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DOMINION OF CANADA

SEVENTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

AND

FINANCIAL STATEMENT



1933 - 1934

OTTAWA, CANADA

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The HON. R. B. HANSON,

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

SIR:

I have the honor of presenting to you herewith the Seventeenth Annual Report of the National Research Council, for the fiscal year 1933-1934.

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.

23732

THE COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

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MINISTER OF FINANCE
MINISTER OF MINES
MINISTER OF AGRICULTURE
MINISTER OF PENSIONS AND NATIONAL HEALTH
MINISTER OF LABOR
MINISTER OF NATIONAL DEFENCE

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- A. S. MACKENZIE, Ph.D., D.C.L., LL.D., F.R.S.C., 25 Kent St., Halifax, N.S.
- JULIAN C. SMITH, M.E., LL.D., Shawinigan Water and Power Co., 611 Power Building, Montreal, Que.
- JOHN STEPHENS, M.A., M.A.I., D.Sc., M.E.I.C., Professor of Mechanical Engineering and Drawing, University of New Brunswick, Fredericton, N.B.
- M. L'ABBÉ ALEXANDRE VACHON, M.A., L. en Ph. et Th., Director, Ecole Supérieure de Chimie, Université Laval, Quebec, Que.
- R. C. WALLACE, M.A., Ph.D., D.Sc., LL.D., F.G.S., F.R.S.C., President, University of Alberta, Edmonton, Alta.

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SEVENTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

REVIEW OF THE ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL

Introduction

On March 31, 1934, the National Research Council completed the seventeenth year of its existence. In the last annual report reference was made to the fact that during the year the new laboratories of the Council had been formally opened and work started therein. During the year under review the equipping and furnishing of these laboratories, a difficult and tedious task, has been continued and has necessarily absorbed a considerable portion of the time of the technical staff, limiting somewhat the time devoted to research problems. The situation in this regard was rendered more difficult by the fact that lack of sufficient junior laboratory assistants caused larger demands on the time of the research staff than could otherwise be justified.

The research work carried on under the authority of the Council during the year can be classified as follows:—

- I. Researches conducted in the National Research Laboratories.
- II. Researches conducted under associate committees, assisted researches in university and other laboratories, and under scholarships.
- III. Analysis and testing, conducted in the National Research Laboratories.
- IV. Reports prepared for individuals and business organizations, necessitating examination of scientific literature; and replies to inquiries for scientific information.

I. Researches Conducted in the National Research Laboratories

During the year 87 researches, including those reported last year as unfinished, have been under way in the National Research Laboratories. Thirty-four were completed; substantial progress was made in 16 others; the remainder, mainly new undertakings, are in the early stages of their development. The work on the incomplete researches is being continued as rapidly as time and opportunity permit. Some of the researches completed have a direct bearing on the utilization commercially of certain of our natural resources, others apply to the perfection of processes already in use, while others have a direct relation to agriculture and the industries related thereto. Plans for the commercial development of some of these results are being undertaken.

Among the completed researches might be mentioned the following: the defrosting of refrigerated products; the suitability of Canadian clays for oil refining; the bonding of rubber to metal; the mechanization and standardization of baking tests; a stream-lined locomotive; the chemical investigation of Canadian weeds poisonous to livestock; a comparative

study of the suitability of Canadian wools for the manufacture of cloth; the determination of more efficient and economical procedure for power laundries in the washing of cotton fabrics; a refractory lining for steel furnaces; a new refractory brick designed to stand severe metallurgical conditions; some new and very promising results in connection with the magnesian products industry have been obtained; the investigation of certain problems in connection with the stability of aircraft floats has been completed for the Department of National Defence; a photoelectric method of determining the velocity of projectiles has been devised and its application to the practical measurement of such velocities has been demonstrated; a new type of apparatus for baking tests which can be applied to small quantities of grain has been perfected, which will result in a great saving in time in plant breeding operations; a study has been completed on the causes of premature seeding in turnips; tests to determine the better of two models of proposed preventative patrol cruisers for the R.C.M.P. have been completed and put to practical use; a research to determine the cause and to correct the instability in aircraft used for photographic survey work has been finished and will be put to use by the Air Force.

Among those researches on which substantial progress has been made might be mentioned: a new method for the preparation of carbon black from natural gas; the preparation of new forms of maple products, with the object of creating an enlarged market for that commodity (practical application is now being made of some new processes devised); the preparation of a bitumen suitable for use in the rubber industry from the natural bitumen from Alberta; certain new processes in connection with the problems of the asbestos industry have been practically completed; investigation of certain problems in connection with the tanning industry; a more economical method of distillation to be applied in the oil industry; the development of an apparatus for the study of plant growth under controlled conditions; the effect of aging and heat treatment on seeds; a systematic study of the wheat plant in the hope of finding significant compounds.

A complete statement of the situation in all of these investigations has been prepared and submitted to the Council, stating in each case the subject of research, the purpose for which it was undertaken, the progress made and the results obtained. Further discussion will be found in other sections of this report.

II. Researches Conducted under Associate Committees, Assisted Researches in University and other Laboratories, and under Scholarships

A. Associate Committees

The ramifications of the work done under associate committees are indicated by the number of bodies co-operating with the Council. These include the Federal Department of Agriculture, the Canadian Society of Technical Agriculturists, Macdonald College, the Nova Scotia Agricultural College, Oka Agricultural Institute, the Ontario Agricultural College, the University of Alberta, the University of British Columbia, the University of Manitoba, the University of Saskatchewan, the Canadian asbestos producers and manufacturers, the Federal Department of Mines, the Quebec Department of Mines, the Canadian Engineering Standards Association, the Board of Grain Commissioners for Canada, McGill University, Queen's University, Toronto University, the Department of National Defence, the Eastern Canadian Laundryowners' Association, the British Leather Manufacturers' Research Association, the Tanners' Association of Canada, the Imperial Bureau of Agricultural Parasitology, Fort Qu'Appelle Indian Health Unit, the Queen Alexandra Sanatorium, the Canadian Marconi Company,

the Canadian Radio Broadcasting Commission, the Department of Marine, the Department of the Interior, the Canadian Co-operative Wool Growers, the British Wool Industries Research Association, the Canadian Woollen and Knit Goods Manufacturers Association. Representatives of most of these organizations serve on one or more of the Council's research committees. Under these committees large researches are undertaken which would not be possible for a single individual or for a group representing a single science. Further, in this way the services of scientific bodies and personnel are utilized in the solution of problems at the minimum of cost to the country.

The following list of subjects on which research is being conducted under these committees will indicate somewhat the scope of their work: the study of methods for combating losses due to animal diseases; the improvement of methods of standardizing and conditioning asbestos and the development of new uses for asbestos and the associated waste material; the scientific study of those phases of coal composition and testing related to coal classification and the determination of the uses to which Canadian coal can be put most profitably; the study of methods for reducing the losses due to plant diseases; the determination of possible commercial products from the gas now being wasted in the process of making gasoline in Turner Valley; a unified program of research on wheat and wheat quality in the prairie provinces; a study of the value of the various insulating materials on the market in Canada and the possible production of suitable products from Canadian materials; the development of commercial products from the magnesian minerals in Canada; a study of the incidence of dangerous parasites in the livestock and in the wild life of Canada in order to establish methods of control; a study of the whole problem of the prevention of tuberculosis in man and animals and especially to determine the value of B.C.G. vaccine for the prevention of this disease; a study of the distribution of the most destructive weeds occurring in Canada in order to provide, if possible, methods for their eradication; determination of the relative value of Canadian wools in comparison with wools imported from other countries; a determination of the methods of improving the quality of Canadian wool with a view to its more extensive uses by Canadian manufacturers, etc.

A complete statement of researches carried on under associate committees and of the progress made to date will be found beginning on page 63 of this report.

B. Assisted Researches

During the year grants in aid of research were made to 13 professors who applied for assistance in connection with researches which were being conducted in their own laboratories. The subject of research in each instance was approved by the Council. It is regretted that many applications that were worthy of the support of the Council had to be refused because of the financial position of the Council. It is hoped that in the near future grants in aid of research in this way can be put once again upon the same basis as they were a few years ago. A statement of work done under these grants will be found beginning on page 111 of this report.

C. Scholarships

During the year 17 students held scholarships under the Council. Of these, six were bursaries, six were studentships and five were fellowships. It is regretted that financial conditions are responsible for a great reduction in the number of grants to graduate students pursuing their studies under the Council, and it is hoped that in this connection also it may be possible, in the near future, to restore the situation to where it was a few years ago.

A complete list of scholarships awarded and the subjects of research will be found beginning on page 117 of this report.

III. Analysis and Testing, Conducted in the National Research Laboratories

A major phase of the work of the National Research Laboratories is that of the analysis and testing of a variety of products. In the main, these are related to researches in progress. One laboratory of the Division of Chemistry is wholly devoted to this work. In addition to work relating to researches, testing in relation to the standardizing activities of the Council, at the request of government departments and commercial firms who desire to establish the quality of their materials, has grown to be an important part of the work of the Division of Physics and Engineering. The following will indicate the type of work now being carried on: type approval testing of electric meters, for the Gas and Electricity Inspection Service; the precision calibration of electrical instruments for universities, public utilities, power companies, etc.; standardizing surveyor's tapes and allied measures for government departments and the public; the systematic checking of lengths of laboratory standards; standardizing cement and other sieves; testing and adjusting surveying instruments and air cameras; testing photographic shutters and measuring the constants on air cameras; standardizing hydrometers of all kinds for government departments and the public; standardizing thermometers of all kinds for government departments and the public; temperature calibrations of measures for the Weights and Measures Inspection Service; measurement of power of windmill used to drive agitator of insecticide hopper for aircraft dusting; testing to determine the content, leakage and contamination of radium tubes and plaques; intercomparison of radium standards to keep the National Research Council working standards precise and up-to-date; time rating of watches and chronometers; inductance and capacity determinations, for the Radio Broadcasting Commission, radio companies, universities and others; determination of heat insulation qualities of commercial building materials; temperature standardization in either the platinum resistance or thermocouple ranges; testing of various optical instruments and devices for government departments and companies; installing and testing various electrical devices for all the divisions of the National Research Laboratories; testing aviation fuel for the Department of National Defence; testing aircraft engine lubricating oil for the Department of National Defence; the calibration or repair of some 261 aircraft and allied instruments for government departments and 32 for commercial firms; calibration of the official Dominion Meteorological Service anemometer; the study of 29 inventions in the Division of Physics and Engineering in order to give the inventors an opinion on their value; testing thorium and uranium in the radium-bearing ore from Great Bear Lake for mesothorium and other impurities; a great variety of analyses of cements, clays, pigments, soaps, etc. This activity of the Council is destined to grow greatly if methods of standardization are developed as expected.

IV. Reports Prepared for Individuals and Business Organizations

During the year under review the demands made upon the Division of Research Information have grown to such proportions as to make additions to the staff of this division in the near future an absolute necessity. Over 100 reports of a technical character dealing with industrial problems have been prepared for members of our own technical staff, individuals interested in agricultural and industrial development and business organizations requiring technical help. The intensive examination of the literature of any technical subject requires time, technical skill and understanding and in most cases a knowledge of the major European languages. Into this division come

for review most of the major scientific journals published in Europe and America, having relation to the work of the three laboratory divisions; namely, Physics and Engineering, Chemistry, and Biology and Agriculture. The subjects dealt with are related not only to the progress of pure science but also to the development of science in industry in so far as industrial organizations permit of publication. While some of the reports mentioned above were short and related to problems of no special difficulty, many of them were of an exceedingly technical character requiring an intensive review of a large amount of literature, resulting in reports of considerable length.

In addition, the Division of Research Information is responsible for the Canadian Journal of Research, twelve issues of which were published during the year under review. The editorial work connected with this publication is a task of major importance and responsibility.

Finally, during the year, 28 scientific papers were published by members of the Research Council staff in the Canadian Journal of Research and 22 papers in other journals, Canadian and foreign. In addition, approximately 3,000 inquiries from individuals and business firms were answered by letter, some of these requiring an intensive study of literature and technical investigation. Over 3,000 tests were made on materials submitted by government departments and business firms. Tests for commercial firms are undertaken only where the test is related to some phase of an investigation in which the Council is interested, but not where the work could be as well done by ordinary commercial laboratories.

In presenting this report attention is called to the fact that the Council had its staff only partially organized when the economic depression began and it has been carrying on, with increased demands in every branch of its activities, with \$125,000 less than was available before the new laboratories were opened. This is not mentioned as a complaint for the circumstances are thoroughly understood and appreciated. The full benefit of the work which the Council is striving to do cannot, however, be realized until a much enlarged staff is available. The present staff has worked enthusiastically and faithfully under a serious handicap for want of junior assistants and competent laboratory technicians. That so much has been accomplished is deeply appreciated.

Outlook

The progress of the work in the laboratories, a consideration of the inquiries received, the growing body of information being accumulated concerning the natural resources of Canada and the possibilities in regard to the expansion of old and the establishment of new Canadian industries, are all continually disclosing new lines of investigation which could be followed up with advantage to the future of Canada. The present financial conditions, however, have put a definite limit upon the work which can be undertaken. The laboratory staff has continued to devote itself enthusiastically to the research projects in hand with the result, as the details in later pages of this report will show, that highly creditable progress has been made during the year.

Looking to the future, it is suggested that every indication points to an even more intensive application of science to industry, including agriculture, than in the past. This will apply not only to the better understanding of the materials entering into industry and their possible improvement, but also to the training of men who will be in technical control. Standardization will also play a most important part. There is the further fact that in all probability for a period at least the doctrine of national self-sufficiency will be an

important factor in determining economic policies and that consequently advantage will lie with those countries possessing important natural resources which are in a position to use them most economically.

I. A Survey of Resources

Using past experience as a guide it is suggested that until a systematic attempt is made to see our natural resources as a whole in relation to our own requirements and the world's demands, we must of necessity work more or less in the dark. Our present methods of industrial development have not only resulted in a great deal of haphazard effort, waste of energy, and material loss, but have resulted in a large proportion of attempts at industrial development failing in the first instance for lack of knowledge. As a consequence new and substantial developments have often been hindered for lack of confidence growing out of previous failures. It has been estimated that the ratio of successes to failures has been not more than one in four and in many cases success has followed only after bitter experience and a final resort to more efficient technical methods. This is especially true of industry resting on science. It would appear, therefore, that one of the first problems to be undertaken is an intensive study of the known natural resources of the country with a view to determining their possible development (*a*) to meet our own internal requirements, (*b*) to provide for the extension of our external trade, (*c*) to serve as a basis for research to meet the foregoing requirements. This would necessitate a careful study of all available reports and other sources of information, followed by surveys where necessary. It is believed that federal government departments, the universities and provincial organizations would co-operate to this end and that the preliminary steps could be undertaken at small cost. Work could be begun in those provinces where the need is greatest.

