

NATIONAL RESEARCH COUNCIL ANNUAL REPORT 1930-31

National Research Council

OTTAWA

CANADA

CHEMISTRY DIVISION.

DOMINION OF CANADA

FOURTEENTH ANNUAL REPORT
OF THE
NATIONAL RESEARCH COUNCIL
CONTAINING THE
REPORT OF THE PRESIDENT
AND
FINANCIAL STATEMENT



1930 - 1931

OTTAWA, CANADA

The HON. H. H. STEVENS,

*Chairman, Committee of the Privy Council on
Scientific and Industrial Research,*

Ottawa, Ontario.

Sir:

I have the honor of presenting to you herewith the Fourteenth Annual Report of the National Research Council, for the fiscal year 1930-1931.

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 COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

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

NATIONAL RESEARCH COUNCIL 1930-1931

President:

H. M. TORY, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Ottawa, Ont.

Secretary-Treasurer:

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

Members:

- CHARLES L. BURTON, Esq., President, Robert Simpson Company, Limited, Toronto, Ont.
- CHARLES CAMSELL, B.Sc., LL.D., F.R.S.C., Deputy Minister, Department of Mines, Ottawa, Ont.
- A. L. CLARK, B.Sc., Ph.D., F.R.S.C., Hon. M.E.I.C., Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
- HUME CRONYN, B.A., LL.D., General Manager, Huron and Erie Mortgage Corp., London, Ont.
- J. T. FOSTER, Esq., Vice-president, Trades and Labor Congress of Canada and President of the Montreal Trades and Labor Council, 747 Stuart Ave., Outremont, Ont.
- A. FRIGON, B.Sc., D.Sc., A.M.A.I.E.E., A.M.E.I.C., Dean, Ecole Polytechnique and General Director for Technical Education in the Province of Quebec, 1430 St. Denis Street, Montreal, Que.
- SIR GEORGE GARNEAU, B.A.Sc., LL.D., 71 St. Peter Street, Quebec, Que.
- J. H. GRISDALE, B.Agr., D.Sc.Agr., Deputy Minister, Department of Agriculture, Ottawa, Ont.
- *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.

* Died—October 25, 1930.

TABLE OF CONTENTS

OF THE

FOURTEENTH ANNUAL REPORT

	PAGE
Review of Activities of the National Research Council.....	7
Introduction.....	7
The Council.....	11
Appointments to the Staff.....	11
Division of Chemistry.....	12
Division of Biology and Agriculture.....	13
Division of Research Information.....	13
Buildings and Equipment.....	14
Summary of Financial Statement for 1930-31.....	15
Financial Statement for the Fiscal Year Ending March 31, 1931	17
Associate Committees.....	17
Assisted Researches.....	18
Postgraduate Research Scholarships.....	19
International Activities.....	21
Reports of Laboratory Divisions.....	22
Division of Biology and Agriculture.....	22
Division of Chemistry.....	25
Division of Physics.....	35
Division of Research Information.....	47
Summary of Activities of Associate Committees.....	50
Associate Committee on Aeronautical Research.....	50
Associate Committee on Animal Diseases.....	51
Associate Committee on Asbestos.....	54
Associate Committee on Biophysics.....	56
Associate Committee of Chemists.....	56
Associate Committee on Coal Classification and Analysis.....	58
Associate Committee on Electrical Measuring Instruments.....	59
Associate Committee on Engineering Standards.....	60
Associate Committee on Field Crop Diseases.....	62
Associate Committee on Gas Research.....	69
Associate Committee on Grain Research.....	70
Associate Committee on Heating and Insulation.....	76
Associate Committee on Honey.....	77
Associate Committee on Laundry Research.....	79
Associate Committee on Leather.....	80
Associate Committee on Magnesite.....	81
Associate Committee on Mining and Metallurgy.....	82
Associate Committee on Nitrogen Fixation.....	84
Associate Committee on Oceanography.....	86
Associate Committee on Physics and Engineering Physics.....	87
Associate Committee on Radio Research.....	89
Associate Committee on Trail Smelter Smoke.....	90
Associate Committee on Tuberculosis.....	92
Associate Committee on Weed Control.....	100
Associate Committee on Wool.....	104
Special Committees and Conferences.....	106
Executive Committee on the Fifth Pacific Science Congress.....	106
Special Committee on Electrical Units and Regulations.....	108
Conference on Iodized Salt.....	110
Summary of Reports on Assisted Researches.....	112
Lateral Support of Steel Columns and Struts.....	112
Continuity of Welded Steel Beams.....	112
The Generation of Electricity by Windmills.....	113
Piezo-electric Pressure Gauge.....	113
High Frequency Research.....	114
Effect of Low Temperature on Steel Castings and Forgings.....	115
Effect of Combined Electric and Magnetic Fields on Spectral Lines.....	115
Spectroscopy of the Light from the Night Sky and Height of the Aurora.....	116
Spectroscopy and Atomic Structure.....	117
Emission and Absorption Spectra.....	118
Scattering of Electrons of High Energy.....	118
Spectroscopy in the Ultra-violet.....	119

TABLE OF CONTENTS—*Concluded*

	PAGE
Power Losses in Dielectrics.....	119
The Determination of Air Humidity.....	120
Joule Effect.....	121
Gas and Water Content of Trees and the Sinkage Problem.....	122
Effect of Light on Life Processes.....	123
The Life Cycle of the Fish Tapeworm.....	123
Slough Itch.....	124
The Inheritance of Sugar and Starch in Corn.....	125
Use of the Photo-electric Cell in Biology.....	126
The Flora of Eastern Canada.....	126
Wireworms of the Canadian Prairie.....	128
Microbiology of Farm Soils of Quebec.....	129
Bark Disease of the Beech.....	130
Feed Flavor or Stable Odor in Milk.....	131
Marine Algae of the Maritime Provinces.....	132
The Effect of Radiant Energy on Growth.....	132
The Action of Alkali on Cement and Concrete.....	133
An Oceanographic Survey of the Strait of Georgia.....	134
The Production of Polysaccharides by Bacteria.....	134
Ultrafiltration of the Dextrins.....	136
Properties of Quebec Farm Soils.....	137
Mineral Constituents of the Floral Parts and Young Fruits of the Apple.....	138
Maple Sugar Research.....	139
Appendices.....	141
Appendix A—The Research Council Act.....	141
Appendix B—Regulations Governing Bursaries, Studentships and Fellowships.....	144
Regulations Governing Foreign Travelling Fellowships.....	147
Appendix C—Scholarships Held During the Year 1930-1931.....	149
Appendix D—Scholarship Graduates 1917-1931.....	153
Appendix E—Regulations Governing the Award of Grants for Research.....	159
Appendix F—Researches in Progress During 1930-1931.....	161
Additional Researches Completed in Previous Years.....	164
Appendix G—Publications of the National Research Council.....	166
Appendix H—Publications of the Canadian Engineering Standards Association.....	168
Appendix I—List of Papers Covering Researches Carried out with Assistance from the National Research Council.....	169
Appendix J—List of Members of Associate Committees.....	186
Associate Committee on Aeronautical Research.....	186
Associate Committee on Animal Diseases.....	186
Associate Committee on Apple Slacks.....	187
Associate Committee on Asbestos Research.....	187
Associate Committee on Biophysics.....	188
Associate Committee on Botanical Survey.....	188
Associate Committee of Chemists.....	189
Associate Committee on Coal Classification and Analysis.....	189
Associate Committee on Electrical Measuring Instruments.....	190
Associate Committee on Engineering Standards.....	191
Associate Committee on Field Crop Diseases.....	193
Associate Committee on Gas Research.....	194
Associate Committee on Grain Research.....	194
Associate Committee on Heating and Insulation.....	195
Associate Committee on Honey.....	195
Associate Committee on Laundry Research.....	195
Associate Committee on Leather.....	196
Associate Committee on Magnesite.....	196
Associate Committee on Mining and Metallurgy.....	196
Associate Committee on New Brunswick Forest Investigations.....	197
Associate Committee on Nitrogen Fixation.....	198
Associate Committee on Oceanography.....	198
Associate Committee on Patents and Awards.....	198
Associate Committee on Physics and Engineering Physics.....	199
Associate Committee on Radio.....	200
Associate Committee on Trail Smelter Smoke.....	200
Associate Committee on Tuberculosis.....	200
Associate Committee on Weed Control.....	202
Associate Committee on Wool.....	202
Executive Committee on the Fifth Pacific Science Congress.....	203
Special Committee on Electrical Units and Regulations.....	203

FOURTEENTH ANNUAL REPORT

of the

NATIONAL RESEARCH COUNCIL



REVIEW OF ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL



Introduction

The National Research Council of Canada has now completed the fourteenth year of its existence. During the year the great economic depression which began in 1929 continued to spread and intensify until it embraced the whole civilized world, with a consequent strain of unparalleled dimensions upon public institutions and industrial organizations.

Many of the great industries which had been developed into profit-making institutions as a result of extensive research programs found themselves for the first time with the balance resulting from operations greatly reduced or on the wrong side of the ledger. Executives were compelled to face the question whether under these conditions research programs should be cut along with other items of expenditure. The fact that in many of the larger industries, especially those based on chemistry and physics, scientific investigations were not only not reduced, but as in the case of the International Nickel Company, greatly intensified, is an indication of the place which research occupies in the minds of industrial leaders.

A further indication of the value of research is seen in the fact that government research agencies everywhere report appeals for assistance and guidance in excess of those previously received. The consequence has been that many new agencies, both public and private, have been created.

Two significant developments have taken place in the United States—first, the erection of the new hydraulic laboratory at the Bureau of Standards, for which Congress had appropriated the money at the preceding session, was begun and will be completed during the present year; second, the erection of the new laboratories of the Mellon Institute was also started. The new Institute will have approximately eight times the laboratory space previously available.

In Great Britain the work of extending and consolidating national research activities has gone steadily forward. Two extremely important extensions have been made to the National Physical Laboratories, one the new water channel for studying models of seacraft of all kinds, including seaplanes and flying boats, the other a high-pressure wind tunnel for studying

the behavior of aircraft under varying air pressures. The opening of the new National Chemical Laboratories at Teddington in association with the National Physical Laboratories also marked a distinctly new and promising departure.

There are now in Great Britain under the direction of the Department of Scientific and Industrial Research twenty-four research associations in which the Department and the industries co-operate, seven research institutes controlled and supported solely by the Department, which have been formed for the study of special industrial problems, and forty research stations dealing with agriculture or industry, some privately and some publicly controlled, whose function it is to promote industrial developments. Many of these stations are connected with the universities of the country and receive subventions from the Government.

The foregoing are but significant illustrations of what is going on over the whole of Europe, including Russia, where scientific research is being intensively organized, and in all progressive Asiatic countries, especially Japan.

It is also significant that in most countries research organizations are extending their activities to include questions of distribution and consumption, as well as production. It would appear that the time is not far distant when the correlation between production, distribution and consumption will be clearly understood and definite lines for co-ordinating the associated agencies clearly marked out.

During the year substantial progress has been made in extending and consolidating the work being done under the National Research Council of Canada. Many of the researches previously organized have been pushed toward completion, as can be seen from the statements made in the sections of this report dealing with assisted and co-operative researches. While, generally speaking, it takes time for the economic benefits of research to be widely felt, as new discoveries must slowly work their way into commercial use, nevertheless some of the researches now being carried on under the direction of the Council have already brought economic results of significance, not only to the industries directly concerned, but indirectly to other important branches of national activity. For example, the result of one research has been the re-establishment of an important industry which, in spite of the depression, has steadily increased its output and has established a market for its products not only in Canada, but in the United States and Great Britain as well. In addition, the annual freight receipts of the railroads have been increased by this industry to the extent of \$100,000 and the value of the coal consumed has increased by \$35,000. Further, it has led to the development of railway connections and the extension of manufacturing plants, thus giving employment to a considerable number of people.

During the year the demand for scientific assistance from industrial groups has greatly increased. A number of new research committees have been organized and set to work. The total number of such committees now

working under the Council is twenty-nine. Details of the work done under these committees will be found in the section of this report devoted to associate committees (page 50).

During the year 46 conferences have been held for the purpose of discussing the scientific and technical problems associated with the Council's activities. One cannot over-emphasize the contribution that has been made in this way to the work of the Council by disinterested scientists and industrialists drawn from every province in Canada.

During the year 80 scientific papers have been published by members of the technical staff of the Council and workers assisted by research grants. This brings the total number of publications to date, on work for the support of which the Research Council has been responsible, up to 582. For a list of these publications see page 166.

In association with the Imperial Conference of 1930 a conference on research was held for the purpose of discussing the broad principles of scientific co-operation among the various research agencies in the British Empire. On convening the conference, it immediately became apparent that the matters to be discussed were of such importance that it would be desirable to have the research conference an integral part of the Imperial Conference. Consequently at a meeting of the heads of delegations to the Imperial Conference it was agreed—

“That the Research Conference be constituted a Committee of the Imperial Conference, to report to this Conference, not only on those matters specifically referred to it by the General Economic Committee, but on other questions also, on the understanding that it would be open to the Imperial Conference, on receiving a Report from the Research Committee, to refer any item in that Report to the General Economic Committee, should they think that course desirable.”

Of the thirteen resolutions unanimously approved by the Research Committee and later by the Imperial Conference the first and second state the fundamentals upon which progress and co-operation must rest. They are as follows:

Resolution I.

FINANCIAL PROVISION FOR RESEARCH

“The Research Committee of the Imperial Conference, being convinced that progress will in the future be dependent to an increasing extent upon the growth and application of scientific knowledge, desire to direct the attention of the various Governments of the British Commonwealth of Nations to the importance of making adequate provision from State funds for the steady pursuit of scientific research into the various problems affecting the material well-being of mankind. They also desire strongly to urge their view that the severe economic depression from which the British Empire, in common with the rest of the world, is now suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utiliza-

tion of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones."

Resolution II.

VISITS OF RESEARCH WORKERS IN THE EMPIRE

"The Research Committee of the Imperial Conference are of the opinion that the existing facilities, by means of which research students throughout the British Empire are enabled to visit laboratories and research stations in other parts of the Empire, in order to receive training in research and to gain additional experience, should be extended, and that funds should be definitely provided in the annual budgets of research organizations with this object in view. The Committee regard it as even more important that financial provision should be made to enable senior workers engaged in research to visit laboratories in other parts of the Empire for the purpose of consultation and the promotion of co-operative relations."

The concluding paragraph of this report is also important as showing the point of view of the committee on co-operative effort:

"In concluding this report, the Committee would urge that, important as many of the proposals they have put forward undoubtedly are, the essential factor which will determine the success or failure of scientific co-operation is the spirit in which these proposals are approached by those mostly concerned, namely, the scientific workers themselves, and the facilities that are provided for them to become acquainted with one another and with one another's work. The advice offered by Lord Balfour in his Introduction to the Report of the Research Special Subcommittee of the Imperial Conference of 1926 has a real and lasting application:—'Let us cultivate easy intercourse and full co-operation will follow.'"

For some years confidential reports on the progress of investigations have been exchanged between the National Research Council of Great Britain and the Dominions. Arrangements have now been made for exchange of research programs in order to reduce overlapping to a minimum. It is anticipated that the principle of affiliation as exemplified in the relation of the National Research Council of Canada to the Wool Industries Research Association and the British Leather Manufacturers Research Association will be developed and extended.

The Conference on Standardization of the Imperial Conference of 1930 also made substantial plans for co-operation in developing and maintaining common fundamental standards and by exchange of information and consultation to secure, where the circumstances of the case permit, common industrial standards as well. Steps are being taken to equip the Division of Physics in the new National Research Laboratories with fundamental

standards checked against those in the National Physical Laboratories in London.

The Council

At the end of the fiscal year four members of the Council retired under the three-year rule of service prescribed in the Research Council Act. The retiring members were—

Frank Dawson Adams, LL.D., D.Sc., F.R.S.

Charles Camsell, LL.D., F.R.S.C.

Augustin Frigon, D.Sc., A.M.A.I.E.E.

Arthur Lewis Clark, Ph.D., F.R.S.C.

During the year J. M. McCarthy was removed by death.

The vacancies were filled by the reappointment of Dr. Camsell, Dr. Clark and Dr. Frigon, and the appointment for the first time of Charles L. Burton, Esq., of Toronto, President of the Robert Simpson Company, and Julian C. Smith, Esq., of Montreal, Vice-president and General Manager of the Shawinigan Power Company.

Dr. Adams, who had previously retired from the vice-principalship of McGill University and the deanship of the Faculty of Applied Science, and was not eligible for reappointment under a rule of the Committee of the Privy Council on Research requiring university representatives to be active members of the staff of a university, was one of the original members of the Council. He was for eighteen months Honorary Administrative Chairman at the time when the work of the Council was administered by a special technical officer. For twelve years he gave freely of his time and energy to the Council's work. A distinguished scientist himself, one of the foremost living geologists, with that spirit of devotion to his country which has always characterized him, he still serves on associate committees of the Council.

During the year the Council suffered a great loss in the death of Henry M. MacKay, Dean of the Faculty of Applied Science, McGill University. Dean MacKay was an engineer of great distinction, an educational leader of the highest reputation in his own field. He brought to the Council a ripe experience and a willing mind. His place will be hard to fill.

Since our last report was written Mr. J. M. McCarthy, B.Sc., who had been a member of the Council for three years, was removed by death. Mr. McCarthy was an engineer of distinction, and rendered valuable service to the Council during his term of office.

Appointments to the Staff

Under the scheme drawn up by the Research Council and approved by Order-in-Council, and later approved by the Royal Commission on Technical and Professional Services under the chairmanship of Mr. E. W. Beatty, the following grades for the professional staff, with the necessary qualifications, have been established:

TITLE	QUALIFICATIONS OR EQUIVALENT	
	<i>Degree</i>	<i>Professional Experience</i>
Director of the Division of Physics (or Chemistry or Biology, etc.)	D.Sc. or Ph.D.	10 to 15 years
Assistant Director	Ph.D.	10 years
Research Physicist (or Chemist or Biologist, etc.)	Ph.D.	8 years
Associate Research Physicist (or Chemist or Biologist, etc.)	M.Sc.	5 years
Assistant Research Physicist (or Chemist or Biologist, etc.)	M.Sc.	2 years
Junior Research Physicist (or Chemist or Biologist, etc.)	M.Sc.	

The aim of the Council has been to get the best qualified men and women for the special problems which they will be called upon to solve. It has also been recognized that variety of training is important. The forty-three university graduates on the technical staff at the end of the year under review represent in their undergraduate training eighteen different institutions of learning, eleven in Canada, four in Great Britain, one in the United States, one in Switzerland and one in Czechoslovakia. Thirty-six of the forty-three graduates received their undergraduate training in our own Canadian institutions. Although vacancies were advertised in foreign journals and many applications were received from outside Canada, only once was it found necessary to go to a foreign country to secure a person with the necessary qualifications, except in five cases in which Canadians temporarily employed in foreign countries were repatriated. Certain graduates of foreign universities living in Canada were selected because of their special qualifications in regard to foreign languages.

The appointments made were as follows:

(a) DIVISION OF CHEMISTRY

Paul Larose, B.Sc., Ph.D., McGill University; five years Professor of Physics and Physical Chemistry, Laval University, Associate Research Chemist, engaged in textile research.

William E. Graham, B.A.Sc., M.A.Sc., British Columbia; M.A., Ph.D., Toronto; two years Industrial Fellow, Mellon Institute of Industrial Research, Associate Research Chemist, engaged in leather research.

David Wolochow, B.A., M.A., University of Saskatchewan; B.Sc., California Institute of Technology; six years in research on cement at the University of Saskatchewan; Associate Research Chemist, engaged in asbestos research.

Morris Katz, B.Sc., M.Sc., Ph.D., McGill University; Assistant Research Chemist, engaged in Trail smelter smoke research.

O. Moorehouse Morgan, B.A., M.A., University of Western Ontario; Ph.D., McGill University; Assistant Research Chemist, engaged in laundry research.

Helen D. Chataway, B.A., B.Sc., M.Sc., University of Manitoba; Ph.D., McGill University; two years Research Assistant, Lehigh University, Bethlehem, Pa.; Junior Research Chemist, engaged in research on fats and oils.

Colin H. Bayley, B.A.Sc., M.A.Sc., M.A., University of Toronto; two years chemist with W. E. Phillips Co., Oshawa, Ont.; Junior Research Chemist, engaged in gas research.

(b) DIVISION OF BIOLOGY AND AGRICULTURE

W. H. Cook, B.Sc., M.Sc., University of Alberta; Ph.D., Stanford University; Junior Research Biologist, engaged in grain research.

J. A. Anderson, B.Sc., M.Sc., University of Alberta; Ph.D., Leeds University; Junior Research Biologist, engaged in grain research.

(c) DIVISION OF RESEARCH INFORMATION

Walter W. Thomson, B.Sc., M.Sc., Ph.D., McGill University; four years' experience in university teaching and industrial research; Junior Research Investigator, on editorial staff.

Richard Ruedy, D.Sc., University of Geneva; three years, Nela Research Laboratory, General Electric Co., Cleveland; two years, Instructor in Physics, University of Toronto; two years with radio manufacturers, Toronto; Junior Research Investigator, engaged in information service and translations.

Charles A. H. MacConkey, dipl. Ing.-Chem., Dr.sc.techn., Technische Hochschule, Zurich; two years of research at Cambridge University, England; two years of industrial research; Junior Research Investigator, engaged in information service and translations.

In addition the following men appointed to the professional staff in the fiscal year ending March 31, 1931, commenced work during the year under review:

Sidney J. Cook, B.A., University of Toronto; five years as Dominion Analyst, Food and Drugs Laboratories, Department of Health, Ottawa; ten years chief of the Mining, Metallurgical and Chemical Branch, Dominion Bureau of Statistics; engaged as General Secretary of the Fifth Pacific Science Congress, in the Division of Research Information.

D. F. Stedman, B.A.Sc., University of British Columbia; Ph.D., London University; four years with Consolidated Mining and Smelting Co. of Canada, Trail; two years instructor in chemistry, University of British Columbia; two years demonstrator in electrochemistry, University of Toronto; Assistant Research Chemist, engaged in research on carbon black and natural gas.

R. H. F. Manske, B.Sc., M.Sc., Queen's University; Ph.D., Manchester University; two years in chemical research in England; one year as research chemist with the General Motors Corp., Detroit; two years in research at Yale University; Associate Research Chemist, engaged in research on alkaloids and the extraction of drugs.

C. Y. Hopkins, B.A., M.A., Queen's University; Ph.D., New York University; three years in research at Northwestern and New York Universities; one year assistant in the Department of Chemical Engineering,

University of Toronto; Assistant Research Chemist, engaged in work on grain screenings, straw, furfural and apples.

Donald C. Rose, B.Sc., M.Sc., Queen's University; Ph.D., Cambridge University; two years in research at Cambridge and Bristol; one year Lecturer in Physics, Queen's University; Assistant Research Physicist, engaged in photo-electrical research.

Charles D. Niven, B.Sc., Aberdeen University; M.A., Ph.D., University of Toronto; five years of industrial development work in Great Britain; one year as research assistant at Toronto University; Assistant Research Physicist, engaged in work on heat insulation.

George C. Laurence, B.Sc., M.Sc., Dalhousie University; Ph.D., Cambridge University; three years in physical research at Cambridge; Junior Research Physicist, engaged in work on radium measurements and static electricity in aeroplane photography

George S. Field, B.Sc., M.Sc., University of Alberta; Junior Research Physicist, engaged in research in electrostatics and ultrasonics.

B. G. Ballard, B.Sc., Queen's University; five years in Engineering Department of the Westinghouse Electric and Manufacturing Co., East Pittsburgh; Assistant Research Physicist, engaged in research in electrical engineering and in the supervision of the installation of equipment in the new National Research Council building.

J. J. Green, B.Sc., A.R.C.Sc., Royal College of Science; D.I.C., Imperial College; Ph.D., London University; two years hydrodynamical research in England; Junior Research Physicist, engaged in aeronautical research.

Buildings and Equipment

During the year under review the work of fitting up the John Street Laboratories was completed and a group of important researches in physics and chemistry undertaken. These laboratories have been equipped for permanent use in so far as the fixed equipment is concerned. Much additional movable equipment has been purchased and installed, which will later be transferred to the new building when it is completed. It is intended that the John Street Laboratories should be put to permanent use in connection with special semi-commercial developments of laboratory processes.

As stated in last year's report the Council, with the approval of the government, began the establishment of aeronautical research laboratories in certain of the old buildings on the John Street property. With slight changes these buildings proved extremely satisfactory for the purpose. The wind tunnel, which has a nine-foot nozzle, is now nearly completed and will be in full operation before the end of 1931-32. The water channel, which is being constructed in order that research on aeroplane floats, hulls and other high-speed craft may be undertaken, is also nearing completion and will be in operation in 1931-32.

The establishment of a complete engine testing plant capable of testing aircraft engines presented special difficulty on account of the noise associated with its operation. A suitable room was found in the underground part of the

old power house which fortunately had adjacent to it an unused chamber eminently fitted for sound absorbing purposes. Substantial progress has been made in fitting up this laboratory. When completed it will be possible to test aircraft engines of any type and to absorb up to 1000 horse power at speeds up to 2500 revolutions per minute. The possession of this equipment will for the first time make it possible for the Government to carry out its own regulations with regard to the testing of aeronautical machinery.

The erection of the new National Research Laboratories has gone steadily forward. Delays have occurred which apparently could not be avoided. Difficult problems with respect to material and equipment affecting materially the internal structure had to be solved. A description of the building was given in the report for last year, and it is not necessary to repeat the description here. Suffice it to say that when completed it will be one of the most modern buildings in existence devoted to scientific and industrial research; a headquarters for scientific effort worthy of Canada and fitted for the solution of the many problems which she offers. It is expected that the laboratories will be available for occupation early in 1932.

During the year much time has been given by the technical staff of the Council to studying details of equipment and fittings. Much thought and care have also been given to the question of staff appointments. Men must be found whose natural endowment and training fit them for work in connection with the special problems to be solved.

Summary of Financial Statement for 1930-1931

During the year under review, the National Research Council received through parliamentary appropriation the sum of \$500,000.00. In addition, the Council received from various other sources the sum of \$50,373.43, making a total gross revenue for the year of \$550,373.43.

The largest item received by the Council other than through parliamentary appropriation was the sum of \$20,972.23 granted to the Associate Committee on Grain Research from a trust fund, which was established in 1928 by the Federal Government for research work on grain, this fund being derived from the disposal of surplus grain at public terminal elevators. In addition, the sum of \$5,000.00 was received from the Sun Life Assurance Company of Canada to assist in the work carried out under the auspices of the Associate Committee on Tuberculosis. In the previous four years the same company had also contributed the sum of \$40,000.00 for the same purpose, and these grants have been of very material assistance to the National Research Council in co-ordinating and stimulating co-operative investigations by various laboratory groups on this major problem affecting both man and animals.

During the year, the Council also received from the Canadian Co-operative Wheat Producers, Limited, the sum of \$3,600.00. The Canadian Wheat Pool decided to offer three fellowships with an annual value of \$1,200.00, one to be tenable in each of the universities of Alberta, Manitoba and Saskatchewan, these fellowships to be open to qualified graduates of any Canadian university who desired to pursue advanced studies and research in problems connected with the grain growing industry of the prairie provinces

of Canada. These fellowships were given through the National Research Council and were subject to the usual regulations of the Council with respect to its own postgraduate scholarships.

The Council also received a substantial sum from the Scottish Canadian Magnesite Company as a contribution toward research work carried out on problems of the magnesite industry in Canada. In addition, the sum of \$11,304.63 was received through the Canadian Engineering Standards Association, which operates as an Associate Committee of the National Research Council, this sum being derived from contributions by various industrial organizations toward the work of the C.E.S.A. and other miscellaneous revenue, such as the sale of specifications. The balance, \$6,641.47, was derived from miscellaneous revenue and refunds.

During the preceding year, the gross revenue of the Council totalled \$464,382.75, this figure being made up by a parliamentary appropriation of \$400,000.00 and the sum of \$64,382.75 received during the year in aid of research and from miscellaneous revenue and refunds.

The gross expenditure of the Council during the year under review totalled \$550,334.22.

Of this sum, \$178,923.82 was expended on grants in aid of research. This expenditure included grants to Associate Committees directing large co-operative investigations, grants to aid individual investigators in carrying out approved researches by furnishing them with either special apparatus required for the investigation or junior assistants, and other direct contributions toward the promotion and co-ordination of research work in Canada.

The sum of \$59,535.00 was expended on postgraduate scholarships established with the object of retaining in Canada the most promising university graduates in science and developing them into a corps of highly trained research workers for service in Canadian industry and in the scientific branches of the federal and provincial governments and in the universities. The Council also expended during the year, on additions to its library and on the publication of scientific information, the sum of \$31,480.77. The sum of \$57,953.17 was expended for equipment and supplies required in the laboratories of the Council. The salaries of the technical officers and staff of the National Research Laboratories, as distinct from administrative staff, amounted during the year to \$126,762.75, and the salaries of the entire administrative staff amounted to \$58,526.99.

Travelling expenses paid by the Council totalled only \$19,457.97, of which expenditure \$14,262.42 was incurred by the members of the National Research Council and by its staff, and the sum of \$5,195.55 was expended in the payment of the travelling expenses of the members of various Associate Committees established by the Council for the purpose of directing and co-ordinating research work on major problems. The administration of the entire organization, including the provision of supplies, etc., totalled during the year \$17,693.75.

From the foregoing it will be seen that, of a total expenditure during the year of \$550,334.22, the Council expended the sum of \$454,655.51 directly

on research work. This figure constitutes approximately 83% of the total expenditure of the Council and does not include either the cost of administration or travelling expenses.

Financial Statement for the Fiscal Year Ending March 31, 1931

S. P. EAGLESON, *Secretary-Treasurer*

Gross Receipts	
Canadian Wheat Pool (Fellowships grant)	\$ 3,600.00
Appropriation	500,000.00
Contributions from industry	6,000.00
Contributions to Canadian Engineering Standards Association	11,304.63
Grain overage trust fund	20,972.23
Refunds	4,327.59
Miscellaneous	4,168.98
	\$550,373.43
Gross Expenditures	
Grants in aid of research	\$178,923.82
Postgraduate research scholarships	59,535.00
Laboratory	57,953.17
Publications	16,199.77
General administration	17,693.75
Travelling expenses of members of Council, Associate Committees and staff	19,457.97
National Research Library	15,281.00
Salaries and honoraria	185,289.74
	\$550,334.22
Refund to Receiver General	39.21
	\$550,373.43

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.

By means of these committees the Council seeks to bring to bear upon the problems it has to face the best scientific opinion that Canada has to offer. As a result of committee discussions, programs of research have been prepared with regard to many of the major undertakings of the Council

before actual work was started. Every institution of the country, educational and industrial, has co-operated without stint. With one exception every individual whose co-operation has been sought has given without compensation what was required of him.

During the year the Associate Committee on Cereal Rust was reorganized, this committee becoming a subcommittee of the Associate Committee on Field Crop Diseases. The Associate Committee on Radio, which had previously functioned as a subcommittee of the Associate Committee on Physics, was made an independent committee and a program of work to be carried out was prepared. The Associate Committee on Asbestos and the Associate Committee on Laundry Research were both organized during the year at the request of the industries concerned, and are now actively at work. Preparation is being made in the new laboratories for undertaking a substantial program of research.

Assisted Researches

Beginning on page 112 will be found abstracts of the researches in progress during the past year with financial assistance from the National Research Council. It is with regret we report that due to economic conditions it was necessary to curtail this year to some extent the number of grants made in this way. No work which the Council has undertaken has proved more fruitful than that done under the assisted researches scheme. With a minimum contribution in the way of technical assistance or equipment many men in the universities have been enabled to carry on research work, in some instances running over a period of years, at very small expense to the Council. Some of these contributions have been exceedingly significant from an economic point of view.

On page 161 will be found a list of the 100 assisted researches in progress during the year, either under committees or individuals. Of these, many were a continuation of researches previously begun. The new projects during the year are as follows:

Grantee	Subject
Mr. R. D. Gibbs, McGill University	Investigations on gas and water content of trees.
Prof. P. H. H. Gray, Macdonald College	Microbiology of soil conditions in eastern Canada.
Prof. W. A. DeLong, Acadia University	Mineral constituents of the floral parts and young fruits of the apple.
Prof. R. C. Dearle, University of Western Ontario	Indirect ultra-violet solar radiation and its distribution.
Prof. R. A. Wardle, University of Manitoba	Parasites of the snowshoe rabbit.
Mr. Otto Schierbeck, Department of Forests of Nova Scotia	Pathological plant problems in Nova Scotia.
Prof. L. G. Saunders, University of Saskatchewan	Status of slough itch in Saskatchewan.
Associate Committee on Asbestos Research	Problems of the asbestos industry.

Grantee	Subject
Associate Committee on Laundry Research	Problems of the laundry industry.
Dr. H. W. Hill, University of British Columbia	Range or fowl paralysis.
Dr. O. S. Aamodt, University of Alberta	Breeding cereal crop plants for resistance to foot- and root-rots and smuts.
Dr. A. W. Henry, University of Alberta	Foot- and root-rot diseases of crop plants.
Dr. G. P. McRostie, Manitoba Agricultural College	Investigations with couch grass and perennial sow thistle.

Postgraduate Research Scholarships

When the National Research Council was appointed, it found that one of the first requirements for the development of scientific research in Canada was the building up of a corps of research workers thoroughly trained in science and competent to undertake independent investigation of scientific problems.

In order to meet this requirement, the Council immediately established three classes of postgraduate scholarships in science, namely, bursaries, studentships, and fellowships, having an annual value of \$750, \$1,000, and \$1,200 respectively. These awards are intended to enable students who have graduated with distinction from a university to continue their training in science until they have qualified for a Ph.D. degree. Three years is the maximum assistance granted to any individual candidate under any combination of these awards.

These scholarships are awarded to the best qualified applicants. The minimum qualification for a bursary is graduation with distinction from an approved university. An applicant for a studentship must have had at least one year of postgraduate research experience, while fellowships are awarded only to persons who possess very high qualifications and who have demonstrated beyond question their ability to carry on independent research.

During the fourteen years ending March 31, 1931, the National Research Council awarded two hundred and sixty-nine bursaries, one hundred and ninety-one studentships and eighty-one fellowships. These five hundred and forty-one awards were held by three hundred and twenty-four persons in eighteen departments of science at twelve Canadian universities. Each grantee carried on his work under the direction of a member of the staff of the university where the award was held, who had agreed to co-operate with the Council in the supervision of this work.

It will be of interest to review briefly what has been accomplished by the National Research Council through the granting of these awards during the past fourteen years.

At the end of the year under review, two hundred and fifty-seven persons had completed their training in science under these awards. The Council has therefore increased to this extent the number of highly trained research

workers available for service in Canadian industries and universities or in the government service. One hundred and thirty grantees held a bursary, studentship, or fellowship for one year, seventy-five persons held awards for two years, and fifty-two persons held awards for three years.

Three hundred and three grantees have secured the degree of M.A. or M.Sc. and one hundred and fifty-two persons have secured their Ph.D. degree.

Some slight indication of the volume of scientific work which has already been carried on by these grantees is obtainable from the fact that one thousand one hundred and seventy-four scientific papers have already been published by these grantees in various scientific and technical journals.

The present occupations of the two hundred and fifty-seven persons who have completed their training under these awards is also of interest. Of these, twenty-eight persons are continuing their postgraduate studies, some under scholarships from other sources and some having gone to foreign universities for special instruction; seventy-three persons are engaged in the teaching profession, sixty-six of these having received appointments to the staffs of Canadian universities, where the majority of them will have an opportunity of continuing their research work and also in training others in research. Fifty-four persons are employed in the industries and fifty have accepted positions in the technical branches of the federal and provincial governments. Twenty-one grantees are employed in various capacities in university and other laboratories, and thirteen persons for various reasons are not at present actively engaged in research work. Three grantees have died and fifteen have failed to furnish the Council with information regarding their present occupations.

The assistance granted through these scholarships to Canadian universities through the stimulation of research work and the building up of postgraduate research schools in Canadian institutions is an important development which has been greatly assisted through these awards.

The Canadian Co-operative Wheat Producers, Limited, decided to offer for the year 1930-31, three fellowships with an annual value of \$1,200 each, one to be tenable in each of the universities of Alberta, Manitoba and Saskatchewan, these fellowships to be open to qualified graduates of any Canadian university who desired to pursue advanced studies and research in problems connected with the grain growing industry of the prairie provinces of Canada. These fellowships were given through the National Research Council and were subject to the usual regulations of the Council with respect to its own postgraduate scholarships.

In addition to the awards already mentioned, the Council has established foreign travelling fellowships, of which a very limited number may be awarded to persons who have completed their training so far as they can go in a Canadian institution and have secured their Ph.D. degree and who desire to take additional training abroad in some very specialized field.

During the year 1930-31, five fellowships, twenty-two studentships and thirty-five bursaries were awarded by the Council to graduates of seventeen Canadian universities. In addition, one Ramsay Memorial fellowship and

one foreign travelling fellowship were awarded and held in England and Germany respectively. The three fellowships offered by the Canadian Co-operative Wheat Producers, Limited, were also awarded and held, one at each of the three universities in the prairie provinces.

International Activities

In accordance with its established policy of avoiding duplication of effort and of keeping in close touch with research centres elsewhere, especially within the Empire, the Council has taken out sustaining memberships in several British research organizations and is thereby kept fully informed of their activities. These include the Wool Industries Research Association, the British Leather Manufacturers Research Association and the Linen Industry Research Association. In addition, the Council supports the International Mathematical Union, the International Chemical Union, the International Union of Pure and Applied Physics, the International Committee on the Annual Table of Constants and the Association of Special Libraries and Information Bureaux, and receives such advantages as may be derived from these memberships.

Of the international conferences and scientific gatherings held during the past year, and at which the Council was represented, the most important was the Imperial Conference, attended by the President of the Council by direction of the Government, and reported elsewhere.

Mr. J. H. Parkin, Assistant Director of the Division of Physics, represented the Council at three important European conferences, the Third International Congress for Applied Mechanics, held at Stockholm, the Fifth International Air Congress, at The Hague, and the International Congress of General Mechanics, at Liège. At the same time Mr. Parkin improved the opportunity to visit several aeronautical laboratories in Europe and secure information regarding the latest European methods of aeronautical research.

REPORTS OF LABORATORY DIVISIONS

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

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Acting Director*

Continuing the co-operative arrangement which had been made pending the erection of the new laboratories at Ottawa, the work of the Division of Biology and Agriculture during the past year was centred at the University of Alberta. The Acting Director also continued to take special responsibility for the work carried on under the aegis of the Associate Committee on Grain Research and the Associate Committee on Weed Control, and more limited responsibility for promoting the program of the Associate Committee on Field Crop Diseases (including cereal rusts). The activities of these committees, for the most part carried on with financial assistance from the National Research Council, are reviewed in a later section of this report. The following summaries cover only the work done directly by the permanent or temporary staff of the Division of Biology and Agriculture.

Phenolic Compounds of the Wheat Plant in Relation to Rust Resistance

J. A. ANDERSON

In earlier reports it was stated that the main phenolic compounds of the wheat plant belonged apparently to the flavone group of pigments. It has now been ascertained by comparative dyeing tests with eight wheat varieties of graded resistance to rust that all contain the same coloring matters. The quantity present varies considerably, but is apparently much greater in the two most resistant varieties.

Preliminary studies on the constituents of a susceptible variety, Little Club, show that it contains the same principal compounds as those already isolated from the resistant variety, Khapli.

Further work has been done on methods for isolating the water-soluble phenolic coloring matter of Khapli, and it is hoped soon to obtain this compound in pure form.

Khaplol, the yellow, water-insoluble phenolic compound isolated from Khapli, was thought to be either 3:5:6:7:4'—or 3:5:7:8:4'—pentahydroxyflavone. The former was synthesized, but was not Khaplol. The results of a subsequent alkaline fusion of Khaplol indicate that it is probably 5:7:3':4':5'—pentahydroxyflavone, and this compound will now be synthesized.

Preparation and Denaturation of the Gluten Proteins

W. H. COOK

The changes in the gluten proteins caused by heat are of interest in connection with the injury resulting from the use of too high temperatures in commercial drying of wheat, and in connection with various processes for the improvement of wheat and flour by heat treatments. The usual methods

of preparing these proteins have been found to cause denaturation, thus making it difficult to estimate the effect of other factors.

A new method of preparing glutenin has been developed. Washed gluten is dispersed in 30% urea solution; starch is removed by passing the dispersion through a Sharples supercentrifuge; glutenin is precipitated (a) by adding magnesium sulphate to about 0.17 saturation, or (b) by adding water until the urea is diluted to about 10% concentration. Such preparations differ in content of amide and arginine nitrogen from those prepared by dispersion in dilute alkali or acid. Exposure to alcohol, as in the older methods of precipitation, or drying, even at room temperature, renders glutenin partially insoluble in 30% urea. Prepared by the new method, glutenin may be studied in regard to its physical properties without previous exposure to abnormal hydrogen ion concentrations.

Gliadin prepared from urea solution has the same nitrogen distribution as that prepared by three methods described in the literature and involving the use of alcohol. The comparison of solubilities has still to be completed.

Heat denaturation, as estimated by changes in critical peptization temperature and viscosity, takes place first in the glutenin, next in the gliadin fractions of low solubility, and finally, under severe treatment, in the remainder of the gliadin.

Gas Production and Retention in Wheat Flour Doughs

J. G. MALLOCH AND R. G. DUNLOP*

An apparatus was constructed for measuring gas production and retention in bread doughs at constant temperatures and at pressures of 670 to 760 mm. Varying the pressure had practically no effect on the quantity of carbon dioxide produced and on the dough volume, but the increased solution of carbon dioxide at high pressures may increase the oven spring and loaf volume.

“Punching,” or kneading, the dough at intervals throughout the fermentation increased its final gas retention and volume as much as 60%, especially in strong flours.

Potassium bromate added to flour as an “improver” increased the elasticity of the dough and promoted gas retention though slightly depressing gas production. The effect on retention was greater in strong flours, and was increased by punching. Maltose and maltose with phosphate promoted only gas production, and acted to the same degree in all flours.

* Wheat Pool Research Fellow.

Composition of Wheat in Relation to Stage of Maturity and Exposure to Frost

R. NEWTON AND A. G. McCALLA

A study of the normal development of the wheat kernel is fundamental to an understanding of the changes produced by frost. In 1930, wheat samples were harvested daily from the time of kernel formation to full maturity, and analyzed (a) immediately, (b) after rapid drying with heat, (c) after slow drying at room temperature, (d) after drying in the stook, (e) after exposure to various degrees of frost and drying in the stook.

There is some evidence that once the envelope of the kernel, which is richer than the endosperm in nitrogen, has been laid down, carbon and nitrogen are moved into the kernel in a practically constant ratio throughout its development. The percentage of nitrogen increases gradually because of the loss of carbohydrates in respiration. Analyses based on air-dried material are misleading, the respiration losses making the nitrogen percentages too high.

The moisture content of the kernels is a satisfactory index of maturity, since it appears to be the key factor regulating chemical changes incident to maturation. At 58% dry matter, all changes in composition practically cease, and wheat can be cut any time after this point with little if any loss in yield or protein. Weight per bushel and commercial grade improve up to this point; both may be damaged by severe freezing at even higher dry-matter contents, though the composition is unaffected.

Translocation of materials from stem and leaves to kernels continues while immature grain is drying in the stook. The rate becomes negligible after the dry-matter content exceeds 50%. At any stage, both translocation and respiration are practically stopped by severe freezing. If frozen at a dry-matter content less than 58%, the checking of respiration leads to a lower nitrogen percentage, and more of the nitrogen will be found in the lower fractions.

The total nitrogen and its fractions in the flours milled from severely frozen samples show the same variations as in the wheat, but in lightly frozen samples the composition of the flour is unaffected.

Baking tests are being used to check the analytical results.

Biological Assays of Crop Residues

R. NEWTON AND R. S. YOUNG

Continuing studies on the effect of crop sequence on the yield and quality of wheat (which have been summarized from year to year in the reports of the Associate Committee on Grain Research), the possible toxicity of fermentation products of crop residues has been investigated by a method of biological assay. The roots and stubble of alfalfa, brome, timothy and western rye grass, unfermented and fermented for 3 weeks, 6 weeks, 9 weeks and 12 weeks under controlled conditions, were extracted with water and the effects of the extracts on cultures of *Penicillium* and wheat plants determined. Both toxic and vitamine-like effects were noted, the latter being dominant except in timothy, brome and western rye extracts at 3 to 6 weeks, in which the toxicity was in the order given. All effects of both kinds had disappeared at 9 to 12 weeks. It seems possible that the transitory toxic products may play a part in the temporary disappearance of nitrates especially noticeable in timothy sod.

These experiments were supplemented by chemical analyses of the residues, and chemical and biological analyses of field soils growing these crops.

Chemicals as Herbicides

W. H. COOK

About 40 chemicals were given preliminary tests in the greenhouse, on 4 annual weeds: lamb's quarters, stinkweed, wild mustard and wild oats;

and on 4 perennial weeds: Canada thistle, couch grass, perennial sow thistle and poverty weed. Their effectiveness at different concentrations and with different methods of application is being studied, also the possibility of improving their effectiveness by adding spreading or emulsifying agents or materials which promote adhesion to the foliage. Residual effect on the soil is tested by growing a crop of wheat after the weeds are destroyed. Mixtures of chemicals are being explored with reference to killing power, reduction of the fire hazard, and residual fertilizing value.

Among the chemicals tested so far, those showing promise as compared with sodium chlorate are sodium arsenite, sodium bichromate, sodium cyanide and phenol.

Weed Survey of the Prairie Provinces

J. M. MANSON

To assist the Associate Committee on Weed Control, a personal reconnaissance was made of the entire settled area of the prairie provinces. This was supplemented by information obtained through a uniform weed survey card distributed to weed inspectors through provincial officers. The distribution of the more important weeds and the areas of severe infestation have been ascertained in a general way. More complete information should be available in the coming season, through the survey cards and through personal visits to check the boundaries of infestations. A report accompanied by maps will then be published, which should give a better picture of the problem than has hitherto been available.

The more serious infestations were usually found in the older districts, but many serious infestations may occur in newer districts unless steps are taken to eradicate patches of such weeds as perennial sow thistle and Canada thistle which have already become established. Various improvements in weed control services have been suggested as a result of information obtained during the survey.

Statistical Analysis of Data Collected by the Associate Committee on Accurate Plot Work

J. W. HOPKINS

An experiment on rates of seeding oats was carried on for the three seasons 1924-25-26 at a number of points in Canada, under the auspices of the Associate Committee on Accurate Plot Work. The large volume of data collected is now being analyzed statistically, and will shortly be made the subject of a report.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

At the beginning of the year under review the professional staff consisted of three research chemists, including the director. The furnishing of the temporary laboratories occupied by the division was completed early in the year and expansion of the staff was begun early in the summer. By the end of the year the professional staff consisted of twenty persons. The subjects to which attention has been chiefly devoted during the year are dealt with separately in the following sections. Owing to the smallness of the staff and

to delays incident in the installation of special pieces of equipment, work on many of these subjects did not get under way until relatively late in the year.

Asbestos

D. WOLOCHOW

After several meetings with representatives of the Canadian producers, at which the technical problems of the industry were discussed, it was decided to undertake work with the object of, (a) standardizing the present method of testing asbestos grades, (b) developing new methods of testing such as will take into account all the various properties of the fibre which are of significance in manufacture, (c) developing new uses for asbestos, especially for the shorter fibred grades.

Work was started in November, 1930. The producing mills and a number of asbestos manufacturing plants were first visited and data were secured on the results of testing the various grades of fibre in the Quebec Standard Testing Machine and also on Ro-tap screens.

Work has also been done on the influence of drying, on testing, on the determination of the moisture and water-soluble content in asbestos, and on the absorption of water by asbestos. A new method of testing, based on the apparent density of the fibre, is being studied. Washing tests have been made. Asbestos of foreign origin has also been examined for comparative purposes.

Some studies have been made on the properties of asbestos of various grades bonded with Portland cement and other binders, and this work is leading to the production of some new asbestos cement and moulded compositions which, it is hoped, will prove to be of commercial value.

The activities of the Associate Committee on Asbestos are briefly described under that heading, beginning on page 54 of this report.

Plastic Magnesia

A. F. GILL, N. P. PITT, C. W. DAVIS

Laboratory work on behalf of the magnesite companies has been directed towards improvement of the properties and methods of utilization of the plastic magnesia and the development of new uses.

A study was made of the effect of the factors of time and temperature in calcination subsequent to the carbonate decomposition. It was found that the physical properties of a plastic magnesia could be modified by heat treatment to give the desired setting time, high water resistance and diminished linear change. It was possible to take advantage of these results in the commercial production of plastic magnesia in spite of the limiting temperature below which Canadian magnesian rock must be calcined to avoid production of free lime. This was accomplished by close sizing of kiln feed, careful control of the burning period and improved technique in temperature measurement and control.

Further laboratory experimentation on the expansion and contraction of plastic magnesia cements, together with observations of existing installations, had indicated that climatic conditions in eastern Canada are a major

factor in the deterioration of magnesia floors. Types of floors which were reported as entirely satisfactory in temperate countries had not stood up under the low winter humidities prevailing in Canada.

A large volume of laboratory work was undertaken with the object of developing flooring compositions which would be least sensitive to humidity changes. By adjustment of the fibre content of mixes and careful control of aggregate sizes, formulas have been obtained which have a margin of safety against cracking much greater than that of the conventional composition floors. In carrying out this work factors such as finishing properties, resiliency and texture were also considered. Successful floors of this type are now in service.

An investigation was also made with the object of developing more satisfactory magnesia composition tile. Cast products of satisfactory mechanical properties and attractive appearance have been made on a small scale.

Other magnesia cement building materials have been studied. Production trials in the factory of a well-known American producer of magnesia floor and wall material gave, with Canadian plastic magnesia, results reported to be equal to those obtained with a special imported foreign plastic. The establishment of a Canadian factory for this product is at present contemplated.

Efforts are being made to take advantage of the relatively high bonding power and fire-proof nature of magnesia cement in connection with various building products in the low-priced field. Some encouraging results have been obtained.

With the increase of the staff on this investigation at the beginning of 1931, some additional work of a theoretical nature was undertaken. Following preliminary qualitative work comparing the behavior of the oxide and hydroxide of magnesium in magnesium chloride solutions, an investigation was made of the conditions necessary to minimum hydration of the oxide in solutions of magnesium chloride. Results have confirmed in a most satisfactory way conclusions previously reached from more empirical data.

Agricultural Wastes

Weed Seeds

C. Y. HOPKINS

Weed seeds, although present to only a small extent in Canadian wheat, represent in the aggregate, when the wheat is screened at the elevators at the head of the lakes, a considerable tonnage. The so-called "refuse screenings" separated at these elevators amount in a normal year to not less than 50,000 tons and in the year 1928-29 amounted to 130,000 tons. Approximately two-thirds of these screenings are weed seeds. Screenings are at present of little or no monetary value, and their utilization has claimed the attention of the National Research Laboratories.

Of the various possible uses of the seeds, their employment in the manufacture of oil appears quite promising. A device on original lines has been developed on a suggestion of Dr. D. F. Stedman's, for separating pure

seeds of a single species from the mixture of seeds as a whole. Considerable quantities of hare's ear mustard and of wild mustard have been separated and found to contain about 30 to 25% of oil, respectively. Lambs quarters, which constitute a notable fraction of the seeds, are much lower in oil content, with the result that the seeds as a whole contain only about 17% of oil.

The thermal death point of the seeds was determined in order to ascertain the temperature to which the material would have to be heated in order to prevent germination, in case it were used as fertilizer.

Refuse screenings were found to contain 9.8% pentosans, equivalent to 5.7% furfural. These figures make it unlikely that they could compete with oat hulls as a source of furfural.

Loganberry Pulp

MISS H. D. CHATAWAY

The pulp residue left after expressing the juice of loganberries in British Columbia wineries was examined, with the object of suggesting possible methods of utilizing this by-product. Samples of the dried pulp were found to consist of approximately 75% seeds and 25% chaff. The pulp contained 1.63% pectin and the seeds 16.7% oil. The material did not contain any starch. As a feeding stuff it may be considered analogous to distillers grain, but contains considerably less protein than the latter.

Straw

L. MARION

In some preliminary work lignin was isolated from wheat and oat straw by various procedures. Oat straw yielded 23.8% lignin when treated with 72% sulphuric acid; 9-10% when treated with alkali; 1.5% when extracted with the methyl ether of glycol.

Maple Products

L. SKAZIN

The value of the maple sugar and syrup produced in Canada in a normal year is approximately \$6,000,000. In the belief that improvement of the present forms of maple products and the development of new forms would lead to expansion of the industry, work in this field was started in the laboratories in August, 1930.

The first project considered was the perfecting of a process originated by Mr. Skazin when working with Dr. J. F. Snell at Macdonald College, Que., for the production of block maple sugar in a form which, unlike the regular blocks, does not harden and become mottled on keeping. The work in this connection has been brought to the point where it is ready for application in commercial trials. The causes of mottling in the regular blocks of sugar have been elucidated. Incidentally, a procedure for the prevention of foaming during the boiling down of sap was discovered.

A new form of maple sugar suitable for certain purposes in confectionery was developed and will be given commercial trials.

Studies were carried out on, (a) the detection microscopically of adulteration of maple products by cane and beet sugar, (b) the hygroscopicity of maple sugar, (c) the influence of invert sugar on the crystallization of maple sugar.

Honey

O. M. MORGAN, MISS H. D. CHATAWAY, L. SKAZIN

The possibility of rendering buckwheat honey paler in color and milder in flavor was demonstrated in the laboratory by Dr. Morgan. It is planned to carry out further work on this subject with the object of making the procedure applicable on a factory scale.

A new product, honey jelly, was developed by Dr. Morgan. This product is made by treating honey with a small proportion of pure fruit pectin at a suitable acidity. When made with the proper proportions of materials it does not ferment, mould or crystallize. Since the work was carried out, it has appeared that a similar product has been developed independently in the United States.

Work has been begun on the determination of the moisture content of honey, as it appears that moisture is the main factor in the spoilage of some batches of honey by fermentation, and hence that a reliable and rapid method of measuring the water content is a desideratum.

Plant Alkaloids

R. H. F. MANSKE

The program of work in this field, which was started in July, 1930, is expected to involve the examination of most of the poisonous weeds and shrubs growing in Canada, with the object of isolating the physiologically active principles and determining their chemical structure. The work is also expected to have a bearing on certain problems of metabolism, and further, it is not impossible that it will lead to the discovery of new drugs.

During the period under review attention has been devoted chiefly to, (a) alkaloid calycanthine, responsible for the poisonous effect on livestock of the seeds of a shrub known to farmers as "bubby," (b) the alkaloids of the giant ragwort (*Senecio jacobaea*) responsible for the cattle disease known in the Maritime Provinces as Winton disease, and the alkaloids from related species.

The work on calycanthine, the early stages of which were carried out at Yale University, has been markedly successful and has revealed the chemical structure of a substantial part of the calycanthine molecule. It has proved that the alkaloid belongs to a group of special interest, the indole alkaloids, the first synthesis of a member of which was carried out by Dr. Manske in 1926. By degradation of benzoylated calycanthine, benzoyl-N-methyltryptamine was isolated and identified by comparison with a synthetic preparation. In the course of the work an improved method was developed for the preparation of diethyl-beta-cyanopropional—an important intermediate in the synthesis of alkaloids of the indole group. The work also involved the synthesis of N-methyltryptamine. Because of its close relation to tryptamine, which is well known to be very active physiologically, arrangements have been made with Dr. Babkin of the Department of Physiology, McGill University, to test this new compound physiologically.

Alkaloids have been isolated from *Senecio jacobaea*, collected in Prince Edward Island, *S. vulgaris* and from *S. latifolius*, brought from South Africa,

where it causes considerable mortality in livestock. The alkaloids on hydrolysis yield a base and an acid. The former are identical from the *jacobaea* and *latifolius* species; the latter are different in the case of the two species just mentioned. The chemical reactions of the base are being studied and a tentative formulation of its structure has been made.

Wool

P. LAROSE, MISS A. S. TWEEDIE

The work consisted first in studying and improving the technique of determining those qualities of wool which are susceptible of measurement in quantitative terms and which may be considered of significance in the behavior of wool in manufacture.

Measurements have been made on some 200 samples of wool, from sheep in an experiment which is now under way at the University of Alberta for the purpose of determining the influence of humidity, temperature and feeding conditions on wool growth and quality. These measurements were extremely laborious, as it was necessary in the case of many quantities to measure a large number of individual fibres to get a fair average. For example, the figures for fibre diameter and tensile strength for a single sample involved measurements on 50-100 individual fibres. In the early stages the work was carried out by A. F. Gill.

In connection with the measurement of fibre diameter an apparatus was devised to enable the diameter of a fibre to be measured along its length and at various angles, so that its elliptical contour might be completely determined.

The material lost by wool on scouring consists of wool grease or wax, suint or perspiration and dirt. Considerable work was done on the technique of determining these fractions, and not only the total scouring loss but the amount of each of the three components was determined on each of the wool samples. Various methods of determining moisture in wool were compared, including the regular conditioning oven at 106°C., a current of dry air at 106°, a vacuum oven at 67° and at 75°. The effect of degreasing and of scouring wool appeared to be to reduce somewhat its moisture content at equilibrium, and in this connection measurements were undertaken on the moisture absorbing power of wool wax.

Observations made during the course of the work indicate, (a) that the finer a sample of wool the smaller relatively is the variation in diameter along the length of individual fibres, (b) that in general the finer the wool the greater is the crimp and the larger the number of scales per unit of length.

The cystine and sulphur were determined in certain samples of wool. In connection with the determination of sulphur, it was concluded that a wet oxidation method gave results which were too low. A catalytic combustion method was found to be satisfactory.

Wool such as that used for Canadian homespun was compared in regard to strength, fineness, lustre and crimp with imported wool used for cap manufacture.

Visits were paid to twelve mills and other organizations interested in the technical problems of wool manufacture.

Laundering

O. M. MORGAN

Work in this field, undertaken at the request of the Eastern Canadian Laundryowners' Association, was started in September, 1930. At the beginning some time was spent at the American Institute of Laundering, maintained by the Laundryowners' National Association at Joliet, Ill. This elicited useful technical information and established a valuable co-operative relationship. Visits were paid to three other laundry laboratories in the United States, to the Laundryowners' Annual Convention at Chicago and to about 15 laundries in Canada. Because of the relation between textile manufacture and laundering, visits were also paid to 13 Canadian textile manufacturing plants.

With the background of information secured by these contacts and by a study of the germane literature, laboratory work was started. This work has been of two types, (a) examining and reporting on damaged fabrics and other difficulties submitted by Canadian laundries, (b) a systematic laboratory study of detergency, aiming to discover facts applicable to the improvement of laundry practice. In the former branch of the work 48 reports were issued. In the latter, special apparatus was designed and built, a suitable experimental technique was developed, and the investigation was got well under way, the study of the influence of the time period of washing (sudsing) and of rinsing being completed.

The first step was to develop a standard method of soiling cloth. After some experimentation a mixture of lampblack, tallow and lubricating oil in carbon tetrachloride was applied by a special apparatus consisting of an immersion tank, rubber covered rollers and a drying frame. An experimental wash wheel was then designed and built, and equipment was assembled for measuring the surface tension, viscosity and pH of soap and washing solutions. By using a photometer, the approach towards 100% whiteness which any given washing procedure brought about in the original, standard, grey, soiled fabric was measured quantitatively.

Other special apparatus provided for the work on laundering includes a cloth tensile strength tester, an apparatus for accelerated fading tests on colored fabrics, a "Launderometer" for ascertaining the fastness of dyes to washing, thread counters, cloth balances, etc.

Leather

W. E. GRAHAM

Leather research was started in August, 1930. Several days were spent at the leather research laboratory at the University of Cincinnati supported by the Tanners' Council of America; visits were also paid to two other prominent leather laboratories in the United States, and to six tanneries in Canada.

The National Research Council took out membership in the British Leather Manufacturers' Research Association and in this way secured the reports describing the ten years' research work which this Association has carried out. In order to put the results of this work at the disposal of the tanners in Canada, a lengthy summary of it is being prepared. The portions

on the curing of hides and on beamhouse work were completed and issued during the period under review.

An enquiry was undertaken into the question of "red heat" damage to hides in transit from the Argentine to Canada and another into the extent to which Canadian hides are damaged by grubs. An account of the recommendations and mode of procedure of the Hide Improvement Society of Great Britain was secured. Certain analyses of tanning extracts were carried out.

Rubber

D. F. STEDMAN, T. R. GRIFFITH

A rubber mill, tensile tester, electrically heated oil bath vulcanizer and accessories for vulcanization tests on rubber were installed and adjusted. Studies were started on the technique of rubber testing, the aspects of the subject to which attention was given being the influence of the shape of the test piece on the ultimate tensile strength, the effect of repeated milling on tensile strength and the error in measuring the thickness of test pieces by the regular gauge. A vulcanizing mould capable of producing satisfactory moulded ring test pieces was designed by Dr. Stedman and is proving very useful as it enables tests to be made on minimal batches of experimental material.

A mathematical study of the stress-strain relations in rubber which is being made on novel lines promises to throw light on the vexed question of the structure of rubber.

Synthetic Resins

C. Y. HOPKINS

Work has been carried out on a new, colorless, glass-clear synthetic resin which seems to have commercial possibilities. It is prepared by the polymerization of an unsaturated ester. The work has naturally divided itself into three phases, (1) a study of methods of preparing the ester, with the object of discovering the best and most economical method, (2) a study of methods of polymerizing the ester, (3) the properties of the products. Promising results have been obtained in the use of the resin for the manufacture of non-shatterable glass. In an accelerated light exposure test, sandwich glass made with the resin showed no discoloration, while glass made in the usual way with celluloid turned brownish. The resin would also appear to be a suitable constituent of lacquers.

