effect occurs is proportional to the frequency.

When blood was irradiated with electromagnetic waves between 9 and 43 metres in wave-length, most of the heat generated was developed in the proteins, less in the corpuscles, and least of all in the electrolytic fluid of the plasma. As the frequency of the waves is increased the relative heating of the corpuscles increases, while that of the proteins decreases.

A theory is given explaining how the field inside the specimen depends on the shape and orientation in the external field and on the dielectric constant of the specimen. Calculation is made of the currents and heating produced and is shown to be in accord with the experimental results. Skin effect is shown by experiment and theory to be negligible for the low conductivities involved, and the heating effects are produced throughout the depth of the specimen heated.

Published paper:

McLennan, J. C. and Burton A. C. Heating of Electrolytes in High Frequency Fields. Can. J. Research, 3: 224-241. 1930.

(*Investigation under the direction of Prof. J. C. McLennan, University of Toronto.*)

Series Spectra and Atomic Structure

Co-operating organization

University of Toronto

During recent years the discovery has been made that the spin of the heavy nucleus of an atom modifies the wave-lengths emitted, and a theory of the effect has been given by Professor Goudsmit of the University of Michigan.

Three investigations have been carried out in order to provide material for putting the theory to an experimental test.

A vacuum spectrograph, with which gratings of either two or three metres focus can be used and spectrograms 38-cm. long obtained, has been completed, and has been used for studying the fine structure of the wave-lengths emitted by singly ionized thallium atoms, Tl II and Tl III, in the region from wave-length 7000Å to 1850Å, of Bi II and Bi III. For some of the observations made a high resolving power 45-plate echelon spectrograph was used (Tl III).

Most of the observations are in agreement with the present view that nuclear spin modifies to the greatest extent the energy of a single electron when it is in the lowest available *s* orbit of the atom.

Published papers:

McLennan, J. C. and Allin, E. J. Fine Structure of Spectral Lines. Phil. Mag. 8: 515-521. 1929.

McLennan, J. C., McLay, A. B. and Crawford, M.F. The Spark Spectrum of Thallium, Tl III. Proc. Roy. Soc. A, 125: 50-53, 570-578. 1929.

(*Investigation under the direction of Prof. J. C. McLennan, University of Toronto.*)

Spectroscopy of the Light from the Night Sky

Co-operating organization

University of Toronto

For purposes such as the study of explosions, or of chemical reactions accompanied by slight luminosity, a spectrograph of high light power is extremely useful. In the present investigation an instrument has been constructed which, by reducing the time of exposure, represents a great improvement upon former models.

The dispersion of the instrument is obtained by a 60° prism; it has a length of face 127 mm. and a height 75 mm.; the refractive indices of the glass substance are, $\mu_D = 1.58320$, $\mu_F = 1.59200$ and $\mu_G = 1.59932$. The collimator lens is an achromatic cemented doublet of 50-mm. aperture and 56-cm. focus. The camera lens is an F/1 lens of 50-mm. focus, designed in accordance with a formula by Mr. T. Smith of the National Physical Laboratory, Teddington, to give good focus for all wave-lengths on a flat tilted plate. This compound lens has four components, of focal lengths 208.0, 213.4, 195.9 and 190.0 mm., respectively, the refractive indices for wave-length 5461Å being equal to 1.6149, 1.5863, 1.6149 and 1.5813.

The instrument was used in a study of the feeble light radiated from the night sky. From the photographs taken at Virginia Water, Surrey, England, and at Caledon, Ontario, Canada, it was found that easily perceptible photographic records of the auroral green line of wave-length 5577Å were obtainable with an exposure of twenty minutes. The intensity of this radiation was therefore about the same at these two widely separated stations. On Sulphur Mountain, Banff, Alberta (8,000 feet about sea-level) the line was obtained in as short a time as ten minutes.

Published paper:

McLennan, J. C. and Ireton, H. J. C. Spectroscopy of the Light from the Night Sky. Can. J. Research, 2: 279-291. 1930.

(*Investigation under the direction of Prof. J. C. McLennan, University of Toronto.*)

Nocturnal Radiation

Co-operating organization

McGill University

There is in progress an investigation which is concerned with the difference between winter and summer radiation. Results so far indicate that the average radiation is about the same for both seasons. In winter the periods of excessive radiation are offset by periods of reduced radiation. The ability to predict extreme conditions of radiation would be of great value, since such periods are accompanied by correspondingly severe weather conditions.

Sky shine, which is scattered radiation from the atmosphere in the form of diffused daylight, not including direct sun rays, has been determined by an automatic recorder, placed on Westmount mountain. From the charts drawn by this instrument there can be determined the strength of radiation, the time taken for clouds to pass, and the amount of sunshine for the day.

In this research, during the last two years, local weather conditions have been accurately indicated in advance. The instrument registers a change in weather already advanced in the upper atmosphere which hours later becomes evident by the appearance of characteristic cloud formations.

The probability of frost, upon which very little successful work has previously been done, has been recorded on several occasions as a large amount of vibration on the chart. The ability to predict frost from day and night observations would be of great value in agricultural areas.

The dense smoke screen that hangs over a city is registered as a cloud or overcast sky. In Montreal, records show that this smoky condition has increased in the last few years. The fact that overhanging smoke is washed away by rain is indicated clearly on the chart when, for a time, a period of unimpared radiation is registered.

(*Investigation under the direction of Dr. H. T. Barnes, McGill University.*)

Ultra-violet Light from the Sun

Co-operating organization

Queen's University

The ultra-violet component of sunlight has a very important effect upon living things, plants, animals, and man. It is therefore important to ascertain its strength, and the extent to which its strength is affected by different weather conditions, such as clouds, haze and mist.

It has been found possible to determine the strength of ultra-violet light by means of a pyrheliometer (an instrument for measuring the energy value of sunlight) and a combination of two light filters made of special glass. By this means it was found that of the radiation of the sun shining from a clear sky at noon in August, at sea-level and latitude 45, two per cent was ultra-violet. The effect of mist and of clouds over the sun was to reduce the amount of the ultra-violet light, but not to the same extent as that of the other light present, so that the proportion of ultra-violet light under these conditions was actually increased. The fact accounts for the tan which the human skin often acquires on such days, since tanning is due to ultra-violet light.

(*Investigation under the direction of Prof. A. B. Klugh, Queen's University.*)

Series Spectra and Atomic Structure

Co-operating organization

University of Alberta

Due to the large separation of the components of the energy levels in heavy elements, the classification of the wave-lengths emitted by these elements is particularly difficult.

About 60 new lines of singly ionized thallium Tl II were classified, and three new energy levels have been established from 15 wave-length measurements of doubly ionized lead Pb III. The substance to be studied was placed in the cavity of a hollow piece of carbon which was used as the negative electrode of the discharge lamp, and helium at a pressure of 5 mm. of mercury was made to pass through the tube.

Published papers:

Smith, Stanley. Extension of Spectrum of Tl II. Phys. Rev. 35: 235-239. 1930.

Smith, Stanley. Second Spark Spectrum of Lead Pb III. Phys. Rev. 34: 393-399. 1929.

(*Investigation under the direction of Prof. Stanley Smith, University of Alberta.*)

The Measurement of Cell Sizes by the Combined Use of Photo-electric Cell and Projection Microscope

Co-operating organization

University of Manitoba

In some types of anaemia the red blood cells become quite irregular in shape, and methods consuming much time and labor must be resorted to in order to determine their comparative sizes. As a rapid means for obtaining the area of irregular cells would be of great use in many biological problems, the combined application of a projection microscope, a red dye and a photo-electric cell insensitive to red light has been investigated.

Uredospores of *Puccinia graminis* (*tritici*) were stained by boiling in carbol-fuchsine for ten minutes. They were then repeatedly washed and centrifuged until the wash water was colorless. Afterwards the spores were dried and some of them mounted in glycerine jelly between an ordinary microscope slide and coverslip. Greatly magnified images, 500 diameters, were projected upon the window of the photo-electric cell. For this latter device the red area acted as a dark spot, and the photo-electric current was proportional to the remainder of the field. If two or more slides were projected in succession, and the amount of response noted in each case, the resulting figures afforded a ready means of comparing the areas of the objects, providing they stained with equal intensity. Readings for 500 cells were taken and arranged in groups differing by 1 mm. galvanometer deflection. An equal number of spores taken at random were then projected on a small white screen, the lengths of the images were measured and arranged in groups differing by 1 mm. in length. A normal distribution of the sizes was found by both methods, but the amount of variation was greater when the photocell method was used.

The same procedure was tried in the case of a film containing normal blood cells stained with acid fuchsine. At the magnification to be used, about 1,200 diameters, the photo-electric current had to be amplified by a vacuum tube and the deflection was not sufficiently steady to allow of accurate determinations. It will be necessary to get a six-fold increase in sensitivity before the measurements can be made.

Published paper:

Savage, A. and Jamieson, M. C. Note on the Combined Use of Photo-electric Cell and Projection Microscope. Can. J. Research, 3: 322-327. 1930.

(Investigation under the direction of Dr. Alfred Savage, Manitoba Agricultural College.)

Oceanographic Survey of the Strait of Georgia

Co-operating organization

University of British Columbia

Areas suitable for oyster culture have been located on the Strait of Georgia separating Vancouver Island from the mainland of the Province of British Columbia. As the suitability of the areas in question is determined to a great extent by temperature, salinity and plankton, a general oceanographic survey of the strait was undertaken. During five summers and three winters collections of 4000 water samples and 2000 plankton samples have been obtained at 150 stations, at depths varying from the surface to the sea floor; the temperature, salinity, hydrogen ion concentration, oxygen, phosphate, silicate and plankton occurrence

have all been measured. The Fraser River and other small streams contribute a great mass of water of low salinity which forms a stable upper layer during the summer, as much as 15 feet in depth in certain regions, and which reaches relatively high summer temperatures, often exceeding 20°C. Conditions suitable for bathing and for oyster culture are thus provided. Fish food in the form of plankton is abundant at the mouths of rivers emptying into the sea.

Published papers:

Hutchinson, A. H. Bio-hydrographical Investigation of the Sea Adjacent to the Fraser River Mouth. Trans. Roy. Soc. Can. 21 (V): 293-310. 1928.

Hutchinson, A. H., Lucas, C. C. and McPhail, M. Seasonal Variations in the Chemical and Physical Properties of the Waters of the Strait of Georgia. Trans. Roy. Soc. Can. 23 (V): 117-185. 1929.

(*Investigation under the direction of Dr. A. H. Hutchinson, University of British Columbia.*)

The Effect of Monochromatic Light Upon Paramecium Caudatum

Co-operating organization

University of British Columbia

The influence of light upon the growth of organisms has been known for a considerable time but, a few special cases excepted, our understanding of the specific effects of light of definite color is still very incomplete. It is to be expected that the observed facts will be more easily interpreted in the case of simple organisms than in those of highly differentiated living beings. For example, all known pathogenic bacteria and protozoa are destroyed by light. As a continuation of former studies described in previous annual reports, in which it was shown that light of specific wave-lengths had a pronounced influence on the growth of *Paramecium caudatum,* work was undertaken to investigate the effect of monochromatic irradiation upon the rate at which the cell substance loses water and separates from the walls when the organisms are placed in sugar or salt solutions. Light corresponding to a definite wave-length was obtained by resolving the radiation from a mercury arc by means of a quartz monochromatic illuminator. The cell culture was maintained in a state of continuous division by having water of suitable composition added to it, and was irradiated for periods of 6 to 24 hours. A very small drop of the irradiated culture in which one or two animals were found was placed on a slide and flooded with sugar or salt solution of known strength. The time required to plasmolyze the organism was recorded by means of a stop watch, the drop being observed under the low power of the microscope. The end point was always definite, since the final change from the disappearance of the vacuoles to the final shrinkage took place within two or three seconds. The average time required for plasmolysis was calculated from observations on ten organisms taken from different drops of reagent and was compared to the rate obtained daily for normal paramecia. The exposure to light of different wave-lengths was found to increase the rate of plasmolysis in both sugar and salt solutions, except when wave-length 4078 Å was used, in which case the behavior was irregular. The monochromatic light which causes retardation of growth of the organism results in an increase in the rate of plasmolysis, particularly in the far ultra-violet. The light which stimulates growth has little influence on plasmolysis. The results may be due to coagulation of colloids causing a decrease of the cellular osmotic pressure.

Published paper:

Hutchinson, A. H. and Ashton, Miriam R. The Specific Effects of Monochromatic Light on the Growth of Paramecium. Can. J. Research, 1: 292-305. 1929.

(*Investigation under the direction of Dr. A. H. Hutchinson, University of British Columbia.*)

The Effect of Pituitary on the Bird

Co-operating organization

Dalhousie University

There are indications that in birds pituitary produces a double effect: first, a sudden rapid dilation of the vessels as shown by a rapid fall in pressure and increased blood flow, then a constriction shown by increased pressure and diminished flow. Messrs. Parke, Davis and Company having donated a generous supply of separate fractions of α and β pituitary, it appeared of interest to study somewhat further their action on the heart, the oviduct and the intestine. The results indicate that the depressor action must be due to some substance to which the bird is specially sensitive and which is more concentrated in the oxytocic fraction α than in the vasopressin fraction β. The depressor substance is neither choline, acetyl choline nor histamine. The vasopressin fraction contains a powerful vasoconstrictor causing the rise in pressure frequently observed in the bird. The blood pressure effects can be largely explained by the peripheral vascular changes.

(*Investigation under the direction of Prof. O. S. Gibbs, Dalhousie University.*)

The Effect of Ultra-violet Light on Certain Aquatic Animals

Co-operating organization

Queen's University

Previous experiments in this investigation have shown that the effect of ultra-violet light on certain aquatic organisms bears a fairly definite relation to the depth at which they live. If little affected, they live near the surface; if appreciably injured by it, they live at greater depth.

The experiments have now been extended to include young eels, marine scuds and combjellies, all of which animals live either at the surface or in shallow water. It was found that these animals are much more resistant to ultra-violet light than are those which live at some depth in the ocean, although they can be killed if exposed to the sun's rays for prolonged periods.

(*Investigation under the direction of Prof. A. B. Klugh, Queen's University.*)

Sporulation of Yeast

Co-operating organization

University of Toronto

The usual method of procuring yeast spores is to spread yeast cells moistened with their culture medium on blocks of gypsum or other material, and let these stand about six days in water. The solution with which the cells are surrounded during this time depends, therefore, upon the culture medium used. The present investigation showed that the yeast can be freed from the culture medium by

filtering and washing; if it is then shaken with solutions of various chemicals, such as dextrose, galactose, levulose and other sugars or acetates, the aeration thus afforded is sufficient to produce sporulation. Shaken with water alone, no ascs are formed. This result shows that it is not the medium in which the yeast is cultivated, but that in which it is subsequently placed, that determines the occurrence of sporulation.

A second result obtained is that in every case the percentage of ascs obtained depends upon the number of yeast cells shaken with a given weight of sugar. If the ratio between these quantities is either too great or too small, no ascs at all are formed. The amount of water in the sporulation medium is unimportant.

Solutions of sodium or potassium acetate make sporulation possible, but solutions containing both an acetate and a sugar gave the largest number of spores.

(*Investigation under the direction of Dr. W. Lash Miller, University of Toronto.*)

Morphology of Arceuthobium Americanum

Co-operating organization

University of Manitoba

So little has been definitely known about the number and arrangement of the floral parts of Arceuthobium that there was insufficient evidence on which to base any theory of the relationship of the genus. For this reason the male and the female flower were carefully studied. In the male flower it was found that the anther is characterized by a system of sterile tissue which represents what is left of the separating partitions of a tetrasporangiate anther. The haploid chromosome number is fourteen. In the female flower the ovary wall is made up of four sterile carpels diagonally arranged. The two embryo sacs in the central papilla lie in the orthogonal plane, and therefore must be borne on an inner alternating whorl of orthogonally arranged carpel rudiments. The inner whorl of carpels bears four multicellular archesporia, only one pair forming embryo sacs.

(*Investigation under the direction of Dr. A. H. R. Buller, University of Manitoba.*)

Glucosides of Plants of Western Canada

Co-operating organization

University of Manitoba

Extracts of various western Canadian plants have been shown to possess definite pharmacological activity. During the summer of 1929 quantities varying from three to twenty kilograms were obtained of *Cypripedium parviflorum* (downy lady's slipper), *Aralia nudicaulis* (wild sarsaparilla), *Pulsatilla patens* (prairie crocus) *Rhus glabra* (smooth sumac), *Anemone canadiensis* (white anemone) and *Cicuta bulbifera* (bulbous hemlock). Some of the material was sent in from different places in the Province of Manitoba in response to a request broadcast by radio. By plunging the material in boiling ethyl alcohol, extracts were prepared, and it was found that precipitates formed on addition of lead acetate solutions. From the extract of *Cypripedium* a minute amount of a crystalline product was obtained, apparently a potassium salt of a benzene glucoside which is pharmacologically active, and which is not a dihydro benzene derivative. Evidence was also obtained of the presence of asparagine in *Cypri-*

pedium. The amounts obtained were not sufficient to permit further chemical characterization. Substances of glucosidic and flavonic character were obtained from wild sarsaparilla and from the white anemone, which were very similar, if not identical, and had a marked action on the frog heart. Results obtained in last year's report were confirmed.

(*Investigation under the direction of Dr. A. T. Cameron, University of Manitoba.*)

The Effect of Radiant Energy on Plant Protoplasm

Co-operating organization

University of British Columbia

The importance of the effect of light of specific wave-lengths upon life processes has been appreciated only recently. It is now well recognized that light is essential for normal growth in most plants and animals, but certain sources of light and certain wave-lengths of light in sunshine may be used to inhibit growth, particularly of bacteria, and also of cells.

Previous reports of this investigation have shown generally that the microscopic forms, yeast, paramecium, and colletotrichum, the fungus causing tomato rot, are stimulated to growth by red, orange, yellow light and near ultra-violet light, while blue, violet and the far ultra-violet light inhibit growth. In the tomato-rot organism the light which inhibits growth stimulates spore formation and reproduction, while light which stimulates growth ordinarily has no effect on spore formation.

These considerations suggested that the effect of the light was on the protoplasm and it has now been found that monochromatic light of certain wave-lengths effects plasmolysis in yeast cells. The monochromatic light which has the greatest inhibitive effect upon the growth of the cells also effects plasmolysis to a marked degree and this light has been found to be in the far ultra-violet (3132 Å — 2535 Å) and to a less extent at 4078 Å. On the other hand, the light which stimulates growth has very little effect on plasmolysis, although such light does increase the rate to some extent. Whether the increased rate of plasmolysis is due primarily to an effect on the permeability of the cell-wall membrane, or to a lowering of the cellular osmotic pressure, probably by reason of coagulation of colloids, has not been determined but the results are in general agreement with the latter interpretation.

Published papers:

Hutchinson, A. H. and Newton, Dorothy. The Specific Effects of Monochromatic Light on the Growth of Yeast. Can. J. Research, 2: 249-263. 1930.