II. Research for the Construction Industry

For some time past urgent representations have been made to the National Research Council from organizations and individuals concerned with the welfare of the building and construction industry in Canada, regarding the present lack of and the necessity for research in this country on problems of that industry. Formal petitions that such work be undertaken have been received from the Canadian Construction Association, the Royal Architectural Institute, the Canadian Hospital Council and the Canadian Manufacturers Association. These petitions point out, among other things, that the construction industry is the third largest in magnitude and importance in Canada; that only meagre scientific data are available regarding materials and practices used in construction in the Dominion; that the lack of suitable facilities in Canada encourages the use of foreign bureaux which adversely affects the use of Canadian materials; that bureaux in the U.S.A., England, or Germany cannot adequately serve the Canadian construction industry since much of the information available is not applicable to Canadian conditions; that the main physical difference between the Dominion as it is today and as it will be a century from now will be the result of construction, and that the establishment of a laboratory for the study of the quality of building materials and equipment would be most conducive to economy and increased efficiency in construction.

The National Research Council has expressed the opinion that work should be undertaken in this field at the earliest possible moment, and that the necessary expenditure would be extremely small compared with the benefits derived both by the construction industry and the public generally.

It is hardly necessary to state that in no phase of industrial activity has greater change taken place in recent years than in the construction industry,

especially in regard to the materials used. This has given rise to a new set of problems associated with the industry for which no systematic solution has been sought in Canada. These include standardization of materials to reduce cost of production, suitability of materials for special uses, ventilation, heating, lighting and other factors affecting the health and happiness of those who dwell and work in buildings.

Much work has been done in other countries where, as stated above, climatic and other causes make the information unsuitable for Canadian conditions. An important part of such work is devoted to the question of the comfort of the users, another part to the type and quantity of materials to be used in construction, and a third part to the reduction of costs of production, especially to bring the cost of suitable housing into relation to community needs.

It will be urged that this is a legitimate field for private enterprise. It is not contended that such is not the case, but in so far as private enterprise must of necessity confine itself to such activities as can be put on a profit-making basis, it is suggested that the public interest is sufficiently great to warrant a full share of the associated research work being assumed as a public responsibility. In the final analysis private enterprise cannot be expected, in a country like ours, to make itself responsible for the accumulation of knowledge vitally necessary to the comfort and happiness of a whole people. In Great Britain a systematic study of every phase of the construction industry has been undertaken by the Department of Scientific and Industrial Research at public expense at an approximate cost of £40,000 per year. The need is just as great in Canada.

III. Agricultural Wastes

In a previous report attention was called to the fact that a survey had been made of existing agricultural wastes with a view to determining whether, by research, these wastes could be utilized in a manner profitable to the farming community. Some of the problems that were suggested for solution by this inquiry are of major importance and would take some years of study. A beginning has been made on several such problems but until financial conditions make it possible to employ additional highly trained specialists and to secure the necessary rather expensive equipment, great progress cannot be very well looked for. In such major researches quick results cannot be expected, but it cannot be doubted that the accruing benefit in the long run would more than compensate for the time and money spent.

An illustration of this is seen in a new fabric recently put upon the market in Great Britain, "creaseless cotton." The head of the firm interested in the business employed two scientists, a physicist and a chemist. In a recent book Professor Julian Huxley tells the story thus: "He took in one hand a piece of wool fabric, in the other a piece of cotton fabric of the same size and weight and crumpled both pieces into a ball. Then he opened his hands again. The wool, with its natural elasticity uncreased itself but the cotton stayed crumpled. 'I want you,' he said, 'to make cotton fabric which will behave like wool. Take ten years if you like.' They tried everything from India rubber and back again. Eventually they got a synthetic substance whose molecules would slip nicely into the cotton fabrics and give them elasticity." It took 14 years before the new fabric was on the market but it was a tremendously profitable research, a good illustration of what time and the application of scientific methods will do.

As an illustration of a short-time result, one might quote the Council's experience in connection with the magnesian products research, where,

although the investigation is still going on, within one year results were obtained which were of material benefit to the industry and made possible its continuance.

IV. Standardization

The movement for standardization which began in the 80's of the last century and which has assumed national proportions in every industrial nation—intensely so in Japan—will play a much more important part in industry in the future than in the past. The creation of industrial standards, as distinguished from fundamental standards, began in 1901 in Great Britain with the founding of the British Engineering Standards Association, supported by the Board of Trade, the industries concerned, and with the scientific support of the National Physical Laboratory. Since that time there has been a rapid organization of commercial standardizing bodies in all the industrial nations of the world, looking to the establishment of standards of quality, measurement and performance. At the present time, 20 nations—namely, Netherlands, Germany, United States, Switzerland, France, Belgium, Canada, Austria, Italy, Japan, Hungary, Australia, Sweden, Czechoslovakia, Norway, Poland, Finland, Russia, Denmark and Rumania—have organized industrial standards associations and 12 other countries are now in the process of being organized.

Running parallel with this development has been the rise of research councils, part of their responsibility being the maintaining of standards, co-ordinating standardization efforts and carrying on research in relation thereto. These have been developed in Great Britain, United States, Germany (recently re-organized on lines similar to the Canadian organization), France, Italy, Japan, Russia, Canada, Australia, New Zealand, and other countries.

Briefly, some of the major practical purposes of the standardization movement are:—

- (1) To aid accuracy in industry through uniform and correct measures;
- (2) To assist commerce in size standardization of containers and products;
- (3) To promote justice in daily trade through systematic inspection and regulation;
- (4) To furnish an efficient control for industrial processes in securing reproducible and uniformly high quality in output;
- (5) To secure high utility in the products of industry by setting an attainable standard of quality;
- (6) To furnish a scientific basis for fair dealing to avoid disputes or settle differences;
- (7) To promote truthful branding and advertising by suitable standards and methods of test;
- (8) To promote precision and avoid waste in science and industry by affording quality standards by which materials may be made, sold and tested;
- (9) To clarify the understanding between maker, seller, buyer, and user as to operative efficiency of appliances and machines, thus making exact knowledge the basis of the buyer's choice;
- (10) To insure effective design and installation of utilities of all kinds;
- (11) To promote safety, efficiency, and convenience in the maintenance and operation of such utilities.

For some years good work has been done in Canada by the Canadian Engineering Standards Association, a corporation of industrial concerns organized for the purpose "of co-ordinating the efforts of producers and consumers for the improvement and standardization of engineering products." On the passage of the Research Council Act in 1924, the Council became the official standardizing agency of the Government of Canada. In order to secure the co-operation of the Canadian Engineering Standards Association, the main committee of that body was made an associate committee of the Council, and has upon it representatives of the National Research Council.

At the last Imperial Conference recommendations were made looking to the establishment of commodity standards in each of the Dominions, thus facilitating the exchange of products of recognized quality. The aim was not to make a set of standards in the Dominions identical with those in Great Britain unless it was perfectly feasible so to do. The desire was to make possible purchase on the basis of a standard of quality which each would recognize. In Great Britain the British Standards Institution has been given the right to use as a trade mark the title "British Standard," and the suggestion was made that corresponding positions should be taken by the standards organizations in the Dominions, so that "British Standard," "Canadian Standard," "Australian Standard," etc., would become an assurance of quality.

Since that time two steps have been taken by the National Research Council of Canada: (1) An Associate Committee on Chemical Standards has been appointed and negotiations have begun with the chemical industries of the country, looking to action in the direction suggested. An examination is now being made of the chemical standards in use in comparison with those of other countries. (2) Later in the year a survey was made of the departmental specifications now in use in the various government departments, looking to the establishment of common standard specifications for government purchasing. As a result of the inquiry all the departments have consented to the establishment of a committee for the purpose of drafting government purchasing specifications. This effort is now being organized and will go forward as rapidly as possible. It is believed that by this means the cost of materials purchased by the Government can be greatly reduced without adversely affecting the producers of the materials purchased. In Great Britain and the United States it is an established practice for government departments to purchase according to specifications in order that they may secure the maximum value for the money spent. It has been estimated that savings amounting to \$100,000,000 annually have been made by the Federal Government of the United States by buying on specification, and that a like proportion of savings could be made by the small purchaser under the same conditions. The real problem is the establishment of specifications in which the consumer's as well as the producer's point of view will be recognized.

The advantages accruing to the producing as well as the consuming public from a proper scheme of standardization are no longer disputed by anyone cognizant of the facts. The Society of Automotive Engineers of the United States has estimated that the adoption of standards with respect to materials, parts and methods saves the United States automobile industry more than \$750,000,000 annually, a fair share of which is participated in by the purchasers of automobiles. This is almost wholly due to the production of individual parts on a mass scale. A manufacturer of parts supplying twenty or more automobile companies, by inducing them to accept the same pattern, stated that he was enabled to cut his price in half and still have a larger profit; while one of the companies buying from him saved \$4,000,000 a year.

Entire industries in Great Britain and also in the United States are now co-operating to simplify their products and eliminate superfluous variety so as to meet the pressure of competition. In the United States, for example, there has been a reduction of 93% in the number of types of paving bricks produced, 81% in the number of types of metal laths, 92% in the sizes of milk bottles, 88% in the sizes of hot water storage tanks, and other similar reductions covering a large group of commodities in common use in the country.

The reason for stating the above in this report is that if steps are taken in the direction of general commodity standards in Canada, as doubtless will be the case, under an established authority, it is evident that much technical work, including analysis and testing, will have to be undertaken in the National Research Laboratories.

The situation in Canada is complicated by the fact that certain authority with regard to specification has been exercised by provincial and local authorities. It is hoped that during the coming year conferences between provincial and local authorities and the National Research Council may be held, looking to co-operative action in the establishment of specifications and codes to be used in common in the whole of Canada, especially in connection with hazardous equipment, material and machines.

Membership of the Council

The term of appointment of the following members of the National Research Council expired on March 31, 1933, in accordance with the provision in the Research Council Act requiring that appointments be for a period of three years:—

Charles L. Burton, Esq., President, Robert Simpson Company, Limited, Toronto, Ontario.

Charles Camsell, B.Sc., LL.D., F.R.S.C., Deputy Minister, Department of Mines, Ottawa, Ontario.

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, Ontario.

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 St., Montreal, Quebec.

Julian C. Smith, M.E., LL.D., Shawinigan Water and Power Company, 611 Power Building, Montreal, Quebec.

After careful consideration of a long list of persons suggested by the National Research Council, and others suitable for appointment to these vacancies, the Subcommittee of the Privy Council on Scientific and Industrial Research recommended to the Government the appointment of Dr. G. S. H. Barton, Deputy Minister, Department of Agriculture, Ottawa, and the re-appointment of Dr. Charles Camsell, Dr. A. L. Clark, Dr. A. Frigon and Dr. Julian Smith, for a term of three years. The appointments were made.

Staff

Resignations

During the year the services of one member of the professional staff were lost to the Council. Mr. K. A. MacKinnon, B.Sc., resigned his position in the Division of Physics and Engineering to become a member of the technical staff of the Canadian Radio Broadcasting Commission.

Appointments

At the end of the year under review the professional staff of the National Research Laboratories totaled 58; of these, 30 are holders of the doctor's degree in science. Every appointment on the Council's professional staff has been made after a thorough inquiry as to technical qualifications, experience and fitness for the particular task to which the individual was to be assigned.

The following appointments were made during the year:—

John T. Henderson, B.Sc., 1927, McGill University; M.Sc., 1928, McGill University; Ph.D., 1932, University of London, England; holder of the Delta Upsilon Memorial Scholarship, 1929, and the Quebec Provincial Scholarship 1930–33, was appointed to the staff of the Division of Physics and Engineering. After receiving his master's degree in Mathematics and Physics at McGill University, Dr. Henderson took postgraduate work and research under Professor Appleton at King's College, London, where he received his Ph.D. degree. He then spent 1½ years of research in the Radio Station at Slough, England, and some time at the Sorbonne in Paris and the Technische Hochschule, in München. Dr. Henderson superintended the preparation of the National Research Council stations for the radio observations in the solar eclipse of 1932 and had charge, in person, of the station at Vankleek Hill.

J. Stuart Johnson, B.Sc. (electrical engineering), was graduated from the University of New Brunswick in 1933. After graduation he was engaged as assistant to the professors in the mechanical and electrical laboratories of the University. He was appointed to the Electrical Measurement Laboratory of the Division of Physics and Engineering in January, 1934.

Apprenticeships

During the year a number of applications came to the Council from graduates of technical schools and the universities to enter the laboratories to work as apprentices. Most of the applicants were young men who had sought and failed to obtain employment and who desired to improve themselves as much as possible, looking to future employment. After careful consideration it was decided to take a number of such young men into the laboratories on an appointment of six months, with the right of reappointment for another six months if their work proved satisfactory, the conditions being as follows:—

1. That they would observe the same hours as the permanent laboratory staff.
2. That no right of future employment was established.
3. That either party could terminate the arrangement without notice.
4. That the Council would not be responsible in case of injury.

In order that they might ensure to these students compensation by way of improvement, commensurate with the work they would do in the laboratories, vocational guidance was organized by the members of the staff so that a regular toll of reading and study was made possible to those serving under the scheme. Fifty persons entered the laboratories and worked for part or the whole year under this arrangement. Many of those who took their first six months' apprenticeship applied to continue for an additional six months. Without question the plan worked out to the mutual advantage of both parties to the agreement. Much work was accomplished in the laboratories because of the presence of these men that could not otherwise have been accomplished and at the same time they assured the Council that they had received benefits commensurate with the time of service.

Fifth Pacific Science Congress

During the year it was decided that the Fifth Pacific Science Congress which was to have been held in Vancouver and Victoria in 1932 on the invitation of the Government of Canada would be convened in June, 1933. The responsibility for the program and the arrangements of the meeting rested upon the Council. A committee consisting of the following was appointed with the responsibility of carrying out the arrangements:—

- H. M. Tory, President, National Research Council, Ottawa, Ontario.
- F. D. Adams, Emeritus Vice-Principal, Emeritus Dean, Faculty of Graduate Studies and of the Faculty of Applied Science, and Logan Professor of Geology and Palaeontology, McGill University, Montreal, Que.
- L. S. Klinck, President, University of British Columbia, Vancouver, B.C.
- S. J. Cook, Division of Research Information, National Research Council, Ottawa, Ont.
- S. P. Eagleson, Secretary-Treasurer, National Research Council, Ottawa, Ont.
- H. Barton, Deputy Minister of Agriculture, Ottawa, Ont.
- R. W. Brock, Dean, Faculty of Applied Science, University of British Columbia, Vancouver, B.C.
- Chas. Camsell, Deputy Minister, Department of Mines, Ottawa, Ont.
- C. McLean Fraser, Professor of Zoology, University of British Columbia, Vancouver, B.C.
- F. E. Lathe, Director, Division of Research Information, National Research Council, Ottawa, Ont.
- J. P. McMurrich, Professor Emeritus of Anatomy, University of Toronto, and Chairman, Biological Board of Canada.
- H. H. Rowatt, Deputy Minister of the Interior and Commissioner of the North West Territories, Ottawa, Ont.

The first five members listed above were officials of the Congress.

The congress was attended by 409 persons representing 17 countries in the Pacific area and lasted for two weeks, from June 1 to 14, 1933. More than 500 papers were presented at the various sections of the Congress. Following the congress a tour was made of British Columbia and part of Alberta, during which visits were made to their major industries. It is believed that not only was the cause of science advanced by the congress but that a basis of mutual understanding between the nations concerned was established, and that commercial contacts were made that will be useful to Canada and other countries represented at the congress.

A full report of what took place will be found on page 108 of this report.