In addition, some study was given to two resinous condensation products.

Gas Research

A. CAMBRON, C. H. BAYLEY

Work in this field was started by Dr. Cambron in July, 1930, and by Mr. Bayley in September, 1930. The work was first directed to the production of benzol from natural gas and some interesting preliminary results were obtained. But it was later arranged that this aspect of the subject should be pursued by Dr. Boomer and his assistants at Edmonton (see Report of Associate Committee on Gas Research, page 69) and the work in this division has been directed chiefly to the study of the heat treatment of Turner Valley natural gas and of the individual hydrocarbons which com-

pose it, from the point of view of the possibility of economically producing olefine hydrocarbons. Such olefines form a source of many valuable commercial chemicals, among which are synthetic ethyl alcohol, ethylene glycol (used as an anti-freeze and for the manufacture of explosives), isopropyl alcohol and butyl alcohol (used in lacquer manufacture).

A large number of experiments have been carried out on the influence on the production of olefines from the natural gas hydrocarbons of the design of the reaction vessel, the temperature, the rate of gas flow, the presence of various chemicals and the method of applying the heat. The work has already indicated conditions under which olefines can be made from natural gas at a lower cost than by any previously known procedure, but as the work is still in active progress, it seems desirable to postpone any detailed account of it. It may be mentioned in passing that a marked difference was found between normal and isobutane on heat treatment, the latter yielding largely isobutylene, whereas the former gave chiefly propylene and ethylene.

In connection with these experiments considerable work was done by Mr. Bayley on methods of analyzing gas mixtures such as those encountered. Fuming sulphuric acid was found to absorb ethylene more rapidly than solutions of bromine or mercuric nitrate, whereas 96% sulphuric acid in four minutes in a Francis pipette absorbs propylene completely but ethylene hardly at all. In some cases unsaturates were determined by absorption in bromine, fractionation of the bromides and regeneration of the hydrocarbons. A satisfactory method of analyzing a mixture of butylene, propylene, ethylene, methane and hydrogen was developed.

The adsorption of hydrogen sulphide by activated alumina was studied in order to ascertain whether this material would be suitable for the purification of natural gas. The possibility of using the material as a catalyst in the pyrolysis of natural gas for the production of olefines was also studied.

Carbon Black

D. F. STEDMAN

In the ordinary chemical process of manufacturing carbon black from natural gas the yield is very poor, being on the average about 3% of the carbon in the gas. The yield by the usual process from gas high in methane, such as occurs in Turner Valley, Alberta, would be even lower than the figure just quoted. Work has been undertaken with the object of improving the yield of black, if possible, without reducing its quality.

The line of work first followed was the decomposition of the gas by means of an arc, which was caused to spread, so as to increase the area of contact. High tension currents of the order of 500 watts at 10,000 volts were used for the arc. Yields of 10% carbon and higher were found to be obtainable; the exit gas contained an appreciable percentage of acetylene and ethylene and considerable hydrogen.

The quality of the black was good. Its particle size was equal to that of the best blacks used in rubber compounding and it gave satisfactory results as regards tensile strength, etc., when used in rubber tire stocks. Its adsorptive capacity was favorable, being lower than that of the finer grades of rubber black made by the channel process. It was concluded, however,

that, owing to the high power consumption in this process of making carbon black, the fact that increase of the arc current raised the proportion of graphite produced and that small units would probably have to be used in translating the process to a large scale, the cost of production of carbon black by the process would be such that only special purpose black could be produced competitively by it. It is hoped to pursue the investigation of the process from this point of view.

In the meantime a careful theoretical analysis of the carbon black flame has been made and an apparatus on new lines planned. In this connection it is interesting to note that in an apparatus in which a jet of oxygen was burned in the gas unexpectedly no carbon black was formed.

Distillation

D. F. STEDMAN

A highly efficient fractionating column designed on new lines has been developed and subjected to preliminary tests, with satisfactory results. The calculated efficiency of the column is such that a given length is equivalent to 35 times the length of a column packed with one-quarter inch glass tubes. The composition of a petroleum fraction of importance in connection with tests on the knock rating of gasoline is now being examined by means of the column.

Miscellaneous

1. *Calcium chlorate*. Experiments were carried out to determine the feasibility of manufacturing calcium chlorate (for use as a weed killer) by the electrolysis of calcium chloride solution. A 35% solution of calcium chloride in an acid medium was electrolyzed, but neither with stationary nor rotating electrodes could the formation of a firmly adherent coat of calcium hydroxide be avoided, and further, the voltage, which was six at first, tended to run up considerably. It was concluded that, as compared with the electrolytic manufacture of sodium chlorate, the manufacture of calcium chlorate was not attractive.

A small quantity of calcium chlorate for use in weed eradication tests was made by a chemical process, the best of the various procedures tried in this connection involving the precipitation of the sodium from sodium chlorate by treatment with ammonium sulphate at -10°C ., evaporation in a vacuum to crystallize ammonium chlorate, addition of lime to the crystals and removal of ammonia by a stream of air.

2. *Isotopes*. Experiments were carried out by Dr. Stedman with a train of special diffusion tubes with the object of applying the results to the separation of isotopes. Air containing 20.4% oxygen was reduced to 18.0% oxygen by one diffusion. The apparent efficiency of the apparatus was 27.3%, but although this is an advance on previous work in the field it was not considered good enough for the work projected and no further time was spent on the subject.

3. *Explosives*. Several samples of dynamite were analyzed and preliminary experimental work was done on the problem of sealing detonators against the entry of moisture.

4. *Water.* Consideration was given to the suitability of certain samples of water for specific purposes, (a) for use in wool scouring, (b) as boiler feed, (c) in electrically heated galvanized and copper tanks.

5. Other enquiries dealt with referred to the use of malt in place of sugar for curing meat, linseed oil quality in various crop years, the metering of molasses, the occurrence of vitamins in apple juice, the use of distillers grains, and other subjects.

DIVISION OF PHYSICS

R. W. BOYLE, *Director*

J. H. PARKIN, *Assistant Director*

During the past year experimental investigations in this division were begun. The work of construction of large-scale apparatus and reconditioning of buildings—for the greater part in preparation for the researches on aeronautics—was continued as detailed below.

Consultations and close co-operation with the Electricity and Gas Inspection Service of the Department of Trade and Commerce, on the subject of the approval of meters for the purchase and sale of electric power, were continued. This is now a responsibility of the National Research Council. On direction from the Council a subcommittee of the division acting with the Electricity and Gas Inspection Service has undertaken a complete revision of the existing definitions and regulations pertaining to all electrical units and standards, and of existing regulations governing the approval of all types of electric meters. This work is still in progress.

Frequent meetings and consultations have been held on subjects of common interest with the Department of National Defence, the associate committees on Aeronautical Research, Engineering Standards, Electrical Measuring Instruments, Heating and Insulation, and other committees of the Council. The division has continued the administration of the workshops of the National Research Laboratories and during the year finished the erection and staffing of the shops and installing the machines. Brief descriptions of these activities are reported below.

Aeronautical Research

J. H. PARKIN, J. J. GREEN, G. J. KLEIN, K. F. TUPPER

In perhaps no other country are aircraft being used in a greater variety of operations or to a greater extent in relation to the population than in Canada. In the past probably the most effective uses of aircraft in the Dominion have been those in connection with the investigation, development and protection of the natural resources. The development of the rich northern regions relatively inaccessible by other means of transportation is being greatly accelerated by means of aircraft.

Appreciating the present and possible future importance of air transportation in the economic development of the Dominion, and the need of producing aircraft suited to the conditions and requirements of the country, the National Research Council, with the approval of the Committee of the Privy Council on Industrial and Scientific Research, undertook to provide suitable facilities for aeronautical research in the National Research Laboratories at Ottawa.

Because of the size and nature of aeronautical laboratories it was not feasible to house them in the new main laboratory building. Since there were on the Edwards mill property certain buildings well suited for the housing of aeronautical laboratories, together with a hydroelectric plant capable of generating sufficient power for their operation, it was decided to construct the aeronautical laboratories in these buildings. An important saving of time and money has thus been effected. The laboratories in this property will be known as the National Research Laboratories Annex.

As the emergency source of power for the wind tunnel was three-phase and the alternators in the hydroelectric plant were two-phase it was necessary to reconnect the latter in order that three-phase equipment might be installed in the laboratories. Further, the hydroelectric plant required certain repairs to make it serviceable. The necessary alterations are now under way. When the plant is placed in operation it is expected that it will be capable of supplying all the power required by the adjoining laboratories during the daytime.

The aeronautical laboratories, now under construction, comprise the following:

(a) *Aerodynamic Laboratory.* The principal equipment of this laboratory is an up-to-date wind tunnel which enables aerodynamic investigations to be conducted and tests of aircraft and aircraft components to be made; it is indispensable to the development of improved aircraft suited to special conditions or requirements. By means of wind tunnel tests, the performance and stability of aircraft can be predicted in less time, at much less cost and without the hazard involved in full scale tests.

Besides purely aeronautical work the wind tunnel will be useful for the determination of wind pressures on structures, buildings, bridges, transmission towers, windmill design, studies in connection with ventilating and exhausting systems, air resistance of trains and cars and the calibration of air-speed instruments.

Design of the wind tunnel by the laboratory staff was commenced in September, 1929, and construction was started in November of the same year. By the end of March, 1931, the construction of the tunnel proper was 90% complete. An open jet, closed return wind tunnel was decided upon because of the numerous advantages of the type but the size and arrangement of the tunnel were determined by local factors, such as the shape and size of the building and the power available.

The jet is 9 ft. in diameter and 13 ft. long and is thus capable of accommodating large-scale models or quite large full-scale aircraft components. The air is circulated by means of a four-bladed propeller, 13 ft. in diameter, driven by a 600 h.p. speed electric motor. Power is supplied from the hydroelectric plant on the property. Speed regulation may be either automatic or manual.

Air speeds are expected such that one-fifth full scale conditions will be attained with complete aircraft models and full scale conditions with certain aircraft components.

The nozzle, collecting bell and expanding cone are of wood stave pipe construction; the remainder of the tunnel is of reinforced concrete. Cascades of vanes guide the air around the corners of the passages with a minimum loss of power. The design of the vanes was based on the results of experiments in the laboratories. A cellular honeycomb may be placed at the entrance to the nozzle. The contraction in the nozzle is over 4.5:1 and, with the honeycomb, should insure an air stream very low in turbulence.

The balance platform located over the jet is structurally separate from the building and tunnel to secure freedom from vibrations.

(b) *Hydrodynamic Laboratory.* This laboratory is equipped with a test tank for the investigation of hydrodynamic problems and the testing of aircraft floats and hulls. Flying boats and aircraft fitted with floats are extensively used in Canada, particularly in the north country where the numerous lakes and rivers provide landing places for such craft in a region lacking other landing facilities. Improvement of floats and hulls and of the performance of aircraft fitted with them is therefore of considerable importance in the Dominion. For this work a testing tank is essential. Up to the present time Canada has not possessed a tank for aircraft work.

The tank will not only be valuable for aeronautical work but will prove of much use in marine work for studies to improve the lines of the hulls of vessels, and for the calibration and rating of meters.

The test tank is a well tried and constantly used source of information in naval architecture and has already proved invaluable for aeronautics. For the latter work high speeds and consequently great length of tank are desirable. In the case of the Ottawa tank, limitations were imposed by local conditions. Two buildings on the property were joined together to form a single building in which a tank, 400 ft. long by 9 ft. wide by 6 ft. deep was built of reinforced concrete. Construction was started in December, 1929, and the concrete portion of the tank was completed by the end of March, 1930. The tank proper was finished during the following year and was first filled in February, 1931. To permit higher speeds than otherwise would be possible a cable drive is to be used for the carriage. During the year design and construction of the carriage and of elements of the drive including tension sheaves and cable attachment were completed, and the drive, including electric motor, speed reducer and variable speed gear were erected. Design and construction of an automatic control gear, to enable high carriage speeds to be obtained in the relatively short tank, is under way.

The tank is provided with sloping beaches at water level and splash troughs which it is expected will suppress the waves quickly and thereby enable tests to be run more frequently than would be possible otherwise.

Design of the automatic towing balance, incorporating several new features, is practically complete and the balance is about 50% constructed.

(c) *Aircraft Engine Laboratory.* The Dominion Government, by subscribing to the convention relating to international air navigation, undertook to certify the airworthiness of aircraft and engines produced in Canada. Air regulations of 1920 give effect to this international undertaking. The federal government is thereby obligated to install adequate testing facilities. The

testing of engines for this purpose being very properly a function of the National Research Laboratories, the Council is installing equipment for the performance testing of aircraft engines.

As the testing of high-power aircraft engines under service conditions necessarily gives rise to much noise, this factor was an important one in selecting a location for the engine testing equipment. A number of sites were considered, but a building on the property appeared most suitable and most promising from the standpoint of noise suppression. An aircraft engine and propeller were operated in the building, and the noise, at various points in the neighborhood, was observed. At no point was it excessive. As the testing equipment will be placed in a subterranean chamber in the building with an insulated ceiling and a muffling chamber, the noise is not expected to prove troublesome.

The necessary alterations and additions in the building were largely completed by March 1931.

The equipment is capable of accommodating air or water cooled, tractor or pusher, right or left hand rotation engines developing up to 1000 h.p. at speeds up to 2500 r.p.m. The equipment is of British manufacture. It was ordered in September, 1929, and was received in Ottawa in April, 1930.

The equipment includes a dynamometer of the hydraulic type, a 250 h.p. fan capable of forcing a 130 m.p.h. air current past the cylinders of air cooled engines and all necessary auxiliaries. Provision is made for applying to the engine under test a thrust equal to the propeller thrust.

A specially equipped single cylinder engine was set up and put in service in May, 1930, for making tests of the detonation characteristics of gasolines. Since then the engine has been in practically continuous use determining the anti-knock rating of aircraft fuels.

Researches Completed

A research paper has been published on the Design of Corners in Fluid Channels, by Klein, Tupper and Green, in the Canadian Journal of Research, vol. 3, p. 272, 1930.

In wind tunnels of the type erected in the National Research Laboratories, cascades of vanes are employed to guide the air around the corners of the passages. As relatively little information has been published or is available on the design of such cascades an investigation was made in the laboratories to secure information on which to base the design of the cascades.

Using a one-sixth scale model wind tunnel, the influences of vane shape, incidence and space were studied. Vane spacing was found to have an important effect on the power loss at the corners, while the effects of vane form and incidence were relatively unimportant.

The information derived renders possible the design of a corner using vanes of simple, inexpensive form, in which the loss will be about one-eighth of that in the corresponding square corner. This information will be of value to the designers of ventilation, exhausting and power plant equipment, hy-

draulic plants and wind tunnels. There has been already a considerable demand for the paper containing the results of the study.

Instrument and Model Shops

A well equipped and staffed workshop for the construction, maintenance and repair of instruments and equipment is an essential part of a large research laboratory. In research work many of the instruments and much of the equipment are of special design and are best constructed in shops in connection with the laboratories, where the work can be done under close and constant supervision. Further, the instruments employed require frequent change, adjustment and repair, for which a shop and experienced staff are necessary.

Provision was made for workshops in the plans of the main laboratory building, but with the construction of the laboratories in the Annex more shop accommodation became necessary and it was considered advisable for economy and ease of administration to concentrate the shops for all the laboratories in one location. By making use of a suitable existing building to enclose these services an important saving was effected.

The building contains metal and wood-working shops, and a drafting room. The metal-working shop is well equipped with an assortment of machine tools for general and precision work, together with sheet metal working tools, welding, forge and heat treating equipment. The carpenter shop contains the usual wood-working machines and equipment. The necessary small tools and supplies are kept in a central tool crib and storeroom. The nucleus of a staff of skilled mechanics has been engaged.

In the drafting room special instruments and equipment are designed and the necessary sketches, drawings and blueprints prepared for the use of the mechanics in the shops. Any diagrams, graphs or figures required for the illustration of research reports and papers are also prepared here.

The shops are employed on the construction, maintenance and repair of instruments and special apparatus for researches and testing, construction of cases and cabinets, of models for aeronautical research, preparation of test specimens and similar work for the laboratories.

The Elimination of Static in the Fairchild Aerial Camera

D. C. ROSE

An investigation of this problem was requested by the Department of National Defence.

Photographs taken from aeroplanes are often completely spoiled by "Static" marking, that is, marks which sometimes look like round white cloudy patches and sometimes like lightning flashes. The source of these marks on the film has been traced and is found to be due to static electricity generated on the surface of the film as it moves through the camera. These static charges cause sparks to pass to various parts of the camera, producing sufficient light to mark the film seriously and often to spoil the photograph completely.

Preliminary experimental work on the electrostatic charging of celluloid has been carried out, as well as a careful study of the passage of the film through the camera. This work suggested several alterations in the design of the camera and the film. Cameras are being prepared by means of which the Department of National Defence will determine the usefulness of these suggestions.

There is considerable evidence that this static charging is particularly bad under certain atmospheric conditions. Atmospheric conditions under which aerial photography is usually carried out are being studied.

Relative humidity, electrical conductivity and temperature measurements are being taken in the slip stream of flying aircraft, as used for photography. Experiments are being performed to reproduce the actual conditions in the laboratory so that a more accurate study of the charging of the celluloid can be made. The measurements in flying aircraft have involved the development of new instruments to measure relative humidity.

The Construction of Artificial Lighting Units Suitable for Grading Grain

D. C. ROSE

The solution of this problem was requested by the Board of Grain Commissioners.

The problem of choosing suitable artificial lighting units to be used for the illumination of grain grading tables was attacked from two points of view. First, the production of a light as nearly as possible the same color and consistency as daylight was considered. Second, the construction of lighting units producing illumination of various colors or combinations of colors which would emphasize the bad and good points of the grain, particularly of wheat, was studied.

A number of daylight lamps of several types were tried in various arrangements so that the best intensity, uniformity and diffusion of the illumination was obtained. An experimental cabinet containing three lights of different colors (neon lamp, mercury vapor lamp and the General Electric sun lamp) was built so that the intensity of the illumination from each lamp could be varied. The lights were so adjusted that starchy, green wheat and frozen wheat, etc., could be most readily distinguished from good wheat. In the choice of the daylight units advantage was taken of consultations with engineers in the illumination department of the Canadian General Electric Company.

These lighting units were examined by representatives of the Board of Grain Commissioners and two units were considered worth a prolonged trial. Arrangements are being made to have them set up in the inspection department of the Board of Grain Commissioners at Winnipeg.

It was thought that if certain of the blemishes in wheat showed marked selective reflection, grading could be made easier by examining the reflected light from a sample of wheat by means of a photo-electric cell and light filters. The light reflected from picked samples of various types of wheat has been

examined spectroscopically, and it has been found that there is not sufficient selectivity to facilitate the grading of grain by this method. For this purpose ultra-violet as well as visible light was tried.

The Water-proofing Qualities of Certain Stone Preservatives

C. D. NIVEN

This research was undertaken to estimate the water-proofing qualities of certain stone preservatives which manufacturers sell for spraying upon buildings. It was claimed that these preservatives would prevent the crumbling which sometimes occurs on the surface of the stone when it is exposed to the weather for some time.

Two of these stone preservatives owe their efficiency to a waxy compound in the solution; this waxy compound is deposited in the pores of the stone and so prevents water from wetting the surface. These two and a third preservative were tested on a rather porous sandstone.

Uncoated stones and stones coated with the different solutions were weighed in air and then steeped in water; they were weighed under water from time to time and an estimate of the rate at which the water was entering the stone was thus obtained. It was found that in less than one day an uncoated stone or a stone coated with either of two preservatives would gain about 4% in weight, while a stone coated with the third would require 10 to 14 days for a similar increase in weight.

The Heat Conductivity of Building Materials

C. D. NIVEN

A testing apparatus of the hot plate type was designed and constructed for measuring the heat conductivity of building materials. It consists of two outside cold plates and a central hot plate. The plates are 18 in. square; this permits the use of a three-inch guard ring around an effective heat-transmitting surface one foot square. The cold plates are kept cool by the circulation of brine pumped from an electric refrigerator. The difference of temperature between the hot and cold plates is measured by copper-constantan thermocouples by means of a potentiometer.

The apparatus is now working very efficiently and the results it gives on standard materials agree with reliable published results. An extended investigation of Canadian heat insulating materials is in progress.

Vibrations in Electric Transmission Lines

C. D. NIVEN

This research was undertaken to investigate small vibrations in electric transmission lines and if possible to explain why spans will occasionally start vibrating as a whole like violin strings. Mathematical consideration indicated that the fundamental frequency of a span or the frequency of the "musical note" should be almost the same as the frequency of swing when a span sways from side to side. Actual experiments failed to show any difference

between the two frequencies, although physical theory had indicated a slight difference.

Since spans were known to vibrate, as a whole, when they were coated with ice, an experiment was arranged to see if an ice-coated cable would resound to a vibration more easily than an uncoated cable. The results showed definitely that the ice coating did not facilitate resonance.

Thermometer Standardization Equipment

C. D. NIVEN

Plans have been laid to install equipment for standardizing thermometers—other than clinical—between the temperatures of 0° C. and 660° C.

Water and sulphur hypsometers and a temperature comparator of ordinary range are being designed.

Radium Measurement

G. C. LAURENCE

A gamma-ray electroscope has been constructed for measuring quantities of radium. With this instrument radium preparations of from 1 to 250 millicuries may be measured to a precision of 0.3% by comparison with the laboratory standards. These standards have been measured by the United States Bureau of Standards in comparison with the American standard, and have been carefully compared with one another in this laboratory. In terms of the international standard the probable error in the measurement of an unknown quantity of radium in this laboratory is 0.4%, with a possible maximum error of not more than 1%.

The National Research Council possesses a small quantity of mesothorium and is prepared to estimate the mesothorium content of radioactive preparations to within a few per cent by comparative gamma-ray absorption measurements, if the preparations are within the limits of strength mentioned above. Preparations of strength outside these limits can be measured less accurately.

Apparatus is being constructed for comparative measurements of X-ray intensities.

Moisture Precipitation on Dust and Ions

G. C. LAURENCE

It is recognized that dust particles, suspended in the atmosphere, act as nuclei on which moisture condenses in the formation of clouds. Laboratory experiments with the Wilson chamber have shown that a definite degree of supersaturation of water vapor is necessary before condensation occurs on ions, and this has been found true, also, in a qualitative measure, for dust particles. The supersaturation required is considerably greater than is believed to occur in the atmosphere, so that the natural formation of clouds is not clearly understood, though some hypotheses have been suggested.

In the course of some experiments with a Wilson chamber it was unexpectedly observed that the rate at which moisture continues to condense

on a drop depends on the size of the drop. A very slight increase in the degree of supersaturation, in a quick adiabatic expansion, changed the size of drops from invisible to clearly visible. This suggests a possible explanation of the difference between laboratory observations and the natural process, if it be supposed that the invisible drops can grow slowly in a slightly supersaturated atmosphere — as, indeed, should be expected.

The question is also of importance in other branches of physics than meteorology. Accordingly, a more careful investigation has been undertaken, and will be extended to condensation on dust particles of different sizes and composition.

Soft X-ray Excitation of the Photo-electric Effect in Metals

G. C. LAURENCE

An apparatus has been built for certain investigations of the excitation of photo-electrons from metals by X-rays of wave-lengths longer than 100 Å. In particular an effort is being made to determine their velocity spectrum. Theoretical interest lies in a comparison of velocity distribution with excitation by visible and ultra-violet light.

Velocity of Sound in Liquids Contained in Cylindrical Tubes

G. S. FIELD

While measuring the velocity of sound in liquids contained in tubes, Boyle and Froman (Report to National Research Council, April, 1929, and *Nature*, 126:602, Oct. 18, 1930) observed that at certain frequencies a phenomenon occurred very similar to selective absorption in optics. This research was undertaken to investigate the problem more thoroughly, and if possible to determine the particular form of energy transference causing the absorption of energy.

As the result of a number of experiments, and a theoretical study of the factors involved, it has been determined that selective absorption of sound energy in tubes occurs when the frequency of the sound wave approaches the frequency of radial resonance in the column of liquid. At this point a longitudinal wave is propagated only with difficulty, and most of the energy is absorbed by the radial vibration. The frequency of this resonant radial vibration is directly proportional to the velocity of sound in the unconfined liquid and inversely proportional to the diameter of the tube.

At low frequencies (before the first absorption band), the velocity is nearly constant with frequency and the wave is nearly plane until the frequency is close to that of the resonant radial vibration. The velocity then drops off suddenly, and the wave departs from its plane form.

On the high frequency side of the absorption band, the velocity of sound is first very high, and then it drops off gradually to its value in the unconfined liquid. The wave is not at all plane near the absorption band, but it becomes more nearly so as the frequency increases.

Another interesting theoretical result is that on the low frequency side of the absorption band, the type of vibration is different from that on the high side.

From this investigation there emerge ideas which can be applied on the subject of vibrations in rods of solid materials, and a research on such rods is now in progress. When this has been completed the much more complex case of bars made of anisotropic material, *e.g.*, crystalline quartz such as is used in radio frequency standards, will be taken up. This last case is of particular importance for radio frequency standardization, and it is expected that the information obtained from these researches will be of much value in the selection and design of new frequency standards.

Velocity of Sound in Cylindrical Rods

G. S. FIELD

In view of the results obtained, both theoretical and experimental, in connection with the propagation of sound through liquid contained in cylindrical tubes, it was decided to carry on a similar research with solid rods. As vibrating bars of quartz and metal are now being employed as primary standards for radio frequencies, it becomes increasingly important to have a complete knowledge of the types of vibration which may occur in such bars.

The above investigation is now under way, and preliminary results, taken in conjunction with certain observations made by Dr. R. W. Boyle and co-workers in former researches, show that interesting conclusions are to be expected.

Transmission of an Ultrasonic Beam Through Air

G. S. FIELD

In order to find out whether or not air will transmit an ultrasonic beam satisfactorily, and if such phenomena as the Doppler effect can be observed therein, a suitable transmitter is now being built for experimentation in this medium. A high-gain amplifier has been constructed for the reception of the beam; and, with the completion of the transmitter, the above research will be undertaken.

High Frequency Vacuum Tube Oscillator

G. S. FIELD

With a view to later experiments with large high-frequency currents a 2 k.w. vacuum tube has been incorporated in a circuit oscillating at frequencies of 60-70 million cycles per second.

Although practically no experiments have yet been performed with this apparatus, there are several problems which it is hoped to investigate in the coming year.

New Type Electrostatic Voltmeter

G. S. FIELD

When a piece of material having a comparatively high dielectric constant is placed in a medium having a lower dielectric constant and in which there exists a potential gradient, the piece of immersed material will tend to set itself so that its longest axis is parallel to the lines of electric force. By sus-

pending an elongated piece of metal in air, for example, it is possible to measure the potential gradient existing in the air, by measuring the amount of rotation of the metal.

In actual experiments it was found possible to measure potential gradients of 200 volts per cm. and up. By employing two electrodes, voltage differences of 5,000 and up were measured.

As a meter of this type could be constructed to have a very low and nearly constant capacity, it might be found useful for measuring high electrostatic and radio-frequency voltages. By careful construction and calibration, such an instrument could be made to give quite accurate results.

Electrical Engineering

B. G. BALLARD

The New Building

Plans and specifications as prepared by the architects and their consulting engineers were reviewed, and it was felt that a number of changes should be made. These changes were as follows:

1. Instead of supplying power to the building with a 550-volt, three-phase system, an 11,000-volt, three-phase system was requested. The investigation indicated that this change could readily be justified on economic grounds. Unfortunately, the sub-basement space in the new building did not allow sufficient head room for an 11,000-volt transformer and it was felt undesirable to utilize any more valuable space for this service. It thus became a question of locating the transformer units in an enclosure on the street or placing them in an underground vault. The former alternative was incompatible with attractive appearance and hence it was agreed to provide a vault in proximity to the heating plant.

2. Investigation revealed that it would be impracticable to supply direct current energy from the Council's hydroelectric plant as the specifications provided, and this scheme was therefore abandoned. The proposed 550-volt services from the generating plant to the new building were also dispensed with.

3. Since a large part of the load throughout the building would be single-phase, some anxiety was felt lest the three-phase system should become badly unbalanced. When this matter was brought to the attention of the consulting engineers, they suggested a three-phase distribution system throughout the building, supplied from transformer banks of three-phase units rather than single-phase units. These three-phase transformers inherently re-establish the balance on the primary side, regardless of the degree of unbalance on the secondary side.

4. The power requirements for the building were analyzed by comparing our service with those of other laboratories of the continent. Unfortunately, no other laboratory had comparable power requirements, so that it was difficult to estimate closely the load which might be anticipated. However, it is felt that provision has been made for adequate service without extravagance.

5. A change in the general arrangement of services in individual laboratory units was requested, with a view to improving facilities for securing power and also to reduce the cost of the installation.

6. A thorough study of doorways and partitions in the new building was made and several changes requested in line with the wishes of the various department heads so as to adapt the units to the type of work which would be undertaken.

7. A summer steam service was requested so that steam for experimental purposes would be available during the periods in which the main heating boilers were shut down.

8. Since it was probable that the level of Sussex Street would be raised approximately two feet, the level of the building was raised by the same amount, which allowed this additional head-room in the sub-basement level. This additional head-room made the sub-basement space extremely valuable for locating heavy machinery and for certain experimental work. It therefore became necessary to request electric service and limited plumbing service in this section.

An investigation was undertaken of a suitable telephone system for the new building, giving consideration both to a private exchange and also a complete service installed by a commercial company. All factors considered, the latter alternative appeared more suitable, and an analysis was made of the number and location of individual telephones which would be required.

Considerable time was devoted to the study of an adequate battery system, which included a tour of some American laboratories to learn their experience and secure first hand information of the systems installed. The general arrangement of the battery system has been decided upon and requests for prices on the necessary material have been sent out. The battery system as proposed necessitated some changes in wiring from that specified in the contract.

High Voltage Laboratory

It was felt that the laboratory should be provided with high voltage transformers and, since it was not possible at this time to provide a separate structure to house such equipment, arrangements were made to place the high voltage transformers in the building. In order to provide adequate head-room, a space through two levels was provided, which should permit r.m.s. voltages up to 750,000. Sketches of the space available were prepared and submitted to various transformer manufacturers, with requests outlining our requirements.

Electrical Systems for the Aeronautical Laboratories

Considerable time was devoted to the electrical system of the wind tunnel. This equipment was installed under contract and it was necessary to be thoroughly familiar with the system. The electrical installation for the dynamometer testing work was also studied and plans made to effect the installation.

Committees

Considerable time was spent on secretarial work for the Committee on Electrical Units and Regulations and the Associate Committee on Radio Research, as well as on studies connected with the activities of the Associate Committee on Electrical Measuring Instruments. Reports of these committees will be found on pages 108, 89 and 59, respectively.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

The Division of Research Information has been created primarily for the collection and distribution of information on scientific and technical subjects, for the benefit both of the professional staff of the National Research Laboratories and investigators elsewhere in Canada. These services are rendered through the preparation of reports in answer to inquiries, the maintenance of a research library, and the publication of the results of the Council's researches. In addition, many closely related tasks have been assigned to the staff, including economic studies, secretarial work for research committees, and translations from foreign languages.

Information Service

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

During the year inquiries have been received on a wide variety of topics. Most of those from the general public have been dealt with concisely, but to the satisfaction of the inquirer. In some cases, especially when the matter has been of importance and where frequent inquiries are received on the same subject, detailed reports have been prepared. Several reviews of the literature have been made on subjects under consideration by associate committees of the Council.

The most important service, however, has been in connection with the work of the National Research Laboratories. When an investigation is proposed it is important to know what has already been done on the problem and what are the probable chances of success. A study of the economics of some problems is alone sufficient to indicate that even if technically successful they would be economically a failure. In such cases it is obviously a great advantage to make a thorough inquiry in advance. Further studies have been carried out in connection with discoveries made in the laboratory to determine whether these can be applied commercially. In fact, much of the work of the information service, while not confined to economics, deals with the economic significance of technical problems. In exceptional cases a thorough review of the previous work on important subjects has required the services of one member of the staff over a period of several months.

As examples of the large number of subjects on which reports and bibliographies have been prepared during the year under review, the following may be cited:

- The fixation of nitrogen and the manufacture and use of fertilizers
- Industrial uses of anhydrite
- The utilization of apple by-products
- The vitamine content of apples

- The electroculture of plants
- The artificial ripening of fruits and vegetables
- The use of peat for purposes other than as a fuel
- The preservation of fish nets
- Recovery of potash and other salts from the waters of a British Columbia lake.
- The cost of manufacture of sodium chlorate in Alberta
- The generation of electrical power from natural gas
- Canadian sources of technical and research papers
- Protective inoculation against tuberculosis with bacillus Calmette-Guérin.

An important part of the work of the staff of this branch has been connected with the activities of associate committees of the Council. The director is secretary of some 15 research committees and is responsible under the chairman for seeing that the decisions of the committees are carried out, while another member of the staff is general secretary of the Pacific Science Congress. Other members serve on certain of the committees and devote a considerable part of their time to the committees' work.

This group is also responsible for many miscellaneous tasks, of which there may be mentioned the translation of scientific papers from German, French, Spanish, Italian and certain other languages, duties in connection with the construction of the National Research Laboratories, interpretation of data secured in investigations, and the preparation of patent applications.

Library

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

The library has been created primarily to serve the staff of the National Research Laboratories, and books and periodicals are purchased with that end in view. At the same time it is recognized that the library should be, to some extent at least, supplementary to other government libraries in Ottawa, and the Council has accordingly refrained from the purchase of numerous sets available in other Ottawa libraries and has bought other sets not obtainable elsewhere in Canada. During the year the library has borrowed from 10 other libraries, including one in the United States, and has loaned to seven.

In the present limited quarters no attempt has been made to build up a large library. Special attention has been paid to securing sets of standard scientific and technical periodicals in English, German and French, as well as a few in other languages, and to the purchase of important current periodicals from all over the world. In the past year 43 partial or complete sets, totaling 1,385 volumes, and approximately 460 periodicals have been received, in addition to a number of government and university reports and bulletins issued at irregular intervals. Most of the current periodicals have been obtained by purchase, but an increasing number is secured by exchange for the publications of the National Research Council. All important periodicals are being bound regularly. During the year 2,732 bound volumes of periodicals and books purchased have been accessioned. An increasing number of patents is being secured, as they are found of considerable value in connection with laboratory investigations.

At the request of the Royal Society of Canada shelf space has been provided for their library, which is made available to the staff of the National Research Council, an arrangement which in the long run should be to the advantage of both organizations. The Council also gratefully acknowledges the receipt of a number of valuable scientific sets from the Library of Parliament, sent as a semi-permanent loan, since it is recognized that these books will be used much more frequently by the staff of the National Research Council, while they are still available, with but a brief delay, to any who may inquire for them in the Library of Parliament.

Publications

W. W. THOMSON, MISS D. DESBARRES

The chief publications of the National Research Council are the *Canadian Journal of Research*, technical reports and bulletins, and the annual report.

The *Canadian Journal of Research* was established about two years ago, the first number having been issued in May, 1929. It was started as a bi-monthly periodical of 75 to 100 pages, but it at once met with a favorable response from Canadian research workers, and suitable papers have been offered in such volume that after three issues the journal was placed on a monthly basis and the size of the individual issue, gradually increased to about 125 pages. The journal is now well established, the subscription list showing a moderate but steady growth, and with an increasing demand from scientific libraries and research workers throughout the world. At present all branches of science are dealt with in one publication, but when the volume of papers available is sufficient it is proposed to have separate journals dealing with biology, chemistry, and physics.

The *Canadian Journal of Research* was created primarily to publish papers descriptive of work done in the National Research Laboratories and with financial assistance from the Council. It is open, however, to suitable scientific papers from all Canadian research workers. Of the 126 papers published to the end of the fiscal year under review, 17 were contributed by the staff of the National Research Council, 79 by research workers assisted financially by the Council, and 30 by other Canadians. Of these papers, 46 have been devoted to biology, 50 to chemistry, 23 to physics, and seven to other miscellaneous sciences.

Previous to the establishment of the Journal most Canadian scientists were compelled to send their papers out of the country in order to secure prompt publication of the results of their researches. This is no longer necessary, and as a result Canada will receive the credit due her for work done inside her boundaries.

In addition to the *Canadian Journal of Research* the Council has published during the year under review the annual report for 1929-30 and a bulletin on Health Hazards in Spray Painting.

The National Research Council's Associate Committee on Engineering Standards (Canadian Engineering Standards Association) has published a number of reports under its own auspices.

SUMMARY OF ACTIVITIES OF ASSOCIATE COMMITTEES*

Associate Committee on Aeronautical Research

Co-operating organization:

Department of National Defence

At the thirty-sixth meeting of the Associate Committee on Aeronautical Research, it was suggested that there should be a reorganization of the committee under its changed name, with representatives of engineering science and of the aircraft industry, and including suitable persons from all parts of Canada. The continuation of the committee's work was considered the more necessary in view of the development of the Aeronautical Research Laboratories in Ottawa. Valuable service could be rendered by the committee in co-ordinating the work of the laboratories with research work done by the Department of National Defence and elsewhere. By retaining on the committee members representative of the aircraft and aero engine industries, questions of interest and problems for research work would be brought directly to the notice of the committee.

It was felt that the bulk of the committee's work could be handled by a comparatively small number of members, in the form of an executive committee who could readily meet, and that it would be necessary to call together the main committee only at very infrequent intervals. All members, however, were to receive the minutes of every meeting and were to be asked to submit any suggestions they might have with regard to the work of the committee.

These suggestions were submitted to the National Research Council, who adopted the recommendations and reorganized the committee. The first meeting of the executive was held on January 31, 1931.

Professor Parkin presented to the committee a report on the visits he had made to aeronautical laboratories and plants in Europe during 1930, supplementing it by a brief account of his observations. The report contained detailed information on the nature and scope of the work being done in European laboratories, together with lucid accounts of their equipment. As regards the aircraft firms he visited, there are in the report descriptions of the noteworthy details of design and outstanding methods of construction. Altogether the report includes information on no less than 39 individual establishments.

In addition to these documents, Professor Parkin submitted to the committee the first report on work done in the National Research Laboratories, Ottawa, on the "Design of Corners in Fluid Channels." This research was undertaken in order to discover the most efficient shape of vane for use in the corners of the 9-ft. wind tunnel of the laboratories, and also to secure information concerning the spacing, chord and incidence that would be most efficient in reducing corner losses and in providing the most uniform velocity distribution.

At the January meeting of the committee, a number of considerations were advanced to indicate the very vital necessity for an aero engine testing

* A list of the committees, with the names of members, will be found in Appendix J, page 186.

equipment. As the Department of National Defence is peculiarly interested in this equipment, the Department undertook to contribute a sum of \$5,000 from its appropriation for aeronautical research to assist in the construction of a building to house the dynamometer which has already been purchased by the Council.

The committee has been informed from time to time of the progress in the construction of the Aeronautical Research Laboratories. The National Research Council had adopted the committee's suggestions, put forward at its thirty-fifth meeting, as to the nature of the equipment for these laboratories, and the four main items—the wind tunnel, model testing tank, engine dynamometer, and fuel testing engine—had all received attention.

Information on the progress of the 9-ft. wind tunnel, model float test tank, engine dynamometer and gasoline testing laboratory is contained in the report of the Division of Physics of the National Research Laboratories, beginning on page 35 of this report.

Associate Committee on Animal Diseases

Co-operating organizations:

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

Following a conference held at Ottawa in February 1930, meetings of the executive and of various subcommittees were held and support was extended to investigations on animal diseases at several centres, following the general policy established by the committee. It was decided to do no special work on reproductive diseases in cattle, although this is considered to constitute a very important problem, since the Federal Department of Agriculture and the Ontario Research Foundation are both engaged in a study of this question. No investigation has yet been authorized on red water in cattle, but the University of British Columbia has been asked to prepare a plan of investigation for submission at a further meeting of the subcommittee appointed to consider this question.

Financial support has been extended to the investigations outlined below.

RESEARCHES ON POULTRY PARASITES AT MACDONALD COLLEGE

The investigation on poultry parasites is part of a much larger investigation on parasites in general which it is proposed to carry out at Macdonald College in co-operation with several other organizations. The committee has been in correspondence with the Empire Marketing Board regarding the possibility of making Macdonald College a centre for parasitological research in the Empire. In this connection Professors Conklin and DuPorte visited England in 1930. The President of the Council also discussed the matter with the Empire Marketing Board while in attendance at the Imperial Conference.

In the system established by the Empire Marketing Board various bureaux have been created, and through these information is being collected and distributed. The Canadian government is making a financial

contribution to the work of these bureaux. The Board has suggested that entomological research in Canada should be carried out by an organization similar to one of the bureaux in England. A proposal has recently been made that the Quebec government should erect the necessary buildings at Macdonald College and that the National Research Council and the Empire Marketing Board should make equal contributions towards the cost of research on parasites over a period of years. It is expected that if this investigation is proceeded with on a large scale additions will be necessary to the Macdonald College staff.

The committee considered the problem of poultry parasites of sufficient urgency to justify the support of an investigation at Macdonald College in advance of the completion of arrangements for the larger project. This has been rendered easier through the possession of the necessary equipment at Macdonald College and the provision of a trained staff.

In this investigation of poultry parasites a survey has been made in the province of Quebec. This indicated that flocks free from parasites are very exceptional. The commonest of the internal parasites found is the caecal worm, *Heterakis gallinae*, which is extremely prevalent, although fortunately not very pathogenic. Its life history has been investigated in some detail. It has not been found possible to obtain infection from eggs in the soil. Experiments have been tried to determine the effect of various chemicals upon the eggs of this parasite, but they have been found quite resistant.

Coccidiosis has been found to be a major problem, being rightly regarded as one of the most important infectious troubles of poultry in Canada and the United States. The mortality in young infected flocks may reach 100%. Three species of tapeworm have been found very widely distributed throughout the province.

The question has arisen whether external parasites play an important part in the transmission of internal parasites. This part of the investigation is still in the preliminary stages. Collections have been made of wild birds, but only one poultry parasite has been found on them. This is a rather troublesome one.

An outbreak of microscopic tapeworm at Macdonald College has led to the use of anthelmintics. Some success has been obtained, but unfortunately the egg production of treated birds has declined rapidly.

From information obtained to date in this investigation it is believed that every chick starts life free from pest. The problem therefore is to keep birds from sources of infection. Infection may go directly from bird to bird, as in all species of intestinal roundworm, or through intermediate hosts, as in the case of tapeworms. No evidence has yet been obtained that any breed of poultry possesses any special resistance to parasites.

(Investigation under the direction of Dr. E. M. DuPorte.)

RESEARCHES ON MASTITIS AT OKA AGRICULTURAL INSTITUTE

The work at Oka has been carried on by Dr. J. M. Rosell, who first made a preliminary study of the problem at Cornell and elsewhere.

The principal object of this investigation is to develop a vaccine for the treatment of infected cows. Preparatory work has been done on the

discovery and perfection of tests to aid diagnosis of the disease in herds near Oka, where many cows are affected. Over 100 diseased cows have been used in this investigation. It has been found that the presence of the disease markedly affects the pH, chlorine and sediment in the milk.

Characteristic strains of streptococci have been isolated and grown on suitable media under controlled conditions. To the cultures phenol has been added in various proportions according to whether dead or attenuated bacilli were desired. In all cases milk has been injected with the vaccine, since its protein content is believed to have a favorable action. The milk has been either pasteurized or treated with formalin previous to injection.

The work on this problem is complicated by the fact that many cases of mastitis appear to be temporarily or permanently cured without treatment. A great number of trials over a long period are obviously required in order to make possible reliable conclusions. Results so far obtained are considered encouraging.

Preliminary tests have also been made with a preventive vaccine. It appeared to be effective in most cases in preventing the development of the disease in vaccinated cows cohabiting with others affected with mastitis. Owing to the fact that the method of transfer of the disease is not well understood, many controls would be necessary to determine the effectiveness of vaccination as a preventive of mastitis.

(Investigation under the direction of Rev. Father Leopold.)

RESEARCHES ON POULTRY PARALYSIS AT THE UNIVERSITY OF BRITISH COLUMBIA

Paralysis of fowls, a disease unknown 30 years ago, seems to be on the increase in a number of countries. Since 1927, it has become widespread on British Columbia poultry farms, and is at present considered to be responsible for the major losses in the pullet flock. The average loss may amount to 15%. All breeds of poultry appear to be subject to paralysis.

Birds from 40 infected flocks were examined from June 1930 to February 1931. The majority of the cases studied were of an acute type, particularly in the early summer. During autumn and winter partial lameness was the rule, the birds continuing to live for months. Complete recovery, however, was rarely observed.

The post-mortem examination of 200 birds showed that visible lesions in the nervous system occurred in all cases examined late in the season. They consisted of enlargements in the network of nerves going to the upper part of the fore or hind limbs and assumed, at times, the proportion of a tumor. Infiltrations of the peripheral nerve and the spinal ganglia with foreign material, such as lymphocytes and plasma cells, were observed. However, lesions of this kind could also be found in apparently normal birds from healthy flocks.

Attempts were made under laboratory as well as under field conditions to transmit the disease from sick to normal birds, but neither inoculation with abnormal nerve tissue, contact with lame birds nor contaminated ground produced paralysis. In response to requests from poultrymen groups of

paralyzed birds were given different treatments, such as ultra-violet light, special diet or the widely advertised iodine vermicide, but all were ineffective. The disease is surmised to be due to a neurotrophic virus.

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

Associate Committee on Asbestos

Co-operating organizations:

Canadian Asbestos Producers and Manufacturers
Dominion Department of Mines
Quebec Bureau of Mines

A preliminary study of the asbestos industry was made in 1926 by the technical staff of the National Research Council, at the suggestion of the Associate Committee on Physics and Engineering Physics, whose members had enumerated a large number of problems. In the report covering this preliminary survey it was recommended that work be done on certain problems of the industry, but as the asbestos producers did not at that time feel any special need of government assistance, the Council decided to take no further action.

In the spring of 1930, however, the asbestos producers after consultation among themselves made a formal request for assistance to the National Research Council. The President accordingly arranged a conference with the producers, which was held at Thetford Mines on June 2, 1930. The situation was reviewed at that meeting, and it was recommended that the National Research Council form a committee to make a systematic study of the problems of the industry and to undertake such laboratory investigations as might appear to be warranted.

Until a few years ago Canada was in the happy position of being the world's chief producer of asbestos, which was readily sold at a good profit. Prices during the war rose to a high level and remained high for some time subsequently, but this proved an incentive to other countries to utilize their asbestos reserves. Important advances took place in the Union of South Africa, Rhodesia, Russia, and the state of Arizona. With increasing quantities of asbestos being offered, the price fell rapidly, this movement being greatly accentuated by the severe depression which began in 1929 and has continued to date. It was a particularly severe blow to Arizona and Canada where labor costs are high and the deposits in general of a comparatively low grade. In South Africa, Rhodesia and Russia, however, the grade of rock is high and labor costs are low. These countries consequently made important advances, chiefly at the expense of Canada. In 1913 Canada produced about 86% of the world's tonnage of asbestos and 71% of its dollar value, whereas in 1929 the tonnage had fallen to 71% and its value to 53%. The relative position of Canada was still further weakened in 1930, although it is to be noted that in the latter year the dollar value of asbestos products manufactured in Canada reached a new high record.

Realizing the urgency of the situation, the National Research Council immediately appointed an asbestos committee with representatives of the asbestos producers and manufacturers and the Dominion and Quebec de-

partments of mines. The first meeting of this committee was held in Thetford Mines on June 28, 1930.

One of the chief technical problems of the industry arises from the fact that there is no easy assay or analytical method for asbestos, such as exists for gold, silver, copper, or any other single element obtainable from mineral deposits. Chemically, asbestos is almost identical with the rock in which it occurs; its value depends chiefly on its peculiar physical structure and properties. The case is still further complicated by the fact that fibres of different lengths vary greatly in value. The asbestos grading method in common use consists in screening under controlled conditions on screens of standard dimensions. No matter how carefully this operation is carried out, however, the results vary. Compressing asbestos for shipment results in compacting the material to such an extent that the buyer, upon screening it after shipment, obtains a lower test than did the seller. As a result the purchaser finds it necessary to "sweeten" his shipments with long fibre asbestos to ensure that they will be up to the desired grade upon reaching their destination. Some dependable tests are urgently required, and the committee accordingly agreed to undertake as one of their first problems, an investigation of possible methods of standardization of tests.

Another problem is the utilization of asbestos of intermediate and short fibre, especially the latter, of which large additional quantities could be recovered by the mills if there were a demand for this grade. Certain uses for the short fibre asbestos have already been developed where its unique properties make it of value, but most of these applications involve the utilization of only small tonnages. What is required is the large scale application of asbestos in important industries.

Problems in milling were also discussed by the committee, but it was agreed that these should be left to the industry for the present, since important improvements in milling practice have already been made.

At the second meeting of the committee held in Ottawa on March 4, 1931, the President of the National Research Council reported that Mr. D. Wolochow, who had had extensive experience in scientific research on cement, had been secured to work under the direction of Dr. G. S. Whitby in the National Research Laboratories and he had already been some months at his task. Tests were being made on standardization and new uses of asbestos, and leads being obtained might prove of commercial importance.

In connection with standardization it was reported that there had been formed under the auspices of the Quebec Bureau of Mines a Committee on Uniform Classification and Grading of Asbestos Mines Products. It was agreed that this committee should be represented on the Associate Committee on Asbestos and that an exchange of minutes should be made in order that each committee might be fully informed of the other's work.

The committee considered the situation in regard to asbestos being brought into America from Russia. It was agreed that it was essential to secure a comparison of asbestos from Russia and Canada, and it was suggested that this be done by having authoritative tests carried out in commercial manufacturing plants under the supervision of the staff of the

National Research Council. It was decided to make arrangements for these tests as soon as possible.

Associate Committee on Biophysics

As previously reported a conference on biophysics was held in Toronto in February, 1930, at which there was a general discussion of important problems awaiting investigation in the field of radiology, especially in relation to the treatment of disease. At this conference a subcommittee was appointed to go over the whole list of problems suggested, consider the advisability of research, and report back to the main committee.

A meeting of this subcommittee was held in Toronto on October 18, 1930. In the absence of Dr. Tory, chairman, Dr. Boyle, Director of the Division of Physics in the National Research Laboratories, presided.

In view of the fact that in the therapeutical use of radiology, which is rapidly increasing, there is little precise knowledge as to the proper wavelengths to use or the optimum time and intensity of treatment, it was agreed that standardization in dosage is of fundamental importance. After a full discussion the committee recommended to the National Research Council that provision be made as soon as possible in the National Research Laboratories for the standardization of measurements of radium, X-rays, ultra-violet and other light, high frequency radiation, and heat radiation. Steps to that end are now being taken.

It was recognized that this meeting of the subcommittee was only a preliminary discussion, and that a very large field exists for research in biophysical problems. It is anticipated that provision will be made for this in due course, although at present the work which can be undertaken is seriously limited by the inadequacy of the funds available.

While not carried out under the committee, it is of interest to note that work on high frequency radiation in relation to chemical reactions and selective heating of animal tissues is under way by Dr. J. C. McLennan in the Physical Laboratory of the University of Toronto. The progress of this investigation to date is summarized on page 114 of this report.

Associate Committee of Chemists

Two meetings of the committee have been held during the year under review, both in Ottawa, on January 4 and May 29, 1930. Dr. G. S. Whitby, Director of the Division of Chemistry in the National Research Laboratories, presided at both these meetings, having succeeded to the chairmanship previously held since the organization of the committee by Dr. R. F. Ruttan, now deceased.

At the earlier meeting Dr. Tory briefly reviewed the work of the National Research Council and outlined the plans for the National Research Laboratories. The committee discussed in particular the arrangements being made for researches in pure and industrial chemistry.

The question of the production of artificial fertilizers in Canada was considered at some length. Messrs. B. L. Emslie and R. J. Walley presented

papers dealing with various phases of this subject. It was noted that the results of recent work differed somewhat from earlier observations regarding the need of fertilizers, particularly in western Canada. There was indicated a need for a comprehensive study of the whole subject. Dr. Hibbert presented a discussion on the relation of agriculture to the chemical industry.

Mr. W. A. P. Schorman gave an interesting demonstration of the use of the Stevens consistometer and showed charts illustrating the value of tests carried out with this instrument, especially as to the temperature and viscosity coefficients. The cold test is regarded as of especial importance in Canada because of the necessity of operating motors in very cold weather.

Dr. Bruce Macallum outlined to the committee some recent advances in the study of vitamins. This had become a question not only of importance to human health, but also of economic value in animal biology. Extensive application was being made in this field, especially in the raising of poultry.

The chairman outlined the work being done on chemical problems in the National Research Laboratories and stated that he would welcome the assistance of the committee in bringing to his attention other chemical problems that should be considered.

At the May meeting of the committee Mr. Wardleworth brought up the question of chemical weed killers and their possible use on a commercial scale, and available sources of these. This matter was discussed at some length, especially in relation to the work of the Associate Committee on Weed Control. For details of the activities of this committee see page 100.

Mr. Lathe gave the committee the results of an inquiry regarding the importance of the problem of elevator screenings, of which some 150,000 to 250,000 tons per year are available at the head of the lakes. The different classes of screenings were discussed with possible uses of each. The problem was regarded by the committee as a suitable one for investigation in the National Research Laboratories, and it was decided to secure as much information as possible with a view to laboratory experimentation.

The chairman gave an account of investigations under way in the National Research Laboratories on natural gas, maple sugar, honey, leather, wool, and laundry problems, in keeping with his policy of informing the committee regarding his work. A number of these problems were discussed in some detail by the committee.

Mr. S. J. Cook, of the Division of Research Information, introduced the question of import statistics relating to the chemical industries. Where work is directed towards the promotion of improved methods of manufacture and the possible development of new enterprises it is of first importance to know in detail present sources of supply, the quantities and values of domestic production, and import trade for all materials in any way related to the problem under consideration. This question was regarded by the committee as of importance to the industry and it was agreed that an effort should be made to secure from the Department of National Revenue detailed information regarding the chemicals now imported, but which could under favorable conditions be manufactured in Canada.

Dr. Hibbert brought up the question of university training prerequisite to postgraduate work in chemistry. He expressed the hope that it might be possible to establish minimum requirements which would be accepted by all Canadian universities. If these could be agreed upon it would greatly facilitate postgraduate instruction. The committee decided to inquire whether the universities would care to enter into a discussion of this important problem.

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

Alberta Department of Mines

Alberta Research Council

American Engineering Standards Sectional Committee on Coal
Classification and Analysis

Dominion Department of Mines

The third general meeting of the committee was held in Ottawa on March 2, 1931, at the time of the annual meeting of the Canadian Institute of Mining and Metallurgy.

Unfortunately no member of the American committee could be present, but Messrs. Gilmore and MacKay reported on the meeting of that committee attended by them. It was evident from these reports that satisfactory progress was being made, although it was obvious that there had not yet been devised any system of coal classification which would meet with universal acceptance. Elaborate plans are under way involving laboratory researches and the work of numerous subcommittees.

Prof. Edgar Stansfield outlined the results of the chemical survey of Alberta coals which had been carried out by the Alberta Research Council in co-operation with the Alberta and Federal Department of Mines. The samples from the mines were chosen to represent an irregular section of the province where the desired range of coals could best be obtained. The suitability of the location chosen was indicated by the fact that on a pure moist-coal basis the fixed carbon varied from 78 to 32%. In no other part of Canada was such a range of coals available in so short a distance.

Much laboratory work had been done on the 13 samples of coal obtained, including proximate and ultimate analyses, separations by heavy solutions to eliminate the effect of ash, storage index, strength index, accelerated weathering tests, alkali treatment, ignition temperatures, and fusion points of ash. Further tests are to be made with organic sulphurs and Dr. E. H. Boomer of the University of Alberta will carry out hydrogenation tests on all samples.

It was agreed that the striking results which had been obtained fully justified the large amount of work involved in this investigation. The committee asked that, if possible, arrangements be made for a similar series of tests on samples taken along the second section of the Alberta coal mining area.

Dr. B. R. MacKay reported for the Subcommittee on the Origin, Constitution, Location and Occurrence of Coal that about 300 samples had been

collected varying in rank from peat to sub-anthracite. These were available for examination in the Museum, as were also 13 pillars of coal taken from mines in Nova Scotia. The latter were intended for a detailed microscopic study.

Mr. R. E. Gilmore reported for the Subcommittee on the Sampling, Analysis and General Uses of Coal. He stated that six standard samples had been distributed to each of a number of Canadian laboratories for analysis in order to check up on the reliability of the methods used. The results from all laboratories were found quite satisfactory, from the point of view of commercial analysis, and several of the best were considered to be good enough even for classification purposes. This subcommittee intends also to investigate methods of sampling, in which the errors are considered to be at least equal in importance to those of analysis.

A report on the applicability of proposed scientific classification schemes to Canadian coals was made by the chairman of that subcommittee, Prof. Edgar Stansfield. He called attention to the difficulty in regard to moisture determinations and emphasized the importance of eliminating mineral matter, in order to bring all coals to a common basis. Much discussion followed on these questions, which are regarded by the committee as very important to the scientific classification of coals. Mr. J. H. H. Nicolls submitted a table giving a large number of analyses of Canadian coals, together with his comments. He also presented classification charts upon which these analyses had been plotted.

Other questions discussed by the committee were the X-ray examination of coals, which is of particular importance in a study of the ash content, chemical surveys of other coal fields than those of Alberta, and attendance at meetings of the American committee.

The committee recommended that Mr. L. Tasker of the Ontario Research Foundation be appointed to the committee, and this was later done by the National Research Council.

Associate Committee on Electrical Measuring Instruments

Co-operating organization:

Gas and Electricity Inspection Service

The most important matter before the committee during the year under review was the question of the permissible error of demand meters. This was discussed fully at the third and fourth meetings of the committee held in Ottawa on September 5, and in Montreal on November 1, 1930, respectively. There were present representatives of the Gas and Electricity Inspection Service, the instrument manufacturers, the power companies and the technical staff of the National Research Council.

Many suggestions were made as to possible variations in the present regulations. Numerous charts were shown to illustrate how various proposals made would work out in actual practice. The question of instrument design and the causes of error were discussed in some detail, since these are

intimately bound up with the question of allowable limits of accuracy. The necessity for a certain amount of friction in the instruments was recognized, although this renders them somewhat less sensitive.

After all aspects of the question had been carefully considered it was agreed that no change should be made in the present regulations which permit an error of $2\frac{1}{2}\%$ of the full scale of maximum demand meters.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association, which operates as an Associate Committee of the National Research Council, as at March 31, 1931, had a total membership of 579. This includes members of the main committee, sectional committees and all working committees.

NEW PUBLICATIONS *Revised Specifications*

During the year revised editions of two specifications have been issued, as indicated below:

B-18-1930, Established List of Stove Bolts

This constitutes an Established List of Stove Bolts, similar to the Established List of Machine Screws published in 1929, and is a revision of the old specification B18-1925. The revision consists of a rearrangement of the data; there has been no radical change.

G30-1930. Standard Specification for Billet-steel Reinforcing Bars

G31-1930. Standard Specification for Rail-steel Reinforcing Bars

G32-1930. Standard Specification for Steel Wire for Concrete Reinforcement

These constitute a revised edition of the former specification A9-1923 covering Reinforcing Materials for Concrete. It has been decided to reclassify these under ferrous metals, rather than under civil engineering and construction, and a publication has been issued covering each type of reinforcing material. The specifications have been brought up to date in accordance with the latest practice; a feature of the first two publications is a supplement covering an established list of sizes for round and square reinforcing bars which provides a practical range of area for use in design. The use of this list by architects and designing engineers is strongly recommended.

CIVIL ENGINEERING AND CONSTRUCTION

Wood Piling. The Committee on Wood Piling has prepared a first draft of the specification, and revisions to this draft are now being considered. In this connection a circular has been issued to the leading lumber and timber dealers asking for information on sizes of piling timber for the different species and it is hoped to compile a table of useful data.

MECHANICAL

Screw Products. Under the Committee on Screw Products four panels have been organized dealing with: (1) Cap and set screws, studs, etc. (2) Machine, carriage and plough bolts. (3) Machine screw nuts. (4) Binder head screws. Reports from these four panels have been received and discussed at a second meeting of the committee and it is hoped shortly to get these reports in form for publication. In this work considerable simplification will be accomplished and it is expected that the established lists which are issued will be of considerable value to both the manufacturers and users of these products.

Standard Color Scheme for the Identification of Piping Systems. A committee has been organized to consider this project, and at its first meeting it appointed a special panel to consider available data and to make a draft specification. This draft has been prepared and will shortly be submitted to the committee for consideration.

Standard Connections for Cutting Edges and Mouldboards of Road Grading Machinery. A committee has been organized to consider a standard for Canada and suggestions for such a standard are being submitted to the committee for their comment. There is every indication that different manufacturers and provincial highway authorities will be able to agree on a Canadian standard.

ELECTRICAL

Power Transformers. Comments on the second draft of this specification and also a special report from the panel of the committee have been circulated to the members of the committee, and it is hoped to prepare a final draft very shortly. It has been held in the meantime for a report from the panel which is considering transformer bushings.

Transformer Bushings. A panel of the Committee on Transformers has held two meetings during the year and a tentative agreement was reached with regard to dimensions for bushing connections on five classes of transformers, 44,000 volts and under, and there is a good prospect that final agreement will be reached on these suggested dimensions. It is hoped to include this report in the proposed specification for power transformers.