Hutchinson, A. H. and Ashton, M. R. The Effect of Radiant Energy on Growth and Sporulation in *Colletotrichum Phomoides.* Can. J. Research, 3: 187-199. 1930.

(*Investigation under the direction of Dr. A. H. Hutchinson, University of British Columbia.*)

The Nature of Chromosomes

Co-operating organization

Queen's University

Crossing studies on *Nigella,* described in last year's report, were continued. Careful study of the plants from seed received from the Botanical Gardens, Madrid, Spain, and described as belonging to different species, made it apparent

that they are all varieties of *Nigella damascena.* It was among these that crosses were so readily made with Mendelian ratios obtained in some cases. One actual species cross was made, *damascena* X *hispanica;* the seed, however, were small and would not germinate. The various true species of *Nigella* studied could not be crossed successfully. The number of chromosomes is six in all cases but their shape and size vary from species to species, indicating a rather distant relationship.

(*Investigation under the direction of Dr. R. O. Earl, Queen's University.*)

Marine Algae of the Maritime Provinces

Co-operating organizations

Biological Board of Canada

Dalhousie University

The abundance of seaweeds along the shores of the Maritime Provinces is of great economical and biological interest. As very little information is available on the distribution of even the most common forms, such as kelp, rockweed, and Irish moss, an attempt was made in this investigation to make a general survey of the prevalent forms characteristic of the line extending from Quebec around the coast to Maine. The stations at which collections were actually made numbered 32. From the material collected, and contributions received from Dr. Huntsman of the Biological Board of Canada, three separate sets of tables were prepared. These list the more common forms of green, red and brown algae for three main regions,—the coast bordering the Bay of Fundy, the eastern Atlantic coast of Nova Scotia and the coast of Prince Edward Island. Blue-green plants are also found, some of them forming quite extensive gelatinous coatings over the rock surfaces, but as the individuals are nearly all microscopic in size, they have not been included in this survey. Analysis of six of the most abundant forms have been made for water, ash, potassium, iodine, nitrogen and crude fibre.

(*Investigation under the direction of Prof. H. P. Bell, Dalhousie University.*)

The Photosynthesis of Marine Algae

Co-operating organizations

Biological Board of Canada

Queen's University

The process by which plants manufacture food from water and the carbon dioxide of the air, by the aid of light, is perhaps the most fundamental process in nature, since it is only by this process of photosynthesis that these simple raw materials can be converted into food for the lower animals and man. Some of the marine algae (seaweeds) offer very suitable subjects for the investigation of photosynthesis, and experiments upon them have a double importance, since they yield information on both the general problem of photosynthesis and the economy of the sea.

The question investigated during the past year was the relative effectiveness of red, green and blue light in the photosynthesis of some of these algae. It was found that for a green alga (*Enteromorpha linza*) red light was by far the most effective, blue much less so, and green had scarcely any effect. On a brownish-red alga (*Porphyra umbilicalis*) green and blue light, while not as effective as red, were equal in effect and much more effective than in the previous case. On a bright red alga (*Delesseria simrosa*) red, green and blue were almost equally

effective. These facts are in accord with theoretical considerations of the habitats of these algae and the way in which the different components of white light penetrate the water, as green light penetrates best, blue next and red least, and the green algae grow nearest the surface, while the bright red algae are found in the deeper waters.

(*Investigation under the direction of Prof. A. B. Klugh, Queen's University.*)

On Apparatus for Measuring Moisture Content

Co-operating organization

University of Toronto

The electrical apparatus devised for rapidly measuring the moisture in wheat and other substances, and described in the previous annual report, has been improved by adding a condenser in parallel with the coil in the grid circuit, the material to be investigated being poured directly into the condenser. This has the effect of making the readings less dependent on the packing of the material and so more consistent in its performance in unskilled hands.

The usefulness of the instrument for the measurement of moisture content in commercial practice has been tested in the laboratory of the St. Lawrence Starch Co. at Port Credit on samples of starch, at the Forest Products Laboratory on different kinds of wood, in a factory near Chicago on white lead and at the laboratory of the Ontario Research Foundation on samples of textiles and wool, cotton and rayon yarns.

The apparatus has been tested to a point where its production and sale is a commercial possibility. The instrument developed gives very consistent readings for the moisture content between percentages peculiar to each substance:

Grain from bone dry to 25% moisture
Starch from 2% to 15% moisture
Woods from bone dry to 15% moisture
White lead from bone dry to 0.8% moisture
Sand and clay from bone dry to 0.8% moisture
Textiles from bone dry to 18% moisture.

(*Investigation under the direction of Dr. E. F. Burton, University of Toronto.*)

The Constitution of Portland Cement and the Deterioration of Concrete in Alkali Soils

Co-operating organization

University of Saskatchewan

Silicates and aluminates of widely varying composition constitute a large part of the material used in the ceramic, glass, building and insulating industries. Due to the wide variation in the chemical and physical properties of the compounds, as evidenced by the appearance of the rocks and their slow deterioration, the behavior of the substances when exposed to external agencies is not always so well known as to ensure the best use of the substance. This is particularly true of newly developed materials, or materials used in new surroundings. In this respect the resistance of silicates and aluminates in concrete against the attack of sulphates is a very pressing problem for Western Canada, where the losses due to the deterioration of concrete are serious.

Former work, an account of which will be found in previous annual reports, has been continued along three main lines, the chemical composition and behavior of concrete, its tensile strength as a function of its composition, and the thermochemistry of compounds which are important in its manufacture.

It is now generally accepted that tricalcium aluminate is one of the important components of Portland cement; the action of sulphate on the hydrates of this substance is considered to be the main cause of the failure of concrete in solutions of sodium and calcium sulphate, that is, in alkali water containing these two salts in solution. One crystalline hydrate of tricalcium aluminate has been known previously; it forms hexagonal plates, needles and spherulites. By treating pure tricalcium aluminate with steam, under a pressure of approximately 70 lb. per sq. in. and drying the product over quicklime, a new form of hydrated tricalcium aluminate was prepared, belonging to the isometric system and crystallizing as cubes and trapezohedrons. It is stable at 100°C., but at 275 to 300°C. it gives up three-quarters of its water and forms a stable hydrate of composition $3CaO\ Al_2O_3\ 6H_2O$. This is decomposed, on heating at 500 to 600°C., to $5CaO\ 3Al_2O_3$ and free lime. When the resulting mixture is placed in saturated steam at 150° C. recombination takes place, and the hexahydrate of tricalcium aluminate is again formed. It was found that it could also be obtained directly by exposing a mixture of lime and alumina of appropriate composition to steam at 150° C. The crystals produced are cubes and more rarely dodecahedrons. When pure tricalcium aluminate is exposed to steam at 150° C., the crystals of the hexahydrate appear as trapezohedrons. In each case the refractive index is the same. A hydrate composed entirely of hexagonal plates is obtained when the temperature at which the tricalcium aluminate takes up water is kept low. At about 25° C., and at atmospheric pressure the hexagonal form goes over into the cubic form, the change apparently taking place the faster the larger the initial percentage of water in the material.

Parallel experiments were made on a number of commercial Portland cements obtained from four different mills. Previous work had shown that prolonged curing in saturated steam at 175°C., renders the mortar almost completely resistant to the action of solutions of sodium sulphate and increases very materially the resistance of the mortar to the action of solutions of magnesium sulphate. A microscopic study of the changes taking place was made, and it was found that free lime gradually disappears and that crystals of calcium hydroxide take their place. These disappear in turn when steaming is continued, while a new crystalline substance is formed which is very stable in solutions of sodium and calcium sulphate, but is decomposed slowly by solutions of magnesium sulphate. The crystals are orthorhombic. They are decomposed by very dilute acids, but are stable in solutions of sodium hydroxide, and are not affected by temperatures as high as 400° C. The great increase in the resistance of Portland cement mortar to alkali action produced by steam curing for 24 hours or more is evidently connected with the production of this crystalline material. Curing in water vapor at temperatures below 100° C. was found to lessen the strength of the material, and at a temperature of 50° C. the resistance to the action of sulphates decreased.

Another way of producing high resistance to sulphate action was found to be the addition of siliceous substances; this has been practised for a long time for the purpose of obtaining a mass of greater workability and greater impermeability to water. The capacity of such substances for binding free lime suggested that they might be effective in preventing sulphate action. This was found to be the case when a pure silica gel was added to ordinary Portland cement. Further studies with silica gel and with many natural and artificial products rich in silica are in progress.

As a preparation for a study of the heats of formation of the constituents of Portland cement, new determinations on the heats of solution of calcium oxide and calcium hydroxide in hydrochloric acid were made. The heat of solution of the calcium hydroxide at room temperature was found to be three calories higher than that obtained with material hydrated in steam at 150° C., but after subtracting the heat of wetting the average values were 550.7 and 550.0° C. The heat of hydration of calcium oxide did not agree with calculated results; a microscopic examination indicated that physical changes in the hydrated material continue for a long time after the temperature of the calorimeter comes to apparent constancy. The heat of solution of calcium oxide was 46.50 calories per mole, and was not materially affected by the temperature of ignition between 800 and 1200° C.

Published papers:

Thorvaldson, T. and Grace, N. S. The Hydration of the Aluminates of Calcium. I. A New Crystalline Form of Hydrated Tricalcium Aluminate. Can. J. Research, 1: 36-47. 1929.

Thorvaldson, T., Grace, N. S., and Vigfusson, V. A. II. The Hydration Products of Tricalcium Aluminate. Can. J. Research, 1: 201-213. 1929.

Thorvaldson, T. and Shelton, G. R. Steam Curing of Portland Cement Mortars. Can. J. Research, 1: 148-154. 1929.

Thorvaldson, T., Wolochow, D. and Vigfusson, V. A. The Use of the Expansion Method in the Study of the Action of Sulphate on Portland Cement Mortars and Concrete. Can. J. Research, 1: 273-284. 1929.

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Thorvaldson, T., Vigfusson, V. A., and Wolochow, D. The Effect of the Addition of Silica Gel to Portland Cement Mortars on their Resistance to Sulphate Actions. Can. J. Research, 1: 385-399. 1929.

Thorvaldson, T., Brown, Weldon G. and Peaker, C. R. Studies on the Thermochemistry of the Compounds Occurring in the System CaO—Al_2O_3—SiO_2. I. The Heat of Solution of Calcium Oxide in Hydrochloric Acid. J. Am. Chem. Soc. 51: 2678-2682. 1929.

Thorvaldson, T., Brown, Weldon G. and Peaker, C. R. III. The Heat of Hydration of Calcium Oxide. J. Am. Chem. Soc. 52: 910-915. 1930.

Thorvaldson, T. and Brown, Weldon G. II. The Heat of Solution of Calcium Hydroxide in Hydrochloric Acid. J. Am. Chem. Soc. 52: 80-88. 1930.

(Investigation under the direction of Dr. T. Thorvaldson, University of Saskatchewan.)

Maple Sugar Research

Co-operating organization

Macdonald College

To put Canadian maple products on the market as uniform, standardized foodstuffs, it is necessary to have a characteristic color, flavor, degree of hardness and texture.

Attempts to discover a color standard more permanent than caramel solution have been unsuccessful. To find the best decolorizing agent, that is, one which

will remove the most color and the least flavor, work has been done on four decolorizing carbons and a hydrated aluminum silicate known as Lloyd's reagent. The most suitable proved to be carboraffin.

Ordinarily, maple sugar, upon standing, hardens to such an extent that it eventually becomes unpalatable. It is extremely desirable, therefore, to discover means of preserving the softness and texture which it has when freshly prepared. With this object in view cylinders 2 in. in diameter and 4.5 in. long were made of maple sugar prepared in three different ways: (1) Syrup was boiled to 119-123° C., poured into a cool vessel, stirred immediately and continuously till the mass had cooled to room temperature. (2) Syrup, boiled to 119-120° C., was poured into a cool vessel, cooled to 45° C., and stirred until crystallization occurred. The soft solid mass in either case was forced through a sieve and gently pressed into moulds. (3) Molten sugar was cast in the usual way.

After three months the cylinders were tested for crushing strength with the result that the pressed cylinders showed more strength and more uniformity of color. The additional strength, however, was not a measure of hardness, since the moulded sugar was more easily broken by the teeth and appeared to be a more desirable product in every way.

Using chloroform as a solvent, the work on the isolation and identification of maple flavoring substances has been continued. So far, a substance closely resembling vanillin has been obtained. Fifty gallons of 1929 syrup are being used for extraction, half with ether and half with chloroform, in further attempts to isolate flavoring substances.

In the ordinary process of sugar-making, sap is evaporated by heating to 104° C., under atmospheric pressure. With the purpose in view of discovering whether or not the flavor is best developed in this way, experiments were carried out. Samples of sap were concentrated by freezing and by boiling under reduced pressure at temperatures below 50° C., but neither of the products were found to possess the true maple flavor.

Some maple products appearing on the market are adulterated with refined sugar. Various methods of analysis for detecting such adulterations have been devised, and these methods have been compared in this research. On analysis, the results obtained for the values of the various compounds of even genuine syrups are variable, and it is that method which shows the least variation that is the most useful. Judged by this criterion the electrical conductivity method is shown to be superior to any of the others. It is suggested that the use of 1 cc. of basic lead acetate per 5 gm. dry matter, in the determination of the lead value, may give a less variable value than the present Canadian lead method.

It is agreed that the preparation of samples of syrup for analysis should be reconsidered with the object of obtaining greater uniformity in water content.

(*Investigation under the direction of Dr. J. F. Snell, Macdonald College.*)

The Production of Polysaccharides by Bacteria

Co-operating organization

McGill University

Sugars deteriorate when exposed to the influence of the atmosphere on account of the presence of micro-organisms which attack raw and refined material. In most cases the result is a gummy substance yielding sugars upon hydrolysis; much less frequently the product is of a cellulosic nature and appears in the form

of a surface layer or "pellicle" on liquids undergoing fermentation. Its formation is attributed to the action of *Bacterium xylinum*. As comparatively little information has been published concerning the formation of cellulose-like material by bacteria, the present investigation was planned as a contribution to the vast field of polysaccharide research.

Several active strains of *Acetobacter xylinum* were obtained from Germany. It was found that a solution of inorganic salts containing potassium nitrate, ammonium sulphate and ammonium chloride on the one hand, or on the other hand, a solution containing urea, triethanolamine or asparagine, in each case provided a nitrogen source adequate for the formation of the cellulosic pellicle by the organism when grown in a medium containing glucose as the carbohydrate. A medium consisting of asparagine 0.1 per cent, potassium dihydrogen phosphate 0.5 per cent, sodium chloride 0.1 per cent, ethyl alcohol 0.5 per cent, and carbohydrate (calculated as glucose) 5 per cent should prove quite satisfactory for the experimental production of the cellulosic substance by *Acetobacter xylinum*.

Where 4 per cent glucose is employed as a substrate for the formation of the cellulosic compound, there is an increase in the weight of the pellicle in each case where thioglycollic acid is added to the culture fluid.

The types of organisms involved in the "gummy" deterioration of sugar are exceedingly numerous. A well-known product, the levan type of polysaccharide, is furnished by the action of *Bacillus mesentericus* Trevisan and *Bacillus subtilis* Cohn. A number of experiments were made in order to find out which carbohydrates were capable of yielding levan. Levan formation occurred only with sucrose and raffinose, and not with melezitose, lactose, xylose, glucose or fructose. This fact is of particular significance inasmuch as previous work on the chemical structure of levan had shown it to be a polymer of 2:6 anhydrofructofuranose, and as sucrose and raffinose have a terminal fructofuranose group. As soon as the rare sugars gentianose, stachyose and turanose, all of which contain a terminal fractofuranose residue as does sucrose, are obtainable, the action on these sugars will be studied. There may be present in the bacterial cells an enzyme capable of exerting a selective action upon the terminal fructofuranose grouping.

An investigation of the conditions influencing the production of dextrin from sucrose indicated that dextrin could be formed by *Leuconostoc mesenteroides* at pH values both above and below pH 7.0, but that the optimum value for the production of dextrin was pH 8.0.

Published paper:

Harrison, F. C., Tarr, H. L. A. and Hibbert, Harold. Studies on Reactions relating to Polysaccharides. XXXIII. The Synthesis of Polysaccharides by Bacteria and Enzymes. Can. J. Research, 3: 449-464. 1930.

(Investigation under the direction of Prof. H. Hibbert, McGill University.)

Action of Various Catalysts in Some Friedel-Crafts Syntheses

Co-operating organization

McGill University

Certain experiments having suggested that it might be possible to replace aluminum chloride in part by the less expensive ferric chloride in the manufacture of anthraquinone, an important dyestuff intermediate, and of ethyl benzene, a fuel which has been stated to possess good anti-knock properties, an investigation was

undertaken to determine the value of various substances as catalysts in the synthesis of the two substances mentioned. The cost of the catalyst used is a deciding factor, as the other materials required are available to-day in large quantities and at low cost.

It was found that amalgamated aluminum is a better catalyst than aluminum chloride for the preparation of the substances in question, the only obstacle to its introduction being the present low price of the chloride. Ferric chloride proved unsuitable.

Published paper:

Gallay, W. and Whitby, G. S. Cataylsts in the Preparation of *o*-Benzoylbenzoic Acid and Ethylbenzenes by the Friedel and Crafts Reaction. Can. J. Research, 2: 31-35. 1930.

(*Investigation under the direction of Dr. G. S. Whitby, McGill University.*)

Ultrafiltration of the Dextrins

Co-operating organization

Dalhousie University

As a rule the process of separating the dextrins obtained by the acid hydrolysis of starch has been one of repeated fractionation with alcohol, requiring months in some instances to carry to completion. Their colloidal nature and their close similarity have rendered difficult the task of separating and of purifying the different constituents, and as a consequence modern opinions of the constitution of starch vary widely. For this reason an investigation was undertaken to find out whether the higher dextrins could be separated by passage through collodion membranes of the correct permeability.

Two sets of large collodion membranes were prepared, allowing different drying times for each so as to vary their permeability. It was found that the membranes were permeable to all the constituents of a commercial sample of dextrin, the velocity being directly proportional to the size of the molecules diffusing; a partial separation, however, could be obtained by repeating the process. Potato starch was separated into its constituents, amylose and amylopectin. Fractional dialysis of the products of the acid hydrolysis of starch, of amylose and of amylopectin through the graded membranes was attempted and products of different characteristics were obtained. The intermediate products resulting from the acid hydrolysis of starch are dextrins, as are the residues left at the end of the dialysis.

(*Investigation under the direction of Dr. E. G. Young, Dalhousie University.*)

The Distribution of Rodents in Manitoba

Co-operating organization

University of Manitoba

During the year under review a study of the distribution of the pocket gopher has been made. The animal's depredations are yearly becoming more pronounced. This is especially true in districts where diversified farming has replaced the all-grain farms. Grass and clover fields are less frequently disturbed by the plough, and these plants furnish an abundance of choice food. The embankments along railways and the many motor highways provide other sites

for homes, and here the animal is consequently found in great numbers. The demand for furs, in some instances, and ignorance in others, have greatly reduced the natural foes,—weasels, badgers, skunks, wolves, foxes, hawks and owls. With the exception of a few isolated localities, which are heavily timbered or swampy, the pocket gopher was found over the whole of that part of the province west of a line drawn from the international boundary south and east of Winnipeg, past that city to a point just south of Lake Manitoba, north to the south-west shore of Lake Dauphin, past Sifton to Ethelbert and Cowan, north and west to Swan River and from that town in a southwesterly direction to Benito.