Intercommonwealth Affiliations

During the year the affiliations with the British Wool Industries Research Association, the British Leather Manufacturers Research Association and the British Linen Industry Research Association have been maintained as in previous years. On the closing down of the Empire Marketing Board an additional obligation in connection with the responsibilities of the Empire Marketing Board in Canada was undertaken by the National Research Council, and pending a further conference on research between Great Britain and the Dominions the present arrangement will continue.

Interdepartmental Co-operation

It is a pleasure to report that there has been a steady growth of co-operation between the National Research Council and the various other departments of government; for example, services have been received from and extended to the Department of Agriculture, the Department of Mines, the Department of the Interior, the Department of Marine, the Department of National Defence, the Department of National Health, the Department of Public Works, the Royal Canadian Mounted Police, the Department of the Secretary of State, the Department of Trade and Commerce, the Civil Service Commission, the Canadian Radio Broadcasting Commission, the International Joint Commission, the Tariff Board of Canada and the Canadian National Railways.

Summary of Financial Statement for 1933-1934

The sum of \$404,500 was voted by parliament during the year under review for the work of the National Research Council. However, because of the difficult financial situation arising from general economic conditions, the Council was requested to effect a saving of \$25,000 from this vote. Consequently, only \$379,500 of the amount voted by parliament was actually available to the Council during the year, and of this amount \$379,499.93 was expended. The corresponding figure for the preceding year was \$408,829.91.

The National Research Council also received during the year from sources other than parliamentary appropriation, additional revenue totaling \$65,114.23, as compared with \$44,518.00 received during the preceding year. The total revenue of the Council during the year under review was therefore \$444,614.16. The corresponding figures during the two preceding years were \$453,347.91 and \$556,832.41, respectively.

The revenue received by the Council during the year from sources other than parliamentary appropriation was derived largely from money paid to the Council to be held in trust for use in the prosecution of research work specified by the donor. A total amount of \$43,497.67 was received from this source. Of this amount \$23,501.33 was derived from the Grain Research Trust Fund established in 1928 to assist in work carried on by the Associate Committee on Grain Research, \$14,189.12 was received from industry, and \$5,465.34 was contributed by the Empire Marketing Board toward the maintenance of the Institute of Parasitology, which has been established at Macdonald College. The sum of \$3,287.10 was derived from fees covering tests carried on in the laboratories of the Council, \$13,989.74 represents unused balances of grants in aid of research which were recalled, and \$1,559.82 was received from the sale of publications of the Council.

The total expenditure of the Council during the year under review amounted to \$444,614.16. Attention is particularly called to the fact that it is necessary for the Council to provide for the salaries of its entire staff, including the laboratory staff, from its appropriation. The expenditure on salaries during the year under review totaled \$266,160.63. Consequently, the amount available from the appropriation for all purposes other than salaries totaled only \$113,339.37, this being considerably less than one-third of the amount voted by parliament.

The sum of \$90,406.50 was expended on grants in aid of research or directly for the promotion of research, as for example, international affiliations with scientific and research organizations abroad. Of this amount \$25,292.27

was provided from the parliamentary appropriation, the sum of \$21,616.56 was derived from special revenue, and the sum of \$43,497.67 was expended from trust funds for this purpose.

All revenue derived by the Council during the year from sources other than parliamentary appropriation and including trust revenue, was applied to the direct assistance and promotion of research work through grants in aid of research. All other activities were financed from the parliamentary appropriation. The sum of \$9,160.00 was expended on postgraduate research scholarships. The corresponding figures in the preceding three years were \$59,335, \$38,490, and \$17,605. The sum of \$16,713.86 was expended on the publication of scientific information including the Canadian Journal of Research and the annual report of the Council.

The operation of the National Research Laboratories required an expenditure of \$45,097.50, the corresponding figure during the preceding year being \$52,932.09. The traveling expenses of members of the Research Council and of all committees associated with the Council, and also the staff of the Council, accounted for an expenditure of \$10,012.56. This was \$6,485.98 less than the amount expended on traveling during the preceding year, the decrease being largely explained by the fact that increased financial pressure forced the cancellation of meetings of several important committees associated with the Council and which under normal conditions should have been held during the year. The administration of the entire organization and all contingencies required an expenditure of \$7,063.11. This was considerably less than the corresponding figure for the preceding year, this saving being effected through drastic retrenchment in the normal expenditure on office equipment, supplies, and contingencies. It should be noted that the expenditure incurred during the year under review on traveling and on administration and contingencies was considerably below normal requirements and could not be maintained definitely at this low level without seriously interfering with the efficiency of the work of the Council.

Financial Statement for the Fiscal Year Ending March 31, 1934

S. P. EAGLESON, *Secretary-Treasurer*

	Revenue	
A. Parliamentary Appropriation		
Vote.....	\$ 404,500.00	
Less Reduction Required by Treasury Board, and.....	\$ 25,000.00	
Unexpended Balance.....	0.07	
	25,000.07	
		\$ 379,499.93
B. Special Fund		
Publications.....	\$ 1,559.82	
Assisted Researches, Refunds.....	13,989.74	
Miscellaneous.....	6,067.00	
	21,616.56	
C. Trust and Indirect Revenue		
Received from Industries.....	\$ 14,189.12	
Grain Research Trust Fund.....	23,501.33	
Empire Marketing Board.....	5,465.34	
Miscellaneous.....	341.88	
	43,497.67	
		\$ 444,614.16

Expenditure

A. Parliamentary Appropriation

Grants in Aid of Research.....	\$ 25,292.27
Postgraduate Research Scholarships.....	9,160.00
Publications.....	16,713.86
Traveling.....	10,012.56
Operation of Laboratories.....	45,097.50
Administration and Contingencies.....	7,063.11
Salaries.....	266,160.63
	<hr/>
	\$ 379,499.93

B. Special Fund

Grants in Aid of Research.....	\$ 17,698.88
International Affiliations.....	3,917.68
	<hr/>
	\$ 21,616.56

C. Trust Fund

Associate Committee on Grain Research.....	\$ 23,501.33
Associate Committee on Magnesian Products.....	5,000.00
Associate Committee on Parasitology.....	5,465.34
Associate Committee on Fire Hazards.....	1,747.94
Associate Committee on Laundry Research..	1,200.00
Associate Committee on Wool Research.....	341.88
Canadian Engineering Standards Association.....	6,241.18
	<hr/>
	\$ 43,497.67

Total Expenditure.....	<hr/> <hr/>
	\$ 444,614.16

REPORTS OF LABORATORY DIVISIONS

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Director*

The continued need for economy prevented any expansion in staff during the past year, but relative to the number of workers the progress achieved was very substantial. Moreover, the program of work was brought under careful review to ensure its vital practical relation to the needs of agriculture in the present crisis. While the National Research Laboratories may properly be expected to stress fundamental research, the fruits of which form the essential working capital of practical experimentation, though they may not always be capable of immediate practical application, it is justifiable in times like these to give the right of way to projects which promise the greatest immediate aid in the rehabilitation of Canadian industry.

A large proportion of the work of the Division of Biology and Agriculture, reported hereunder, is of fundamental value to the plant breeders of the country in their efforts to improve the yield and quality of Canadian crops, prime factors in controlling profitableness and marketability. Other projects, like those on weed control and the influence of weather on wheat yield, are closely concerned with the practical problems of production.

Earnest consideration has been given to the possibility of assisting by research in the restoration of balanced grain acreages and a more stable agricultural policy in the prairie provinces. A program of barley research was outlined and preliminary steps taken to give it effect. Studies on refrigerated transport have also been initiated, to assist in making Canadian meat and poultry products more attractive to overseas buyers, and thus to make moderate diversification of western agriculture more possible.

Much of the work has been done in co-operation with other institutions and government departments, and not a little of it at the request of such departments. The laboratory work on wheat gluten, reported by Dr. Cook and Mr. Rose, was done at the University of Alberta, where Mr. Rose is supported by a grant from the Associate Committee on Grain Research. An important investigation of the determination of the moisture content of grain by electrical instruments, by Dr. Cook and Mr. Hopkins, of this laboratory, and Dr. Geddes, of the Laboratory of the Board of Grain Commissioners, was done at the request of the Department of Trade and Commerce, and will be found summarized in the Report of the Associate Committee on Grain Research, page 77. Data on wheat yield and protein content, accumulated by the Dominion Experimental Farms over many years and made available by them to us, form the basis of statistical studies by Mr. Hopkins, noted hereunder. The contact with Prof. E. W. Crampton, of Macdonald College, established through the study of grain rations published last year as National Research Council Report No. 28, has led to further collaborative studies on problems in experimental feeding trials, noted here by Mr. Hopkins. The investigation of "bolting" in turnips, reported by Dr. Peto, was done at the request of the Dominion Seed Branch, Department of Agriculture.

Space forbids mention of many minor services rendered other government departments on request, but one of rather substantial size should be noted, namely, the preparation by Dr. Malloch of publicity pamphlets on

wheat and flour for the use of the Department of Trade and Commerce. Members of the division have also answered by letter many technical inquiries from the country at large on all sorts of topics.

Brief progress reports on the more substantial researches of the year, prepared by the individuals concerned, follow.

Standardization of Experimental Baking Test

J. G. MALLOCH

The equipment of the baking laboratory was completed by the installation of a Sheldon air-conditioning unit. By its use it is possible to control the temperature to within $\pm 1^\circ$ C. and the relative humidity to within $\pm 2\%$, and thus to eliminate the possible effects of fluctuating laboratory conditions on the results of the baking test. Certain improvements were made in the design of the punching and moulding machine, and subsequently over 1000 doughs have been successfully put through. The baking procedure has now been mechanized as far as possible. The only operations which require handling of the dough are the transfers between the machines and containers. Extensive tests have shown that the accuracy of the results is much improved by the use of the punching and moulding machine, but that further work will be necessary to find and remove additional causes of variation and to make the test unquestionably reliable.

A low-temperature thermostat for storage of the yeast suspension and an automatic timing device to control the dough mixer have been designed and constructed.

Apparatus for Testing Small Samples of Wheat and Flour

J. G. MALLOCH

It is desirable that plant breeders should be able to obtain an indication of the baking quality of their new wheat varieties as early as possible in the breeding process, in order that they may save the time and expense involved in carrying forward material which may later be found to be unsuitable. To this end, experiments with a method of milling using 100 grams or less of wheat have been undertaken. The method involves brushing off the bran by a rotating wire brush and grinding the residue to flour in a plate mill.

A recording dough mixer which will measure certain characteristics of flour using only 10 grams of material has been designed and constructed. The utility of this machine for determining the correct amount of water to add in baking is under investigation, and it is hoped that it may also be of service in determining the quality of plant breeders' samples.

Apparatus for Plant Growth under Controlled Conditions

W. H. COOK

The chambers described in the last report were tested during the past year for variations in temperature and light intensity. The light was found reasonably constant at all points on the floor of the cabinet, but it tended to decrease in intensity during the course of an experiment owing to the gradual formation and accumulation of opaque substances in the enclosed distilled-water screens. This has been rectified by substituting open-water screens, which can be cleaned daily as a part of operation routine.

The conditioned air enters through the bottom and passes out around the top. When operating at 70° F. a temperature gradient of about 0.75° F. from floor to ceiling was found when the lights at the top were off, reversing when the lights came on. By introducing recirculating fans to increase the vertical air movement from 0.68 m.p.h. to a little over 2 m.p.h., this temperature variation in space has been reduced to less than the variation in time. The latter depends on the accuracy of the controllers, and has a standard deviation of about 0.5° F.

The results of two experiments with wheat plants, grown in the chambers to test them before making the foregoing modifications, showed a greater variance between jars than within jars. As the latter should include any experimental errors or genetical variations, it was concluded that growth conditions varied in different parts of the cabinet. This, together with the light and temperature variations noted, led to the changes in the apparatus described above. A special germinator has also been constructed for producing uniform seedlings for transplanting to the chambers.

Studies on the Gluten Proteins

W. H. COOK AND R. C. ROSE

In studying the properties of the gluten proteins in relation to wheat quality as affected by various factors, *e.g.*, by heat used in commercial drying, one of the fundamental problems is to secure the proteins in a pure form suitable for investigation without changing them in the process of preparation. Viscosity changes are a sensitive test of change in gluten dispersions and have been used in checking the behavior of gluten in new solvents.

The viscosity of gluten dispersed in the classical solvents, sodium hydroxide and acetic acid, always decreased on storage or on heat treatment. Precipitation tests gave evidence of incipient hydrolysis on storage. In two neutral solvents found capable of dispersing gluten, *viz.*, 30% urea and 12% sodium salicylate solutions, the gluten also decreased in viscosity on storage, but increased under certain heat treatments, thus indicating a behavior akin to the coagulation of albumins. As acids and alkali appear to cause incipient hydrolysis, their effect on the gluten must be considered more drastic than the coagulating effect of the neutral solvents.

Chemical Weed Killers

W. H. COOK

Preparation has been made for testing on perennials the chemicals most toxic to annual weeds, as reported last year. Since perennial plants require a long time to establish an adequate root system the actual tests have not yet been made.

An effort is being made to develop a more rapid method of determining toxicity than the weed-spraying method previously employed. In order to avoid the complicating effect of such variables as soil and the genetic constitution of such unselected plants as weeds, culture solutions and elite stock Marquis wheat have been employed in these experiments. It was found that the growth rate of plants grown at the same time in an ordinary greenhouse was constant, within ordinary experimental error. When toxic substances were added directly to the culture solution, the results suggested that the decrease in growth rate with increasing dosage is related to the minimum lethal dose. If the correlation is sufficiently close, it will form the basis of a more rapid method for determining toxicity.

Biochemistry of Rust Resistance

J. A. ANDERSON

The effects of hydrogen ion concentration, and of diluted extracts of Vernal, Khapli, Marquis and Little Club wheat plants on the germination of urediniospores of *Puccinia graminis tritici*, form 21, were reinvestigated on a larger scale.

There was considerable variation in the germination of the spores from day to day with respect to hydrogen ion concentration. In consequence it is impossible to outline the range of maximum germination with any great precision. It lies between pH 5.8 and 6.5.

Studies were made of the germination of spores and the growth of germ tubes in concentrations of 2.5, 5, 10 and 15% of the press-juice from each of the four wheat varieties. Germination counts were made on a total of 160,000 spores. The data were analyzed statistically. The methods separated the varieties in the majority of cases. In particular, it was shown conclusively that Little Club extract has a greater inhibitory effect on germination than extracts of Marquis and Vernal; that at lower concentrations, Khapli extract has a greater inhibitory effect on spore germination than Marquis extract; and that Little Club extract inhibits the growth of germ tubes to a greater extent than extracts of the other three varieties. Since Vernal and Khapli are resistant to form 21 whilst Marquis and Khapli are susceptible, the results show quite definitely that there is no direct relation between the inhibitory effect of the press-juice on urediniospore germination or the growth of germ tubes and the rust resistance of the variety.

Four classes of wheat, composed of hybrid lines from a Marquis × H-44-24 cross, showing all four possible combinations of seedling and mature plant rust reactions, were sown in the field and leaves collected at the three-leaf stage and after heading. The dried tissue is being analyzed quantitatively. The results obtained to date show that such differences as exist between the classes at the same stage of growth are comparatively small and are not related to rust resistance.