Transformer and Switch Oil. A summary of replies to the questionnaire which was sent out to the committee, asking for information on specifications, was sent out for comment, and a summary of the comments was also sent to the committee, which held its second meeting during the year. After considerable discussion a small panel was appointed, consisting of a representative of the power users, the transformer manufacturers and the oil interests. This panel has now submitted a draft specification which has been sent out to the committee for comment and it is hoped to have a meeting of the committee in the near future to consider this draft.

Lead-covered Power Cable. A committee has been organized to discuss a specification for this material and some data have been sent to the mem-

bers of the committee for their preliminary consideration. A first meeting will be held shortly.

Canadian Electrical Code, Part II.—Specifications for Electrical Apparatus.

A draft specification covering power-operated radio receiving devices was circulated to the members of the C.E.S.A. Panel on Specifications and also to the members of the Radio Manufacturers Association. Two meetings of the panel have been held and this draft specification has been revised and a second draft sent out for comment. The first draft of a specification covering electric signs has also been sent out to the panel for their comment and copies of both specifications have been sent to the electrical section of the British Engineering Standards Association.

Canadian Electrical Code, Part III.—Outside Wiring Rules.

The work of the sub-panels has made rather slow progress during the year but it is hoped to submit progress reports to the correlating sub-panel early in May. It has been proposed to reorganize Sub-panel No. 4, so that it may deal only with matters concerning conductive co-ordination, and matters concerning grounding will now be assigned to the Code Panel on Grounding, which operates under the Electrical Code Committee.

INTERNATIONAL CO-OPERATION

An active correspondence has been maintained with different national standardizing bodies throughout the world and exchange of specifications has been continued. Empire standardization was discussed at the Imperial Economic Conference at London last October and an endeavor will be made to secure closer co-operation among the different standardizing bodies in the Empire. A new organization has just been established in New Zealand.

FINANCIAL

The scheme for sustaining membership is now operating under the Financial Committee appointed in 1929. There are now 75 sustaining members on the list and the total amount received from subscriptions for 1930 amounted to \$6,600.00. The National Research Council has continued its financial support and this, together with sums received from industrial firms, has enabled the Association to carry on its work in a satisfactory manner. The total expenditure of the Association for the year ending March 31, 1931 was \$16,639.71.

Associate Committee on Field Crop Diseases (Western Section)

Co-operating organizations:

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

In April, 1931, the Associate Committee on Rusts and the Associate Committee on Field Crop Diseases (other than rusts) met as a single Committee on Field Crop Diseases. This meeting represented the eighth meeting of the rust investigators and the third meeting of the investigators of foot-rots and other diseases. The rust committee was organized at a time when the urgency of rust investigations was very great. These investigations are now proceeding to a very satisfactory conclusion. Since the great urgency for the organization and co-ordination of rust work has passed it seemed advisable to bring all of the investigations of field crop diseases under one committee, with the necessary subcommittees on various important groups. Five subcommittees have been organized, as follows: (1) Plant Disease Surveys; (2) Rusts; (3) Foot- and Root-rots; (4) Smuts; (5) Plant Breeding. The object of this form of organization is to provide for conferences of small groups of those actively participating in specific research projects.

The progress made to date in the co-operative researches on wheat stem rust was summarized as follows by the chairman of the committee, in a statement issued following the annual meeting in Winnipeg:

“The results obtained both in the development of rust-resistant varieties and in understanding the fundamental nature of the dread disease show that Canada has taken a place in rust research that is second to none, indeed, so far as I can see, it is in the very front rank.

“We have made a tremendous advance in the last five or six years. We have made progress which might well fill us with pride. There should, however, be no relaxation in the effort. It looks as if we had pretty nearly solved the major problem but there is considerable yet to be done before we can with confidence put out a variety or varieties to the farmers and look with indifference on the conditions that now send the rust spores from the south into Manitoba and Saskatchewan, and even on to the Peace River districts of Alberta.”

PLANT DISEASE SURVEYS IN THE PRAIRIE PROVINCES

One of the important phases of plant pathological work is the gathering of accurate and reliable information on the prevalence and distribution of plant diseases. This work has been carried on for a number of years by both Dominion and provincial organizations. There was a need for co-ordinating further the activities of those participating in survey work, especially in methods of making observations and the recording of data. It was agreed at the 1930 meeting at Saskatoon that information on all plant diseases be collated, first by the plant pathologists in each province, and then summarized by the Division of Botany of the Dominion Department of Agriculture. The final report is tabled at the opening session of the annual meeting of the Associate Committee on Field Crop Diseases. Brief sum-

maries are presented by the leaders in the various laboratories, and thus the whole question of plant diseases is brought before the conference.

Uniform plant disease survey report cards were devised which can be used by all groups making observations in the prairie provinces.

The most notable observations on plant diseases during the past year were centered around the smuts of cereals. There was a great increase in the damage caused by the smuts, especially bunt, or stinking smut of wheat. Of great scientific interest was the outbreak of stem smut of rye in Saskatchewan this year. It was found in 19 fields out of 84 examined. Sporadic outbreaks may occur but it is not likely to be destructive year after year.

RESEARCH AT THE DOMINION RUST LABORATORY, WINNIPEG

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

A summary of the results from 11 years of survey shows that certain forms of rust, such as No. 17, were predominant in the earlier years and then became of relatively little importance. Later, form 21 has been very common, and in the last few years form 38. This change is rather significant since Marquis is resistant to form 38 and Garnet, one of the newer varieties grown widely in recent years, is quite susceptible to it. Twelve out of 49 physiologic forms of stem rust which have been found in Canada have been responsible for 93% of all the rust epidemics in Canada from 1919 to 1930.

In order to study all phases of the life cycle of the rust organism it was necessary to develop sane artificial methods for stimulating the germination of dormant teliospores. It was discovered that a short period of freezing (2-7 days) followed by alternate wetting and drying, invariably resulted in germination. Hybridization between different rust forms from wheat and rye results in four new forms. They were all less virulent on both wheat and rye. It is probable that such hybridization is not important as a source of virulent strains of wheat stem rust or rye stem rust.

For the first time two physiologic forms of stripe rust were demonstrated to exist in Canada. Cross inoculation between wheat and barley collections indicate that the variety name *Puccinia glumarum tritici* should be retained to describe the form occurring on both wheat and barley, and that *P. glumarum hordei* should be dropped. Cultural studies with stripe rust demonstrated that the longer infected wheat is kept at a low temperature the greater its susceptibility, and inversely, the longer it is kept at a high temperature, the greater is the resistance. It was previously reported that in wheat stem rust in general the opposite was true. In the case of leaf rust of barley (*Puccinia anomala*) the temperature exerted a different, or opposite effect on different physiologic forms.

The development of varieties that resist rust has now come to the point of routine procedure. Such varieties can be produced at will and in large numbers by anyone acquainted with the simple technique of breeding self-fertilized plants. The production of varieties good in other respects than rust resistance is exceedingly difficult. The new hybrid strains are being subjected to numerous tests in addition to rust reaction. Four strains promising in many desirable characteristics besides rust reaction will be selected for increase in 1931.

Sulphur dusting has continued to give approximately the same effective control of stem rust as in previous years. It has also been found that frequent applications prevent the development of a bacterial disease of wheat called black chaff.

The disease garden studies have served a very useful purpose in furnishing information concerning the arrangement of experimental field plots, and the method of recording disease infection results. With the use of more efficient technique, the disease garden test should be a reliable one for eliminating the varieties which are the most susceptible to the root- and foot-rot diseases. Studies in greenhouse pot cultures of some of the new hybrid varieties demonstrated a greater resistance to certain foot-rot organisms than that possessed by either parent.

Studies on the reaction of several wheat varieties to bunt, *Tilletia tritici* and *T. laevis* demonstrated the existence of physiologic forms. Two physiologic forms of the loose smut fungus on wheat were found also, one specialized on the durums and one on the hard red spring wheats.

Pure culture experiments with *Ustilago avenae* and *U. levis*, the covered and loose smuts of oats were shown to be heterothallic chlamydospores being produced only on oat plants inoculated with two cultures of opposite sex. The two species were found to hybridize readily.

Several other projects in this laboratory are well under way and are progressing satisfactorily.

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

RESEARCH AT THE UNIVERSITY OF ALBERTA

Studies have been continued on the phenolic constituents of the cell contents of wheat leaves, and on their possible relation to rust resistance. Comparative dyeing tests carried out with eight wheat varieties of graded resistance to rust indicate that all contain the same coloring matter. This further supports the hypothesis that phenolic compounds play a part in rust resistance. Little Club, a susceptible variety, contains the same main compounds as those isolated from Khapli, a resistant variety. The constitution of Khapliol, the yellow water-insoluble, phenolic coloring matter, isolated from Khapli wheat, is still in doubt.

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

Both the non-living and living environmental factors of the soil may influence the development of pathogenic organisms. Work on the latter fac-

tors has demonstrated that the dominant effect of the natural soil flora is a suppressive one, at least on *Helminthosporium sativum*. Severe seedling blight resulted when the pathogen was placed on sterilized soil. A trace of unsterilized soil had almost as great an inhibitive action as a selectively large amount. When more than a trace was used there was almost complete suppression of the pathogen. A combination of a number of organisms caused the greatest inhibition of the pathogen. This indicated that the suppressive action is primarily due to the natural soil flora rather than to other soil organisms.

Recontamination of grain treated with formaldehyde may be largely avoided if the grain is sown while still moist. There is apparently no protection after the grain is dry. A relatively low percentage of the smut balls was broken in passing through a seed drill. Formaldehyde caused an average reduction in germination of 13% in wheat sown at six different points in Alberta in 1930.

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

There has been a considerable increase in the prevalence of bunt on wheat during the past two years in the prairie provinces. The average loss per car grading "smutty" was \$130. The total loss in the field is even greater than that due to decrease in grade. It has been demonstrated that the newer varieties of wheat, in general, are more susceptible than those grown formerly and that there has been a change in the number, prevalence and distribution of physiologic forms of the causal organisms (*Tilletia tritici* and *T. laevis*). Six physiologic forms differing in infection capabilities were found. The highest infection rating was obtained when the soil temperature was at 10°C. Correlation studies indicated that there were certain genetic linkages between smut reaction and some of the morphological characters. Progress is being made in producing resistant varieties.

Forty-five winter wheat varieties were heavily attacked by the foot-rot disease caused by *Ophiobolus graminis*. There was a negative correlation between yield of grain and percentage of culms blighted. The correlation coefficient of $-.497 \pm .08$ shows that yield has been adversely affected by take-all and that there must be a difference in varietal reaction.

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

RESEARCH AT THE DOMINION LABORATORY OF PLANT PATHOLOGY,
UNIVERSITY OF ALBERTA

Stripe rust has been found to be fairly general in Alberta during the past few years. Wild barley, *Hordeum jubatum*, appears to be the host primarily responsible for the spread of this disease. If the winter wheat plants are sufficiently protected by snow, stripe rust overwinters on the leaves. Evidence has also been obtained to show that it overwinters on wild barley. The general infection, however, occurs from air-borne spores. It is not yet an important economic problem but the introduction and general use of susceptible varieties may make it so.

Studies are being continued on the effect of the association of micro-organisms on the pathogenicity of root-rotting fungi. The inoculum of each

of the pathogens was found to be more effective when added to sterilized soil than when it was incorporated in unsterilized soil. All pathogens behaved in this way whether they were used singly or in combination. During a 40-day period following the application of the inoculum to the soil, there was a natural reduction in the virulence of the pathogen. Studies on the effects of the association of fungi and bacteria and their filtrates on the pathogenicity of *O. graminis* in sterilized soil showed, in general, the living cultures of fungi and bacteria to have been more active than the filtrates in suppressing the pathogenicity of *O. graminis*.

The practical value of potato seed treatments against scab has been questioned. The results from a number of experiments have led to the conclusion that the methods now recommended for disinfecting seed potatoes to reduce common scab on the resulting crop are of no practical value under ordinary field conditions in Alberta.

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

RESEARCH AT THE UNIVERSITY OF MANITOBA

The work of the past season in breeding rust resistant common wheats has consisted chiefly in testing a number of F_6 lines. The Iumillo \times Marquis lines were discarded because of inferior milling and baking quality. Several of the Kota \times Marquis lines were promising and only two of the Kota \times Ruby lines remained after last year's eliminations. The Kanred \times Kota lines were a little later than Marquis in maturity but will be tested for another year. Several of the Pentad \times Marquis lines were particularly promising, being resistant to rust, strong-strawed, as early as Marquis and equal or superior to it in milling and baking quality.

Sulphur dusting was an effective means for controlling rust on barley. Yield and weight per kernel were increased as well as protein content. The dusted plots were more normal in growth than the undusted, and four days later in maturity.

(Investigations under the direction of Prof. A. T. Elders.)

The work was concluded on several years of hybridization and selection in crosses between strains of emmer and durum, and varieties of *T. vulgare*. The testing of the strains produced will be continued with the Manitoba Agricultural College and the Dominion Rust Research Laboratory.

(Investigations under the direction of Prof. H. F. Roberts.)

RESEARCH AT THE UNIVERSITY OF SASKATCHEWAN

Observations made during the past summer have confirmed previous impressions that the browning root-rot disease on wheat is closely related to soil conditions brought about by the common practice of summerfallowing as well as seasonal climatic conditions. The disease is virtually absent in the stubble crop following. The disease is equally prevalent on all soil types, especially where the rainfall is normal or above normal. The disease is not seed borne, consequently seed treatments are of no significance.

Studies on the identification of *Pythium* species produced evidence to the effect that comparisons of the pH relationships may be of real value in classifying the genus.

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

The curve which represents the distribution of the functioning pollen grains in *vulgare* × emmer hybrids is nearly the reverse of the curve representing the theoretical distribution. A satisfactory technique was developed for making observations on the distribution of the chromosomes in the formation of the pollen grain. The actual numbers as determined by observation are very close to the theoretical and very different from those in functioning grains. The results in the F₂ are not due to the non-formation of expected chromosome types of pollen grains but to something which happens after the grains have formed and divided. Many fail to function owing to their slowness in nuclear development which is correlated with a deficiency in cytoplasm.

The pollen grains proved to be excellent material for studying the morphology of the chromosomes as there is only one-half the chromosome number. The chromosomes in this stage can be identified by their length, constrictions, etc.

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

Two random hybrid populations of wheat were inoculated with physiologic form 21 of stem rust at two different temperatures. The group inoculated at the lower temperature (61°F.) showed resistance dominant to susceptibility while the group inoculated at the higher temperature (70°F.) showed susceptibility dominant. The results were explained genetically on a three factor hypothesis with the assumption that the factors for susceptibility at a higher temperature are curtailed in their action at a lower temperature such that the majority of the plants are resistant. The results with the higher temperature (70°F.) are in agreement with field observations and consequently would be the most practical and useful in breeding for stem rust resistance in wheat.

Studies on the endosperm development in the F₂ of a *T. dicoccum* × *T. vulgare* cross showed that shrunken seeds tended to give plants that were more *vulgare*-like than those from plump seeds. In case a large amount of seed is available, it appears that there is no special need to give particular attention to the shrunken seeds.

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

RESEARCH AT THE DOMINION LABORATORY OF PLANT PATHOLOGY,
UNIVERSITY OF SASKATCHEWAN

Isolation studies on the fungous flora of wheat crown and roots at a number of different points in the prairie provinces showed *H. sativum* and various kinds of *Fusaria* to be the most common. Isolations from the crown generally showed an increase in the number of organisms as the season advanced.

A study of seed troubles in relation to root-rot of cereals and the fungi associated with the seed has shown that a visual examination, a centrifuge test with a moist chamber and a sterile sand test will give a good indication of the disease factor in a sample of barley.

Amputation of various portions of the root system of wheat plants has shown that injuries to the seminal root system are serious during the seedling stage but become less serious as the season advances. The trend for the crown root amputations is the reverse. Amputations just before maturity are less injurious than previous to this phase.

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

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
Calgary Technical School
Dominion Department of Mines
Institute of Technology and Art, Calgary
University of Alberta

During the year the waste of gas in Alberta, particularly in the Turner Valley, has continued on an ever-increasing scale. The committee has therefore concentrated its efforts almost entirely on the utilization of this gas. In the meantime negotiations are on foot which it is hoped will lead to at least a partial reduction in the present scale of gas wastage.

Two meetings of the committee have been held during the year, in Ottawa on May 23, 1930, and in Edmonton on January 9, 1931.

At these meetings Dr. Boomer outlined the progress made in the research on natural gas, which is being carried out under his direction in the laboratories of the University of Alberta. Viking gas has been used in these experiments. It is almost sulphur-free, but contains a smaller proportion of the higher hydrocarbons than does the gas of the Turner Valley, the methane content being about 93% as calculated from combustion analyses.

In order to find catalysts which might promote the formation of ethyl alcohol from water gas, or from a mixture of carbon dioxide and hydrogen, a series of experiments was carried out on the decomposition of alcohol, on the principle that a catalyst which promotes a given reaction will also promote the reverse reaction. No catalyst has yet been found which will give a clean decomposition, but some of those tried have produced carbon dioxide and hydrogen almost exclusively. When water gas under a pressure of 2,500 pounds was heated in a glass-lined steel reaction chamber in the presence of a catalyst it gave mixtures of acetic acid, methyl alcohol and water, without any carbon deposit.

Work was carried out on the heat treatment of natural gas, and in particular the relation between the yields of solid and liquid hydrocarbons, the composition of the gas and the temperature of the reactions. The gas was passed at different rates through quartz tubes in order to vary the time of contact, the temperatures used being in the neighborhood of 1000°C.

There proved to be an optimum time of contact for the maximum yield of liquid products and another for the formation of acetylene. Ethylene on the other hand did not reach a maximum, the yield increasing with rising temperature and decreasing time of contact. The light oils produced in the reactions were collected by means of charcoal. The liquid consisted of 81 to 90% benzene, about 10% toluene and a small naphthalene fraction, the total yield being about 12% of the theoretical.

A third group of Dr. Boomer's investigations dealt with the use of natural gas, or of hydrogen produced from it, in the hydrogenation of low-grade coal or bitumen. In an autoclave provided with means for agitating the contents Murray bitumen was found to take up hydrogen very rapidly. Conditions were found under which by cyclic operation a total yield of 65 to 70% of the original bitumen could be obtained as gasoline without the formation of any coke. The use of natural gas in the place of hydrogen resulted in the formation of considerable coke.

Mr. Rosewarne presented reports giving the analyses of natural gas which had been made by officials of the Department of Mines on samples taken from various wells in the Turner Valley district and from other parts of Canada. The helium content was determined in 100 samples obtained from nearly all of the provinces. It varied from nothing up to 0.2%, being as a rule extremely small. Even the maximum concentration is not considered to be of any value in view of the much larger sources of helium available in the United States.

Dr. Whitby described the gas investigations under way in the National Research Laboratories, a short account of which is given on page 32 of this report.

At the May meeting Prof. McLennan outlined his work on the action of high-speed electrons upon gases. Results have been obtained on the use of electrons having a speed up to 140,000 miles per second on certain simple organic substances, which included formaldehyde, acetaldehyde, acetone, and methyl and ethyl alcohols. It was found that cathode rays rapidly polymerized gaseous formaldehyde and also decomposed the resulting solid paraformaldehyde into the oxides of carbon, hydrogen and methane. Yellow condensates were produced on exposing acetaldehyde and acetone to the action of the rays. Cathode rays decompose methyl and ethyl alcohols with but a slight separation of liquid products in the latter case and none in the former. The amount of aldehydes present during the bombardment was determined, and it is suggested that the decomposition process consists of dehydrogenation with the subsequent decomposition of aldehydes.

Associate Committee on Grain Research

Co-operating organizations:

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

During the year extensive co-operative investigations on factors affecting the milling and baking quality of wheat have been conducted under the auspices of the committee. These investigations are divided into three large projects, as follows:

1. Drying of wheat
2. Frost injury
3. Variety tests.

The experimental work on these projects has been carried on in the three universities. In addition co-operative experiments on the improvement of laboratory methods have been conducted by these institutions.

The Dominion Grain Research Laboratory has assumed full responsibility for the annual survey of the protein content of the wheat crop and has conducted tests on electrical apparatus for the determination of moisture in grain. The Dominion cerealist has acted in a consultative capacity.

The university laboratories have been continuing the investigation of problems fundamental to the co-operative projects of the committee. The results of these investigations are published by the individual investigator, but on the approval of at least two other members of the committee such papers are included in the committee's series of papers. Eleven papers have been approved for publication in this series during the year under review.

CO-OPERATIVE INVESTIGATIONS

Drying of Wheat

The work on this project included the collection of samples from commercial driers at Vancouver and further studies with the experimental drier. In these there was used a new drier which is capable of more precise control and a greater range of drying conditions than were possible with the first drier. The work included studies of drying efficiency and of possible damage to the milling and baking qualities of the wheat dried.

The efficiency of drying increased with air temperature and decreased with air flow. On the other hand the injury to baking quality was affected more by heat than by any other factor, and 180°F. must be regarded as the maximum safe air temperature.

Drying very damp wheat in two stages appeared to possess no advantage over the single stage method in preventing injury to baking quality. In fact, samples dried in this way showed slightly more damage than when dried in one stage and the drying operation was less efficient.

Drying to low final moisture content resulted in appreciable injury only when the air temperature was above 180°F. At this temperature slight damage took place on drying to as low as 10% moisture.

Wheat decreases in weight per bushel as the moisture content increases, and drying by means of heat never brings it back to the original bushel weight. The extent of recovery is greater when drying covers only a short moisture range, and when the wheat is dried at a slow rate.

Germination tests were tried as a possible index of injury, and although they showed qualitative agreement in many cases, their value as a check on drying operations has not yet been proved.

Frost Injury of Wheat

A report on the survey of the frozen wheat crop of 1928 is now being prepared. The survey showed that slight damage to the appearance of the wheat by frost is not necessarily indicative of damage to baking quality. This observation has been confirmed by the results of baking tests on the artificially frozen samples produced in 1930. In this series samples were frozen at different stages of maturity and to different degrees. It was found that the baking quality was not injured when the wheat contained less than 42% moisture at the time of freezing. Arrangements have been made to continue these studies by making annual surveys of the quality of frozen wheat.

Quality of Wheat Varieties Grown in Canada

The field work in connection with this project has been completed. Samples have been obtained of over 20 varieties of wheat grown at widely scattered points in the prairie provinces for the last three years. The testing of last year's samples is now in progress and the data will be analyzed and a report issued as soon as possible. The information gathered has already proved to be of great value in the discussion of questions involving quality of varieties. The outstanding quality of Reward, among all the varieties tested, has been clearly shown, and the wider use of this variety in place of Garnet is being encouraged.

Value of a Mechanical Moulder in Test Baking

As a part of the program of improvement of laboratory methods, studies were made of the variability in loaf volume with machine and hand moulding. The major part of this work was done at the University of Manitoba but in addition co-operative studies were made in the other university laboratories. The reduction in variability obtained by use of machine moulding does not justify the purchase of these machines at the present time.

INDEPENDENT RESEARCHES AT THE UNIVERSITIES

Grain Research at the University of Alberta

The effect of timothy, brome, western rye grass and alfalfa on the yield and quality of the succeeding wheat crops is being studied. In addition to the field work and milling and baking tests extensive investigations of the soil composition and microbiology are being carried on. Unfortunately, during the past two summers the rainfall has been below normal and the sods in the portion of the experimental block which was broken in 1928 have not decomposed. As a result no differences in the yield or quality of the wheat following the various forage crops were observed in 1930.

The yield and quality of wheat in nine different rotations are being studied. The samples are grown on experimental plots at the university. In addition, samples for the study of sequence effects have been received from other experimental stations in Alberta.

The effect of association with another crop on the yield and quality of wheat has been the subject of a few preliminary experiments. The results of these indicate that sweet clover may be seeded with wheat to advantage. The quality of the wheat is improved and the yield is the same or slightly greater than that of wheat seeded without sweet clover.

Two experiments on the relation between yield and protein content of wheat were conducted last summer. In the first it was found that any reduction in yield brought about by removing portions of the plants was accompanied by an increase in protein content. In the second the correlation between the yield and protein content of fifty 18-ft. rows selected at random from scattered points in a single field was found to be $-0.40 \pm .08$.

Note: Other grain researches financed and directed by the National Research Council at the University of Alberta, will be found summarized in the report of the Division of Biology and Agriculture, page 22.

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

Soil biology and nitrification studies of plots under alfalfa, timothy, western rye grass, and brome grass, of wheat plots following these crops, and of a fallow plot, were continued in 1930.

The nitrates, in the fallow plots, were higher in the latter half of the season, in both 1929 and 1930, than in any other plots. In the sod plots the nitrates were low, as usual, particularly under the grasses. They were higher under alfalfa than under grasses, and the differences between the grass plots were not significant. Following these sods, under the second crop of wheat, the alfalfa plots contained more nitrates than the grass plots, and the differences between different grass plots were not significant. Under the first crop of wheat following these sods, in 1929, the decreasing order of nitrates was: alfalfa, western rye, timothy, brome. Following the breaking of these soils, in 1930, the decreasing order of nitrates was again the same. There is ample evidence that nitrates are produced more rapidly under wheat following alfalfa than following grasses, and there is some evidence that nitrates are produced more rapidly under wheat following western rye grass than following timothy or brome grass.

The bacterial counts were highest in the fallow plots in 1927, 1928 and 1930, but not in 1929. In the sod plots the numbers were usually slightly higher under alfalfa than under grasses, and the differences between the different grasses were not significant. Under wheat following sods the numbers were not definitely higher than under sods. They were slightly higher under wheat following alfalfa than following grass in both 1929 and 1930. The differences between wheat following timothy and western rye grass were not significant. Following the breaking of these sods in 1930 the decreasing order of average numbers was: alfalfa, western rye, timothy. Generally speaking the differences in bacterial numbers between the different plots are not large, but there is some evidence that the numbers are relatively high in plots of fallow, alfalfa, and wheat following alfalfa.

The fungi counts in the fallow plots were relatively high in 1929 and 1930, but not as high as in the alfalfa plots. In the sod plots the fungi were

highest under alfalfa in both 1929 and 1930, and the differences between the grass plots were not significant. The numbers were higher under sod than under wheat in both 1929 and 1930. Under wheat following sod the numbers were higher following alfalfa than following grasses. Following the breaking of sod it was observed that large mucors predominated in the alfalfa plots. Thus there is evidence that fungi counts are generally highest in alfalfa plots (higher even than in fallow plots) and generally higher under wheat following alfalfa than following grasses. There is also evidence that the counts are higher under sod, generally, than under wheat.

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

GRAIN RESEARCH AT THE UNIVERSITY OF MANITOBA

A study was started early in 1930 on the influence of heating germ at different moisture contents and temperatures for various times, and on the deleterious effect of germ on the baking quality of germ-flour mixtures. It was found that variations in the moisture content of the germ had a pronounced influence on the changes induced by a given heat treatment. With time and temperature of heating fixed, the higher the moisture content of the germ the greater the reduction in its deleterious effect on the baking quality of germ-flour mixtures. Biochemical studies showed that increases in moisture content, or in the temperature or time of heating the germ, resulted in a progressive reduction in lipoid phosphorus content and in the peptizability of the germ proteins by inorganic salt solutions.

The study of the influence of the temperature of storage and the moisture content of wheat flour on the rate of aging is being continued. The results so far obtained indicate that lowering the moisture content of the flour and the temperature at which it is stored decreases the rate of aging. Flours from the low grade mill streams improved in baking quality to a greater extent than highly refined flours under the same conditions of storage.

A study of the heat of hydration of wheat flour, including the starch of wheat, rice and potato, has been completed. The heat of hydration varies widely, depending upon the moisture content of the flour. For example, a highly refined hard red spring wheat flour, containing 1.7% moisture, evolved 18.3 calories per gram of dry matter on complete hydration, while at 16.3% moisture the heat of hydration was only 0.5 calories per gram. The results obtained indicate that the heat evolved is due to the imbibition of water by the hydrophilic colloids of the flour, the data giving a typical adsorption curve when the increments in heat were plotted against the corresponding increments in water taken up. Variations in quantity of protein of similar quality do not result in significant variations in the heat of hydration of wheat flour at a given moisture level, but flours containing protein of poor quality gave slightly lower heats of hydration. Variations in the size of the aggregate particles of flour were not reflected in variations in the heat of hydration. Wheat starches prepared from flours milled from hard and soft wheats gave essentially the same heats of hydration, which were considerably greater than for wheat flour at the same moisture level. The heats of hydration of the starch of rice, wheat and potato were in the inverse order to that which would be expected if the hydration occurred as a purely

surface effect. The specific heats of wheat flour and starch were found to be 0.397 and 0.44 calories per gram dry matter respectively.

A comparative study of the official vacuum oven method for determining the moisture content of ground wheat with the results obtained by the Tag-Heppenstall moisture meter, an electrical apparatus designed for the estimation of moisture on whole grain, showed that 90.8% of the 335 samples analyzed gave an agreement within $\pm 0.3\%$ moisture by the two methods. The results indicate that the Tag-Heppenstall moisture meter may be used with ground wheat, thus increasing its utility in the cereal research laboratory, since the moisture content of whole wheat is liable to vary appreciably from that of the ground sample on which the chemical determinations are made, owing to the heat of friction and to loss of moisture by exposure during grinding.

A study is also under way on the influence of commercial fertilizers on the protein, ash and phosphorus content of Manitoba grown wheat, and their effect on wheat quality. The wheats used for this investigation were fertilized with a nitrogenous, a phosphatic and a potassic fertilizer, applied singly and in combination, the fertilizer being drilled in just below the seed at the time of planting.

With regard to protein content, the fertilizer treatment was without influence, except where a nitrogenous fertilizer was included. All treatments in which a nitrogenous fertilizer was applied, yielded wheats significantly higher in protein than the control plot. The nitrogenous fertilizers, either alone or in combination with phosphorus or potash, or both, tended to yield wheat of slightly lower ash content, the decrease being more marked when a phosphatic fertilizer was also used. Fertilizing had no effect on the phosphorus content of wheat. Flours milled from samples representing the different fertilizer treatments are being submitted to experimental baking tests, but this work is not yet completed.

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

GRAIN RESEARCH AT THE UNIVERSITY OF SASKATCHEWAN

Attention has been directed to the question whether composite samples of wheat may be regarded as representative of the average of the individuals and *vice versa*. This problem has a very practical aspect, inasmuch as the cereal chemist makes deductions from average values and assumes that they are applicable to the mixture being exported; in other cases composite samples are used to judge the quality of a number of individual lots, on the assumption that the composite sample fairly represents the average of the separate parcels. A quite extensive investigation of the relation of these two sorts of samples has led to the general conclusion that when dealing with a given type of wheat no complementary action is evident and that the average value of individuals gives a good estimate of the value of the composite. This does not hold true for mixtures of common and durum wheats.

In a comparative study of various methods for preparing gliadin and glutenin from wheat flour it was found that the composition of the proteins as determined by the Van Slyke analysis varies according to the method used. Duplicate preparations by one method give closely agreeing results. The

differences noted in the various preparations are therefore attributable to changes in the protein and not to experimental error. The Van Slyke analysis furnishes no means of deciding which method of preparation is best.

Investigation of viscosity as a means for differentiating flour quality led to the conclusion that when the salts are leached from the flours, the values obtained by the MacMichael viscosimeter are not significantly correlated with either protein of the flour or with the loaf volume. Flour-water suspensions of the unleached flours, however, give viscosity values showing very high correlation with both protein and baking value. It was found, furthermore, that the actual increase in viscosity due to increased concentration of lactic acid is a reliable criterion of baking quality.

With a series of flours ranging in protein from 8% to 18% the value of the constant b (calculated according to Gortner's method) was found to be constant with leached flours, indicating that no qualitative differences exist and that the variations in quality as shown by the baking values are attributable almost entirely to the quantity of protein present.

On the basis of tests made on Marquis, Garnet and Reward wheats grown under the same environmental conditions, it was decided that in baking and blending quality, Garnet is generally lower and Reward higher than Marquis grown in the same place. Similar relations hold for protein of wheat. The differences between the three varieties appear to be accentuated when they are grown under conditions favorable to the production of wheat low in protein.

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

Associate Committee on Heating and Insulation

Co-operating organizations:

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

The progress being made in building insulation in Canada may be judged by the fact that the retail value of Canadian consumption now amounts to about \$4,000,000 yearly. Of the insulating material used some 75% is produced in Canada, the remainder being chiefly cork and cork board used for cold storage installations and refrigerators. That there is ample room for further expansion, however, is indicated by the fact that the amount of insulation now used is sufficient for only about 15% of the new houses constructed. Eleven firms are manufacturing insulators from wood pulp, eel grass, and other Canadian raw materials. These facts were brought out by Mr. G. D. Mallory of the Dominion Fuel Board at a meeting of the committee held in Toronto on October 11, 1930, at which Prof. R. W. Angus presided in the absence of the regular chairman, Dr. Camsell.

At this meeting Dr. R. W. Boyle, Director of the Division of Physics in the National Research Laboratories, presented a tabulated statement

showing the results of tests carried out at McGill, Queen's and Toronto universities on a wide variety of insulating materials. These tests were undertaken primarily to supply information to the Advisory Board on Tariff and Taxation.

On consideration of the results it was observed that there was substantial agreement between the different laboratories on all of the harder building boards made from wood pulp and similar raw materials. On gypsum products and the softer materials agreement was less satisfactory. It was recognized that this depended to some extent upon unavoidable variation in conditions of tests and on lack of uniformity in the samples. Wide differences in results may be obtained by varying the pressure, and other factors also have considerable influence. Mr. James Govan related one instance in which the condensation of water during a test had made tests in a cold laboratory impossible.

It was agreed that it would be advisable to have further tests on some of the materials carried out in the National Research Laboratories, with apparatus embodying the most recent improvements in design, before the results of the committee's work were made public. These tests are now under way.

The question of standards for insulating materials was discussed at some length. It seemed to the committee desirable that new materials coming on the market should be compared with some definite standard of commonly known heating value, but in view of the fact that progress in manufacture was so rapid, it was agreed that it was not possible to establish rigid standards at the present time.

Prof. Reilley pointed out that sound-proofing had not made nearly as good progress as heat insulation. Work done in this respect was outlined, and evidence was presented to show that a number of manufacturing companies fully appreciated the importance of this problem and were actively engaged in endeavoring to produce materials of satisfactory acoustic properties.

Associate Committee on Honey

Co-operating organizations:

Dominion Department of Agriculture
Manitoba Agricultural College
Montreal District Beekeepers Association

Three meetings were held during the year under review—a general meeting of the committee in May, 1930, an executive committee meeting in December, 1930, and a full meeting of the committee in February, 1931.

At the May meeting Dr. A. G. Lochhead reported on work in progress, under his direction in the bacteriological laboratories of the Dominion Department of Agriculture, with financial assistance from the National Research Council. There was being carried out a study of the infection of honey by sugar-tolerant yeasts, including an examination of soil samples from a wide area, to discover if possible the source of yeasts causing fermentation. There

was also under way a morphological and physiological study of the yeasts isolated and a comparison of these was being made with types previously described. It was already possible to conclude that the ordinary field soil cannot be regarded as a primary source of infection of honey. Many honey-fermenting yeasts were found in apiary soil, but it was considered that infection of this soil took place from the bees and honey rather than *vice versa*. Of these types isolated from different sources several species appeared to be entirely new—a matter of considerable scientific interest.

Examination was made of 24 samples of honey dew for sugar-fermenting yeasts, but none of these were found, although some authorities claim that the comparatively high percentage of nitrogenous matter in honey dew encourages fermentation.

Much work has been done on honey preservatives. These tests have been made on 80% honey, the dilution having been made for the purpose of speeding up fermentation processes. Eight preservatives have been tested. Some of these have had no effect, others entirely prevent fermentation in quantities as low as 0.01%. Some of these preservatives may prove to be of commercial value. Other questions are also involved, however, as the effect of these preservatives on flavor, and the limits permissible by law. Apparently a smaller quantity of preservative will be required for undiluted honey than for the 80% samples used.

In this study fermentation has been found much more active in honey than in synthetic nutrient solutions of equal sugar content. A series of experiments was undertaken to determine the cause of this observed fact. The results are not yet conclusive, but apparently there are in honey one or more activators which do not exist in cane sugar.

At the same meeting Mr. L. T. Floyd reported on experiments carried out by Dr. W. F. Geddes at the Manitoba Agricultural College on the substitution of honey for sugar in making bread. No appreciable difference was found in the fermentation rate, a fact accounted for on the supposition that sucrose in bread is converted to levulose and dextrose at least as rapidly as the latter is converted to alcohol and carbon dioxide.

Mr. C. B. Gooderham of the Central Experimental Farm outlined to the committee his experiments with some 200 samples of honey of which biological and chemical analyses were being made. These samples were being stored under identical conditions, and observations will be made of fermentation and any other changes taking place. Further, 50 samples of honey, also analyzed, were being stored under the five different temperature conditions, and similar observations were being made.

The granulation of honey was also discussed. Prof. Millen of the Ontario Agricultural College stated that this problem had been fairly well solved by Mr. Dyce of the staff of the Ontario Department of Agriculture.

At the February meeting of the committee Mr. Gooderham reported that none of the samples in storage had yet fermented, except those being kept at 70°F. Observations are being continued.

Dr. Lochhead reviewed the progress being made in bacteriological work. He was attempting to determine the amount of yeast infection in honey and whether any particular type of yeast was responsible for fermentation. The work on preservatives had been extended to include undiluted honey, but none of the samples had yet fermented. Honey could also be preserved by sterilization or storage at low temperatures, but none of the three methods appeared to be entirely free from objection.

Dr. Whitby reported on the honey researches being carried out in the National Research Laboratories under his direction. These are reported on page 29 under the Division of Chemistry.

Analytical problems were discussed by Dr. C. J. Watson, under whose direction the analyses at the Experimental Farm had been made. He considered the determination of moisture as very unsatisfactory, but regarded the others as sufficiently good. The use of the refractometer was an attractive possibility,—it would probably prove much better than the hydrometer generally used.

Bee diseases were also considered, and it was agreed that work should be done on this subject if opportunity offered.

The problem of bleaching beeswax was brought up by Mr. Floyd, who presented a resolution from the Manitoba Beekeepers Association asking that research be done. Mr. Floyd reported, however, that one Canadian company was said to have solved the problem satisfactorily. It was agreed to secure samples of imported and domestic bleached wax.

Associate Committee on Laundry Research

Co-operating organization:

Eastern Canadian Laundryowners Association

As stated in the last annual report, a conference of representatives of the Eastern Canadian Laundryowners Association was held in Toronto on March 5, 1930, at which a recommendation was made that a committee be appointed by the National Research Council to co-operate with this organization in an investigation of laundry problems. The National Research Council at its first meeting thereafter appointed an Associate Committee on Laundry Research. The initial meeting of this committee was held in Toronto on October 16, 1930. In the absence of Dr. Tory, who was attending the Imperial Conference, the chair was taken by Dr. Whitby, Director of the Division of Chemistry in the National Research Laboratories.

The acting chairman reported to the committee that Dr. O. M. Morgan had been secured by the National Research Council for its laundry research. He had already made a study of the literature on the subject, and orders for some equipment had been placed. He and Dr. Morgan had visited a number of research centres and laundries in the United States. Of special interest was the research laboratory and the full-scale laundry of the Laundryowners National Association at Joliet, Ill. A visit was also made to the Ohio Mechanics Institute at Cincinnati where two-year courses are given in

laundry methods, each student receiving in this time twelve months of instruction with an equal period of practical work.

The laundryowners present expressed great interest in the work of the committee and generously offered the use of their plants as required for commercial tests. They emphasized the importance of combining a study of laundry methods with those of textile manufacture, since these are intimately related.

The committee discussed training in laundry methods as given at the Toronto and Montreal technical schools. This has proved of great value to the industry in supplying men who know something of the theoretical side of the work in which they are engaged.

Since this meeting of the committee substantial progress has been made in the laundry investigations in the National Research Laboratories. An outline of this work is given in the report of the Division of Chemistry on page 31.

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

The second meeting of the committee was held in Toronto on November 18, 1930, under the chairmanship of Dr. G. S. Whitby, in Dr. Tory's absence at the Imperial Conference. The Council's leather investigations outlined on page 31 of this report are being carried out in the National Research Laboratories under Dr. Whitby's direction.

Dr. Whitby and Dr. Graham reported on their visits to laboratories and tanners in the United States. They had noted interesting developments in a new unhairing agent and in the analysis of tanning extracts. Laboratories and equipment had been specially studied, in view of the necessity of securing information of service in connection with the leather researches at Ottawa.

Dr. Graham discussed at some length the work of the British Leather Manufacturers' Research Association, with whom an arrangement has been made for an exchange of information. This information must be regarded as confidential and its distribution confined to the groups co-operating in the work of the committee.

The problem of damage to hides by parasites, bacteria, and improper handling was considered at some length. Of parasites, the worst was considered to be the warble fly, for the control of which a campaign was being carried out in England under the Empire Marketing Board. In that country it had been estimated that each animal could be washed four times per season with an effective chemical at a cost for materials of less than two pence a season per animal. At this rate all the cattle in the country could be protected for about £35,000, as against an annual loss estimated at £1,000,000. The committee agreed to collect information from Canadian tanners regarding the extent of losses in this country. It is recognized that while the losses

through damage to leather are serious, they are much less than the accompanying losses due to the reduction in the milk and butter and beef produced.

Of bacterial losses, the greatest is due to "red heat," which it has been suggested may be due to bacteria existing in sea salt, as was observed in connection with red discoloration of cured codfish, an investigation of which was made by the National Research Council. It was agreed that inquiry should be made at once regarding damage to hides by bacteria.

Problems of the beamhouse and tanyard were discussed in some detail. It was agreed that for the time being the committee should concentrate on the latter as being of greater urgency.

It was brought to the attention of the committee that Canadian belting manufacturers were anxious to have an investigation of their problems. Dr. Whitby reported that provision was to be made in the National Research Laboratories for this work, and steps would be taken at once to secure some of the necessary equipment.

Associate Committee on Magnesite

Co-operating organizations:

Canadian Refractories Limited
Dominion Department of Mines

Satisfactory progress has been made during the year under review in all phases of the committee's work. It is gratifying to observe also the continued expansion of the Canadian refractories industry at a time when related industries are suffering from the severest depression in many years. In this connection it may be noted that the co-operating companies comprising Canadian Refractories Limited have during the year greatly increased their appropriation for research under the committee, thereby permitting expansion of the committee's activities.

No further experimental work has been recently done in the development of new refractories for use in open-hearth steel furnaces, since the present products are proving highly satisfactory in use. Sales are being extended in Canada, Great Britain and the United States, the only countries in which sales campaigns have been conducted to date. Laboratory work on these products has been confined to the development of new uses. Such are being found in refractory cements, rammed linings for furnaces and similar applications in both iron and copper metallurgical plants.

Work has been actively carried on during the year on the use of magnesian products in the manufacture of refractory brick, much of this work being done, as previously, by the committee's staff in the Ceramic Laboratories of the Dominion Department of Mines. Brick made in this laboratory have been tried in commercial furnaces of various types. Extensive trials will be necessary before it can be definitely determined in which field they will be most useful, but it is believed that their chemically neutral character and their extremely high resistance to fracture under sudden temperature changes will lead to their large-scale use. Patents have been applied for in Canada,

Great Britain and the United States, and it is expected that protection will be sought in all important countries of the world.

Through the co-operation of two large manufacturers of refractories, brick have been made up and burned in commercial furnaces. It has been demonstrated that no radical changes from methods of manufacture of ordinary brick will be necessary and that the product of commercial operations will not be inferior to brick made in the laboratory.

Much of the committee's work has been devoted to the manufacture of a satisfactory plastic magnesia and to the development of methods of its use in oxychloride cements. In the past such cements have suffered in the hands of inexperienced users through lack of standardization of procedure. Satisfactory methods are now being worked out, and immediate application to commercial practice is being made. It is anticipated that this work will lead to a much wider use of oxychloride products, not only for composition floors for which they have been primarily designed, but also in a wide variety of building materials. Theoretical work on the formation of oxychloride cements has yielded interesting results which throw light on their behavior in use and indicate what may be expected under modified conditions.

Comparatively early in this investigation methods were worked out for the manufacture of magnesium bisulphite liquor in ordinary Jensen towers normally used with limestone. A patent has been obtained in Canada upon the process developed, but no commercial application was made until recently when a trial was arranged through the co-operation of one of the large paper companies. In this trial there has been demonstrated the practicability of the procedure developed in the laboratory and also that under certain conditions marked advantages may be expected in its use. The extent of the field in which these advantages will outweigh the higher cost of magnesian rock compared with limestone has yet to be demonstrated.

Associate Committee on Mining and Metallurgy

The thirteenth meeting of the committee was held in Ottawa on March 3, 1931, at the time of the annual meeting of the Canadian Institute of Mining and Metallurgy. Dr. Frank D. Adams, chairman of the committee, presided.

The chairman outlined to the committee the activities carried on by the National Research Council during the previous year. He also reported on the progress which had been made to date in the establishment at Ottawa of national research laboratories and in the construction of the new research building.

At the suggestion of Dr. Alfred Stansfield the committee discussed the advisability of undertaking a general survey of the production of various metals in Canada together with their uses and markets. Dr. Stansfield thought that an economic study of the problem might be of distinct value, and out of it might come suggestions whereby further metallurgical development would take place in Canada. Mr. McLeish informed the committee

that Dr. Camsell had presented at the Imperial Conference a memorandum on the same general subject, and he understood that an Empire inquiry might be instituted. It was agreed to follow up this matter and determine whether any action by the committee was advisable.

A communication was received from Mr. R. H. Stewart regarding the properties of pure zinc and suggesting that the committee might undertake a study with the object of developing new uses. After full discussion the committee considered that it was not necessary to confine this study to zinc alone, but it was generally believed that the producing companies would carry out such work. It was finally agreed to recommend the appointment of a subcommittee to give further consideration to Mr. Stewart's suggestion.

Mr. Lathe raised the question of international collaboration in metallurgical research, regarding which communications had been received through Dr. Stansfield from the Institute of Metals in Great Britain. It was proposed that each country should appoint a metallurgist of high standing to collect information regarding published work in metallurgy in his own country and submit a report to a central organization which would provide for a general distribution of the material. The National Research Council had been asked to undertake this work for Canada. After full discussion it was agreed to recommend that the National Research Council be represented at the meeting of the international committee to be held in Zurich in September, 1931, where the question of organization was to be considered, and that final decision regarding action to be taken be deferred pending the report of the delegate appointed. It was also agreed to ask the Canadian Institute of Mining and Metallurgy for an expression of opinion on this subject.

Mr. J. G. Morrow, Chairman of the Subcommittee on Iron Ores, could not be present at the general meeting, but later submitted a report discussing the sources of ore for Canadian furnaces, methods of beneficiation, the production of steel from sponge iron and improvements in blast furnace practice. The subcommittee is keeping in close touch with developments not only in Canada, but in other countries as well, in order that immediate advantage may be taken of developments of possible use in this country.

The present position of silver was discussed by the committee, and it was agreed to ask the Division of Chemistry to consider the possible development of new uses for this metal.

Mr. McLeish introduced the problem of using Canadian titaniferous iron ores and the manufacture of titanium pigments and ferro-titanium. He referred to the work of the Mines Branch in connection with the production of electrolytic iron and titanium pigments. Some work was now in progress under private initiative. The committee recommended that the National Research Council survey the literature with reference to the possible utilization of Canadian titaniferous iron ores.

Mr. McLeish outlined six other problems arising out of investigations of the Mines Branch, with the suggestion that these might be taken up by the National Research Council or the universities. The following problems were named:

1. The effect of pyrrhotite on lime and cyanide consumption in the cyaniding of gold ores.
2. The effect of arsenic in cyaniding high arsenic content gold ores.
3. The action of aluminum as a precipitant for gold from cyanide solution where little or no silver is present.
4. The problem of the precious metal loss in refinery slags from the treatment of gold precipitate and the treatment of refinery slags in cyanide plants.
5. Problems relating to the sampling of gold bullion with a view to the standardization of a method of sampling.
6. The problem of a standard method for the assay of the metals of the platinum group in base metal ores.

After considerable discussion it was agreed that these problems should be referred to the National Research Council for consideration by their technical officers and such action as might be deemed advisable.

Mr. Lathe introduced the problem of the development of Manitoba pegmatites, regarding which the advice of the National Research Council had been sought. Several rare metals were found in some quantity, and there might be developments of commercial value. The Department of Mines had been consulted and the provincial geologist of Manitoba, and they agreed that this was a very large problem which they could not undertake. The committee decided not to recommend any action by the National Research Council until further developments have taken place.

Associate Committee on Nitrogen Fixation

No meeting of the committee has been held in the year under review, but the annual report for the committee has been prepared as usual, this work having been carried out by Mr. A. C. Halferdahl of the Council's Division of Research Information. The preparation of the report is becoming increasingly difficult as there has been a very rapid increase in the amount of literature on the subject.

As foreseen in the last annual report the production of nitrogen throughout the world has already considerably outrun consumption; as a result fixed nitrogen has sold during the past year at the lowest price in history, and there are those who predict that still lower prices will prevail as further improvements in technology are made. Synthetic ammonia threatens the existence of a proportion of the Chilean nitrate industry because of the lowered cost of production. One writer has given data which indicate that ammonia from coke-oven-gas hydrogen may be expected to yield a fair profit even though sold considerably below present prices. It is most significant that the large low-cost producers of nitrate in Chile, using an improved process, have recently lost money on their operations after paying the Chilean government export tax. The result has been the formation of a huge nitrate company in which the Government of Chile has been made half owner and

in return for which the government has abrogated the tax which has been \$12.50 per ton on a product that sells for about \$40 per ton delivered at Atlantic ports.

The depressed condition of agriculture throughout the world during the past year has had its effect on the fertilizer industry. Every large producer of nitrogen in any important industrial country, except in North America and Norway, has curtailed its output. Germany is producing at about 60% of rated capacity. Expansion of existing plants and the building of new plants continue in the United States, where no surplus of production exists.

Many agriculturists can find no profit in the use of fertilizers since in any case they cannot sell the produce except at ruinous prices. It seems to be the opinion in many quarters that a smaller agricultural production is to be preferred. This may be true, but lower costs are unquestionably desirable, and one way to attain lower costs is by increasing the yield per unit of area for the same operating and overhead charges. This result may be expected by the intelligent use of fertilizers on land suitable for agriculture. Poorer land should be used for other purposes.

With a view to lowering costs, further improvements in the production of hydrogen are being made. One new departure is the use of natural gas as a source of hydrogen for synthetic ammonia by the Shell Chemical Co., in California.

The importance of catalysts and catalysis in ammonia synthesis cannot be overemphasized, since without catalysts the industry would be non-existent. The intermediate-compound theory has received considerable support through the work of Mittasch and Frankenburger of the I. G. Farbenindustrie A. G.

Synthesis of ammonia from atmospheric nitrogen by micro-organisms has been proved by Winogradsky. Variation of pressure of the gases affects the work of these bacteria. Certain algae have also been shown to synthesize compounds of nitrogen.

Air oxidation of ammonium sulphite liquors to give sulphate of ammonia in the presence of a trace of a cobalt salt appears to be commercially feasible, and if so, this may be of considerable value to the producers of by-product ammonia. Cheap phosphoric acid for use in absorbing ammonia in by-product plants should be of distinct advantage. The use of anhydrite for this purpose has been mooted in England.

Blast furnace production of phosphoric acid for fertilizer use has been commercialized in Tennessee and further furnaces are contemplated. Apparently five to eight large-sized blast furnaces could supply the entire present demand for superphosphate manufacture in the United States. Beneficiation of potash-bearing silicates along with the furnacing of the lime phosphate rock seems to be a distinct possibility, although no commercial plants using potash-bearing rocks for flux are yet in operation.

It appears that a potash industry of importance has been started in the Texas-New Mexico fields. The Government of the United States did the

pioneering work in drilling and otherwise exploring the possibilities of the region for potash and after a number of years results were so promising that private companies have entered this field and potash salts are now being marketed.

Mixtures of pure fertilizer salts give high-analysis fertilizers, but such mixtures have certain disadvantages. They are too limited in composition, and it has been found that small amounts of a relatively large number of elements can with advantage and profit be present in fertilizer materials. This problem has not previously arisen because the ordinary low-analysis fertilizer mixtures contain as a rule sufficient of these unusual elements. Further, much trouble is being experienced in securing a uniform distribution of the concentrated fertilizers now on the market.

The consensus of opinion in regard to artificial composting of straw on farms is that ordinarily this procedure is not profitable in Canada and the United States.

Production of dried concentrated feed from frequently cut grassland has been shown to be feasible, and may in time render the farmer independent of outside concentrated feeding stuffs for his stock.

The nitrogen and fertilizer business in Canada has made substantial progress during the year. The large-scale plant of the Consolidated Mining and Smelting Co. of Canada, Ltd., at Trail, B.C., has been put into operation. Canadian Industries, Ltd., have expanded their facilities to some extent. A new fertilizer plant is reported to be planned for Saint John, New Brunswick. Fertilizers are imported into Canada in considerable amount and further expansion of the manufacturing industry in this country may be expected.

Associate Committee on Oceanography

Co-operating organizations:

Biological Board of Canada

University of British Columbia

No meeting of the entire committee was held during the year but several somewhat informal meetings of three, four or five members of the committee, served as a basis on which to work. The chairman consulted with each member personally during the year and referred matters to each by correspondence. This has worked out so satisfactorily that the expense that would be incurred in calling a meeting of the whole committee seemed scarcely warranted.

The committee, as well, kept in touch with the similar committee in the Pacific region of the United States. This was made possible, to a large extent by the attendance of Dr. Hutchinson and the chairman at a meeting in Eugene, Oregon, in June, 1930, which was attended by at least one representative of every institution in this area that is doing any work in oceanography of the Pacific. The summary of the work done during the year, given at this meeting, was distinctly encouraging and plans for further work were enthusiastically considered.

As the Associate Committee on Oceanography has been appointed to act as the Sectional Committee on Oceanography for the Fifth Pacific Science Congress, many of the plans for oceanographic work have been prepared with the Congress in view.

The most extensive new project that is now well under way is the investigation of fiords connected with the strait of Georgia — a Congress Symposium subject. Three fiords have been selected, Howe Sound, Burrard Inlet and Saanich Arm. The first has a wide mouth open to the influence of the Fraser river, is V-shaped, interrupted by a number of large islands and fed by a large glacier river, the Squamish; the second opens through a narrow channel, the Lion's Gate, is constricted throughout its length of approximately 40 miles, and a number of small streams enter it at intervals; the third has a large lake-fed stream, the Cowichan river, which enters an island-protected area outside and near its mouth, and another small lake-fed river near its head. It is beyond the influence of the Fraser river and has a high salinity.

These fiords vary greatly and present an excellent opportunity for the study of the effect of physical and chemical conditions on the marine forms of life. The high hydrogen sulphide content of the lower levels in Saanich Inlet is to be noted specially.

Work on this problem has been carried on throughout the year, and is being continued. The results so far obtained are proving quite as interesting as was anticipated.

The oceanographic work that has been going on for some years in the strait of Georgia has been continued. The main new feature is the investigation of the source of phosphate. This is a problem of considerable difficulty but is a matter of importance in relation to the abundance of plankton.

The committee has not given much attention to the matter of fisheries technology since that is receiving satisfactory treatment at the Fisheries Experimental Station at Prince Rupert. The committee is keeping in touch with the investigation there.

The work on temperatures and circulation is a continuation of that done in previous years, mainly under the direction of Mr. John Patterson.

Associate Committee on Physics and Engineering Physics

The thirteenth meeting of the committee was held in the physics building of the University of Toronto, on October 17 and 18, 1930.

In discussing the helium problem the chairman, Prof. J. C. McLennan, expressed the opinion that no present source of helium in Canada could compete with the American wells, the gas from which contains as much as 7 or 8% of helium. Nevertheless in view of the importance of helium the committee agreed that an intensive exploration of Canada for this gas was desirable.

Professor McLennan called the attention of the committee to a number of problems presented by the upper atmosphere. He exhibited two cameras which he had secured and with which it would be possible to photograph

the aurora with 15-sec. exposures. It was agreed that since this equipment was available every support should be given to measuring the height of the aurora in Canada. In Norway Stoermer had made a great number of determinations by photographing the aurora from two points 10 to 100 miles apart. In Canada the railway line to Churchill and the telegraph and telephone lines in that region were regarded as very suitable places for an investigation.

Dr. Boyle explained the work which was going on in Alberta on the testing of lubricating oils. Mr. Lathe mentioned a new consistometer which would eventually be of great value in determining the practical behavior of oils at both high and low temperatures and which appeared to reveal much more useful information than the ordinary viscosity and cold tests.

Dr. Boyle informed the committee that provision had been made in the National Research Laboratories for standardizing radium. He had already received a number of substandards from Belgium and he could at any time standardize radium in considerable amount. Dr. Allen mentioned in this connection that Manitoba, Saskatchewan, Alberta and Ontario were all establishing cancer research institutes and radium was being purchased. At Halifax a quantity of 200 mg. of radium was available, all in solution.

The committee then witnessed a demonstration of the heating effects of radio waves of from 3 to 30 metres in length. It approved of a continuation of research on short waves under Prof. McLennan's direction.

The committee discussed a statement prepared by Dr. Collins on the use, by the Geological Survey, of geophysical methods of prospecting. The committee agreed with the recommendations therein made that the development of new methods and apparatus should be assigned to institutions devoted to research in physics, and that the Geological Survey should apply the geophysical methods to the solution of geological problems. Work was already under way on the location and delimitation of ore deposits in various parts of Canada. Professor Gilchrist told of the work which he had carried on jointly with the Geological Survey for three seasons. The method which he used was to put in a central probe with others at equal distances around it instead of using two electrodes only. In the lignite district near James Bay the device was found to be advantageous; lignite could be located even though covered to a depth of about 60 ft. by heavy clay.

In discussing the question of high-tension transmission lines Professor Price expressed the opinion that in view of the large sources of power handled on commercial lines, investigations would have to be carried out by the power companies themselves. Dr. Boyle's inquiries, however, indicated that at the present time a large amount of research is carried out in laboratories rather than on commercial lines. Provision was being made in the National Research Laboratories for voltages up to 750,000, with power up to 450 kv. a. or more. Mr. Clarke suggested the possibility that scientific investigators might use newly installed line equipment for testing purposes before it was required in regular service.

A statement was submitted by Mr. Clarke calling attention to the depletion of the supplies of timber suitable for telephone and telegraph poles,

caused by the use of uncreosoted timber in outdoor locations. Western cedar takes creosote fairly well, but the expense of bringing it from British Columbia to eastern Canada is considerable. Creosoted pine is not as satisfactory. A fair quantity of southern yellow pine is imported from Louisiana and Alabama. The committee agreed that the creosoting of Canadian timber was a matter which should be pressed.

Other subjects discussed were the development of altimeters, radio standards, electrical methods of moisture determination, colloids, artificial grounds, insulating materials, corrosion, alloys, cathode rays, clay conduits, scholarships for physicists and the training of physicists in the universities.

Associate Committee on Radio Research

Co-operating organizations:

Department of National Defence

Radio Branch, Department of Marine

The Associate Committee on Radio Research was established by the National Research Council at its 86th meeting, held on September 12, 1930. Prior to this time a subcommittee of the Associate Committee on Physics and Engineering Physics had followed the work on radio research. However, the increasing importance of radio developments indicated the desirability of a separate associate committee which could devote its time exclusively to radio problems.

The first meeting of the new committee was held in Montreal on January 3, 1931. In view of the inconvenience of calling together the members of a large committee at frequent intervals to discuss urgent radio problems which might arise, it was agreed to form a small committee consisting of seven members who could be called together for consultation on short notice. Already advice has been sought from local members of the committee on problems which have been presented by Canadian inventors.

It was brought to the committee's attention that very little information existed with regard to broadcasting conditions in Canada and that such information was not only essential in the interests of technical developments, including the establishment of the most satisfactory wave bands, but also to provide reliable data for international negotiations. Both Colonel Steel of the Department of National Defence and Mr. Bain, Department of Marine, emphasized the vital necessity of immediately undertaking investigations of Canada's radio conditions. It was pointed out that two international conferences were scheduled for the near future and that Canadian delegates should be prepared to take an active part at these meetings.

The nature of the information which should be secured, the investigations which should be undertaken, and the methods of handling these were discussed at length. The committee was emphatic in its decision that the National Research Council should establish a permanent branch devoted to radio research. It recommended that the Council take immediate steps to secure a man qualified for the investigation. This man should first devote his time to a study of Canadian radio stations to determine the constancy

of their frequency and the width of band they occupy. It was also felt that he should undertake to develop a high precision frequency standard for the radio frequency range. This would serve as a primary standard of radio frequency for Canada. The Department of Marine is installing a frequency standard accurate to at least one part in a million. This apparatus will be used to a large extent for routine checking. The National Research Council standard should be even more accurate since it must be the ultimate standard against which all other Canadian radio frequency standards are checked. Moreover, a constant effort should be made to secure higher precision, and research with this in view should be a function of the Radio Branch of the National Research Council. The present congestion in all radio channels presages more exacting demands on future radio frequency precision standards. While no government branch now engaged in radio work has the necessary men and equipment to undertake investigations of this nature, both Colonel Steel and Mr. Bain promised all possible assistance from their respective departments, to the National Research Council.

In view of the fact that it would be most desirable to secure information on existing Canadian stations for the Canadian delegates to the International Radio Conferences to be held at Madrid and Stockholm, the committee were of the opinion that the Council should initiate work as soon as possible. As a result of this, the National Research Council has placed advertisements in leading technical journals for a man to undertake this work and a large number of applications have been received and reviewed.