The greatly enhanced value of the badger's pelt has caused an incessant demand for information regarding the life habits of the animal. A detailed study was unfortunately impossible, because the badger has become too rare.

(*Investigation under the direction of Mr. Ferris Neave, University of Manitoba.*)

Internal Parasites of Poultry

Co-operating organization

Macdonald College

Complaints arising from parasitic trouble in poultry have become so frequent and the amount of information relative to conditions in Canada found so inadequate, that a study of this kind was undertaken for the Province of Quebec. Nine different species of internal parasites have been identified in poultry during the past year, and information has been secured as to their distribution throughout the province, as well as data on their comparative economic importance. All examinations were made directly on the premises from stock raised in the immediate vicinity, assistance being lent by the provincial poultry instructors and the Bureau of Animal Industry at Washington.

The most common parasite was found to be *Eimeria avium*. It constitutes one of the major problems of the poultry raiser, and occurs in counties as far east as Montmagny, l'Islet and Frontenac, south through Huntingdon county and west through Argenteuil and Labelle. Another widely distributed parasite is *Ascaridia lineata* (intestinal roundworm), heavy infestations of this species of worm being associated as a rule with ill-kept poultry plants. Scarcely a poultry flock in the province is free from *Heterakis gallinae* (the caecal worm); if the worms are not too numerous, they may complete their development without any noticeably bad effect on the bird. A tapeworm apparently overlooked because of its small size, *Davainea proglottina,* is undoubtedly the cause of mortality and unthriftiness in a very considerable number of the poultry flocks in this province; it was found to be widespread and surprisingly numerous. Other worms, as the capillary worm, the triangular, the slender, the funnel-headed and the cesticillid tapeworm, appear to be less prevalent, but occur in widely separated counties, which indicates the possibility of their being present in other flocks throughout the province.

The parasites are transmitted from bird to bird through the worm eggs being passed by an infected bird and being later taken up, with the food or water, by another bird. A two per cent ammonia solution will kill the eggs.

Published paper:

Baker, Alex. D. Internal Parasites of Poultry. Scientific Agriculture, 11: 150-159. 1930.

(*Investigation under the direction of Mr. Alex. D. Baker, Macdonald College.*)

Laws Governing the Special Senses

Co-operating organization

University of Manitoba

The question has often to be answered whether an increase in the number of lamps in workshops, factories, schools, streets, etc., means to the eyes an increase in illumination in proportion with the costs involved. At a certain stage, at any rate, the number of lamps has to be increased greatly before the eye becomes aware of the difference. The law establishing a relation between the increase in physical energy necessary to produce an increase in the strength of sensation is known as the Weber-Fechner law. This is one of the most difficult laws of nature to be subjected to a rigid test. The required increase is the larger the stronger the actual stimulus, and the ratio between the two has been generally considered to be constant provided the range of intensities is not too large.

As mentioned in last year's report, Weber's law applies accurately to the sense of vision, there being, however, at definite intensities, sudden changes in the value of the ratio of the just perceptible increment to the stimulating intensity.

Continuing this investigation, the validity of Weber's law was extended to the sense of taste.

It was also subjected to an examination in the sense of hearing. Sources of sound giving 180 or 575 complete vibrations per second were operated by a stream of air collected over water in a pressure tank. The sound intensity was measured by a Rayleigh disc for different blowing pressures of the air, that is, for different weights placed on the top of the tank. The pressure could be varied in small steps by adding small weights, and by repeated trials a value of the weight was found which produced a just perceptible increment of intensity. The measurements did not even remotely conform to a law of constant ratios, but when the reciprocal of the just perceptible increase in pressure was divided by the logarithm of the pressure a nearly constant value was obtained. On account of the growing number of applications, arrangements are now being made to extend the investigation to a greater range of pitch and of intensity. In a new series of experiments, a second source of sound of the same pitch was placed close to the right ear of the observer and sounded for one minute. The sensitivity of the right ear was depressed at first, came back to normal after a few minutes and reached enhanced sensitivity after another similar interval, only to drop back to its normal value after perhaps a quarter of an hour. A similar though less pronounced oscillation was obtained when the left ear was exposed to a strong sound while the right was temporarily protected by a heavy pad of wool and metal. The same relation between the just perceptible increment of intensity of a sound and the intensity was found in normal, depressed and enhanced states of sensitivity.

Published papers:

Macdonald, P. A. and Allen, John F. The Psychophysical Law. I. The Sense of Vision. Phil. Mag. 9: 817-827. 1930. II. The Sense of Audition. Phil. Mag. 9: 827-834. 1930.

Allen, John F. The Depression and Enhancement of Auditory Sensitivity. Phil. Mag. 9: 834-842. 1930.

(*Investigation under the direction of Dr. Frank Allen, University of Manitoba.*)

V. POSTGRADUATE RESEARCH SCHOLARSHIPS

A survey made by the National Research Council shortly after its organization revealed the fact that there was in Canada a serious shortage of men qualified to undertake independent research in the solution of important scientific industrial problems. This led to the establishment of a system of postgraduate scholarships for outstanding university graduates. Approximately $50,000 annually is now being devoted to this purpose.

Four classes of scholarships are awarded under this system,—bursaries, studentships, fellowships and travelling fellowships, of an annual value of $750, $1,000, $1,200 and $1,500 each, respectively.

The minimum qualification for a bursary is graduation with distinction from a Canadian university of recognized standing. A few bursaries are reserved annually for the most brilliant men in the graduating classes, but the number of applicants for these scholarships has so increased in recent years that most of the awards are now made to men who have already had one year of postgraduate work. A second bursary is not ordinarily given to one individual.

A person who has held a bursary, and who has demonstrated his capacity for original research, may apply for a studentship. A second studentship may be awarded to an individual who has done highly satisfactory work.

Fellowships are awarded to only a few outstanding persons each year.

Travelling fellowships are available in limited number for holders of Ph.D. degrees who wish to go abroad for a study of special problems. A very high standard of scholarship is required.

In addition to these scholarships, for which funds are provided by the National Research Council, the Council also awards certain scholarships provided by other organizations. At present there are available the Ramsay Memorial Fellowship in chemistry, of the value of $1,750, to be held in a foreign university, and three Canadian Wheat Pool Fellowships, of $1,200 each, for research in agriculture in Canadian universities.

Regulations governing the award of National Research Council scholarships will be found in Appendix B.

A list of scholarships held during the year 1929-30 will be found in Appendix C, and a list of all scholarship graduates to date in Appendix D.

FINANCIAL STATEMENT

FINANCIAL STATEMENT FOR THE FISCAL YEAR ENDING MARCH 31, 1930

Receipts

Appropriation		$400,000.00
Contributions from industry		10,900.00
Contributions to Canadian Engineering Standards Association		7,550.07
Grain overage trust fund		36,195.29
Refunds		8,470.47
Miscellaneous		1,266.92
		$464,382.75

Expenditures

Grants in aid of research	$220,442.60	
Postgraduate research scholarships	49,990.00	
Laboratory	21,065.76	
Publications	16,092.00	
General administration	18,092.38	
Travelling expenses of members of Council, Associate Committees and staff	23,334.53	
National Research Library	30,202.96	
Salaries and honoraria	83,419.12	
		$462,639.35
Refund to Receiver General		1,743.40
		$464,382.75

APPENDICES

APPENDIX A

14-15 George V.
Chap. 64

THE RESEARCH COUNCIL ACT

(Assented to July 19, 1924.)

HIS MAJESTY, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:

1. This Act may be cited as The Research Council Act, 1924.

2. In this Act, unless the context otherwise requires,—

(a) "Committee" shall mean the Committee of the Privy Council on Scientific and Industrial Research;

(b) "Chairman" shall mean the Chairman of the Committee of the Privy Council on Scientific and Industrial Research;

(c) "Council" shall mean the Honorary Advisory Council for Scientific and Industrial Research;

(d) "President" shall mean the President of the Honorary Advisory Council for Scientific and Industrial Research.

3. There shall be a Council to be called the Honorary Advisory Council for Scientific and Industrial Research.

4. (1) The Council shall consist of not more than fifteen members who shall be appointed by the Governor in Council on the recommendation of the committee.

(2) The members of the Council, with the exception of the President, shall hold office for a period of three years, and not less than four members shall retire each year. Provided that of the members first appointed under this Act, not more than five shall each be appointed for a period of three years, not more than five members shall each be appointed for a period of two years, and not more than five members shall each be appointed for a period of one year.

(3) Any retiring members shall be eligible for reappointment.

5. There shall be a President of the Council who shall be appointed by the Governor in Council on the recommendation of the committee. The President shall be the chief executive officer of the Council and shall have supervision over, and direction of, the work of the Council and of the officers, technical and otherwise, appointed for the purpose of carrying on the work of the Council. He shall receive such salary and be employed for such term of office as the Governor in Council may prescribe, and such salary shall be paid out of the monies provided for the work of the Council.

6. The Council shall have charge of all matters affecting scientific and industrial research in Canada which may be assigned to it by the Committee, and shall also have the duty of advising the committee on questions of scientific and technological methods affecting the expansion of Canadian industries or the utilization of the natural resources of Canada.

7. The Council is hereby constituted a body corporate capable of suing and being sued and having the power to acquire money, securities, real estate or property by gift, grant, bequest, donation or otherwise, and of holding lands, tenements, hereditaments, goods, chattels and any other property, movable or immovable, for the purpose of, and subject to, this Act.

8. The Council shall meet at least four times a year in the city of Ottawa on such days as may be fixed by the Council, and may also meet at such other times and places as the Council may deem necessary.

9. No member of the Council, with the exception of the President, shall receive any payment or emolument for his services, but each member shall receive such payments for travelling and other expenses in connection with the work of the Council as may be approved by the Governor in Council.

10. Without thereby limiting the general powers of the Council conferred upon or vested in it by this Act, it is hereby declared that the Council may exercise the following powers namely:

(a) To make by-laws for the conduct of its business;

(b) To control and direct the work of the Council through the President, and, in case of the illness, absence or suspension of the President, or in the case of vacancy in the office of President, through an Acting President temporarily appointed by the Council;

(c) To undertake in such way as may be deemed advisable,—

(i) To promote the utilization of the natural resources of Canada;

(ii) Researches with the object of improving the technical processes and methods used in the industries of Canada, and of discovering processes and methods which may promote the expansion of existing or the development of new industries;

(iii) Researches with the view of utilizing the waste products of industries;

(iv) The investigation and determination of standards and methods of measurements, including length, volume, weight, mass, capacity, time, heat, light, electricity, magnetism and other forms of energy; and the determination of physical constants and the fundamental properties of matter;

(v) The standardization and certification of the scientific and technical apparatus and instruments for the Government service and for use in the industries of Canada; and the determination of the standards of quality of the materials used in the construction of public works and of the supplies used in the various branches of the Government service;

(vi) The investigation and standardization, at the request of any of the industries of Canada, of the materials which are or may be used in, or of the products of, the industries making such request;

(vii) Researches, the object of which is to improve conditions in agriculture;

(d) To have charge of, and direction or supervision over, the researches which may be undertaken, under conditions to be determined in each case, by or for single industrial firms, or by such organizations or persons, as may desire to avail themselves of the facilities offered for this purpose;

(e) To expend such sums of money as may be annually appropriated by Parliament for the work of the Council or which shall have been received by the Council through bequest, donation or otherwise;

(f) With the approval of the Committee, to appoint such scientific, technical and other officers as shall be nominated by the President, and to fix the tenure of such appointments, to prescribe the several duties of such officers, and, subject to the approval of the Governor in Council, to fix their remuneration;

(g) Subject to the approval of the Chairman, to publish, from time to time, such scientific and technical information as the Council may deem necessary.

11. (1) All discoveries, inventions and improvements in processes, apparatus or machines, made by a member or any number of members of the technical staff of the Council shall be vested in the Council and shall be made available to the public under such conditions and payment of fees or royalties or otherwise as the Council may determine, subject to the approval of the Governor in Council.

(2) The Council, with the approval of the Governor in Council, may pay to its technical officers and to others working under its auspices who have made valuable discoveries, inventions or improvements in processes, apparatus and machines such bonuses or royalties as in its opinion may be warranted.

12. All the receipts and expenditures of the Council shall be subject to examination and audit by the Auditor General.

13. (1) The President shall report annually to the Council upon the progress and efficiency of the work of the Council and as to its requirements, and shall make such recommendations therein as he may deem necessary.

(2) The Council shall, after the conclusion of the fiscal year, make a report to the Committee containing the report of the President of the Council and also containing a statement of the receipts and expenditures of the Council during the preceding fiscal year. Such reports shall be printed and laid before Parliament within fifteen days of the making thereof, or, if Parliament is not then in session, within fifteen days after the commencement of the next session of Parliament.

14. Chapter twenty of the statutes of 1917 is repealed.

APPENDIX B

Regulations Governing Bursaries, Studentships and Fellowships

A. General Regulations

1. These bursaries, studentships and fellowships are intended, not to facilitate attendance on ordinary collegiate studies, but to enable students, who have passed through a university curriculum, and have given distinct evidence of capacity for original research (or, in the case of bursaries, students who have at least won high distinction in scientific study during their undergraduate course), to continue the prosecution of science with the view to aiding its advance or its application to the industries of the country. Evidence of this capacity is strictly required, this being the main qualification. The most suitable evidence is the presentation of a research already performed.

2. They are open on equal terms to men and women, and are awarded to the applicants who are deemed best qualified by the evidence submitted.

3. An applicant for a bursary, a studentship or a fellowship must be a British subject resident in Canada.

4. An applicant to be eligible for an award, must not have passed the thirty-second anniversary of his birth on March 31 of the year of application.

5. A married person cannot hold a bursary, studentship or fellowship.

6. A candidate must (1) be a *bona fide* graduate of a university or college in which special attention is given to scientific study, or (2) have received an equivalent training in an institution possessing adequate facilities of a scientific character for providing such training.

7. The departments of science in which capacity for research will be accepted as qualifying for an award are: Biology (economic), Chemistry, Engineering, Geology, Metallurgy, Mineralogy, Physics and Mathematics.

8. Application for a bursary, studentship or fellowship must be made by the candidate to the National Research Council. He shall submit a complete record of his academic career. Recommendations from the heads of the scientific departments with which he was connected, and the professors or instructors under whom he studied, showing that in their estimation he promises to be worthy of training for scientific research, must be submitted. All such recommendations must be forwarded to the National Research Council by the professor recommending the candidate and through the head of the department concerned. The candidate shall state the institution at which he intends to study, and the general line of work to be followed. The application will be considered and decided upon by the National Research Council or by a special committee appointed by the same.

9. Each applicant must arrange for his admission to some approved university, and submit with this application a statement from the professor under whom he intends to work in such university, that such professor has agreed to undertake the supervision of his work with the approval of the head of the university department concerned. Such supervisor will be expected to submit to the Council a confidential report on the grantee's work at the midyear and on the conclusion of the award.

10. The date of the beginning of the tenure of an award shall coincide with the beginning of the academic session of the university at which the grantee is to carry on his work. In very exceptional circumstances, the National Research Council, upon receipt of a formal application from the grantee, may permit a change of tenure to be made.

11. Successful candidates are required to devote themselves for a period of at least nine months of each year wholly to the objects of the award, and during that time are forbidden to hold any position of emolument or to engage in teaching.

12. The holder of a bursary, studentship or fellowship shall furnish on or before February 1, a detailed midyear report of his work up to that time; and also on completion of the tenure of his award, and not later than July 31, a complete and detailed report of the work carried on during the entire year.

13. The National Research Council shall have the right to publish under its own auspices information arising from scholarships, and no paper covering work carried out under a scholarship may be published without permission from the Council.

14. Awards are payable as follows: 40 per cent on October 1; 50 per cent on February 1, or thereafter, on receipt of a satisfactory first half-yearly report; 10 per cent after the expiration of the nine months' period of tenure and the submission to the National Research Council of a satisfactory report on the work of the holder for the whole period.

15. A person who holds a bursary is expected to qualify for and proceed to a studentship and as a general rule a bursary will not be renewed for a second year; but a person may be awarded a studentship a second time, or a fellowship a second time. In no circumstances, however, will the Council make more than three years' grants to any one person under any combination of bursaries, studentships and fellowships. However, a travelling fellowship, similar to the Ramsay Memorial fellowship, may be awarded to one who has already received three awards, if in the opinion of the National Research Council the applicant be of outstanding ability.

B. Special Regulations Governing Bursaries

16. A bursary is of the value of $750.00.

17. Application for a bursary must be made not later than March 15.

18. The principal work of the holder of a bursary must be a research in some branch of science, but he is expected to give a considerable time to an advanced course of study.

19. A person who has held a bursary and who has, during his tenure of it, shown distinct evidence of capacity for original research is eligible to be a candidate for a studentship.

20. A bursary must be held at a Canadian university approved by the Council.

C. Special Regulations Governing Studentships

21. A studentship is of the value of $1,000.00.

22. Application for a studentship must be made not later than March 15.

23. The principal work of the holder of a studentship must be a research in some branch of science, the extension of which is important to the national industries; but he may give a reasonable amount of time to an advanced course of study.

24. A person who has held a studentship and whose work has been highly satisfactory to the Council is eligible to be a candidate for a second studentship, or even for a fellowship.

25. A first studentship must be held at a Canadian university approved by the Council; but a second studentship may, by special approval of the Council, be carried on in some Canadian scientific laboratory or works.

D. Special Regulations Governing Fellowships

26. A fellowship is of the value of $1,200.00.

27. Application for a fellowship must be made not later than March 15.

28. A fellowship will be awarded only to a candidate whose record shows that he possesses the capacity to conduct *independent* research.

29. The principal work of the holder of a fellowship must be a research in some branch of science, the extension of which is important to the national industries.

30. A person who has held a fellowship and whose work has been of great excellence is eligible to be a candidate for a second fellowship. In no circumstances will a third fellowship be awarded.

Address all communications to,

The Secretary,
National Research Council,
Ottawa, Ont.

Regulations Governing Foreign Travelling Fellowships

These Fellowships have been established by the National Research Council with the purpose of enabling those who have already shown evidence of a high order of ability in scientific research to broaden their experience and outlook, and thus become of more value to Canada. These Fellowships, accordingly are to be held outside of Canada so that the holders may benefit by study under, and contact with, leaders in their special subjects in other parts of the world. It is also hoped that the establishment of these Fellowships will give those young investigators, who have become too largely absorbed in routine teaching duties, an opportunity of getting a new start in the prosecution of research.