Organic Constituents of Wheat Leaves

J. A. ANDERSON

The constitution of tricetin, a flavone coloring matter isolated from Khapli wheat leaves, was reported in 1932. Tricetin occurs in the leaves as the dimethyl ether, tricetin. A study of the hydrolytic products and dyeing properties of the latter indicated that it was 5, 7, 4'-trihydroxy-3', 5'-dimethoxyflavone (3', 5'-dimethyl tricetin) and the constitution was confirmed by synthesis.

Time has not been available for further study of the water-soluble coloring matter of Khapli leaves, although steps have been taken towards the isolation of a considerable quantity of the crude compound.

Influence of Weather Conditions on the Growth and Yield of Wheat

J. W. HOPKINS

The statistical study of the relation between weather conditions during the growing season and the resulting yield of wheat in central and southern Alberta and Saskatchewan, mentioned in last year's report, has been continued and extended.

Plot yields recorded annually at a number of agricultural experiment stations in this area show a significant correlation between yield and the amount and distribution of seasonal rainfall. On the whole, above-average rainfall is associated with higher yield, but the result of a given increment of rain at different times is partly dependent on soil conditions. On fertile soil rainfall just prior to harvesting results in a reduction of yield, probably owing to lodging. The average summer rainfall sequence is very similar in each of the above few districts. There is a moderate degree of correlation between the amounts of rain recorded in different districts during the same season, but the simultaneous occurrence of extremely wet or dry seasons over the whole area seems infrequent. The maximum influence of precipitation upon yield appears to be exerted during the month of June.

Temperature conditions during the growing season seem to be secondary to rainfall in influencing yield. Above-average temperatures are generally beneficial at the time of sowing, detrimental during mid-summer and again beneficial prior to harvesting, but as in the case of rainfall, the effect produced is influenced by soil conditions. No consistent relation is evident between either rainfall or temperature and the relative yield of early and late maturing varieties.

It is apparent that the yields secured are in all cases influenced by factors other than those considered, and the precipitation during the autumn, winter and spring months prior to sowing are being investigated in this connection.

An investigation of the relation between weather conditions during the growing season and the protein content of wheat grown in western Canada has also been begun. This was made possible by the acquisition of observational records accumulated over a period of 17 years by Dr. F. T. Shutt, late Dominion chemist, Department of Agriculture.

Statistical Study of Routine Experimental Baking Results

J. W. HOPKINS

Typical routine results supplied by laboratories collaborating with the Associate Committee on Grain Research were studied with a view to ascertaining the degree of precision attained and to formulating an efficient system of rejection and repetition of determinations.

Greater differences were revealed between the accuracy obtained by the use of the same formula in different laboratories than by the use of different formulas in the same laboratory. In all laboratories and by all formulas, instances occur of consistent differences between the loaf volumes obtained from a given series of flours on two separate days. Such variation is, however, haphazard in its incidence. The distribution of range in volume of approximately 150 sets of duplicate loaves baked in the Edmonton and Winnipeg laboratories by each of two formulas was investigated. In both laboratories the nature of the distribution yielded by the bromate formula indicated the possibility of improving the accuracy of the mean by the rejection of outlying observations. The simple and malt-phosphate formula distributions did not, however, differ significantly from the normal expectation.

Statistical Analysis of Results of Experimental Feeding Trials

J. W. HOPKINS

In collaboration with Professor E. W. Crampton of Macdonald College, a study of sources of variability in the results of experimental feeding trials with swine was undertaken. A significant correlation between the initial

weight of an individual, its feed consumption, and the final weight attained was demonstrated in the case of pigs of four different age groups covering the range of commercial feeding periods. The relation between feed intake and resultant growth exhibits a progressive change from the weaning to the final fattening period.

It was shown that the "gain-feed" ratio commonly employed in interpreting the results of comparative feeding trials does not adjust the observed final weights for variations in initial weight and feed intake as efficiently as a statistical procedure based on the analysis of covariance. Two papers describing the results of this investigation and illustrating the statistical analysis of the results of a comparative feeding trial with swine are in course of publication in the *Journal of Nutrition*.

"Bolting" or Premature Seed Setting in Turnips

F. H. PETO

Premature seed setting in turnips has caused appreciable losses to the growers in certain years and very little is known as to the causal factors. At the request of the Dominion Seed Branch, Department of Agriculture, an experiment was designed to determine the influence of temperature on bolting. The plants were grown in the greenhouse with all the growth factors kept comparable, except temperature, which was varied for the different treatments. The results clearly show the dominant effect of temperature in determining the growth habits of the plant as well as the incidence of seed setting. For example, turnips grown for the first 50 days at 50–55° F. and afterwards maintained at 65–72° F. showed definite evidence of bolting after 70 days' growth, while plants grown continuously at 65–72° F. developed normal bulbous roots without any evidence of bolting after 130 days' growth.

An extension of the above experiment is at present in progress, in cooperation with the Forage Crop Division of the Central Experimental Farm, to determine whether a pre-seeding or vernalizing treatment would cause turnips to bolt in the year of seeding. The seed was maintained at a high moisture content in a partially germinated condition at temperatures of 1, 5, and 9° C. for 21, 28 and 35 days prior to sowing in the field. This method may prove to be suitable for the detection of strains with an inherent tendency to bolt.

The Effect of Temperature on Chromosomal Mutation Rates in Cereals and Grasses

F. H. PETO

The work outlined in last year's report showed that heat treatments of ungerminated seeds of cereals resulted in a marked increase in frequency of occurrence of chromosomal mutations. Additional studies have been made on the effect of abnormal temperatures at various stages of growth, in the hope that fundamental knowledge may be obtained as to the effect of the environment in bringing about genetical changes. Attempts are also being made to develop a method of inducing chromosome doubling in plants. A successful method should be very valuable to the plant breeder as a means of conferring fertility on sterile hybrids in which the sterility is attributed to the dissimilarity of the chromosome complements.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

The scope of the division's work during the year is outlined fairly fully in the sections which follow. In these preliminary paragraphs attention may perhaps be drawn to some of the items the practical significance of which can be most readily appreciated.

It has been shown that clays exist in Canada which, especially when suitably processed, are equal and indeed superior for use in oil refining, etc., to any of the imported clays now used, and as a result of the work a plant has been erected for processing a domestic clay. It has been shown that the waste natural gas of Turner Valley is capable of yielding carbon black equal in quality to the imported black now exclusively used by the Canadian rubber industry. It has been shown that by suitable treatment a bitumen for use in rubber manufacture at least equal to the imported bitumens now used can be produced from the "tar sands" of Alberta. A comprehensive study has been made of the economic and technical feasibility of using surplus wheat for the production of alcohol to be used in a blended gasoline-alcohol motor fuel. The first systematic study to be undertaken on the short-fibre grades of Canadian asbestos used as cement (for heat insulation, etc.) has been carried out during the year. Standardization of the specifications of the machine used in grading asbestos has been completed and received the approval of the producers. It may be expected to reduce uncertainties in regard to grading in the selling and buying of Canadian asbestos. Satisfactory procedures for tanning the substantial number of hides now available yearly from the buffalo herd at Wainwright, Alberta, have been established. In the field of textiles a method for measuring in quantitative terms the softness or harshness of wool has been developed; a practical treatment has been worked out and adopted by many laundries in Canada for cleaning the edges of the double cuffs on shirts without damaging the fabric by scrubbing, and a system has been put into operation, which, by means of "test bundles," checks the efficiency of power laundries, and has already led to many of the co-operating laundries improving their procedure to a point where reductions in the strength of cotton fabrics of as little as 5% are suffered in a succession of 20 washes.

The practical possibility of producing benzole, a motor fuel of high anti-knock rating, from waste Turner Valley gas has been brought nearer, if not rendered certain, by the further progress of work in the laboratories on the subject. A new adhesive for bonding rubber firmly to metal has been developed, which will, it is expected, form the basis of a new manufacturing industry. Studies relating to the production of dried apples have established the conditions required to yield a product from Canadian apples equal and indeed superior to the foreign products which at present command a substantial premium in the export market. A plant in which this information will be applied has been built by a Canadian firm. Work on maple products, which encounters the handicap that the season during which experiments can be made on the production of syrup from sap is so short, has yielded significant results in regard to the factors which decide the flavor of the product, and has determined more exactly than before the best conditions for preparing the super-flavored syrup previously developed in the laboratories. The feasibility of making from raw sugar refined cane sugar syrup suited to the jam and canning trades, without the use of methods and equipment as elaborate as those necessary to make refined granulated sugar, has been demonstrated.

Investigations on the adaptation of Canadian magnesian rock to the production of basic refractory linings for metallurgical furnaces have been pursued steadily during the year and have been reflected in the use, both in Canada and abroad, of the products for an increased number of purposes. Interesting new alkaloids have been isolated from wild bleeding hearts. The chemical investigation of native plants has also included a study of the corms of jack-in-the-pulpit. The seed fibre of milkweed has been found to be unsatisfactory as a textile fibre. Investigation is being continued on other economic possibilities of the plant. Following a disastrous fire in a match factory, a scheme has been put into operation under which all brands of matches produced in Canada are tested in the laboratories.

The staff has continued to meet for a period of one-and-a-half hours each week for the purpose of keeping one another informed of progress in chemical research generally throughout the world. In addition, a monthly lecture has been delivered by a member of the staff, with the same purpose in view.

A tendency towards the employment of more chemists in Canadian industry seems to be noticeable. It is observed with satisfaction, as the effectiveness of these laboratories in assisting the development of Canadian industry is facilitated by the presence of technical men in the industrial organizations themselves. It could be hoped that more of the large firms whose headquarters or affiliations are outside Canada would see the desirability of maintaining research in addition to merely control laboratories in Canada, as a few conspicuous exceptions already do.

As in previous years, the section on magnesian products has been under the direction of Mr. F. E. Lathe, of the Division of Research Information, who has rendered very valuable help in this connection.

Absorption of Vapor by Solids

L. M. PIDGEON

Certain porous solids such as charcoal, silica gel, etc., are able to take up gases and vapor from air. The gas mask is a well known application of this property, while commercial applications include the drying of air and the recovery of volatile solvents. An apparatus has been developed to measure the sorptive powers of any solid. In the year under review a research on the sorption of alcohol, benzene, and water by silica gel has been completed and the results published. An examination of the sorptive powers of "active silica," a new sorbent developed in these laboratories, has been carried out, the published results of which investigation are to appear shortly.

In conjunction with A. van Winsen, the sorption of water by asbestos has been examined and an apparatus developed to determine the physical effects of sorbed water. The results of these researches have been published. Reference to this work is made under "Asbestos."

The sorption of vapors by rubber and allied compounds has been examined and results obtained having a bearing on the relation between vapor pressure, concentration and degree of polymerization.

Alberta Bitumen

M. KATZ

An extended, systematic study has been made of the conversion of the semi-fluid bitumen of the Alberta "tar sands" into solid products of various consistencies by blowing air through the heated material.

The relation between the physical consistency and chemical composition of a series of blown asphalts varying from 60° C. to 169° C. in softening point (ball and ring method), was studied. The products were separated into four main components, (1) asphaltous acids and anhydrides, (2) asphaltenes, (3) resins, and (4) oily constituents, and these were examined chemically through the intermediate stages up to the finished product. It was found that the amounts of asphaltous acids and anhydrides decrease with rise in fusing point of the bitumen. The oily constituents and resins also decrease but the asphaltene content increases. The molecular weights of the oily constituents remain practically unaltered during blowing; the resins increase in molecular weight from 733 to 1012, while the asphaltenes show the largest increase, 2219 to 4690. Only traces of oxygen are found in the products blown for 6 to 8.5 hr. at 270° C.; the amount, however, increases in the later stages of blowing to a maximum of 1.88%. The oily constituents do not contain oxygen, which is distributed mainly in the resin fractions, with smaller amounts occurring in the asphaltene fractions. The sulphur and nitrogen in the bitumen are distributed principally among the resins and asphaltenes. The essential process in blowing bitumen with air is considered to be one of condensation by removal of some hydrogen to form water, followed by polymerization—assisted by the sulphur in the bitumen—to products of higher molecular weight. The work has been successful in producing from Alberta bitumen products similar in composition and physical properties to commercial grades of mineral rubber.

The immediate practical objective of the above work was to produce bitumen suitable for use in rubber manufacture. Bitumen (mineral rubber) now used in the Canadian rubber industry is imported. Full details of the work are given in a paper to be published in the Canadian Journal of Research, April, 1934.

Utilization as Mineral Rubbers

A careful study has been made of the behavior in rubber of four rubber-soluble bitumens having softening points of 104, 133, 151 and 169° C. (b. and r. method). For comparative purposes two commercial grades of mineral rubber fusing at 149 and 168° C. have also been investigated. The plasticity of milled rubber is altered to a smaller extent by additions of Alberta mineral rubber than by that of the commercial grades of similar fusing point. The latter yield softer stocks due to their high oil content. By choosing an Alberta product of much lower fusing point, *i.e.*, blown for a shorter time, satisfactory softening was obtained without reducing the strength of the vulcanized rubber below that given by commercial grades of mineral rubber.

Vulcanized tread stocks containing Alberta bitumen show a higher modulus than those containing commercial grades of mineral rubber of similar fusing point. The Alberta bitumen stocks also show a lower permanent set.

In a tread stock (carbon black stock) it is clearly shown that the modulus of the rubber is increased with rise in fusing point of the bitumen. The aging qualities of the commercial and Alberta types of mineral rubber are comparable.

Asbestos

D. WOLOCHOW, A. VAN WINSEN

The process for the economic utilization of asbestos tailings, whereby active silica and magnesium salts are simultaneously made, and which was mentioned in the previous report as having been carried through to the semi-

commercial scale, has been studied further. Approximately 1000 lb. of active silica has been prepared and distributed to be tested for various purposes (drying gases, ingredient in Portland cement, etc.). One very interesting application has been found in the medical field and this is being tested clinically. The commercial possibilities of the process are being studied by several chemical manufacturers.

A comprehensive study of asbestos cements has been completed and a detailed report prepared. This study had been undertaken at the request of the asbestos producers and the report has been submitted to them. The properties of asbestos cements which have been studied and which have been related to the screen tests and apparent densities of the fibres, include the consistency, covering capacity, shrinkage, density and thermal conductivity of the various grades.

With reference to the studies on asbestos cements, the staff designed and built a special testing machine to determine the modulus of rupture of various asbestos-cement slabs.

Further study was made with reference to the use of asbestos as a filler; special highly fiberized, closely screened fibres of low grit content were prepared and methods of preparing such fibres were studied, the Pulp and Paper Division of the Forest Products Laboratories kindly rendering assistance.

Experiments are being made to determine the apparent density of asbestos fibre at various pressures, with the object of developing a supplementary method of grading asbestos fibres.

A report on the screening action of perforated plates, with particular reference to their possible use in the Quebec standard testing machine, has also been submitted to the producing companies.