It was emphasized that, on the completion of the work already suggested, there were a large number of problems still awaiting solution. Canada, by virtue of her vast area extending through various temperature zones, has radio transmission problems peculiar to herself which she will have to solve through her own efforts. For instance, little is known with regard to the nature of the Heaviside layer in this country. The difficulty of transmission in certain regions and directions should be the subject of extensive investigation. Moreover many problems of more general nature are presenting themselves and it was pointed out that there was room for extensive research into the methods of controlling radio station frequencies.

Mr. Bain outlined some of his investigations of attenuation factors. In general, these factors have been regarded as constant, but Mr. Bain's experience had indicated a constantly diminishing factor and the committee strongly approved of a continuation of his investigations.

Several topics for papers which might be presented at the 1933 Pacific Science Congress were discussed. It was felt that papers on Canadian radio conditions would make interesting and valuable contributions.

Associate Committee on Trail Smelter Smoke

Co-operating organizations:

British Columbia Department of Agriculture
Dominion Department of Agriculture
Dominion Forest Service

As outlined in the previous annual report, the National Research Council was asked by the Dominion Government to investigate the claims of alleged damage being done in the northern part of the state of Washington by fumes from the large metallurgical works of the Consolidated Mining and Smelting Company of Canada, Limited, at Trail, B.C. The evidence obtained in the first season's work by the scientists employed by both the National Research Council and the United States Department of Agriculture, which organization investigated the question for the American Government, was given at a session of the International Joint Commission held in Washington in January and February, 1930. No decision having been rendered, however, it became necessary to continue the investigation during the whole of the fiscal year 1930-31.

As in the previous season, field crop studies in the affected district were supervised by Dr. G. H. Duff of the University of Toronto. Sample plots were sown at strategic points. Observations were made of markings by sulphur dioxide throughout the district, and a careful record was kept of conditions prevailing at the time of such markings. These included concentration of sulphur dioxide, length of fumigation, temperature, humidity, light, wind direction and velocity. Full details were recorded throughout the season and yields of the various crops were noted. Other plots were used in the study of the effect of the addition of fertilizers and of irrigation to determine whether, under favorable agricultural conditions, the sulphur dioxide concentration was sufficient to appreciably affect yields. Observations were again made of crops throughout the district, and the amount by which crops were reduced by sulphur dioxide fumigation was estimated.

Mr. M. S. Middleton of the British Columbia Department of Agriculture again visited the district and observed horticultural conditions. Further observations were made upon trees which had been tagged in the first season, and a special study of fruit spurs was carried out.

No detailed investigation of the livestock of the area was made, since this work had been satisfactorily completed in the first season, but Dr. Bruce of the Dominion Department of Agriculture visited the district to examine certain cattle alleged to be suffering from the effect of sulphur dioxide, in order to determine the cause of their condition.

Forest studies were continued and extended, since, while the district has been mainly logged off, many claims have arisen of alleged damages to standing timber. This work was again supervised by Mr. A. W. McCallum, forest pathologist, with the assistance of Mr. R. Hopping, entomologist, both of the Dominion Department of Agriculture. Detailed studies of typical groups of trees were made over many areas in the district, the condition of each tree being noted and the cause of that condition, as far as could be determined. A special study was made of the prevalence of fires throughout the district as shown by marks left upon the bark and sections of trees. Reproduction was closely checked in many areas, since it is important to know whether sulphur dioxide has affected the formation and viability of seed and the growth of young tree seedlings. Several thousand trees were bored, the cores measured for periods extending back in some cases as much as 40 years by the Dominion Forest Service, and growth curves were studied

by the staff of the National Research Council. This examination of forest conditions was made over a considerably wider area than in 1929.

The chemical studies in the area were continued and greatly extended. They undoubtedly constitute the most detailed study ever made of sulphur dioxide concentrations in any area. Readings of sulphur dioxide concentration of the atmosphere were made by automatic recorders every 20 minutes, night and day, from the latter part of 1929 and will be continued for some time in the future. In this way records have been kept of gas concentrations at different points in the Columbia river valley. Analyses have been made of sulphur in the needles of conifers, in field crops and in the soil, and analyses on a large scale have also been made of field crops for protein content. The field work in this investigation was directed by Dr. Morris Katz, and all the chemical work was given general supervision by Dr. G. S. Whitby of the Division of Chemistry.

The committee was not satisfied to confine its work to the district affected, but arranged for fumigation experiments at the Summerland Experimental Station of the Dominion Department of Agriculture. At this station extensive artificial fumigations were made under widely varied conditions on both forest trees and field crops. One very important point on which information was desired was to determine whether damage to forests was possible when the temperature was low. Accordingly fumigations were carried out in the winter, and were continued with gradually increasing temperatures throughout the period of new growth in the spring over a wide range of sulphur dioxide concentrations and other conditions.

During the season of 1930 the National Research Council was asked by the Consolidated Mining and Smelting Company of Canada, Limited, and the Christian Community of Universal Brotherhood (Doukhobors) to investigate the question of damage to certain lands held by the latter in the Columbia river valley above the Trail smelter, that is, on the Canadian side of the international line. This work was carried out by Mr. D. F. Putnam under the direction of Dr. G. H. Duff. The investigation resulted in recommendations as to a settlement; these were accepted by both parties concerned, and payment was promptly made.

Associate Committee on Tuberculosis

Co-operating organizations:

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

The work of the committee during the year under review was continued along the lines originally planned. It was made possible by a

generous grant from the Sun Life Assurance Company, the co-operation of numerous organizations, and a large vote from the National Research Council.

No meeting of the committee was held during the year ending March 31, 1931, but the results obtained in the various investigations were reported at a well attended meeting held on April 7, 1931, in Ottawa. After full consideration of what had been accomplished to date the committee agreed that it was time to draw up a list of tentative conclusions, especially in regard to B.C.G. (*Bacillus Calmette-Guérin*), which was the most important single phase of the tuberculosis question investigated. The deliberations of the committee were eventually crystallized in the following statement unanimously agreed to by those present, and the publication of which was authorized:

BACILLUS CALMETTE-GUERIN

1. B.C.G. represents a strain of bovine tubercle bacillus of reduced virulence and pathogenicity.
2. B.C.G. has acquired relatively fixed characters as to its virulence when maintained upon a specific medium (bile potato medium).
3. This relative avirulence may be maintained when B.C.G. is grown upon Sauton's medium or glycerinated potato; but as a precautionary measure, it may be returned to the bile potato medium at repeated intervals,—these intervals being at present unknown.
4. Under artificial conditions the virulence of B.C.G. may be enhanced by various cultural means, quite apart from the question of possible contamination of cultures.
5. When cultivated under the conditions of paragraph 3, B.C.G. is by many investigators regarded as innocuous to experimental animals on first passage, but others claim that occasionally it may become pathogenic.
6. When cultivated under the conditions of paragraph 4, B.C.G. may exhibit both virulence and pathogenicity.

Immunity

1. It is evident that much work remains to be done before the problem of vaccinal immunity is solved.
2. The use of B.C.G. as a vaccine, particularly when applied parenterally, confers a degree of resistance. This is determined by the absence of lesions or by the reduced extent and rate of development of the tuberculous process arising from natural or experimental infection.
3. The evidence available indicates that the degree of resistance diminishes from year to year.
4. The period of maximum resistance following vaccination, the rate of decrease of resistance and the results of revaccination have not been determined.
5. It is recognized that there is a possibility of a carrier state appearing in vaccinated animals.

Proposals for Future Work

1. The determination of a standard medium or media containing the elements which maintain a constant avirulence for the production of a stable vaccine.

2. A study of all the factors which enhance the virulence of the attenuated strain.

3. A study of the factors which, when utilizing stabilized vaccines, may effect the alteration of the virulence and pathogenicity of the organism in experimental animals.

4. A study of the factors governing variation of the organism in relation to possible enhancement of virulence in the animal (apart from highly virulent strains).

5. A study of other attenuated strains and cultures for the production of living vaccines.

6. A comparative study of the resistance induced by living and dead vaccines.

7. The determination of the duration of the increased resistance after vaccination.

8. That further investigations be instituted into the carrier question.

The following are brief summaries of the reports on the various investigations in progress under the Associate Committee on Tuberculosis. All of these investigations received financial support from the National Research Council, with the exception of those of the Dominion Department of Agriculture.

TUBERCULOSIS RESEARCH OF THE DOMINION
DEPARTMENT OF AGRICULTURE

Researches on tuberculosis at the Animal Diseases Research Institute at Hull have been carried on during the year, but no detailed report has been submitted. In August, 1930, Dr. Watson attended the Eleventh International Veterinary Congress in London, and at the meeting of the committee outlined the discussion on tuberculosis which took place there and reviewed the whole situation in regard to B.C.G. in the light of his own experience.

Of all the cattle vaccinated with B.C.G. in his investigations 78.4% showed tuberculous lesions at necropsy as against 75% of the unvaccinated controls. He was nevertheless prepared to give qualified support to those who state that vaccination with B.C.G. creates some resistance to bovine tuberculosis, as measured by the extent or severity of the tuberculous lesions developing within a stated interval of time. This resistance, when manifest, is more in evidence during the first year of life or in the trials of short duration. As time goes on and as reinfections and superinfections occur, the tuberculous involvement is frequently of no less extent in the vaccinated than in the unvaccinated animals.

Work has been carried out with deep broth cultures of B.C.G., and these have proved virulent to rabbits, as a result of which it is feared that

B.C.G. may regain its virulence even in the animal body. It is claimed that the virulence of B.C.G. is fixed only as long as its environment is fixed and as long as all other factors, physical and chemical, concerned in its growth and in the development of its inherent or potential properties, are kept constant.

At best, the vaccination of infants with B.C.G. is considered to be a question of expediency in cases where children are born and raised in contact with tuberculous cases. It may also be a question of expediency in connection with bovine tuberculosis in certain European countries where the incidence of the disease is many times greater than in Canada. It is believed that in this country present methods for the control of tuberculosis are preferable.

Further work on the chemistry of tuberculosis and more complete studies on the biology, mutation and pathogenesis of tubercle bacilli appear to be essential in fundamental research on this problem.

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

TUBERCULOSIS RESEARCH AT THE FORT QU'APPELLE SANATORIUM

The purpose of the researches undertaken in the Fort Qu'Appelle Indian health unit is to determine the various factors of importance in the epidemic of tuberculosis among the Indians of the western plains, to determine the nature of the germ causing this epidemic, whether bovine or human, also to ascertain what practical preventive measures could be instituted which would reduce the frequency of the disease and mortality from it; furthermore, if advisable, to institute prophylactic vaccination among these susceptible people.

Tuberculosis is the most frequent cause of death amongst Indian children and young adults. In the short period since 1928 the tuberculosis death rate amongst Indians has been reduced by 35%, but it still remains thirteen times that of the white population, while the general death rate is four times as great as that of the whites. A close relation has been observed between general living conditions and tuberculosis, as well as the general death rate.

A special study has been made of school children. Frequent physical examinations were carried out, and close attention was paid to nutritional conditions. Of 320 children in two schools during 1930 only one admitted in normal health developed tuberculosis, as against 15 in the years 1926-27.

A marked variation in family resistance to tuberculosis has been found. Certain families stand out as distinctly tuberculous, with low resistance, many members dying with acute disease. These susceptible families represent 12.5% of the 142 families under observation in one area. The frequency of active tuberculosis amongst adults is nevertheless lower than is generally believed, the majority having no active tuberculosis.

The analysis of the nature of the bacillus causing tuberculosis, whether bovine or human, is believed to have been definitely completed. In a study

of 34 strains of tubercle bacilli isolated from Indians all were of the human type. Of the families now suffering severely from tuberculosis, only one had positive reactors amongst their herds of cattle.

X-ray photographs have been taken of 833 cases varying from infancy to old age. This study has been made to determine the incidence of calcification, the time of life at which calcification takes place, and, if possible, the relation of calcification to resistance. It has been found that calcification increases rapidly from infancy and attains a maximum in the age period 10 to 14 years, above which age there is a gradual decline.

Work is being actively prosecuted with a first-class research staff and an enlarged clinical and public health service. A marked effect of the present efforts being made should be evident within a few years.

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

TUBERCULOSIS RESEARCH AT THE QUEEN ALEXANDRA SANATORIUM

Work has been carried on in two main fields—determination of the biochemical nature of tuberculosis antibodies, and the advancement of clinical knowledge through the medium of X-rays.

The first of these problems is recognized as a particularly difficult one. It is considered, however, that if antibodies can be isolated in a chemically pure state and in high concentration, their effects on normal and tuberculous experimental animals might be studied with greater precision than is possible with purely clinical correlations in the humans. It has proved possible to isolate antibodies free from protein and in fair concentration, but so far the results have not been entirely consistent. The surprising fact has been discovered that the addition of calcium and magnesium salts to distilled water resulted in a positive complement fixation being obtained in the absence of positive serum. Both calcium and magnesium are required to give this reaction.

In the X-ray investigation an explanation has been worked out for the banded appearance of the edges of shadows in radiographs. This has been proved to be the result of an optical illusion. The problem has been studied with a recording microphotometer purchased by the National Research Council for this purpose. With the co-operation of Prof. Allen of the Department of Physics of the University of Western Ontario, a study is being made of the pure physics of the problem. An extensive study is also being made of the clinical interpretation of X-ray shadows. Several scientific papers are being published on the findings made in this research.

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

TUBERCULOSIS RESEARCH AT QUEEN'S UNIVERSITY

In this bacteriological research, work has been under way for some time on four phases of the problem of dissociation. The first is a study of the dissociation of B.C.G., on which a preliminary report was made a year

ago. This work is still incomplete. A closely related study is the correlation of colony structure, acid agglutination and virulence of tubercle bacilli. The third is an investigation of the antigenic activity of R and S forms of tubercle bacilli (R colonies are usually rough in form and avirulent; S colonies, smooth and virulent). The fourth study is the dissociation of *Mycob. leprae* and other acid-fast species.

From a study made of the dissociation of tubercle bacilli it is concluded that these bacilli are subject to dissociation, behaving in precisely the same manner as other species of bacteria which have been subjected to a detailed study. Of the five B.C.G. cultures made the subject of experiment, four have, after prolonged growth on a special alkaline medium, assumed the S form and have proved virulent to guinea pigs. The fifth culture still fails to show any departure from the characteristic growth habit or colony structure of the typical B.C.G. It should be borne in mind that this dissociation of B.C.G. has taken place only after a long series of experiments using a medium radically different from that recommended by Calmette.

Twenty-eight cultures of tubercle bacilli, including human, bovine and avian forms from widely differing sources, have been compared as to colony structure, habit of growth in fluid media, acid agglutination and virulence for animals. It was found that the recently isolated highly virulent cultures and all the cultures with a long history of high virulence grew in solid media in S colony form; on fluid media, in the case of bovine and human types, as a continuous veil-like pellicle, in the avian types as a diffuse suspension; and all were agglutinated only at a high acidity. All the avirulent or low virulent cultures or those with a history of loss of virulence now grow on solid media in R colonies; in fluid media as a heavy pellicle tending to separate into discrete islands, and are agglutinated at a relatively low acidity.

The specificity of antigens prepared from various types of acid-fast organisms has not been found absolute. In this group the differences in the antigenic activity of R and S strains are very slight, but a quantitative technique has been developed and used throughout. This phase of the investigation is being continued.

As a part of the general problem of dissociation of acid-fast bacteria, several species other than tubercle bacilli have been examined. Of these *Mycob. leprae* has been studied in the greatest detail. Appreciable dissociation in the R and S types has again been observed.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF ALBERTA

This investigation, carried out by the Alberta Committee on Tuberculosis Research, has extended over a period of years. During the past year results have been obtained of experiments started in 1928 on 68 calves divided into four groups of 17 each, of which two groups have been kept as controls.

The first experiment was to investigate the pathogenicity of B.C.G. Seventeen animals were vaccinated by mouth as young calves, each with three doses of 50 mg. of B.C.G., which was administered in milk. An equal number of controls were kept with the vaccinated calves, and all were slaughtered when over two years of age. No evidence whatever was found of tuberculosis at post-mortem examination, in either the vaccinated animals or controls, although a careful microscopic examination was made of the tissues.

The second experiment was undertaken to determine the resistance to contact infection of animals vaccinated by mouth. Seventeen vaccinated calves and an equal number of unvaccinated controls, after an initial period of isolation, were fed for four months on milk from tuberculous cows, and were then placed in close contact with tuberculous cattle for a period of over six months. At the age of two years and more all animals were slaughtered and their carcasses examined. Of the vaccinated animals 17.7% showed minor evidences of tuberculosis, as compared with 37.5% in the controls.

From these experiments the following conclusions are drawn:

1. B.C.G. vaccine is non-pathogenic for bovines.
2. Vaccination by mouth with B.C.G. produces moderate resistance to tuberculosis in bovines.
3. New-born calves vaccinated by mouth with B.C.G. and protected from outside sources of infection are not capable of transmitting tuberculosis to non-vaccinated controls in close contact over a long period. B.C.G. is therefore not a menace to unvaccinated animals.
4. As B.C.G. is a bovine strain and is non-pathogenic for the young calf, its natural host, it may be assumed that carried and administered according to Calmette's methods, this organism will not dissociate or revert to type in the tissues.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF MONTREAL

Five years have now elapsed since the vaccination of infants with B.C.G. was first begun. To date 1,878 infants have been vaccinated, of whom 499 have been under close observation. A matter of special interest is that a number of these have been in intimate contact with persons suffering from tuberculosis. Of the observed cases, 39 have been in contact with positive sputum cases and 130 with clinical cases. Through the co-operation of the Bruchési Anti-tuberculosis Institute it has been possible to observe for comparative purposes unvaccinated children living under similar conditions. Of the controls so studied, 195 were in contact with positive sputum cases and 118 with clinical cases. The proportion of deaths amongst the vaccinated children has been considerably less than half that of the unvaccinated. This result, while favorable to B.C.G., must be accepted with caution, as the number of children is not sufficiently large for accurate statistical data.

Further, observations have usually been based on clinical diagnosis rather than on post-mortem examination. Of the babies still living the percentage suffering from tuberculosis is again less than half as large amongst the vaccinated as amongst the unvaccinated.

While, as stated above, too much stress must not be placed on these results, which are favorable to the use of B.C.G., it may be noted that they are in accord with experiments on a much larger scale carried out in other countries. Further, the evidence is considered very strong that B.C.G. as administered is entirely harmless to infants. Work will be continued with observations on a larger group of both vaccinated infants and unvaccinated controls.

Tests have been made on 44 cases of tuberculosis in humans to determine whether the bacilli were of human or bovine type. These individuals all suffered from pulmonary tuberculosis. Forty-two samples of sputum yielded bacilli of the human type, while two were bovine.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF TORONTO

A study was undertaken five years ago of the types of tubercle bacilli isolated from human lesions primarily to determine whether they were of human or bovine origin, and what were the relative proportions of the two in individuals of different ages. Altogether, materials have been examined from 320 medical and surgical cases of tuberculosis. From this study it would appear that bovine tuberculosis is an almost negligible factor in adult human infection, but is a factor of considerable importance in childhood tuberculosis. Of the children studied, 13.6% of the cases of non-pulmonary tuberculosis leading to disablement and prolonged treatment were caused by bovine tubercle bacilli. It has been demonstrated that bovine tuberculosis is preventable, being effectively controlled by the pasteurization of milk. In the city of Toronto, where the pasteurization of milk has been rigidly enforced since 1915, not a single case of bovine infection has been found in the children brought up on pasteurized milk. Of the 30 cases of bovine tuberculosis, the children came without exception from parts of the province where pasteurization was not carried out. In a number of cases it was possible to demonstrate the presence of bovine tubercle bacilli in the milk fed to the children. Further, the nature of the infection in the majority of cases indicated the mouth as the portal of entry.

With the co-operation of one of the large dairy companies in the city of Toronto a study was undertaken of raw milk with the object of determining whether tubercle bacilli are present in milk before pasteurization and, if so, whether pasteurization is effective in destroying them. Samples of milk were tested from 200 farms, and of these eight (4%) contained tubercle bacilli. The milk from the farmers' cans is pooled in large vats for pasteurization, and of these vats 26% showed tubercle bacilli, demonstrating how easily infection may spread if milk is not pasteurized. On the other hand, of 100 samples of pasteurized milk not one contained tubercle bacilli by

biological test. At present an examination is being made of certified milk, but of 50 samples so far tested tubercle bacilli have not been recovered from a single one.

The relation between silicosis and pulmonary tuberculosis is commonly ascribed to anatomical changes in pulmonary tissues. It also suggests, however, the possibility that the silica itself has an influence in accentuating the growth of the tubercle bacilli. A series of experiments was therefore undertaken using as sources of silica both sodium silicate and silicic acid. The surprising result was obtained that the growth of cultures in both cases took place about twice as fast as in the absence of silica. There was noted further a rich production of pigment—human strains becoming golden-brown and bovine strains yellowish brown in color. Even proportions of silica as low as 0.001% were found to stimulate the growth of tubercle bacilli.

It has been accepted that the avian tubercle bacillus is but slightly pathogenic for mammals, but several workers have observed the disease in humans. In this investigation three cases have been noted, one being a boy of ten and the other two being adults. Of the three cases one also showed tubercle bacilli of the human type.

From a study made of this disease it would appear that the avian tubercle bacillus must be regarded as a possible factor in human infection, particularly in those cases where clinical manifestations and the histo-pathology of lesions present difficulty of interpretation. Symptoms in such cases are variable and often misleading. The only means of definite identification of the avian tubercle bacillus are through cultures and suitable animal experimentation.

It is of interest to note that Dr. R. M. Price, who has for some time been engaged on the investigations outlined above, has recently been awarded the Starr gold medal by the University of Toronto for her researches on tuberculosis.

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

Associate Committee on Weed Control

Co-operating organizations:

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

A recent report of the Agricultural Service Department Committee of the United States Chamber of Commerce asserts that the annual losses from weeds considerably exceed the combined losses from plant and animal diseases and from insects and other predatory creatures. Weeds rob crops of food, room for growth, water and light; they contaminate farm products and so

lower their quality; they harbor insects and fungus pests; they injure livestock and humans; they greatly increase farm labor and expense.

The second meeting of the committee dealing with this important problem was held at Edmonton on January 9-10, 1931. The reports presented indicated substantial progress in carrying out the program outlined at the first meeting a year earlier. At the conclusion of the second meeting, the Subcommittee on Chemical Experiments held a session in which the uniform plan of field experimentation and recording of data was revised in the light of the first season's experience.

WEED INVESTIGATIONS BY THE FEDERAL DEPARTMENT OF AGRICULTURE

The Dominion Experimental Farms are carrying on a large number of projects on cultural and cropping methods for the control of weeds, on chemical eradicates, on botanical studies, and on the use of weed seeds in livestock feeding.

The Dominion chemist analyses for the committee samples of a considerable number of commercial herbicides.

WEED INVESTIGATIONS BY THE ALBERTA DEPARTMENT OF AGRICULTURE

Tests of chemicals on annual weeds indicated that stinkweed could be controlled by treatments with 50 lb. or more of sulphuric acid per acre, applied in the rosette stage. Sulphates of iron and copper also gave good results and partial control was obtained by the use of sodium bisulphate. Sodium dichromate controlled stinkweed but injured wheat. Flax was injured by sulphuric acid. Wherever weeds were controlled by chemical treatments, wheat maturity was somewhat delayed, perhaps partly as a result of the removal of weed competition.

Perennial weeds were effectively controlled by sodium chlorate and herbicides containing chlorates, although the rates recommended for commercial herbicides were too low to effect eradication in one treatment. Perennial sow thistle treated three days after blossoms opened produced viable seed. Attempts to eradicate dandelions from lawns without destruction of the grass were unsuccessful.

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

WEED INVESTIGATIONS BY THE MANITOBA DEPARTMENT OF AGRICULTURE

On the basis of counts made in the season of treating, Canada thistle and sow thistle were more easily controlled by chemicals than couch grass or wild barley. Dandelions were most resistant. One pound of sodium chlorate per 100 sq. ft. gave poor results on couch grass. All perennials, however, showed greater mortality as the amount of chemical was increased. The addition of calcium chloride to sodium chlorate did not appear to improve its action on weeds. Some commercial herbicides gave disappointing results and one at least was sold with very impracticable directions for use.

(Investigation under the direction of Mr. Geo. Batho.)

WEED INVESTIGATIONS BY THE SASKATCHEWAN
DEPARTMENT OF AGRICULTURE

A check on work commenced at Jansen in 1929 showed that fall observations did not provide a reliable index of herbicidal efficiency. Among the chemicals tested only the chlorates and herbicides depending on chlorates for their action were satisfactory. Contrary to recommendations usually given, sow thistle plants from six to eight inches high were more severely damaged by chemicals than those treated at blossoming time.

(Investigation under the direction of Messrs. S. H. Vigor and J. Cameron.)

At Lockwood, Watson, and other points in Saskatchewan, sodium chlorate proved the most effective chemical for controlling perennials, the effectiveness of various herbicides being in proportion to their content of chlorate and the amount used per unit area. At least two pounds of chlorate per 100 sq. ft. are required for Canada thistle and one and one-half for sow thistle. Spraying was found the most effective means of application. Copper nitrate, ammonium sulphate and sodium chloride were found to have little effect on the root systems of perennials.

Chemicals satisfactory for wild mustard control in wheat were sulphuric acid, copper nitrate, iron sulphate, sodium dichromate and sodium chloride. In certain concentrations and amounts these had little effect on the grain. Grains showed differing resistance to 100 gal. of 4½% sulphuric acid per acre, the order of resistance being wheat, oats, barley, spring rye. Among forage crops, western rye grass, sweet clover, alfalfa and corn showed resistance in the order given. Significant increases in wheat yield were obtained only where weed infestation was very severe. The weight per thousand kernels was usually reduced by chemical treatments, particularly by copper salts, which also tended to spoil the general appearance of the grain. Sulphuric acid solutions of from 10 to 25% concentration killed all mustard plants and reduced the stand of wheat 10%. A 25% solution retarded maturity six days. Sodium dichromate slightly reduced tillering, height, and weight per thousand kernels, and caused a significant decrease in wheat yield.

(Investigation under the direction of Dr. L. E. Kirk.)

WEED INVESTIGATIONS AT THE UNIVERSITY OF ALBERTA

Plant parasites of weeds are being investigated as possible aids in reducing weed damage and as constituting in some cases a menace to crop plants. It is planned to ascertain what weed parasites are most prevalent and most destructive in western Canada and the conditions under which they are most active.

Studies are at present under way on a fungus disease affecting ball mustard, a rot of cactus, a wilt of Canada thistle and a rhizome rot of couch grass, all of which have been found in the prairie provinces.

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

Field studies on the effect of chemical herbicides on the soil indicated that soil bacterial numbers were not greatly affected by sulphuric acid, but at the higher rates of application there was some reduction in the number of fungi and in the rate of nitrification. No definite trend in numbers of bacteria and fungi resulted from application of sodium chlorate at various rates. In this case the rate of nitrification could not be satisfactorily determined by existing methods. An effort is being made to develop methods for determining nitrates in the presence of chlorates, also the rate of decomposition of chlorates in the soil.

Greenhouse studies indicated that application of three pounds of sodium chlorate per 100 sq. ft. may adversely affect germination and growth of wheat for some months, the severity of the effect varying with the type of soil. This effect was not noted where sulphuric acid was used.

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

Note.—The weed survey of the prairie provinces by Mr. J. M. Manson, and the experiments with chemicals as herbicides by Dr. W. H. Cook, with headquarters at the University of Alberta, were entirely financed and directed by the National Research Council, and will be found summarized in the report of the Division of Biology and Agriculture, page 24.

WEED INVESTIGATIONS AT THE UNIVERSITY OF MANITOBA

Studies have been initiated on couch grass and perennial sow thistle. These refer to the germination of the seed and the development of the stolons at various depths of planting; the growth of stolons in different soil types; and the food reserves and moisture content of stolons at different dates, the fall analyses being considered in relation to winter-killing.

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

WEED INVESTIGATIONS AT THE UNIVERSITY OF SASKATCHEWAN

Botanical studies of various weeds were made in a weed nursery established during the year. Information has been collected on periods of growth, seed production, height, root development, and nature of the epidermis of common weed plants. All of these characters have a bearing on control methods.

In wild oat studies it was found that germination will, under suitable conditions, occur at any time in the growing season even at depths as great as nine inches. Mutilation of plants resulted in many cases in the cuttings taking root and producing normal plants. Deeply seeded wild oats produced two, three, and occasionally four, sets of secondary roots.

Root cuttings of Canada thistle and perennial sow thistle as short as one-quarter of an inch were found to produce new plants. The root systems of perennials were shown to be depleted of carbohydrates by the prevention of growth above ground. This was particularly true of sow thistle, the root-stalks of which disappeared during one season of black fallow. Mowing of

the vegetative parts gave the same effect to a less degree. The root system of Canada thistle under fallow appeared to maintain its ability to produce new plants much better than did those of sow thistle or couch grass.

(Investigation under the direction of Dr. L. E. Kirk.)

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)

The committee has now adopted the policy of having the section on wool growing meet at a convenient time during the summer, to be followed by a joint meeting of the growers and manufacturers in Toronto at the time of the winter fair, which is held in November of each year.

At the former meeting, held in Ottawa on July 2, 1930, the committee was fortunate in having present Dr. J. E. Nichols, who was just completing an Empire wool survey for the Empire Marketing Board, this work being carried out in co-operation with the Wool Industries Research Association. Dr. Nichols briefly outlined his work, stating that most attention had been paid to mutton, since in Great Britain the value of the wool clip was only about one-seventh that of the mutton produced. He called the attention of the committee to the Empire Wool Conference which it was proposed to hold in London at the time of the Imperial Conference. He thought that the National Research Council should be represented there.

Brief reports were presented of the wool investigations in progress under the committee, and arrangements were made for their continuation throughout another season. At the annual meeting more complete reports were available.

Dr. Fairfield described at the joint meeting of the committee his breeding experiments with Corriedale sheep at the Lethbridge Experiment Station of the Department of Agriculture, which had been carried on without financial assistance from the National Research Council. He had two projects under way, the building up of a pure Corriedale flock from sheep imported from New Zealand, and extensive cross-breeding experiments intended to improve the grade of flocks by the use of Corriedale rams. Both projects were making satisfactory progress. He commented upon the long wool on the faces of Corriedale sheep as a disadvantage in Canada, though probably not a serious objection to this breed. He thought that this difficulty might be reduced by breeding. He considered New Zealand Corriedales superior to the American sheep of the same breed which he had secured.

Dr. Fairfield reported for a subcommittee consisting of himself, Dean Shaw and Prof. Sackville, regarding mass breeding experiments with Corriedale rams at Cardston. They had been fortunate in securing the active co-

operation of a prominent sheep rancher. Two groups had been selected of 300 young Rambouillet ewes each, very uniform in character, and these were bred respectively to Corriedale and Rambouillet rams. The progeny were being observed for mutton conformation and wool quality and quantity. Similar breeding work was to be carried out in the next two seasons, and the results would be closely observed by the subcommittee.

Mr. MacMillan of the Dominion Department of Agriculture could not be present at the November meeting, but submitted a report on the grading of 5,099 head of pure bred rams and ewes, a work which had been done by the Department to enable breeders to eliminate unsatisfactory individuals from their flocks. It was believed that this would be of great benefit, as many inferior animals had been found. Special attention was being paid to the fleeces of rams which were the head of pure bred flocks.

Dean Shaw reported that in the fall of 1928 he had visited England and purchased pure bred Leicester, Cheviot, Corriedale and Ryeland sheep for breeding experiments at the University of Saskatchewan. Owing to an outbreak of foot and mouth disease, these sheep had arrived too late for the first breeding season, but Corriedale, Romney Marsh and Rambouillet rams had been used on the Saskatchewan flocks instead, and the progeny were being given detailed study. The original breeding program would be proceeded with in due course, the object being to determine the cross most suitable under range conditions in western Canada, especially for the production of the best market lambs and the highest wool quality.

Work under way at the University of Alberta on the influence of environmental factors on wool quality was reported on by Prof. Sackville. Factors being studied included temperature, humidity, time of shearing, plane of nutrition, protein intake and mineral content of feeds, the effect of these being noted on wool growth and quality. Tests of the wool produced were being carried out in the Division of Chemistry of the National Research Laboratories, determinations being made for moisture, grease, fibre diameter, fibre-staple ratio and the number of crimps to the inch. An enormous amount of detail work was necessary and it would be impossible to draw any definite conclusions from the first season's work.

Dr. Whitby reported on the wool investigations in progress in the National Research Laboratories outlined on page 30 of this report.

In discussing problems of wool manufacture, the committee agreed that humidity was one of the most important. Climatic conditions in Canada react against the Canadian manufacturer in that imported yarns are sold on the basis of 18.5% moisture, but it is generally not possible to keep wools at this high percentage of moisture in Canada, with the result that clothing of a stated weight is actually heavier when manufactured from Canadian made yarns. Humidification is not practised in Canadian mills.

The committee discussed the blending of wools for manufacture and the adaptation of Canadian wools to a variety of purposes. It was agreed that work on these problems would have to be done by the laboratories in close co-operation with commercial mills. The manufacturers present generously offered the use of their mills for such a study.

SPECIAL COMMITTEES AND CONFERENCES*

Executive Committee on the Fifth Pacific Science Congress

Plans were developed during the year for the Fifth Pacific Science Congress that is to be held in Victoria and Vancouver in June, 1932.† Under the guidance of Dr. H. M. Tory, President of the Congress, program material was mapped out, authors were selected to prepare papers, and the necessary invitations issued. Progress was made in the organization of Congress committees and in the arrangements for general and sectional meetings.

As noted in the sketch of the history and purpose of the Pacific Science Congress movement, which appeared in the annual report for 1929-30, these Congresses, which are now held every three years, had their origin in a common recognition of the need for co-ordination of effort among the workers engaged in the study of scientific problems relating to the Pacific area. The first Pan-Pacific Science Congress was held in Honolulu, Hawaii, in 1920. Further Congresses have been held in Australia, 1923; Japan, 1926; Java, 1929; and on the invitation of the Dominion Government, the Fifth Pacific Science Congress is to be held in Canada in June, 1932.† The National Research Council of Canada has been appointed to take full charge of arrangements.

During the year just closed five meetings of the executive committee and two other conferences, which were also attended by the chairmen of sectional committees, were held for the discussion of Congress plans.

After some preliminary work, the general scheme of the program was evolved, committees were formed, and the work of arranging for papers was undertaken. Before the end of the year a complete first draft of the program had been made, a booklet concerning the Congress had been printed and distributed, and the official Government invitations to participate in the Congress had been issued.

Program plans provide for five morning periods of three hours each for the discussion of symposium subjects of interest to all delegates. Distinguished speakers at these assemblies will present in broad outline the main themes for discussion. Then, during three other morning periods at meetings of the two main divisions of the Congress—Physical Sciences and Biological Sciences—further consideration will be given to the particular phases of Congress studies that are of special interest to each division. Afternoon sessions will be devoted to sectional and joint sectional meetings.

In this way it is hoped to present a conspectus of scientific research in the fields of physical and biological sciences in the countries bordering on the Pacific ocean, and in the divisional and sectional meetings to provide ample opportunity for the discussion of specific subjects.

As far as may be possible, papers intended for presentation at the Congress will be printed in advance of the meeting and records will be kept of the discussions for inclusion in the printed proceedings of the Congress,

* A list of the committees, with the names of members, will be found in Appendix J, page 203.

† Since this report was prepared the Dominion Government has postponed the Fifth Pacific Science Congress until 1933.

to be published later. Copies of the proceedings will be supplied to all delegates attending the Congress, and in addition, provision is being made to meet the demand for copies required by libraries and individuals interested in the study of Pacific problems.

In planning the program, the executive committee has directed that invitations for papers shall be distributed among the countries bordering on the Pacific ocean in such a way that not more than one-half of the contributed papers shall be from residents of the United States and Canada. In this way it is expected that adequate representation will be given to all Pacific countries.

Thirty countries have been invited to co-operate with Canada in this Congress and to send representatives to participate in the discussions and to contribute papers on selected topics.

In the division of Physical Sciences, provision has been made for seven sections comprising astronomy, geodesy and geography, geology and mineral resources, meteorology and terrestrial magnetism, oceanography, radio, and seismology and volcanology.

There are nine sections in the Biological Sciences group including agriculture, anthropology and ethnology, animal diseases, botany and plant pathology, entomology, fisheries, forestry, public health, and zoology.

General assemblies of the Congress are to be held during five morning periods for the discussion of subjects selected for symposium treatment. One of these sessions will be given to the consideration of recent applications of science to agriculture and forestry, the time allotted being divided equally between these two topics, and a second session will be devoted to similar developments in the fields of mining and fisheries.

Another subject that is of prime importance to navigators and those interested in the study of Pacific oceanography, is to be developed in a symposium discussion on air and water circulation in the Pacific regions. One whole morning will be given to this topic. Discoveries resulting from recent scientific expeditions, particularly in the south Pacific, are regarded as of far-reaching importance, and it is expected that reports of these studies will be included in this symposium.

While extensive studies have been made of fiords in Europe and some work has been done on those of the west coast of Canada, the available information on the fiords of the Pacific has not yet been co-ordinated, although the subject is of very great interest to geologists and students of oceanography. Invitations have been issued to the countries bordering on the Pacific ocean to co-operate in a symposium on this subject during the fourth general Congress meeting, and it is expected that the results of this study will provide the first authoritative and comprehensive compilation of data on this very important subject.

Another Congress symposium session is to be given to a discussion on "The Origin and Antiquity of American Aborigines," on which there are

conflicting views. Outstanding speakers have been asked to review the evidence on this important subject.

In the division of Biological Sciences there will be three meetings, one of which will deal with nature's equilibrium (Pacific forms) including periodicity or reciprocal fluctuations; and the relation between rate of growth and longevity. A second conference will consider the effect of the introduction of exotic plant and animal forms, and the concluding symposium will be on the forest resources of the Pacific basin.

Four subjects have been selected for symposium treatment in the division of Physical Sciences including recent soundings, gravity investigations and mapping of sea floors; submarine valleys—their nature and origin; correlation of glaciation in northern and southern hemispheres; and present day mountain building in the Pacific.

The Fifth Pacific Science Congress will bring to Canada several hundreds of the leading scientific workers of the world, for not only will the countries bordering on the Pacific ocean be represented by some of their most distinguished savants, but there will also be in attendance some of the notable figures of the scientific world from Great Britain, France, Germany, Sweden, Holland, Denmark, and Spain. The advice and assistance of these world scientists during their visit to Canada in connection with the Fifth Pacific Science Congress will undoubtedly be of great value to Canadian investigators. In a wider field, their influence on the public mind in Canada, which has been awakened to the value of research in the solution of national problems, is bound to be stimulating and productive of much good.

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service

The National Research Council is legally entrusted with certain responsibilities in connection with the measurement of electricity. The special Committee on Electrical Units and Regulations was appointed to investigate these responsibilities and make recommendations to the Council as to the action which should be taken.

The committee first reviewed the various acts of Parliament and orders-in-council dealing with this matter so as to determine the existing legal status of electrical measurements and also the exact nature of the Council's obligations.

The Electrical Units Act establishes three fundamental international units which are to be used as a basis for all other electrical units. These comprise a unit of potential difference, a unit of current strength, and a unit of resistance. Parliament has also approved the unit of energy known as the kilowatt hour as a commercial unit of supply. Broadly, the duties of the Council are:

1. To establish and define any additional units which it considers advisable.

2. To maintain a complement of primary standards to determine these units and the units established by Parliament. The Council must be prepared to compare and certify any secondary standards which may be submitted.
3. To exercise control over the types of instruments which are used commercially to measure electrical qualities.

Since many of the units involve a unit of time, the committee has recommended that the mean solar second be legally defined and adopted and accordingly suggested a definition. It has also made a study of the following units and has prepared definitions. These units are based upon the mean solar second and the three units established by Parliament.

I Units of electrical quantity.

- (1) The coulomb.
- (2) The ampere hour.

II Unit of electrical capacity.

- (1) The farad.

III Unit of inductance.

- (1) The henry.

IV Units of energy.

- (1) The joule.
- (2) The watt hour.
- (3) The electrical horsepower year.

V Units of power.

- (1) The watt.
- (2) The electrical horsepower.

At present the problem of measuring electrical supply on a peak demand basis is under consideration by the Associate Committee on Electrical Measuring Instruments. This committee is also studying the sale of electrical service by means of such a conventional unit as the kilovolt ampere. When a decision has been reached the Committee on Electrical Units and Regulations will suggest any units necessary to conform to the recommendations made.

It should be noted that all the above units are based on international units established by the International Electrical Congress and therefore are themselves international. Thus they are uniform with the units adopted by the important countries of the world.

The determination of the above units involves, in addition to a complement of primary standards, elaborate auxiliary apparatus including temperature-controlled oil baths, precision comparison instruments, etc. Up to the present time the Council has not had the staff or facilities to assemble and instal the necessary apparatus. The committee therefore felt that some existing standards should be declared the primary standards of Canada until such time as the Council could instal adequate equipment in its own labor-

atories. It has therefore recommended that for the time being certain identified standards of potential difference and resistance now in the possession of the laboratories of the Electricity and Gas Inspection Service, Department of Trade and Commerce, be nominated as the primary standards of Canada. The recommended standards comprise:—

- (a) Six standard cells.
- (b) Two one-ohm resistors.
- (c) Two high current capacity resistors used for measuring current. Determinations of current strength are made by passing the unknown current through the standard resistor and comparing the resulting potential drop with standard voltages.

In all cases the standards are accompanied by certificates issued by the National Physical Laboratory of England, setting forth the measured values of the standards. The laboratory of the Electricity and Gas Inspection Service is equipped with the necessary apparatus for making comparisons. The committee has recommended a definite procedure to be followed when comparisons are made with the above standards.

The Council subsequently adopted the recommendations of the committee.

The work of the committee is continuing steadily. It is proposed to study the requirements of the Council's laboratories with regard to primary standards and also to prepare a set of specifications for the approval of the type of various meters employed commercially to measure electricity.

Conference on Iodized Salt

In the summer of 1930 the National Research Council received the following resolution from the Council of the Canadian Chemical Association and also a letter from the Canadian Medical Association supporting this resolution.

“Whereas, it is not yet certain that the indiscriminate use of iodized salt is entirely beneficial to public health,

Be it resolved that the Council of the Canadian Chemical Association ask the National Research Council of Canada to appoint a committee to investigate the use, optimum iodine content and control of iodized salts in Canada.”

On consideration of this resolution the National Research Council authorized a preliminary conference of recognized authorities on the subject to advise the Council as to what action should be taken. Such a conference was held in Ottawa on December 12, 1930. After full consideration of the whole question the following statements were agreed to as representing the opinion of the committee.

- (1) Iodine frequently prevents the occurrence of goitre.
- (2) It is doubtful whether iodine ever cures goitre when once developed.

- (3) The effect of iodine in large doses is definitely harmful in certain cases in which goitre has already occurred.
- (4) Salt is the most suitable medium for the distribution of iodine to the general public.
- (5) The present iodine content of iodized table salt as ordinarily marketed in Canada is unnecessarily high.

The following recommendations were unanimously passed by the conference for consideration by the National Research Council:

(1) That a survey be made of the prevalence of goitre among animals in the various districts in Canada, and that in this connection the co-operation of the federal and provincial departments concerned and of the veterinary colleges be sought.

(2) That the Ontario Department of Health be requested to cooperate in this problem by authorizing the compilation of information as to the prevalence of goitre in connection with the medical examination of school children in various districts in the province.

(3) That the co-operation of the proper authorities be sought with the object of carrying out a similar survey among school children on the island of Montreal.

(4) That the co-operation of the departments of health of the various provinces be sought with the object of securing such information as to the prevalence of goitre as they may now have available, and such further action as may be considered necessary.

(5) That steps be taken to ascertain the amount of iodized salt used in the districts covered by any surveys which are undertaken.

(6) That the National Research Council appoint an associate committee to consider the whole question of the prophylactic use of iodine, and related problems.

(7) That a bibliography of the literature on this question should be prepared by the National Research Council.

(8) That the whole traffic in patent medicines containing thyroid or iodine should be controlled as a protection to the public.

(9) That the question of whether the iodization of table salt should be mandatory be referred to the associate committee.

At the first meeting of the National Research Council following this conference authority was given for the taking of the Canadian survey, as recommended by the Conference, and the preparation of a bibliography of the literature on the subject of iodine in relation to goitre. These projects are now under way and when an opportunity has been afforded for their consideration the Council will deal with the other recommendations of the conference.

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 169.

A list of research grants made by the Council from the beginning of its work is given in Appendix F, page 161.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 50.

Regulations governing the award of grants for research will be found in Appendix E, page 159.

Lateral Support of Steel Columns and Struts

Co-operating organization:

University of Toronto

It is evident that the size of a steel column can be reduced in weight and section if the column is given lateral support by means of properly proportioned and placed struts. Because of lack of data the design of columns so supported has been largely a matter of guesswork.

During the year under review considerable progress has been made in determining experimentally the behavior of a number of columns that have been subjected to centric and eccentric loading while being at the same time stressed laterally at the mid-point. Studies so far made of the results show that the columns behave consistently in a certain definite manner. The load line, which is the resultant of the axial load on the column and the lateral stress, is always a straight line. Furthermore, resultant load lines obtained by varying the amount of the axial load and the lateral stress intersect at a point whose location depends on whether the axial load is centric or eccentric. Whether the load is applied centrically or eccentrically, the respective resultant load lines are parallel.

Until a larger number and diversity of dimensions of columns have been tested, design formulas are not deemed advisable.

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

Continuity of Welded Steel Beams

Co-operating organization:

University of Toronto

The greater the rigidity of connections of steel frame members of buildings and bridges, the less may be the size and weight of the members in

many instances. The work done up to the present favors welded to riveted connections.

While the experimental results thus far obtained in this study must be extended and confirmed, it has been shown that where two beams are connected to the column flanges, either of the welded connections is markedly more rigid than the riveted tee connection for all loads up to the safe capacity of the beams. Connections of beams to the column web show little difference in rigidity at loads up to approximately 25% of the safe load; but above this load, for normal loading, welded connections are much more rigid than riveted ones, while for a load exceeding 50% of the safe load, welded connections are more rigid than riveted ones for either normal or reversed loading.

Because of the incidental stiffening effect of the material welded to the beam flanges in welded connections to a column web, the positive moment at mid-span of the beam is advantageously reduced to an amount below that for a perfectly restrained uniform beam.

It has been shown that column flange distortion reduces the restraint obtained with conventional riveted and welded connections, and designers may find the use of diaphragms between column flanges both practicable and economical in cases where a high coefficient of restraint is desirable.

*(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 commercially built windmill reported upon in previous years has given, while in service during the past year, about the same output of electric energy as before, or about four times the requirements of the ordinary household for lighting purposes. However, failure in service of important parts of the apparatus put the machinery out of operation for nearly two months in the year. Apparently various changes in design will be required to develop a satisfactory apparatus for operation under ordinary conditions on the isolated farm.

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

Piezo-electric Pressure Gauge

Co-operating organization:

McGill University

Slabs of quartz find increasingly extensive application for maintaining mechanically the constancy of electric oscillating circuits into which they are inserted in broadcast and short wave stations. They may prove equally useful when their function is reversed, that is, when they are used for generating electric currents under the influence of mechanical forces acting upon their surfaces. Gas pressures, for instance, may be measured in this

way in electrical units, and the readings may be magnified at will and recorded with the least possible delay.

Continuing work along these lines, described in the previous annual report, the volume-pressure curves of a Diesel engine, known as a Petter hot-surface injection engine, were compared with the diagrams given by a mechanical indicator.

The crystal sections, six circular quartz disks about an inch in diameter and each three sixteenth of an inch thick, were piled on top of one another in the form of a condenser and placed in a holder on which the pressure from the explosion reacted. The negative charges produced by the pressure were collected, and the potential differences amplified by radio tubes, the positive surfaces of the crystals being connected to ground. The pressure changes, appearing as variations in the output current, were rendered visible with the help of an oscillograph having a known time scale. Knowing the position of the piston or the fly-wheel, the pressure-time curve obtained during one stroke was transformed into a volume-pressure diagram.

For calibration the crystal indicator was removed from the engine and screwed into a special form of hydrostatic pressure apparatus. The curves obtained with the aid of the pressure-quartz proved to be of the same shape as those obtained several years ago with the Cambridge mechanical indicator. The maximum pressure observed during one cycle was about 310 lb. per square inch.

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

High Frequency Research

Co-operating organizations:

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

As selective heating by means of high frequency waves is rather extensively used in medical treatment, it was thought well worth while to extend the experiments described in the previous annual report to waves shorter than 10 metres and to measure the electrical properties of body materials (their conductivities and dielectric constants) at high frequencies.

The law of maximum heating was confirmed for a wave-length of 6.5 m. It was found that in this region the dielectric constant of dilute solutions of potassium chloride was the same as that of water. Various pieces of meat were heated in the field of the high frequency oscillator, and by the use of a paint that changes color at 35°C. the development of heat in the different places was followed by the taking of photographs. Selective effects could be modified by a change of wave-length. The temperatures developed by the oscillations in different parts of a hen's egg have been measured by using a thermocouple made in a hypodermic needle. Experiments of the relative heating of different body substances are in progress.

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

Effect of Low Temperatures on Steel Castings and Forgings

Co-operating organization:

University of Manitoba

Safety of life and limb and economy of material used in constructing conveyances, machines and structures is possible only when the physical properties of the materials to be used are known. This research has been undertaken to obtain for use in design fundamental data on the physical properties of steel castings and forgings at low temperatures which prevail in Canada during considerable portions of the year. Such data are not now available.

The materials used in crankshafts, connecting rods, and other moving parts of engines, locomotives and aeroplanes are often subjected to fatigue stresses at low temperatures. Many other parts such as shafting, trolley wires, transmission lines, elevator cables, bridge members, and all objects which carry live loads of high amplitude are subjected to repeated stresses and sometimes failure occurs for this reason. Such failures generally occur suddenly and without warning and are therefore of the most dangerous character.

Tests so far have been restricted to finding the endurance limits of specimens at room temperatures. Owing to the mild winter, conditions were not favorable for running low temperature tests. When weather conditions are favorable two of the machines will be placed outside and tests run when the temperature is well below the freezing point. A recording thermometer will be used to note the temperatures on a chart. If it is found impossible to conduct outdoor tests the machines will be placed in a refrigerator and the low temperatures obtained by artificial means.

(Investigation under the direction of Prof. R. W. Moffat, University of Manitoba.)

Effect of Combined Electric and Magnetic Fields on Spectral Lines

Co-operating organization:

McGill University

Information on atomic structure and possible artificial transformation of atoms is now mainly gained through the study of the effect of strong electric and magnetic forces. One problem in this field is the influence, upon a certain frequency radiated by the atom, of a strong electric field (Stark effect) and a magnetic field (Zeeman effect) applied at the same time. The two fields may be parallel or at right angles.

For the study in parallel fields a discharge tube was placed along the hollow poles of an electromagnet. The tube was filled with pure helium at a pressure of 2 mm. of mercury and excited by a 10,000 volt source of direct current. A tube of lavite surrounded the negative electrode so as to constrict the discharge and create a high voltage drop per centimetre near the metal surface. The violet line of frequency ($2p - 5f$) of the plane helium atom appeared clearly as a doublet, the separation of the two fine structure components remaining nearly constant in fields up to 70,000 volts per centimetre.

The strong electric field produces a shift in the frequency of this double line when the vibrations parallel to the electric field are considered, a second order Stark effect, and two new double components appear vibrating at right angles to the field. The pattern is the same for both lines of the doublet.

When a parallel magnetic field is added, the components belonging to the stronger line of the doublet persist, but are split up into two components of unequal strength. The components of the weaker line disappear in strong magnetic fields with the exception of the one for which m_k is equal to minus two in the initial state.

In the work with crossed fields the electric vibration of the light examined was always perpendicular to the magnetic field. In the diffuse series, such as the lines 4922, 4388, 4471 and 4026Å, the Zeeman separations are clearly wider than normal when the electric field is present, the lines on both sides are of uneven strength and new lines appear as predicted by Bohr. These features are even more marked in the so-called fundamental combination series, which show wide separations of the outside strong Zeeman components, many weaker lines and an asymmetric pattern both as regards the position of the components and their intensity.

For studying the effects in crossed fields a radial discharge was passed between a cylindrical anode and a cathode placed along the axis of the cylinder and parallel to the magnetic field. The discharge was constricted by pieces of lavite insulation placed near the electrodes.

Published paper:

Foster, J. S. The Effect of Combined Electric and Magnetic Fields on the Helium Spectrum II. Proc. Roy. Soc. 131: 133-146. 1931.

(Investigation under the direction of Dr. J. S. Foster, McGill University.)

Spectroscopy of the Light from the Night Sky and Height of the Aurora

Co-operating organizations:

Bell Telephone Company
Ontario Department of Mines
Temiskaming and Northern Ontario Railway
University of Toronto

During strong auroral displays telegraph communications may be seriously affected and short radio wave communications interrupted. The distance from the earth at which the aurora occurs has been measured during a number of years in Norway, and it is of interest to find out whether it is formed at the same height over Canadian territory.

Two observing stations were set up near James Bay, and auroral displays photographed during the latter part of January and in February, 1931. One station was located at Blacksmith Rapids, 50 miles from Moose Factory, and the other at Coral Rapids, 30 miles farther south. The stations were connected by telephone lines, and each was provided with cameras and lenses similar to those used by Professor Stoermer in Norway. The method of obtaining the heights is based on measurements made from corresponding pairs

of photographs that were taken at the same time. The calculations are similar to those made in terrestrial triangulation in survey work or in range finding. Reference points in the heavens are provided by the stars photographed on the plates.

The results indicate that the commonest range of height of auroral light flashes lies between 85 and 105 kilometres with some cases as high as 250 and others as low as 70. The results agree with similar measurements obtained in Scandinavia.

In the high speed spectrograph described in the previous annual report, the four component lens constructed by Messrs. Ross of London was replaced by a single aspherical camera lens model of the Adam Hilger Company. The focal length of the lens was 55.63 mm. in the blue-green, its diameter 57.15 mm. and its angular field 6.5° . Using this lens a visibly perceptible record of the green line present in the polar and non-polar aurora could be obtained with an exposure of about 60% of that required when the Ross component camera lens was inserted. For obtaining good definition throughout the range of wave-lengths the Ross lens was superior.

Published paper:

J. C. McLennan, H. S. Wynne-Edwards and H. J. C. Ireton.
Height of Polar Aurora in Canada. *Can. J. Research*, 5:285-297. 1931.

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

Spectroscopy and Atomic Structure

Co-operating organizations:

United States Bureau of Standards

University of Alberta

In recent years methods of estimating the composition of alloys or compounds by measuring the strength of spectral lines emitted in the arc or spark have been greatly improved and adapted to industrial work. In the case of zirconium and similar elements the analysis is rendered rather difficult by the large number of lines which appear, corresponding to different stages of ionization.

In co-operation with the Bureau of Standards work was undertaken with the intention of bringing as many lines as possible into a recognized system. At the University of Alberta the source of light was a spark discharge between zirconium terminals operated both in a vacuum and in an atmosphere of hydrogen. Strong lines observed in the hydrogen source, but absent in the vacuum source, were due to singly ionized zirconium. Lines stronger in hydrogen than in a vacuum were due to doubly charged zirconium, and those stronger in a vacuum than in hydrogen to trebly ionized atoms. These latter lines belong to a doublet system, and it was possible to compute the lower energy levels and to determine the ionization potential, 34.83 volts, at which the zirconium atom loses the last of its outer electrons. The wave-lengths characteristic of the spark spectrum belong to the doubly ionized atom. From the available wave-lengths a system of over 60 single and triple

energy levels could be established which account for 135 ultra-violet lines. The energy levels are without exception those required by Hund's theory for atomic systems with two external electrons. There still remain a number of lines of unknown origin, mostly faint.

Published paper:

Kiess, C. C. and Lang, R. J. The Structure of the Spectra of Doubly and Trebly Ionized Zirconium, Bur. Standards J. Research, 5:305-324. 1930.

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

Emission and Absorption Spectra

Co-operating organization:

University of Toronto

From investigations carried out during the last two years in different countries it has become clear that the heavy central positive portions of the atoms of many of the elements are spinning, and, as a result, possess mechanical and magnetic moments. There is an interaction between this magnetic field and the field produced by the outer electrons of the atom. An external magnetic field as furnished by a strong magnet modifies and sometimes breaks down the balance between the two forces, and the result is revealed by changes in the finest structures of the wave-lengths emitted by the atom. Many of the radiations emitted have very complex structures, so that it is exceedingly difficult to give a satisfactory interpretation of the effects (Zeeman effects) observed in the magnetic field. For this reason six lines in the first and four in the second spark spectrum of thallium were studied. The former lines showed complex patterns indicating incomplete breaking down of the interaction between the atomic field; the four higher spark lines were simpler and will be easier to explain.

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

Scattering of Electrons of High Energy

Co-operating organization:

Queen's University

Electrons of speeds corresponding to from 300,000 to 1,000,000 volts penetrate through thin metal sheets and may be used, in place of X-rays, for studying flaws in castings. A number of the small negative particles, however, are deflected by the metal atoms, some so strongly that they leave the metal at the surface at which they entered. The incoming and the outgoing path form an angle, the angle of scattering. When the angle of scattering is not much over 90° the number of electrons turned back is proportional to, amongst other things, the mass m per unit area offered by the scattering material.

When fast electrons from radium E were studied, as they were bent back by aluminum plates, the results were quite different for angles of scattering of the order of 150° . The relative intensities were

	85	151	204	250
for m	0.0076	0.0148	0.0224	0.0370

It is probable that the loss of energy suffered by the electron during the change in direction explains the difference.

(Investigation under the direction of Dr. J. A. Gray, Queen's University.)

Spectroscopy in the Ultra-violet

Co-operating organization:

University of Alberta

The wave-lengths observed in the spectrum of bismuth and lead, metals which are neighbors of the radioactive group of elements, are difficult to classify; they occupy a considerable range and are widely separated.

Certain discrepancies in the system proposed by Rao and Narayan for doubly ionized lead, Pb III, were found, which do not exist when the classification mentioned in the previous annual report is adopted. Some 20 lines are known to belong to trebly ionized lead, Pb IV, and the energy levels from which they originate could be established.

The spectra of high frequency discharges through lead and bismuth vapors were photographed. It was possible to identify what must be the resonance lines of trebly ionized bismuth, Bi IV. The first one has a hyper-fine structure as is to be expected, the bismuth nucleus possessing a magnetic moment. The observed intensities agree with theoretical predictions.

Published paper:

Smith, Stanley. A Note on the Spectra of Doubly and Trebly Ionized Lead. *Phys. Rev.* 36: 1-4. 1930.

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

Power Losses in Dielectrics

Co-operating organization:

University of Alberta

Owing to the ever increasing size of high-voltage distribution networks, methods for rapidly testing insulators and insulating materials would be very useful. One difficulty is the variation in dielectric strength found in samples of the same material. As certain relations are known to exist between the dielectric constant and the optical properties of a material, such as refraction and absorption, it was thought that the measurement of the weakening of short waves, in particular the absorption of ultra-violet light, would furnish a means for studying values and changes of dielectric strength. A number

of photographs were taken of the spectrum of an iron arc as seen through such dielectrics as clear fused quartz, pyrex, glass for the ultra-violet, quartz-lite, corex and mica. They showed a large variation in their ability to pass ultra-violet light as they do in dielectric loss, but the cut-off point was not very definite, and it will be necessary to obtain greater accuracy by means of a hydrogen discharge tube giving a continuous source of light.

*(Investigation under the direction of Prof. H. J. MacLeod,
University of Alberta.)*

The Determination of Air Humidity

Co-operating organizations:

Dominion Department of Mines
McGill University

The measurement of air humidity is both difficult and important. Quick and accurate determinations of air humidity are required not only for meteorological purposes but with increasing frequency for the control of industrial operations. It is also well recognized that humidity plays a large part in the maintenance of human health and comfort.

In this investigation especial attention has been paid to electrical methods of determining humidity. Recently, however, an entirely different method has been developed, one which promises to be of practical value in various fields.

This method is based on the principle that dry air has a slightly greater density than damp air. As a consequence it becomes possible by suitable means to make determinations dependent upon density, which can be interpreted in terms of atmospheric humidity. This is done in the following manner. Two vertical columns are joined by a tube at the top, one of which is filled with dry air and the other with air of which the humidity is to be measured. Differences in density are revealed by a difference in pressure at the bases of the two columns. Means have been developed for measuring this pressure with great accuracy, and the instrument used can be made to read directly in percentages of relative humidity at a given temperature. A table of corrections may be drawn up to enable the apparatus to be used readily at other temperatures.

This principle can be applied to advantage for other purposes than the determination of air humidity. For example, it is useful in determining the proportions in which air and gas, designed for heating and other purposes, are mixed. This air-gas ratio is determined by filling one of the columns of the apparatus with air and the other with the air-gas mixture. When the difference in pressure has been recorded the second column is emptied and refilled with standard gas taken directly from the delivery pipes. This is also balanced against the standard column of air and the ratio of the differences in reading of the two determinations gives the percentage of gas present. Formerly thermal conductivity methods have been used for such determinations, but it has been found that balancing columns one metre in height will give the air-gas ratio with an accuracy 10 times that obtained by the

older method. Even greater precision can be obtained by increasing the height of the columns.

This application of balancing columns is not limited to work on coal gas, but will serve equally well for the accurate determination of the ratio of any two constituents in a mixture, provided only that the two constituents are independently available.

In this investigation the hygostat originally obtained from the Department of Mines has been greatly improved by the complete reconstruction of some parts. Metal has been substituted for wood in the construction of the drying chamber and a more satisfactory method has been devised for the maintenance of constant humidity. With the improved apparatus it is found possible to maintain constant humidity over long periods of time with a minimum of attention. The relative humidity in the chamber can be maintained within 1% in spite of changes as high as 20% in the outside air, and temperature changes of 6°F.