In order to be eligible for a Fellowship a candidate must hold the degree of Ph. D., or its equivalent, from a university recognized by the Council for the purpose. He must present proof that he has already prosecuted research with success and distinction and has made and published some definite, valuable contribution to science.

These Fellowships shall be of a value of $1,500, payments to be made as follows: fifty per cent at the beginning of the Fellowship period; forty per cent at the end of six months' tenure of the award and ten per cent upon receipt of a satisfactory report covering the work carried on throughout the year. Appointments of Fellows are for twelve months, and may be made at any time, but usually so as to coincide with the beginning of the academic year.

A Fellow must, during the whole period of his tenure of a Fellowship, engage in fundamental research at a university or other institution approved by the Council, but he may give a portion of the time to attendance on advanced courses of study. He cannot engage in teaching nor hold any position of emolument.

A Fellow must submit to the Council, shortly before the end of the first six months of the tenure of his Fellowship, a detailed report, in duplicate, on the progress of his work. He must also present before the termination of his Fellowship an account of his research in form for publication. It is understood that all results of investigation by the Fellow shall be made available to the public without restriction. The publication by a Fellow of the results of the investigation carried on during the tenure of his Fellowship must include a suitable acknowledgment of his indebtedness to the Council. The grantee should notify the Council promptly regarding any publication proposed, and when such publication appears the author must furnish twelve copies of the paper to the Council.

A Fellow must obligate himself to return to Canada with the intention of devoting his best energy and best endeavors to the promotion of science, either on its pure or on its applied side.

Appointments are subject to the condition that, when a Fellowship has been accepted by the applicant, it will not be vacated within the year without the consent of the Council.

Application must be made on a form which will be supplied by the Secretary of the National Research Council. The applicant must give evidence of his training and research capacity, including a list, and copies where possible, of all work published by him; also endorsements of responsible scientists, including estimates of the applicant's qualifications. He must also submit for approval the specific nature of the problem which he wishes to investigate, and the name of the institution which he proposes to attend and of the man under whom he wishes to work. He should also outline his plan for future scientific investigations.

APPENDIX C

54 Scholarships Held During the Year 1929-1930

FOREIGN TRAVELLING FELLOWSHIPS

Grantee	Graduated	Where held	Subject of Research
Neal M. Carter	B.A.Sc., M.A.Sc., University of British Columbia; Ph.D., McGill University.	Kaiser Wilhelm Institut für Lederforschung, Dresden, Germany.	Chemical nature of cellulose.
H. M. Cave	B.A., M.A., Queen's University.	Berlin University, University of Munich.	New quantum mechanics.
Carl C. Coffin	B.A., Dalhousie University; M.Sc., Ph.D., McGill University.	Van't Hoff Laboratories, University of Utrecht.	The conditions of formation of so-called explosive antimony.

RAMSAY MEMORIAL FELLOWSHIP

Grantee	Graduated	Where held	Subject of Research
Lloyd M. Pidgeon	B.A., University of Manitoba; M.Sc., Ph.D., McGill University.	Clarendon Laboratory, Oxford.	Mechanism of oxidation.

FELLOWSHIPS

Grantee	Graduated	Where held	Subject of Research
Elizabeth J. Allin	B.A., M.A., Ph.D., University of Toronto.	Department of Physics, University of Toronto.	Fine structure of lines in the visible region of the second spark spectrum of thallium.
Colin Barnes	B.Sc., M.Sc., Leeds University; Ph.D., McGill University.	Department of Theoretical Physics, Cambridge University, England.	The new quantum mechanics and its relation to statistical mechanics.
William Chalmers	B.A., M.A., University of British Columbia; Ph.D., McGill University.	Department of Organic Chemistry, McGill University.	Influence of structure on the ability of organic compounds to polymerize.
M. F. Crawford	B.A., University of Western Ontario; M.A., University of Toronto.	Department of Physics, University of Toronto.	Investigation of the fine structure of the Tl, II spectrum.
Cecil T. Lane	B.Sc., M.Sc., Ph.D., McGill University.	Department of Physics, McGill University.	Magnetic susceptibility of the alkali metals in the vapor state.
Oliver M. Morgan	B.A., M.A., University of Western Ontario; Ph.D., McGill University.	Department of Physical Chemistry, McGill University.	Vapor pressures and electrolytic conductivities of aqueous solutions of sulphur dioxide, carbon dioxide and ammonia.

STUDENTSHIPS

Grantee	Graduated	Where held	Subject of Research
John Allardyce	B.A., M.A., University of British Columbia.	Department of Biochemistry, McGill University.	Chemistry of the parathyroid hormone.
J. M. Anderson	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto.	Duration of metastable states at low temperature.

Grantee	Graduated	Where held	Subject of Research
R. H. Ball	B.A., M.A., University of British Columbia.	Department of Organic Chemistry, McGill University.	Synthesis and properties of new cellulose ethers.
Alfreda A. Berkeley	B.A., University of British Columbia; M.A., Ph.D., University of Toronto.	Department of Marine Biology, University of Toronto.	The life history of the commercially valuable shrimps of British Columbia.
Arthur Stanley Cook	B.A., M.A., Dalhousie University.	Department of Biochemistry, University of Toronto.	Certain nitrogen and sulphur compounds in fish muscle.
Wilfred Gallay	B.A., M.Sc., Ph.D., McGill University.	Department of Cellulose Chemistry, McGill University.	The nature of polymerization, etc.
L. E. Howlett	B.A., University of British Columbia; M.A., University of Toronto.	Department of Physics, McGill University.	Raman effect in liquids.
H. C. Laird	B.A., University of Western Ontario; M.A., University of Toronto.	Department of Geology, University of Toronto.	The nature and origin of the silurian chert beds at Hamilton.
G. O. Langstroth	B.A., Dalhousie University; Ph.D., McGill University.	Department of Physics, McGill University.	The relative intensities of the stark components in helium.
J. Goston Morazain	B.Sc., Laval University; B.Sc., McGill University.	Department of Cellulose Chemistry, McGill University.	The fundamental principles involved in cyclic acetal formation.
William H. Mueller	B.Sc., University of Alberta; M.Sc., Ph.D.,McGill Unisity.	Department of Chemistry, McGill University.	Comparative studies in oxidation.
John B. Phillips	B.Sc., M.Sc., Ph.D., McGill University.	Department of Organic Chemistry, McGill University.	Nature of the resins in jack pine.
Edward C. Powell	B.Sc., M.Sc., University of Saskatchewan.	Department of Chemistry, McGill University.	The structure of lignin.
Charles A. Sankey	B.A.Sc., University of Toronto; M.Sc., Ph. D., McGill University.	Department of Chemistry, McGill University.	The properties of lignin and related compounds.
C. V. Wilson	B.Sc., M.Sc., University of Saskatchewan.	Department of Chemistry, McGill University.	The structure of lignin.
H. R. Wyman	B.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University.	Calorimetric measurements in relation to crystal forms and surface effects.
John M. Young	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University.	(1) Hall effect (2) Electrical discharge in gases.
Walter H. Zinn	B.A., M.A., Queen's University.	Department of Physics, Queen's University.	(1) Distribution of X-rays scattered by liquids and solutions. (2) Absorption of X-rays of different wave-lengths.

BURSARIES

Grantee	Graduated	Where held	Subject of Research
John Stanley Allen	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, McGill University.	Nature of polymerization and its relation to the dipolar moment of organic products.
May Annetts	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto.	Process of coagulation of colloidal solutions.
Jean Chas. Bernier	B.A.Sc., University of Montreal.	Department of Electricity, Ecole Polytechnique.	The transient synchronizing power of A.C. machinery.
John L. Binder	B.Sc., M.Sc., University of Saskatchewan.	Department of Physical Chemistry, University of Saskatchewan.	The activation of hydrogen by electric discharge.
C. Eugene Coke	B.Sc., M.Sc., University of Manitoba.	Department of Chemistry, University of Toronto.	Solubility of ethylene gas in colloidal solutions.
George S. Field	B.Sc., University of Alberta.	Department of Physics, University of Alberta.	Effect of varying conditions on the radiation from a short wave radio transmitter.

Grantee	Graduated	Where held	Subject of Research
Edgar A. Filby	B.Sc., M.Sc., University of Saskatchewan.	Department of Physical Chemistry, University of Saskatchewan.	Activation of hydrogen by electric discharge.
Gordon F. Frame	B.A., M.A., Dalhousie University	Department of Organic Chemistry, Dalhousie University.	Condensation reaction of benzaldehyde to benzene in the presence of potassium cyanide.
Nathaniel H. Grace	B.A., M.A., University of Saskatchewan.	Department of Physical Chemistry, McGill University.	The absorption of vapors by wood and cellulose.
O. A. Gratias	B.Sc., M.Sc., University of Saskatchewan.	Department of Physics, University of Saskatchewan.	The formation of aggregates of atoms in radon.
G. V. Helwig	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University.	Determination of the structure of certain crystal hydrates by X-ray anaylsis.
Wm. Wallace Johnston	B.A., University of Toronto.	Department of Zymology, University of Toronto.	The gas production of clostridium aceto butylicum.
Geo. A. Ledingham	B.Sc.. M.Sc., University of Saskatchewan.	Department of Plant Pathology, University of Toronto.	The life history of parasites causing root-rot of wheat in Ontario.
Everett P. Linton	B.Sc., Mount Allison University.	Department of Physical Chemistry, McGill University.	Preparation and properties of pure hydrogen peroxide.
M. K. McPhail	B.A., University of British Columbia.	Department of Biochemistry, McGill University.	The extract of the anterior lobe of the pituitary.
Duncan Ross McRae	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University.	Connection between the fine structure and stark components in hydrogen and like spectra.
F. R. Morehouse	B.Sc., Mount Allison University.	Department of Physical Chemistry, McGill University.	Preparation of ethyl acetylene.
Stuart M. Pady	B.A., M.A., McMaster University.	Department of Botany, University of Toronto.	Development of telia in a number of rusts that attack forest trees.
Arthur Paquet	B.Sc., Laval University; B.Sc., McGill University.	Department of Cellulose Chemistry, McGill University.	Cyclic acetal formation.
Stanley Z. Perry	B.Sc., M.Sc., McGill University.	Department of Cellulose Chemistry, McGill University.	The polymerization of ethylene oxide and its bearing on the structure of cellulose.
Daniel Melvin Robertson	B.A., M.A., University of Manitoba.	Department of Physics, McGill University.	Electric, thermal and magnetic properties of the alkali and other metals. Conductivity of alkaline metals in liquid and solid states.
Harold D. Smith	B.A., M.A., University of British Columbia; M.A., University of Toronto.	Department of Physics, University of Toronto.	Raman effect with liquid air, hydrogen, helium, etc.
H. S. Sutherland	B.Sc., Mount Allison University; M.Sc., McGill University.	Department of Physical Chemistry, McGill University.	Gas reactions under high pressure.
Henry Thiessen	B.Sc., University of Saskatchewan.	Department of Mathematics, University of Saskatchewan.	Tensor analysis.
Robert Turnbull	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto.	Interpretation of the absorption of radiation in gas, liquid and solid phases.
Robert H. Wright	B.A., University of British Columbia.	Department of Physical Chemistry, McGill University.	The physical properties of the system H_2S—H_2O.

APPENDIX D

229 Scholarship Graduates—1917-1930

Grantee	University where undergraduate training received	Present Occupation
F. B. Adamstone, B.A., M.A., Ph.D.	Toronto	Associate in Zoology, University of Illinois, Urbana, Ill.
D. S. Ainslie, B.A., M.A., Ph.D.	Toronto	Instructor in Physics, University of Western Ontario, London, Ont.
Miss Marian Anderson, B.A., M.Sc.	New Brunswick	Deceased.
F. M. Archibald, B.Sc., M.A., Ph.D.	Acadia	No information.
M. J. Atkinson, B.Sc., M.Sc.	Saskatchewan	In charge of mosquito control operations for Lucerne-in-Quebec Community Association, Montebello, Que.
W. F. Baker, B.A., B.Sc., M.Sc.	Manitoba	With Anglo-American Co., South Africa.
W. H. Barnes, B.Sc., M.Sc., Ph.D.	McGill	Sessional Lecturer in Physics, McGill University, Montreal, Que.
H. C. Bates, B.A., M.A.	Toronto	Research Physicist, Corning Glass Works, Corning, N.Y.
C. H. Bayley, B.A., B.Sc., M.A.Sc., M.A	Toronto	Junior Research Chemist, National Research Council, Ottawa, Ont.
R. W. Beattie, B.Sc., M.Sc.	Queen's	Fellowship holder of the Halowax Division of the Bakelite Corp. at Pennsylvania State College, State College, Pa.
A. H. Bell, B.A., Ph.D.	Toronto	Geologist, Petroleum Section, Illinois Geological Survey, Urbana, Ill.
H. P. Bell, B.Sc., M.Sc., M.A., Ph.D.	Dalhousie	Associate Professor of Botany, Dalhousie University, Halifax, N.S.
L. V. Bell, B.Sc., M.A., Ph.D.	Alberta	Geologist, Dept. of Mines, Quebec.
P. A. Berard, B.A., L. es Ch.Sc.	Montreal	Milk Analyst, City Hall, Montreal, Que.
G. H. Berkeley, B.A., M.A., Ph.D.	Queen's	Senior Plant Pathologist, Laboratory of Plant Pathology for Southern Ontario, St. Catharines, Ont.
E. G. Bishop, B.Sc., M.Sc., Ph.D.	McGill	Geological Staff, Anglo-American Corp. of South Africa, Broken Hill, Northern Rhodesia, Africa.
Miss E. L. Bishop, B.A., M.A.	Toronto	Teacher of Mathematics, Georgetown High School, Georgetown, Ont.
L. L. Bolton, B.A., M.A.	British Columbia	Instructor in Zoology, University of Washington, Seattle, Wash.
E. H. Boomer, B.Sc., M.Sc., Ph.D.	British Columbia	Assistant Professor in Chemistry, University of Alberta, Edmonton, Alta.
Miss M. A. Borden, B.A., M.A.	Dalhousie	Graduate Student, University of London, London, England.
H. A. Braendle, B.A., M.A.	Toronto	Technical Department, Binney & Smith Co., New York, N.Y.
O. C. Bridgeman, B.A., M.A., Ph.D.	Saskatchewan	Research Associate, Bureau of Standards, Washington, D.C.
W. G. Brown, B.Sc., M.Sc.	Saskatchewan	Graduate Student, University of California, Berkeley, Cal.
B. S. W. Buffam, B.Sc., M.Sc., Ph.D.	McGill	With Anglo-American Co., Northern Rhodesia, Africa.
J. W. Burns, B.Sc., M.Sc.	New Brunswick	Asst. Professor of Chemistry, University of Western Ontario, London, Ont.
K. H. Butler, B.A., M.A., Ph.D.	Dalhousie	Research Chemist, Grasselli Chemical Co., Red Bank, N.J.
Miss M. F. Cale, B.A., M.A.	Toronto	Married.
G. B. Carpenter, B.A., M.A., Ph.D.	British Columbia	Chemist, DuPont Ammonia Corp., Wilmington, Dela.
P. Cartier, B.Sc., L. es Sc.Ch.	Montreal	Asst. Professor of Chemistry, University of Montreal, Montreal, Que.
Miss M. L. Chalk, B.A., M.Sc., Ph.D.	McGill	Research in Physics with Prof. O. W. Richardson at King's College, London University, London, England.
G. C. Chamberlain, B.S.A.	Ontario Agricultural College	Plant Pathologist, Dominion Experimental Farms, St. Catharines, Ont.
Miss H. D. Chataway, B.A., B.Sc., M.Sc., Ph.D.	Manitoba	Junior Research Chemist, National Research Council, Ottawa, Ont.
E. Chauret, I.Ch., L. es Sc.	Montreal	Chief Chemical Engineer in the Concrete Department of the Laboratory for Testing Materials, Montreal, Que.
H. R. Chipman, B.A., M.A., Ph.D.	Dalhousie	Chemist, Fisheries Experimental Station (Atlantic) Halifax, N.S.
N. D. Clare, B.Sc., M.Sc.	Manitoba	Roessler & Hasslacher Chemical Co., Niagara Falls, Ont.
Miss M. L. Clark, B.A., M.A.	Toronto	Teacher of Mathematics, Collingwood Collegiate Institute, Collingwood, Ont.
R. J. Clark, B.A.	McGill	Physical Laboratory, The University, Edinburgh, Scotland.
Miss E. Cohen, B.A., M.A., Ph.D.	Toronto	Research Student, University of Bristol, Bristol, England.
Miss L. Corbett, B.A., M.A.	Queen's	Married.