In order to obtain first-hand information on the use and value of asbestos as an electrical insulator, visits were made to a number of Canadian manufacturers of electrical machinery and wire and cable. Data thus obtained proved of value in estimating the possibilities of asbestos in this field and the effects of the magnetic iron present in Canadian asbestos on its use as an electrical insulator. In this same connection a study has been made of the literature on the oxides of iron and on the occurrence and nature of the iron compounds in asbestos. The methods suggested by several patents for the removal of iron from asbestos have been examined critically and an improved, simplified method is being tried out.

In experiments on new lines, some very interesting results have been obtained with asbestos tailings. Preliminary work indicates that good yields of useful products may be obtained by the method used in the laboratory.

A study has been begun of milled asbestos fibre, using mineralogical analysis and microscopic examination, with the object of obtaining data on the fundamental make-up of the various grades of milled fibre.

Further work has been done on the standardization of the Quebec standard asbestos testing machine. One new machine was built according to the plans which were tentatively adopted in the previous year; this machine proved to be satisfactory, hence the plans and specifications proposed by the Council were finally adopted by the Associate Committee on Asbestos and by the Quebec Asbestos Producers Association. Specifications for brass testing screens as the standard for the testing machine were also approved and adopted by these organizations. The complete specifications are now being printed and will be available to the public at the cost of preparation.

Considerable work has been done to investigate the effect of the condition of the screen cloth on the screen test result and a proposed procedure, as to the manner in which a screen cloth should be attached to its screen box, has been suggested to the industry.

In the course of this work on standardization of the testing machine it was observed that the variable humidity of the fibre caused by ordinary changes in atmospheric conditions had a considerable effect on its screen test value. In order to probe the reason for this behavior a study was made in conjunction with Dr. Pidgeon to determine the amount of moisture taken up by asbestos fibre at different humidities, and also the rate at which this adsorption takes place. Subsequently a study was made of the effect of sorbed water on the physical properties of asbestos; as a result of these studies a hypothesis has been advanced to explain the effect of humidity on screen test results.

The staff has designed and built a template in order to facilitate the checking of the Quebec standard testing machines.

Biochemistry

I.—R. H. F. MANSKE

There are numerous plants native to Canada, many of them poisonous to livestock, which are known or suspected to contain substances of pronounced physiological and pharmacological activity, and a program of investigating these was begun in 1930.

The results recorded in the last report have been greatly extended and a number of new alkaloids have been found in those plants already investigated. In the Fumariaceae family, two new plants have been subjected to a careful examination. These are wild bleeding hearts (*Dicentra formosa* and *D. oregana*), and both have yielded large quantities of hitherto rare alkaloids, so that these are now available for pharmacological investigation. The results have been published in the Canadian Journal of Research, four papers having appeared during the year under review. Thanks to the cooperation of Dr. V. E. Henderson, Professor of Pharmacology, University of Toronto, several of the alkaloids isolated are being tested pharmacologically.

Among other plants of interest may be mentioned *Menispermum canadense* (Canada moonseed) which was obtained in large quantity. The total alkaloids have been isolated, but their nature has not yet been determined. The investigations of *Delphinium brownii* (tall larkspur) and *Zygadenus venonesus* (death camas) have been continued.

An investigation of poison ivy poisoning is under way, but owing to the necessarily slow progress of the dermatological work it is expected that some time will elapse before positive results can be announced.

II.—L. MARION

A study has been made of the non-basic constituents of *Adlumina fungosa* (climbing fumatory), the alkaloids of this plant having been investigated previously in this laboratory by Dr. Manske. The study of *Mimulus ringens* (monkey flower) which had been started last year has been continued, and has revealed the existence of interesting crystalline compounds and a saponin which are being further investigated. An attempt has also been made to isolate the poisonous constituents of *Actaea rubra* (red baneberry) and the plant has been found to contain an appreciable quantity of *i*-inositol, as well as a crystalline glycoside which is insoluble in water. This substance is now being studied.

A paper reporting results of the chemical investigation of the tuberous roots or corms of *Arisaema triphyllum* (jack-in-the-pulpit) appeared in the Canadian Journal of Research for February, 1934.

Magnesian Products

A. F. GILL, N. P. PITT

The co-operative investigation on behalf of the Canadian producers of basic refractories was continued during the year and considerable progress was made. Laboratory work was directed towards improvement of existing basic refractories and the development of new products for which demand was recognized.

In order to meet special requirements of one large consumer in the steel industry, a new type of clinker was developed. This showed very high stability in respect to moisture attack, coupled with improved resistance to basic open-hearth slags. Following successful laboratory and plant trials, this material is now being made and sold on a commercial basis.

Notable improvement was effected in plastic basic refractories of the type which are normally used with an added bond. Two products have been brought to the commercial stage, *viz.*, an improved "ramming-mix" for more general application where economy would result from monolithic refractories, and also a special product designed primarily for the construction of tap-holes in open-hearth steel furnaces.

In addition to the developments mentioned above, considerable work of a more fundamental nature has been carried on. A large number of furnace tests have been made with a view towards more closely defining the effect of impurities and of various dead-burning agents on such properties as refractoriness, setting quality, slag resistance, etc. As a result of this work, it is expected that the quality of clinker produced will be considerably improved.

While lack of building activity has continued to retard progress in the use of plastic magnesia for flooring and other purposes, some production was, however, obtained and a number of installations were made. This laboratory has continued to act in an advisory capacity to users of this material.

Carbon Black

L. M. PIDGEON

Carbon black is an important raw material in the rubber industry, as it has been largely responsible for the great resistance to abrasion and the long life shown by modern tire treads. The carbon black imports into Canada in 1929 were 14,039,959 lb. valued at \$944,973, and in 1933 were 9,942,893 lb. valued at \$302,253. The British market has increased from 18,887,337 lb. in 1928 to over 31,000,000 lb. in 1933. Carbon black is made by partial combustion of natural gas, large amounts of which are available in the Turner Valley in Alberta. During the year under review an experimental carbon black plant has been constructed and a large number of samples of black prepared from Turner Valley gas. The quality of the black and the yields obtained compare favorably with those for natural gas in the U.S.A. The presence of sulphur in the gas, however, presents a problem which must be overcome before economic utilization of the gas will be possible at present prices. Further experiments involving special treatment of the gas, give promise of results which may make profitable the production of carbon black in Canada.

Various methods of testing and evaluating blacks have been investigated, including the optical method referred to in the previous report.

Distillation

D. F. STEDMAN

(a) Examination of Turner Valley Naphtha

About 80 gal. of this naphtha has been separated into small fractions ready for final examination.

For this examination there has been developed a special type of distilling column of high capacity which is about 10 times as effective as any previously available, and which also holds up very little of the reflux liquid. This column gives up to 25 theoretical plates of separation per foot of height, retains but 1 cc. of liquid per sq. in. of cross section per theoretical plate, and can now be produced in laboratory sizes from 1 to 5 in. diameter, the latter size having a capacity of over one ton of benzene refluxed per day.

This column, combining high capacity with high efficiency and low liquid tie-up, should find ready commercial application.

One of these columns, 16 ft. high and of 1 sq. in. cross section, has just been completed for use with the naphtha and for general experimental purposes; it is intended to use four such stills for this work, as close separations are slow and laborious.

(b) Isotopes

For several months an attempt has been under way to separate the isotopes of chlorine by fractional distillation, using earlier editions of the above column, 6 ft. high. With this equipment it seems possible to obtain very small separations of light chlorine from heavy, but the differences obtained are so small, of the order of .03 unit of atomic weight, that exceedingly delicate measurements are needed to detect it, and the work must be continued to be entirely certain the effects are real.

So far, carbon tetrachloride seems to give slightly light heads, and but little separation through the main body of the distillation; *i.e.*, the symmetrical light form boils a trifle lower than the remainder, but the other forms boil very close together. The separations attained were $-.042$ and $+.006$ atomic weight units.

Tests on dichlormethane give rather the opposite effect,—no change in the light heads, and heavy ends .023 atomic weight unit heavier than normal chlorine.

It is intended to utilize the still with 16-foot column for a further examination of this effect before employing it for the distillation of naphtha.

Fruit and Vegetable Processing

N. H. GRACE

A number of problems relating to the dried-apple industry have been considered. The important subject of sulphur dioxide content in relation to color, flavor and retention of quality on storage has been studied. Optimum conditions of treatment have been determined for apples which are to be subjected to rapid drying by modern methods. An experimental study of resulphuring indicates that this is a method of treatment which is capable

of effecting substantial improvement in the ordinary evaporated apple. The operation is both simple and inexpensive, and gives a product which retains its color over customary storage periods.

Special problems have been dealt with, such as the effect of slice thickness on the rate of drying and the relative bulk on rehydration, the effect of extremely low temperatures—such as winter temperature in western Canada—on the quality of dried apples, and the packing under pressure of dried apples of different moisture contents. Further, an experimental study has been made of possibilities for the commercial application of a process which was developed in these laboratories for producing dried apples of improved flavor.

A brief study of the dehydration of celery indicates an interesting possible outlet for surplus celery in the form of dried products.

A detailed survey has been made of the general problems of the fruit and vegetable industry in Canada, with special reference to research possibilities.

Advice has been given on the sulphur dioxide preservation of fruit and fruit pulp and on the processing of raisins.

Gas Research

A. CAMBRON, C. H. BAYLEY

The investigation of the thermal conversion of propane to aromatics in high-chromium alloy tubes has been continued. Recycling experiments carried out under a pressure of one atmosphere have shown that, when the gas flow is highly turbulent, high rates of conversion can be obtained at temperatures as low as 800–810° C., which is well within the range in which high-chromium steel tubes can be used. Yields of 23.3 lb. of crude benzene per 1000 cu. ft. of propane put through have been obtained at 800° C., together with 10 lb. of liquids boiling above 200° C. The crude benzene obtained under the above conditions contains about 64% benzene, 14% toluene, 7.8% styrene and small amounts of cyclopentadiene, xylenes and higher aromatics. The liquids boiling about 200° C. contain about 25% naphthalene and 12.5% anthracene, together with smaller amounts of mono- and dimethyl naphthalenes, acenaphthene and phenanthrene.

The production of aromatics by the above process yields a residual gas containing about 20% ethylene, of which gas there is produced about 33 lb. per 1000 cu. ft. of propane put through.

Estimates have been prepared of the cost of production of aromatics by the above process and of the cost of production of alcohols. The estimates show that there are distinct commercial possibilities in these directions, provided an adequate supply of gas is assured.

Heavy petroleum oils can be broken down by a combination of heat and pressure to give lighter and more valuable products. When these oils are so treated in the gaseous form the process is known as vapor-phase cracking. During the year under review a rather extensive series of laboratory experiments has been carried out on vapor-phase cracking under carefully controlled conditions. Conditions necessary to secure high yields of aromatic constituents and hence high anti-knock rating in the cracked gasoline were ascertained. Under these conditions the content of olefines in the cracked product is reduced and that of benzene and toluene increased correspondingly.

The standard method of producing synthetic ethyl alcohol from ethylene, a gas obtainable by the cracking of paraffin hydrocarbon gases or of oil

vapors, is absorption in concentrated sulphuric acid followed by addition of water and distillation. In an effort to improve the rate of absorption, the possible value as catalytic agents of a large number of substances has been studied, but with one exception no appreciable effect was observed. The substances included molybdcic, arsenic, beryllium and stannic oxides, selenic acid, phospho-molybdcic acid, diphenylamine, hydroquinone, pyrogallol, nitrosyl sulphuric acid, aluminium sulphate. Systematic experiments were also made on the influence of the rate of solution of ethylene on its rate of reaction with sulphuric acid.

Although high-chromium alloy steel tubes have been found suitable for the thermal treatment of hydrocarbon gases and for the vapor phase cracking of petroleum, as regards freedom from carbon deposition and heat resistance, it has been found that this alloy gradually undergoes surface carburization when the alloy is heated in the presence of hydrocarbon gases for prolonged periods at high temperature. Such surface carburization brings about structural alteration in the alloy and causes it to lose its resistance to air oxidation at high temperature. A protective coating has been developed which permanently protects high-chromium alloys against carburization under the above conditions, and indications are that the use of such a coating will add considerably to the useful life of such alloys when they are subjected alternately to a carburizing and oxidizing atmosphere at high temperature.

Government Purchasing Specifications

A. F. GILL

A preliminary study has been made of the procedure followed in various governmental departments in connection with the purchase of materials and supplies. This was directed primarily towards determining whether co-ordination and amplification of existing purchase specifications would be justified. The conclusion was reached that there was considerable scope for collaboration between different departments and that valuable economy might result. Accordingly, steps are now being taken towards the formation of a co-operative interdepartmental committee to effect the necessary consolidation.

Laundering

O. M. MORGAN, B. J. KENALTY

A "test bundle" service for power laundries has been started. Bundles are issued for washing with white work and another type of bundle is issued for washing with colored work. By the use of these test bundles it is possible to check upon the efficiency of dirt removal and whiteness retention, tensile strength losses are determined and the effect of the washing process on colored fabrics is controlled. Certain laundries availing themselves of this service have reduced their tensile strength losses as much as from 28% to 5%; they have increased the efficiency of their dirt removal from 75% to 98% and at the same time have reduced their washroom costs.

Some work has been started on the production of a cheap water softening sand made from Canadian raw material originating in the asbestos mines. To date no water softening sand of Canadian origin has been available. The results from this piece of research are quite promising.

In July, 1933, a series of thirteen wetting-out agents were applied to badly stained cuffs and collars of shirts in a Toronto laundry. Out of this group four were selected for their efficient stain removal and low cost. A pamphlet was issued to all Canadian laundries informing them of these mixtures, their preparation and use. Good results are reported.

The effect has been investigated of drying, in air containing one and two parts of sulphur dioxide per million, as in certain industrial city areas, cotton fabrics wetted with solutions such as would be contacted in power laundry rinse waters. The effects of humidity, temperature and light have been examined and kept under all possible control. The sulphur dioxide has been found to have little or no effect in producing deterioration of the fabric.

A series of experiments has been started to compare the efficiency of washing done by power laundries with that done in small domestic washing machines, the latter being performed by the Department of Household Science, University of Toronto. These experiments are still in progress.

In connection with the service work for the industry, 325 reports have been issued covering new and damaged fabrics, soaps, alkalies, water problems, etc. There have been 153 regular test bundles reported while an additional 130 test bundles have been used for special tests in various plants.

Leather

W. E. GRAHAM

The National Research Council was asked by the National Parks Branch to undertake a study of suitable methods for tanning buffalo skins. A large number of these skins are available annually; when tanned for coats and robes they should provide a source of considerable revenue. Work done in these laboratories has demonstrated that these skins can be successfully tanned by suitable adaptation of standard methods for either alum or oil tannage. Further details of the processes are under investigation and the studies are being extended to the general problem of fur tanning.

A study has been undertaken of the evaluation of the wear resistance of sole leather on an abrasion testing machine constructed in the shops of the National Research Council. Some comparative tests have already been made on leathers from plant experiments. Other apparatus for evaluating the quality of leather has been installed.

An investigation has been started into the cause of the deterioration of shoe upper leather so commonly found in the vamps. This deterioration is associated with perspiration, and the present work has been directed to finding out the chemical and physical changes which have occurred. These studies will serve to direct efforts towards preventing the deterioration.

A study is in progress on the deterioration of upholstery leather in industrial atmospheres. This damage is associated with the accumulation of sulphuric acid in the leather.