(Investigation under the direction of Dr. A. N. Shaw.)

Joule Effect

Co-operating organization:

Queen's University

When a gas expands without doing external work, as for example into a vacuum, a small reduction in temperature results. This is due to the increased molecular distances involving an increase in potential energy and a decrease in kinetic energy. This lowering of temperature is known as the Joule effect.

In light gases, such as hydrogen and helium, where the attractive forces are small, the Joule effect will be correspondingly small; but with heavier molecules, as those of carbon dioxide, the effect is appreciable.

In this investigation there have been devised new methods of measurement which should prove more accurate and under better control than anything previously used. Two large cylindrical steel tanks, each of approximately 80 litres capacity, are connected together by couplings through a special valve containing a large hole which can be quickly opened when required. Pressures are measured with U-tube differential manometers.

The gas under experiment after being carefully dried and purified is compressed in one tank while the other is exhausted. Finally the valve in the connecting pipe is opened and the gas expands to fill the whole space. When the gas under pressure expands there is, of course, marked cooling in the tank from which it comes and corresponding heating in the other tank. The whole apparatus is immersed in water so that the temperatures are quickly restored. The method consists in measuring the change in pressure which occurs after the establishment of uniformity of pressure throughout the apparatus. From this the aggregate cooling effect may be calculated. Initial experiments indicate a measurable cooling, but a large number of

determinations will be necessary in order to establish the value of the Joule effect at various temperatures.

(Investigation under the direction of Dr. A. L. Clark.)

Gas and Water Content of Trees and the Sinkage Problem

Co-operating organizations:

Canadian Pulp and Paper Association

McGill University

Price Brothers and Company, Ltd.

The cheapest method of getting trees to the pulp and paper mills is by driving the wood in the many small streams. The drive may be short or may take two or even three seasons. During long trips about one-tenth of the supply is lost by sinkage. This loss is determined by the rate at which water displaces air in the logs as well as by the water content of the wood substance at the time of cutting.

This second factor, the seasonal changes of the water content of native grown woods, was studied by analyzing standard sets of logs during the year. Each set included top, middle and butt logs from three trees, nine logs in all. In the case of soft woods: black and white spruce (*Picea mariana* and *Picea canadensis*), jackpine (*Pinus banksiana*) and larch (*Larix laricina*), the sapwood is wet, with little if any change during the year, the average water being about 160% of the weight of dry wood. As the wood has a density of about 0.41 and the shrinkage amounts to 10%, sapwood will have a density, when cut, of very nearly 1.0. The heartwood is uniformly dry, and the question whether a tree will be a good floater depends on the proportion of heartwood present. All but the top logs, in which the ratio of sapwood to heartwood is high, are in general good floaters.

In the case of the balsam fir (*Abies balsamea*), irregular patches of very wet heartwood are present in all the trees, which may contain as much water as the sapwood, about 200% based on dry weight. In the balsam fir the water is evenly distributed through the sapwood; in spruce and larch the highest water content is found in the fourth growth ring from the outside.

Of hardwoods, birch and aspen poplar (*Betula papyrifera*, *Betula lutea*, *Populus tremuloides*) were examined. The birch shows no heartwood and is wet right through with slightly higher water content in the centre. There is a very marked decrease in the proportion of water in the outer part of the tree from the time the leaves open until they fall, followed by a slight increase in autumn. Poplar has, moreover, a small heartwood. Birch and poplar will float much better if cut in late summer, but even at their best the logs of birch are too wet for immediate flotation on all but the shortest drives. It is necessary to resort to artificial drying. In this respect, the best results are obtained from trees cut in June and left to dry with the leaves on. The branches keep the trees off the ground, while piled logs are only just clear of the forest floor. The average water content of such trees fell to 36%. The standing birch loses nearly as much water between June and October as 4-ft. logs piled in the bush. Barked logs, on the other hand,

are much drier than standing trees, the water amounting to 41% in the first and to 85% in the second case. These percentages are all based on the weight of dry wood.

In the laboratory fermentation takes place in the logs during both seasoning and flotation, and carbon dioxide is produced as a result. This gas increases quite markedly the buoyancy of the logs.

Published papers:

Gibbs, R. D. Sinkage Studies II. The Seasonal Distribution of Water and Gas in Trees. *Can. J. Research*, 2: 425-439. 1930.

Scarth, W. and Gibbs, R. D. III. Changes in the Water-gas System in Logs During Seasoning and Flotation. *Can. J. Research*, 3: 80-93. 1930.

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

Effect of Light on Life Processes

Co-operating organization:

Queen's University

The transparency of the sea-water falls rapidly with decreasing wavelength in the ultra-violet, and it may be expected that the distribution of lower organisms, such as constitute, for instance, the food of fishes, will depend on this change.

In continuing work described in the previous annual report a number of animals were placed for from three to 14 days in quartz tubes held in separate compartments of a box. Each compartment received filtered light, either visible radiation, both visible and ultra-violet, or ultra-violet alone. Young starfishes, *Asterias vulgaris*, were not affected by ultra-violet radiation. The nudibranch, *Eolis gymnota*, which occurs at depths from seven to 10 metres, proved sensitive to ultra-violet. The little thin-shelled mollusc, *Yoldia sapotilla*, was also found to be affected injuriously by ultra-violet, while the amphipod *Hyperia galba* which has the peculiar habit of living in the cavity of the jelly-fish, proved to be resistant to ultra-violet radiation.

Published paper:

Klugh, A. Brooker. The Effect of the Ultra-violet Component of Sunlight on Certain Aquatic Organisms, III. *Can. J. Research*, 4: 483-486. 1931.

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

The Life Cycle of the Fish Tapeworm

Co-operating organization:

University of Manitoba

Pike, usually known in western Canada as jackfish, (*Esox lucius*) caught in Lake Winnipeg, harbor parasites, and when fed to dogs during the summer give the dogs worms; winter-caught fish are not harmful.

In order to ascertain the reason for this difference, fish supplied for sale in the open market during the year have been examined. Most of the fish came from the southern arm of Lake Winnipeg. Many of the summer fish were obtained near the shore, while the winter-caught fish were usually taken through the ice from farther off shore.

The larvae of the tapeworm (*Diphyllobothrium latum*) encountered in the winter-caught fish were small and frequently motionless; only a few were found in the flesh of pike caught during March, April and May. When dogs were fed motile winter larvae very few adult tapeworms developed. Larvae contained in the summer-caught fish produced 60% adult tapeworms; they are numerous and active, and when placed on the wetted surface of one's hand they crawl about vigorously. Even after ordinary cold storage freezing the larvae when warmed show considerable activity.

These observations show that infection of the fish takes place each year during the summer months. The parasite after living in the muscle for several months, shrivels up and degenerates, whereas it develops normally with the dog as a host. During the winter, ice and snow prevent the infection of the lake waters with eggs and larvae. The fishing of pike which are to be marketed should therefore be done during the late winter and the spring months. As the fish has little or no market value, means of eradicating it might be considered. Thorough cooking of all summer-caught fish fed to dogs would help to control the parasite.

(Investigation under the direction of Dr. Daniel Nicholson,
University of Manitoba.)

Slough Itch

Co-operating organization:

University of Saskatchewan

Contact with the water of certain pools or lakes produces an inflammation of the skin known as slough itch or swimmers' itch. The disease is known throughout the southern part of Saskatchewan, the prairie portion of Manitoba and Alberta and the neighboring states to the south; it has also been reported from Lesser Slave Lake and Peace River Crossing in northern Alberta. Workers in the United States have demonstrated that the condition is due to the attack of a kind of worm larva, *Cercaria elvae*, which in search of a host penetrates the human skin and perishes. Another form of these larvae, the blood fluke, is known to live and develop in the blood vessels of man, where its eggs clog and rupture the capillaries.

In order to determine what kind of larva is present in Saskatchewan large and small bodies of water within a radius of 25 miles of Saskatoon were examined for the parasite. An effort was also made to find the primary host that acts as a carrier of the eggs. The parasites were obtained by collecting a large number of water snails (*Lymnaea*). A few hours after the snails had been placed in small bottles of water, the larvae, if present, were seen swimming vigorously in the water when held up to the light. Work on the snails was started on May 19, but the trematode larvae appeared only on

June 11, 350 snails having been examined by this time. The percentage of infested snails remained low, averaging 2% until the end of July, when a marked increase was noticed, reaching 30% in snails from Brown Lake at the end of August. Apparently the snails obtain their infection in the spring and summer from eggs scattered in the water by the primary host.

Some bodies of water were harboring snails, but no trematode larvae of the type causing the disease. For some reason the primary host does not frequent these sloughs and the snails have no opportunity to become infected. The sloughs found to contain the parasite were Pike Lake, Brown Lake, the outlet to Brown Lake and a small roadside pool. Workers in the United States have recently obtained artificial infection of white mice with one species of larvae, and it will be necessary to examine whether in the present case the larvae reach their adult stage and deposit eggs in wild mice, which would thus become indirectly responsible for slough itch.

(Investigation under the direction of Dr. L. G. Saunders, University of Saskatchewan.)

The Inheritance of Sugar and Starch in Corn

Co-operating organization:

University of Manitoba

In the ordinary evolution of the principal varieties of corn the starchy varieties originated in the south, and as they moved northward the kernel became harder, the flinty type being the final product in the northeastern United States and Canada. A stable northern variety of genuine dent corn is desired which will not develop flinty characteristics.

With this end in view, 67 strains of hybrid corn were grown at the Manitoba Agricultural College. Crosses among plants of the same strain or line were made on practically all of the strains. The parentage consisted of two or three of the following: Early Malakov, Northwestern Dent, Pickaninny and Improved Squaw. The hybrids and selections were planted May 26 and 27, 1930, and the average dates of the ripening of the pollen were recorded as indicating the earliness. Sixteen strains had average pollinating-dates from August 5 to 7, an average of 41 days from planting. Later in the season the total weight of ears and the ratio of grain to weight of ear were determined. The average ratio of weight of grain to weight of ear for all the hybrid lots was 76.9%, running as high as 80 to 85% in as many as 13 lots out of a total of 54. This is on a basis of 288 ears. In the case of three strains of Northwestern Dent grown on the same plot the average ratio was only 71%. It was difficult to eliminate the cropping out of the flinty character in very many of the strains; but a number of promising strains were obtained. Two of these were at the same time early and dwarf and had low ears. Some strains or plants developed unusually large or long husk-leaves.

(Investigation under the direction of Prof. H. F. Roberts, University of Manitoba.)

Use of the Photo-electric Cell in Biology

Co-operating organization:

University of Manitoba

In many measurements photo-electric cells can take the place of the human eye, and where comparisons have to be made the cells are more likely to give an unbiased result. They find already a large number of uses in industry.

Continuing work on this subject, described in the previous annual report, the area and shape of blood cells in a film of normal blood and two films of anemic blood (primary and secondary anemia) have been studied by means of the combined application of a projection microscope, a red dye, a photo-electric cell and a special vacuum tube. The use in a standard circuit of the FP-54 vacuum tube recently placed on the market made it possible to obtain steady and measurable readings on a galvanometer giving a deflection of one mm. at one m. distance for a current of 0.003 millionth amp. Small changes in the current supplying the projection lamp, however, made it necessary to work between 1 and 5 a.m. To be satisfactory for this kind of study, blood films had to be made in which nearly every corpuscle was separated from its neighbor by a distance of several times the diameter of each. The films were fixed by immersion in a saturated aqueous solution of mercuric chloride for 20 min. and then thoroughly washed in distilled water. They were stained with acid fuchsin for 10 min. and washed until no trace of stain could be detected between the red corpuscles. A magnification of 1400 diameters was used, and 500 corpuscles were measured and compared in each film. The frequency distribution of the sizes was apparently normal in all three cases. However, in ordinary anemia of mild degree the red corpuscles stain less readily than those of normal blood. It will be necessary to separate the two factors, staining intensity and staining area, before there can be drawn any definite conclusions on the precise difference of pathological conditions in primary or pernicious and secondary anemia.

(Investigation under the direction of Prof. A. Savage, University of Manitoba.)

The Flora of Eastern Canada

Co-operating organization:

University of Montreal

An investigation has been under way for some years on the flora of eastern Canada, field work being devoted particularly to areas in the eastern part of the province of Quebec and to a smaller extent in the province of New Brunswick. Subsequent studies of the material collected were made in the botanical laboratories of the University of Montreal.

Considerable field work has been done on the northern shore of the Baie des Chaleurs, a district which forms the northern limit of numerous plant species and whose study is essential to a proper understanding of the New

Brunswick flora. The extensive deltas of rivers found in this district have been given special attention. There is found along these rivers a flora of varied origin, whose history is yet largely unsolved. Collections and photographs have been made over an area extending about ten miles from the mouth of each of the more important rivers of the district. An examination has also been made of the inland country of Gaspé peninsula in the vicinity of Lake Ste. Anne, of parts of southern and southwestern New Brunswick, and of the district in the province of Quebec north of the city of Montreal.

In the last two years over 15,000 botanical specimens have been placed in the national herbarium at Ottawa and in the larger herbaria of the world. These specimens will receive further study in this investigation, and will be available for research by other workers. Further, a collection of fresh-water algae has been made in every locality visited. This material, preserved in 4% formalin, is at present being studied and a report upon it will be published in due course.

A special study is being made of a localized evolution which seems to be taking place in every one of the secluded valleys of the Baie des Chaleurs drainage. Information obtained in this study may be of far-reaching importance, throwing light upon the development of the flora of the Gulf of St. Lawrence.

Attention has been paid to the introduction of Eurasian water weeds or noxious plants. An effort is being made to determine the role played by the waters of the St. Lawrence river in the immigration of plants which are constantly gaining a foothold in northeastern America.

In connection with this work the following publications have been issued during the period covered by the present report:

1. Les variations laurentiennes du *Populus tremuloides* et du *P. grandidentata*.
2. Le genre *Roripa* dans le Québec.
3. *L'Anacharis canadensis*. Histoire et solution d'un imbroglio taxonomique.
4. Les *Liliiflores* du Québec.

The following papers have been presented to meetings of scientific societies:

1. Additions aux *Cypéracées* de l'Amérique de Nord. Royal Society of Canada, 1929.
2. Sur quelques éléments labiles de la flore riparienne du St-Laurent. Royal Society of Canada, 1929.
3. Sur la florule halophytique de la source minérale de Varennes, Qué. Royal Society of Canada, 1929.
4. Qu'est-ce que *l'Elodea canadensis* Michx? Royal Society of Canada, 1930.
5. Contribution à l'étude de la flore montréalaise. Royal Society of Canada, 1930.
6. Le genre *Roripa* dans le Québec. Royal Society of Canada, 1930.

7. Contribution à l'étude des *Actaea* du Québec. Royal Society of Canada, 1931.
8. Sur un *Aster* nouveau d'affinité cordillérienne du bassin de la rivière Bonaventure, Qué. Royal Society of Canada, 1931.
9. Sur une nouvelle *Gentiane* crossopétalée et ses affinités cordillériennes et eurasiatiques. Royal Society of Canada, 1931.
10. What is *Elodea canadensis* Michx? American Association for the Advancement of Science, Buffalo, 1930.
11. How to illustrate a local flora. American Association for the Advancement of Science, Buffalo, 1930.

(Investigation under the direction of Prof. Marie-Victorin,
University of Montréal.)

Wireworms of the Canadian Prairie

Co-operating organization:

University of Alberta

It is probable that no grain fields in Alberta are entirely free from the northern grain wireworm (*Ludius aeripennis*), while many of them are so heavily infested that in years which are favorable to the development of the insects susceptible crops are in danger of complete destruction.

A survey on the distribution of the density of population showed striking differences. The areas of greatest numbers are in the open prairies in the central portion of the province, and in the originally fairly open park-land of the Peace River district. In these regions the rainfall is usually sufficient to bring a wheat crop to maturity. The areas of scarcity are the solid bush country. Much of this country, as in the general neighborhood of Edmonton, has been practically denuded of trees during the past 20 years, and now resembles the open prairie. Despite this fact, no serious wireworm damage has ever been reported within a radius of 200 miles from Edmonton. One badly infested field was found in 1928 at Wetaskiwin, about 50 miles to the south of Edmonton; in 1930 no wireworms were left. Generally speaking, rainfall is heavier around Edmonton than it is in the territory held by the northern grain wireworm.

As the insect is non-migratory in all its stages of development, it would appear that wherever it now occurs, whether in large or small numbers, it has long been represented, though overlooked owing to its keeping below the ground. Some factor linked up with the clearing of the land must have favored their increase to destructive numbers in Alberta.

In order to find means of controlling the wireworm nuisance, it is necessary to know the life-habits of the organism. The eggs are inconspicuous and difficult to find, and so, too, are the tiny wireworms which hatch. They are very sensitive to exposure during the summer, as mentioned in a previous annual report, and if kept on the surface on a hot summer day, soon die, but it is difficult to take advantage of this fact for their eradication. Wireworms, unlike most larvae, do not readily die when

kept away from roots so long as they have access to organic matter contained in damp soil. Only in the early stages of development is there a reasonable prospect of destroying wireworms by starvation. Laboratory experiments showed that wheat was the most satisfactory food for newly emerged larvae; the roots were eaten extensively, so that a clean wheat field forms a very suitable nursery in the latter part of June when the eggs hatch. As in other cases oats supported life less satisfactorily than did wheat and no wireworms could be raised on a number of weeds, such as redroot, pigweed and sunflowers. This would indicate that as with other types of wireworms a change of crop will frequently clear the land. Experiments made on Marquis, Reward, Ruby and Garnet wheat showed that they were all attacked, but that the Garnet variety is less able to withstand and recover, and it is advisable to seed fields that are known to be infested with wireworms with Marquis or Reward wheat in preference to Garnet.

If one period of egg-laying be permitted on any field the wireworms which hatch may live as long as five years, so that the population does not rise and fall from year to year as rapidly as does that of other insects. It is important to know at what depths the eggs are laid under different conditions of soil texture, moisture and temperature. Experiments along this line are difficult to conduct. It is known that in general the female beetle examines large numbers of shelters before selecting an egg-laying site, and in the small laboratory plots the insects failed to lay eggs except in very few instances. Outdoor observations suffered from the fact that during two seasons the month of June was much cooler than normal. With regard to the hatching of the eggs it was found that temperatures above 100°F. kill the eggs within 12 hours even when the surroundings are provided with ample moisture. This temperature is, however, rarely reached at a greater depth than one inch from the surface. At soil moistures such as are maintained when the soil is exposed to 60% air humidity no eggs hatched if they had been exposed for one or more 12-hour periods to temperatures of over 88°F. It would appear that variations to and from moderately high temperatures are more fatal to the eggs than is exposure to uniform temperatures that are several degrees higher.

*(Investigation under the direction of Prof. E. H. Strickland,
University of Alberta.)*

Microbiology of Farm Soils of Quebec

Co-operating organizations:

Macdonald College

Quebec Department of Agriculture

Nearly three-fourths of the newly cleared farm lands of Quebec are found to be infertile. A large mass of half-decomposed organic matter has accumulated in the surface layers; the soil is acid, and the action of micro-organisms is slow.

On comparing fertile and poor soil collected from southeastern counties it becomes apparent that the free-living nitrogen organisms and the most

efficient cellulose destroying bacteria are practically absent in the infertile soils.

A quantitative study of the most active micro-organisms found in Quebec soils is now under way.

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

Bark Disease of the Beech

Co-operating organization:

Nova Scotia Department of Lands and Forests

In the Maritime Provinces of eastern Canada the bark disease of the American beech (*Fagus grandifolia*, Ehrh.) has become so grave as to threaten the extinction of the tree as a timber producer. In Nova Scotia hardly a stand of maturing beech can be found in which certain of the trees are not infested and perishing.

In order to study the causes and remedies numerous collections of diseased material were made showing the affected bark and wood and frequently bearing organisms which seem to be associated with the disease. These included both an insect, the felted beech-coccus (*Cryptococcus fagi* Baerensprueng) and fungi, especially a *Nectria* species. The bark-louse occurs on the bark in great numbers, attacking healthy beeches of all ages and crown classes. The white wool-like threads which it exudes and which form a loose protective weft over each colony give to the trunks an appearance not unlike that resulting from driven snow or whitewashing. Eggs are laid in early summer, hatch in a few weeks, and the young larvae roam over the bark in countless thousands, insert their stylets into the bark or minute wounds and begin feeding and moulting. The mature individuals are legless, and deposit their eggs periodically from midsummer until frost.

The other organism which seems to be consistently associated with diseased beeches is a parasitic fungus, a species of *Nectria* closely related to a number of canker-inducing forms. The time of the year when inoculation and infection occur in nature has not yet been determined, nor has the length of time from initial infection until fruiting. Following infection, the fungus starts growing both along the surface layers and towards the centre, producing new crops intermittently through the summer and autumn. Large areas of bark die, and when the lesions spread virtual girdling of the trees may result. The fungus does not grow on all coccus-infested trees; it is present, however, on practically all dead or dying trees.

In order to study the development and spread of the disease, a series of plots including 1228 beeches of various ages and in different forest types were laid out and each tree was marked and described. Several hundred artificial inoculations have been made on beeches in the forest in Nova Scotia and New Brunswick and in the greenhouse at Harvard University. Most of the greenhouse inoculations did not result in fungous growth—they were perhaps not made under suitable conditions; the forest inoculations have not yet been studied.

On a number of trees the bark-louse was removed from an area of about two feet in vertical extent by scrubbing with a dry brush, or with soap and water, or with a kerosene-soap emulsion. The cleansed areas were protected against inroads by bandaging the ends with wrappings of factory cotton and sealing all margins with roofing tar. By selecting trees which have harbored the insect for different periods of time and following up the development of lesions on the cleansed patches, it will be possible to decide whether the fungus settles on the tree before, concurrently with, or after the insect.

(Investigation under the direction of Mr. O. Schierbeck, Nova Scotia Department of Lands and Forests.)

Feed Flavor or Stable Odor in Milk

Co-operating organization:

University of British Columbia

Inasmuch as milk consists of a variety of chemical compounds suitable for the growth of micro-organisms, it is to be expected that many changes in it may take place as a result of their growth. Although the number of bacteria in freshly drawn milk from healthy cows is relatively small, the types which may fall into the milk from the body of the cow, or gain access by way of containers or equipment, are among the most undesirable of all the organisms found in milk or its products. As an illustration of how many channels there are to increase the number of bacteria per unit volume of milk, a so-called feed flavor or stable odor, caused in reality by bacteria, has been studied.

About 100 bacterial cultures were prepared from material gathered from receptacles in which feeds are held, from implements used in the mixing of feeds, milking stools, water in drinking bowls, gutters, floors, manure, bedding, mud, rafters, ditches, milk sheet cover and the hands of milkers. With more than one-half of the total number of the cultures it was possible to produce a feed flavor and frothing in milk. Nearly 40 cultures caused an odor related to feed-flavor and three organisms gave a disagreeable odor in milk.

The organisms responsible for these effects were found to belong to groups of bacteria which produce souring and gassing of milk, such as *Aerobacter aerogenes*, which comes largely from soil and grain, and *Escherichia coli*, a normal inhabitant of the intestines of man and animals. Of 42 isolated cultures, 18 strains seemed to be closely related to *Aerobacter oxytocum*, 16 to *Aerobacter cloacae*, eight to *Aerobacter aerogenes* and 16 belonged to the genus *Escherichia*. In addition 44 other organisms were secured, a large proportion being of the *Escherichia* genus, which gave a feed flavor or stable odor to milk when they were first isolated, but not after being in pure culture for some months.

Published paper:

Sadler, W. and Irwin, M. L. Feed Flavor or Stable Odor in Milk. Can. J. Research, 3: 200-204. 1930.

(Investigation under the direction of Prof. H. M. King and Prof. W. Sadler, University of British Columbia.)

Marine Algae of the Maritime Provinces

Co-operating organizations:

Biological Board of Canada
Dalhousie University

In a number of countries, great quantities of seaweed are supplied to live-stock breeders as an addition to the feed of cattle; it assists in keeping the live-stock healthy and strong. A study of forms of algae occurring along the coasts of Canada is therefore of interest.

On the basis of the work described in the previous annual report, maps were prepared showing the distribution of the more common green, red and brown forms, such as the red *Rhodymenia palmata*, *Chondrus crispus*, (Irish Moss) and *Porphyra laciniata*, the brown *Fucus serratus*, *Alaria esculenta*, *Laminaria digitata*, etc.

An incomplete survey of the Prince Edward Island region showed that the forms were not only different from those in other parts of the Maritime Provinces, but their comparative abundance was strikingly different. For instance *Fucus serratus* is found in abundance in this region, and yet it occurs nowhere else on the Atlantic coast of North America. Irish moss could be gathered by the ton, whereas it is almost absent from the Bay of Fundy region and none too plentiful on the Atlantic coast. Similar differences were noted for many other varieties. At Souris an abundance of deep-water red algae was found, including many species which are rare at any other point in the Maritime Provinces, and many of the forms were of a distinctly southern type.

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

The Effect of Radiant Energy on Growth

Co-operating organization:

University of British Columbia

In a continuation of this investigation, experiments have been performed on the effect of radiant energy on the growth and sporulation of a fungus which is a common cause of ripe-rot on tomatoes.

It has been found that the lines of the mercury arc spectrum may be grouped in three classes on the basis of their effect on the growth of this fungus: those which cause constant retardation, those which cause constant stimulation, and those which cause primary retardation followed by stimulation.

On the basis of the effect on the production of spores there are two classes of lines in the mercury arc spectrum: those which hasten spore development and those which have no apparent effect. Spore production is generally stimulated by monochromatic light causing retardation or extreme stimulation of growth and is apparently not affected by light which moderately stimulates growth. An optimum duration has been demonstrated by the illumination causing the accelerated development of spores.

Evidence has been obtained that the effect of monochromatic light is upon the protoplasm and not upon the culture, since cultures grown on non-irradiated media from irradiated spores show the same effects as those obtained by irradiating three-day cultures. In many cases the effect of irradiation upon this fungus is evident in the growth ten days after the spores have been illuminated. There is a marked similarity of the growth of this fungus, yeast and paramecium.

Published paper:

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

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

The Action of Alkali on Cement and Concrete

Co-operating organization:

University of Saskatchewan

This investigation, which was started nearly 10 years ago, is now nearing completion, and the work during the year under review was directed towards bringing the various phases of the investigation to a close. Considerable time must still elapse, however, before the completion of the long-term experiments on the resistance of concrete to sulphate action, which have been under way for some years.

These long-term experiments deal mainly with the following:

- (1) Use of siliceous admixtures in concrete.
- (2) Steam-cured concrete.
- (3) The efficiency of membrane waterproofing.
- (4) The permanence of cements other than Portland.

The experimental work on the modification of the raw mix used in the manufacture of Portland cement, with the object of increasing the resistance of the finished product to alkali action, has yielded very promising results. This work was based on the previous laboratory experiments on the pure components of Portland cement. The preparation of alkali-resistant cement has been carried on during the last two years both on a small scale in laboratory furnaces and on a semi-commercial scale in co-operation with one of the large cement companies. Cements of extremely high resistance to alkali action have been produced and are now being tested, and further experiments are planned for the future.

The work on the hydration of the pure constituents of Portland cement and the thermochemistry of these compounds has been continued.

(Investigation under the direction of Dr. T. Thorvaldson.)

An Oceanographic Survey of the Strait of Georgia

Co-operating organization:

University of British Columbia

This survey has been made in order to determine the effect of the flow of water from the Fraser river on temperature, salinity, currents and fish food, all possible factors in the direction of salmon migration.

The correct valuation of the Fraser river in these respects has necessitated a survey of the water of the Strait of Georgia and an estimate of the relative importance of water entering the Strait from other sources. It is believed that the data obtained have a potential economic value as a basis for the further knowledge of the habits of fish, the establishment of oyster beds, the development of clam beaches and of crab and shrimp industries, and the location of summer resorts. Conclusions regarding the interrelations of salinity, temperature, pH, tidal movements and phytoplankton are of considerable scientific interest.

It has been found that the fresh water entering the Strait of Georgia, mainly from the Fraser river, forms a marked upper layer on the surface of the Strait which is characterized by low salinity and high temperature. The increase in temperature as compared with sea water may amount to as much as 18° F. Throughout the greater part of the season this surface layer has a stability sufficient to resist tidal and wave movements. Since time is a factor, the heat effect of the sun becomes most evident in regions some distance from the river mouth. In the case of the Fraser river this distance may exceed ten miles. Abundant fish food in the form of plankton is present and the amount is greatest in the regions where the most complete mixing of fresh and sea water takes place. Evidently each water contributes certain conditions or factors favorable for plankton growth and a further investigation to determine the exact nature of these conditions is therefore being made. Mass movements of the surface layer accompany tidal changes, resulting in variations in salinity, temperature and plankton at any point, according to the source of the water movement and the phase of the tide.

Published paper:

The Epithalassa of the Strait of Georgia, A. H. Hutchinson and C. C. Lucas, *Can. J. Research*, 5: 231-284. 1931.

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

The Production of Polysaccharides by Bacteria

Co-operating organization:

McGill University

This investigation was undertaken as a contribution to the study of polysaccharide chemistry, including the determination of the nature of the gummy substances and membranes or "pellicles" formed by the action of micro-organisms upon various carbohydrates in nutrient solutions.

The action of a number of the organisms concerned and the products formed have been examined. *Bacillus mesentericus* Trevisan and *B. subtilis* Cohn acting upon solutions containing sucrose and raffinose form a polysaccharide, levan, the structure of which has been determined. With various other sugars levan was not formed. This is due to the specific action of the organism upon a terminal group which is present in the sucrose and raffinose molecules but not in those of the other sugars studied.

The constitution of cellulose, in so far as the purely chemical side of the question is concerned, seems to be definitely established. Hydrolysis of cellulose results in a quantitative yield of glucose and it is interesting to note that in the present investigation, for the first time, it has been possible to demonstrate the reverse action, namely, the polymerization of glucose to cellulose by the action of bacteria, the simplest form of plant life. However, the mechanism by which cellulose is formed in the plant is still unknown, and it would seem that some information regarding this mechanism might be obtained by studying the action of bacteria on simple carbohydrates and related compounds.

A "cellulose" is formed by the action of *Acetobacter xylinus* on nutrient solutions containing glucose. Dry-spinning of a chloroform solution of the triacetate yielded a silk-like fibre which on complete de-acetylation formed a fibre of regenerated cellulose. X-ray examination of the latter and the application of chemical methods to the polysaccharide obtained by direct bacterial synthesis from glucose, proved conclusively the identity of the synthetic cellulose in question with normal cotton cellulose.

Four strains of *Leuconostoc mesenterioides* were studied and a medium suitable for the production of relatively large amounts of the polysaccharide from sucrose has been evolved. All of these organisms brought about formation of the polysaccharide, dextran, in nutrient solutions containing sucrose while two of them showed a slight activity in this respect towards glucose. Melezitose, raffinose, fructose, galactose, lactose, maltose, xylose and glycerol did not yield any polysaccharide. It is not yet certain whether a definite relation exists between the structure of the polysaccharide formed and the sugar utilized, as was found to be the case with levan.

The dextrans prepared by the action of *B. leuconostoc mesenterioides* and *B. leuconostoc dextranicus* on solutions of sucrose have been isolated in a pure state, free from ash and other impurities. The nature and structure of these dextrans are being investigated.

Experiments have been carried out, the results of which go to show that we are dealing here with a glucoglucoside of a disaccharide. The composition of the disaccharide has not yet been ascertained. It is a peculiar substance readily undergoing further polymerization on being isolated and this fact increases the difficulty in determining its constitution. The results obtained, however, show that the previous view that dextran is simply a polymerized anhydroglucose is incorrect.

Dextran has been shown by other investigators to have a very definite immunological action as ascertained by experiments on horses and rabbits.

The polysaccharide isolated from pneumococci can be combined with a variety of proteins and in each case an immunological substance (an antigen) is obtained. It has been proved that dextran, when absorbed on a neutral colloid material, namely, nitrocellulose, and introduced into the animals under investigation, induces a very specific action in bringing about a greater flow of the serum containing an antitoxin and this can be more readily isolated in a pure state. This discovery is likely to have far-reaching results in the preparation of sera, in the science of immunology and in the cure of disease.

The preparation of other polysaccharides is being actively carried on with a view to obtaining substances which may prove useful in the investigation of diseases such as anthrax, streptococci infection and others.

Published papers:

Hibbert, Harold, Tipson, R. Stuart and Brauns, F. Studies on Reactions Relating to Carbohydrates and Polysaccharides XXXIV. The Constitution of Levan and its Relation to Inulin. *Can. J. Research*, 4: 221-239. 1931.

Tarr, H. L. A. and Hibbert, Harold, XXXV. Polysaccharide Synthesis by the Action of *Acetobacter xylinus* on Carbohydrates and Related Compounds. *Can. J. Research*, 4: 372-388. 1931.

Hibbert, Harold and Brauns, F. XXXVI. Structure of the Levan Synthesized by the Action of *Bacillus subtilis* on Sucrose. *Can. J. Research*, 4: 596-604. 1931.

Tarr, H. L. A. and Hibbert, Harold, XXXVII. The Formation of Dextran by *Leuconostoc mesenteroides*. *Can. J. Research*, 5: 414-427. 1931.

Hibbert, Harold and Hallonquist, Earl, XXXVIII. Preparation, Separation and Identification of the Isomeric Bromoethylidene Glycerols. *Can. J. Research*, 5: 428-435. 1931.

Hibbert, Harold and Barsha, Jacob, XXXIX. Structure of the Cellulose Synthesized by the Action of *Acetobacter xylinus* on Glucose. *Can. J. Research*, 5: 580-591. 1931.

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

Ultrafiltration of the Dextrins

Co-operating organization:

Dalhousie University

Dextrin, a whitish gummy substance found in plant sap and in bread crust, and produced in industry by heating starch or treating starch with acids, is a mixture of various substances and difficult to separate into its components. A general method is to prepare membranes which allow to pass only a single substance, that with the smallest molecules.

In continuing the work of separation described in the previous annual report new membranes were prepared from commercial brands of cellulose nitrate, the parlodion of DuPont and the celloidin of Scherring Kahlbaum. The material was dissolved in a mixture of ethyl alcohol and anhydrous diethyl ether, poured over the end of an inclined glass tube, and air-dried after several coatings had been applied. The membranes thus formed were impermeable to glucose. But after soaking them in varying strengths of alcohol, as proposed by Brown, filters were obtained which showed a graded permeability to glucose, and it seemed that traces only of dextrans were coming through the less permeable membranes. The work on the characteristics of the different fractions of dextrans is still incomplete.

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

Properties of Quebec Farm Soils

Co-operating organizations:

Macdonald College

Quebec Department of Agriculture

In many counties of Quebec the soil of the cleared farm lands shows a poor balance between mineral constituents and organic matter. In order to obtain the highest crop yield it is necessary to know what materials are lacking and how they may best be supplied, by adding barnyard manure, lime or chemical fertilizers. It is necessary to examine many hundreds of samples of garden and field soils before more or less general recommendations can be made.

The need for more accurate information on this point is well shown by the wide variation in the calcium and phosphorus content of some Quebec red clover and timothy hays. In order to determine the causes, clover, hay and soil samples were secured during the second week in July, 1929, from the Chateauguay River basin, a dairy farming district. The soils were heavy clay loams; all had been treated with barnyard manure, but none of the soils had ever received lime or commercial fertilizers. The clover hays appeared to be normal, but the timothy hays were very low in lime. Their lime content was smaller the lower the amount of lime found in the first eight inches of the soil. As the presence of lime in the rations of animals is of great importance, it would appear that liming of the heavily-cropped soils of the dairy farms of Quebec province should be practiced to a much greater extent in future than it is at present.

In extending this work to virgin soils and subsoils, 100 samples were collected from six hilly counties of the Quebec Eastern Townships' region (counties of Brome, Compton, Richmond, Shefford, Sherbrooke and Stanstead). The relatively low temperature found in this region in winter, short growing seasons, heavy snowfalls and rainfalls, the height of the country above sea-level, the glacier action in the past, the chemical composition of the rocks from which most of the soil has arisen, all combine to make the problem of soil improvement in the area a difficult one to solve.

Practically all the soils of the region were found to have in their surface eight inches a relatively high percentage of organic matter; they are low in calcium and phosphorus and show low nitrate nitrogen content throughout the growing season. A deficiency of these mineral elements, coupled with high moisture, retards the decomposing action of the micro-organisms. The subsoils are richer in lime, magnesia and the sesqui-oxides of iron and aluminium than are the surface soils; the reverse is true of organic carbon, nitrogen and sulphur, except soils of the muck swamp class. It would appear, therefore, that most of the soils of this region would have their crop-carrying capacity improved by mixing surface and subsoil materials.

A study of soil samples collected from ten counties of the Richelieu, lower Ottawa and St. Lawrence river valleys indicates similar conditions. In all districts fertile areas of land, generally clays, alternate with extremely infertile land of the podsol type, that is, soils characterized by leaching of the sesqui-oxides and by half decomposed acid organic matter, a store of material which needs to be set free.

Published papers:

McKibbin, R. R. Soils and Soil Treatments in Quebec. *Sci. Agr.* 11: 361-368. 1930.

McKibbin, R. R. and Pugsley, L. I. Soils of the Eastern Townships of Quebec. *Macdonald College, Tech. Bull.* 6: 1-64, 1930.

Pugsley, L. I. and McKibbin, R. R. Calcium Relationships of Forage Crops. *Can. J. Research*, 4: 39-51. 1931.

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

Mineral Constituents of the Floral Parts and Young Fruits of the Apple

Co-operating organization:

Acadia University

Knowledge of the influence which lime, phosphoric acid, potash and iron have on the composition, color and size of apples is of importance in producing a uniform grade of sound fruit, and is particularly useful in districts where the soil is low in certain minerals.

As a contribution to this question, a study was made of the effect of fertilizers on the chemical composition of blossoms and young apples (Gravenstein, Wagener, Spy, King, Russett and Ribston Pippin), obtained from orchards in Kings County, N.S., and from the experimental fertilizer plots of the Dominion Experimental Farm, Kentville. The collection of blossoms was begun on May 25 and continued to June 6, and the samples of young fruit were gathered on June 11, the average weight of the apples being about 0.05 gm. at that date. The use of potash fertilizers had the effect of increasing the potassium content of the anthers, but no increase in the amounts of calcium and phosphorus was found when fertilizers containing these elements were employed. No marked difference could be noted

in the young fruit as the result of application of calcium, potassium, or phosphorus fertilizers. However, the use of nitrate of soda seemed to increase the proportion of magnesia, phosphoric acid and potash present in young apples and to lower the sum total of mineral matter, whereas muriate of potash, on the contrary, tended to increase the ash content and lower the proportions of magnesium and phosphoric acid. Considerable differences were found between material collected from trees under conditions of cultural neglect as compared with that from trees under good cultural conditions.

*(Investigation under the direction of Dr. W. A. DeLong,
Acadia University.)*

Maple Sugar Research

Co-operating organization:

Macdonald College

In order to be readily marketable, maple sugar products must be of uniform composition and methods of concentration must not alter the characteristic flavor.

From work described in the previous annual report it appeared that the maple sugar flavor is not developed when the sap is concentrated in a vacuum below 60°C. It was then found that if the sap is first heated to 110°C. and later concentrated under reduced pressure, flavor is present. A number of syrups were prepared in the ordinary way, evaporating the sap by heating to 104°C., under atmospheric pressure, but gases were bubbled through the liquid during the process of concentration in order to determine whether or not the flavor could be improved in this way. The gases used were air, oxygen, nitrogen, hydrogen and carbon dioxide. Air and nitrogen seemed to give the most uniform results. With the sap received during the early part of the season, which lasted from March 15 to April 9 at Ste. Anne de Bellevue, oxygen and carbon dioxide gave syrups lighter in color than those concentrated without these gases, but during the latter part of the season all the syrups made were very dark in color.

One great difficulty in the maple industry and in the chemical examination of the sap is that the sap cannot be kept for any length of time, but must be concentrated immediately after being gathered, to prevent damage by micro-organisms. Chloroform placed in the buckets in which the sap is collected prevents bacterial growth; the sap may then be kept without spoiling for a week before it is worked up.

For the official chemical methods of analysis of maple sugar, samples containing 65% of solid matter are required. When the samples are prepared in the usual way, they are found to vary widely, having from 54 to 71% of dry matter. It was observed that when the refractive index of the syrup is measured while the sample is being concentrated, until a value of 1.4521 is reached, much more uniform samples result, the range being 63.5 to 70.25% solid matter for 164 samples. Eleven collaborators in three Canadian and five United States laboratories took part in this work.

The lead value methods for detecting adulteration with refined sugar have been further studied. The collaborators were asked to send samples of their basic lead acetate solutions to one laboratory where an analysis was made. The alkalinity varied a great deal, and the lead numbers obtained with them decreased with the amount of basic lead. The range could be narrowed down by preparing the basic lead acetate solution from normal lead acetate and yellow litharge, that is, litharge heated to 650°C. for three hours in an electric muffle furnace.

Products from the counties of Stanstead, Argenteuil, Compton, Beauce and Brome were used in this work.

Published paper:

Snell, J. F. Report on Maple Products. J. Assoc. Official Agr. Chem. 14: 158-172. 1931.

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

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 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 Research Council by the professor recommending the candidate and through the head of the department concerned. The candidate shall state the institution at which he intends to study, and the general line of work to be followed. The application will be considered and decided upon by the Research Council or by a special committee appointed by the same.

9. Each applicant must arrange for his admission to some approved university, and submit with 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 mid-year and on the conclusion of the award.

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

11. Successful candidates are required to devote themselves for a period of at least 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 mid-year report of his work up to that time; and also on completion of the tenure of his award, and not later than July 31, a complete and detailed report of the work carried on during the entire year.

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 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 Research Council the applicant be of outstanding ability.

B. Special Regulations Governing Bursaries.

16. A Bursary is of the value of \$750.*

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

* This amount has been temporarily reduced to \$600.

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

19. A person who has held a bursary and who has, during the 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.*

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.*

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, Ontario.

* These amounts have been temporarily reduced to \$750, and \$1000 respectively.

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 to 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
67 Scholarships held during the year 1930-1931

FOREIGN TRAVELLING FELLOWSHIPS

Grantee	Graduated	Where held	Subject of Research
Wm. Chalmers.....	B.A., M.A., University of British Columbia; Ph.D., McGill University.	Department of Chemistry, University of Freiburg, Freiburg, Germany.	Viscosity and molecular weight of some colloids.

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, England.	Mechanism of oxidation.

***WHEAT POOL FELLOWSHIPS**

Grantee	Graduated	Where held	Subject of Research
Robt. G. Dunlop.....	B.Sc., University of Saskatchewan.	Department of Field Crops and Plant Biochemistry, University of Alberta, Edmonton, Alta.	Gas production and retention in bread dough.
H. R. Sallans.....	B.Sc., University of Saskatchewan.	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.	Chemical and physico-chemical means for differentiation of the quality factor in Canadian hard red spring wheat.
C. A. Winkler.....	B.Sc., University of Manitoba.	Department of Agricultural Chemistry, Manitoba Agricultural College, Winnipeg, Man.	Factors affecting the manufacture of bread.

*Fellowships at \$1,200 each provided by the Canadian Wheat Pool.

FELLOWSHIPS

Grantee	Graduated	Where held	Subject of Research
J. M. Anderson.....	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	The duration of metastable states of the rare gases.
A. S. Cook.....	B.A., M.A., Dalhousie University.	Department of Pathological Chemistry, University of Toronto, Toronto, Ont.	Properties of glucosamine.
D. LeB. Cooper.....	B.Sc., M.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The density of carbon dioxide and aberrations from the ideal gas laws.
L. E. Howlett.....	B.A., University of British Columbia; M.A., University of Toronto.	Department of Physics, McGill University, Montreal, Que.	Raman effect.
F. H. Peto.....	B.S.A., University of Manitoba; M.Sc., University of Alberta.	Department of Agricultural Botany, University College of Wales, Aberystwyth, Wales.	A study of meiosis and mitosis in certain <i>Lolium</i> and <i>Festuca</i> species, their hybrids and derivatives.

SCHOLARSHIPS

STUDENTSHIPS

Grantee	Graduated	Where held	Subject of Research
J. S. Allen.....	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Nature of polymerization and its relation to the dipolar moment of organic products.
Miss May Annetts.....	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Coagulation phenomena in colloidal solutions.
J. C. Bernier.....	B.A.Sc., (Civil Eng.) University of Montreal.	Department of Electrical Engineering, University of Montreal, Montreal, Que.	Electronic saturation and applications to filter circuits.
A. C. Burton.....	B.Sc., University of London; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Effects of short electromagnetic waves.
Miss M. Campbell.....	B.A., M.A., University of British Columbia.	Department of Zoology, University of Toronto, Toronto, Ont.	Life history of two copepods <i>Colanus tonsus</i> Brady and <i>Euchalta japonica</i> Marukawa.
C. E. Coke.....	B.Sc., M.Sc., University of Manitoba; M.A., University of Toronto.	Department of Chemistry, University of Toronto, Toronto, Ont.	Solubility of nitrous oxide in an emulsion of paraffin oil in water.
E. A. Filby.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Physical Chemistry, McGill University, Montreal, Que.	The density of cellulose and wood pulp under different amounts of absorbed water vapor.
G. F. Frame.....	B.A., M.A., Dalhousie University.	Department of Organic Chemistry, McGill University, Montreal, Que.	Certain reactions of α -ketonic nitrates and esters.
N. H. Grace.....	B.A., M.A., University of Saskatchewan.	Department of Physical Chemistry, McGill University, Montreal, Que.	The absorption of vapors by wood cellulose.
G. V. Helwig.....	B.Sc., M.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The structure of certain optically active dithionates.
W. W. Johnston.....	B.A., M.A., University of Toronto.	Department of Zymology, University of Toronto, Toronto, Ont.	The influence of certain salts of the lower fatty acids on the metabolism of <i>Clostridium acetobutylicum</i> .
H. C. Laird.....	B.A., University of Western Ontario; M.A., University of Toronto.	Department of Geology, University of Toronto, Toronto, Ont.	Study of chert formation in Ontario.
G. A. Ledingham.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Plant Pathology, University of Toronto, Toronto, Ont.	Phycomycetous parasites of cereals.
E. P. Linton.....	B.Sc., Mount Allison University; M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	An investigation of the resonance method for the measurement of the dielectric constant.
M. K. McPhail.....	B.A., University of British Columbia.	Department of Biochemistry, McGill University, Montreal, Que.	The pituitary and its relation to sex physiology.
F. R. Morehouse.....	B.Sc., Mount Allison University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The preparation of the acetylenes and a study of their physical properties.
S. M. Pady.....	B.A., M.A., McMaster University.	Department of Botany, University of Toronto, Toronto, Ont.	Development of telia in a number of rusts that attack forest trees.
H. D. Smith.....	B.A., M.A., University of British Columbia; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Raman effect with liquefied gases.
H. S. Sutherland.....	B.Sc., Mount Allison University; M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	A study of the reaction between hydrogen chloride and the olefines.
H. L. A. Tarr.....	B.S.A., M.S.A., University of British Columbia.	Department of Bacteriology, McGill University, Montreal, Que.	The synthesis of polysaccharides by the action of bacteria.

Grantee	Graduated	Where held	Subject of Research
Robt. Turnbull.....	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Absorption of light by liquid argon at various pressures and temperatures.
Robt. H. Wright.....	B.A., University of British Columbia.	Department of Physical Chemistry, McGill University, Montreal, Que.	The properties of aqueous hydrogen sulphide solutions.

BURSARIES

Grantee	Graduated	Where held	Subject of Research
J. F. Allen.....	B.A., University of Manitoba; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Superconductivity.
W. E. Barker.....	B.A., M.A., Queen's University.	Department of Organic Chemistry, McGill University, Montreal, Que.	The addition reactions of vinyl phenyl ketone.
J. Barsha.....	B.Sc., McGill University.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Studies of polymerization related to carbohydrate chemistry.
Miss M. A. Bennie.....	B.A., Queen's University.	Department of Bacteriology, Queen's University, Kingston, Ont.	The cataphoretic potential of bacteria with the idea of distinguishing the R and S strains of acid-fast bacteria.
F. R. Burton.....	B.Sc., M.Sc., McGill University.	Department of Geology, McGill University, Montreal, Que.	A study of the geological relations in a highly metamorphosed belt of Quebec.
Miss M. R. Butler.....	B.A., M.Sc., Dalhousie University.	Department of Biochemistry, University of Toronto, Toronto, Ont.	Protein content of chondrus crispas.
J. Campbell.....	B.A., University of Toronto.	Department of Biochemistry, University of Toronto, Toronto, Ont.	Synthesis of protein by tissue enzymes.
H. M. Chisholm.....	B.Sc., Dalhousie University.	Department of Physics, Dalhousie University, Halifax, N.S.	Specific heats of metals.
R. E. Fitzpatrick.....	B.S.A., Macdonald College, Que.	Department of Botany, University of Toronto, Toronto, Ont.	Studies on the life history of certain exoaccaceae.
A. F. Gallagher.....	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	The physical and chemical properties of the polyethylene glycols and their derivatives.
Miss M. E. Greig.....	B.A., McGill University; M.A., University of Saskatchewan.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	The relation of structures to polymerization.
G. W. Gurd.....	B.A., University of Western Ontario.	Department of Physical Chemistry, McGill University, Montreal, Que.	The equilibria existing in aqueous solutions of sulphur dioxide and other soluble gases.
K. W. Hall.....	B.Sc., University of New Brunswick.	Department of Physics, University of Toronto, Toronto, Ont.	Determination of spin moments of atomic nuclei by investigation of indium and other metallic vapors.
E. G. Hallonquist.....	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Constitution of spruce lignin.
W. F. Hampton.....	B.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The heat capacity of gels.
R. N. H. Haslam.....	B.A., University of Saskatchewan.	Department of Physics, University of Saskatchewan, Saskatoon, Sask.	Electrical properties of monomolecular films.

SCHOLARSHIPS

Grantee	Graduated	Where held	Subject of Research
J. F. Heard.....	B.A., University of Western Ontario; M.A., McGill University.	Department of Physics, McGill University, Montreal, Que.	Stark effect in complex spectra.
Miss E. M. Hearne.....	B.A., M.A., Queen's University.	Department of Genetics and Cytology, Queen's University, Kingston, Ont.	Investigation of Siberian pea and the honey locust from point of view of hybridization.
W. M. Herron.....	B.A., Queen's University.	Department of Bacteriology, Queen's University, Kingston, Ont.	Rancidity in cheddar cheese.
R. G. Hunter.....	B.A., M.A., University of Toronto.	Department of Physics, McGill University, Montreal, Que.	The crystal analysis of hydrates with X-rays.
F. T. Jolliffe.....	B.A., M.A., Queen's University.	Department of Geology, Queen's University, Kingston, Ont.	Factors influencing the deposition of gold in gels and their relation to natural geological processes.
J. Katzman.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The mechanism of the potential distribution in an electrical discharge through gases.
H. E. Mason.....	B.Sc., Mount Allison University.	Department of Organic Chemistry, McGill University, Montreal, Que.	(1) The action of sulphurous acid on cellulose. (2) Studies in lignin.
N. B. McMaster.....	B.S.A., Macdonald College.	Department of Biology, Macdonald College, Que.	Study of the effect of environmental conditions upon the micro-flora of the soil.
F. L. Munro.....	B.A., M.A., University of British Columbia.	Department of Physical Chemistry, McGill University, Montreal, Que.	Penetration of wood.
C. L. Newcombe.....	B.A., M.A., Acadia University; M.S., University of West Virginia.	Department of Biology, University of Toronto, Toronto, Ont.	A study of mya arenaria (clam).
F. H. Nicoll.....	B.Sc., University of Saskatchewan.	Department of Physics, University of Saskatchewan, Saskatoon, Sask.	Reflection of molecules from liquid surfaces.
W. B. Ross.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Effects of temperature and light radiation upon copper oxide rectifiers.
H. H. Saunderson.....	B.A., B.Sc., M.Sc., University of Manitoba.	Department of Physical Chemistry, McGill University, Montreal, Que.	Penetration in wood.
L. F. Somerville.....	B.A., Bishops College.	Department of Organic Chemistry, McGill University, Montreal, Que.	Some reactions of delta retonic nitrites.
W. W. Stewart.....	B.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The viscosity of gases.
G. E. Thompson.....	B.S.A., M.A., University of Toronto.	Department of Botany, University of Toronto, Toronto, Ont.	Diseases of poplars.
J. C. Tobin.....	B.A., St. Francis Xavier College.	Department of Physics, McGill University, Montreal, Que.	Relaxation of discharge tubes and the photoelectric effect.
A. R. Williams.....	B.Sc., M.Sc., Queen's University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Surface energy of sulphur.
J. T. Williamson.....	B.A., McGill University.	Department of Geology, McGill University, Montreal, Que.	The accessory minerals of certain crystalline rocks and their value in correlation and determination of origin.

APPENDIX D

257 Scholarship Graduates—1917-1931

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.....	Assistant Professor of Physics, University of Toronto, Toronto, Ont.
W. J. Allardyce, B.A., M.A., Ph.D.....	British Columbia	Graduate Student, McGill University, Montreal, Que.
Miss E. J. Allin, B.A., M.A., Ph.D.....	Toronto.....	Demonstrator and Research Assistant, Department of Physics, University of Toronto, Toronto, Ont.
Miss Marian Anderson, B.A., M.Sc.....	New Brunswick.....	Deceased.
F. M. Archibald, B.Sc., M.A., Ph.D.....	Acadia.....	No information.
N. J. Atkinson, B.Sc., M.Sc.....	Saskatchewan.....	Biologist for the Lucerne-in-Quebec Community Association, Limited, Log Chateau, Lucerne-in-Quebec, Que.
W. F. Baker, B.A., B.Sc., M.Sc.....	Manitoba.....	With Anglo-American Company, South Africa.
R. H. Ball, B.A., M.A., Ph.D.....	British Columbia.....	Graduate Student, McGill University, Montreal, Que.
C. Barnes, B.Sc., M.Sc.....	Leeds.....	Graduate Student, University of Toronto, Toronto, Ont.
W. H. Barnes, B.Sc., M.Sc., Ph.D.....	McGill.....	Lecturer in Chemistry, 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.Sc., M.A.Sc., M.A.....	Toronto.....	Junior Research Chemist, National Research Council, Ottawa, Ont.
R. W. Beattie, B.Sc., M.Sc.....	Queen's.....	Research, Halowax Corporation, Bloomfield, N.J.
A. H. Bell, B.A., Ph.D.....	Toronto.....	Geologist in Charge, Petroleum Section, Illinois State Geological Survey, Urbana, Ill.
H. P. Bell, B.Sc., M.Sc., M.A., Ph.D.....	Dalhousie.....	Professor of Botany, Dalhousie University, Halifax, N.S.
L. V. Bell, B.Sc., M.A., Ph.D.....	Alberta.....	Geologist, Department of Mines, Quebec.
P. A. Berard, B.A., L.ès Sc.Ch.....	Montreal.....	Milk Analyst, City Hall, Montreal, Que.
Miss A. A. Berkeley, B.A., M.A., Ph.D.....	British Columbia.....	Married. (Volunteer worker for the Biological Board of Canada.)
G. H. Berkeley, B.A., M.A., Ph.D.....	Queen's.....	Senior Plant Pathologist, Laboratory of Plant Pathology for Southern Ontario, St. Catharines, Ontario.
J. L. Binder, B.Sc., M.Sc.....	Saskatchewan.....	Graduate Student, University of California, Berkeley, Cal.
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 of 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., Ph.D.....	Saskatchewan.....	Research in Band Spectra, Ryerson Physical Laboratory, University of Chicago, Chicago, Ill.
B. S. W. Buffam, B.Sc., M.Sc., Ph.D.....	McGill.....	Assistant Professor of Geology, University of Buffalo, Buffalo, N.Y.
J. W. Burns, B.Sc., M.Sc.....	New Brunswick.....	Assistant Professor of Chemistry, University of Western Ontario, London, Ont.
K. H. Butler, B.A., M.A., Ph.D.....	Dalhousie.....	Research Chemist, Grasselli Chemical Co., 256 Vanderpool Street, Newark, N.J.
Miss F. M. Cale, B.A., M.A.....	Toronto.....	Married.
G. B. Carpenter, B.A., M.A., Ph.D.....	British Columbia.....	Chemist, DuPont Ammonia Corp., Wilmington, Del.
N. M. Carter, B.A.Sc., M.A.Sc., Ph.D., F.R.G.S.	British Columbia.....	Chemist and Oceanographer, Pacific Biological Station, Nanaimo, B.C.
P. Cartier, B.Sc., L.ès Sc. Ch.....	Montreal.....	Assistant Professor of Chemistry, University of Montreal; Director and Consulting Chemist of Industrial and Commercial Laboratories, Ltd., Montreal, Que.
H. M. Cave, B.A., M.A., Ph.D.....	Queen's.....	Lecturer in Physics, Queen's University, Kingston, Ont.
Miss M. L. Chalk, B.A., M.Sc., Ph.D.....	McGill.....	Lecturer in Physics, Macdonald College, Que.
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 Assistant, Division of Chemistry, National Research Council, Ottawa, Ont.
E. Chauret, I.Ch., L. es Sc.....	Montreal.....	Chief Chemical Engineer in the Concrete Department of the Laboratory of Testing Materials, Montreal, Que.

SCHOLARSHIP GRADUATES

Grantee	University where undergraduate training received	Present Occupation
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, N.Y.
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.
C. C. Coffin, B.A., M.Sc., Ph.D.....	Dalhousie.....	Lecturer in Physical Chemistry, Dalhousie University, Halifax, N.S.
Miss E. Cohen, B.A., M.A., Ph.D.....	Toronto.....	Instructor in Physics, Mount Holyoke College, Hadley, Mass.
Miss L. Corbett, B.A., M.A.....	Queen's.....	Married.
R. G. Corneil, B.Sc., A.C.I.C.....	Queen's.....	Teacher of Science, Kitchener and Waterloo Vocational School, Kitchener, Ont.
M. F. Crawford, B.A., M.A.....	Western Ontario.....	On staff of 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.....	Assistant Professor, Department of Physics, University of Saskatchewan, Saskatoon, Sask.
A. C. Cuthbertson, B.Sc., M.Sc., Ph.D.....	McGill.....	Assistant Professor of Chemistry, Mount 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, Ecole Polytechnique 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.....	Instructor, Department of Physics, University of Western Ontario, London, Ont.
V. H. Emory, B.A.Sc.....	Toronto.....	Service Engineer, Fraser Paper, Limited, Madawaska, Maine, U.S.A.
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.
G. S. Field, B.Sc., M.Sc.....	Alberta.....	Junior Research Physicist, National Research Council, Ottawa, Ont.
J. H. Findlay, B.A., B.Sc., M.Sc., Ph.D.....	Queen's.....	Research Physicist, Union Switch and Signal Company, Swissvale, Pa.
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.....	Assistant Professor of Chemistry, Medical College of Virginia, Richmond, Va.
H. R. Foreman, B.A., M.A.....	Toronto.....	President and Sales Manager, H. R. Foreman & Co., Ltd., Heating and Refrigerating Engineers, 75 King St. West, Toronto, Ont.
J. H. Fox, B.A., M.A.....	Western Ontario.....	Vice-principal, 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.....	Assistant in Palaeontology in the Royal Ontario Museum, Toronto, and Instructor in Palaeontology at the University of Toronto, Toronto, Ont.
D. K. Froman, B.Sc., M.Sc., Ph.D.....	Alberta.....	Lecturer, Department of Physics, Macdonald College, Que.
W. A. Gale, B.A.Sc., M.A.Sc.....	British Columbia.....	Assistant Director of Research with American Potash and Chemical Corp., Trona, Cal.
W. Gallay, B.A., M.Sc., Ph.D.....	McGill.....	Assistant Research Chemist, National Research Council, Ottawa, Ont.
J. F. L. Germain, B.A., A.R.C.Sc.....	Montreal.....	No information.
N. E. Gibbons, B.A., M.A.....	Queen's.....	Brady Laboratory, 310 Cedar Street, New Haven, Conn.
B. E. Gilbert, B.A., M.A., Ph.D.....	McMaster.....	Director and Plant Physiologist of the Rhode Island Agricultural Experiment Station, Kingston, R.I.
Miss K. F. Godwin, B.A., M.Sc., Ph.D.....	McGill.....	Married. Research in Physiology, Cambridge University, Cambridge, England.
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., Ph.D., D.I.C.....	Saskatchewan.....	Graduate Student, University of California, Berkeley, Cal.
A. R. Graham, B.S.A., M.Sc.....	McGill.....	Assistant Entomologist engaged in Forest Insect Parasite Investigations, Parasite Laboratory, Dominion Department of Agriculture, 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.
O. A. Gratiás, B.Sc., M.Sc.....	Saskatchewan.....	Graduate Student, Clarendon Laboratory, Oxford, England.
C. Greaves, B.Sc., M.Sc., Ph.D.....	McGill.....	Junior Chemist in the Division of Wood Preservation, Forest Products Laboratories, Ottawa, Ont.
H. Greenberg, B.Sc., M.Sc., Ph.D.....	McGill.....	Research Chemist with the 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.....	No information.
R. H. Harris, B.Sc., M.Sc.....	Saskatchewan.....	Chemist in charge of laboratory of the Quaker Oats Company, Saskatoon, Sask.