Grantee	University where undergraduate training received	Present Occupation
R. G. Corneil, B.Sc., A.C.I.C.	Queen's	Student Ontario College of Education, Toronto, Ont.
M. F. Crawford, B.A., M.A.	Western Ontario	Graduate Student, University of Toronto, Toronto, Ont.
R. M. Crozier, B.A., M.A., Ph.D.	British Columbia	Research Department, Shawinigan Chemicals, Shawinigan Falls, Que.
B. W. Currie, B.Sc., M.Sc., Ph.D.	Saskatchewan	Asst. Professor, Department of Physics, University of Saskatchewan, Saskatoon, Sask.
A. C. Cuthbertson, B.Sc., M.Sc., Ph.D.	McGill	Asst. Professor of Chemistry, Mt. Allison University, Sackville, N.B.
Miss A. E. Dempsey, B.A., M.A.	McMaster	Married.
A. B. de Passillé, B.Sc.A., I.C., I.Ch.	Montreal	Professor of Chemistry, University of Montreal, Montreal, Que.
E. P. Dolan, B.Sc., M.A.	St. Francis Xavier	Deceased.
A. M. I. A. W. Durnford, B.A., M.A., Ph.D.	Western Ontario	Technical Assistant, Department of Physics, University of Toronto, Toronto, Ont.
B. H. Emory, B.A.Sc.	Toronto	Technical Sales Service Division, Fraser Companies, N.B.
A. B. A. Evans, B.Sc., M.Sc., A.I.C.	Birmingham	Publisher, Agard & Co., Ltd., Birmingham, England.
T. S. C. Fawcett, B.A.Sc., M.A.Sc.	Toronto	No information.
J. H. Findlay, B.A., B.Sc., M.Sc., Ph.D.	Queen's	Fellow in Physics, Princeton University, Princeton, N.J.
R. E. Foerester, B.A., M.A., Ph.D.	British Columbia	Research Biologist in charge of Pacific Salmon Research Stations, Cultus Lake, B.C.
J. C. Forbes, B.A., M.A., Ph.D.	Saskatchewan	Research Professor at Medical College of Virginia, Richmond, Va.
H. R. Foreman, B.A., M.A.	Toronto	President and Sales Manager, H. R. Foreman & Co., Ltd., Toronto, Ont.
J. H. Fox, B.A., M.A.	Western Ontario	Teacher of Biology and Physics, Hon. W. C. Kennedy Collegiate, Windsor, Ont.
Miss C. W. Fritz, B.A., M.Sc., Ph.D.	McGill	Timber Pathologist, Forest Products Laboratories, Ottawa, Ont.
Miss M. A. Fritz, B.A., M.A., Ph.D.	McGill	Asst. in Palaeontology at Royal Ontario Museum and Instructor in Palaeontology, University of Toronto, Toronto, Ont.
D. K. Froman, B.Sc., M.Sc., Ph.D.	Alberta	Lecturer in Physics, University of Alberta, Edmonton, Alta.
W. A. Gale, B.A.Sc., M.A.Sc.	British Columbia	Asst. Director of Research, American Potash and Chemical Corp., Trona, Cal.
J. F. L. Germain, B.A., A.R.C.Sc.	Montreal	No information.
N. E. Gibbons, B.A., M.A.	Queen's	Brady Laboratory, New Haven, Conn.
B. E. Gilbert, B.A., M.A., Ph.D.	McMaster	Director and Plant Physiologist, Rhode Island Agricultural Experiment Station, Kingston, R.I.
Miss K. F. Godwin, B.A., M.Sc., Ph.D.	McGill	Married. Lecturer in Zoology, McGill University, Montreal, Que.
W. L. Gordon, B.S.A., M.Sc., A.A.A.S.	McGill	Plant Pathologist, Dominion Rust Research Laboratory, Winnipeg, Man.
N. S. Grace, B.Sc., M.Sc.,	Saskatchewan	Dept. of Physical Chemistry, Imperial College of Science, London, England.
A. R. Graham, B.S.A., M.Sc.	McGill	Asst. Entomologist, Dominion Department of Agriculture, Entomological Branch, Parasite Laboratory, Belleville, Ont.
W. E. Graham, B.A.Sc., M.A.Sc., M.A., Ph.D.	British Columbia	Associate Research Chemist, National Research Council, Ottawa, Ont.
C. Greaves, B.Sc., M.Sc., Ph.D.	McGill	Junior Chemist, Division of Wood Preservation, Forest Products Laboratories, Ottawa, Ont.
H. Greenberg, B.Sc., M.Sc., Ph.D.	McGill	Research Chemist, U.S. Industrial Alcohol Company, Baltimore, Md.
H. B. Hachey, B.Sc., M.Sc.	St. Francis Xavier	Hydrographer to the Biological Board of Canada, St. Andrews, N.B.
R. Hamer, B.A., M.A., Ph.D.	Saskatchewan	Professor of Physics, Acadia University, Wolfville, N.S.
R. H. Harris, B.Sc., M.Sc.	Saskatchewan	Chemist in charge of laboratory of the Quaker Oats Company, Saskatoon, Sask.
J. L. Hart, B.A., M.A., Ph.D.	Toronto	Fisheries Investigator with Biological Board of Canada and the Province of British Columbia, Nanaimo, B.C.
W. H. Hatcher, B.A., M.Sc., Ph.D.	McGill	Associate Professor of Chemistry, McGill University, Montreal, Que.
Eric Hearle, B.S.A., M.Sc.	Toronto	Assistant Entomologist, Dominion Entomological Laboratory, Kamloops, B.C.
G. H. Henderson, B.A., B.Sc., M.A., Ph.D., F.R.S.C.	Dalhousie	Professor of Mathematical Physics, King's College, Dalhousie University, Halifax, N.S.
Paul G. Hiebert, B.A., M.A., M.Sc., Ph.D.	Manitoba	Lecturer in Chemistry, University of Manitoba, Winnipeg, Man.
A. C. Hill, B.Sc., M.Sc., Ph.D.	Dalhousie	Research Department, Canada Power and Paper Corporation, Laurentide Division, Grand'Mere, Que.

Grantee	University where undergraduate training received	Present Occupation
Miss E. M. Hill, B.A., M.Sc.	McGill	No information.
G. W. Holden, B.A., M.Sc., Ph.D.	Bishop's College	Analytical and Research Chemist, Charles E. Frosst & Co., Montreal, Que.
C. Y. Hopkins, B.A., M.A., Ph.D.	Queen's	Assistant Research Chemist, National Research Council, Ottawa, Ont.
E. O. Houghton, B.Sc., M.Sc.	McGill	Chemist, Fraser Companies, Limited, Edmunston, N.B.
W. V. Howard, B.A., M.Sc., Ph.D.	McGill	Assistant Professor, Department of Geology, University of Illinois, Urbana, Ill.
H. J. C. Ireton, B.A., M.A.	Toronto	Demonstrator, Lecturer, and Research Associate in the University of Toronto, Toronto, Ont.
A. B. Jackson, B.S.A., M.A.	Toronto	Farmer.
W. F. James, B.A., M.Sc., Ph.D.	St. Francis Xavier	Consulting Geologist, Amos, Que.
R. S. Jane, B.A.Sc., M.Sc., Ph.D.	British Columbia	Department of Plant Research, Shawinigan Chemicals, Shawinigan Falls, Que.
J. A. Jenkins, B.Sc., M.Sc.	Saskatchewan	Research Assistant, University of California, Berkeley, Cal.
C. M. Jephcott, B.A., M.A., Ph.D.	Toronto	Research Associate, Department of Physiology, University of Toronto, Toronto, Ont.
H. W. Johnston, B.Sc., M.Sc., Ph.D., M. P. E. Q., A.M.E.I.C., M.Soc. Chem.Ind., M.Am.Chem.Soc.	McGill	Chemical Engineer, Forest Products Laboratories of Canada, Montreal, Que.
I. W. Jones, B.A., B.Sc., Ph.D.	Alberta	Geologist, Division of Geology, Department of Mines, Province of Quebec, Quebec, Que.
W. A. Jones, B.A.Sc., M.A.Sc., M.A., Ph.D.	British Columbia	Geological Department of the Hollinger Consolidated Gold Mines, Ltd., Timmins, Ont.
Miss M. B. Kearney, B.A., M.A.	Toronto	Registrar and Instructor in Physics, Converse College, Spartanburg, S.C.
E. J. King, B.A., M.A., Ph.D.	McMaster	Biochemist in the Department of the Banting Medical Research, Toronto, Ont.
M. H. Kingdon, B.A., M.A., Ph.D.	McMaster	Physicist, Research Laboratory, General Electric Company, Schenectady, N.Y.
L. W. Koch, B.A., M.A.	Queen's	Assistant Plant Pathologist, Dominion Laboratory of Plant Pathology, St. Catharines, Ont.
A. L. Kuehner, B.A., M.A.	Queen's	Professor of Chemistry, Bishop's University, Lennoxville, Que.
P. Larose, B.Sc., M.Sc., Ph.D.	McGill	Associate Research Chemist, National Research Council, Ottawa, Ont.
G. C. Laurence, B.Sc., M.Sc., Ph.D.	Dalhousie	Junior Research Physicist, National Research Council, Ottawa, Ont.
W. A. Lawrence, B.A., M.A., Ph.D.	McMaster	Stanley Professor of Organic Chemistry and Head of Department of Chemistry, Bates College, Lewiston, Maine.
J. F. Lehmann, B.Sc., M.Sc., Ph.D.	Alberta	Physicist, Synthetic Ammonia and Nitrate, Limited, Billingham, Stockton-on-Tees, England.
S. Lehrman, B.A., M.A.	Toronto	No information.
A. H. Leim, B.A., Ph.D.	Toronto	Director, Fisheries Experimental Station, Halifax, N.S.
Miss Mattie Levi, B.A., M.A., Ph.D.	Toronto	Married.
S. G. Lipsett, B.Sc., M.Sc., Ph.D.	Manitoba	Research Chemist, J. T. Donald & Co., 42 Belmont St., Montreal, Que.
F. R. Lorriman, B.A., M.A., Ph.D.	Toronto	Lecturer in Chemistry, University of Toronto, Toronto, Ont.
G. H. W. Lucas, B.A., M.A., Ph.D.	Toronto	Associate Professor in Pharmacology, University of Toronto, Toronto, Ont.
A. D. MaCallum, B.A., M.Sc., Ph.D.	Toronto	Research Chemist, Roessler & Hasslacher Chemical Company, Niagara Falls, N.Y.
J. K. L. MacDonald, B.Sc., M.Sc.	McGill	Research Student at Cambridge University, Cambridge, England.
P. A. MacDonald, B.Sc., M.Sc., Ph.D.	Manitoba	Research Assistant, University of Manitoba, Winnipeg, Man.
Miss A. P. MacDougall, B.A., M.A.	McMaster	Married.
D. G. MacGregor, B.A.	Dalhousie	Professor of Physics, Mount Allison University, Sackville, N.B.
J. E. Machacek, B.S.A., M.S.A., Ph.D.	Saskatchewan	Lecturer in Plant Pathology, Macdonald College, Macdonald College, Que.
C. A. MacKay, B.A., M.A., Ph.D.	Dalhousie	Professor of Physics, University of Saskatchewan, Saskatoon, Sask.
Miss M. E. MacKay, B.A., M.A., Ph.D.	Dalhousie	Holding a Rockefeller grant under Dr. W. B. Cannon of Harvard University, Cambridge, Mass.
K. A. MacKinnon, B.Sc., M.Sc.	Queen's	Ph.D. student in field of communication at Cruft Laboratory, Harvard University, Cambridge, Mass.
D. J. MacLeod, B.A., M.A.	Queen's	Pathologist in charge, Field Laboratory of Plant Pathology, Fredericton, N.B.
M. D. MacLeod, B.Sc., M.Sc.,	McGill	No information.

Grantee	University where undergraduate training received	Present Occupation
R. H. F. Manske, B.Sc., M.Sc., Ph.D.	Queen's	Associate Research Chemist, National Research Council, Ottawa, Ont.
L. E. Marion, B.Sc., M.Sc., Ph.D.	Queen's	Assistant Research Chemist, National Research Council, Ottawa, Ont.
W. M. Martin, B.S.A., M.Sc., Ph.D.	Alberta	Assistant Chemist, University of Montana, Agricultural Experiment Station, Bozeman, Ma.
G. L. Matheson, B.Sc., M.Sc., Ph.D.	McGill	With Standard Development Company, Elizabeth, N.J.
L. A. Matheson, B.A., M.A.	Western Ontario	Fellow in the Graduate School, Department of Physics, University of Michigan, Ann Arbor, Mich.
J. E. Maynard, B.A., B.Sc., M.Sc., Ph.D.	Manitoba	Teacher of Mineralogy and Geology and Assistant in Chemistry, Macdonald College, Que.
A. W. McCallum, B.Sc.F., M.A.	Toronto	Forest Pathologist, Division of Botany, Department of Agriculture, Ottawa, Ont.
G. C. McCartney, B.A., M.A., M.Sc.	Manitoba	Graduate Student, University of Wisconsin, Madison, Wis.
W. H. McCurdy, B.A., M.A., Ph.D.	Dalhousie	Research Laboratory, Westinghouse Electric Company.
J. L. McDonald, B.A., M.D.	St. Francis Xavier	No information.
S. R. McDougall, B.A.Sc., M.A.Sc.	British Columbia	Shop Methods Division, Northern Electric Co., Ltd., Montreal, Que.
J. W. McKinney, B.Sc., M.Sc., Ph.D.	Alberta	Research Chemist, Brown Company, Berlin, N.H.
C. G. McLachlan, B.A.Sc., M.A.Sc., M.C.I.M.M., M.A.I.M.M.	British Columbia	Concentrator Superintendent, Noranda Mines, Limited, Noranda, Que.
H. R. McLarty, B.A., M.A.	McMaster	Pathologist-in-charge, Field Laboratory of Plant Pathology, Summerland, B.C.
A. B. McLay, B.A., M.A., Ph.D.	McMaster	Technical Assistant in Physics, University of Toronto, Toronto, Ont.
S. McLean, B.A., M.A.	McMaster	Experimental Lamp Department of General Electric Company, Cleveland, Ohio.
J. H. McLeod, B.Sc., M.A., Ph.D.	Saskatchewan	Instructor in Physics, Harvard University, Cambridge, Mass.
T. C. McMullen, B.A., M.A., Ph.D.	Toronto	Teacher of Chemistry, and Dean of Albert College, Belleville, Ont.
Miss A. I. McPherson, B.A., M.Sc.	McGill	No information.
W. C. McQuarrie, B.A., M.A., Ph.D.	Toronto	Assistant Professor of Physics, Lafayette College, Easton, Pa.
J. A. McRae, M.A., Ph.D., A.I.C., F.I.C.	Queen's	Professor of Chemistry, Queen's University, Kingston, Ont.
J. Melville, B.A.Sc., M.A.Sc.	British Columbia	Assay Office, Consolidated Mining and Smelting Company of Canada, Lt., Trail, B.C.
J. H. Mennie, B.A., M.A., B.Sc., Ph.D.	British Columbia	Physical Chemist, Experimental Station for Fisheries, and Associate Professor for Chemistry, Fisheries Department, Dalhousie University, Halifax, N.S.
W. E. K. Middleton, B.Sc., M.Sc.	Saskatchewan	On the Staff of Meteorological Office, Toronto, Ont.
G. Molleur, I.C.	Montreal	Quebec Streams Commission, Quebec, Que.
J. G. Morazain, B.Sc., M.Sc.	Laval	Graduate Student at McGill University, Montreal, Que.
C. F. Morrison. B.E., M.Sc.	Saskatchewan	Lecturer in Civil Engineering, University of Toronto, Toronto, Ont.
D. M. Morrison, B.Sc., M.Sc., Ph.D.	British Columbia	Chief Technologist, Arkansas City Refinery Shell Petroleum Corp., Arkansas City, Kan.
D. D. Mossman, B.Sc., M.A.	McGill	Research Fellow in Essential Oils and Perfume Chemistry, Columbia University, New York City, N.Y.
Miss B. K. E. Mossop, B.A., M.A., A.A.A.S.	Toronto	Specialist in Science, Ingersoll Collegiate Institute, London, Ont.
Miss I. Mounce, B.A., M.A., M.Sc., Ph.D.	British Columbia	Assistant Plant Pathologist, Central Experimental Farm, Ottawa, Ont.
M. J. Mulligan, B.A., M.A.	Toronto	Research Chemist, General Motors Research Laboratories, Detroit, Mich.
L. A. Munro, B.A., M.A., Ph.D.	Dalhousie	Assistant Professor of Chemistry, Queen's University, Kingston, Ont.
A. W. H. Needler, B.A., M.A., Ph.D.	Toronto	Assistant-in-charge of Oyster Investigation in Prince Edward Island for the Biological Board of Canada, Ellerslie, P.E.I.
Miss D. E. Newton, B.S.A., M.Sc.	McGill	On the Staff of Macdonald College, Macdonald College, Que.
Miss M. Newton, B.S.A., M.Sc., Ph.D.	McGill	Senior Plant Pathologist, Dominion Rust Laboratory, Agricultural College, Winnipeg, Man.
J. L. Nickerson, B.A., M.A.	Dalhousie	Instructor in Physics, Princeton University, Princeton, N.J.
C. D. Niven, B.Sc., M.A., Ph.D., A.I.C.	Aberdeen	Assistant Research Physicist, National Research Council, Ottawa, Ont.

Grantee	University where undergraduate training received	Present Occupation
Miss M. K. O'Brien, B.A., M.A.	Toronto	Sister M. Emerentia, St. Joseph's Convent, Toronto, Ont.
H. G. Oddy, B.A., M.A., Ph.D.	McMaster	No information.
H. B. O'Heir, B.A., B.Sc., M.Sc.	McGill	Riordon Sales Corporation, Montreal, Que.
Miss M. Olding, B.A.	McGill	Married.
A. J. O'Leary, B.Sc., M.Sc.	Queen's	Assistant in Physics, Columbia University, New York City, N.Y.
D. S. Pasternack, B.Sc., M.Sc., Ph.D.	Queen's	Research Chemist, Alberta Research Council, Edmonton, Alberta.
A. L. Patterson, B.Sc., M.Sc., Ph.D., F. Inst. P.	McGill	Associate in the Division of Biophysics, Rockefeller Institute, New York City.
Miss I. J. Patton, B.A., M.Sc.	McGill	No information.
Miss L. E. Paynter, B.Sc., M.Sc.	Saskatchewan	Laboratorian, Fort Qu'Appelle Sanatorium, Fort San, Sask.
C. R. Peaker, B.Sc., M.Sc., Ph.D.	Saskatchewan	Research Chemist, United States Rubber Company, Passaic, N.J.
R. A. Pelletier, B.Sc., M.Sc., Ph.D.	McGill	Assistant Consulting Geologist to the Rhodesian Anglo American, Ltd., Broken Hill, Northern Rhodesia, Africa.
J. F. Phillips, B.A.Sc., M.A., A.C.I.C.	Toronto	Teacher at Danforth Technical School, Toronto, Ont.
R. A. Prosser, B.Sc., M.A.	Acadia	Chemical Engineer, American Potash and Chemical Corporation, Trona, Cal.
H. N. Racicot, B.A.	McMaster	Plant Pathologist for Western Quebec, Division of Botany, Central Experimental Farm, Ottawa, Ont.
D. S. Rawson, B.A., M.A., Ph.D.	Toronto	Assistant Professor of Zoology, University of Saskatchewan, Saskatoon, Sask.
C. D. Reid, B.Sc., M.Sc., A.M., Ph.D.	Alberta	Instructor in the Department of Physics, Harvard University, Cambridge, Mass.
Miss C. E. Rice, B.A., M.A.	Queen's	Research Assistant, Division of Laboratories and Research, New York State Department of Health, Albany, N.Y.
Miss C. E. Robertson, B.Sc., M.Sc., Ph.D.	McGill	Married.
A. D. Robinson, B.A., M.A., Ph.D.	Saskatchewan	Assistant Professor in Agricultural Chemistry, Manitoba Agricultural College, Winnipeg, Man.
H. L. Robson, B.Sc., Ph.D., F.C.I.C.	Saskatchewan	Research Chemist, Synthetic Iron Color Company, Richmond, Cal.
D. C. Rose, B.Sc., M.Sc., Ph.D.	Queen's	Assistant Research Physicist, National Research Council, Ottawa, Ont.
P. V. Rosewarne, B.A., M.A.	McMaster	Engineer-in-charge Oils and Natural Gas Section, Fuel Research Laboratories, Department of Mines, Ottawa, Ont.
W. W. E. Ross, B.A.	Toronto	Assistant Magnetician, Meteorological Service, Toronto, Ont.
W. Rowles, B.Sc., M.Sc., Ph.D.	Saskatchewan	Lecturer in Physics, Macdonald College, Macdonald College, Que.
J. Russell, B.A., M.Sc., Ph.D.	British Columbia	Research Chemist, Eastman Kodak Company, Rochester, N.Y.
E. W. Sampson, B.Sc., M.Sc., M.A.	Manitoba	Research Assistant, Princeton University, Princeton, N.J.
J. O. G. Sanderson, B.Sc., M.Sc., Ph.D.	Alberta	Geologist, Imperial Oil Limited, Calgary, Alta.
B. W. Sargent, B.A., M.A.	Queen's	Research in Radioactivity, under Prof. Sir E. Rutherford, Cavendish Laboratory, Cambridge, England.
J. E. Saunders, B.A.Sc., M.Sc., M.C.I.M.M.	McGill	Deceased.
W. R. Sawyer, B.Sc., M.Sc.	Queen's	Graduate Student, McGill University, Montreal, Que.
D. A. Scott, B.A., M.A., Ph.D.	Toronto	Assistant Director of Connaught Laboratories, Toronto, Ont.
W. F. Seyer, B.A., M.Sc., Ph.D.	Alberta	Associate Professor of Electro and Industrial Chemistry, University of British Columbia, Vancouver, B.C.
B. Shaffer, B.A.Sc., M.A.Sc.	Toronto	No information.
Miss E. Shanley, B.A., M.Sc.	McGill	No information.
W. W. Shaver, B.A., M.A., Ph.D.	Toronto	Research Physicist, Corning Glass Works, Corning, N.Y.
G. M. Shrum, B.A., M.A., Ph.D.	Toronto	Associate Professor of Physics, University of British Columbia, Vancouver, B.C.
W. W. Simpson, B.A., M.A., Ph.D.	British Columbia	Student in Medicine in University of Toronto, Toronto, Ont.
H. des B. Sims, B.A., M.A.	Toronto	Research Chemist, Insulin Division, Connaught Laboratories, Toronto, Ont.
C. Sivertz, B.A.Sc., M.Sc., Ph.D.	British Columbia	Instructor in Chemistry, University of Western Ontario, London, Ont.
V. Sivertz, B.S., M.S., Ph.D.	Washington	Instructor in Chemistry, University of Washington, Seattle, Washington.
C. W. Small, B.Sc., M.A.	Acadia	Associate Professor of Chemistry, Acadia University, Wolfville, N.S.
H. G. Smith, B.A., M.A., Ph.D.	Toronto	Assistant Professor of Physics, University of British Columbia, Vancouver, B.C.