Work has been done on the products of the destructive distillation of waste leather as a means of utilizing the large amounts of this material available annually.

A considerable quantity of Canadian Staghorn sumac was gathered and is being examined as a possible domestic source of tannin. The tannin content is rather too low but further studies of its practical tanning value are being made.

A number of analyses of commercial leathers have been made and other servicing problems have been studied for Canadian tanners.

Two bulletins on methods of making leather which were started at the end of the previous year were completed and are ready for distribution in either French or English editions. One bulletin on "Home Tanning" gives simple methods suitable for the purpose and the other "A Brief Description of Processes of Making Leather" gives in more detail procedures intended for inquirers who wish to organize small but fairly complete community tanneries.

Maple and Other Sugars

L. SKAZIN

The main conditions for the production of super-flavored maple syrup according to the process discovered in these laboratories were established during the course of the 1933 sap season, and independent judgment about the quality of flavor developed was obtained from seven experts. It was interesting to note from these judgments that the flavor of syrups prepared according to the new process, when properly diluted with cane syrup, did not differ from the quality of flavor of the ordinary syrup. One part of highly flavored syrup gives the same maple taste effect as from 8 to over 20 parts of ordinary maple syrup and should be of value in ice cream and confectionery manufacturing.

An investigation into the formation of invert sugar in maple products has shown that the inversion of sucrose depends mainly on the duration of boiling, and also to some extent on the percentage of solids present in the syrup. To produce maple products with minimum invert sugar it is necessary to reduce the duration of boiling to as short a time as possible, especially at higher concentrations of solids.

It has been demonstrated that a good quality maple icing sugar can be produced from dark "Beauce" sugar, if the sugar is redissolved and filtered in order to remove the insoluble particles (mainly calcium malate) which are responsible for the gritty taste of the product.

The feasibility of making cane sugar syrup direct from raw sugar for use in jam manufacture and fruit canning has been studied, and a suitable process developed. It was demonstrated that affinating of raw sugar followed by treatment with 0.5-1.0% of good decolorizing carbon, produces a good sugar syrup for the purposes in view. The color of syrup so produced is equal to or even better than the color of syrup made by dissolving refined, granulated cane sugar.

A study was made of the relative efficiencies of 17 samples of decolorizing carbon now being used by industrial firms or public utilities in Canada for decolorizing sugar syrups, vegetable oils and fats and for the treatment of water supplies. These samples all represented imported products. A decolorizing carbon produced experimentally by a Canadian manufacturer was tried out in comparison with the imported carbons (W. Gallay collaborating).

Little additional work has been done on honey during the year, but communications received from technical men, especially in the United States, show that the methods of determining the water content of honey which were worked out last year in these laboratories, have been recognized as an important step forward. (Miss H. D. Chataway.)

Milkweed

L. MARION

The properties of the milkweed floss in respect to spinning or weaving were investigated with the kind co-operation of one of the Canadian textile manufacturing companies. While the cloth produced from a mixture of floss and cotton staple was not markedly inferior to an all-cotton cloth in tensile strength, the difficulties encountered in the manufacture were numerous and of such a nature as to render unattractive this use of the milkweed floss

with the present standard equipment. The most serious drawbacks were the handling of the smooth floss fibres, which afford no grip, and the high loss in the carding operation due largely to the brittleness of the fibres.

Further work with milkweed is being directed towards an attempt to isolate the bast fibres in such a way that they may be utilized. The plant was collected at various periods of growth, *i.e.*, when in bloom, at the early fruiting season, and when mature, in order to ascertain the most suitable time for collecting the material so that the fibres might be most readily removed. The stems do not seem to be readily amenable to ordinary flax-retting processes.

Permanence of Documents

MISS H. D. CHATAWAY

Following an inquiry from official quarters as to the probable permanence of various government papers, extensive tests, both physical and chemical, have been carried out in the laboratories on a wide variety of papers and a number of inks used in different government departments. In this connection the helpful advice of the Pulp and Paper Division of the Forest Products Laboratories is acknowledged.

The study has prepared the way for the drawing up of standards in a field in which, because of its complexity, they are badly needed.

Power Alcohol

C. Y. HOPKINS

The possibility of using grain alcohol as a supplementary motor fuel in Canada has been examined and a full report has been issued which deals with both the economic and practical phases of the subject. The report includes a survey of the use of alcohol in motor fuel in foreign countries, a review of the properties of alcohol-gasoline mixtures, and estimates of the cost of motor fuel containing alcohol as compared with ordinary gasoline.

Engine tests with a number of the mixtures were completed by the Division of Physics and Engineering.

Water Tolerance of Motor Fuels Containing Alcohol

One of the objections to the use of alcohol-gasoline mixtures for motor fuels is the possible separation of the fuel into layers upon accidental addition or absorption of small amounts of water. This danger can be minimized by adding a third liquid to the mixture. Benzene and isopropyl alcohol have been suggested for this purpose and accordingly the value of each in preventing stratification was determined. It was found that isopropyl alcohol, which can be produced from the waste gases of petroleum refineries, is much more effective than benzene. The water tolerance of alcohol-gasoline mixtures was also determined, and the tendency of such mixtures to absorb water from the air was found to be small, if not negligible. (With C. H. Bayley.)

In order to ascertain the possible yield of alcohol from grain screenings, a careful determination was made of the starch content of No. 1 feed screenings, refuse screenings and certain individual weed seeds found in refuse screenings. This work is being extended to include the lower grades of wheat.

Refining and Bleaching Clays

W. GALLAY

The total annual value of refining and bleaching clays used in Canada is about \$300,000, virtually all of which is imported. A survey of promising Canadian deposits was made and samples were collected from various districts in British Columbia, Alberta, Saskatchewan, Ontario, Quebec and the maritime provinces.

There are a large number of individual fields of utilization for this type of clay and it was found impossible to predict the efficiency of an unknown material by specific physical or chemical tests. The plan followed was therefore as follows. Direct contact was established with large manufacturers in each field, unrefined products were obtained from them, and then refining and bleaching experiments were carried out under conditions closely simulating those used in industry. Large clay consumers were kept in touch with the work continually. In one instance, experiments were performed on a semi-industrial scale.

In the cases where raw Canadian clays were found to possess good initial efficiency, the optimum activation treatment was worked out for the highest final efficiency. In each field of utilization, the Canadian materials in both the crude and activated states were compared in efficiency with the imported materials now in use.

The following lines of utilization for these materials were investigated:—

Refining of lubricating distillates

Refining of cracked gasoline by the counter-current process and by the Gray tower process

Bleaching of vegetable and animal oils and fats

Bleaching of linseed oil

Bleaching of pilchard oil

Recovery of various types of used dry-cleaning solvents

Reclamation of used insulating oil

Reclamation of used crank-case oil.

In all instances, the refined products were thoroughly tested in the laboratory in comparison with standard products.

Two Canadian clays in particular have shown excellent results in many of the above fields. One of them has proved to be superior to every imported material in nearly all of these lines of utilization. A plant has been erected for the activation of this material.

Removal of Magnesia from Cement Rock

A. F. GILL

Some preliminary work was done on behalf of a cement company which was desirous of lowering the magnesia content of limestone by chemical means. Laboratory tests were made in connection with the removal of the magnesia as a bicarbonate from a water suspension of the finely ground material. The possibility of applying a selective calcination process to this problem was investigated, *i.e.*, partial calcines containing essentially all free magnesia and various portions of free lime were treated with carbon dioxide solution. Although it was found possible to get a fairly sharply defined magnesium oxide and calcium carbonate mixture, better subsequent removal of the magnesia was obtained when a substantial proportion of the calcium carbonate was calcined as well. This was considered to be due to shielding of the magnesium oxide by stable, undecomposed calcium carbonate.

Rubber

M. KATZ, T. R. GRIFFITH

The National Research Council was requested to investigate the problem of the bonding to metal surfaces of fabrics containing rubber. This resulted in the discovery of a new adhesive for the purpose. It is expected that a new manufacturing plant will be erected in which use will be made of the process.

A carbon black prepared by Dr. Pidgeon in his experimental carbon black plant was investigated as a rubber compounding ingredient. It was found to be entirely suitable for general use in rubber compounding.

The properties of certain Canadian clays from Alberta and Quebec have been investigated in rubber stocks in order to determine their suitability as rubber fillers in comparison with standard grades of imported clays. Bentonite was found to be unsuitable for rubber compounding because of its high adsorptive power for vulcanizing agents. This resulted in greatly retarding the rate of cure of rubber stocks. The behavior in rubber of various mixtures of kaolin and silica was also investigated. The work is being continued in the hope of finding one or more domestic clays (preferably located in eastern Canada) equally as suitable for use in rubber manufacture as the imported clays now used.

During the past year the rubber laboratory has, with the aid of its vulcanizing and testing equipment, answered a number of inquiries and continued in its capacity of giving technical advice in regard to the manufacture of rubber goods. Some of these inquiries were related to the following topics: plastic rubber, rubber stamps, rubber solvents, retreading of old tires, manufacture of battery boxes, impregnation of cotton gloves with rubber, reconditioning of overshoes, mineral rubber from blown petroleum residues.

The mathematical work on the rubber stress-strain curve, mentioned in the last annual report, has been completed and a lengthy memoir published in the Canadian Journal of Research under the title "A Mathematical Treatment of a Theory of Rubber Structure."

An article on "Synthetic Rubber" written by G. S. Whitby and M. Katz appeared in the November and December, 1933, issues of the "Journal of Industrial and Engineering Chemistry." Reprints of this article have to date been requested from most English-speaking countries and from Japan, Germany, Soviet Russia, Java, Sumatra, Italy and France.

Straw

L. MARION

The work on wheat straw has this year been concerned with the isolation of a large quantity of lignin and a thorough study of the resin which is removed by extraction with a mixture of methanol and benzene. It is important to know the properties of the various constituents of this fraction of straw. A considerable quantity of this extract, or so-called resin, has been found to consist of lignin. This indicates that some of the lignin in straw is more readily separated than the rest from cellulose and other constituents. The resin also contains a small quantity of sterol glucoside, apparently identical with that which has been obtained from the wheat germ. The largest fraction of the extract is soluble in fat solvents (petroleum ether and ether) and consists largely of glycosides, free fatty acids, a hydrocarbon, a mixture

of sterols and a substance insoluble in methanol but soluble in benzene. The last substance has a fairly low melting point (82°C.) and is a very good emulsifying agent. No resin acids whatever are present.

Survey of Chemical Imports

A. F. GILL

From information supplied by the Department of National Revenue, an analysis was made of some of the larger groups of chemical imports with a view towards selecting any significant items of a type which might be suitable for Canadian manufacture. Considerable information was obtained and this is being used from time to time in connection with trade inquiries and as a basis for possible developments.

Studies of certain larger items among the chemical imports suggested avenues of investigation and a number of them are being followed at the present time. It is proposed that investigations of this kind be continued as a regular feature of the program of the laboratories and that the work be enlarged should occasion demand it.

Trail Smelter Fumes Investigation

M. KATZ

Further work was carried out on this subject and supervision was exercised over the field work conducted throughout the year.

Wool

P. LAROSE, MISS A. S. TWEEDIE

A large number of time-consuming tests were made on samples of wool sent by the University of Alberta in connection with experiments being carried out to determine the effect of environment on wool. These tests included measurements of staple length, fibre length, crimp, tensile strength and fibre diameter on 170 samples, as well as the determination of grease, suint, dirt and yield of clean wool on these samples.

An apparatus for testing the resistance of cloth to wear has been developed. A number of tests have been made with it on cloth made of Canadian wool and cloth made of colonial—*i.e.*, Australian and New Zealand—wool. The results show that the wearing quality of the Canadian wool is just as good as, if not better than, that of the colonial wool.

A new method for measuring the compressibility or resilience of wool was devised. This is another step in the establishment of testing methods by means of which it will be possible to compare fully the quality or value of Canadian wools with others. Some preliminary work has already been done with this apparatus and will be published in the June number of the Canadian Journal of Research. The apparatus has also been used successfully in the laboratories with other fibres such as kapok, milkweed and asbestos.

The fastness of a number of dyeings supplied by the U.S. Bureau of Standards was determined in the fugitometer. This is work preliminary to the setting up of standards of fastness to light. In this connection a meeting of the A.A.T.C.C. Committee on Light Fastness was attended.

An investigation of wool wax was begun and some work carried out on the change which the wax undergoes on standing.

A number of tensile strength determinations on linen yarn and cloth and whiteness tests on the cloth were carried out for the Fibre Division staff of the Experimental Farm in order to determine the effect of various bleaching treatments.

Miscellaneous

1. *Analysis.* Among the analyses carried out during the year were:—

(a) Inorganic analysis of cements, refractories, clays, pigments, metals and solutions. (400 samples, 1200 determinations.)

(b) Analysis of cosmetics, soaps, washing compounds, fats, waxes, starch and textiles. (60 samples—170 determinations.)

(c) Water analysis, boiler compounds, with some study of boiler-water treatment.

(d) Continued study and analysis of antifreeze solutions with an investigation into their possible use in a special case.

(e) Compounds used in chemical hot water bottles, an explosive, some products from the corrosion of metals, bitumen products for ash and sulphur, paper samples for acidity and rosin. (C. W. Davis.)

2. *Pitchblende.* Samples of pitchblende from the Great Bear Lake district were analysed for uranium, thorium and the rare earth metals. Special attention was given the thorium determination since meso-thorium can be considered an impurity in commercial radium salts. (C. W. Davis.)

3. *Matches.* In co-operation with the Department of Insurance and Canadian match manufacturers, a systematic testing of matches was organized and 54 samples of matches were reported on. (C. W. Davis.)

4. *Gasoline.* Seventeen samples of aviation gasoline were tested by standard methods in connection with a special investigation of anti-knock compounds in aviation fuel. (C. W. Davis.)

5. *Deodorants.* The action of a number of essential oils and odoriferous synthetic products as deodorants has been studied. The work was concerned more particularly with masking the odor of turpentine. (L. Marion.)

6. *Food for Ranch Beavers.* Analytical examination of dried birch, alder and poplar leaves was made to determine which would be the most suitable food for the raising of beavers. (C. Y. Hopkins.)

7. *Drying of Brewers' Yeast.* In response to a demand for a special grade of dried yeast for export, the different methods of drying yeast were reviewed and recommendations as to the proper conditions of drying were made. Yeasts already on the market were tested. (C. Y. Hopkins.)

8. *Vitamins.* Although no facilities are yet available for thorough investigations of this nature, colorimetric assay for vitamin A content were made on cod liver oil, and on several special products containing cod liver. (L. Skazin.)

9. *Synthetic Resins.* Continuing the investigation of a special type of synthetic resin, two new substances have been prepared which are easily converted into hard resins. One of these is of interest on account of its similarity in structure to the synthetic rubber base, chloroprene. Its properties are being studied. (C. Y. Hopkins.)

10. *Dye for Liquid Levels.* In order to select the most suitable dye for coloring the fluid in the fore and aft levels of aircraft a number of dye solutions were examined as to their fastness to light by means of an accelerated fading test. (P. Larose.)

11. *Metal Spraying.* A lecture on metal spraying was delivered to a group in Montreal and was published. Various parties interested in the development of metal spraying in Canada have been given technical advice by a member of the division who has had special experience in the business. (A. van Winsen.)