Grantee	University where undergraduate training received	Present Occupation
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.
P. G. Hiebert, B.A., M.A., M.Sc., Ph.D.	Manitoba	Assistant Professor of Chemistry, University of Manitoba, Winnipeg, Man.
A. C. Hill, B.Sc., M.Sc., Ph.D.	Dalhousie	Research Department, Canadian International Company, Hawkesbury, Ont.
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	Assistant Sulphite Superintendent, 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, 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, Toronto, Ont.
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, 3420 University Street, 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	Assistant Professor, Department of the Banting Medical Research, Toronto, Ont.
K. 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., Ph.D.	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.
C. T. Lane, B.Sc., M.Sc., Ph.D.	McGill	Research Student, University of Munich, Germany.
G. O. Langstroth, B.A., Ph.D.	Dalhousie	Research Student, Physics Research Department, King's College, Strand, London, Eng.
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 the Department of Chemistry, Bates College, Lewiston, Me.
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., 1181 Guy Street, Montreal, Que.
F. R. Lorriman, B.A., M.A., Ph.D.	Toronto	Assistant Professor of Chemistry, University of Toronto, Toronto, Ont.
G. H. W. Lucas, B.A., M.A., Ph.D.	Toronto	Associate Professor of 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, Eng.
P. A. MacDonald, B.Sc., M.Sc., Ph.D.	Manitoba	Radium Physicist, University of Manitoba, Winnipeg, Man.
Miss A. P. MacDougall, B.A., M.A.	McMaster	Married. (Research on insect pests in Ecuador.)
D. G. MacGregor, B.A., M.A.	Dalhousie	Professor of Physics, Mount Allison University, Sackville, N.B.
J. E. Machacek, B.S.A., M.S.A., Ph.D.	Saskatchewan	Assistant Pathologist, Dominion Rust Research Laboratory, Winnipeg, Man.
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	Research Student, Harvard University, Cambridge, Mass.

Grantee	University where undergraduate training received	Present Occupation
K. A. MacKinnon, B.Sc., M.Sc., Ph.D.	Queen's.....	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.
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 Professor, University of Montana, Agricultural Experiment Station, Bozeman, Montana.
G. L. Matheson, B.Sc., M.Sc., Ph.D.....	McGill.....	With Standard Oil Development Co., Elizabeth, N.J.
L. A. Matheson, B.A., M.A., Ph.D.....	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., M.Sc., Ph.D.	Manitoba.....	Instructor in Mineralogy, Syracuse University, Syracuse, N.Y.
A. W. McCallum, B.Sc.F., M.A.	Toronto.....	Forest Pathologist, Division of Botany, Department of Agriculture, Ottawa, Ont.
G. C. McCartney, B.A., B.Sc., M.Sc., Ph.D.	Manitoba.....	Department of Geology, Yale University, New Haven, Conn.
W. H. McCurdy, B.A., M.A., Ph.D.....	Dalhousie.....	X-ray Division, Westinghouse Lamp Co., Bloomfield, N.J.
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., 1261 Shearer St., Montreal, Que.
J. W. McKinney, B.Sc., M.Sc., Ph.D...	Alberta.....	Research Chemist, (Cellulose Acetate), Brown Co., 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, The 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.....	Assistant Professor of Physics, McMaster University, Hamilton, Ontario.
S. McLean, B.A., M.A.....	McMaster.....	Experimental Engineer, Lamp Development Laboratory, Incandescent Lamp Department of General Electric Company, Nela Park, Cleveland, O.
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.
D. R. McRae, B.Sc., M.Sc.....	McGill.....	Graduate Student, McGill University, Montreal, Que.
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...	Lead Refinery, Consolidated Mining and Smelting Co. of Canada, Ltd., Trail, B.C.
J. H. Mennie, B.A., M.A., B.Sc., Ph.D.	British Columbia...	Assistant Professor of Chemistry, McGill University, Montreal, Que.
W. E. K. Middleton, B.Sc., M.Sc.....	Saskatchewan.....	Meteorologist, Meteorological Service of Canada, Toronto, Ont.
G. Molleur, I.C.....	Montreal.....	Quebec Streams Commission, Quebec, Que.
J. G. Morazain, B.Sc., M.Sc.....	Laval.....	Graduate Student, McGill University, Montreal, Que.
O. M. Morgan, B.A., M.A., Ph.D.....	Western Ontario.....	Assistant Research Chemist, National Research Council, Ottawa, Ont.
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 Corporation, Arkansas City, Kansas.
D. D. Mossman, B.Sc., M.A.....	McGill.....	Research Fellow in essential oils and perfume chemistry, Columbia University, New York, N.Y.
Miss B. K. E. Mossop, B.A., M.A., A.A.A.S.	Toronto.....	Specialist in Science, Ingersoll Collegiate Institute, Ingersoll, Ont.
Miss Irene Mounce, B.A., M.A., M.Sc. Ph.D.	British Columbia...	Assistant Plant Pathologist, Central Experimental Farm, Ottawa, Ont.
W. H. Mueller, B.Sc., M.Sc., Ph.D.....	Alberta.....	Department of Plant Research, Shawinigan Chemicals, Shawinigan Falls, Que.
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 Biologist with the Biological Board of Canada, in charge of oyster investigations in Prince Edward Island and of Prince Edward Island Marine Station, Eglerslie, P.E.I.
Miss D. E. Newton, B.S.A., M.Sc.....	McGill.....	Lecturer in Mycology, Macdonald College, Que.
Miss M. Newton, B.S.A., M.Sc., Ph.D.	McGill.....	Senior Plant Pathologist, Dominion Rust Laboratory, Agricultural College, Winnipeg, Man.

Grantee	University where undergraduate training received	Present Occupation
J. L. Nickerson, B.A., M.A.....	Dalhousie.....	Assistant Professor of Physics, Mount Allison University, Sackville, N.B.
C. D. Niven, B.Sc., M.A., Ph.D., A.I.C.	Aberdeen.....	Assistant Research Physicist, National Research Council, Ottawa, Ont.
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.....	Instructor in Physics, College of the City of New York, New York, N.Y.
A. Paquet, B.Sc., M.Sc.....	Laval.....	Graduate Student, McGill University, Montreal, Que.
D. S. Pasternack, B.Sc., M.Sc., Ph.D.....	Queen's.....	Research Chemist with the Alberta Research Council, Edmonton, Alta.
A. L. Patterson, B.Sc., M.Sc., F.Inst.P., Ph.D.	McGill.....	No information.
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, 2nd and South St., Passaic, N.J.
R. A. Pelletier, B.Sc., M.Sc., Ph.D.....	McGill.....	Assistant Consulting Geologist, Northern Rhodesia, South Africa.
J. F. Phillips, B.A.Sc., M.A., A.C.I.C.....	Toronto.....	Teacher of Western Technical School, Toronto, Ont.
J. B. Phillips, B.Sc., M.Sc., Ph.D.....	McGill.....	Research Assistant, Massachusetts Institute of Technology, Cambridge, Mass.
E. C. Powell, B.Sc., M.Sc.....	Saskatchewan.....	Graduate Student, McGill University, Montreal, Que.
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.....	Physicist, Development Department, Eastman Kodak Company, Rochester, N.Y.
Miss C. E. Rice, B.A., M.A.....	Queen's.....	Graduate Student, University of Toronto, Toronto, Ont.
Miss C. E. Robertson, B.Sc., M.Sc., Ph.D.	McGill.....	Married.
D. M. Robertson, B.A., M.A.....	Manitoba.....	Graduate Student, McGill University, Montreal, Que.
A. D. Robinson, B.A., M.A., Ph.D., A.C.I.C.	Saskatchewan.....	Assistant Professor in Agricultural Chemistry, Winnipeg, Man.
H. L. Robson, B.Sc., Ph.D., F.C.I.C.....	Saskatchewan.....	Research Chemist, Mathieson Alkali Works, Niagara Falls, N.Y.
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, Division of Fuels and Fuel Testing, Mines Branch, 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.....	Assistant Professor of Physics, 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, Ltd., in Alberta, Calgary, Alta.
C. A. Sankey, B.A.Sc., M.Sc., Ph.D.....	Toronto.....	Research Department, Price Bros. & Co., Ltd., Quebec, Que.
B. W. Sargent, B.A., M.A.....	Queen's.....	Lecturer in Physics, Queen's University, Kingston, Ont.
J. E. Saunders, B.A.Sc., M.Sc.....	McGill.....	Deceased.
W. R. Sawyer, B.Sc., M.Sc., Ph.D.....	Queen's.....	1931-32 Research Assistant, Mallinckrodt Laboratory, Harvard University, Cambridge, Mass.
D. A. Scott, B.A., M.A., Ph.D.....	Toronto.....	Assistant Director of the Connaught Laboratories, University of Toronto, 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 at 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.....	No information.
C. Sivertz, B.A.Sc., M.Sc., Ph.D.....	British Columbia.....	Assistant Professor of Chemistry, University of Western Ontario, London, Ont.

SCHOLARSHIP GRADUATES

Grantee	University where undergraduate training received	Present Occupation
V. Sivertz, B.S., M.S., Ph.D.	Washington	Instructor in Chemistry, University of Washington, Seattle, Wash.
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.
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, England.
H. D. Squires, B.A., M.Sc., Ph.D.	New Brunswick	Assistant Professor of Geology, Oregon State School of Mines, Corvallis, Oregon.
E. W. R. Steacie, B.Sc., M.Sc., Ph.D.	McGill	Assistant Professor of 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	Abitibi Power and Paper Co., Ltd., Iroquois Falls, Ont.
B. P. Sutherland, B.A.Sc., M.Sc., Ph.D.	British Columbia	Chief of Research, Chemical and Fertilizer Department, Consolidated Mining and Smelting Company of Canada, Ltd., Trail, B.C.
C. W. Sweitzer, B.A., M.A., Ph.D.	Toronto	Senior Industrial 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.
H. Thiessen, B.Sc., M.Sc.	Saskatchewan	Assistant in Mathematics, Brown University, Providence, R.I.
K. Thomson, B.A., M.A.	Western Ontario	Instructor in 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 Co., 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	No information.
I. Walerstein, B.A., Ph.D.	Toronto	Assistant Professor of Physics, Purdue University, Lafayette, Indiana.
D. 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., Ph.D.	McGill	Lecturer in Physics, Queen's University, Kingston, Ont.
Miss M. Weinberg, B.A., M.A., M.Sc.	Manitoba	Married.
M. S. Whelan, B.Sc., M.Sc., Ph.D.	Saskatchewan	Research Chemist, E. I. Du Pont de Nemours & Co., Wilmington, Del.
E. F. Whyte, B.A., M.A., Ph.D.	Dalhousie	Dominion Analyst, Dominion Dept. of Health, Halifax, N.S.
J. O. Wilhelm, B.Sc., M.A.	Saskatchewan	Technical and Research Assistant, Department of Physics, University of Toronto, Toronto, Ont.
C. V. Wilson, B.Sc., M.Sc.	Saskatchewan	Research Student at McGill University, Montreal, Que.
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 of Canada, Ltd., Trail, B.C.
K. S. Wyatt, B.A., B.Sc.	Mount Allison	Research Chemist, Detroit-Edison Co., Detroit, Mich.
H. R. Wyman, B.Sc., M.Sc.	Dalhousie	Research Chemist, Imperial Oil Refineries Limited, Dartmouth, N.S.
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	Associate Professor of Physics, University of Manitoba, Winnipeg, Man.
J. M. Young, B.Sc., M.Sc.	McGill	Engineer, Canadian Marconi Company, Montreal, Que.
W. H. Zinn, B.A., M.A.	Queen's	Assistant in Physics, Columbia University, New York City.

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

100 Researches in Progress During 1930-1931

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 Dept. of Agriculture; University of Alberta; University of Saskatchewan.
Chemical control of weeds.....	Associate Committee on Weed Control	Three co-operating laboratory groups: University of Alberta; University of Saskatchewan; University of Manitoba.
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.
Problems of the asbestos industry.....	Associate Committee on Asbestos Research	National Research Laboratories, Ottawa.
Problems of the leather industry.....	Associate Committee on Leather Research	National Research Laboratories, Ottawa.
Problems of the laundry industry.....	Associate Committee on Laundry Research	National Research Laboratories, Ottawa.
Electrical measuring instruments.....	Associate Committee on Electrical Measuring Instruments	National Research Laboratories, Ottawa.
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	Two co-operating laboratory groups: University of Alberta; University of Toronto.

ASSISTED RESEARCHES

Subject of Research	Grantee	Where Carried On
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 Nitrogen Fixation	Dept. of Physics, Toronto University, and Research Information Division of National Research Council.
The problem of slack barrels in apple shipments	Associate Committee on Apple Slacks	Federal Department of Agriculture.
Utilization of Canadian iron ores.....	Subcommittee on Iron Ores of the Associate Committee on Metallurgy	Steel Company of Canada, Hamilton, Ont.
Destruction of wood piling by marine boring animals	Associate Biological Committee	Atlantic Biological Station of the Biological Board of Canada.
Pressure variations inside the cylinders of the internal combustion engine	Dr. D. A. Keys.....	Dept. of Physics, McGill University, Montreal, Que.
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.
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.
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.
1. Physical and chemical oceanography 2. Marine biology 3. Fish technology	Dr. C. McLean Fraser.....	Three co-operating organizations: University of British Columbia; Biological Board of Canada; Dominion Meteorological Service.
Studies on humidity.....	Prof. A. N. Shaw.....	Dept. of Physics, McGill University, Montreal, Que.
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.
Effects of certain reagents upon plants	Prof. R. O. Earl.....	Dept. of Biology, Queen's University, Kingston, Ont.
The marine algae of the Canadian Atlantic coast	Prof. H. P. Bell.....	Dept. of Botany, Dalhousie University, Halifax, N.S.
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	Prof. 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.

Subject of Research	Grantee	Where Carried On
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.....	National Research Laboratories, Ottawa.
Earth's nocturnal radiation in relation to weather	Dr. H. T. Barnes.....	Dept. of Physics, McGill University, Montreal, Que.
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 Chemistry, 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.
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 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.
Relation of bacteria to incidence of feed flavors and stable odors in milk	Profs. H. M. King and W. Sadler	Dept. 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.
Action of bacteria and enzymes on carbohydrates and products resulting therefrom	Dr. H. Hibbert.....	Dept. of Chemistry, McGill University, Montreal, Que.
Investigations on gas and water content of trees	Prof. R. D. Gibbs.....	Dept. of Botany, McGill University, Montreal, Que.
Microbiology of soil conditions in eastern Canada	Prof. P. H. H. Gray.....	Dept. of Bacteriology, Macdonald College, Que.
Mineral constituents of the floral parts and young fruits of the apple	Prof. W. A. DeLong.....	Dept. of Chemistry, Acadia University, Wolfville, N.S.
Indirect ultra-violet solar radiation and its distribution	Prof. R. C. Dearle.....	Dept. of Physics, University of Western Ontario, London, Ont.
Parasites of the snowshoe rabbit.....	Prof. R. A. Wardle.....	Dept. of Zoology, University of Manitoba, Winnipeg, Man.
Investigations into the bark disease of the beech	Mr. Otto Schierbeck.....	Field work in forests of Nova Scotia.
Status of slough itch in Saskatchewan.	Prof. L. G. Saunders.....	Dept. of Biology, University of Saskatchewan, Saskatoon, Sask.

APPENDIX F (Part II)

93 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. Bourgoïn.
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.
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.

Subject of Research	Grantee
Effects of velocity on re-absorption rates.....	Prof. O. S. Gibbs.
Effect of ultra-violet rays on eggs, chicks and laying hens.....	F. C. Elford.
Adhesion of ice to various surfaces of aeroplane structure	Dr. H. T. Barnes.
Sound analysis of carillon on Peace Tower.....	Prof. E. F. Burton.
The active principle of yeast.....	Prof. W. L. Miller.
Factors governing the milling and baking quality of wheat.....	Dr. R. Newton.
Ultrasonics (inaudible sound waves).....	Dr. R. W. Boyle.
Bacillary white diarrhoea in poultry.....	Prof. H. W. Hill and
	Prof. E. A. Lloyd.
Rotary derivatives of a boat type seaplane.....	Prof. J. H. Parkin.
Fog alarm research.....	Dr. L. V. King.
Glucosides of plants indigenous to western Canada.....	Prof. A. T. Cameron.
The habit and life history of the smaller mammals of the prairies.....	Mr. F. Neave.
Mistletoe, parasitic on jack pine.....	Miss E. S. Dowding.
Winter hardiness in crop plants.....	Dr. R. Newton.
The chemistry of fish curing.....	Dr. A. B. Macallum.
Researches in the field of low temperatures.....	Prof. J. C. McLennan.
Chlorination of methane gas.....	Prof. M. C. Boswell.
Designing and testing of a series of windmills for producing electric power	
on farms.....	Prof. J. H. Parkin.
Cause of the reversed blood pressure of fowls.....	Prof. O. S. Gibbs.
Experiments on catalysis.....	Dr. G. S. Whitby.
Best methods for obtaining accurate results in testing varieties, strains	
and treatments of grain.....	Associate Committee on Accurate
	Plot Work.
Reforestation experiments on cut-over and burnt-over lands.....	Associate Committee on New Brun-
	swick Forest Problems.
Health hazards in spray painting.....	Associate Committee on Spray
	Painting.

APPENDIX G

Publications of the National Research Council

ANNUAL REPORTS

Annual reports for fiscal years 1916-17 to 1930-31.

MONTHLY PUBLICATION

Canadian Journal of Research
From May 1, 1929 to date
Two volumes annually.

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. Kriebel, 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.....	Associate Committee on Industrial Fatigue, 1921.
8.	A Method of Melting 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.....	Wilfred Sadler, N.D.D., B.S.A., M.Sc., and R. L. Vollum, M.A., 1926.
17.	The Mosquitoes of the Lower Fraser Valley, British Columbia and their Control.....	Eric Hearle, M.Sc., 1926.
18.	Investigation 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.

Bulletin Number	Title	Author
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.
- A 1—1928 Standard Specification for Steel Railway Bridges. (3rd ed.) Price 50c.
 A 1a—1928 Material Specifications, Steel Railway Bridges. (2nd reprint) Price 15c.
 C 2—1929 Standards for Single-phase Distribution Transformers. (2nd ed.)
 C 3—1924 Standard Specification for Galvanized Telegraph and Telephone Wires.
 B 4—1921 Standard Specification for Wire Rope for Mining, Dredging and Steam Shovel
 Purposes. (Under revision)
 A 5—1927 Standard Specification for Portland Cement. (2nd ed.)
 A 6—1929 Standard Specification for Steel Highway Bridges. (2nd ed.) Price 50c.
 D 7—1922 Standard Specification for Flexible Steel Wire Rope and Strand for Aircraft
 Purposes.
 G 8—1923 (Replaced by G26-1929 and G27-1929. See below.)
 A 9—1923 (Replaced by G30-1930, G31-1930 and G32-1930. See below.)
 C 10—1923 Standard Specification for Tungsten Incandescent Lamps.
 D 11—1924 Interim Report on the Manufacture, Testing and Use of Gasoline.
 B 12—1924 Standard General Specification for Galvanized Steel Wire Strand.
 E 13—1924 Standard Specification for Railway Wire-fencing and Gates.
 C 14—1924 Standard Specification for Reinforced Concrete Poles.
 C 15—1924 Standard Specification for Eastern Cedar Poles.
 A 16—1930 Standard Specification for Steel Structures for Buildings. (2nd ed.)
 C 17—1925 Standard Requirements for A.C. Watthour Meters.
 A 19—1926 Standard Classification for Items of Highway Expenditure.
 A 20—1927 Standard Specification for Movable Bridges.
 C 21—1927 Standard Specification for Control Cable for Electrical Power Plant Equipment.
 C 22—1930 Canadian Electrical Code, Part I. (2nd ed.)
 A 23—1929 Standard Specification for Concrete and Reinforced Concrete. Price \$1.00.
 G 24—1929 Standard Specification for Sampling for Check Analysis of Steel Billets, Bars
 and Shapes.
 G 25—1929 Standard Specification for Carbon Steel Billets and Bars of Forging Quality.
 G 26—1929 Standard Specification for Commercial-quality Hot-rolled Bar Steels.
 G 27—1929 Standard Specification for Commercial Cold-finished Bar Steels and Cold-
 finished Shafting.
 G 28—1929 Standard Specification for Carbon Steel Castings.
 B 29—1929 Established List of Machine Screws.
 G 30—1930 Standard Specification for Billet-steel Reinforcing Bars.
 G 31—1930 Standard Specification for Rail-steel Reinforcing Bars.
 G 32—1930 Standard Specification for Steel Wire for Concrete Reinforcement.
 B 18—1930 Established List of Stove Bolts.

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
AERONAUTICS			
A. R. P. No. 8, Thick Aerofoils.....	Parkin, J. H., Craine, H. C. and MacAllister, J. S. E.	Bull. 4, School Eng. Research, Univ. of Toronto.	1924
A. R. P. No. 17, Research on Channel Wall Interference.....	Parkin, J. H., Shortt, J. E. B. and Heard, C. G.	Bull. 7, School Eng. Research, Univ. of Toronto.	1927
A. R. P. No. 18a. Pressure Distribution over the U. S. A.—27 Aerofoil.	Parkin, J. H., Shortt, J. E. B. Heard and, C. G.	Bull. 7, School Eng. Research, Univ. of Toronto.	1927
A. R. P. No. 18b. Pressure Distribution over the Gottingen—387 Aerofoil.	Parkin, J. H., Shortt, J. E. B. and Cade, J. G.	Bull. 7, School Eng. Research, Univ. of Toronto.	1927
A. R. P. No. 19. Biplane Investigation.....	Parkin, J. H., Shortt, J. E. B. and Cade, J. G.	Bull. 7, School Eng. Research, Univ. of Toronto.	1927
The Design of Corners in Fluid Channels...	Klein, G. J., Tupper, K. F. and Green, J. J.	Can. J. Research, Vol. 3.	1930
AGRICULTURE, GENERAL			
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 Ware- houses 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 Re- lation to the Yield and Quality of the Succeeding Wheat Crop.	Newton, R. and Malloch, J. G.	Sci. Agr.	1930
Variation in the Quality of Wheat Grown in Replicate Plots.	Newton, R. and Malloch, J. G.	Sci. Agr. Vol. X.	1930
ANIMAL DISEASES			
Effect of Bacillary White Diarrhoea In- fection on Egg Production.	Asmundson, V. S. and Biely, Jacob.	Poultry Sci. Vol. VII, No. 6	Sept. 1928
Control of Bacillary White Diarrhoea In- fection 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
Effect of Pullorum Disease on Second Year Year Egg Production.	Biely, Jacob.....	Sci. Agr., Vol. XI.	Dec. 1930
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
Some Problems of the Fox-raising Industry	Hunter, Andrew.	National Research Council Bulletin No. 8.	1920
Food Requirements of the Ranch Fox.....	Smith, G. Ennis.....	National Research Council Bulletin No. 9.	1921
A Study of the Head Length Variability of Equine Spermatozoa.	Savage, A., Williams, W. L. and Fowler, N. M.		
BACTERIOLOGY			
The Effect of Autolysis in Sterile Tissues on Subsequent Bacterial Decomposition. Red Discoloration of Cured Codfish.....	Gibbons, N. E. and Reed, G. B. Harrison, F. C. and Kennedy, Miss M.	J. Bact. Vol. XIX, No. 2.	Feb. 1930
Red Discoloration of Cured Codfish (Scientific Data).	Harrison, F. C. and Kennedy, Miss M.	National Research Council Report No. II.	1922
Discoloration, Smut or Blackening of Canned Lobster.	Harrison, F. C. and Hood, E. G.	Roy. Soc. Can. Sec. V. National Research Council Report No. 12.	1923

Title of Paper	Author	Where Published	Date Published
BACTERIOLOGY—Continued			
Discoloration, Smut or Blackening of Canned Lobster (Scientific Data). Bacteriology of Certain Sea Fish.....	Harrison, F. C. and Hood, E. G. Harrison, F. C., Perry, Miss H. M. and Smith, P. W. P.	Roy. Soc. Can. Sec. V. National Research Council Report No. 19.	1926
Motility of Bacteria as Effected by Hydrogen Ion Concentration. Pigments of <i>Pseudomonas Pyocyaneus</i>	Reed, G. B. and MacLeod, D. J.	J. Bact. Thesis for M.A. degree, Queen's University, Kingston, Ont.	Mar. 1924 April 1923
Effects of Hydrogen Ion and Salt Concentration upon the Morphological Structure and upon Formation of Certain Bacteria. Discoloration in Canned Lobsters.....	MacLeod, D. J. Reed, G. B. and MacLeod, D. J.	Thesis for M.A. degree, Queen's University, Kingston, Ont. Report of Biological Board of Canada.	April 1923 1924
The Bacterial Content of Graded Butter....	Sadler, W. and Vollum, R. L.	Trans. Roy. Soc. Can. Sec. V.	1923
An Attenuated <i>Streptococcus Lacticus</i> Strain (Kruse) The Relation of Bacteria to the Quality of Graded Butter. The Duration of <i>B. Welchii</i> Antitoxin Immunity in Rabbits.	Sadler, W. and Vollum, R. L. Sadler, W. and Vollum, R. L. Reed, G. B. and Spence, Miss C. M.	Trans. Roy. Soc. Can. Sec. V. National Research Council Report No. 16. J. Infectious Diseases.	1923 1926 1927
The in vivo Action of <i>B. Welchii</i> Toxin in Erythrocytes in Comparison with other Haemotoxins. An Investigation into the Question of the Early Putrefaction of Eviscerated Fish in which the Gills have been left.	Reed, G. B., Orr, J. H. and Spence, Miss C. M. Gross, L.	J. Infectious Diseases. National Research Council Report.	1927 1919
A Comparison of the Action of <i>B. Welchii</i> Toxin with other Haemotoxins on Human and Rabbit Red Cells in vitro. Gas-metal Electrode Potentials in Sterile Culture Media for Bacteria. Soil as a Source of Infection of Honey by Sugar-tolerant Yeasts. The Effect of Preservatives on Fermentation by Sugar-tolerant Yeasts from Honey.	Orr, J. H., Campbell, W. A. and Reed, G. B. Boyd, E. M. and Reed, G. B. Lochhead, A. G. and Farrell, Miss L. Lochhead, A. G. and Farrell, Miss L.	Can J. Research, Vol. 2. Can. J. Research, Vol. 4. Can. J. Research, Vol. 3. Can. J. Research, Vol. 3.	1930 1931 1930 1930
BIOCHEMISTRY			
The Parathyroid Gland.....	Collip, J. B.	Harvey Lectures for 1925-26.	1927
The Purification of Pepsin, its Properties and Physical Characters. The Antipressor Fraction from Liver Tissue and its Physiologic Action.	Forbes, J. C. James, A. A., Laughton, N. B. and Macallum, A. Bruce	J. Biol. Chem. J. Am. Med. Assoc. Vol. 87.	Feb. 1927 July 31, 1926
Preliminary Note on the Distribution of Glucosides in Western Canadian Plants. The Effect of Pituitary on the Bird.....	McCullagh, R. Roy. Morash, R. and Gibbs, O. S.	Trans. Roy. Soc. Can. XX, Sec. V. J. Pharmacol. Vol. XXXVII, No. 4.	1926 Dec. 1929
The Enzymes of <i>B. Coli Communis</i>	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. The Coagulation of Protein by Sunlight.	Young, E. G.	Proc. Roy. Soc. London, Vol. 93. Proc. Roy. Soc. London, Vol. 93.	1922 1922
The Quantitative Determination of Bios. Chemical Study of Bios.....	Lucas, G. H. W. Lucas, G. H. W.	Trans. Roy. Soc. Can. Sec. III, Vol. XVI. Trans. Roy. Soc. Can. Sec. III, Vol. XVII.	1922 1923
The Fractionation of Bios and Comparison of Bios with Vitamines B and C. The Relationship between Rigor Mortis and the Glycogen, Lactic Acid and Free Phosphorus of Fish Muscle. The Immediate Post Mortem Changes in Fish Muscle. Changes Occurring in Mammalian Muscle Immediately after Death. The Effects of Asphyxia and Isletectomy on the Blood Sugar of <i>Myoxocephalus</i> and <i>Ameiurus</i> . Immediate Post Mortem Changes in Mammalian Muscle. Is the Apparent Winter-killing of Sweet Clover and Red Clover a Result of Disease Injury? Seasonal Changes in the Composition of Winter Wheat Plants, in Relation to Frost Resistance.	Lucas, G. H. W. Leim, A. H., MacLeod, J. J. R. and Simpson, W. W. MacLeod, J. J. R. and Simpson, W. W. MacLeod, J. J. R. and Simpson, W. W. Simpson, W. W. Simpson, W. W. and MacLeod, J. J. R. Newton, R. and Brown, W. R. Newton, R. and Brown, W. R.	J. Phys. Chem. Vol. XXVII. Contr. to Can. Biology. Contr. to Can. Biology. Proc. Soc. Exptl. Biol. Med. Am. J. Physiol. Trans. Roy. Soc. Can. Sec. 5. Sci. Agr. J. Agr. Sci.	Nov. 1924 1927 1927 1926 July 1926 1926 Nov. 1924 Oct. 1926

Title of Paper	Author	Where Published	Date Published
BIOCHEMISTRY—Continued			
The Extraction of Plant Tissue Fluids and Their Utility in Physiological Studies.	Newton, R., Brown, W. R. and Martin, W. M.	Plant Physiol. Vol. 1, No. 1.	Jan. 1926
Apparatus for Continuous Dialysis at a Low Temperature.	Newton, R. and Martin, W. M.	Plant Physiol. Vol. 2, No. 1.	Jan. 1927
Studies on the Nature of Rust Resistance in Wheat. I. General Introduction. II. Physico-chemical Properties of Host-cell Contents. III. Culture and Injection Experiments to Demonstrate Inhibiting or Accessory Substances.	Newton, R., Lehmann, J. V. and Clarke, A. E.	Can. Research Vol. 1.	1929
Studies on the Nature of Rust Resistance in Wheat. IV. Phenolic Compounds of the Wheat Plant.	Newton, R. and Anderson, J. A.		
The Bound Water of Wheat-flour Suspensions.	Newton, R. and Cook, W. H.	Can. J. Research, Vol. 3.	1930
A Study of the Utility of Protein Peptization by Inorganic Salt Solutions as a Means of Predicting Loaf Volume.	Geddes, W. F. and Goulden, C.H.	Cereal Chem.	Nov. 1930
Physico-chemical Studies on the Nature of Drought Resistance in Crop Plants. (2 papers).	Newton, R. and Martin, W. M.	Can. J. Research, Vol. 3.	1930
Modifications of Rumsey's Method for the Determination of Diastatic Activity in Flour.	Malloch, J. G.....	Cereal Chem., Vol. VI.	1929
BIOPHYSICS			
The Effect of Light at Different Wavelengths on the Rate of Reproduction of <i>Volvox fureus</i> and <i>Colostrium Acerosum</i> .	Klugh, A. Brooker.....	New Phytologist, 24.	1925
Ecological Photometry and New Instrument for Measuring Light.	Klugh, A. Brooker.....	Ecology, 6.	1925
Light Penetration into the Bay of Fundy and into Chamcook Lake, N.B.	Klugh, A. Brooker.....	Ecology, 8.	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
On Reflex Visual Sensations.....	Allen, Frank.....	J. Optical Soc. Am., Vol. 7, and Am. J. Phys. Op., Vol. 5.	1923
On Reflex Visual Sensations and Color Contrast.	Allen, Frank.....	J. Optical Soc. Am., Vol. 7, p. 29 and Am. J. Phys. Op., Vol. 6.	1924 1923 1925
The Reflex Origin of Color Contrast.....	Allen, Frank.....	J. Optical Soc. Am., Vol. 9.	1924
The Reflex Origin of the Self-light of the Retina.	Allen, Frank.....	J. Optical Soc. Am., Vol. 9.	1924
On the Tactile Sensory Reflex.....	Allen, Frank and Hollenberg, A.	Quart. J. Exptl. Physiol., Vol. 14.	1924
On the Tactile Sensory Reflex.....	Allen, Frank and Weinberg, Miss M.	Quart. J. Exptl. Physiol. Vol. 15.	1925
The Gustatory Sensory Reflex.....	Allen, Frank and Weinberg, Miss M.	Quart. J. Exptl. Physiol. Vol. 15.	1925
The Variation of Visual Sensory Reflex Action with Intensity of Stimulation.	Allen, Frank.....	J. Optical Soc. Am. Vol. 13.	1926
The Sensations of Temperature, Pain and Pressure.	Allen, Frank and Macdonald, P. A.	Quart. J. Exptl. Physiol. Vol. 16.	1927
Post-contraction—the Proprioceptive Reflex: its Inhibition and Augmentation.	Allen, Frank and O'Donoghue, C. H.	Quart. J. Exptl. Physiol. Vol. 16.	1927
The Graphical Representation of the Stimulation of the Retina by Colors.	Allen, Frank and Fleming, A. J.	Phil. Mag. Vol. 6.	Aug. 1928
The Secretory Activity of the Parotid Gland.	Allen, Frank.....	Quart. J. Exptl. Physiol. Vol. 19, No. 4.	July 1929
On the Verification of the Principle of Reflex Visual Sensations.	Hollenberg, M. S.....	J. Optical Soc. Am. Vol. 8.	1924
Visual Sensory Reflexes and Color Blindness.	Hollenberg, A.....	J. Optical Soc. Am. Vol. 9.	1924
On the Rate of Freezing in Fish Muscle.....	Langstroth, G. O.....	Trans. Nova Scotian Inst. Sci.	1929
Studies on the Photosynthesis of Marine Algae, No. 1. Photosynthetic Rates of <i>Enteromorpha linza</i> , <i>Porphyra umbilicalis</i> and <i>Delesseria sinuosa</i> in Red, Green and Blue Light.	Klugh, A. B.....	Can. Biol. and Fish Vol. VI.	1930
The Unitary Behavior of the Nervous System.	Allen, F.....	Can. J. Research, Vol. 4.	1931
The Specific Effects of Monochromatic Light on the Growth of Yeast.	Hutchinson, A. H. and Newton, Miss D.	Can. J. Research, Vol. 2.	1930
The Effect of Radiant Energy on Growth and Sporulation in <i>Colletotrichum Phomoides</i> .	Hutchinson, A. H. and Ashton, Miss M. R.	Can. J. Research, Vol. 3.	1930
The Specific Effects of Monochromatic Light on the Growth of <i>Paramecium</i> .	Hutchinson, A. H. and Ashton, Miss M. R.	Can. J. Research, Vol. 1.	1929

Title of Paper	Author	Where Published	Date Published
BIOPHYSICS—Continued			
The Effect of the Ultra-violet Component of Sunlight on Certain Marine Organisms.	Klugh, A. Brooker.....	Can. J. Research, Vol. 1.	1929
The Effect of the Ultra-violet Component of the Sun's Radiation upon some Aquatic Organisms.	Klugh, A. Brooker.....	Can. J. Research, Vol. 2.	1930
The Effect of the Ultra-violet Component of Sunlight on Certain Aquatic Organisms.	Klugh, A. Brooker.....	Can. J. Research, Vol. 3.	1930
BOTANY			
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
Chromosome Homologies in Wheat and Aegilops.	Jenkins, J. A.....	Am. J. Botany, XVI.	Apr. 1929
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 Behaviour in Triploid Wheat Hybrids.	Thompson, W. P.....	J. Genetics, 17.	1926
Chromosome Behaviour in a Cross Between Wheat and Rye.	Thompson, W. P.....	Genetics, 11.	1926
Preponderance of Dicocum-like Characters and Chromosome Numbers in Hybrids Between Triticum Dicocum 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
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
Researches on Fungi, Vol. IV.....	Buller, A. H. R.....	Longmans, Green & Co., London, Eng.	1931
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. and 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. Univ. 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

Title of Paper	Author	Where Published	Date Published
BOTANY—Continued			
The Occurrence of Biologic Forms of Wheat Stem Rust in Western Canada.	Newton, Miss M.....	Sci. Agr. I.	1921
A Preliminary Note on the Occurrence of Biologic Forms of Wheat Stem Rust in Western Canada.	Newton, Miss M.....	Phytopathology, II.	1921
Studies in Wheat Stem Rust (<i>Puccinia graminis tritici</i>).	Newton, Miss M.....	Trans. Roy. Soc. Can. 3rd. Series, 16.	1922
Colloidal Changes Associated with Protoplasmic Contraction.	Scarth, G. W.....	Quart. J. Exptl. Physiol., Vol. 14, 1 and 2.	Apr. 1924
The Action of Cations on the Contraction and Viscosity of Protoplasm in <i>Spirogyra</i> .	Scarth, G. W.....	Quart. J. Exptl. Physiol., Vol. 14, 1 and 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
Growing Wheat and Barley Hybrids in Winter by Means of Artificial Light.	Harrington, J. B.....	Sci. Agr. Vol. VII, No. 4.	Dec. 1926
The Reaction of Wheat Plants at Two States of Growth to Stem Rust.	Harrington, J. B. and Smith, W. K.	Sci. Agr. Vol. VIII, No. 11.	July 1928
Les variations laurentiennes du <i>Populus tremuloides</i> et du <i>P. grandidentata</i> .	Fr. Marie-Victorin.....	Cont. Lab. Bot. Univ. of Montreal.	1930
Le genre <i>Rorippa</i> dans le Québec.....	Fr. Marie-Victorin.....	Cont. Lab. Bot. Univ. of Montreal.	1930
<i>L'Anacharis canadensis</i>	Fr. Marie-Victorin.....	Cont. Lab. Bot. Univ. of Montreal.	1931
The Relationship between Morphologic Characters and Rust Resistance in a Cross between Emmer (<i>Triticum dicoccum</i>) and Common Wheat (<i>Triticum vulgare</i>).	Harrington, J. B.....	Can. J. Research, Vol. 2.	1930
The Inheritance of Reaction to Black Stem Rust of Wheat in a <i>Dicoccum x Vulgare</i> Cross.	Harrington, J. B. and Smith, W. K.	Can. J. Research, Vol. 1.	1929
Cytological Irregularities in Hybrids between Species of Wheat with the Same Chromosome Number.	Thompson, W. P. and Robertson, H. T.	Cytologia, Vol. 1.	1930
Shrivelled Endosperm in Species Crosses in Wheat, its Cytological Causes and Genetical Effects.	Thompson, W. P.....	Genetics, Vol. 15.	1930
Chromosome Conditions in the Second and Third Generations of Pentaploid Wheat Hybrids.	Jenkins, J. A. and Thompson, W. P.	Can. J. Research, Vol. 2.	1930
The Natural Microflora of the Soil in Relation to the Foot-rot Problem of Wheat.	Henry, A. W.....	Can. J. Research, Vol. 4.	1931
Studies on the Nature of Rust Resistance in Wheat. V. Physiology of the Host.	Hanna, W. F.....	Can. J. Research, Vol. 4.	1931
CHEMISTRY (General and Physical)			
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
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
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
Nicotine and Tobacco Waste.....	Hone, A. D.....	National Research Council Report No. 4.	1919
The Properties of Pure Hydrogen Peroxide 1.	Maass, O. and Hatcher, W. H.	J. Am. Chem. Soc. Vol. XLII, No. 12.	Dec. 1920
The Electro-viscous Effect in Rubber Sols.	Whitby, G. S. and Jane, R. S.	2nd Colloid Symposium & Monograph, N.Y.	1924
Die Viskosität von Ammoniumoleatlösungen.	Hatschek, Emil and Jane, R. S.	Kolloid-Z. Vol. 38.	Jan. 1926
Untersuchungen über den Schermodul und die Relaxation einiger Sole.	Hatschek, Emil and Jane, R. S.	Kolloid-Z. Vol. 39.	1926
Die Viskosität von Suspensionen starrer Teilchen und ihre Abhängigkeit vom Schergefälle.	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.	1916

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Gen. & Phys.)—Cont'd			
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
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 1.	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
A Contribution to the Chemistry of Lubrication.	Seyer, W. F. and McDougall, R. S.	Roy. Soc. Can.	1923
Relation of Hydrogen Ion Concentration to the Corrosion of Iron.	Shiple, J. W. and McHaffie, I. R.	Can. Chem. Met.	May 1924
Alternating Current Electrolysis.....	Shiple, J. W. and Goodeve, Chas. F.	J. Eng. Inst. Can.	Feb. 1927
A Law of Alternating Current Electrolysis and the Electrolytic Capacity of Metallic Electrodes.	Shiple, J. W. and Goodeve, Chas. F.	J. Am. Electro-chemical Soc.	1927
The Law of Alternating Current Electrolysis Extended to the Relation of Frequency.	Shiple, J. W. and Goodeve, C. F.	Trans. Roy. Soc. Can.	1927
The Action of Sulphates on the Components of Portland Cement.	Thorvaldson, T., Vigfusson, V. A. and Larmour, R. K.	Trans. Roy. Soc. Can.	1927
The Effect of Steam Treatment of Portland Cement Mortars on their Resistance to Sulphate Action.	Thorvaldson, T. and Vigfusson, V. A.	Eng. J.	Mar. 1928
Notes on the Relative Resistance of Various Cements to the Action of Sulphate Waters.	Thorvaldson, T.....	Eng. J.	Mar. 1928
Disintegration of Portland Cement in Sulphate Waters.	Thorvaldson, T., Harris, R. H. and Wolochow, D.	Ind. Eng. Chem. Vol. 17, No. 5.	May 1925
The Chemistry of Portland Cement and its Disintegration by Alkali Ground Waters.	Thorvaldson, T.	Eng. J.	Sept. 1922
Action of Sodium and Magnesium Sulphates on Constituents of Portland Cement.	Shelton, G. R.....	Ind. Eng. Chem. 17.	1925
Action of Sodium and Magnesium Sulphates on Calcium Aluminates.	Shelton, G. R.....	Ind. Eng. Chem. 17.	1925
Differentiation of the Action of Acids, Alkali Waters and Frost on Normal Portland Cement Concrete.	MacKenzie, C. J. and Thorvaldson, T.	Eng. J.	Feb. 1926
Action of Sodium and Magnesium Sulphates on Portland Cement.	Shelton, G. R.....	Ind. Eng. Chem. 18.	1926
Expansion of Portland Cement Mortar Bars during Disintegration in Sulphate Solutions.	Thorvaldson, T., Larmour, R. K. and Vigfusson, V. A.	Eng. J.	Apr. 1927
The Action of Water on Tricalcium Silicate and Beta Dicalcium Silicate.	Thorvaldson, T. and Vigfusson, V. A.	Trans. Roy. Soc. Can.	1928
The Hydration of the Aluminates of Calcium.	Thorvaldson, T. and Grace, N. S.	Can. J. Research, Vol. 1, No. 1.	May 1929
The Preparation and Properties of the Margarines.	Thomson, W. W.....	Trans. Roy. Soc. Can.	May 1926
The Vapor Pressure of Acetone at Low Temperatures.	Archibald, E. H. and Ure, Wm.	Trans. Roy. Soc. Can.	1927
Extraction of Potash Orthoclase Feldspar.	Whyte, E. F.....	Nova Scotian Inst. Sci.	1922
The Diffusion of Oxygen Through Silver....	Johnson, F. M. G. and Larose, P.	J. Am. Chem. Soc. 49.	Feb. 5, 1927
The Absorption of Vapors by Alumina.....	Munro, L. A. and Johnson, F. M. G.	J. Ind. Eng. Chem.	Jan. 1925
The Sorption of Vapors by Alumina: Water Vapor.	Munro, L. A. and Johnson, F. M. G.	J. Phys. Chem.	Feb. 1926
The Mechanism of the Catalysis of Hydrogenation by Nickel.	Boswell, M. C.....	Proc. Roy. Soc. Can. 16, III.	1922
On the Mechanism of the Action of Promoters in Catalysis.	Boswell, M. C. and Bayley, C. H.	J. Phys. Chem. 29.	1925

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Gen. & Phys.)—Cont'd			
On the Mechanism of the Inhibition of the Catalytic Action of Platinum Black and Partially Reduced Nickel Oxide by Chlorine.	Boswell, M. C. and Bayley, C. H.	J. Phys. Chem. 29.	1925
The Chemical Combination of Helium.....	Boomer, E. H.....	Nature, 115.	1923
Experiments on the Chemical Activity of Helium.	Boomer, E. H.....	Proc. Roy. Soc. London, 109A.	1925
Molecular Weight, Determinations and Solubilities in Liquid Chlorine.	Butler, H. K. and McIntosh, D.	Trans. Roy. Soc. Can. Sec. III.	1927
Compounds of Halogens with Each Other.	Butler, H. K. and McIntosh, D.	Trans. Nova. Scotian Inst. Sci.	1927
Supersaturation of Gases in Liquids.....	Clare, N. D.....	Trans. Roy. Soc. Can.	June 1925
Unsaturation and Molecular Compound Formation III.	Maass, O., Boomer, E. H. and Morrison, D. M.	J. Am. Chem. Soc. 45.	1922
Molecular Attraction and Reaction Velocity.	Maass, O. and Sivertz, C.	J. Am. Chem. Soc.	Dec. 1925
Vapor Densities at Low Pressures and over an Extended Temperature Range, 1. The Properties of Ethylene Oxide Compared to Oxygen Compound of Similar Molecular Weight.	Maass, O. and Boomer, E. H.	J. Am. Chem. Soc. 44.	1922
Aberrations from the Ideal Gas Laws in Systems of One and Two Components.	Maass, O. and Mennie, J. H.	Proc. Roy. Soc. London, A. Vol. 110.	1926
Oxonium Compounds in the Vapor State. Methyl Ether-Hydrogen Chloride.	Maass, O. and Morrison, D. M.	J. Am. Chem. Soc.	July 1923
Existence of a Compound, Hydrogen Bromide-Methyl Ether in the Vapor State.	Maass, O. and Morrison, D. M.	Trans. Roy. Soc. Can.	1923
Effect of Molecular Attraction on the Total Pressure of a Gas Mixture.	Maass, O. and Morrison, D. M.	Trans. Roy. Soc. Can.	1924
The Freezing Point and Density of Pure Hydrogen Peroxide.	Cuthbertson, A. C., Matheson, G. L. and Maass, O.	J. Am. Chem. Soc.	Apr. 1928
The Properties of Pure Hydrogen Peroxide II.	Matheson, G. L. and Maass, O.	J. Am. Chem. Soc.	Mar. 1929
Sulphur Dioxide and its Aqueous Solutions 1. Analytical Methods, Vapor Density and Vapor Pressure of Sulphur Dioxide. Vapor Pressure and Concentration of the Solutions.	Maass, C. E. and Maass, O.	J. Am. Chem. Soc.	May 1928
Liquid Chlorine as an Ionizing Solvent.....	McIntosh, D. and Mennie, J. H.	Proc. Roy. Soc. Can.	1922
Helium Compound.....	Morrison, D. M.....	Nature.	Aug. 13, 1927
On the Formation of a Gaseous Helide of Radium Active Deposit.	Morrison, D. M.....		1927
The Electrolysis of Soda-lime Glass.....	Mulligan, M. J.....	Trans. Roy. Soc. Can. 19.	1925
The Electrochemical Behavior of Glass.....	Mulligan, M. J. and Ferguson, J. B.	Trans. Roy. Soc. Can. 21.	1927
The Electrolysis of Soda-lime Glass. II. Studies in Electrical Resistance.	Rebbeck, J. W., Mulligan, M. J. and Ferguson, J. B.	J. Am. Ceram. Soc. 8.	1925
The Solubility and Rate of Solution of Oxygen in Silver.	Stacie, E. W. R. and Johnson, F. M.G.	Proc. Roy. Soc. London, Vol. 112A.	Sept. 1926
The Solubility of Oxygen in Silver.....	Stacie, E. W. R. and Johnson, F. M. G.	Can. Chem. Met.	May 1926
The De-tarring of Gas by Electrical Precipitation.	Davidson, J. G.....	National Research Council Report No. 3.	1918
The Manufacture of Sodium Sulphide.....	Freeman, Horace.....	Can. Chem. Met.	July 1927
Investigation on the Treatment of Nova Scotia Oil Shales.	Flynn, A. E.....	National Research Council Report No. 18.	1926
Freezing Points and Heat Capacities of Aqueous Solutions of Potassium Chloride.	Barnes, W. H. and Maass, O.	Can. J. Research, Vol. 2.	Mar. 1930
Action Catalytique des Rayons Ultra-violet.	Bourgoin, L.....	Can. Chem. Met.	Apr. 1923
The Temperature Coefficients of Electrical Conductivity for Concentrated Solutions of Calcium Chloride, with Precision Measurements of Conductivity for the Higher Concentrations.	Crowe, Miss M.....	Trans. Roy. Soc. Can. Vol. 21. Sec. III.	July 1927
The Effect of Ultra-violet Light on Rubber Colloids.	Hamer, R.....	Phys. Rev. Vol. 18.	1921
The Effect of Temperature Changes on Rubber Colloids.	Hamer, R.....	Phys. Rev. Vol. 19.	1922
On the Decomposition of Ammonia by High-speed Electrons.	McLennan, J. C. and Greenwood, G.	Proc. Roy. Soc. London, A. Vol. 120.	1928
The Electrochemical Behavior of Silicate Glasses, III. Cathode and Anode Gases.	Mulligan, M. J., Ferguson, J. B. and Rebbeck, J. W.	J. Phys. Chem. Vol. 32.	May 1928
The Electrochemical Behavior of Silicate Glasses, IV. Solid Electrolytic Deposits.	Mulligan, M. J., Ferguson, J. B. and Rebbeck, J. W.	J. Phys. Chem. Vol. 32.	June 1928
The Electrochemical Behavior of Silicate Glasses, V. The Electrical Properties of the Anode Layers.	Ferguson, J. B., Mulligan, M. J. and Rebbeck, J. W.	J. Phys. Chem. Vol. 32.	July 1928
The Effect of Velocity on Diffusion Rates.	Murray, A. E.....	Trans. Nova Scotian Inst. Sci.	Nov. 14, 1928

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Gen. & Phys.)—Cont'd			
Molecular Attractive Forces and the Velocity of Chemical Reactions.	Coffin, C. C. and Maass, O.	Can. J. Research, Vol. 3.	1930
Note on the Effect of Intensive Drying on the Velocity of Gaseous Reactions.	Coffin, C. C. and Maass, O.	Can. J. Research, Vol. 3.	1930
Physikalisch-chemische Studien am sogenannten explosiven Antimon. IV. Equilibrium Phenomena in Coagulation of Colloids.	Cohen, Ernest and Coffin, C. C.	Z. physik Chem. Vol. 149, No. 6.	
The Density of Carbon Dioxide.....	Burton, E. F. and Annetts, Miss M.	J. Phys. Chem. Vol. XXXV.	Jan. 1931
The Penetration of Water Vapor into Wood.	Cooper, D. LeB. and Maass, O.	Can. J. Research, Vol. 2.	1930
Calcium Relationships of Forage Crops.....	Pidgeon, L. M. and Maass, O.	Can. J. Research, Vol. 2.	1930
Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al ₂ O ₃ -SiO ₂ . I. The Heat of Solution of Calcium Oxide in Hydrochloric Acid.	Pugsley, L. I. and McKibbin, R. R.	Can. J. Research Vol. 4.	1931
Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al ₂ O ₃ -SiO ₂ . II. The Heat of Solution of Calcium Hydroxide in HCl. 200 H ₂ O.	Thorvaldson, T., Brown, W. G. and Peaker, C. R.	J. Am. Chem. Soc. Vol. 51.	1929
Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al ₂ O ₃ -SiO ₂ . III. The Heat of Hydration of Calcium Oxide.	Thorvaldson, T. and Brown, C. R.	J. Am. Chem. Soc. Vol. 52.	1930
Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al ₂ O ₃ -SiO ₂ . IV. The Heat of Solution of Tricalcium Aluminate and Its Hydrates in Hydrochloric Acid.	Thorvaldson, T., Brown, W. G. and Peaker, C. R.	J. Am. Chem. Soc. Vol. 52.	1930
Steam Curing of Portland Cement Mortars. A New Crystalline Substance.	Thorvaldson, T., Brown, W. G. and Peaker, C. R.	J. Am. Chem. Soc. Vol. 52.	1930
The Hydration of the Aluminates of Calcium. II. The Hydration Products of Tricalcium Aluminate.	Thorvaldson, T. and Shelton, G. R.	Can. J. Research, Vol. 1.	1929
Studies on the Action of Sulphates on Portland Cement. I. The Use of the Expansion Method in the Study of the Action of Sulphates on Portland Cement Mortar and Concrete.	Thorvaldson, T., Grace, N. S. and Vigfusson, V. A.	Can. J. Research, Vol. 1.	1929
Studies on the Action of Sulphates on Portland Cement. II. Steam-curing of Portland Cement Mortar and Concrete as a Remedy for Sulphate (Alkali) Action.	Thorvaldson, T., Wolochow, D. and Vigfusson, V. A.	Can. J. Research, Vol. 1.	1929
Studies on the Action of Sulphates on Portland Cement. III. The Effect of the Addition of Silica Gel to Portland Cement Mortars on their Resistance to Sulphate Action.	Thorvaldson, T., Vigfusson, V. A. and Wolochow, D.	Can. J. Research, Vol. 1.	1929
Chemical and Physico-chemical Changes Induced in Wheat and Wheat Products by Elevated Temperatures.	Thorvaldson, T., Vigfusson, V. A. and Wolochow, D.	Can. J. Research, Vol. 1.	1929
A Study of some Factors Influencing the Activity of Aluminum and Ferric Chlorides in the Friedel and Craft's Reaction.	Geddes, W. F.....	Can. J. Research, Vol. 1.	1929
The Alternating Current Electrolysis of Water.	Boswell, M. C. and McLaughlin, R. R.	Can. J. Research, Vol. 1.	1929
Freezing Points and Heat Capacities of Aqueous Solutions of Potassium Chloride.	Shibley, J. W.....	Can. J. Research, Vol. 1.	1929
The Path of Liquid Penetration in Jack Pine.	Barnes, W. H. and Maass, O.	Can. J. Research, Vol. 2.	1930
The Heating of Electrolytes in High Frequency Fields.	Johnston, H. W. and Maass, O.	Can. J. Research, Vol. 3.	1930
Action of High Speed Electrons on Methane, Oxygen and Carbon Monoxide.	McLennan, J. C. and Burton, A. C.	Can. J. Research, Vol. 3.	1930
Report on Maple Products.....	McLennan, J. C. and Glass, J. V. S.	Can. J. Research, Vol. 3.	1930
Application of the Bromate Differential Test in the Estimation of Baking Quality of Canadian Hard Red Spring Wheat Flour.	Snell, J. F.....	Ind. Eng. Chem., An. Ed., Vol. 1.	1929
A Volume-measuring Apparatus for Small Loaves.	Larmour, R. K. and MacLeod, A. G.	Sci. Agr., Vol. IX.	Apr 1929
	Malloch, J. G. and Cook, W. H.	Cereal Chem.	May 1930
CHEMISTRY (Organic)			
The Action of Alkali Cyanides on Xanthates and Dithiocarbamates.	Cambron, A.	Can. J. Research, Vol. 2.	1930
Oxygen-compound Formation with Acetaldehyde at Low Temperature.	Cooper, D. L.....	Trans. Nova Scotian Inst. Sci.	1928

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Organic)—Continued			
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.	1926
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.	1927
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution VIII.	Hatcher, W. H. and Holden, G. W.	Trans. Roy. Soc. Can., Ser. III, Vol. 21, Sec. 3.	1927
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.	1928
Hydrogen Peroxide as an Oxidizing Agent in Acid Solution X.	Hatcher, W. H. and Hill, A. C.	Trans. Roy. Soc. Can. Ser. III, Vol. 23, Sec. 3.	1929
The Constitution of Kerogen.....	McKinney, J. W.....	J. Am. Chem. Soc.	Apr. 1924
Influence of Certain Organic Accelerators on Vulcanization of Rubber.	Whitby, G. S. and Walker, O. J.	J. Ind. Eng. Chem.	Sept. 1921
Further Experiments on the Influence of Fatty Acids on Vulcanization.	Whitby, G. S. and Evans, B. A.	J. Soc. Chem. Ind. Vol. XLVII, No. 18.	May 4, 1928
Some Derivatives of Acenaphthene.....	Allan, F. B. and Lorriman, F. R.	J. Am. Chem. Soc.	Jan. 1925
Salicin Content of British Columbian Willows and Poplars.	Clark, R. H. and Gillie, K. B.	Am. J. Pharm.	1921
The Cascara Content of the Wood and Bark of Rhamnus Pushiana.	Clark, R. H. and Gillie, K. B.	Am. J. Pharm.	1921
Alkaloidal Content of British Columbia Datura Stramonium and Conium Maculatum.	Clark, R. H. and Offard, H. H.	Trans. Roy. Soc. Can.	1925
The Tannin Content of British Columbia Alnus Rubra.	Clark, R. H. and Offard, H. H.	Trans. Roy. Soc. Can.	1925
The Essential Oil Content of Chamaesyris Nootkatensis (yellow cedar).	Clark, R. H. and Lucas, C. C.	Trans. Roy. Soc. Can.	1926
The Alkaloidal Content of British Columbia Grown Hydrastis Canadensis and Antropa Belladonna.	Clark, R. H. and Winter, A. G.	Trans. Roy. Soc. Can.	1926
The Essential Oil Content of Some British Columbian Grown Mints.	Clark, R. H.....	Trans. Roy. Soc. Can.	1926
Catalysts in the Preparation of <i>o</i> -Benzoylbenzoic Acid and Ethylbenzenes by the Friedel and Crafts Reaction.	Gallay, W. and Whitby, G. S.	Can. J. Research, Vol. 2, No. 1.	Jan. 1930
Chemical and Physico-chemical Changes Induced in Wheat and Wheat Products by Elevated Temperatures II	Geddes, W. F.....	Can. J. Research, Vol. 2, No. 1.	Jan. 1930
Chemical and Physico-chemical Changes in Wheat and Wheat Products induced by Elevated Temperatures. III. The Influence of Germ Constituents on Baking Quality and Their Relation to Improvement in Flour Induced by Heat and Chemical Improvers.	Geddes, W. F.....	Can. J. Research, Vol. 2, No. 3.	Mar. 1930
Reaction of Lactones with Aromatic Hydrocarbons and Aluminum Chloride.	King, E. J.....	Trans. Roy. Soc. Can. Vol. XIX.	1925
Reaction of Lactones and of Furfuran Derivatives with Aromatic Hydrocarbons and Aluminum Chloride.	King, E. J.....	J. Am. Chem. Soc. Vol. 49.	1927
Application of the Bromate Differential Test in the Estimation of Baking Quality of Canadian Hard Red Spring Wheat Flour.	Larmour, R. K. and MacLeod, A. G.	Sci. Agr. Vol. IX, No. 8.	Apr. 1929
Friedel and Craft's Reaction. Nitrophthalic Anhydrides and Acetylaminophthalic Anhydrides with Benzene and Aluminum Chloride.	Lawrance, W. A.....	Am. Chem. J.	Sept. 1920
Friedel and Craft's Reaction. Some Substituted Phthalic Anhydrides with Toluene and Aluminum Chloride.	Lawrance, W. A.....	Am. Chem. J.	Dec. 1921
Syntheses of Alkylidenecyanoacetic Acids and of Substituted Succinic Acids, Part I. Acids Containing Aromatic Residues.	Lapworth, A. and McRae, J. A.	Trans. Chem. Soc. Vol. 121.	1922
Part II. Preparation of Acids Containing Saturated Aliphatic Residues and the Constitution of the Aliphatic Alkylidenecyanoacetic Esters.	Lapworth, A. and McRae, J. A.	Trans. Chem. Soc. Vol. 121.	1922
Resorcinolphenylsuccinein.....	Lapworth, A. and McRae, J. A.	Trans. Chem. Soc. Vol. 121	1922
Molecular Refraction of Natural and Methyl Rubber.	Macallum, A. D. and Whitby, G. S.	Trans. Roy. Soc. Can. III.	1924
The Fluorescent Glucosides of Diervilla dierilla and Symphoricarpos Occidentalis.	McCullagh, D. R., Walton, C. H. A. and White, F. D.	Trans. Roy. Soc. Can. Sec. V.	1929