Grantee	University where undergraduate training received	Present Occupation
Miss C. M. Spence, B.A., M.A.	Queen's	Married.
Miss J. D. Spier, B.A., M.Sc.	McGill	Demonstrator, Department of Botany, McGill University, Montreal, Que.
D. O. Sproule, B.Sc., M.Sc.	Alberta	Holder of 1851 Exhibition Scholarship, London, Eng.
H. D. Squires, B.A., M.Sc., Ph.D.	New Brunswick	Instructor in Geology, Ohio State University, Columbus, Ohio.
E. W. R. Steacie, B.Sc., M.Sc., Ph.D.	McGill	Lecturer in Chemistry, McGill University, Montreal, Que.
H. N. Stephens, B.A., M.A., Ph.D.	McMaster	Assistant Professor of General Inorganic Chemistry, University of Minnesota, Minneapolis, Minn.
M. G. Sturrock, B.Sc., M.Sc., Ph.D.	Alberta	Chemist, Abitibi Power and Paper Company, Limited, Iroquois Falls, Ont.
B. P. Sutherland, B.A.Sc., M.Sc., Ph.D.	British Columbia	Chemist, Consolidated Mining and Smelting Company, Limited, Trail, B.C.
C. W. Sweitzer, B.A., M.A., Ph.D.	Toronto	Fellow at Mellon Institute, Pittsburgh, Pa.
Miss E. M. Taylor, B.A., M.A., Ph.D.	Toronto	Research Assistant, Connaught Laboratories, University of Toronto, Toronto, Ont.
F. R. Terroux, B.A., B.Sc., M.Sc.	Lyola College	Research Student, Cavendish Physical Laboratory, Cambridge, England.
K. Thomson, B.A., M.A.	Western Ontario	Graduate Student, Department of Physics, University of Michigan, Ann Arbor, Mich.
W. W. Thomson, B.Sc., M.Sc., Ph.D.	McGill	Editorial Staff, National Research Council, Ottawa, Ont.
A. S. Townsend, B.Sc., M.Sc., M.A.	Queen's	Chemist, The Guaranty Silk, Dyeing and Finishing Company, St. Catharines, Ont.
W. Ure, B.A.Sc., M.A.Sc., Ph.D.	British Columbia	Assistant Professor of Chemistry, University of British Columbia, Vancouver, B.C.
W. H. Vining, B.Sc., M.Sc.	Queen's	Chemist with Roessler and Hassachler Company, Niagara Falls, N.Y.
I. Walerstein, B.A., Ph.D.	Toronto	Instructor in Physics, Purdue University, Lafayette, Ind.
O. J. Walker, B.A., M.A., Ph.D.	Saskatchewan	Associate Professor of Chemistry, University of Alberta, Edmonton, Alta.
E. E. Watson, B.Sc., M.Sc.	McGill	Lecturer in Physics, Queen's University, Kingston, Ont.
Miss M. Weinberg, B.A., M.A., M.Sc.	Manitoba	Married.
M. S. Whalen, B.Sc., M.Sc., Ph.D.	Saskatchewan	Reasearch Chemist with E. I. Du Pont de Nemours and Company, Wilmington, Dela.
E. F. Whyte, B.A., M.A., Ph.D.	Dalhousie	Dominion Analyst, Dominion Department of Health, Halifax, N.S.
J. O. Wilhelm, B.Sc., M.A.	Saskatchewan	Technical Assistant, Department of Physics, University of Toronto, Toronto, Ont.
D. Wolochow, B.A., M.A., B.Sc., A.C.I.C.	Saskatchewan	Associate Research Chemist, National Research Council, Ottawa, Ont.
C. A. H. Wright, B.Sc., M.Sc., Ph.D.	British Columbia	Assistant to General Superintendent, Chemical and Fertilizer Department, Consolidated Mining and Smelting Company, Limited, Trail, B.C.
K. S. Wyatt, B.A., B.Sc.	Mount Allison	Research Chemist, Detroit-Edison Company, Detroit, Mich.
W. S. Yarwood, B.Sc., M.Sc.	Manitoba	No information.
F. H. Yorston, B.Sc., M.Sc., Ph.D.	McGill	Assistant Chemist, Forest Products Laboratories of Canada, Montreal, Que.
E. G. Young, B.A., M.Sc., Ph.D.	McGill	Professor of Biochemistry, Dalhousie University, Halifax, N.S.
J. F. T. Young, B.A., M.A., Ph.D.	Toronto	Assistant Professor of Physics, University of Manitoba, Winnipeg, Man.
J. M. Young, B.Sc., M.Sc.	McGill	Engineer, Canadian Marconi Company, Montreal, Que.

APPENDIX E

Regulations Governing the Award of Grants for Research

1. The recommending of the giving or refusing of grants by the National Research Council shall be in the hands of a committee of seven members of the Council to be known as the Committee on Assisted Researches. This committee may utilize the advice and assistance of any persons inside or outside the Council who, in their judgment, may be of value in any application under consideration.

2. The applicant must give a brief statement of the proposed investigation, its scope, time required, results hoped for, total cost, grant asked, specific purpose to which grant applied for is to be put, evidence of ability to carry on the investigation, and concise statement of adequacy of general equipment of laboratory wherein investigation is to be carried on. If the applicant has asked for or has received a grant from any other body, he must state this fact in his application.

3. Grants will, as a general rule, only be made to persons who are conducting investigations in established laboratories which possess the fundamental apparatus and facilities necessary for research of the nature proposed, and where the ordinary overhead charges are already provided for, and will not be made for the purchase of standard apparatus which a well-equipped laboratory should possess.

4. Grants made are to be for requirements of one year only, but further grants may be made annually.

5. Grants will be made only to persons who can show capacity for independent research, and who have a reputation for trustworthiness and responsibility.

6. Grants are to be made only for the actual expenses of investigation, but may be used in whole or in part for the payment of assistants, and are not intended to support the grantee while carrying out the investigation.

7. When a grant has been made for a specific purpose, it must be used for that purpose only. If the grantee desires to change in any manner the subject of his investigation he must make application to have the grant made available for the altered investigation.

8. All apparatus and materials purchased with grants are to be regarded as the property of the Council and when the investigation is concluded are to be subject to the disposition of the Council.

9. The grantee shall submit annually, or whenever called upon, an itemized statement of all apparatus and materials purchased during the preceding year with National Research Council funds. Such a statement, covering the entire investigation, shall also be submitted upon the completion or conclusion of the investigation, together with a report by the grantee on the condition of such apparatus and materials at the conclusion of the investigation.

10. A report of progress is to be made annually by the grantee, or whenever called for, and, in every case, on the completion or conclusion of the investigation.

11. The grantee shall render annually, or whenever called upon, an itemized account of his expenditures, with vouchers. Such account shall also be made on the completion or conclusion of the investigation, and the balance of the grant required shall be paid over to the National Research Council.

12. The grantee shall present a complete copy of the results of his investigation, before its publication, to the National Research Council, who shall have the right of publishing it under their own auspices. When the grantee publishes his research, he will make due acknowledgment of the assistance received from the Council.

13. The Council will give careful consideration to every application, but will not assign reasons for refusing to make grants applied for.

14. All apparatus used in researches subsidized by the National Research Council and purchased out of the Council grants shall, upon the conclusion of the research, be returned to the custody of the Council, unless otherwise provided for in specific cases by resolution of the Council.

15. No grant shall be awarded unless the applicant has submitted a satisfactory résumé of the previous work and the present state of knowledge in connection with the proposed research.

16. No research assistant may be appointed nor may any grant be paid by the Council until a detailed statement of the training, experience, and general qualifications of the proposed assistant has been submitted to the National Research Council and the proposed salary rate approved by the Council.

APPENDIX F

111 Researches in Progress During 1929-30

Subject of Research	Grantee	Where Carried On
The utilization of Canadian magnesite	Associate Committee on Magnesite	National Research Laboratories, Ottawa; Federal Department of Mines, Ottawa.
Alleged damage caused by smoke fumes from the Trail smelters	Associate Committee on Trail Smelter Smoke	Northport district of Northern Washington, U.S.A.
Cereal grain rust ----------	Associate Committee on Cereal Rust	Four co-operating laboratory groups: Dominion Rust Laboratory, Dept. of Agriculture, Winnipeg; University of Manitoba; University of Alberta; University of Saskatchewan.
Problems of the grain industry-	Associate Committee on Grain Research	Four co-operating laboratory groups: Board of Grain Commissioners, Winnipeg; University of Manitoba; University of Alberta; University of Saskatchewan.
Tuberculosis in man and animals	Associate Committee on Tuberculosis	Seven co-operating laboratory groups: Dept. of Bacteriology, University of Alberta; Dept. of Pathology and Bacteriology, University of Toronto; Dept. of Bacteriology, Queen's University; Faculty of Medicine, University of Montreal; Queen Alexandra Sanatorium, London, Ont.; Fort Qu'Appelle Sanatorium, Fort San, Sask.; Federal Dept. of Agriculture.
Problems of the wool industry--	Associate Committee on Wool	Three co-operating laboratory groups: Dominion Department of Agriculture; University of Alberta; University of Saskatchewan.
Chemical control of weeds -----	Associate Committee on Weed Control	Two co-operating laboratory groups: University of Alberta; University of Saskatchewan.
Diseases of animals ----------	Associate Committee on Animal Diseases	Three co-operating laboratory groups: University of Montreal; University of British Columbia; Macdonald College.
Engineering standardization ---	Associate Committee on Engineering Standards	Ottawa, Ont.
Foot and root-rot diseases of crop plants	Associate Committee on Field Crop Diseases	Four co-operating laboratory groups: University of Alberta; University of Manitoba; University of Saskatchewan; Federal Dept. of Agriculture.
Heating and insulation of buildings	Associate Committee on Heating and Insulation	Three co-operating laboratory groups: Dept. of Mechanical Engineering, Queen's University; Dept. of Mechanical Engineering, University of Toronto; Dept. of Mechanical Engineering, University of Saskatchewan.
Standardization of classification and analysis of coal	Associate Committee on Coal Classification and Analysis	University of Alberta.
Natural gas ----------	Associate Committee on Gas Research	University of Alberta.
Problems of the honey industry	Associate Committee on Honey Research	Federal Department of Agriculture and National Research Laboratories.
Developments in nitrogen fixation	Associate Committee on Nitroger Fixation	Dept. of Physics, Toronto University, and Research Information Division of National Research Council.

Subject of Research	Grantee	Where Carried On
The problem of slack barrels in apple shipments	Associate Committee on Apple Slacks	Federal Department of Agriculture.
Reforestation experiments on cut-over and burnt-over lands	Associate Committee on New Brunswick Forest Problems	Two co-operating laboratory groups: Dominion Forest Service, Dept. of Interior, Ottawa, Ont.; Dept. of Lands and Mines, Fredericton, N.B.
Utilization of Canadian iron ores	Subcommittee on Iron Ores of the Associate Committee on Metallurgy	Steel Company of Canada, Hamilton, Ont.
Best methods for obtaining accurate results in testing varieties, strains and treatments of grain	Associate Committee on Accurate Plot Work	Dominion Experimental Farms.
1. Physical and chemical oceanography 2. Marine biology 3. Fish technology	Associate Committee on Oceanography	Three co-operating organizations: University of British Columbia; Biological Board of Canada; Dominion Meteorological Service.
Health hazards in spray painting	Associate Committee on Spray Painting	Three co-operating laboratory groups: Federal Department of Health; Ontario Department of Health; Quebec Department of Health.
Destruction of wood piling by marine boring animals	Associate Biological Committee	Atlantic Biological Station of the Biological Board of Canada.
Factors governing the milling and baking quality of wheat	Dr. Newton	Dept. of Field Husbandry, University of Alberta, Edmonton, Alberta.
Pressure variations inside the cylinders of the internal combustion engine	Dr. D. A. Keys	Dept. of Physics, McGill University, Montreal, Que.
Ultrasonics (inaudible sound waves)	Dr. R. W. Boyle	Dept. of Physics, University of Alberta, Edmonton, Alta.
Wireworms and false wireworms	Prof. E. H. Strickland	Dept. of Entomology, University of Alberta, Edmonton, Alta.
Concrete deterioration	Prof. T. Thorvaldson	Dept. of Chemistry, University of Saskatchewan, Saskatoon, Sask.
Bacillary white diarrhoea in poultry	Prof. H. W. Hill and Prof. E. A. Lloyd	Dept. of Bacteriology, University of British Columbia, Vancouver, B.C.
The inheritance of sugar and starch in Indian corn	Prof. H. F. Roberts	Dept. of Botany, University of Manitoba, Winnipeg, Man.
Generation of electricity using a windmill as the prime mover	Prof. A. R. Greig	Dept. of Mechanical Engineering, University of Saskatchewan, Saskatoon, Sask.
Rotary derivatives of a boat type seaplane	Prof. J. H. Parkin	Aerodynamic Laboratory, University of Toronto, Toronto, Ont.
Fog alarm research	Dr. L. V. King	Dominion Lighthouse, Prescott, Ont.
The exploitation of high speed cathode rays for chemical processes	Prof. J. C. McLennan	Dept. of Physics, University of Toronto, Toronto, Ont.
Glucosides of plants indigenous to western Canada	Prof. A. T. Cameron	Dept. of Biochemistry, University of Manitoba, Winnipeg, Man.
Emission and absorption spectra in the infra-red and extreme ultra-violet regions	Prof. J. C. McLennan	Dept. of Physics, University of Toronto, Toronto, Ont.
Effect of radiant energy on protoplasm	Prof. A. H. Hutchinson	Dept. of Botany, University of British Columbia, Vancouver, B.C.
Continuity of welded steel beams	Prof. C. R. Young	Mechanics of Materials Laboratory, University of Toronto, Toronto, Ont.
Surface energy of solids	Prof. F. M. G. Johnson and Dr. O. Maass	Dept. of Chemistry, McGill University, Montreal, Que.
Plant resources of eastern Canada	Fr. Marie-Victorin	Dept. of Botany, University of Montreal, Montreal, Que.

Subject of Research	Grantee	Where Carried On
The habit and life history of the smaller mammals of the prairies	Mr. F. Neave	Dept. of Zoology, University of Manitoba, Winnipeg, Man.
Studies on humidity ----------	Prof. A. N. Shaw	Dept. of Physics, McGill University, Montreal, Que.
Chlorination of methane gas ---	Prof. M. C. Boswell	Dept. of Organic Chemistry, University of Toronto, Toronto, Ont.
The effect of light on life processes	Prof. A. B. Klugh	Dept. of Biology, Queen's University, Kingston, Ont.
Effects of electric and magnetic fields	Prof. J. S. Foster	Dept. of Physics, McGill University, Montreal, Que.
Investigation of gas laws ------	Dr. O. Maass	Dept. of Chemistry, McGill University, Montreal, Que.
Mistletoe, parasitic on jackpine	Miss E. S. Dowding	Dept. of Botany, University of Alberta, Edmonton, Alta.
Effects of certain reagents upon plants	Prof. R. O. Earl	Dept. of Biology, Queen's University, Kingston, Ont.
Winter hardiness in crop plants	Dr. R. Newton	Dept. of Field Husbandry, University of Alberta, Edmonton, Alta.
The chemistry of fish curing --	Dr. A. B. Macallum	Dept. of Biochemistry , McGill University, Montreal, Que.
The marine algae of the Canadian Atlantic coast	Prof. H. P. Bell	Dept. of Botany, Dalhousie University, Halifax, N.S.
Researches in the field of low temperatures	Prof. J. C. McLennan	Dept. of Physics,University of Toronto, Toronto, Ont.
Fungi ----------	Prof. A. H. R. Buller	Dept. of Botany, University of Manitoba, Winnipeg, Man.
The effect of temperature and fatigue on the strength of castings	Prof, R. W. Moffatt	Dept. of Civil Engineering, University of Manitoba, Winnipeg, Man.
Mechanical properties of metals at low temperatures	Profs. I. F. Morrison and A. E. Cameron	Dept. of Mining Engineering, University of Alberta, Edmonton, Alta.
Ultra-violet spectroscopy with vacuum grating spectrograph	Dr. R. J. Lang and Prof. S. Smith	Dept. of Physics, University of Alberta, Edmonton, Alta.
Color vision ----------	Dr. F. Allen	Dept. of Physics, University of Manitoba, Winnipeg, Man.
The spectrum of the aurora and the light from the sky and its bearing on radio transmission	Prof. J. C. McLennan	Dept. of Physics, University of Toronto, Toronto, Ont.
Power loss in dielectrics -------	Dr. H. J. MacLeod	Dept. of Physical and Electrical Engineering, University of Alberta, Edmonton, Alta.
The deterioration of rubber ---	Dr. G. S. Whitby	Dept. of Chemistry, McGill University, Montreal, Que.
Earth's nocturnal radiation in relation to weather	Dr. H. T. Barnes	Dept. of Physics, McGill University, Montreal, Que.
Processes leading to the utili--zation of natural gases	Dr. E. H. Boomer	Dept. of Chemistry, University of Alberta, Edmonton, Alta.
Cathode rays ----------	Dr. J. A. Gray	Dept. of Physics, Queen's University, Kingston, Ont.
Chemical problems of the maple sugar industry	Dr. J. F. Snell	Dept. of Physics, Macdonald College, Que.
Development of a rapid electrical method of determining moisture in grain, timber, etc.	Prof. E. F. Burton	Dept. of Physics, University of Toronto, Toronto, Ont.
Mineral deficiency of Quebec soils	Dr. R. R. McKibbin	Dept. of Chemistry, Macdonald College, Que.
Study of short radio waves ----	Prof. J. C. McLennan	Dept. of Physics, University of Toronto, Toronto, Ont.