12. *Inquiries.* These showed a substantial increase over the previous year, some 400 being received apart from those dealing with the laundry research work. The increase is largely from corporations and government and other public bodies. In a considerable number of instances experimental work was required. These inquiries were answered by special reports, letters or personal interviews. Special reports were prepared on such subjects as:—*(a)* treatment of wooden forms for concrete; *(b)* manufacture of bakers' yeast from waste sulphite liquor; *(c)* freezing of dried apples; *(d)* effect of low temperatures on formaldehyde solutions; *(e)* subjects suggested by the Department of National Defence; *(f)* decolorization of cracked gasoline; *(g)* refining of animal and vegetable oils; *(h)* distillers' dried grains; *(i)* utilization of copper smelter slag; *(j)* diatomaceous earth in sugar refining; *(k)* recovery of silver and cellulose from used motion picture films; *(l)* explosive mixtures of gasoline vapor-air mixtures; *(m)* pyrolysis of waste leather and use of distillate as weed killer; *(n)* thermoplastic rubber; *(o)* fine grinding of fish muscle; *(p)* development of a special adhesive for labeling poultry.

Inquiries answered more briefly include:—*(a)* specifications for soaps, textiles, etc.; *(b)* uses and sources of supply of chemicals and other materials; *(c)* manufacture of table syrup, carbon black, soy bean oil, cleansers, inks, polishes, mucilage, battery case, etc.; *(d)* textile fibres; *(e)* chemical constituents of plants, fruits, etc.; *(f)* dextrin in honey, etc.

DIVISION OF PHYSICS AND ENGINEERING

R. W. BOYLE, *Director*

J. H. PARKIN, *Assistant Director*

In the year under review the Physics and Engineering Division met with an increased volume of work to be performed, particularly in the number and variety of standardizing and other tests to be carried out for government departments and industries.

The Council adopted a schedule of fees for laboratory tests and standardization.

Most of the new activities undertaken by the division during the year are comprised under the three important new committees appointed by the Council:—(1) Special Committee on Definitions, Units and Regulations Governing Gas Measurements and Approval of Type of Gas Meters. This committee was appointed to cover the responsibilities pertaining to gas meters delegated to the Council by the Minister of Trade and Commerce. (2) Associate Committee on Radiology, to supervise all matters pertaining to the use by the medical profession of radium and X-rays. A conference consisting of delegates from hospitals, universities, medical associations and the National Research Council was held in May, 1933, at Kingston, Ontario. The appoint-

ment of the Associate Committee on Radiology arose from this conference, and the committee held its first meeting in November, 1933. (3) Under the auspices of the Associate Committee on Survey Research, which had been appointed in the previous year, work has been fully organized and five technical panels have been appointed to give detailed attention to their respective problems. The division will be largely concerned with the work of these panels; already a large amount of work has come through the committee to the laboratories and to the Council workshops, and a great deal more is expected.

In connection with the Associate Committee on Radio Research active work was begun in a field station erected at Rockcliffe. The Council in this regard is greatly indebted to the very valuable and effective co-operation and assistance of the Department of National Defence, which undertook the erection of two field laboratories. The Council equipped this field station with necessary instruments and supplied the personnel. Continuous records of atmospheric disturbances are now being taken at the station.

Mention should be made of further work in co-operation with the Department of Agriculture on refrigerated transport of poultry and meats, particularly to the English markets. A special defrosting chamber was erected on the Surrey Docks, London, England, to the design and under the supervision of Dr. Howlett. This chamber can now be used for the purposes of taking refrigerated meat and poultry out of chill without the deposition of moisture and consequent damage to the salable value of the products.

Detailed accounts of the work carried out in the year by the division are herewith subjoined.

Metrology and Related Measurements

R. H. FIELD, W. J. LINFORD

Following instructions from the Minister of Trade and Commerce, the Dominion standards of weight and measure (established by the Weights and Measures Act) were transferred to the National Research Laboratories under the care of this section. Some attention was given to policy and the procedure to be followed in utilizing fundamental standards for calibrating secondary standards, particularly in consideration of the recommendations of the Imperial Conference of 1930. Correspondence on the subject is being exchanged with the National Physical Laboratory, London.

From time to time during the year it was found necessary to refer requests for standardizing operations to laboratories outside Canada, owing to lack of the necessary equipment.

Metrology

The laboratory standards of length were carefully rechecked in preparation for the arrival of four invar wires, 24 metres long, belonging to the International Bureau of Weights and Measures. These wires are being circulated to the national standardizing laboratories of those countries supporting the International Committee of Weights and Measures, and are for the purpose of comparing the lengths and thermal constants measured at different centres. Surprising discrepancies have been found in one or two instances, and the comparisons are complicated by secular changes in the wires themselves. The four wires reached the National Research Laboratories at the end of March.

Optical and Allied Instruments

Assistance was rendered to officers of the Geodetic Survey of Canada conducting an investigation of the errors in primary triangulation theodolites. The equipment for testing the theodolites was found quite suitable for this work, which resulted in important changes being made in the methods of construction. The investigations were described in papers published in the Canadian Journal of Research.

A practical design was prepared for a plotting instrument for air surveys, following a scheme proposed by the Staff Officer, Surveys, Department of National Defence, in co-operation with the Associate Committee on Surveys. In co-operation with the same committee, investigations were made of the effect of temperature on the constants of an air camera.

On behalf of the Geological Survey of Canada an improved form of parallax-measuring stereoscope was designed, and later constructed in the instrument shop.

The following list includes some of the standardization and associated tests made for government departments and others during the year:—

	Government	Commercial
Thermometers standardized	214	5
Clinical thermometers	2174	—
Hydrometers standardized	316	2
Air cameras calibrated	12	—
Photographic shutter speeds	55	—
Length measurements	33	6
Screens tested	2	3

Ballistics

D. C. ROSE

The new method of measuring the velocities of projectiles has been perfected. The bullet interrupts beams of light shining on photoelectric cells. The resulting current pulse in the photoelectric cell circuit, after being amplified, is recorded. Various methods of recording were investigated. The use of a thyratron or grid-controlled discharge tube in conjunction with an Einthoven galvanometer improved the accuracy of measurement considerably by eliminating disturbances caused by vibrations set up when the gun is fired.

The velocity measuring apparatus was designed primarily for rifle bullets and the tests were made in a short rifle range in the sub-basement of the National Research Laboratories.

Some attention was given to the application of this method of measuring velocities to larger projectiles. Small-scale experiments with rifle bullets indicated that the method was applicable to projectiles of almost any class by the construction of suitable mounts for the photoelectric cells and illuminating lamp.

The Development of a Grid-controlled Discharge Tube as a Light Source for Recording Purposes

D. C. ROSE

The development of an easily controlled discharge tube in conjunction with a rotating drum camera has been undertaken for recording purposes where short time intervals between phenomena must be accurately known.

The apparatus is being developed primarily to record the time interval between interruptions of beams of light by a rifle bullet and is a further development and simplification of the velocity measuring apparatus described above. Such a recording instrument, however, has many other applications, such as making records for particle counters or stroboscopic work of various sorts. Discharge tubes similar to commercial thyratrons have the desired characteristics in so far as the control of the discharge is concerned, but have been developed for their current-carrying capacity and not as light sources. Tubes having similar control characteristics are being developed with a view to improving their light-emitting properties.

Electrical Measurements Laboratory

A. J. GRANT

K. A. MACKINNON up to November, 1933

J. S. JOHNSON from January 22, 1934

Meter Approval

Fifteen types of meters or meter attachments were tested for approval of type. Six alterations in approved meters were investigated to insure that the alterations complied with specifications.

Field Investigation of Watt-hour Meter Accuracy in Connection with an Extension of the Reseal Period

The report on the above investigation, under authority of the Minister of Trade and Commerce, was completed and a full report with recommendations was sent to the Minister.

Moisture Testers

The moisture testers submitted to the Division of Biology and Agriculture for competitive tests were examined from the point of view of their characteristics as physical instruments.

Miscellaneous

In addition to the above other electrical precision work included standardization of standard cell voltages; tests on electrolysis of seaplane float plating and rivets; testing current and potential transformers; calibration of precision electrical apparatus; checks for fire or water damage on precision apparatus for Queen's University.

An investigation of electricity meter bearings and lubrication is in progress.

Electrical Engineering

B. G. BALLARD

Electrical Laboratories Equipment

A large portion of the staff's time has been devoted to the installation of equipment in various parts of the laboratory. The switchboards controlling the rotating machinery in the electrical engineering laboratory have been in operation for several months and work is proceeding rapidly on the switchboards and circuits controlling the various electric services.

A small 900-cycle alternator with step-up transformer has been set up and is now available for any work in the building requiring frequencies of this order at either low or moderately high voltages.

Voltage Regulation

During the year, a study of a regulator for precise voltage control of alternating current and direct current machinery, as well as speed control of direct current machinery, has been undertaken. Primarily, the control is being exercised by thyratron tubes, which in turn are controlled by other electronic tubes through a suitable system of amplification. This investigation is still in progress.

Electrical Accessories of Oil Burners

A number of oil burners have been submitted to the laboratory for approval listing. The electrical features of these burners were tested in accordance with the specifications of the Canadian Engineering Standards Association.

Various minor problems were undertaken, including the devising of equipment to measure temperatures in aircraft carburettors during flight, measurement of losses in a loading generator supplied with a gasoline knock-test engine, dielectric tests, etc.

Ultrasonics

G. S. FIELD

Vibrations in Rods—Viscosity Measurements

The measurement of the coefficient of solid viscosity is of considerable theoretical and practical importance, the latter particularly in the case of the heat treatment of metals. Arising out of previous work on vibrating rods, a method has been devised for measuring this coefficient, which it is hoped will be very useful. Considerable experimentation has been required to perfect this method, and the work is still going forward.

Depth Sounder Test

A commercial marine depth sounder has been tested in the water channel of the aeronautical laboratories. Although this is the first time a laboratory test of such apparatus has been performed to give direct results for depths up to 400 feet, the test was found to be very satisfactory.

Acoustics

G. S. FIELD

Testing Laboratory

Construction has been started on a laboratory for testing the acoustic properties of various kinds of building materials. It is expected that this laboratory will be in operation towards the end of the coming year, and that it will then be possible to undertake commercial testing.

Microphone Calibration

Apparatus has been set up for measuring the response of microphones for frequencies from about 30 to 8000 cycles per second. A great deal of experimentation has been done in an effort to make these measurements sufficiently precise, and more research is still required to make the apparatus completely satisfactory.

Light

L. E. HOWLETT

Photometry

The equipping of the photometric laboratory has proceeded satisfactorily during the year and it is now possible to calibrate lamps for horizontal and spherical candle power. Distributions of intensity around lamps and reflectors can also be determined. Routine tests of the above types have been performed during the year.

Grading of Eggs

The work of improving the candling of eggs in co-operation with the Poultry Division of the Live Stock Branch has been continued. As a result of this work the egg-grading methods and standards in Canada have been revised and improved. Further work is to be done on this problem. This work has been set forth and explained in a pamphlet sent out by the Department of Agriculture.

Spectrophotometry

The work of setting up apparatus for the accurate standardization of filters and reflectors is proceeding.

Routine Tests

A number of routine tests of an optical nature have been performed.

Cold Storage Research

L. E. HOWLETT

The project for the prevention of condensation on meat and poultry products coming from cold storage has been continued. Last year the successful completion of a small-sized installation for the purpose was reported. During the present year a large-scale plant has been equipped under the supervision of the staff on the Survey Commercial Docks, London, for the better handling of Canadian exports to the English market. Tests showing that this installation completely prevents condensation have been successfully made. A complete report of the project is contained in a bulletin issued by the National Research Council.

Co-operation has been given the Poultry Division of the Live Stock Branch along other lines where problems of Physics were involved.

Radium

G. C. LAURENCE

Certification of Needles and Tubes

During the year 188 radium preparations (of total content 1.207 gm. valued at about \$60,350) were measured, tested and certified. Of this amount 79% was prepared from Canadian ore.

Radioactive Purity of Canadian Radium

Radio from LaBine Pt., Great Bear Lake, was tested for mesothorium and found to be practically free from this objectionable impurity.

X-ray Equipment

The installation of equipment for X-ray standardization was completed.

Biophysical Investigations, etc.

Assistance was given to the Department of Agriculture in investigations of effects of X-radiation on germinal and other tissue in poultry. A few radiographic examinations of castings were made.

Heat

C. D. NIVEN

House Insulation

The work of testing various kinds of house insulation for commercial firms has been continued throughout the year as samples were submitted. Such tests have included work on several kinds of rock wool prepared by the Department of Mines and also on some samples of sphagnum moss sent to the laboratories from Alberta.

A "hot-box" apparatus is at present under construction; when this apparatus has been completed it will be possible to measure the heat transmission of samples of area 5 ft. \times 5 ft. by this larger-scale method of test.

High Temperature Insulation

The investigation on diatomite undertaken at the request of the Department of Mines has been completed. The report on this work has been submitted and clearly demonstrates that the heat insulation provided by the diatomite brick made at Quesnel, B.C., is very satisfactory. The work for the Division of Chemistry which consisted of making tests at about 300° F. on five samples of asbestos material, prepared on a laboratory scale, has also been completed.

Humidification of Houses

A number of tests were made on a new humidifier, a report on which had been requested by a commercial firm.

Temperature Standardization

The work begun two years ago in connection with the establishment of primary temperature standards is still being continued. The laboratory is now equipped for standardizing platinum thermometers at the three fixed points on the temperature scale, *viz.*, melting ice, boiling water and boiling sulphur. Provision has also been made for taking the melting points of zinc, lead, and antimony with the standard platinum, platinum-rhodium thermocouple.

Temperature Control in Railway Refrigeration Cars

The work begun last year in finding an apparatus to measure the temperatures inside cars indicated that these were unsatisfactory, but means to remedy this condition were not discovered. Work was accordingly undertaken to find what the heat loss from cars of different designs really was, and to investigate the possibilities of getting a better heating device than the standard "charcoal heater." The work is being conducted with the co-operation of the Department of Agriculture, the Canadian National Railway Company and the Canadian Pacific Railway Company.

Radio Research

J. T. HENDERSON

The work of this laboratory is covered in the report of the Associate Committee on Radio Research.

Aeronautics

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

During the year progress has been made in the equipping of the aeronautical laboratories and they are now reasonably well equipped. Progress has necessarily been slow, owing to the necessity of carrying on urgent work and to lack of workshop staff to construct the special apparatus required. Owing to pressure of work it has been practically impossible to make any calibration of the major equipment.

Lack of research staff has also resulted in the suspension of several important investigations. It has been necessary to proceed with the most important and urgent researches and tests, and consequently certain studies have been in abeyance for a year or more.

Most of the work in these laboratories has consisted of tests and development work. Pressure of testing work, coupled with lack of staff, has prevented the carrying on of pure research. Further, most of the work has been for government departments and particularly the Department of National Defence.

In this connection, it is a pleasure to acknowledge the very cordial co-operation of the Department of National Defence in this work. While, owing to curtailment of staff in the department, the sending of officers and men to the laboratories has had to be suspended, the department has assisted with personnel in certain of the tests.