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Organic)—Continued			
The Friedel and Craft's Reaction with Phthalic Anhydride.	McMullen, T. C.....	J. Am. Chem. Soc.	Sept. 1922
Some Preparation from Maleic and Fumaric Acids.	Oddy, H. G.....	J. Am. Chem. Soc. Vol. 45. No. 9.	Sept. 1923
Friedel and Craft's Reaction. Bromophthalic Anhydrides, Benzene and Aluminum Chloride.	Stephens, H. N.....	J. Am. Chem. Soc. Vol. 43.	Aug. 1921
Laevulinic Aldehyde from Oxidized Rubber.	Whitby, G. S. and Stephens, H. N.	India-Rubber J.	1922
Acidity of Raw Rubber.....	Whitby, G. S.....	Trans. Inst. Rubber Ind. 1.	1925
The Resin of Hevea Rubber.....	Whitby, G. S., Dolid, J. and Yorston, F. H.	Trans. Chem. Soc. 129.	1926
A Study of the Action of Sulphur on Linseed Oil.	Whitby, G. S. and Chataway, Miss H...	J. Soc. Chem. Ind. 45.	1926
Significance of the Resin of Hevea Rubber in Vulcanization and in the Aging of Raw Rubber.	Whitby, G. S. and Greenberg, H.	Ind. Eng. Chem. 18.	1926
Organophilic Colloids.....	Whitby, G. S.....	Colloid Symposium Monograph 4.	1927
The Preparation and Physical Properties of Isobutylene.	Coffin, C. C. and Maass, O.	Trans. Roy. Soc. Can.	July 1927
Studies on the Reactions Relating to Carbohydrates and Polysaccharides. XX. Preparation, Properties and Identification of Glycerol, Beta-Methyl Ether.	Hibbert, H., Whelan, M. S. and Carter, N. M.	J. Am. Chem. Soc.	Jan. 1929
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXI. Comparison of Tendencies of Saturated and Unsaturated Aldehydes towards Cyclic Acetal Formation.	Hibbert, H., Houghton, E. O. and Taylor, K. A.	J. Am. Chem. Soc.	Feb. 1929
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXII. The Isomeric Cinnamylidene Glycerols.	Hibbert, H. and Whelan, M. S.	J. Am. Chem. Soc.	Feb. 1929
Mechanism of Organic Reactions: II. The "Non-Existence" of a Migratory Methyl Group in the Conversion of Glycerol-dichlorohydrin into Glycerol Monomethyl Ether.	Hibbert, H. and Whelan, M. S.	J. Am. Chem. Soc. 51.	1929
The Mechanism of the Acetal Reaction. The Explosive Rearrangement of Hydroxyethyl Vinyl Ether into Ethylidene Glycol.	Hill, S. and Pidgeon, L. M.	J. Am. Chem. Soc.	Oct. 1928
Mechanism of Organic Reactions. I. The Wandering of Acyl Groups in Glycerol Esters.	Hibbert, H. and Carter, N. M.	J. Am. Chem. Soc. Vol. 51.	1929
Synthese von β -Glyceriden.....	Bergmann, Max and Carter, N. M.	Hoppe-Seyler's Z. physiol. Chem., Vol. 191.	1930
Notiz über Synthese des β -Phenolglucosids.	Carter, N. M.....	Ber. Vol. 63, p. 586.	1930
Synthese des 2-Glycerin-d-glucosids.....	Carter, N. M.....	Ber. Vol. 63, No. 7, p. 1684	1930
Notiz über ein neues Aceton-glycerin (α, α' -Isopropyliden-glycerin).	Carter, N. M.....	Ber. Vol. 63, No. 9, p. 2399	1930
Investigation of the Reaction Between Hydrogen Chloride and the Three Butylenes.	Coffin, C. C., Sutherland, H. S. and Maass, O.	Can. J. Research, Vol. 2.	1930
Studies on Reactions Relating to Carbohydrates and Polysaccharides. Part XXVI. Structure of Acetone Glycerol.	Hibbert, H. and Morazain, J. G.	Can. J. Research, Vol. 2.	1930
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXVII. Synthesis and Structure of Trichloroethylidene Glycerol.	Hibbert, H., Morazain, J. G. and Paquet, A.	Can. J. Research, Vol. 2.	1930
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXVIII. The Structure of Isopropylidene Glycerol.	Hibbert, H. and Morazain, J. G.	Can. J. Research, Vol. 2.	1930
Studies on Lignin and Related Compounds. II. Glycol-lignin and Glycol-ether-lignin.	Hibbert, H. and Marion, L.	Can. J. Research, Vol. 3.	1930
The Nitration of Glycol-lignin.....	Hibbert, H. and Marion, L.	Can. J. Research, Vol. 3.	1930
The Oxidation of Some Dibasic Acids.....	Hatcher, W. H. and Mueller, W. H.	Can. J. Research, Vol. 3.	1930
Studies on Lignin and Related Compounds. III. Glycerol-Chlorohydrin-Lignin.	Hibbert, H. and Phillips, J. B.	Can. J. Research, Vol. 3.	1930
The Nature of the Resins in Jack Pine (<i>Pinus Banksiana</i>).	Hibbert, H. and Phillips, J. B.	Can. J. Research, Vol. 4.	1931
Studies in Iso-ureas and Iso-ureides. I. Some New Iso-ureas; Salts and Acyl Derivatives.	Basterfield, S. and Powell, E. C.	Can. J. Research, Vol. 1.	1929
Studies in Iso-ureas and Iso-ureides. II. The Condensation of Iso-ureas with Diketones and Ketonic Esters.	Basterfield, S. and Powell, E. C.	Can. J. Research, Vol. 1.	1929
Studies on Lignin and Related Compounds. V. Action of Halogens on Lignin and Wood.	Hibbert, H. and Sankey, C. A.	Can. J. Research, Vol. 4.	1931

Title of Paper	Author	Where Published	Date Published
CHEMISTRY (Organic)—Continued			
A Study of the Relative Value of Honey and Sucrose in Bread Manufacture.	Geddes, W. F. and Winkler, C. A.	Can. J. Research, Vol. 3.	1930
The Chlorination of Methane.....	Boswell, M. C. and McLaughlin, R. R.	Can. J. Research, Vol. 1.	1929
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXXIII. The Synthesis of Polysaccharides by Bacteria and Enzymes.	Harrison, F. C., Tarr, H. L. A., and Hibbert, H.	Can. J. Research, Vol. 3.	1930
On the Hydrogenation of Bitumen from the Bituminous Sands of Alberta.	Boomer, E. H. and Saddington, A. W.	Can. J. Research, Vol. 2.	1930
The Formation of Ethane in the Catalytic Decomposition of Ethyl Alcohol.	Boomer, E. H. and Morris, H. E.	Can. J. Research, Vol. 2.	1930
Studies on Reactions Relating to Carbohydrates and Polysaccharides. XXXIV. The Constitution of Levan and its Relation to Inulin.	Hibbert, H., Tipson, R. S. and Brauns, F.	Can. J. Research, Vol. 4.	1931
Mechanism of Organic Reactions. III. The Nature of the Mechanism of Migration of the Acyl Radical.	Hibbert, H. and Greig, Miss M. E.	Can. J. Research, Vol. 4.	1931
Calycanthine II. The Degradation of Calycanthine to N-Methyl-tryptamine.	Manske, R. H. F.	Can. J. Research, Vol. 4.	1931
CONSTRUCTION			
Fuel Saving Possibilities in House Heating.	Arkley, L. M. and Govan, James	National Research Council Report No. 10.	1922
Gunitite as a Protection for Steel Structures.	Gillespie, Peter and Gulliton, P. J.	Bull. 4, School Eng. Research Univ. of Toronto.	1924
Report on Pilot Tests Conducted for the Structural Steel Welding Committee of the American Bureau of Welding at the University of Toronto, 1927-28.	Gillespie, Peter, Hughes, C. A., Jackson, K. B. and Fox, J. H.	Bull. 8, School Eng. Research, Univ. of Toronto.	1927-28
ENTOMOLOGY			
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
Wireworms of Alberta.....	Strickland, E. H.....	Univ. of Alberta, Dept. of Extension.	Jan. 1926
Bionomics of the Tabanidae of the Canadian Prairie.	Cameron, A. E.....	Bull. Entomological Research, Vol. 17, Pt. 1.	July 1926
A Local Outbreak of the Winter or Moose Tick (Dermacentor Albipictus) in Saskatchewan.	Cameron, A. E.....	Bull. Entomological Research, Vol. 17, Pt. 3.	Mar. 1927
The Occurrence of Cuturelva (Diptera Oestridae) in Western Canada.	Cameron, A. E.....	Parasitology, Vol. 18, No. 4.	Dec. 14, 1926
The Larva and Breeding-place of Aedes Aldrichi.	Hearle, E.....	Can. Entomologist.	Feb. 1921
Mosquito Control Investigations in British Columbia.	Hearle, E.....	Sci. Agr.	Feb. 1921
The Importance of Mosquitoes, with Notes on B. C. Species.	Hearle, E.....	Proc. B. C. Ent. Soc. No. 13 & 15.	1921
Some Mosquito Problems of British Columbia.	Hearle, E.....	Ont. Ent. Soc. Report No. 51.	1921
An Aerial Survey of Mosquito Breeding Places.	Hearle, E.....	Agr. Gaz. Can., LX. 3.	1923
A New Mosquito from British Columbia.	Hearle, E.....	Can. Entomologist.	Jan. 1923
Mosquitoes of the Lower Fraser Valley, B.C., and their Control.	Hearle, E.....	National Research Council Report No. 17.	1926
GEOLOGY			
The Essexites of Mount Royal, Montreal, Que.	Bancroft, J. A. and Howard, W. V.	Trans. Roy. Soc. Can. Vol. XVII, Sec. IV.	1923
The Stratigraphy and Palaeontology of Toronto and Vicinity, Part IV—Hydrozoa, Echinodermata, Trilobita and Markings.	Fritz, Miss M. A.....	Ont. Dept. of Mines.	1925
The Palaeontology and Stratigraphy of the Workmen's Creek Section of the Upper Ordovician of Ontario.	Fritz, Miss M. A.....	Trans. Roy. Soc. Can.	1926
Some Outliers of the Monteregean Hills.....	Howard, W. V.....	Trans. Roy. Soc. Can. Vol. XVI, Sec. IV.	1922
Devonian Volcanic Rocks near Dalhousie, N.B.	Howard, W. V.....	Bull. Geol. Soc. Am. Vol. 111.	Sept. 30, 1926
Carleton-Nouvelle Map Area.....	Howard, W. V.....	Geol. Survey Can.	
The Clays of Lake Agassiz Basin.....	Maynard, J. E.....	Trans. Roy. Soc. Can. Sec. IV.	1925
Solution, Transportation and Precipitation of Iron and Silica.	Moore, E. S. and Maynard, J. E.	Econ. Geol. Vol. XXIV, No. 3, May, 1929; No. 4, June-July, 1929; No. 5.	Aug. 1929

Title of Paper	Author	Where Published	Date Published
GEOLOGY—Continued			
The Stratigraphy and Palaeontology of Toronto and Vicinity, Part III—Gastropoda, Cephalopoda and Vermes.	Parks, W. A. and Fritz, Miss M. A.	Ontario Dept. of Mines.	1923
Analyses of Cretaceous and Tertiary Sediments and Stratigraphical Relationships.	Sanderson, J. O. G.....	Trans. Roy. Soc. Can.	1924
Areal and Structural Geology of the St. George Map Area.	Squires, H. D.....	Geol. Survey, Ottawa.	
The Clays of Lake Agassiz Basin. 1. Their Colloidal Content.	Wallace, R. C. and Maynard, J. E.	Trans. Roy. Soc. Can. Sec. IV.	1924
The Distribution of the Colloidal Products of Rock-wearing.	Wallace, R. C.....	Trans. Roy. Soc. Can. Vol. XVII. Sec. IV.	1923
The Red River as an Erosive Agent.....	Wallace, R. C., Ward, G. and Baker, W. F.	Trans. Roy. Soc. Can. Vol. XX. Sec. IV.	1926
Heavy Minerals in Sand Horizons in Manitoba and Eastern Saskatchewan.	Wallace, R. C. and McCartney, G. C.....	Trans. Roy. Soc. Can. Vol. XXII. Sec. IV.	1928
The Genesis of Sulphide Ores.....	Freeman, Horace.....	Eng. Mining J.-Press.	Dec. 1925
MEDICINE AND PUBLIC HEALTH			
Tuberculosis Among the Indians of the Great Canadian Plains.	Ferguson, R. G.....	Trans. of the 14th Annual Conference Nat. Assoc. for the Prevention of Tuberculosis.	1928
Survey of General Conditions of Industrial Hygiene in Toronto.	Assoc. Committee on Ind. Fatigue.	National Research Council Report No. 7.	1921
Histamine and Salivary Secretion.....	Mackay, Miss M. E.....	Am. J. Physiol.	1927
The Vascular Reaction of the Pilocarpinized Submaxillary Gland to Histamine.	Mackay, Miss M. E.....	J. Pharmacol.	1927
The Mosquito Control Act of British Columbia.	Hearle, E.....	Agr. J. B. C. VI.	1921
Vaccination against Tuberculosis with Bacillus Calmette-Guérin.	Rankin, A. C.....	Can. J. Research, Vol. 1.	1929
METALLURGY AND ORE-DRESSING			
The Graphitic Softening of Cast Iron.....	Shipley, J. W. and McHaffie, I. R.	Ind. Eng. Chem.	June 1924
A Method of Smelting Titaniferous Iron Ores.	Goodwin, W. M.....	National Research Council Report No. 8.	1921
The Utilization of the Low Grade Iron Ores of Canada.	Morrow, J. G., Chairman Sub-committee on Iron Ores	National Research Council Report No. 14	1924
A Contribution to the Kick versus Rittinger Dispute.	Haultain, H. E. T.....	Bull. 4, Sec. 4, Univ. of Toronto.	
An Explanation of Flotation Based on X-ray data.	McLachlan, C. G.....	Eng. Min. J. Vol. 120.	
Synthetic Testing for Flotation.....	McLachlan, C. G.....	Trans. Can. Inst. Mining Met. Vol. 29.	1926
The Impact Resistance of Steels at Low Temperatures.	Morrison, I. F. and Cameron, A. E.	Second (Triennial) Empire Min. & Met. Congress.	Sept. 1927
The Briquetting of Lignites.....	Ross, R. A.....	National Research Council, Report No. 1.	1918
The Effect of Low Temperature upon the Impact Resistance of Steel Castings.	Moffatt, R. W.....	Can. J. Research, Vol. 2.	1930
PHYSICS			
Variations in the Structure of the Lithium Red Line 6708.	Ainslie, D. S.....	Trans. Roy. Soc. Can. Sec. III.	May 1924
On the Critical Frequency of Pulsation of Tones (II).	Allen, Frank.....	Phil. Mag. Vol. 47.	1924
On the Dilatation of Superconductors.....	McLennan, J. C., Allen, J. F. and Wilhelm, J. O.	Trans. Roy. Soc. Can. Vol. XXV. Sec. III.	1931
The Hyperfine Structure of Some Lines in the Arc and First Spectrum of Indium.	McLennan, J. C. and Allin, E. J.	Proc. Roy. Soc. A. Vol. 129	1930
The Fine Structure of Some Lines in the Visible Region of the Spectrum of Thallium III.	J. C. McLennan, and Allin, Miss E. J.	Proc. Roy. Soc. A. Vol. 129.	1930
Duration of Metastable States.....	Anderson, J. M.....	Can. J. Research, Vol. 2.	Jan. 1930
The Standardization of Roentgenography.	Andrus, P. M.....	Can. Med. Assn. J. Vol. 21.	1929
The Physical Characters of Penumbra Shadows and their Significance in Roentgenography.	Andrus, P. M.....	Can. J. Research, Vol. 3.	1930
The Crystal Structure of Ice Between 0°C. and -183°C.	Barnes, W. H.....	Proc. Roy. Soc. A. Vol. 125.	1929
A New Adiabatic Calorimeter.....	Barnes, W. H. and Maass, O.	Can. J. Research, Vol. 3.	1930
Specific Heats and Latent Heat of Fusion of Ice.	Barnes, W. H. and Maass, O.	Can. J. Research, Vol. 3.	1930

Title of Paper	Author	Where Published	Date Published
PHYSICS—Continued			
The Compressibility of Solids by an Interferometer Method.	Bates, H. C.	Proc. Roy. Soc. Can.	1923
Cavitation in the Propagation of Sound.	Boyle, R. W.	Trans. Roy. Soc. Can.	May 1922
Audible Sonic Beats from Inaudible Sources.	Boyle, R. W., Morgan, O. M. and Lehmann, J. F.	Trans. Roy. Soc. Can.	May 1923
A New Photographic Method of Demonstrating the Interference of Longitudinal Wave Trains.	Boyle, R. W. and Lehmann, J. F.	Trans. Roy. Soc. Can.	May 1925
Visualization and Energy Survey of High Frequency Diffraction Beams.	Boyle, R. W., Lehmann, J. F. and Reid, C. D.	Trans. Roy. Soc. Can.	May 1925
The Small Effect of High Frequency on the Velocity of Longitudinal Waves in Liquids.	Boyle, R. W. and Taylor, G. B.	Trans. Roy. Soc. Can.	May 1925
Reflecting Power of Various Materials of Ultrasonic Waves.	Boyle, R. W. and Taylor, G. B.	Trans. Roy. Soc. Can.	Jan. 1926
Practical Experiments on the Detection of Icebergs and on Sounding by Means of Ultrasonic Beam.	Boyle, R. W. and Reid, C. D.	Trans. Roy. Soc. Can.	Jan. 1926
The Relation Between the Thickness of a Partition in a Medium and its Reflection of Sound Waves.	Boyle, R. W. and Lehmann, J. F.	Am. Phys. Soc.	Feb. 1926
Cavitation in the Track of an Ultrasonic Beam.	Boyle, R. W. and Taylor, G. B.	Bull. Am. Phys. Soc.	Feb. 1926
The Constancy of Ultrasonic Velocity in Liquids with Increasing Frequency.	Boyle, R. W. and Taylor, G. B.	Bull. Trans. Roy. Soc. Can.	May 1927
The Passage of Acoustic Waves Through Materials.	Boyle, R. W. and Lehmann, J. F.	Bull. Trans. Roy. Soc. Can.	May 1927
Ultrasonic Stationary Waves.....	Boyle, R. W.	Nature.	Oct. 1, 1927
Ultrasonics.....	Boyle, R. W.	Science Progress, Vol. 23	1928
I. Reflection of Sound Energy and Thickness of Plate Reflector—Ultrasonic Method.	Boyle, R. W. and Froman, D. K.	Can. J. Research, Vol. 1.	1929
II. Transmission of Sound Energy and Thickness of Plate Transmitter at Normal Incidence—Ultrasonic Method.	Boyle, R. W. and Sproule, D. O.		
Diffraction Reflection and Scattering of Ultrasonic Waves. Their Influence on Torsion-Pendulum Measurements of Sound Intensity.	Boyle, R. W. and Lehmann, J. F.	Can. J. Research, Vol. 2.	1930
Note on a Phenomenon Connected with the Aurora.	Burton, A. C.	Can. J. Research, Vol. 4.	1931
A New Method for the Rapid Estimation of Moisture in Wheat.	Burton, E. F. and Pitt, A.	Can. J. Research, Vol. 1.	1929
The Destruction of the Fluorescence of Dilute Solutions by Ultra-violet Light.	Cale, Miss F. M.	Trans. Roy. Soc. Can.	May 1922
Distribution of Characteristic X-radiation of Small Angles.	Cave, H. M.	Trans. Roy. Soc. Can., Vol. 20, Sec. 3.	1926
The Mathematical Methods of the New Quantum Mechanics.	Cave, H. M.		
On the Variation of the Coefficient of Viscosity of Gases with Temperature.	Clark, R. J.	Trans. Roy. Soc. Can.	May 1929
Magnetic Properties of Single Crystals of Zinc and Cadmium.	Cohen, Miss E.	Nature.	Mar. 10, 1928
The Specific Heat of Molybdenum from 250°C. to -40°C.	Cooper, D. and Langstroth, G. O.	Phys. Rev. Vol. 33.	Feb. 1929
Spark Spectra of Bismuth, Bi II and Bi III. Evidence of Hyperfine Structure.	McLennan J. C., McLay, A. B. and Crawford, M. F.	Proc. Roy Soc. 129	Nov. 1930
On Recent Advances in Wireless Propagation Both in Theory and Practice.	Eve, A. S.	J. Franklin Inst. Vol. 200.	Sept. 1925
The Effect of Combined A. C. and D. C. Plate Supply on a Short Wave Triode Oscillator.	Field, Geo. S.	Can. J. Research Vol. 3.	1930
The Influence of Certain Factors on the Output of a Triode Oscillator.	Field, Geo. S.	Can. J. Research, Vol. 3.	1930
Methods of Making Lecher-wire Measurements.	Field, Geo. S.	Can. J. Research, Vol. 3.	1930
Spectra Excited by Active Nitrogen.....	Findlay, J. H.	Trans. Roy. Soc. Can., III.	1928
Relative Intensities of Stark Components in Hydrogen.	Foster, J. S. and Chalk, Miss M. L.	Nature.	Oct. 23, 1926
Effect of Combined Electric and Magnetic Fields on the Helium Spectrum.	Foster, J. S.	Proc. Roy. Soc. A., Vol. 122.	1929
Relative Intensities of Stark Components in Hydrogen.	Foster J. S. and Chalk, L.	Proc. Roy. Soc. A Vol. 123.	1929
Patterns and Paschen-back Analogue in the Stark Effect for Neon.	Foster, J. S. and Rowles, W.	Proc. Roy. Soc. A, Vol. 123.	1929
The Softening Exhibited by Secondary X-rays.	Gray, J. A.	Trans. Roy. Soc. Can. Vol. 16, Sec. 3	1922
Note on Theories of X-ray Scattering.....	Gray, J. A.	Trans. Roy. Soc. Can. Vol. 20, Sec. 3.	1926
The Scattering of X-rays of Gases.....	Gray, J. A. and Cave, H. M.	Trans. Roy. Soc. Can., Vol. 21, Sec. 3.	1927
The Absorption and Scattering of the Gamma Rays of Radium.	Gray, J. A. and Cave, H. M.	Trans. Roy. Soc. Can., Vol. 21, Sec. 3.	1927

Title of Paper	Author	Where Published	Date Published
PHYSICS—Continued			
Winter Temperatures at the Centre of a Tree Trunk.	Hachey, H. B.....	Roy. Soc. Can.	1924
The Rotation of Ice Suspended in Benzol.	Hachey, H. B.....	J. Franklin Inst.	June 1924
The Raman Effect and Chemical Bonds in Certain Organic Liquids.	Howlett, L. E.....	Can. J. Research, Vol. 4.	1931
Dissociation of Hydrogen and Nitrogen by Electron Impacts.	Hughes, A. L.....	Phil. Mag. Vol. 41.	May 1921
X-rays from Boron and Carbon.....	Hughes, A. L.....	Phil. Mag. Vol. 42, and Trans. Roy. Soc. Can. Vol. 15, Sec. 3.	Jan. 1922 1921
Intensities in the Helium Spectrum.....	Hughes, A. L. and Lowe, P.	Proc. Roy. Soc. Vol. 104.	Nov. 1923
Intensities in the Hydrogen Spectrum.....	Hughes, A. L. and Lowe, P.	Phys. Rev. Vol. 21.	1923
Selected Radiations Emitted by Specially Excited Mercury Atoms.	Ireton, H. J. C.....	Trans. Roy. Soc. Can. Vol. 15, Sec. 3.	1921
Researches on Sound Measurement.....	King, L. V.....	National Research Council Bulletin No. 2.	1918
Astrophysical Data from Eastern Canada.	Klugh, A. B. and Sawyer, W. R.	Can. J. Research, Vol. 2.	1930
An Ultra-violet Photometer for Field Use	Klugh, A. B.....	Ecology, Vol. XI.	1930
The Magnetic Susceptibility of Caesium in the Solid and Liquid State.	Lane, C. T.....	Phil. Mag. Vol. 8.	Sept. 1929
The Theory of the Zone Plate Derived from Voigt's Integral.	Lane, C. T.....	Can. J. Research, Vol. 2; No. 1.	Jan. 1930
Magnetic Susceptibility of Rubidium.....	Lane, C. T.....	Phys. Rev. Vol. 35, No. 7.	Apr. 15, 1930
The Purification of Helium.....	Lang, R. J.....	Trans. Roy. Soc. Can. Vol. 17.	1923
Standard Wave-lengths for Use in the Extreme Ultra-violet.	Lang, R. J.....	Phys. Rev. Vol. 28, No. 1.	July 1926
Series Spectra of Silver-like Atoms.....	Lang, R. J.....	Proc. Natl. Acad. Sci.	May 1927
The Spectra of Gallium, Germanium and Indium.	Lang, R. J.....	Phys. Rev. Vol. 30, No. 6.	1927
On the Spectra of Doubly and Trebly Ionized Titanium (Ti III and Ti IV).	Lang, R. J. and Russell, H. N.	Astrophys. J. Vol. 66.	1927
The Second Spark Spectrum of Zinc, Zn. III.	Lang, R. J. and Laporte, Otto.	Phys. Rev. Vol. 30, No. 4.	Oct. 1927
The Spectra of Singly and Doubly Ionized Germanium (Ge II and III).	Lang, R. J.....	Proc. Natl. Acad. Sci. Vol. 14, No. 1.	1928
Lowest Terms in the Spark Spectrum of Nickel and Copper (Ni II and Cu II).	Lang, R. J.....	Phys. Rev. Vol. 31, No. 5.	May 1928
Spark Spectra of Germanium.....	Lang, R. J.....	Phys. Rev. Vol. 34, No. 5.	Sept. 1, 1929
Second Spark Spectrum of Antimony and a Note on the First Spark Spectrum of Tin.	Lang, R. J.....	Phys. Rev. Vol. 35, No. 5.	Mar. 1, 1930
Spectrum of Gallium and the (4s4p ²) Configuration in Gallium I and Indium I.	Sawyer, R. A. and Lang, R. J.	Phys. Rev. Vol. 34.	1929
Application of the X-ray Laws to Optical Spectra of Higher Rank and the Classification of Ga IV and Ge V.	Mack, J. E., Laporte, Otto and Lang, R. J.	Phys. Rev. Vol. 31, No. 5.	May 1928
On the Spectra of Doubly Ionized Arsenic, Antimony and Bismuth.	Lang, R. J.....	Phys. Rev. Vol. 32, No. 5.	Nov. 1928
Relative Intensities of Stark Components in Helium.	Langstroth, G. O.....	Proc. Roy. Soc. A. Vol. 129.	1930
A New Determination of the Range of the Alpha Particles of Uranium I and II.	Laurence, G. C.....	Trans. Nova Scotian Inst. Sci. Vol. 17, Pt. I.	Aug. 16, 1927
On Photo-electric Conductivity of Diamond and other Fluorescent Crystals.	Levi, Miss M.....	Trans. Roy. Soc. Can.	1922
Characteristic X-rays from Light Elements.	Levi, Miss M.....	Trans. Roy. Soc. Can.	1924
Characteristics in the Argon Spectrum.....	Lowe, P. and Rose D. C.	Trans. Roy. Soc. Can. Vol. 18, Sec. III.	1924
On Infra-red Spectroscopy.....	Lubovitch, V. P. and Pearen, Miss E.	Trans. Roy. Soc. Can. Vol. 16.	1922
An Automatic Low-temperature Thermostat.	Maass, O. and Barnes, W. H.	J. Am. Chem. Soc.	Feb. 5, 1927
Thermo-luminescence of Calcite and other Crystals.	MacKay, C. A.....	Proc. Roy. Soc. Can.	1921
On the Origin of the Electrodeless Discharge.	MacKinnon, K. A.....	Phil. Mag. Vol. 8.	Nov. 1929
Scattering of Light by Dust-free Liquids.—Changes with Temperature.	Martin, W. H. and Lehrman, Simon.	J. Phys. Chem. Vol. 27.	June 1923
The Arc and Spark Spectra of a Number of Elements in the Lower Quartz Spectral Region.	McDonald, Miss M., Sutton, Miss E. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 20.	1926
The Absorption of Helium by Charcoal.....	McLean, Stuart.....	Trans. Roy. Soc. Can.	1918
The Absorption of Gases by Carbonized Lignites.	McLean, Stuart.....	Trans. Roy. Soc. Can.	1920
The Density of Absorbing Materials.....	McLean, Stuart.....	Trans. Roy. Soc. Can.	1920
The Thermal Evolution of Gases Absorbed by Charcoals and Carbonized Lignites.	McLean, Stuart.....	Trans. Roy. Soc. Can.	1921
Spectroscopy of the Light from the Night Sky.	McLennan, J. C. and Ireton, H. J. C.	Can. J. Research, Vol. 2.	1930
On the Fluorescence and Channelled Absorption Spectra of Caesium and other Alkali Elements.	McLennan, J. C. and Ainslie, D. S.	Proc. Roy. Soc. A, Vol. 103	1923

Title of Paper	Author	Where Published	Date Published
PHYSICS—Continued			
On the Fluorescence of Aesculin.....	McLennan, J. C. and Cale, Miss F. M.	Proc. Roy. Soc. A, Vol. 102	1922
On the Absorption of κ 5460.97 Å by Luminous Mercury Vapor.	McLennan, J. C., Ainslie, D. S. and Cale, Miss F. M.	Trans. Roy. Soc. Can.	Oct. 1922
On the Excitation of Characteristic X-rays from Light Elements.	McLennan, J. C. and Clark, Miss M. L.	Trans. Roy. Soc. Can.	May 1922
Liquefaction of Hydrogen and Helium. II. Communication.	McLennan, J. C. and Shrum, G. M.	Trans. Roy. Soc. Can. Vol. 16.	1922
On the Liquefaction of Hydrogen and Helium, III Communication.	McLennan, J. C. and Shrum, G. M.	Trans. Roy. Soc. Can. Vol. 17.	1923
A New Type of Metal Vacuum Flask.....	McLennan, J. C. and Shrum, G. M.	Trans. Roy. Soc. Can. Vol. 18.	1924
The Secondary Spectrum of Hydrogen at Very Low Temperatures.	McLennan, J. C. and Shrum, G. M.	Roy. Soc. Can. Vol. 18.	1924
On the Luminescence of Nitrogen, Argon other Condensed Gases, at very Low Temperatures.	McLennan, J. C. and Shrum, G. M.	Proc. Roy. Soc. London, A, Vol. 106.	1924
The Crystal Structure of Carbon Dioxide.	McLennan, J. C. and Wilhelm, J. O.	Trans. Roy. Soc. Can. Vol. 19.	1925
On the Structure of the Mercury Green Line $\kappa = 5460.97$ Å and of the Balmer Lines of Hydrogen.	McLennan, J. C. and Ireton, H. J. C.	Trans. Roy. Soc. Can. Vol. 19.	1925
On the Origin of the Auroral Green Line κ 5577 Å and other Spectra Associated with the Aurora Borealis.	McLennan, J. C. and Shrum, G. M.	Proc. Roy. Soc. London, Vol. 108.	1925
Helium.....	McLennan, J. C.....	Encyclopedia Brit.	1926
Helium in Canada.....	McLennan, J. C.....	Nature.	Jan. 1926
The Infra-red Spectra of Certain Elements.	McLennan, J. C., Smith, H. G. and Peters, C. S.	Trans. Roy. Soc. Can., Vol. 19.	1925
The Spectrum of the Aurora and the Con- stitution of the Upper Atmosphere.	McLennan, J. C.....	Roy. Inst. Lecture.	June 11, 1926
On the Luminescence of Solid Nitrogen and Argon.	McLennan, J. C.....	Nature.	Jan. 10, 1925
The Auroral Green Line.....	McLennan, J. C.....	Nature.	Mar. 14, 1925
The Auroral Green Line.....	McLennan, J. C.....	Nature.	Apr. 25, 1925
On the Oxygen Spectra Line κ 5577.35 Å.	McLennan, J. C., McLeod, J. H. and McQuarrie, W. C.	Nature.	Sept. 25, 1926
On the Phosphorescence of Nitrogen.....	McLennan, J. C., Ireton, H. J. C. and Thomson, K.	Nature.	Sept. 18, 1926
A Note on the Structure of the Arc Spec- tra of Elements of the Oxygen Group.	McLennan, J. C., McLay, A. B. and McLeod, J. H.	Phil. Mag.	Sept. 1927
On the Wave-length of the Auroral Green Line in the Oxygen Spectrum.	McLennan, J. C. and McLeod, J. H.	Roy. Soc. Proc. London, A, Vol. 115.	1927
An Investigation into the Nature and Oc- currence of the Auroral Green Line κ 5577 Å.	McLennan, J. C., McLeod, J. H. and McQuarrie, W. C.	Roy. Soc. Proc. London, A, Vol. 114.	1927
The Band Spectra of Hydrogen and Heli- um at Low Temperatures.	McLennan, J. C., Smith, H. G. and Lea, C. A.	Roy. Soc. Proc. London, A, Vol. 113.	1926
An Extension of the Graphical Method of Determining Crystal Structures to the Orthorhombic System.	McLennan, J. C. and Wilhelm, J. O.	Trans. Roy. Soc. Can. Vol. 21.	1927
The Magnetic Susceptibility of Alkali Metals.	McLennan, J. C., Ruedy, R. and Cohen, E.	Proc. Roy. Soc. London, A, Vol. 116.	1927
The Luminescence of Solid Nitrogen under Cathode Ray Bombardment.	McLennan, J. C., Ireton, H. J. C. and Thomson, K.	Proc. Roy. Soc. London, A, Vol. 116.	1927
Intensities in the Secondary Spectrum of Hydrogen at Various Temperatures.	McLennan, J. C., Smith, H. G. and Collins, W. T.	Proc. Roy. Soc. London, A, Vol. 116.	1927
On the Crystal Structure of Solid Oxygen.	McLennan, J. C. and Wilhelm, J. O.	Phil. Mag.	Feb. 1927
Electrical Conductivity at Low Tempera- tures.	McLennan, J. C. and Niven, C. D.	Phil. Mag.	Aug. 1927
The Crystal Structure of the n-Paraffin, Octane, Hexane and Pentane.	McLennan, J. C. and Plummer, W. G.	Trans. Roy. Soc. Can. Vol. 21.	1927
On the Emission and Absorption Spectra of Mercury.	McLennan, J. C. and Shaver, W. W.	Proc. Roy. Soc. London, A, Vol. 100.	1921
On the Origin of the Auroral Green Line in the Oxygen Spectrum.	McLennan, J. C., Ruedy, R. and McLeod, J. H.	Trans. Roy. Soc. Can. Vol. 21.	1927
On the Absorption and Series Spectra of Lead.	McLennan, J. C., Young, J. F. T. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 18, Sec. III.	1924
On the Absorption and Series Spectra of Tin.	McLennan, J. C., Young, J. F. T. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 18, Sec. III.	1924
Absorption Spectra of Various Elements in the Ultra-violet.	McLennan, J. C. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 19, Sec. III.	1925

Title of Paper	Author	Where Published	Date Published
PHYSICS—Continued			
On the Series Spectrum of Gold.....	McLennan, J. C. and McLay, A. B.	Proc. Roy. Soc. A, 108.	1925
On the Structure of the Arc Spectrum of Manganese.	McLennan, J. C. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 20, Sec. III.	1926
On the Structure of the Arc Spectrum of Platinum.	McLennan, J. C. and McLay, A. B.	Trans. Roy. Soc. Can. Vol. 20, Sec. III.	1926
On the Structure of the Arc Spectrum of Gold.	McLennan, J. C. and McLay, A. B.	Proc. Roy. Soc. A. 112.	1926
Atomic States and Spectral Terms.....	McLennan, J. C., McLay, A. B. and Smith, H. G.	Proc. Roy. Soc. A. 112.	1926
The First Spark Spectrum of Thallium, Tl II.	McLennan, J. C., McLay, A. B. and Crawford, M. F.	Trans. Roy. Soc. Can.	1928
The Second Spark Spectrum of Mercury, Hg. III.	McLennan, J. C., McLay, A. B. and Crawford, M. F.	Trans. Roy. Soc. Can.	1928
On the Luminescence of Solid Nitrogen under Cathode Ray Bombardment.	McLennan, J. C., Ireton, H. J. C. and Samson, E. W.	Proc. Roy. Soc. London.	1928
On the Intensities of the Light of the Oxygen Green Line of the Night Sky.	McLennan, J. C., McLeod, J. H. and Ireton, H. J. C.	Trans. Roy. Soc. Can.	1928
On the Zeeman Resolution of the Oxygen Spectral Line at λ 5577 Å., the Auroral Green Line.	McLennan, J. C., McLeod, J. H. and Ruedy, R.	Phil. Mag. Vol. 6.	Sept. 1928
Bakerian Lecture—The Aurora and its Spectrum.	McLennan, J. C.....	Proc. Roy. Soc. London.	1928
The Fine Structure of Spectral Lines.....	McLennan, J. C. and Allin, Miss E. J.	Phil. Mag. Vol. 8, and Trans. Roy. Soc. Can. 3rd Ser. Vol. 23.	Oct. 1929
On the Electrical Conductivity of Certain Metals at Low Temperatures.	McLennan, J. C., Howlett, L. E. and Wilhelm, J. O.	Trans. Roy. Soc. 3rd Ser. Vol. 23, Sec. III.	1929
On the Phosphorescence of Solid Argon Irradiated with Cathode Rays.	McLennan, J. C., Samson, E. W. and Ireton, H. J. C.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 22, Sec. III.	1929
Note on the Raman Effect with Liquid Methane.	McLennan, J. C., Smith, H. D. and Wilhelm, J. O.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 23, Sec. III.	1929
The Raman Effect in Liquid Ortho and Para Hydrogen.	McLennan, J. C., Smith, H. D. and Wilhelm, J. O.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 23, Sec. III.	1929
On the Energy Levels of Molecular Oxygen.	McLennan, J. C., Smith, H. D. and Wilhelm, J. O.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 24, Sec. III.	1930
On the Photo-electric Effect with Lead and Mercury at Low Temperatures.	McLennan, J. C., Hunter, R. G. and McLeod, J. H.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 24, Sec. III.	1930
The Spark Spectrum of Thallium, Tl III.	McLennan, J. C., McLay, A. B. and Crawford, M. F.	Proc. Roy. Soc. A, Vol. 125.	1929
The Spark Spectrum of Thallium, Tl II.	McLennan, J. C., McLay, A. B. and Crawford, M. F.	Proc. Roy. Soc. A, Vol. 125.	1929
Fine Structure of Lines.....	McLennan, J. C., McLay, A. B. and Crawford, M. F.	Proc. Roy. Soc. A, Vol. 125.	1929
Some Further Investigations of the Magnetic Susceptibilities of Single Metallic Crystals.	McLennan, J. C. and Cohen, Miss E.	Roy. Soc. Can. 3rd Ser. Vol. 23, Sec. III.	1929
The Crystal Structure of Solid Methane.....	McLennan, J. C. and Plummer, W. G.	Phil. Mag. Vol. 7.	May 1929
The Scattering of Electrons from Single Crystals of Nickel.	Patterson, A. L.....	Nature.	July 9, 1927
Über das Gibbs-Ewaldsche reziproke Gitter und den dazugehörigen Raum (On the Reciprocal Lattice of Gibbs and Ewald and the Space Connected with it).	Patterson, A. L.....	Z. Physik.	1927
Über die Messung der Grosse von Kristallteilchen mittels Roentgen Strahlen.	Patterson, A. L.....	Z. Physik. Krist.	1927
Intensity Measurements of Spectral Lines. A Method of Exciting Spectra of Certain Metals.	Robertson, J. K..... Robertson, J. K.....	J. Optical Soc. Am. Phil. Mag.	Nov. 1923 April 1926
Intensities in the Argon Spectrum.....	Lowe, P. and Rose, D. C.	Trans. Roy. Soc. Vol. 18.	1924
Energy Losses of Electrons in Mercury Vapor.	Rose, D. C.....	Can. J. Research, Vol. 3.	1930
The Ranges of β -Rays.	Sargent, B. W.....	Trans. Roy. Soc. Can. Vol. 22, Sec. III.	1928
Note on the Combined Use of Photo-electric Cell and Projection Microscope.	Savage, A. and Jamieson, M. C.	Can. J. Research, Vol. 3.	1930
Note on the Extreme Ultra-violet Spectrum of the Carbon Arc.	Shaver, W. W.....	Trans. Roy. Soc. Can. Vol. 17, Sec. III.	1923

Title of Paper	Author	Where Published	Date Published
PHYSICS—Continued			
Arc, Spark and Absorption Spectra of Argon.	Shaver, W. W.....	Trans. Roy. Soc. Can. Vol. 16, Sec. III.	1922
Note on the Electrodeless Discharge in the Vapors of Phosphorus and Sulphur.	Shaver, W. W.....	Trans. Roy. Soc. Can. Vol. 18, Sec. III.	1924
On the Extreme Ultra-violet Spectra of Alkali Metals.	Shaver, W. W.....	Trans. Roy. Soc. Can. Vol. 17.	1924
The Doublet Separation of the Balmer Lines.	Shrum, G. M.....	Proc. Roy. Soc. London, A, Vol. 105.	1924
On the Prism Method of Determining the Refractive Indices of Metallic Vapors.	Smith, H. G.....	Trans. Roy. Soc. Can. Vol. 16.	June 1922
Changes in the Refractivities of Excited Atoms and Molecules.	Smith, H. G.....	Trans. Roy. Soc. Can. Vol. 17, Sec. III.	June 1923
On the Fine Structure of the Band Spectra of Sodium, Potassium, and Sodium-potassium Vapors.	Smith, H. G.....	Proc. Roy. Soc. Vol. A. 106	June 1923
On the Depression of the Centre of a Thin Circular Disc.	Smith, Stanley.....	Trans. Roy. Soc. Can.	1922
A Note on the Spectrum of Doubly Ionized Scandium.	Smith, Stanley.....	Proc. Natl. Acad. Sci. Washington.	Feb. 1927
Wave-length Measurements in the Vacuum Spark Spectrum of Lead from 2200Å to 5000Å.	Smith, Stanley.....	Trans. Roy. Soc. Can.	1928
Some Multiplets of Doubly Ionized Lead.	Smith, Stanley.....	Proc. Natl. Acad. Sci. Vol. 14, No. 11.	Nov. 1928
Some Multiplets of Singly Ionized Thallium.	Smith, Stanley.....	Proc. Natl. Acad. Sci. Vol. 14, No. 11.	Dec. 1928
Extension of the Spectrum of Thallium II.	Smith, Stanley.....	Phys. Rev. Vol. 35, No. 3.	Feb. 1, 1930
Second Spark Spectrum of Lead Pb III.	Smith, Stanley.....	Phys. Rev. Vol. 34, No. 3.	Aug. 1, 1929
Raman Effects with Liquid and Gaseous Nitrous Oxide.	McLennan, J. C., Smith, H. D. and Wilhelm, J. O.	Trans. Roy. Soc. Can. Vol. XXIV, Sec. III.	1930
Light-scattering in Aqueous Salt Solutions.	Sweitzer, C. W.....	Trans. Roy. Soc. Can.	1925
Light-scattering in Aqueous Salt Solutions.	Sweitzer, C. W.....	Trans. Roy. Soc. Can.	1926
Light-scattering in Aqueous Salt Solutions.	Sweitzer, C. W.....	J. Phys. Chem.	Aug. 1927
Note on Ultrasonic Cavitation.....	Taylor, G. B. and Sproule, D. O.	Trans. Roy. Soc. Can. 3rd Ser. Vol. 23, Sec. III.	1929
A New View of Surface Forces.....	Taylor, Wilson.....	Univ. Press, Toronto.	
On the Electrical Discharge in Mixed Gases.	Terroux, F. R.....	Phys. Rev.	Dec. 1926
On the Absorption of Light by Gaseous Liquid and Solid Xenon.	McLennan, J. C. and Turnbull, R.	Proc. Roy. Soc. A, Vol. 129.	1930
Dispersion of an Electron Beam.....	Watson, E. E.....	Phil. Mag.	April 1927
On the Critical Frequency of Pulsation of Tones.	Weinberg, Miss M. and Allen, Frank.	Phil. Mag. Ser. 6, Vol. 47, No. 277.	Jan. 1924
On the Effect of Aural Fatigue upon the Critical Frequency of Pulsation of Tones.	Weinberg, Miss M. and Allen, Frank.	Phil. Mag. Ser. 6, Vol. 47, No. 277.	Jan. 1924
On the Effect of Fatiguing the Ear with a Combination of Two or More Tones.	Weinberg, Miss M.....	Phil. Mag. Ser. 6, Vol. 47, No. 277.	Jan. 1924
The Spark Spectra of Indium and Gallium in the Extreme Ultra-violet Region.	Weinberg, Miss M.....	Proc. Roy. Soc. Can. Sec. A, Vol. 107.	1925
The Crystal Structure of Solid Oxygen.....	Wilhelm, J. O.....	Phil. Mag.	Feb. 1927
An Extension of the Graphical Method of Determining Crystal Structures to the Orthorhombic System.	Wilhelm, J. O.....	Trans. Roy. Soc. Can. Vol. 21, Sec. 3.	1927
Application of the Theory of Magnetism to the Calculation of Atomic Diameters.	Young, J. F. T.....	Proc. Roy. Soc. Can. Vol. 16.	1922
A Method of Increasing the Dispersion of a Constant Deviation Spectroscope.	Young, J. F. T.....	J. Optical Soc. Am. Vol. 7.	1923
The Crystal Structure of Various Heusler Alloys by the Use of the X-ray.	Young, J. F. T.....	Phil. Mag. Vol. 46.	1923
The Continuous Spectrum of Mercury.....	Robertson, J. K., Mackinnon, K. A. and Zinn, W. H.	J. Optical Soc. Am. Vol. 17, No. 6.	1928
New Phenomena in X-ray Scattering.....	Gray, J. A. and Zinn, W. H.	Can. J. Research, Vol. 2.	1930

APPENDIX J

LIST OF MEMBERS OF ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S., Chairman.....	Dean of the Faculty of Graduate Studies and Director, Department of Physics, McGill University, Montreal, Que.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex- officio), Ottawa, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Re- search Council, Ottawa, Ont.
E. P. Fetherstonhaugh, M.C., B.Sc., M.E.I.C.....	Dean of the Faculty of Engineering and Arch- itecture, University of Manitoba, Winni- peg, Man.
L. Gilchrist, M.A., Ph.D., F.R.S.C.....	Department of Physics, University of Toron- to, Toronto, Ont.
R. A. Loader, Esq.....	de Havilland Aircraft of Canada, Ltd., To- ronto, Ont.
Air-Commodore R. H. Mulock, C.B.E., D.S.O.....	Canadian Airways Ltd., Room 914, Univer- sity Tower Building, 660 St. Catherine St. W., Montreal, Que.
J. H. Parkin, B.A., M.E., F.R.Ae.S., M.A.S.M.E.....	Assistant Director, Division of Physics, Na- tional Research Council, Ottawa, Ont.
John Patterson, M.A., F.R.S.C.....	Director, Meteorological Service, 315 Bloor St. W., Toronto, 5, Ont.
A Stansfield, D.Sc., A.R.S.M., F.R.S.C.....	Department of Metallurgy, McGill Univer- sity, Montreal, Que.
Group-Captain E. W. Stedman, O.B.E., M.E.I.C., A.M.I.C.E., F.R.Ae.S., A.R.C.Sc.....	Chief Aeronautical Engineer, Department of National Defence, Ottawa, Ont.
Lt.-Col. W. A. Steel, R.C.C.S.....	Wireless Officer, Department of National De- fence, Ottawa, Ont.
James Young, Esq.....	Canadian Pratt and Whitney Aircraft, Ltd., Longueuil, Que.
J. J. Green, A.R.C.Sc., B.Sc., D.I.C., Ph.D., Secretary.....	Department of Physics, National Research Council, Ottawa, Ont.

Associate Committee on Animal Diseases

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Otta- wa, Ont.
J. P. Collip, M.A., Ph.D., M.D., D.Sc., F.R.C.S.....	Professor of Biochemistry and Chairman of the Department, McGill University, Mont- real, Que.
J. G. FitzGerald, M.D., LL.D., F.R.S.C.....	Professor of Hygiene and Preventive Medicine, and Director, Connaught Laboratories and School of Hygiene, University of Toronto, Toronto, Ont.
J. H. Grisdale, B.Agr., D.Sc., A.....	Deputy Minister, Department of Agriculture, Ottawa, Ont.
S. Hadwen, D.V.S., F.E.S.....	Director of Veterinary Science, Ontario Re- search Foundation, 47 Queen's Park, To- ronto, Ont.
N. MacL. Harris, M.B.....	Chief, Laboratory of Hygiene, Department of Health, Ottawa, Ont.
H. W. Hill, M.B., M.D., D.P.H., L.M.C.C.....	Professor of Bacteriology, and of Nursing and Health, University of British Columbia, and Director of the Vancouver General Hospital Laboratories, Vancouver, B.C.

George Hilton, V.S.....	Veterinary Director General, Department of Agriculture, Ottawa, Ont.
O. Klotz, M.D., C.M.....	Department of Pathology and Bacteriology, University of Toronto, Toronto, Ont.
Rev. Father Leopold, D.S.A.....	Director, Oka Agricultural Institute, La Trappe, Que.
José M. Rosell, M.D.....	Chief, Department of Bacteriology, Oka Agricultural Institute, La Trappe, Que.
C. D. McGilvray, M.D.D., D.V.Sc.....	Principal, Ontario Veterinary College, Guelph, Ont.
A. Savage, B.S.A., D.V.M., M.R.C.V.S.....	Professor of Animal Pathology, Manitoba Agricultural College, Winnipeg, Man.
P. R. Talbot, V.S., D.V.M.....	Provincial Veterinarian, Department of Agriculture, Edmonton, Alta.
E. A. Watson, V.S.....	Chief Pathologist, Department of Agriculture, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Apple Slacks

J. H. Grisdale, B.Agr., D.Sc., A., Chairman	Deputy Minister, Department of Agriculture, Ottawa, Ont.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex-officio) Ottawa, Ont.
W. S. Blair, Esq.....	Superintendent, Experimental Farm, Kentville, N.S.
A. S. Mackenzie, Ph.D., D.C.L., LL.D., F.R.S.C.....	President, Dalhousie University, Halifax, N.S.
G. E. McIntosh, Esq.....	Commissioner, Fruit Branch, Department of Agriculture, Ottawa, Ont.
W. A. Middleton, Esq.....	Provincial Horticulturist, Department of Natural Resources, Halifax, N.S.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Asbestos Research

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Research Council, Ottawa, Ont.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
A. C. Halferdahl, M.A.Sc.....	Research Investigator, National Research Council, Ottawa, Ont.
A. S. Johnson, Jr., Esq.....	Managing Director, Johnson's Company, Thetford Mines, Que.
Eugene Larochelle, B.A., C.E.....	Inspector of Mines, Province of Quebec, Thetford Mines, Que.
J. G. Ross, Esq.....	Mines Manager, Asbestos Corporation, Ltd., Thetford Mines, Que.
C. H. Shoemaker, Esq.....	Canadian Johns-Manville Corporation, Asbestos, Que.
O. C. Smith, Esq.....	Manager, Bell Asbestos Mines, Incorporated, Thetford Mines, Que.
E. E. Spafford, Esq.....	Quebec Asbestos Corporation, East Broughton, Que.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Biophysics

- H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C.,
F.R.H.S., Chairman..... President, National Research Council, Ottawa,
Ont.
- P. M. Andrus, M.D..... Queen Alexandra Sanatorium, London, Ont.
- R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C..... Director, Division of Physics, National Re-
search Council, Ottawa, Ont.
- A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S..... Dean of the Faculty of Graduate Studies and
Director, Department of Physics, McGill
University, Montreal, Que.
- J. A. Gray, B.Sc., D.Sc., O.B.L., F.R.S.C..... Professor of Physics, Queen's University,
Kingston, Ont.
- J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D.,
F.R.S..... Professor of Physics, Director of the Physical
Laboratory, and Dean of the School of
Graduate Studies, University of Toronto,
Toronto, Ont.
- T. Parizeau, M.D..... Vice-Dean and Director of Studies, Faculty
of Medicine, University of Montreal,
Montreal, Que.
- A. H. Pirie, M.D..... X-ray Department, Royal Victoria Hospital,
Montreal, Que.
- G. E. Richards, M.B..... Director, Department of Radiology, General
Hospital, Toronto, Ont.
- J. K. Robertson, M.A., F.R.S.C..... Associate Professor of Physics, Queen's Uni-
versity, Kingston, Ont.
- G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C..... Director, Division of Chemistry, National
Research Council, Ottawa, Ont.
- F. E. Lathe, M.Sc., Secretary..... Director, Division of Research Information,
National Research Council, Ottawa, Ont.

Associate Committee on Botanical Survey

- H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C.,
F.R.H.S., Chairman..... President, National Research Council, Ottawa,
Ont.
- J. Adans, M.A..... Department of Botany, Central Experimental
Farm, Ottawa, Ont.
- H. P. Bell, B.Sc., M.Sc., M.A., Ph.D..... Professor of Botany, Dalhousie University,
Halifax, N.S.
- A. H. R. Buller, D.Sc., Ph.D., LL.D., F.R.S.C..... Professor of Botany, University of Manitoba,
Winnipeg, Man.
- W. H. Collins, B.A., Ph.D., F.R.S.C..... Department of Mines, Ottawa, Ont.
- John Dearness, M.A., LL.D..... London, Ont.
- Roy Fraser, B.S.A., M.A..... Professor of Biology, Mount Allison Univer-
sity, Sackville, N.B.
- W. P. Fraser, B.A., M.A..... Professor of Biology, University of Saskat-
chewan, Saskatoon, Sask.
- H. T. Güssow, LL.D..... Dominion Botanist, Central Experimental
Farm, Ottawa, Ont.
- A. H. Hutchinson, M.A., Ph.D..... Professor and Head of the Department of
Botany, University of British Columbia,
Vancouver, B.C.
- F. J. Lewis, D.Sc., F.R.S., F.R.S.C., F.L.S..... Professor of Botany, University of Alberta,
Edmonton, Alta.
- W. T. MacClement, M.A., D.Sc..... Professor of Biology, Queen's University,
Kingston, Ont.
- M. O. Malte, B.Sc., M.Sc., Ph.D..... Department of Mines, Ottawa, Ont.
- Fr. Marie-Victorin, D.Sc., F.R.S.C..... Department of Botany, University of Mont-
real, Montreal, Que.
- Robt. Newton, B.S.A., M.Sc., Ph.D., F.R.S.C..... Professor of Field Crops and Plant Biochem-
istry, University of Alberta, Edmonton,
Alta.
- A. E. Porsild, Esq..... Northwest Territories and Yukon Branch,
Department of the Interior, Ottawa, Ont.

G. W. Scarth, M.A.....	Professor of Botany, McGill University, Montreal, Que.
R. B. Thomson, B.A.....	Professor of Phanerogamic Botany, University of Toronto, Toronto, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee of Chemists

G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C., Chairman.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex-officio), Ottawa, Ont.
J. Watson Bain, B.A.Sc., F.R.S.C.....	Professor of Chemical Engineering, University of Toronto, Toronto, Ont.
H. E. Bigelow, Ph.D.....	Professor of Chemistry, Mount Allison University, Sackville, N.B.
K. A. Clark, Ph.D.....	University of Alberta, Edmonton, Alta.
S. J. Cook, B.A., A.I.C., F.C.I.C.....	Research Chemist, National Research Council, Ottawa, Ont.
R. T. Elworthy, B.Sc., Ph.D., F.I.C.....	Industrial Processes Development, Ltd., Kingston, Ont.
F. M. G. Johnson, M.Sc., Ph.D., F.I.C., F.R.S.C.....	Director, Department of Chemistry, McGill University, Montreal, Que.
F. B. Kenrick, M.A., Ph.D.....	Professor of Chemistry, University of Toronto, Toronto, 5, Ont.
Fred E. Lee, Esq.....	Consolidated Mining and Smelting Co., Trail, B.C.
H. W. Matheson, M.Sc.....	Vice-President, Shawinigan Chemicals, Ltd., Power Building, Montreal, Que.
Hervé Nadeau, L. ès Sc., F.C.I.C.....	Laboratoire Nadeau Ltée, Montreal, Que.
D. A. Pritchard, Ph.D.....	Canada Salt Company, Sandwich, Ont.
W. A. P. Schorman, Esq.....	Consulting Engineer, Royal Bank Building, Toronto, Ont.
J. W. Shipley, A.M., Ph.D., F.C.I.C., F.R.S.C.....	Department of Chemistry, University of Alberta, Edmonton, Alta.
J. F. Slee, Esq.....	Superintendent, Coke Plant, Steel Corporation of Canada, Hamilton, Ont.
E. T. Sterne, Esq.....	Manager G. F. Sterne and Sons, Ltd., Brantford, Ont.
George H. Tomlinson, B.A.....	General Manager, Canadian Cellulose Co., Ltd., Cornwall, Ont.
Alexandre Vachon, Ph.D., D.Theol., M.A.....	Professor of Mineralogy and Geology, Laval University, Quebec, Que.
J. A. Wales, Esq.....	Vice-President, McColl Frontenac Oil Co., Montreal, Que.
R. J. Walley, M.Sc.....	Chief Chemist, Canadian Industries Ltd., McMasterville, Que.
T. H. Wardleworth, F.C.S.....	National Drug and Chemical Company, Montreal, Que.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Coal Classification and Analysis

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Joint Chairman.....	President, National Research Council, Ottawa, Ont.
Chas. Camsell, B.Sc., LL.D., F.R.S.C., Joint Chairman.....	Deputy Minsiter, Department of Mines, Ottawa, Ont.
F. A. Combe M.E.I.C., P.E.Q., M.A.S.M.E.....	Consulting Combustion and Steam Engineer, 1188 Phillips Square, Montreal, Que.

J. B. deHart, M.Sc., M.E.I.C.....	Alberta Mines Branch, Lethbridge, Alta.
J. R. Donald, B.A., B.Sc., P.E.Q., M.E.I.C.....	Director, J. T. Donald Company, 40-42 Belmont Street, Montreal, Que.
George Drummond, B.Sc.....	Drummond Company, McGill Building, McGill Street, Montreal, Que.
G. S. Eldridge, B.Sc.....	Consulting Engineer, Cave Building, 567 Hornby Street, Vancouver, B.C.
A. E. Flynn, A.R.S.M., D.I.C.....	Department of Mining Engineering, Nova Scotia Technical College, Department of Natural Resources, Halifax, N.S.
John D. Galloway, M.Sc.....	Provincial Mineralogist, Department of Mines, Victoria, B.C.
R. E. Gilmore, M.Sc.....	Supt., Fuel Research Laboratory, 552 Booth Street, Ottawa, Ont.
F. W. Gray, Esq.....	Assistant General Manager, British Empire Steel Corporation, Sydney, N.S.
Chas. R. Hazen, M.Sc.....	Vice-President, Milton Hersey Company, 980 St. Antoine Street, Montreal, Que.
B. R. MacKay, B.Sc., Ph.D., F.G.S.A., F.R.S.C.....	Geological Survey, Department of Mines, Ottawa, Ont.
A. Mailhiot, B.Ap.Sc.....	Professor of Geology, L'Ecole Polytechnique, Montreal, Que.
John McLeish, B.A., F.S.S.....	Director, Mines Branch, Department of Mines, Ottawa, Ont.
W. E. McMullen, Esq.....	Department of Lands and Mines, Fredericton, N.B.
T. M. Molloy, Esq.....	Commissioner of Labor and Industries, Regina, Sask.
J. H. H. Nicolls, B.Sc., M.Sc.....	Fuel Research Laboratory, 552 Booth Street, Ottawa, Ont.
L. J. Rogers, B.A.Sc., M.A.....	Assistant Professor of Chemistry, University of Toronto, Toronto, 5, Ont.
F. H. Sexton, B.Sc., D.Sc., LL.D.....	President, Nova Scotia Technical College, Halifax, N.S.
Edgar Stansfield, M.Sc.....	Professor of Industrial Research, University, of Alberta, Edmonton, Alta.
L. R. Thomson, M.E.I.C.....	Consulting Engineer, 10 Cathcart Street, Montreal, Que.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Electrical Measuring Instruments

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
B. G. Ballard, B.Sc.....	Physicist, Division of Physics, National Research Council, Ottawa, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Research Council, Ottawa, Ont.
C. V. Christie, M.Sc., M.E.I.C.....	Professor of Electrical Engineering, McGill University, Montreal, Que.
W. P. Dobson, Esq.....	Hydro-Electric Power Commission, 8 Strachan Avenue, Toronto, Ont.
E. Holder, Esq.....	Meter Engineer, Shawinigan Water and Power Company, Power Building, Craig St. West, Montreal, Que.
D. M. Jemmet, M.A., M.Sc.....	Professor of Electrical Engineering, Queen's University, Kingston, Ont.
D. A. McKenzie, Esq.....	Hydro-electric Power Commission, 190 University Ave., Toronto, Ont.
J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S.....	Professor of Physics, Director of the Physical Laboratory, and Dean of the School of Graduate Studies, University of Toronto, Toronto, 5, Ont.

H. W. Price, B.A.Sc.....	Professor of Electrical Engineering, University of Toronto, Toronto, Ont.
J. L. Stiver, B.A.Sc.....	Director, Electrical and Gas Standards Laboratories, Department of Trade and Commerce, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.
W. B. Buchanan, Esq., (Alternate for Mr. W. P. Dobson).....	Hydro-electric Power Commission, 8 Strachan Avenue, Toronto, Ont.
H. A. Dupré, A.C.G.I., M.I.C.E., M.E.I.C., (Alternate for Mr. J. L. Stiver).....	Assistant Director, Electrical and Gas Standards Laboratories, Department of Trade and Commerce, Ottawa, Ont.
G. A. Wallace, M.Sc., (Alternate for Prof. C. V. Christie).....	Department of Electrical Engineering, McGill University, Montreal, Que.

Associate Committee on Engineering Standards

H. H. Vaughan, Esq., Chairman.....	Consulting Engineer, 285 Beaver Hall Hill, Montreal, Que.
J. G. Morrow, Esq., Vice-Chairman.....	Inspecting Engineer, Steel Company of Canada, Ltd., Hamilton, Ont.
J. B. Porter, E.M., Ph.D., Sc.D., M.Inst.C.E., M.E.I.C., Vice-Chairman.....	Emeritus Professor of Mining Engineering, McGill University, Montreal, Que.
R. J. Durley, M.Inst.C.E., M.E.I.C., M.Am.Soc.M.E., Honorary Secretary.....	General Secretary, Engineering Institute of Canada, 2050 Mansfield Street, Montreal, Que.
W. C. Adams, Esq.....	Chief Engineer, Northern Electric Co., Ltd., 1261 Shearer Street, Montreal, Que.
J. Watson Bain, B.A.Sc., F.R.S.C.....	Professor of Chemical Engineering, University of Toronto, Toronto, 5, Ont.
F. L. C. Bond, Esq.....	Canadian National Railways, Montreal, Que.
M. Aurelien Boyer.....	Principal, Ecole Polytechnique, University of Montreal, 1430 St. Denis Street, Montreal, Que.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Research Council, Ottawa, Ont.
E. Godfrey Burr, B.Sc.....	Assistant Professor of Electrical Engineering, McGill University, Montreal, Que.
K. M. Cameron, Esq.....	Chief Engineer, Department of Public Works, Ottawa, Ont.
C. V. Christie, B.Sc., M.A.....	Professor of Electrical Engineering, McGill University, Montreal, Que.
A. L. Clark, B.Sc., Ph.D., F.R.S.C., Hon. M.E.I.C.....	Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
J. D. Craig, B.A., B.Sc., D.L.S., M.E.I.C.....	Director General of Surveys, Department of the Interior, Ottawa, Ont.
A. R. Decary, Esq.....	Chief Engineer, Quebec District, Public Works Department, Quebec, Que.
W. P. Dobson, Esq.....	Chief Testing Engineer, Hydro-electric Power Commission of Ontario, 8 Strachan Avenue, Toronto, Ont.
Col. A. E. Dubuc.....	Department of Railways and Canals, Ottawa, Ont.
G. H. Duggan, Esq.....	Dominion Bridge Company, Montreal, Que.
C. P. Edwards, O.B.E., F.I.R.E., A.M.E.I.C.....	Director of Radio, Department of Marine, Ottawa, Ont.
A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S.....	Dean of the Faculty of Graduate Studies and Director, Department of Physics, McGill University, Montreal, Que.