Subject of Research	Grantee	Where Carried On
Designing and testing of a series of windmills for producing electric power on farms	Prof. J. H. Parkin	Dept. of Mechanical Engineering, University of Toronto, Toronto, Ont.
The conversion of starch to glucose	Prof. E. G. Young	Dept. of Biology, Dalhousie University, Halifax, N.S.
Unsaturated hydrocarbons as a source of chemical products	Dr. O. Maass	Dept. of Chemistry, McGill University, Montreal, Que.
Studies of life in the Pacific adjacent to the Fraser River	Prof. A. H. Hutchinson	Pacific Biological Station, Nanaimo, B.C.
Ultra-violet spectroscopy	Prof. S. Smith	Dept. of Physics, University of Alberta, Edmonton, Alta.
The active principle of yeast	Prof. W. L. Miller	Dept. of Chemistry, University of Toronto, Toronto, Ont.
The life cycle of fish tapeworm	Dr. D. Nicholson	Dept. of Pathology, University of Manitoba, Winnipeg, Man.
Investigation and preparation of yeast spores	Prof. W. L. Miller	Dept. of Chemistry, University of Toronto, Toronto, Ont.
Measurement of the Joule effect of hydrogen, carbon dioxide and other gases	Dr. A. L. Clark	Dept. of Physics, Queen's University, Kingston, Ont.
The lateral support of steel columns and struts	Prof. C. R. Young	Mechanics of Materials Laboratory, University of Toronto, Toronto, Ont.
Cause of the reversed blood pressure of fowls	Prof. O. S. Gibbs	Pharmacology Dept., Dalhousie University, Halifax, N.S.
Relation of bacteria to incidence of feed flavors and stable odors in milk	Profs. H. M. King and W. Sadler	Department of Animal Husbandry, University of British Columbia, Vancouver, B.C.
The uses of the photo-electric cell	Prof. A. Savage	Animal Pathology Laboratory, Manitoba Agricultural College, Winnipeg, Man.
Experiments on catalysis	Dr. G. S. Whitby	Department of Chemistry, McGill University, Montreal, Que.
Action of bacteria and enzymes on carbohydrates and products resulting therefrom.	Dr. H. Hibbert	Department of Chemistry, McGill University, Montreal, Que.

APPENDIX F (Part II)

74 Additional Researches Completed in Previous Years

Subject of Research	Grantee
The inheritance of earliness and lateness in wheat	Dr. W. P. Thompson.
Water requirements of crops in western soils	E. S. Hopkins.
The relation of bacteria to the quality of graded butter	Prof. W. Sadler.
Fungi	Dr. A. H. R. Buller.
Acidity and lime requirements of soils in Quebec and New Brunswick	Dr. J. F. Snell.
The influence of acid in the soil on useful (nitrogen fixing) bacteria	Dr. F. C. Harrison.
Insulin-like substances in plants	Dr. J. B. Collip.
Action of pure salts on the structure and growth of vegetable cells	Prof. G. W. Scarth.
The influence of diet on the fur and health of captive foxes	Associate Committee on Nutritional Problems of the Fox Industry.
The resistance of plants to low temperatures	Prof. J. F. Lewis.
The biological origin of false wild oats	Prof. J. R. Fryer.
Life history and habits of the Tabanidae (horsefly)	Prof. A. E. Cameron.
Study of the blood chemistry in animals with the super renal glands removed	Prof. J. B. Collip.
Investigation of the life history of the onion maggot	Prof. E. M. DuPorte.
The use of Canadian oils in ore concentration	Dr. J. B. Porter.
The extraction of benzene and toluene (valuable liquids) from coal gas	Dr. H. S. Davis.
De-tarring of gas by electrical precipitation	Dr. J. G. Davidson.
Reduction of iron ores by gases	Dr. A. Stansfield.
A method of smelting titaniferous iron ores	Dr. C. W. Drury and A. F. G. Cadenhead.
The testing of oil shales in the field	Louis Simpson.
The treatment of silver-lead-zinc ores	Horace Freeman.
The preparation (production) of metallic barium	Prof. H. E. Bigelow.
Oil from shales	Prof. A. E. Flynn.
Alberta tar sands	Dr. A. Lehmann.
Lake Agassiz clay deposits	Prof. R. C. Wallace.
The microscopic examination of cement during hardening	F. M. Dawson.
Causation of cracks in concrete protective coating on iron and steel structures	Prof. P. Gillespie.
The corrosion of iron and steel in the soil	Prof. J. W. Shipley.
Investigation on the utilization of the resources of helium in Canada	Associate Committee on Helium.
The properties and liquefaction of helium.	Prof. J. C. McLennan.
Canadian waste sulphite liquor as a source of alcohol	Dr. V. K. Krieble.
The discoloration of cured codfish	Dr. F. C. Harrison.
The discoloration of canned lobster	Dr. F. C. Harrison.
Artificial propagation of the sturgeon	Associate Biological Committee.
The food relations of certain minute organism (Entomostraca) in the cultivation of fresh water fishes	Prof. A. B. Klugh.
Bacteria found in frozen fish	Dr. F. C. Harrison.
Nicotine from tobacco waste	Arthur D. Hone.
Utilization of milkweed	Dr. A. C. Neish.
Problems of industrial fatigue	Associate Committee on Industrial Fatigue.
The utilization of peat	Department of Mines.
Channel interference in wind channel testing	Prof. J. H. Parkin.
Interference in radio broadcast reception	Prof. T. R. Roseburgh.
Fog signalling	Prof. L. V. King.
Vitamines	Food Research Committee.
Surface tension in liquids and emulsions	Prof. J. C. McLennan.
Chemical reactions at high pressures	Prof. J. C. McLennan.
Conductivity and vapor pressure of salt solutions	Dr. A. N. Shaw.
Crystalline shapes of bicarbonate of soda	Prof. Paul Riou.
Investigation on Röntgen rays	Dr. J. A. Gray.
The bridging of the gap in the ether waves between those produced by the ultra-violet light and the so-called X-rays	Prof. A. L. Hughes.
The spectrum of infra-red rays	Prof. J. C. McLennan.
The action of ultra-violet rays	Prof. L. Bourgoin.
Intensity measurements in spectra	Prof. J. K. Robertson.
The spectrum of tin	Prof. J. K. Robertson.
Constitution of rubber	Dr. G. S. Whitby.
Generation of explosive gases in electric water heaters and boilers	Dr. J. W. Shipley.
The breeding efficiency of bulls and horses	Dr. A. Savage.
Experimental study of precipitation of iron and silica	Dr. E. S. Moore.
Cultivation of medicinal plants in British Columbia	Dr. R. H. Clark and Prof. J. Davidson.
Laws governing the screening of crushed ores	Dr. J. B. Porter.
Grinding ore in ball mills and rock crushing by rolls	Prof. H. E. T. Haultain.
Determining the elimination of magneto noises from aircraft receiving sets	Prof. H. Vickers.
Storage of fruit in warehouses	Associate Committee on Fruit.
Use of ultra short waves for direction indicating apparatus	Major W. A. Steel.

Subject of Research	Grantee
Radium emanation	Dr. G. H. Henderson and Dr. D. A. McIntosh.
Dielectric losses in different classes of porcelain	Prof. A. V. Wendling.
Relation of silver ores to diabase	Dr. E. S. Moore.
Magnetic susceptibility of the alkali metals	Dr. A. S. Eve.
Chemical separation: identification and possible synthesis of antipressor substance from hepatic tissue	Dr. A. A. James.
Structure and growth of anchor ice	Dr. H. T. Barnes.
Effects of velocity on reabsorption rates	Prof. O. S. Gibbs.
Effect of ultra-violet rays on eggs, chicks and laying hens	F. C. Elford.
Adhesions of ice to various surfaces of aeroplane structure	Dr. H. T. Barnes.
Sound analysis of carillon on Peace Tower	Prof. E. F. Burton.

APPENDIX G

Publications of the National Research Council

ANNUAL REPORTS

Annual reports for fiscal years 1916-17 to 1929-30.

MONTHLY PUBLICATION

Canadian Journal of Research
Vol. I. May—December, 1929
Vol. II. January—June, 1930
Vol. III. July—December, 1930

TECHNICAL REPORTS

Report Number	Title	Author
1	The Briquetting of Lignites	R. A. Ross, E.E., D.Sc., 1918.
2	The Recovering of Vapors from Gases	Harold S. Davis, M.A., Ph.D., and Mary Davidson Davis, B.A., 1918.
3	The De-tarring of Gas by Electrical Precipitation	J. G. Davidson, Ph.D., 1918.
4	Nicotine and Tobacco Waste	A. D. Hone, M.A., 1919.
5	Canadian Waste Sulphite Liquor as a Source of Alcohol	V. K. Krieble, 1919.
6	An Investigation into the Question of Early Putrefaction of Eviscerated Fish in Which the Gills have been Left	L. Gross, M.A., 1919.
7	Survey of General Conditions of Industrial Hygiene in Toronto	The Associate Committee on Industrial Fatigue of the National Research Council, 1921.
8	A Method of Smelting Titaniferous Iron Ore	W. M. Goodwin, 1921.
9	Food Requirements of the Ranch Fox	G. E. Smith, B.A.Sc., 1921.
10	Fuel Saving Possibilities in House Heating	L. M. Arkley and James Govan, 1922.
11	The Red Discoloration of Cured Codfish	F. C. Harrison, D.Sc., F.R.S.C., and Miss Margaret E. Kennedy, B.A., M.Sc., 1922.
12	The Discoloration, Smut, or Blackening of Canned Lobster	F. C. Harrison, D.Sc., F.R.S.C., and E. G. Hood, Ph.D., 1923.
13	Cultural Criteria for the Distinction of Wood-destroying Fungi	Clara W. Fritz, B.A., M.Sc., 1924.
14	The Utilization of the Low Grade Iron Ores of Canada	Subcommittee on Iron Ores of the National Research Council, J. G. Morrow, Steel Company of Canada, Hamilton, Ontario, Chairman, 1924.
15	Marine Borers on the Atlantic Coast of Canada	R. H. M'Gonigle, B.A., 1925.
16	The Relation of Bacteria to the Quality of Graded Butter	Wilfrid Sadler, N.D.D., B.S.A., M.Sc., and R. L. Vollum, M.A., 1926.
17	The Mosquitoes of the Lower Fraser Valley, British Columbia, and their Control	Eric Hearle, M.Sc., 1926.
18	Investigations on the Treatment of Nova Scotia Oil Shales	A. E. Flynn, A.R.S.M., 1926.
19	Bacteriology of Certain Sea Fish	F. C. Harrison, D.Sc., F.R.S.C., 1926.
20	Consideration of the Relation Between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment	R. H. M'Gonigle, B.A., 1926.
21	The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer	J. H. Fox, M.A., 1927.
22	An Experimental Study of Sieving	J. B. Porter, Ph.D., D.Sc., 1928.
23	The Storage of Apples in Air-cooled Warehouses in Nova Scotia	S. G. Lipsett, Ph.D., 1928.
24	The Drying of Wheat	Associate Committee on Grain Research, 1929.

BULLETINS

Bulletin Number	Title	Author
1	The Need of Industrial Research in Canada	Frank D. Adams, Sc.D., LL.D., F.R.S., 1918.
2	Researches on Sound Measurement with Reference to the Testing of Fog Signal Machinery	L. V. King, M.A., D.Sc., F.R.S.C., 1918.
3	How to Handle Frozen Fish	E. E. Prince, D.Sc., LL.D., 1918.
4	Hints on Frozen Fish	E. E. Prince, D.Sc., LL.D., 1918.
5	Science and Industry	Prof. J. C. Fields, Ph.D., F.R.S., 1918.
6	The Heating of Houses, Coal and Electricity Compared. (Out of Print)	A. S. L. Barnes, 1918.
7	The Manufacture of Ethyl-alcohol from Wood Waste. (Out of Print)	G. H. Tomlinson, B.A., 1919.
8	Some of the Problems of the Fox Raising Industry. (Out of Print)	Andrew Hunter, M.A., M.B., Ch.B. (Edin.), 1920.
9	The Honorary Advisory Council for Scientific and Industrial Research and its Work. A Brief Résumé of the Activities of the Council up to 1921	Frank D. Adams, Sc.D., LL.D., F.R.S., 1921.
10	A Plan for the Development of Industrial Research in Canada	R. F. Ruttan, B.A., M.D., F.R.S.C., 1921.
11	Nitrogen Fixation	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1924.
12	Nitrogen in Industry	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1926.
13	Interim Report on Protein Content as a Factor in Grading Wheat	Associate Committee on Grain Research, 1929.
14	Report on Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat	R. Newton, Ph.D., F.R.S.C.
15	Review of Literature dealing with Health Hazards in Spray Painting	Prepared under the Auspices of the Associate Committee on Spray Painting.

APPENDIX H

Publications of the Canadian Engineering Standards Association

(The National Research Council's Associate Committee on Engineering Standards)

No.

A1 —1928 Standard Specification for Steel Railway Bridges. (3rd ed.) Price 50c.
A1a—1928 Material Specifications, Steel Railway Bridges. (2nd reprint) Price 15c.
C2 —1929 Standards for Single-phase Distribution Transformers. (2nd ed.)
C3 —1924 Standard Specification for Galvanized Telegraph and Telephone Wires.
B4 —1921 Standard Specification for Wire Rope for Mining, Dredging and Steam Shovel Purposes. (Under revision)
A5 —1927 Standard Specification for Portland Cement. (2nd ed.)
A6 —1929 Standard Specification for Steel Highway Bridges. (2nd ed.) Price 50c.
D7 —1922 Standard Specification for Flexible Steel Wire Rope and Strand for Aircraft Purposes.
G8 —1923 (Replaced by G26—1929 and G27—1929. See below.)
A9 —1923 (Replaced by G30—1930, G31—1930 and G32—1930. See below.)
C10—1923 Standard Specification for Tungsten Incandescent Lamps.
D11—1924 Interim Report on the Manufacture, Testing and Use of Gasoline.
B12—1924 Standard General Specification for Galvanized Steel Wire Strand.
E13—1924 Standard Specification for Railway Wire-fencing and Gates.
C14—1924 Standard Specification for Reinforced Concrete Poles.
C15—1924 Standard Specification for Eastern Cedar Poles.
A16—1930 Standard Specification for Steel Structures for Buildings. (2nd ed.)
C17—1925 Standard Requirements for A.C.Watthour Meters.
B18—1925 Standard Specification for Stove Bolts.
A19—1926 Standard Classification for Items of Highway Expenditure.
A20—1927 Standard Specification for Movable Bridges.
C21—1927 Standard Specification for Control Cable for Electrical Power Plant Equipment.
C22—1930 Canadian Electrical Code, Part I. (2nd ed.)
A23—1929 Standard Specification for Concrete and Reinforced Concrete. Price $1.00.
G24—1929 Standard Specification for Sampling for Check Analysis of Steel Billets, Bars and Shapes.
G25—1929 Standard Specification for Carbon Steel Billets and Bars of Forging Quality.
G27—1929 Standard Specification for Commercial Cold-finished Bar Steels and Cold-finished Shafting.
G26—1929 Standard Specification for Commercial-quality Hot-rolled Bar Steels.
G28—1929 Standard Specification for Carbon Steel Castings.
B29—1929 Established List of Machine Screws.

Note: G26—1929 and G27—1929 are published in one volume.

The above are on sale at 25 cents per copy, except as noted, and may be obtained from—The Secretary, Canadian Engineering Standards Association, Central Chambers, Ottawa, Ontario, Canada.

APPENDIX I

List of Papers Covering Researches Carried out With Assistance from the National Research Council.

Title of Paper	Author	Where Published	Date Published
ANATOMY			
The Rate of Growth of the Sea Mussel (*Mytilus edulis L.*) at St. Andrews, N.B., Digby, N.S., and in Hudson Bay.	Mossop, Miss B. K. E.	Trans. Roy. Can. Inst.	1922
A Study of the Sea Mussel (*Mytilus edulis L.*)	Mossop, Miss B. K. E.	Cont. to Can. Biol.	1921
ANIMAL HUSBANDRY			
A Statistical Study of the Head Length Variability of Bovine Spermatozoa and its Application to the Determination of Fertility.	Savage, A., Williams, W. W., and Fowler, N. M.	Trans. Roy. Soc. Can. Sec. V.	1927
Methods of Determining the Reproductive Health and Fertility of Bulls; a Review with Additional Notes.	Williams, W. W. and Savage, A.	Ithaca N.Y., Cornell Veterinarian.	Oct. 1927
BACTERIOLOGY			
Effect of Bacillary White Diarrhoea Infection on Egg Production.	Asmundson, V.S. and Biely, Jacob.	Poultry Sci. Vol. VII, No. 6.	Sept. 1928
Control of Bacillary White Diarrhoea Infection of Poultry in British Columbia.	Biely, Jacob ----------	Sci. Agr. Vol. IX, No. 7.	Mar. 1929
Hemophilus Sp. and Neisseria Sp. in Skin Abscesses in Rabbits and Guinea Pigs.	Gibbons, N. E. -------	J. Infectious Diseases, Vol. 45, No. 4.	Oct. 1929
The Effect of Autolysis in Sterile Tissues on Subsequent Bacterial Decomposition.	Gibbons, N. E. and Reed, G. B.	J. Bact. Vol. XIX, No. 2.	Feb. 1930
Red Discoloration of Cured Codfish.--	Harrison, F. C. and Kennedy, Miss M.	National Research Council, Report No. 11.	1922
Red Discoloration of Cured Codfish (Scientific Data).	Harrison, F. C. and Kennedy, Miss M.	Roy. Soc. Can. Sec. V.	
Discoloration, Smut or Blackening of Canned Lobster.	Harrison, F. C. and Hood, E. G.	National Research Council, Report No. 12.	1923
Discoloration, Smut or Blackening of Canned Lobster (Scientific Data).	Harrison, F. C. and Hood, E. G.	Roy. Soc. Can. Sec. V.	
Bacteriology of Certain Sea Fish.----	Harrison, F. C. and Perry, Miss H. M. and Smith, P. W. P.	National Research Council, Report No. 19.	1926
Motility of Bacteria as Effected by Hydrogen Ion Concentration.	Reed, G. B. and MacLeod, D. J.	J. Bact.	Mar. 1924
Pigments of Pseudomonas Pyocyaneus	MacLeod, D. J. ------	Thesis for M.A. degree, Queen's University, Toronto, Ont.	Apr. 1923
Effects of Hydrogen Ion and Salt Concentration upon the Morphological Structure and upon Formation of Certain Bacteria.	MacLeod, D. J. ------	Thesis for M.A. degree, Queen's University, Kingston, Ont.	Apr. 1923
Discoloration in Canned Lobsters.----	Reed, G. B. and MacLeod, D. J.	Report of Biological Board of Canada.	1924
The Bacterial Content of Graded Butter.	Sadler, W. and Vollum, R. L.	Trans. Roy. Soc. Can. Sec. V.	1923
An Attenuated Streptococcus Lacticus Strain (Kruse).	Sadler, W. and Vollum, R. L.	Trans. Roy. Soc. Can. Sec. V.	1923
The Relation of Bacteria to the Quality of Graded Butter.	Sadler, W. and Vollum, R. L.	National Research Council, Report No. 16.	1926
The Duration of B. Welchii Antitoxin Immunity in Rabbits.	Reed, G. B. and Spence, Miss C. M.	J. Infectious Diseases.	1927
The in vivo Action of B. Welchii Toxin in Erythrocytes in Comparison with other Haemotoxins.	Reed, G. B., Orr, J. H. and Spence, Miss C. M.	J. Infectious Diseases.	1927
BIOCHEMISTRY			
The Parathyroid Gland----------	Collip, J. B. ----------	Harvey Lectures for 1925-26.	1927
The Purification of Pepsin, its Properties and Physical Characters.	Forbes, J. C. --------	J. Biol. Chem.	Feb. 1927
Some Problems of the Fox-raising Industry.	Hunter, Andrew -----	National Research Council, Bulletin No. 8.	1920
The Antipressor Fraction from Liver Tissue and its Physiologic Action.	James, A. A., Laughton, N. B. and Macallum, A. Bruce	J. Am. Med. Ass'n. Vol. 87.	July 31, 1926
Preliminary Note on the Distribution of Glucosides in Western Canadian Plants.	McCullagh, R. Roy ---	Trans. Roy. Soc. Can. 1926, XX, Sec. V.	1926

Title of Paper	Author	Where Published	Date Published
BIOCHEMISTRY—*Con.*			
The Effect of Pituitary on the Bird.	Morash, R. and Gibbs, O. S.	J. Pharmacol. Vol. XXX-VII, No. 4.	Dec. 1929
Food Requirements of the Ranch Fox.	Smith, G. Ennis	National Research Council, Bulletin No. 9.	1921
The Enzymes of B. Coli Communis.	Young, E. G. and Gray, E. C.	Proc. Roy. Soc. London, Vol. 92.	1921
On the Optical Rotatory Power of Crystalline Ovalbumin and Serum Albumin.	Young, E. G.	Proc. Roy. Soc. London, Vol. 93.	1922
The Coagulation of Protein by Sunlight.	Young, E. G.	Proc. Roy. Soc. London, Vol. 93.	1922
BIOLOGY			
The Distribution and Economic Importance of Mollusca in Lake Nipigon.	Adamstone, F. B.	Univ. of Toronto Studies Biol. Series No. 22.	1923
The Bottom Fauna of Lake Nipigon.	Adamstone, F. B.	Univ. of Toronto Studies Biol. Series No. 22.	1924
The Bottom Organisms of Lake Nipigon.	Adamstone, F. B. and Harkness, W. J. K.	Univ. of Toronto Studies Biol. Series No. 24.	1923
The Distribution and Economic Importance of the Bottom Fauna of Lake Nipigon with the Appendix on the Bottom Fauna of Lake Ontario.	Adamstone, F. B.	Univ. of Toronto Studies Biol. Series No. 25.	1924
Sex Reversal in *Pandalus danae*	Berkeley, A. A.	Am. Naturalist, Vol. LXIII.	Nov.-Dec. 1929
The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer, Pyrausta Nubilalis Hubn.	Fox, J. H.	National Research Council, Report No. 21.	1927
A Cytological Study of Puccinia Coronata Cda. on Banner and Cowra 35 Oats.	Fraser, W. P. and Ruttle, Miss M.	Univ. of California, Pub. in Bot. Vol. 14, No. 2.	1927
The Origin of False Wild Oats.	Huskins, C. L. and Fryer, J. R.	Sci. Agr.	Sept. 1925
Genetical and Cytological Studies of the Origin of False Wild Oats.	Huskins, C. L.	Sci. Agr.	May 1926
An Investigation into the Question of the Early Putrefaction of Eviscerated Fish in which the Gills have been left.	Gross, L.	National Research Council, Report No. 6.	1919
Chromosome Homologies in Wheat and Aegilops.	Jenkins, J. A.	Am. J. Botany, XVI.	Apr. 1929
The Effect of Light at Different Wavelengths on the Rate of Reproduction of Volpox Fureus and Colosterium Acerosum.	Klugh, A. Brooker	New Phytologist, 24.	1925
Ecological Photometry and New Instrument for Measuring Light.	Klugh, A. Brooker	Ecology, 6.	1925
A New Cyclosypris from Eastern Canada.	Klugh, A. Brooker	Trans. Roy. Can. Inst. XIV.	1925
Light Penetration into the Bay of Fundy and into Chamcook Lake, N.B.	Klugh, A. Brooker	Ecology, 8.	1927
The Ecology, Food Relations and Culture of Freshwater Entomostraca.	Klugh, A. Brooker	Trans. Roy. Can. Inst. XVI.	1927
A Land Model of the Ecological Photometer.	Klugh, A. Brooker	Ecology, 8.	1927
The Growth-rate of Certain Marine Algae in Relation to Depth of Submergence.	Klugh, A. Brooker and Marten, J. R.	Ecology, 8.	1927
The Life History of the Shad (Alosa Sapidissima) (Wilson) with Special Reference to the Factors Limiting its Abundance.	Leim, A. H.	Cont. to Can. Biology, N.S., Vol. ii.	1924
Marine Borers on the Atlantic Coast of Canada.	M'Gonigle, R. H.	National Research Council, Report No. 15.	1925
Consideration of the Relation Between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment.	M'Gonigle, R. H.	National Research Council, Report No. 20.	1926
Inheritance of the Length of the Flowering and Ripening Periods in Wheat.	Thompson, W. P.	Trans. Roy. Soc. Can. 12.	1918
Inheritance of Earliness and Lateness in Wheat.	Thompson, W. P.	Trans. Roy. Soc. Can. 13.	1919
Earliness in Wheat and its Inheritance	Thompson, W. P.	Sci. Agr.	1921
Correlation of Characters in Hybrids of Triticum Durum and T. Vulgare.	Thompson, W. P.	Genetics, 10.	1925
Cytological Conditions in Wheat in Relation to Rust Problem.	Thompson, W. P.	Sci. Agr. 5.	1925
Chromosome Behavior in Triploid Wheat Hybrids.	Thompson, W. P.	J. Genetics, 17.	1926

Title of Paper	Author	Where Published	Date Published
BIOLOGY—*Con.*			
Chromosome Behavior in a Cross Between Wheat and Rye.	Thompson, W. P. ----	Genetics, 11.	1926
Preponderance of Dicoccum-like Characters and Chromosome Numbers in Hybrids Between Triticum Dicoccum and T. Vulgare.	Thompson, W. P. and Hollingshead, Miss L.	J. Genetics, 17.	1927
The Cytology of a Tetraploid Wheat Hybrid (Triticum spelta x T. monococcum).	Thompson, W. P. and Melburn, Miss M.	Am. J. Botany, 14.	
The Cytology Species Hybrids in Wheat.	Thompson, W. P. ----	Sci. Agr.	Sept. 1927
Characters of Common Wheat in Plants with Fourteen Chromosomes.	Thompson, W. P. ----	Trans. Roy. Soc. Can.	1927
Chromosome Numbers in Functioning Germ Cells of Species-hybrids in Wheat.	Thompson, W. P. ----	Genetics, 13.	1928
BIOLOGY, ECONOMIC			
The Commercial Shrimps of British Columbia.	Berkeley, A. A. ------	Museum and Art Notes, Vol. IV, No. 3.	Sept. 1929
Interim Report on Protein Content as a Factor in Grading Wheat.	Assoc. Committee on Grain Research.	National Research Council, Bull. No. 13.	1929
The Drying of Wheat.----------	Assoc. Committee on Grain Research.	National Research Council, Report No. 24.	1929
A Statistical Study of the Reliability of the Experimental Milling Test.	Geddes, W. F. and West, H. E.	Sci. Agr. Vol. X, No. 5.	Jan. 1930
The Storage of Apples in Air-cooled Warehouses in Nova Scotia.	Lipsett, S. G., under direction of Assoc. Comm. on Fruit Storage.	National Research Council, Report No. 23.	1928
Time of Plowing Brome Grass Sod in Relation to the Yield and Quality of the Succeeding Wheat Crop.	Newton, R. and Malloch, J. G.	Sci. Agr.	
BOTANY			
Fern Rusts of Abies.----------	Bell, H. P. ----------	Botan. Gaz.	Mar. 1927
Seasonal Disappearance of Certain Algae.	Bell, H. P. ----------	Trans. Nova Scotian Inst. Sci.	Mar. 1927
Researches on Fungi, Vol. II.-------	Buller, A. H. R. -----	Longmans, Green & Co., London, Eng.	1922
Researches on Fungi, Vol. III.-------	Buller, A. H. R. -----	Longmans, Green & Co., London, Eng.	1924
Commercial Drug Plant Cultivation in British Columbia.	Davidson, Jno. -------	Sci. Agr.	Apr. 1923
The Vegetation of Alberta, III. The Sandhill Areas of Central Alberta with Particular Reference to the Ecology of Arceuthobium Americanum Nutt.	Dowding, Miss E. S. -	J. Ecology, Vol. XVII, No. 1.	Feb. 1929
Cultural Criteria for the Distinction of Wood-destroying Fungi.	Fritz, Miss C. W. ----	Trans. Roy. Soc. Can. & National Research Council, Report No. 13.	1923
The Problem of Sex in Coprinus Lagopus.	Hanna, W. F. --------	Ann. Botany, Vol. XXXIX.	1925
The Inheritance of Spore Size in Coprinus Sterquilinus.	Hanna, W. F. --------	Trans. Br. Mycological Soc. Vol. XI.	1926
The Fusarium Wilt of China Asters.--	Jackson, A. B. -------	Sci. Agr.	Mar. 1927
Les Equisétinées du Québec, XIV.----	Fr. Marie-Victorin ---	Cont. Lab. Bot. University of Montreal.	1927
Les Gymnospermes du Québec, XIV.	Fr. Marie-Victorin ---	Cont. Lab. Bot. University of Montreal.	1927
Sur un Botrychium nouveau de la flore américaine et ses rapports avec le B. lunaria et le B. simplex.	Fr. Marie-Victorin ---	Trans. Roy. Soc. Can. Sec. V.	1927
Additions aux Cyperacées de l'Amérique du Nord.	Fr. Marie-Victorin ---	Cont. Lab. Bot. University of Montreal.	1929
Homothallism and the Production of Fruit-bodies by Monosporous Mycelia in the Genus Coprinus.	Mounce, Miss I. ------	Trans. of Br. Mycological Soc. Vol. VII.	1921
Marine Spore Forming Bacteria.------	Newton, Miss D. E. --	Cont. to Can. Biology, N.S. Vol. 1, part 3.	1923
The Bisexuality of Individual Strains of Coprinus Rostrupianus.	Newton, Miss D. E. --	Ann. Botany, Vol. XL.	1926
The Distribution of Spores of Diverse Sex on the Hymenium of Coprinus Lagopus.	Newton, Miss D. E. --	Ann. Botany, Vol. XL.	1926
Biologic Forms of Wheat Stem Rust In Western Canada.	Newton, Miss M. ----	Proc. West Canada Soc. Agron. 1.	1920
The Occurrence of Biologic Forms of Wheat Stem Rust in Western Canada.	Newton, Miss M. ----	Sci. Agr. 1.	1921
A Preliminary Note on the Occurrence of Biologic Forms of Wheat Stem Rust in Western Canada.	Newton, Miss M. ----	Phytopathology, 11.	1921

Title of Paper	Author	Where Published	Date Published
BOTANY—*Con.*			
Studies in Wheat Stem Rust (Puccinia graminis tritici).	Newton, Miss M.	Trans. Roy. Soc. Can. 3rd, Series 16.	1922
Colloidal Changes Associated with Protoplasmic Contradiction.	Scarth, G. W.	Quart. J. Exptl. Physiol., Vol. 14, 1 & 2.	Apr. 1924
The Action of Cations on the Contradiction and Viscosity of Protoplasm in Spirogyra.	Scarth, G. W.	Quart. J. Exptl. Physiol., Vol. 14, 1 & 2.	Apr. 1924
The Toxic Action of Distilled Water and its Antagonism by Cations.	Scarth, G. W.	Trans. Roy. Soc. Can. Vol. 18.	1924
The Penetration of Cations into Living Protoplasm.	Scarth, G. W.	Am. J. Botany, Vol. 12, No. 3.	Mar. 1925
The Elasticity of Gelatin in Relation to pH and Swelling.	Scarth, G. W.	J. Phys. Chem. 29.	Aug. 1925.
CHEMISTRY, GENERAL			
Precipitation of Some of the Rare Earths by Creams of Insoluble Oxides and Carbonates based on the Principle of Hydrolysis.	Neish, A. C. and Burns, J. W.	Can. Chem. J.	1921
Milkweed, its Characteristics and Uses	Neish, A. C. and Burns, J. W.	Can. Chem. J.	1921
The Acidity of the Soil from the Viewpoint of its Concentration of Hydrogen Ion.	Carleton, E. A.	Sci. Agr. 3.	1923
A Comparison of the Jones Calcium Acetate Method for Lime Requirement with the Hydrogen Ion Concentration of Some Quebec Soils.	Carleton, E. A.	Soil Science, 16.	1923
The Litmus Method of Detecting the Soil Reaction.	Carleton, E. A.	Soil Science, 16.	1923
Sur l'influence de quelques corps organiques sur la vitesse d'absorption du gaz carbonique par les solutions de carbonate neutre de sodium.	Riou, Paul and Cartier, Paul.	Compt. rend. 7.	Feb. 1927
Oxygen-compound Formation with Acetaldehyde at Low Temperature.	Cooper, D. L.	Trans. Nova Scotian Inst. Sci.	1928
The Application of the Differential Pressure Method to the Estimation of the Benzene and the Total Light Oil Content of Gases.	Davis, H. S., Davis, Mary D. and MacGregor, D. G.	J. Ind. Eng. Chem. 10.	1918
Studies in the Absorption of Light Oils from Gases.	Davis, H. S. and Davis, Mary D.	J. Ind. Eng. Chem. 10.	1918
The Recovery of Vapors from Gases.--	Davis, H. S. and Davis, Mary D.	National Research Council, Report No. 2.	1918
The System Magnesium Sulphate-sodium Sulphate-water and a Method for the Separation of Salts.	Archibald, E. H. and Gale, W. A.	J. Am. Chem. Soc. Vol. XLVI, No. 8.	Aug. 1924
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution, VIII.	Hatcher, W. H. and Holden, G. W.	Trans. Roy. Soc. Can., 3rd Series, Vol. 21, Sec. 3.	1927
Nicotine and Tobacco Waste.	Hone, A. D.	National Research Council, Report No. 4.	1919
The Properties of Pure Hydrogen Peroxide I.	Maass, O. and Hatcher, W. H.	J. Am. Chem. Soc. Vol. XLII, No. 12.	Dec. 1920
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution IV—Formaldehyde.	Holden, G. W. and Hatcher, W. H.	Trans. Roy. Soc. Can.	1926
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution V—Glyoxal.	Holden, G. W. and Hatcher, W. H.	Trans. Roy. Soc. Can.	1926
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution VI—Glycolic and Acetic Acids.	Holden, G. W. and Hatcher, W. H.	Trans. Roy. Soc. Can.	1927
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution VII—The Formation of Organic Peracids.	Holden, G. W. and Hatcher, W. H.	Trans. Roy. Soc. Can.	1928
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution IX.	Hatcher, W. H. and Hill, A. C.	Trans. Roy. Soc. Can. Vol. XXII, Sec. III.	1929
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution X.	Hatcher, W. H. and Hill, A. C.	Trans. Roy. Soc. Can. 3rd Series, Vol. XXIII, Sec. III.	
The Electro-viscous Effect in Rubber Sols.	Whitby, G. S. and Jane, R. S.	2nd Colloid Symposium & Monograph, N.Y.	1924
Die Viskosität von Ammoniumleatlösungen.	Hatschek, Emil and Jane, R. S.	Kolloid-Z., Vol. 38.	Jan. 1926
Untersuchungen über den Schermodul und die Relaxation einiger Sol.	Hatschek, Emil and Jane, R. S.	Kolloid-Z., Vol. 39.	1926
Die Viskosität von Suspensionen Starrer Teilchen and ihre Abhängigkeit vom Schergefalle.	Hatschek, Emil and Jane, R. S.	Kolloid-Z., Vol. 40.	1926
The Observation of Cataphoresis in Colorless Sols. 1b. The Charge on Rubber in Benzene.	Humphrey, R. H. and Jane, R. S.	Trans. Faraday Soc. of London, Vol. 22.	1926
Die Beobachtung der Kataphorese in Farblosen Solen.	Humphrey, R. H. and Jane, R. S.	Kolloid-Z., Vol. 41.	1927
Alcohol from Waste Sulphite Liquor.-	Krieble, V. K.	National Research Council, Report No. 5.	1919

Title of Paper	Author	Where Published	Date Published
CHEMISTRY, GENERAL—*Con.*			
Canadian Waste Sulphite Liquor as a Source of Alcohol.	Krieble, V. K. -------		1919
A Chemical Investigation of the Asphalt in the Tar Sands of Northern Alberta.	Krieble, V. K. and Seyer, W. F.	J. Am. Chem. Soc.	June, 1921
The Surface Energy and the Heat of Solution of Solid Sodium Chloride I.	Lipsett, S. G., Johnson, F. M. G. and Maass, O.	J. Am. Chem. Soc.	Apr. 1927
A New Type of Rotating Adiabatic Calorimeter. The Surface Energy and Heat of Solution of Sodium Chloride II.	Lipsett, S. G., Johnson, F. M. G. and Maass, O.	J. Am. Chem. Soc.	Aug. 1927
A Micro-calorimeter. ----------	Lipsett, S. G., Johnson, F. M. G. and Maass, O.	J. Am. Chem. Soc.	Apr. 1928
The Surface Energy of Solid Sodium Chloride III. The Heat Solution of Finely Ground Sodium Chloride.	Lipsett, S. G., Johnson, F. M. G. and Maass, O.	J. Am. Chem. Soc.	Oct. 1928
The Application of the Differential Pressure Method to the Estimation of the Benzene and the Total Light Oil Content of Gases.	Davis, H. S., Davis, Mary D. and MacGregor, D. G.	J. Ind. Eng. Chem.	Sept. 1918
The Constitution of Kerogen.----------	McKinney, J. W. -----	J. Am. Chem. Soc.	Apr. 1924
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APPENDIX J

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