COMMITTEE MEMBERS

- J. M. R. Fairbairn, Esq.....Chief Engineer, Canadian Pacific Railway Company, Montreal, Que.
- E. P. Fetherstonhaugh, M.C., B.Sc., M.E.I.C...Dean, Faculty of Engineering and Architecture, University of Manitoba, Winnipeg, Man.
- A. E. Foreman, B.Sc.....Portland Cement Association, 908 Birks Building, Vancouver, B.C.
- A. Frigon, B.Sc., D.Sc., A.M.A.I.E.E.,
A.M.E.I.C.....Dean, Ecole Polytechnique, and General Director of Technical Education in the Province of Quebec, 1430 St. Denis Street, Montreal, Que.
- F. A. Gaby, B.A.Sc., D.Sc.....Hydro-electric Power Commission of Ontario, Toronto, Ont.
- G. Gordon Gale, B.Sc.....Vice-President and General Manager, Gati-neau Power Company, Victoria Bldg., Ottawa, Ont.
- L. W. Gill, M.Sc., M.E.I.C.....Principal, Hamilton Technical Institute, Ham-ilton, Ont.
- A. R. Goldie, Esq.....Babcock-Wilcox and Goldie-McCulloch, Ltd., Galt, Ont.
- J. H. Grisdale, B.Agr., D.Sc.A.....Deputy Minister, Department of Agriculture, Ottawa, Ont.
- Lt.-Col. W. J. Keightley.....Chief Inspector of Ammunitions, Depart-ment of National Defence, Quebec, Que.
- F. E. Lathe, M.Sc.....Director, Division of Research Information, National Research Council, Ottawa, Ont.
- Olivier O. Lefebvre, Esq.....Chief Engineer, Quebec Streams Commission, Montreal, Que.
- R. V. Macauley, Esq.....Chief Engineer, Bell Telephone Company of Canada, Montreal, Que.
- C. J. MacKenzie, B.E., M.C.E., M.C.....Dean and Professor of Civil Engineering, Uni-versity of Saskatchewan, Saskatoon, Sask.
- D. H. McDougall, LL.D., M.E.I.C., M.M.I.S.,
M.A.I.M.M.E.....c/o McDougall Engineering Company, Ltd., 15 King Street, W., Toronto, Ont.
- Lt.-Col. C. N. Monsarrat.....Consulting Engineer, Montreal, Que.
- Tom Moore, Esq.....Trades and Labour Congress of Canada, 172 MacLaren Street, Ottawa, Ont.
- A. Neighorn, Esq.....Manager, The Nichols Chemical Company, Ltd., 285 Beaver Hall Hill, Montreal, Que.
- J. I. Newell, Esq.....Vice-President, British Columbia Electric Railway Co., Ltd., Vancouver, B.C.
- Lt.-Col. G. Ogilvie, C.M.G.....Department of Mines, Ottawa, Ont.
- J. M. Oxley, Esq.....Chapman and Oxley, Architects, 372 Bay Street, Toronto, Ont.
- J. H. Parkin, B.A., M.E., F.R.AeS., M.A.S.M.E.....Assistant Director, Division of Physics, Na-tional Research Council, Ottawa, Ont.
- Eng. Commander T. C. Phillips, R.C.N.....Consulting Naval Engineer, Department of National Defence, Ottawa, Ont.
- P. L. Pratley, Esq.....Monsarrat and Pratley, Drummond Building, Montreal, Que.
- T. A. Russell, Esq.....President, Willys-Overland, Ltd., Toronto, 9, Ont.
- J. A. Shaw, Esq.....Canadian Pacific Railway Company, Mont-real, Que.
- T. L. Simmons, Esq.....Chief Engineer, Board of Railway Commis-sioners, Ottawa, Ont.
- Alfred Stansfield, D.Sc., A.R.S.M., M.E.I.C.,
F.R.S.C.....Professor of Metallurgy, McGill University, Montreal, Que.
- Group-Captain E. W. Stedman, O.B.E ,
M.E.I.C., M.I.C.E., F.R.AeS., A.R.C.Sc.....Chief Aeronautical Engineer, Department of National Defence, Ottawa, Ont.
- A. F. Stewart, Esq.....Regional Chief Engineer, Canadian National Railways, Moncton, N.B.
- T. F. Sutherland, Esq.....Chief Inspector of Mines, Department of Mines, 5 Queen's Park, Toronto, Ont.

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, Ottawa, Ont.
E. B. Wardle, Esq.....	Chief Engineer, Laurentide Company, Ltd., Grand'Mere, Que.
C. R. Young, B.A.Sc., C.E., M.E.I.C.....	Professor of Civil Engineering, University of Toronto, Ont.
B. S. McKenzie, B.A., B.Sc., M.E.I.C., M.C.I.M.M., Secretary.....	Canadian Engineering Standards Association, Central Chambers, Ottawa, Ont.

Associate Committee on Field Crop Diseases

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Joint Chairman*	President National Research Council, Ottawa, Ont.
J. H. Grisdale, B.Agr., D.Sc.A., Joint Chairman*	Deputy Minister, Department of Agriculture, Ottawa, Ont.
E. S. Archibald, B.A., B.S.A., LL.D.*	Director, Experimental Farms, Department of Agriculture, Ottawa, Ont.
H. T. Güssow, LL.D.*	Dominion Botanist, Central Experimental Farm, Ottawa, Ont.
W. C. Murray, M.A., LL.D., F.R.S.C.*	President, University of Saskatchewan, Sas- katoon, Sask.
Robt. Newton, Ph.D., F.R.S.C.*	Professor of Field Crops and Plant Biochem- istry, University of Alberta, Edmonton, Alta.

Western Section

A. H. R. Fuller, D.Sc., Ph.D., LL.D., F.R.S., F.R.S.C.....	Professor of Botany, University of Manitoba, Winnipeg, Man.
J. H. Craigie, Ph.D.....	Director, Dominion Rust Laboratory, Winni- peg, Man.
W. P. Fraser, B.A., M.A.....	Professor of Biology, University of Saskat- chewan, Saskatoon, Sask.
C. H. Goulden, Ph.D.....	Cereal Specialist, Federal Department of Agriculture, Manitoba Agricultural College, Winnipeg, Man.
J. B. Harrington, B.S.A., Ph.D.....	Professor of Field Husbandry, University of Saskatchewan, Saskatoon, Sask.
A. W. Henry, B.S.A., M.S.A., Ph.D.....	Associate Professor of Plant Pathology, De- partment of Field Crops, University of Alberta, Edmonton, Alta.
G. P. McRostie, B.S.A., M.S.A., Ph.D.....	Professor of Agronomy, Manitoba Agricul- tural College, Winnipeg, Man.
G. B. Sanford, B.S.A., M.S., Ph.D.....	Dominion Laboratory of Plant Pathology, University of Alberta, Edmonton, Alta.
P. M. Simmonds, Ph.D.....	Senior Plant Pathologist, Dominion Field Laboratory of Plant Pathology, University of Saskatchewan, Saskatoon, Sask.
W. P. Thompson, M.A., Ph.D., F.R.S.C.....	Professor of Biology, University of Saskatche- wan, Saskatoon, Sask.
O. S. Aamodt, B.S., M.S., Ph.D., Secretary.....	Associate Professor of Plant Breeding, Uni- versity of Alberta, Edmonton, Alta.

Eastern Section

D. L. Bailey, Ph.D.....	Department of Botany, University of Toronto, Toronto, Ont.
G. H. Berkeley, B.A., M.A., Ph.D.....	Plant Pathologist, St. Catharines, Ont.
Frank L. Drayton, Esq.....	Central Experimental Farm, Ottawa, Ont.
F. J. Hockey, Esq.....	Pathologist-in-Charge, Field Laboratory of Plant Pathology, Kentville, N.S.

* Member of both Eastern and Western Sections of Committee.

W. T. Macoun, Esq.....	Dominion Horticulturist, Central Experimental Farm, Ottawa, Ont.
A. W. McCallum, B.Sc.F., M.A.....	Plant Pathologist, Central Experimental Farm, Ottawa, Ont.
L. H. Newman, B.S.A.....	Dominion Cerealist, Central Experimental Farm, Ottawa, Ont.
H. N. Racicot, B.A.....	Plant Pathologist, Division of Botany, Central Experimental Farm, Ottawa, Ont.

Associate Committee on Gas Research

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
E. H. Boomer, B.Sc., M.Sc., Ph.D.....	Assistant Professor, Department of Chemistry, University of Alberta, Edmonton, Alta.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S.....	Professor of Physics, Director of the Physical Laboratory, and Dean of the School of Graduate Studies, University of Toronto, Toronto, Ont.
P. V. Rosewarne, B.A., M.A.....	Fuel Research Laboratory, 552 Booth Street, Ottawa, Ont.
Edgar Stansfield, M.Sc.....	Professor of Industrial Research, University of Alberta, Edmonton, Alta.
R. C. Wallace, M.A., B.Sc., Ph.D., D.Sc., F.G.S., F.R.S.C.....	President, University of Alberta, Edmonton, Alta.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Grain Research

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa Ont.
F. J. Birchard, Ph.D.....	Chief Chemist, Dominion Grain Research Laboratory, Winnipeg, Man.
W. F. Geddes, B.S.A., M.A., Ph.D., F.C.I.C.....	Professor of Agricultural Chemistry, Manitoba Agricultural College, Winnipeg, Man.
T. J. Harrison, B.S.A.....	Assistant Commissioner, Board of Grain Commissioners, Winnipeg, Man.
R. K. Larmour, Ph.D.....	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.
W. C. Murray, M.A., LL.D., F.R.S.C.....	President, University of Saskatchewan, Saskatoon, Sask.
L. H. Newman, B.S.A.....	Dominion Cerealist, Central Experimental Farm, Ottawa, Ont.
Robert Newton, Ph.D., F.R.S.C.....	Professor of Field Crops and Plant Biochemistry, University of Alberta, Edmonton, Alta.
Edgar Stansfield, M.Sc.....	Professor of Industrial Research, University of Alberta, Edmonton, Alta.
T. Thorvaldson, Ph.D., F.R.S.C.....	Professor of Chemistry, University of Saskatchewan, Saskatoon, Sask.
J. G. Malloch, Ph.D., Secretary.....	Research Assistant, University of Alberta, Edmonton, Alta.

Associate Committee on Heating and Insulation

Chas. Camsell, B.Sc., LL.D., F.R.S.C., Chairman.....	Deputy Minister, Department of Mines, Ottawa, Ont.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex- officio), Ottawa, Ont.
R. W. Angus, B.A.Sc.....	Professor of Mechanical Engineering, Univer- sity of Toronto, Toronto, Ont.
L. M. Arkley, M.Sc.....	Professor of Mechanical Engineering, Queen's University, Kingston, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.	Director, Division of Physics, National Re- search Council, Ottawa, Ont.
James Govan, R.A.I.C.....	Consulting Architect, 905 Northern Ontario Building, Toronto, 2, Ont.
A. R. Greig, B.Sc.....	Professor of Mechanical Engineering, Univer- sity of Saskatchewan, Saskatoon, Sask.
F. O. Hamel, Esq.....	Senior Mechanical, Heating and Ventilating Engineer, Department of Public Works, Ottawa, Ont.
G. D. Mallory, B.Sc.....	National Development Bureau, Department of Interior, Ottawa, Ont.
C. D. Niven, B.Sc., M.A., Ph.D.....	Division of Physics, National Research Council, Ottawa, Ont.
J. H. Parkin, B.A., M.E., F.R.Ae.S., M.A.S.M.E.....	Assistant Director, Division of Physics, National Research Council, Ottawa, Ont.
H. E. Reilly, M.S.....	Assistant Professor of Physics, McGill Uni- versity, Montreal, Que.
J. A. Ruddick, LL.D.....	Commissioner, Dairy and Cold Storage Branch, Department of Agriculture, Otta- wa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Honey

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Re- search Council, Ottawa, Ont.
L. T. Floyd, Esq.....	Provincial Apiarist, Department of Agricul- ture, Winnipeg, Man.
C. B. Gooderham, B.S.A.....	Dominion Apiarist, Central Experimental Farm, Ottawa, Ont.
J. H. Grisdale, B.Agr., D.Sc.A.....	Deputy Minister, Department of Agriculture Ottawa, Ont.
A. G. Lochhead, B.A., M.Sc., Ph.D.....	Dominion Agricultural Bacteriologist, Central Experimental Farm, Ottawa, Ont.
R. H. F. Manske, B.Sc., M.Sc., Ph.D.....	Research Chemist, National Research Council Ottawa, Ont.
F. E. Millen, B.S.A.....	Professor of Apiculture and Provincial Apiar- ist, Ontario Agricultural College, Guelph, Ont.
W. J. Tawse, Esq.....	96 St. James St. East, Montreal, Que.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Laundry Research

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
Hugh Adams, Esq.....	Assistant Manager, Brighton Laundry Ltd., 826 Bloor Street West, Toronto, Ont.

David Fredette, Esq.....	c/o New Method Washing Ltd., 6425 Christopher Columbus St., Montreal, Que.
G. Ross Marshall, Esq.....	President, South Shore Laundry Co., St. Lambert, Que.
O. M. Morgan, B.A., M.A., Ph.D.....	Research Chemist, National Research Council, Ottawa, Ont.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Leather

H. M. Tory, M.A., D.Sc., LL.D.; F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
G. T. Beardmore, Esq.....	Beardmore Belting Co., Ltd., Acton, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Research Council, Ottawa, Ont.
L. O. Breithaupt, Esq.....	Breithaupt Leather Co., Corner Weber and Breithaupt Sts., Kitchener, Ont.
C. H. Cleveland, Esq.....	President, Goodhue Belting Company, Danville, Que.
Jos. Daoust, Esq.....	Daoust, Lalonde & Co., Montreal, Que.
W. S. Edwards, Esq.....	Edwards and Edwards, Cobourg, Ont.
W. E. Graham, B.Sc., M.A.Sc., Ph.D.....	Department of Chemistry, National Research Council, Ottawa, Ont.
K. M. Kilbourne, Esq.....	Wickett & Craig, Ltd., Don Esplanade, Toronto, Ont.
W. H. Lytle, Esq.....	A. R. Clarke & Co., Ltd., 633 Eastern Ave., Toronto, Ont.
J. H. Parkin, B.A., M.E., F.R.Ae.S., M.A.S.M.E.....	Assistant Director, Division of Physics, National Research Council, Ottawa, Ont.
J. A. Thurston, Esq.....	c/o J. Leckie Co., Ltd., 220 Cambie St., Vancouver, B.C.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Magnesite

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C. F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
F. D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C., Hon. M.I.M.M., Hon. M.A.I.M.M.E.....	Emeritus Vice-principal, Emeritus Dean of the Faculty of Graduate Studies and of the Faculty of Applied Science, and Logan Professor of Geology and Palaeontology, McGill University, Montreal, Que.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
A. L. Clark, B.Sc., Ph.D.....	Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Mining and Metallurgy

Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C., Hon. M.I.M.M., Hon. M.A.I.M.M.E., Chairman.....	Emeritus Vice-principal, Emeritus Dean of the Faculty of Graduate Studies and of the Faculty of Applied Science and Logan Professor of Geology and Palaeontology, McGill University, Montreal, Que.
--	---

Chas. Camsell, B.Sc., LL.D., F.R.S.C., Vice-chairman.....	Deputy Minister, Department of Mines, Ottawa, Ont.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council (Ex-officio), Ottawa, Ont.
S. G. Blaylock, B.Sc., LL.D.....	General Manager, Consolidated Mining and Smelting Company, Trail, B.C.
C. V. Corless, M.Sc., LL.D., M.E.I.C., M.Inst.M.M.	Director and General Manager (Canada), Mond Nickel Company, Tillsonburg, Ont.
Theo. C. Denis, B.Sc.....	Superintendent of Mines, Department of Colonization, Mines and Fisheries; Quebec, Que.
J. D. Galloway, M.Sc.....	Provincial Mineralogist, Victoria, B.C.
George A. Guess, M.A.....	Professor of Metallurgical Engineering, University of Toronto, Toronto, Ont.
H. E. T. Haultain, M.I.M.M., M.E.I.C.....	Professor of Mining Engineering, University of Toronto, Toronto, Ont.
G. J. MacKay, B.Sc.....	Professor of Metallurgy, Queen's University, Kingston, Ont.
A. Mailhiot, B.Ap.Sc.....	Professor of Geology, L'Ecole Polytechnique, Montreal, Que.
W. G. McBride, B.Sc.....	Department of Mining Engineering, McGill University, Montreal, Que.
D. H. McDougall, LL.D., M.E.I.C., M.M.I.S., M.A.I.M.M.E.....	c/o McDougall Engineering Company, Ltd., 15 King Street West, Toronto, Ont.
John McLeish, B.A., F.S.S.....	Director, Mines Branch, Department of Mines, Ottawa, Ont.
J. G. Morrow, Esq.....	Inspecting Engineer, Steel Company of Canada, Limited, Hamilton, Ont.
Fraser D. Reid, B.Sc., M.E.I.C.....	Coniagas Mines, Limited, 320 Bay Street, Toronto, Ont.
J. G. Ross, Esq.....	Manager, Asbestos Corporation of Canada, Thetford Mines, Que.
F. H. Sexton, B.Sc., D.Sc., LL.D.....	President, Nova Scotia Technical College, Halifax, N.S.
Alfred Stansfield, D.Sc., A.R.S.M., M.E.I.C., F.R.S.C.....	Professor of Metallurgy, McGill University, Montreal, Que.
Edgar Stansfield, M.Sc.....	Professor of Industrial Research, University of Alberta, Edmonton, Alta.
R. H. Stewart, B.Sc.....	Consulting Mining Engineer, 717 Vancouver Block, Vancouver, B.C.
R. C. Wallace, M.A., B.Sc., Ph.D., D.Sc., F.G.S., F.R.S.C.....	President, University of Alberta, Edmonton, Alta.
O. E. S. Whiteside, M.Sc.....	General Manager, International Coal and Coke Company, Ltd., Coleman, Alta.
S. P. Eagleson, Esq., Secretary.....	Secretary-Treasurer, National Research Council, Ottawa, Ont.

Associate Committee on New Brunswick Forest Investigations

G. H. Prince, Esq., Chairman.....	Deputy Minister, Department of Lands and Mines, Fredericton, N.B.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex-officio), Ottawa, Ont.
D. Roy Cameron, B.A., B.Sc.F., M.E.I.C.....	Associate Director of Forestry, Department of the Interior, Ottawa, Ont.
W. M. Robertson, B.Sc.F.....	Forestry Branch, Department of the Interior, Ottawa, Ont.
L. S. Webb, Esq.....	Provincial Forester, Fredericton, N.B.
S. P. Eagleson, Esq., Secretary.....	Secretary-Treasurer, National Research Council, Ottawa, Ont.

Associate Committee on Nitrogen Fixation

- J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D.,
F.R.S., Chairman..... Professor of Physics, Director of the Physical
Laboratory, and Dean of the School of
Graduate Studies, University of Toronto,
Toronto, 5, Ont.
- H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C.,
F.R.H.S..... President, National Research Council, (Ex-
officio), Ottawa, Ont.
- A. Frigon, B.Sc., D.Sc., A.M.E.I.C..... Dean, Ecole Polytechnique, 1430 St. Denis
Street, Montreal, Que.
- H. W. Matheson, M.Sc..... Vice-president, Canadian Electro Products
Co., Ltd., Montreal, Que.
- F. T. Shutt, M.A., D.Sc., F.I.C., F.R.S.C..... Assistant Director and Dominion Chemist,
Experimental Farm, Ottawa, Ont.
- G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C. Director, Division of Chemistry, National
Research Council, Ottawa, Ont.
- F. E. Lathe, M.Sc., Secretary..... Director, Division of Research Information,
National Research Council, Ottawa, Ont.

Associate Committee on Oceanography

- C. McLean Fraser, M.A., Ph.D., F.R.S.C.,
Chairman and Secretary..... Professor and Head of the Department of
Zoology, University of British Columbia,
Vancouver, B.C.
- H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C.,
F.R.H.S..... President, National Research Council, (Ex-
officio), Ottawa, Ont.
- A. T. Cameron, M.A., D.Sc., F.I.C., F.C.I.C.,
F.R.S.C..... Department of Biochemistry, University of
Manitoba, Winnipeg, Man.
- W. A. Clemens, Ph.D..... Director, Pacific Biological Station, Nanaimo,
B.C.
- F. N. Denison, Esq..... Meteorological Service, Victoria, B.C.
- D. B. Finn, Esq..... Director, Pacific Experimental Station for
Fisheries, Prince Rupert, B.C.
- R. E. Foerster, B.A., M.A., Ph.D..... Dominion Government Hatcheries at Cultus
Lake, Vedder Crossing P.O., B.C.
- A. G. Huntsman, B.A., M.B..... Associate Professor of Marine Biology, Uni-
versity of Toronto, and Director, Atlantic
Experimental Station for Fisheries, Halifax,
N.S.
- A. H. Hutchinson, M.A., Ph.D..... Professor and Head of the Department of
Botany, University of British Columbia,
Vancouver, B.C.
- J. P. McMurrich, M.A., Ph.D., LL.D..... Professor of Anatomy and Director of the
Anatomical Department, University of
Toronto, Toronto, Ont.
- John Patterson, M.A., F.R.S.C..... Director, Meteorological Service, Toronto,
Ont.
- Wilfrid Sadler, B.S.A., M.Sc., N.D.D..... Department of Dairying, University of British
Columbia, Vancouver, B.C.
- Sir F. Stupart, F.R.S.C..... 15 Admiral Road, Toronto, Ont.

Associate Committee on Patents and Awards

- H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C.,
F.R.H.S., Chairman..... President, National Research Council, Ottawa,
Ont.
- Frank D. Adams, Sc.D., LL.D., F.R.S., Hon.
M.E.I.C., Hon. M.I.M.M., Hon.
M.A.I.M.M.E..... Emeritus, Vice-principal, Emeritus Dean of
the Faculty of Graduate Studies and of the
Faculty of Applied Science and Logan Pro-
fessor of Geology and Palaeontology, McGill
University, Montreal, Que.

Col. O. M. Biggar, K.C.....	Smart & Biggar, 8 O'Connor Street, Ottawa, Ont.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
A. L. Clark, B.Sc., Ph.D., F.R.S.C.....	Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.
F. J. Hambly, Esq.....	Manager, Electric Reduction Company, Buckingham, Que.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Physics and Engineering Physics

J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S., Chairman.....	Professor of Physics, Director of the Physical Laboratory, and Dean of the School of Graduate Studies, University of Toronto, Toronto, 5, Ont.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex-officio), Ottawa, Ont.
F. Allen, M.S., Ph.D., LL.D., F.R.S.C.....	Professor of Physics, University of Manitoba, Winnipeg, Man.
T. Alty, D.Sc., Ph.D.....	Professor of Physics, University of Saskatchewan, Saskatoon, Sask.
J. S. Bates, Ch.E., Ph.D., A.M.E.I.C.....	Research Engineer, Price Bros. & Co., Ltd., Quebec, Que.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Research Council, Ottawa, Ont.
D. Buchanan, M.A., Ph.D., F.R.S.C.....	Dean of the Faculty of Arts and Science, University of British Columbia, Vancouver, B.C.
E. F. Burton, B.A., Ph.D.....	Department of Physics, University of Toronto, Toronto, Ont.
K. M. Cameron, M.Sc.....	Chief Engineer, Department of Public Works, Ottawa, Ont.
S. B. Chadsey, Esq.....	Massey-Harris Co., Ltd., Tractor Department, Toronto, 2, Ont.
C. V. Christie, B.Sc., M.A.....	Professor of Electrical Engineering, McGill University, Montreal, Que.
J. L. Clarke, Esq.....	Transmission Engineer, Bell Telephone Co., 118 Notre Dame St. W., Montreal, Que.
W. P. Dobson, M.A.Sc., M.E.I.C.....	Laboratory Engineer, Hydro-electric Research Laboratories, 8 Strachan Avenue, Toronto, Ont.
W. H. Eastlake, Esq.....	General Manufacturing Department, Northern Electric Company, Ltd., 121 Shearer Street, Montreal, Que.
C. P. Edwards, O.B.E., F.I.R.E., A.M.E.I.C.....	Director of Radio, Department of Marine, Ottawa, Ont.
G. G. Gale, Esq., B.Sc.....	Canadian Hydro-electric Commission, Victoria Bldg, Ottawa, Ont.
J. A. Gray, O.B.L., B.S., D.Sc., F.R.S.C.....	Department of Physics, Queen's University, Kingston, Ont.
T. C. Hebb, M.A., B.Sc., Ph.D.....	Professor of Physics, and Head of the Department, University of British Columbia, Vancouver, B.C.
G. H. Henderson, B.A., B.Sc., M.A., Ph.D., F.R.S.C.....	Professor of Mathematical Physics, Dalhousie University, Halifax, N.S.
H. O. Keay, B.Sc., M.E.I.C.....	Consulting Engineer, Laurentide Pulp & Paper Co., Grand'Mere, Que.
D. A. Keys, M.A., Ph.D., F.R.S.C.....	Professor of Physics, McGill University, Montreal, Que.
Brig.-Gen. A. G. L. McNaughton, C.M.G., D.S.O.....	Chief of the General Staff, Department of National Defence, Ottawa, Ont.

J. H. Parkin, B.A., M.E., F.R.Ae.S., M.A.S.M.E.....	Assistant Director, Division of Physics, National Research Council, Ottawa, Ont.
H. W. Price, B.A.Sc.....	Professor of Electrical Engineering, Univer- sity of Toronto, Toronto, Ont.
R. Meldrum Stewart, M.A.....	Director, Dominion Observatory, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Radio Research

A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S., Chairman.....	Dean of the Faculty of Graduate Studies and Director, Department of Physics, McGill University, Montreal, Que.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex- officio), Ottawa, Ont.
R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.....	Director, Division of Physics, National Re- search Council, Ottawa, Ont.
C. P. Edwards, O.B.E., F.I.R.E., A.M.E.I.C.....	Director of Radio, Department of Marine, Ottawa, Ont.
A. Frigon, B.Sc., D.Sc., A.M.E.I.C., A.M.A.I.E.E.....	Dean, Ecole Polytechnique, 1430 St. Denis Street, Montreal, Que.
H. J. MacLeod, B.Sc., M.Sc., M.A., Ph.D.....	Department of Physical and Electrical En- gineering, University of Alberta, Edmon- ton, Alta.
J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S.....	Professor of Physics, Director of the Physical Laboratory and Dean of the School of Graduate Studies, University of Toronto, Toronto, 5, Ont.
A. S. Runciman, E. E.....	Superintendent of Transmission Lines, Shaw- inigan Water & Power Company, Power Building, Craig Street, W., Montreal, Que.
V. G. Smith, B.A.Sc.....	Department of Electrical Engineering, Uni- versity of Toronto, Toronto, Ont.
Lt.-Col. W. A. Steel, R.C.C.S.....	Wireless Officer, Department of National Defence, Ottawa, Ont.
H. J. Vennes, B.A.....	Transmission Engineer, Northern Electric Company, 1261 Shearer Street, Montreal, Que.
H. Vickers, M.E., M.Sc., Ph.D.....	Department of Electrical Engineering, Uni- versity of British Columbia, Vancouver, B.C.
B. G. Ballard, B.Sc., Secretary.....	Physicist, Division of Physics, National Re- search Council, Ottawa, Ont.

Associate Committee on Trail Smelter Smoke

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa Ont.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
J. H. Grisdale, B.Agr., D.Sc.A.	Deputy Minister, Department of Agriculture, Ottawa, Ont.
S. P. Eagleson, Esq.....	Secretary-Treasurer, National Research Coun- cil, Ottawa, Ont.

Associate Committee on Tuberculosis

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Joint Chairman.....	President, National Research Council, Ottawa, Ont.
--	---

J. H. Grisdale, B.Agr., D.Sc.A., Joint Chairman.....	Deputy Minister, Department of Agriculture, Ottawa, Ont.
J. A. Amyot, C.M.G., M.B.....	Deputy Minister, Department of Health, Ottawa, Ont.
J. A. Baudouin, M.D., D.P.H.....	Professor of Hygiene and Director, School of Applied Social Hygiene, University of Montreal, Montreal, Que.
Albert Dauth, M.V.....	Secretary, School of Veterinary Medicine, Montreal, Que.
J. G. FitzGerald, M.D., LL.D., F.R.S.C.....	Professor of Hygiene and Preventive Medi- cine, Director, Connaught Laboratories and School of Hygiene, University of Toronto, Toronto, Ont.
S. Hadwen, D.V.S., F.E.S.....	Director of Veterinary Science, Ontario Re- search Foundation, 47 Queen's Park, Toronto, Ont.
N. MacL. Harris, M.B.....	Chief, Laboratory of Hygiene, Department of Health, Ottawa, Ont.
H. W. Hill, M.B., M.D., D.P.H., L.M.C.C.....	Professor of Bacteriology; and of Nursing and Health, University of British Columbia, and Director of the Vancouver General Hospital Laboratories, Vancouver, B.C.
George Hilton, V.S.....	Veterinary Director General, Department of Agriculture, Ottawa, Ont.
Oskar Klotz, M.D., C.M.....	Professor of Pathology and Bacteriology, University of Toronto, Toronto, Ont.
A. B. Macallum, Ph.D., Sc.D., LL.D., F.R.S.....	Emeritus Professor of Biochemistry, McGill University, 317 Piccadilly Street, London, Ont.
D. J. MacKenzie, M.D.....	Director, Provincial Health Laboratory, Hali- fax, N.S.
C. D. McGilvray, M.D.V., D.V.Sc.....	Principal, Ontario Veterinary College Guelph. Ont.
J. C. Meakins, M.D., F.R.S.P., F.R.S.(E), F.R.S.C.....	Professor of Medicine and Director of the De- partment, Director of the University Clinic, McGill University, and Physician-in-Chief, Royal Victoria Hospital, Montreal, Que.
A. G. Nicholls, M.A., M.D., C.M., D.Sc., F.R.S.C.....	c/o Canadian Medical Association, 3640 University Street, Montreal, Que.
T. Parizeau, M.D.....	Faculty of Medicine, University of Montreal, Montreal, Que.
A. C. Rankin, C.M.G., M.D., C.M., D.P.H., M.R.C.S.....	Professor, Bacteriology and Hygiene, Director Provincial Laboratory, Dean, Faculty of Medicine, University of Alberta, Edmonton, Alta.
G. B. Reed, B.Sc., Ph.D.....	Professor of Bacteriology, Queen's University, Kingston, Ont.
A. Savage, B.S.A., D.V.M., M.R.C.V.S.....	Professor of Animal Pathology, Manitoba Agricultural College, Winnipeg, Man.
P. R. Talbot, V.S., D.V.M.....	Provincial Veterinarian, Department of Agri- culture, Edmonton, Alta.
A. Vallee, M.D.....	Professor of Pathology and Bacteriology, Laval University, Quebec, Que.
E. A. Watson, V.S.....	Chief Pathologist, Department of Agriculture, Ottawa, Ont.
R. E. Wodehouse, O.B.E., M.D., D.P.H.....	Secretary, Canadian Tuberculosis Association, Plaza Building, Ottawa, Ont.
S. P. Eagleson, Esq., Secretary.....	Secretary-Treasurer, National Research Coun- cil, Ottawa, Ont.

Associate Members

W. A. Dryden, Esq.....	Brooklin, Ont.
P. H. Moore, B.S.A.....	Superintendent, Colony Farm, Essondale, B.C.
R. R. Ness, Esq.....	Howick, Que.
D. Raymond, Esq.....	President, Windsor Hotel, Montreal, Que.
R. A. Wright, Esq.....	President, The Western Canada Live Stock Union, Drinkwater, Sask.

Associate Committee on Weed Control

Robert Newton, Ph.D., F.R.S.C., Chairman.....	Professor of Field Crops and Plant Biochemistry, University of Alberta, Edmonton, Alta.
H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S.....	President, National Research Council, (Ex-officio), Ottawa, Ont.
Geo. Batho, Esq.....	Secretary, Weeds Commission, Department of Agriculture and Immigration, Winnipeg, Man.
B. L. Emslie, Esq.....	Technical Promotion Manager, Fertilizer Division, Canadian Industries Ltd., P.O. Box 1260, Montreal, Que.
E. L. Gray, B.S.A.....	Field Crops Commissioner, Department of Agriculture, Edmonton, Alta.
A. W. Henry, B.S.A., M.S.A., Ph.D.....	Associate Professor of Plant Pathology, University of Alberta, Edmonton, Alta.
E. S. Hopkins, B.S.A., M.S.A.....	Dominion Field Husbandman, Experimental Farm, Ottawa, Ont.
L. E. Kirk, B.A., M.S.A., Ph.D.....	Professor of Field Husbandry, University of Saskatchewan, Saskatoon, Sask.
J. M. McKay, Esq.....	General Agricultural Agent, Canadian Pacific Railway, Winnipeg, Man.
G. P. McRostie, B.S.A., M.S.A., Ph.D.....	Professor of Agronomy, University of Manitoba, Winnipeg, Man.
R. E. Neidig, Ph.D.....	Consolidated Mining and Smelting Co., Trail, B.C.
J. W. Shipley, A.M., Ph.D., F.C.I.C., F.R.S.C.....	Professor of Chemistry, University of Alberta, Edmonton, Alta.
F. T. Shutt, M.A., D.Sc., F.I.C., F.R.S.C.....	Dominion Chemist, Central Experimental Farm, Ottawa, Ont.
Wesley G. Smith, B.Sc.....	Department of Agriculture, Edmonton, Alta.
Major H. G. L. Strange.....	Chairman, Educational Committee, Canadian Seed Growers' Association, Fenn, Alta.
S. H. Vigor, B.S.A.....	Field Crops Commissioner, Department of Agriculture, Regina, Sask.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Associate Committee on Wool

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Chairman.....	President, National Research Council, Ottawa, Ont.
H. Barton, B.S.A.....	Dean of the Faculty of Agriculture and Professor of Animal Husbandry, Macdonald College, Que.
Alfred Burton, Esq.....	Manager, Middlesex Mills, London, Ont.
S. Chagnon, Esq.....	Live Stock Branch, Department of Agriculture, Quebec, Que.
A. E. Craig, Esq.....	Sales Manager, Barrymore Cloth Company, 1179 King Street, West, Toronto, 2, Ont.
D. C. Dick, Esq.....	President, Textile Dyers Corporation, Cobourg, Ont.
W. H. Fairfield, M.S., LL.D.....	Superintendent, Experimental Farm, Lethbridge, Alta.
J. H. Grisdale, B.Agr., D.Sc.A.....	Deputy Minister, Department of Agriculture, Ottawa, Ont.
Major D. Hallam.....	Secretary, Canadian Woollen & Knit Goods Manufacturers' Association, 350 Bay Street, Toronto, 2, Ont.
H. W. Lundy, Esq.....	Assistant Manager, Penman's Ltd., Paris, Ont.
A. A. MacMillan, B.S.A.....	Live Stock Branch, Department of Agriculture, Ottawa, Ont.
G. E. O'Brien, Esq.....	Manager, Canadian Co-operative Wool Growers, 217 Bay Street, Toronto, Ont.

D. N. Panabaker, Esq.....	Manager, R. Forbes Company, Hespeler, Ont.
G. B. Rothwell, B.S.A.....	Dominion Animal Husbandman, Central Experimental Farm, Ottawa, Ont.
J. P. Sackville, B.S.A., M.A.....	Professor of Animal Husbandry, University of Alberta, Edmonton, Alta.
A. M. Shaw, B.S.A.....	Dean, Faculty of Agriculture, University of Saskatchewan, Saskatoon, Sask.
J. C. Steckley, B.S.A.....	Associate Professor of Animal Husbandry, Ontario Agricultural College, Guelph, Ont.
W. H. J. Tisdale, B.S.A.....	Assistant Manager, Canadian Co-operative Wool Growers, 217 Bay Street, Toronto, 2, Ont.
G. S. Whitby, M.Sc., Ph.D., A.R.C.Sc., F.R.S.C.....	Director, Division of Chemistry, National Research Council, Ottawa, Ont.
William Whitelaw, Esq.....	Guelph, Ont.
Frederick A. J. Zeidler, M.A., Ph.D., F.C.I.C.....	President and Treasurer, Dickinson Dye Works, Ltd., 69 High Park Boulevard, Toronto, Ont.
F. E. Lathe, M.Sc., Secretary.....	Director, Division of Research Information, National Research Council, Ottawa, Ont.

Executive Committee of the Fifth Pacific Science Congress

H. M. Tory, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., President.....	President, National Research Council, Ottawa, Ont.
F. D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C., Hon. M.I.M.M., Hon. M.A.I.M.M.E., Vice-president.....	Emeritus Vice-Principal, Dean of the Faculty of Graduate Studies and of the Faculty of Applied Science, and Logan Professor of Geology Palaeontology, McGill University, Montreal, Que.
L. S. Klinck, M.S.A., D.Sc., LL.D., Vice-president.....	President, University of British Columbia, Vancouver, B.C.
S. J. Cook, B.A., A.I.C., F.C.I.C., General Secretary.....	General Secretary, Fifth Pacific Science Congress, National Research Council, Ottawa, Ont.
S. P. Eagleson, Esq., Treasurer.....	Secretary-Treasurer, National Research Council, Ottawa, Ont.
R. W. Brock, M.A., LL.D., F.G.S., F.R.S.C.....	Dean, Faculty of Applied Science, University of British Columbia, Vancouver, B.C.
Chas. Camsell, B.Sc., LL.D., F.R.S.C.....	Deputy Minister, Department of Mines, Ottawa, Ont.
C. McLean Fraser, M.A., Ph.D., F.R.S.C.....	Professor of Zoology, University of British Columbia, Vancouver, B.C.
J. H. Grisdale, B.Agr., D.Sc.A.....	Deputy Minister, Department of Agriculture, Ottawa, Ont.
J. P. McMurrich, M.A., Ph.D., LL.D.....	Chairman, Biological Board of Canada, University of Toronto, Toronto, Ont.

Special Committee on Electrical Units and Regulations

R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C., Chairman.....	Director, Division of Physics, National Research Council, Ottawa.
B. G. Ballard, B.Sc.....	Assistant Research Physicist, Division of Physics, National Research Council, Ottawa
H. A. Dupré, A.C.G.I., M.I.C.E., M.E.I.C.....	Assistant Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa.
D. C. Rose, B.Sc., M.Sc., Ph.D.....	Assistant Research Physicist, Division of Physics, National Research Council, Ottawa.
J. L. Stiver, B.A.Sc.....	Director, Electricity and Gas Inspection Services, Department of Trade and Commerce, Ottawa.

INDEX

	PAGE		PAGE
Aamodt, Dr. O. S.....	19, 66	Associate Committee on Asbestos	
Absorption Spectra, Emission and.....	118	Members.....	187
Accurate Plotwork, Statistical Analysis of Data Collected by the Associate Committee on.....	25	Report.....	54
Action of Alkali on Cement and Concrete.....	133	Associate Committee on Biophysics.....	
Adams, Dr. F. D.....	11, 82	Members.....	188
Aerial Camera, Elimination of Static in the Fairchild.....	39	Report.....	56
Aeronautical Laboratories, Electrical Systems for the.....	46	Associate Committee on Botanical Survey	
Aeronautical Research.....	35	Members.....	188
Aeronautical Research, Associate Com- mittee on		Associate Committee of Chemists	
Members.....	186	Members.....	189
Report.....	50	Report.....	56
Agricultural Wastes.....	27	Associate Committee on Coal Classifica- tion and Analysis	
Air Humidity, Determination of.....	120	Members.....	189
Algae of the Maritime Provinces, Marine	132	Report.....	58
Alkali on Cement and Concrete, Action of	133	Associate Committee on Electrical Measuring Instruments	
Alkaloids, Plant.....	29	Members.....	190
Allen, Prof. F.....	88	Report.....	59
Anderson, Dr. J. A.....	13, 22	Associate Committee on Engineering Standards	
Angus, R. W.....	76	Members.....	191
Animal Diseases, Associate Committee on		Report.....	60
Members.....	186	Associate Committee on Field Crop Diseases (Western Section)	
Report.....	51	Members.....	193
Appendices.....	141	Report.....	62
Apple, Mineral Constituents of the Floral Parts and Young Fruits of the	138	Associate Committee on Gas Research	
Apple Slacks, Associate Committee on		Members.....	194
Members.....	187	Report.....	69
Appointments to the Staff.....	11	Associate Committee on Grain Research	
Asbestos.....	26	Members.....	194
Asbestos, Associate Committee on		Report.....	70
Members.....	187	Associate Committee on Heating and Insulation	
Report.....	54	Members.....	195
Ashton, M. R.....	133	Report.....	76
Assisted Researches.....	18	Associate Committee on Honey	
Assisted Researches, Summary of Re- ports on.....	112	Members.....	195
Associate Committee on Aeronautical Research		Report.....	77
Members.....	186	Associate Committee on Laundry Research	
Report.....	50	Members.....	195
Associate Committee on Animal Diseases		Report.....	79
Members.....	186	Associate Committee on Leather	
Report.....	51	Members.....	196
Associate Committee on Apple Slacks		Report.....	80
Members.....	187	Associate Committee on Magnesite.....	
		Members.....	196
		Report.....	81
		Associate Committee on Mining and Metallurgy	
		Members.....	196
		Report.....	82
		Associate Committee on New Brunswick Forest Investigations	
		Members.....	197

	PAGE		PAGE
Associate Committee on Nitrogen Fixation		Botanical Survey, Associate Committee on	
Members.....	198	Members.....	188
Report.....	84	Boyle, Dr. R. W.....	35, 56, 76, 88
Associate Committee on Oceanography		Brauns, F.....	136
Members.....	198	Building Materials, Heat Conductivity of.....	41
Report.....	86	Buildings and Equipment.....	14
Associate Committee on Patents and Awards, Members.....	198	Bulletins.....	166
Associate Committee on Physics and Engineering Physics		Bursaries, Studentships and Fellowships, Regulations Governing.....	141
Members.....	199	Burton, C. L.....	11
Report.....	87	Cambron, Dr. A.....	32
Associate Committee on Radio Research		Cameron, J.....	102
Members.....	200	Camsell, Dr. C.....	11, 83
Report.....	89	Canada, Flora of Eastern.....	126
Associate Committee on Trail Smelter Smoke		Canadian Engineering Standards Association, Publications.....	168
Members.....	200	Carbon Black.....	33
Report.....	90	Cement and Concrete, Action of Alkali on.....	133
Associate Committee on Tuberculosis		Chataway, Dr. Helen D.....	13, 28, 29
Members.....	200	Chemicals as Herbicides.....	24
Report.....	92	Chemistry, Division of.....	25
Associate Committee on Weed Control		Chemists, Associate Committee of	
Members.....	202	Members.....	189
Report.....	100	Report.....	56
Associate Committee on Wool		Clark, Dr. A. L.....	11, 122
Members.....	202	Clarke, J. L.....	88
Report.....	104	Coal Classification and Analysis, Associate Committee on	
Associate Committees.....	17	Members.....	189
Associate Committees, List of Members	186	Report.....	58
Associate Committees, Summary of Activities of.....	50	Collins, Dr. W. H.....	88
Atomic Structure, Spectroscopy and.....	117	Committee of the Privy Council on Scientific and Industrial Research.....	4
Aurora, Height of the.....	116	Composition of Wheat in Relation to Stage of Maturity and Exposure to Frost.....	23
Bacteria, Production of Polysaccharides by.....	134	Concrete, Action of Alkali on Cement and.....	133
Bain, Prof. J. W.....	89	Conference on Iodized Salt.....	110
Ballard, B. G.....	14, 45	Construction of Artificial Lighting Units Suitable for Grading Grain.....	40
Bark Diseases of the Beech.....	130	Continuity of Welded Steel Beams.....	112
Barsha, J.....	136	Cook, S. J.....	13, 47, 57
Batho, G.....	101	Cook, Dr. W. H.....	13, 22, 24, 103
Baudouin, Dr. J. A.....	99	Corn, Inheritance of Sugar and Starch in.....	125
Bayley, C. H.....	13, 32	Council, Members of the.....	4, 11
Beech, Bark Diseases of the.....	130	Craigie, Dr. J. H.....	65
Bell, Prof. H. P.....	132		
Biological Assays of Crop Residues.....	24		
Biology, Use of the Photo-electric Cell in.....	126		
Biology and Agriculture, Division of.....	22		
Biophysics, Associate Committee on			
Members.....	188		
Report.....	56		
Boomer, Dr. E. H.....	32, 58, 69		

	PAGE		PAGE
Crop Residues, Biological Assays to.....	24	Executive Committee on the Fifth Pacific Science Congress.....	106
Davis, C. W.....	26	Members.....	203
Dearle, Prof. R. C.....	18	Fairchild Aerial Camera, Elimination of Static in the.....	39
DeLong, Dr. W. A.....	18, 139	Fairfield, Dr. W. H.....	104
Denaturation of the Gluten Proteins, Preparation and.....	22	Farm Soils of Quebec, Microbiology of..	129
DesBarres, Miss D.....	49	Feed Flavor and Stable Odor in Milk...	131
Determination of Air Humidity.....	120	Fellowships, Regulations Governing.....	144
Dextrins, Ultrafiltration of the.....	136	Ferguson, Dr. R. G.....	96
Dielectrics, Power Losses in.....	119	Field, George S.....	14, 43, 44
Distillation.....	34	Field Crop Diseases (Western Section), Associate Committee on Members.....	193
Division of Biology and Agriculture.....	22	Report.....	62
Division of Chemistry.....	25	Fifth Pacific Science Congress, Executive Committee on the.....	106
Division of Physics.....	35	Financial Statement for the Fiscal Year Ending March 31, 1931.....	17
Division of Research Information.....	47	Financial Statement for 1930-1931, Summary of.....	15
Doughs, Gas Production and Retention in Wheat Flour.....	23	Fish Tapeworm, Life Cycle of the.....	123
Duff, Dr. G. H.....	91	Flora of Eastern Canada.....	126
Dunlop, R. G.....	23	Floral Parts and Young Fruits of the Apple, Mineral Constituents of the....	138
DuPorte, Dr. E. M.....	52	Floyd, L. T.....	78
Eagleson, S. P.....	17	Foreign Travelling Fellowships, Regulations Governing.....	147
Effect of Combined Electric and Magnetic Fields on Spectral Lines.....	115	Forgings, Effect of Low Temperatures on Steel Castings and.....	115
Effect of Light on Life Processes.....	123	Foster, Dr. J. S.....	116
Effect of Low Temperatures on Steel Castings and Forgings.....	115	Frigon, A.....	11
Effect of Radiant Energy on Growth....	132	Frost, Composition of Wheat in Relation to Stage of Maturity and Exposure to.....	23
Elders, Prof. A. T.....	67	Fruits of the Apple, Mineral Constituents of the Floral Parts and Young....	138
Electric and Magnetic Fields on Spectral Lines, Effect of Combined.....	115	Gas and Water Content of Trees and the Sinkage Problem.....	122
Electric Transmission Lines, Vibrations in.....	41	Gas Production and Retention in Wheat Flour Doughs.....	23
Electrical Engineering.....	45	Gas Research.....	32
Electrical Measuring Instruments, Associate Committee on Members.....	190	Gas Research, Associate Committee on Members.....	194
Report.....	59	Report.....	69
Electrical Units and Regulations, Special Committee on.....	108	Geddes, Prof. W. F.....	75, 78
Electricity by Windmills, Generation of	113	Generation of Electricity by Windmills	113
Electrons of High Energy, Scattering of	118	Gibbs, R. D.....	18, 123
Electrostatic Voltmeter, New Type.....	44	Gilchrist, Dr. L.....	88
Elimination of Static in the Fairchild Aerial Camera.....	39	Gill, A. F.....	26, 30
Emission and Absorption Spectra.....	118	Gill, Miss M. S.....	48
Emslie, B. L.....	56	Gilmore, R. E.....	59
Engineering Standards, Associate Committee on Members.....	191		
Report.....	60		

	PAGE		PAGE
Gluten Proteins, Preparation and Denaturation of the.....	22	International Activities.....	21
Gooderham, C. B.....	78	Introduction.....	7
Goulden, Dr. C. H.....	65	Iodized Salt, Conference on.....	110
Govan, J.....	77	Ireton, H. J. C.....	117
Graham, Dr. W. E.....	12, 31, 80	Irwin, M. L.....	131
Grain, Construction of Artificial Lighting Units Suitable for Grading.....	40	Joule Effect.....	121
Grain Research, Associate Committee on Members.....	194	Katz, Dr. M.....	12, 92
Report.....	70	Keys, Prof. D. A.....	114
Grants for Research, Regulations Governing the Award of.....	159	Kiess, C. C.....	118
Gray, E. L.....	101	King, Prof. H. M.....	131
Gray, Dr. J. A.....	119	Kirk, Prof. L. E.....	102, 104
Gray, Prof. P. H. H.....	18	Klein, G. J.....	35
Green, Dr. J. J.....	14, 35	Klotz, Dr. O.....	100
Greig, Prof. A. R.....	113	Klugh, Prof. A. B.....	123
Griffith, T. R.....	32	Lang, Prof. R. J.....	118
Growth, Effect of Radiant Energy on....	132	Larmour, Dr. R. K.....	76
Halferdahl, A. C.....	47, 84	Larose, Dr. Paul.....	12, 30
Hallonquist, E.....	136	Lateral Support of Steel Columns and Struts.....	112
Harrington, Dr. J. B.....	68	Lathe, F. E.....	47, 57, 83
Heat Conductivity of Building Materials.....	41	Laundering.....	31
Heating and Insulation, Associate Committee on Members.....	195	Laundry Research, Associate Committee on Members.....	195
Report.....	76	Report.....	79
Henry, Dr. A. W.....	19, 66, 102	Laurence, Dr. G. C.....	14, 42, 43
Herbicides, Chemicals as.....	24	Leather.....	31
Hibbert, Dr. H.....	57, 58, 136	Leather Research, Associate Committee on Members.....	196
High Frequency Research.....	114	Report.....	80
High Frequency Vacuum Tube Oscillator.....	44	Leopold, Rev. Father.....	53
High Voltage Laboratory.....	46	Library.....	48
Hill, Dr. H. W.....	19, 54	Life Cycle of a Fish Tapeworm.....	123
Honey.....	29	Life Processes, Effect of Light on.....	123
Honey, Associate Committee on Members.....	195	Light from the Night Sky, Spectroscopy of the.....	116
Report.....	77	Light on Life Processes, Effect of.....	123
Hopkins, Dr. C. Y.....	13, 27, 32	Lighting Units Suitable for Grading Grain, Construction of Artificial.....	40
Hopkins, J. W.....	25	Lochhead, Dr. A. G.....	77
Hopping, R.....	91	Loganberry Pulp.....	28
Humidity, Determination of Air.....	120	Lucas, C. C.....	134
Hutchinson, Dr. A. H.....	86, 133, 134	Macallum, Dr. A. B.....	57
Information Service.....	47	MacConkey, Dr. C. H.....	13, 47
Inheritance of Sugar and Starch in Corn.....	125	MacKay, Dr. B. R.....	58
Instrument and Model Shops.....	39	MacKay, H. M.....	11
		MacLeod, Prof. H. J.....	120

	PAGE		PAGE
MacMillan, A. A.....	105	Newton, Dr. R.....	22, 23, 24, 65, 73
Magnesia, Plastic.....	26	Nicolls, J. H. H.....	59
Magnesite, Associate Committee on Members.....	196	Nichols, J. E.....	104
Report.....	81	Nicholson, Dr. D.....	124
Magnetic Fields on Spectral Lines, Effect of Combined Electric and.....	115	Nitrogen Fixation, Associate Committee on Members.....	198
Malloch, Dr. J. G.....	23, 73	Report.....	84
Mallory, G. D.....	76	Niven, Dr. C. D.....	14, 41, 42
Manske, Dr. R. H. F.....	13, 29	Oceanographic Survey of the Strait of Georgia.....	134
Manson, J. M.....	25, 103	Oceanography, Associate Committee on Members.....	198
Maple Products.....	28	Report.....	86
Maple Sugar Research.....	139	Pacific Science Congress, Executive Committee on the Fifth.....	106
Marie-Victorin, Prof.....	128	Papers Covering Researches Carried Out with Assistance from the National Research Council, List of.....	169
Marine Algae of the Maritime Provinces	132	Parkin, J. H.....	21, 35, 50
Marion, Dr. L.....	28	Patents and Awards, Associate Com- mittee on, Members.....	198
McCalla, A. G.....	23	Patterson, J.....	87
McCallum, A. W.....	91	Phenolic Compounds of the Wheat Plant in Relation to Rust Resistance.....	22
McCarthy, J. M.....	11	Photo-electric Cell in Biology, Use of....	126
McKibbin, Dr. R. R.....	138	Photo-electric Effect in Metals, Soft X-ray Excitation of the.....	43
McLeish, J.....	82	Physics, Division of.....	35
McLennan, Prof. J. C. 56, 70, 87, 114, 117, 118		Physics and Engineering Physics, Asso- ciate Committee on Members.....	199
McRostie, Dr. G. P.....	19, 103	Report.....	87
Members of the Associate Committees, List of.....	186	Piezo-electric Pressure Gauge.....	113
Microbiology of Farm Soils of Quebec....	129	Pitt, N. P.....	26
Middleton, M. S.....	91	Plant Alkaloids.....	29
Milk, Feed Flavor and Stable Odor in..	131	Plastic Magnesia.....	26
Millen, F. E.....	78	Polysaccharides by Bacteria, Produc- tion of.....	134
Mineral Constituents of the Floral Parts and Young Fruits of the Apple..	138	Postgraduate Research Scholarships.....	19
Mining and Metallurgy, Associate Com- mittee on Members.....	196	Power Losses in Dielectrics.....	119
Report.....	82	Prairie, Wireworms of the Canadian.....	128
Model Shops, Instrument and.....	39	Pratten, Dr. F. H.....	96
Moffat, Prof. R. W.....	115	Preparation and Denaturation of the Gluten Proteins.....	22
Moisture Precipitation on Dust and Ions	42	Pressure Gauge, Piezo-electric.....	113
Morgan, Dr. O. M.....	12, 29, 31, 79	Price, Dr. R. M.....	100
Morrow, J. G.....	83	Production of Polysaccharides by Bacteria.....	134
National Research Council, Members....	4	Properties of Quebec Farm Soils.....	137
New Brunswick Forest Investigation, Associate Committee on Members.....	197	Publications.....	49
New Building.....	45		
Newton, Dr. J. D.....	74, 103		

	PAGE		PAGE
Publications of the Canadian Engineering Standards Association.....	168	Schorman, W. A. P.....	57
Publications of the National Research Council.....	166	Shaw, Prof. A. N.....	121
Pugsley, L. I.....	138	Shaw, Dean A. M.....	104
Putnam, D. F.....	92	Simmonds, Dr. P. M.....	69
Quebec, Microbiology of Farm Soils of	129	Sinkage Problem, Gas and Water Content of Trees and the.....	122
Quebec Farm Soils, Properties of.....	137	Skazin, L.....	28, 29
Radiant Energy on Growth, Effect of....	132	Slough Itch.....	124
Radio Research, Associate Committee on Members.....	200	Smith, J. C.....	11
Report.....	89	Smith, Prof. S.....	119
Radium Measurement.....	42	Smith, W. G.....	101
Rankin, Dr. A.....	98	Snell, Dr. J. F.....	28, 140
Reed, Dr. G. B.....	97	Soils of Quebec, Microbiology of.....	129
Regulations Governing Bursaries, Studentships and Fellowships.....	144	Soils, Properties of Quebec Farm.....	137
Regulations Governing Foreign Travelling Fellowships.....	147	Sound in Cylindrical Rods, Velocity of	44
Regulations Governing the Award of Grants for Research.....	159	Sound in Liquids Contained in Cylindrical Tubes, Velocity of.....	43
Reilley, H. E.....	77	Special Committee on Electrical Units and Regulations.....	108
Reports of Laboratory Divisions.....	22	Members.....	203
Research Council Act, Chap. 64.....	141	Special Committees and Conferences....	106
Research Information, Division of.....	47	Spectra, Emission and Absorption.....	118
Researches in Progress During 1930-1931	161	Spectral Lines, Effect of Combined Electric and Magnetic Fields on.....	115
Resins, Synthetic.....	32	Spectroscopy and Atomic Structure.....	117
Roberts, Prof. H. F.....	67, 125	Spectroscopy in the Ultra-violet.....	119
Rose, Dr. D. C.....	14, 39, 40	Spectroscopy of the Light from the Night Sky and Height of the Aurora	116
Rosell, Dr. J. M.....	52	Staff, Appointments to the.....	11
Rosewarne, P. V.....	70	Stansfield, Dr. A.....	82
Rubber.....	32	Stansfield, Prof. E.....	58, 59
Ruedy, Dr. R.....	13, 47	Static in the Fairchild Aerial Camera, Elimination of.....	39
Rust Resistance, Phenolic Compounds of the Wheat Plant in Relation to.....	22	Statistical Analysis of Data Collected by the Associate Committee on Accurate Plot Work.....	25
Ruttan, Dr. R. F.....	56	Stedman, Dr. D. F.....	13, 27, 32, 33, 34
Sackville, Prof. J. P.....	104	Steel, Lt.-Col. W. A.....	89
Sadler, Prof. W.....	131	Steel Beams, Continuity of Welded.....	112
Salt, Conference on Iodized.....	110	Steel Castings and Forgings, Effect of Low Temperatures on.....	115
Sanford, Dr. G. B.....	67	Steel Columns and Struts, Lateral Support of.....	112
Saunders, Dr. L. G.....	18, 125	Stevens, Hon. H. H.....	3
Savage, Prof. A.....	126	Stewart, R. H.....	83
Scarth, Prof. G. W.....	123	Stone Preservatives, Water-proofing Qualities of Certain.....	41
Scattering of Electrons of High Energy	118	Strait of Georgia, An Oceanographic Survey of the.....	134
Schierbeck, O.....	18, 131	Straw.....	28
Scholarship Graduates.....	153		
Scholarships Held During the Year 1930-1931.....	149		

	PAGE		PAGE
Strickland, Prof. E. H.....	129	Velocity of Sound in Cylindrical Rods....	44
Struts, Lateral Support of Steel Columns and.....	112	Velocity of Sound in Liquids Contained in Cylindrical Tubes.....	43
Studentships, Regulations Governing....	144	Vibrations in Electric Transmission Lines.....	41
Summary of Activities of Associate Committees.....	50	Vigor, S. H.....	102
Summary of Financial Statement for 1930-1931.....	15	Voltmeter, New Type Electrostatic.....	44
Summary of Reports on Assisted Researches.....	112	Walley, R. J.....	56
Synthetic Resins.....	32	Wardle, Prof. R. A.....	18
Tapeworm, Life Cycle of the Fish.....	123	Wardleworth, T. H.....	57
Tarr, H. L. A.....	136	Water Content of Trees and the Sinkage Problem, Gas and.....	122
Tasker, L.....	59	Water-proofing Qualities of Certain Stone Preservatives.....	41
Technical Reports.....	166	Watson, Dr. C. J.....	79
Thermometer Standardization Equip- ment.....	42	Watson, Dr. E. A.....	95
Thompson, Dr. W. P.....	68	Weed Control, Associate Committee on Members.....	202
Thomson, Dr. W. W.....	13, 49	Report.....	100
Thorvaldson, Dr. T.....	76, 133	Weed Seeds.....	27
Tipson, R. S.....	136	Weed Survey of the Prairie Provinces...	25
Tory, Dr. H. M.....	3, 56, 106	Welded Steel Beams, Continuity of.....	112
Trail Smelter Smoke, Associate Com- mittee on		Whalley, Miss M. E.....	47
Members.....	200	Wheat Flour Doughs, Gas Production and Retention in.....	23
Report.....	90	Wheat in Relation to Stage of Maturity and Exposure to Frost, Composition of.....	23
Transmission of an Ultrasonic Beam Through Air.....	44	Whitby, Dr. G. S.....	25, 55, 56, 70, 79, 80, 92
Trees, Gas and Water Content of.....	122	Willoughby, Miss D. Y.....	48
Tuberculosis Research, Associate Committee on		Windmills, Generation of Electricity by	113
Members.....	200	Wireworms of the Canadian Prairies.....	128
Report.....	92	Wolochow, D.....	12, 26, 55
Tupper, K. F.....	35	Wool.....	30
Tweedie, Miss A. S.....	30	Wool, Associate Committee on Members.....	202
Twohey, Miss E.....	48	Wynne-Edwards, H. S.....	117
Ultrafiltration of the Dextrins.....	136	X-ray Excitation of the Photo-electric Effect in Metals, Soft.....	43
Ultrasonic Beam Through Air, Trans- mission of an.....	44	Young, Prof. C. R.....	112, 113
Ultra-violet, Spectroscopy in the.....	119	Young, Prof. E. G.....	137
Use of the Photo-electric Cell in Biology	126	Young, R. S.....	24
Vacuum Tube Oscillator, High Frequency.....	44		
Vanterpool, Prof. T. C.....	68		