It must again be emphasized that the equipment of these laboratories, while installed primarily for aeronautical work, will be useful for much work of a general engineering character and has already proved its usefulness in this way, as for instance, in the improvement of the hulls of boats and vessels and in current meter calibration.

Aerodynamic Laboratory

The most important accomplishment in the wind tunnel during the year was the completion and placing in operation of the aerodynamic balances. The balances, designed by the staff, have been under construction in the shops for some years. Since their completion they have been in constant use on different tests and have functioned satisfactorily. During the year the pit trolley, pit platforms, and control panel for the high speed model motor were installed, the concrete portions of the tunnel were painted to reduce the dust and the automatic speed control was checked and adjusted. A photographic multiple manometer has been designed and constructed and the construction of a small smoke tunnel commenced.

The first development tests were made, for a Canadian aircraft firm, of an aircraft being designed for freight service in the north country. At the end of the year the first aircraft wing rib was being set up for strength tests for certificate of airworthiness purposes.

Hydrodynamic Laboratory

An important piece of work carried out in the model-testing basin consisted of tests on models of a proposed 60-foot patrol cruiser for the Royal

Canadian Mounted Police. The cruiser "Interceptor" has since been built and launched and it is understood that the trial results of the cruiser compare very closely with those predicted from the tests of the model in the basin. The basin tests enabled certain improvements in performance to be effected.

Stability tests of barge models have also been made.

A study has been made of the possibility of rating current meters and anemometers in this laboratory. Current meters can be accurately, quickly and conveniently calibrated. Owing to air currents in the building the accurate calibration of anemometers at low speed is only possible in the basin laboratory under special conditions, but such calibrations may be made, as heretofore, in the wind tunnel.

Through the co-operation of the Director of Scientific Research, Air Ministry, a one-sixteenth scale model of a successful and much tested flying boat hull—the Singapore IIC—has been sent to the laboratories to check the technique and results of the Ottawa laboratory against those of English basins and to extend certain work being done in England.

The basin rails have been accurately aligned and leveled to within ± 0.0025 in., trolley wires and tuning fork timing system installed, and the towing dynamometer has been converted from an indicating to a recording instrument, recording time, distance, resistance and trim. Certain alterations have also been made in the recorder to facilitate current meter calibration and to permit tests of floats at fixed trim. A dock has been constructed at the operating end of the basin.

Engine Laboratory

(1) *Dynamometer laboratory.* Certain structural alterations were necessitated during the year, including the moving of the main doorway and crane rail and the construction of a gasoline storage room. Two gasoline storage tanks and piping have been installed. New apparatus provided includes a low range flow meter and air thermometers.

(2) *Detonation laboratory.* This laboratory has been engaged continuously throughout the year on tests of aviation gasolines, oils and engine accessories. Minor additions and alterations to the equipment have been made to facilitate and extend the scope of the work. The variable compression testing unit is being provided with a high-temperature cooling system.

(3) *Museum.* Working intermittently, as opportunity offered, two aircraftmen on loan from the Department of National Defence, have prepared certain aircraft engines and parts for display and have rigged a Camel aeroplane (war machine). The aircraftmen were recalled in July and since that time, owing to lack of staff, no progress has been possible.

Aircraft and Allied Instrument Laboratory.

The installation of this laboratory, after its removal from Cliff St., was completed, with the exception of certain pieces of special equipment, early in the year, and since that time the staff has been engaged continuously on the test, calibration and adjustment of instruments for government services and the test and calibration of instruments for commercial firms. Some progress has been made with the construction of a vibration stand for aircraft instrument testing and means have been provided for testing pressure gauges up to 4000 lb. per sq. in.

Special equipment to test the gauges used on water sprinkler systems was designed during the year.

The carbon dioxide refrigerator, which is capable of cooling its special test chamber to -40° F., besides proving efficient in the testing of instruments for which it was designed, has been of service to researches in other lines where very low test temperatures were required.

The facilities of the laboratory have been made use of by a subcommittee of the Associate Committee on Survey Research, to investigate the reported irregular operation of intervalometers and to devise means of improving the performance of these instruments.

The laboratory has rendered service to the government services of the provinces of Quebec and British Columbia in the adjustment and test of aneroid barometers for survey operations.

The laboratory has also rendered service to the Royal Canadian Air Force in the instruction of their aerial survey training classes.

Locomotive Research

Patents have been granted in the following countries on the external form for steam locomotives developed as a result of a study in the laboratory (see last year's report): Canada, England, United States of America, France and Switzerland; the claims have been allowed in Germany.

The Canadian patents are to be placed at the disposal of the Canadian National and Canadian Pacific Railways. (J. J. Green.)

Windmill Research

The dynamometer for this work was designed and largely constructed during the year. The windmill model had previously been constructed. Active work has been suspended for some months owing to pressure of other work. (G. J. Klein.)

Development of New Aircraft

A Canadian aircraft firm requested wind tunnel tests, for the purpose of checking the design and to obtain information on which to base performance calculations, of the model of a new aeroplane being designed and built in Canada. The machine is a convertible freight or nine-place passenger aeroplane, designed primarily for service in the mining districts of northern Canada. Extensive series of tests were made on the complete machine and on the individual components with the object of reducing the air resistance by such modifications as were permissible. Mutual interference of components was examined, the wing wake was explored from the standpoint of tail buffeting and the effect on the characteristics of the variation of position of wing relative to body was investigated. The effect of many suggested modifications was determined. The test results were corrected to give information applicable to the full-scale aircraft.

Two machines of the type are now under construction and are expected to be in operation in 1934. (J. J. Green, G. J. Klein.)

Patrol Cruiser

It was stipulated in the contract awarded for the construction of a 60-foot patrol cruiser for the Royal Canadian Mounted Police that the model should be tested in the model-testing basin at Ottawa. Two models having different lines were submitted. Tests were made to determine the better of the two designs for the specified conditions. Subsequently, numerous tests were undertaken on the model judged the better, with the object of increasing its performance. Considerable improvement was effected by certain modifications. (K. F. Tupper.)

Aircraft Pitching Moment

As a result of the difficulty experienced by pilots on photographic survey operations in preserving constant altitude with a certain aircraft equipped with floats, the Department of National Defence requested that a study be made in the wind tunnel with a view to discovering the cause and correcting the instability. The model constructed for pressure distribution tests was used. As a result of the tests in the wind tunnel the cause was found to be the large float spreader tube. A modified design of this tube has been built into one aeroplane of the type and it is understood that flying trials of the machine made by the Royal Canadian Air Force show that the trouble has been corrected. (J. J. Green.)

Aircraft Skis

Tests made on full-sized aircraft skis to determine the pitching moments (see last annual report) indicated that these were of considerable magnitude. As the Air Ministry proposed to send a Hawker "Audax" aeroplane to Canada for winter trials and as this aircraft has great maneuverability and a high performance, the pitching moments on skis fitted to this aeroplane were a matter of concern. The Department of National Defence requested that an endeavor be made in the laboratory to develop some means of reducing the aerodynamic pitching moment on aircraft skis.

An investigation, both theoretical and experimental, was made of the possibility of stabilizing the ski by means of an aerofoil at the rear and later by means of turning up the heel of the ski. An R.C.A.F. ski, size E, was used in the experiments. Gravity pitching moments on the ski were also measured.

After consideration of all the results, it was concluded that the rear turn-up was the better solution and a suitable turn-up was recommended for the "Audax" skis.

It is understood that flying trials by the Royal Canadian Air Force of the Audax with skis modified as recommended indicate the modifications to be satisfactory. (J. J. Green.)

Alcohol-Gasoline Blends

In co-operation with the Division of Chemistry, an investigation has been made of the mechanical characteristics—octane number, highest useful compression ratio, power and specific consumption—of blends of gasoline with 5, 10 and 15% of ethyl alcohol.

Later, in connection with the work of the Division of Chemistry on Turner Valley gas, a similar investigation was made of blends of gasoline with 10, 20 and 30% of ethyl alcohol, isopropyl alcohol, ethyl and isopropyl alcohol, and with 10 and 20% of benzene. (M. S. Kuhring.)

Engine Lubrication Indicating Device

At the request of the Department of National Defence, an investigation has been commenced with the object of developing some means for indicating the lubrication of internal combustion engines, particularly aircraft engines, which will take account of the viscosity of the lubricant, as well as the pressure. (M. S. Kuhring.)

Pressure Distribution over Tail Units of Aircraft

The model (Bellanca Pacemaker) and multiple manometer for this study have been completed. Active work has been suspended pending the completion of more urgent work. (J. J. Green.)

Formation of Gum in Gasoline

The bomb and heating tank for this investigation have been made but work has had to be suspended owing to lack of staff and pressure of other work. (M. S. Kuhring.)

Strength of Flat Rectangular Plates

A new testing fixture and testing technique have been developed, overcoming troubles encountered in using the original equipment. A special micrometer has also been designed and made. Some work has been done with the new equipment during the year and an interim report has been prepared. Loss of personnel has necessitated suspension of the work. (K. F. Tupper.)

Aircraft Float Research, Aircraft Slot Investigation and Effect of Humidity on the Operation of Internal Combustion Engines

These investigations have been suspended owing to the pressure of more urgent work.

Tests Completed or in Progress

Aircraft engine	Temperature calibration one- and five-gallon standard measures
Aluminium solder	Oil barge
Rotor propeller	Freight barge
Anemometer	10 cc. plunger
Water meter	Bronze tablet
Current meter	Aerial sign
Humidifier	Aircraft wing ribs
Gasoline dispenser (temperature compensated)	Aviation gasolines
Automobile engine moisture device	Lubricating oils

Tests Made of Aircraft and Allied Instruments

	Government	Commercial	Total
Height instruments	40	3	43
Airspeed instruments	46	3	49
Tachometers	51	7	58
Directional instruments	65	3	68
Altitude instruments	10	0	10
Engine gauges	69	5	74
Barometers and barographs	17	13	30
Hygrometers and hygrographs	3	1	4
Miscellaneous	4	1	5
	305	36	341

Inquiries

A total of 106 technical inquiries were answered, including the examination of 31 inventions.

Fire Hazard Laboratory

J. H. PARKIN, T. H. DOHERTY

This laboratory has been engaged continuously, and under considerable pressure, in the testing for safety of operation of domestic oil burners of both the pressure or automatic, and atmospheric or range types. Much of the pressure in connection with the work resulted from the requirement placed in regulations issued by the fire marshal of British Columbia that the oil burners for sale or use in the province should be approved by the National Research Council.

Some six pressure burners and 12 atmospheric burners of different types and models were tested and listed, and two atmospheric burners were under test at the end of the year under review. Some 49 inquiries regarding the testing of oil burners and other fire hazard tests were answered.

An increasing number of United States manufacturers are submitting burners for test, in order to have access to the Canadian market.

In order to render the work of the laboratory in listing oil burners more effective, a factory inspection and labeling service has been inaugurated and is now in operation.

Consideration has been given to the hazard involved in the use of so-called "Diesel" oil and of kerosene in atmospheric burners.

The equipping of the laboratory has continued. Additional apparatus, found necessary as a result of experience, or necessitated by test requirements, or required to facilitate the work, has been provided during the year, including: warm-air furnace, oil service tanks, atomizing chamber, valve tester, air ducts, large furnace 25-cycle motor-generator set, kitchen ranges and additional flues.

In co-operation with the Canadian Engineering Standards Association, considerable time has been devoted to the drafting of standards for oil burners of both the pressure and atmospheric types, and several conferences with manufacturers have been participated in.

An Associate Committee on Fire Hazard Testing has been organized under whose general direction the work of the laboratory will be carried on. The members of the committee also serve to keep the laboratory in touch with practice and developments in the field.

Numerous conferences have been held with representatives of the Hydro-Electric Power Commission of Ontario with the object of working out an arrangement covering the listing of the electrical parts of oil burners which will avoid unnecessary duplication of effort and expense to the manufacturer.

During the year, requests for the testing and listing of acetylene generators, gasoline lamps, stoves, etc., gasoline generators, dry cleaners' solvents, inhalators, gasoline engines for fire pump drive and fire extinguishers have been received. Much of this work cannot, under existing financial conditions, be undertaken. The testing of inhalators, dry cleaners' solvents, and gasoline lamps and stoves is either under way or in preparation.

Instrument and Model Shops

J. H. PARKIN

The functioning of the laboratories, as of any laboratories of the kind, is dependent on the provision of properly equipped and staffed instrument shops in which the special precision scientific instruments and apparatus,

designed and developed in the laboratories for use in the different researches, can be made under close supervision. Many such instruments and apparatus cannot be obtained on the market and experience has demonstrated that it is not feasible to have them made in outside shops. The character of such instruments and apparatus, their variety and precision require, for their production, accurate, resourceful and skilled mechanics and high-grade tools. The shops also undertake the modification, repair, installation and maintenance of the mechanical and electrical equipment of the laboratories and construct the accurate scale models required for wind tunnel and testing basin work.

A considerable amount of work, of a character that cannot be done conveniently elsewhere, is also done for other government departments.

Some of the instruments and equipment constructed in the shops during the year under review are listed below and will serve to indicate the character and variability of the work:

Electrostatic voltmeter	Aerodynamic balances
Dough modifying machine	Windmill dynamometer
Valve testing apparatus	Electrical switchboards
X-ray spectrometer	Model aircraft
Optical micrometer	Integrating photometric sphere
Leather wear testing machine	Photometer bench

The central laboratory shops include machine shop, fine instrument shop, sheet metal, forge and welding shop, cabinet shop, tool crib and stores, together with drafting, blueprinting and photostatting facilities. Provision of an electrical shop is under way.

The shops function under the direction of a Workshops Committee composed of members of the laboratories' staff, under the chairmanship of the president, through the technical officer in charge of the shops.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

Detailed information regarding the work of the division will be found in the annual report for 1931-32, pages 57-61. The following brief statement merely outlines the more important activities of the division for the year under review.

National Research Library

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

The need for economy has again been an important factor in the work of the library. Faced with the necessity of reducing expenditures to a minimum, the Library Committee, which is responsible for all purchases, decided to continue its subscriptions to all the more important periodicals in order that the files of these might be unbroken, but to purchase only those sets and individual volumes most urgently required.

The total number of regular and irregular publications received is now 818, of which more than 100 are obtained in exchange for the Canadian Journal of Research. Eight periodicals of little value have been dropped and 40 new periodicals have been added to the list.

The number of volumes accessioned during the year was only 1765, including 710 volumes of periodicals bound. The accession number at present is only 14,166 (not including pamphlets), a number so small as to indicate

that when economic conditions improve the Library Committee must consider the provision of a large number of sets of periodicals required for reference purposes. Many important scientific sets are not available in any Ottawa library and some of these are not found in any library in Canada.

A further indication of the inadequacy of the present library is seen in the fact that during the year under review it was necessary to obtain books or periodicals on loan from 18 libraries in Canada and six in the United States. While the necessity for occasional loans can never be entirely eliminated, the number of such loans should be greatly reduced, as the delay in obtaining information frequently involves serious inconvenience. It may be noted further that those members of the staff of the division who give most of their time to a study of the literature frequently have to spend long periods in other libraries in Ottawa, particularly in those of the Departments of Agriculture and of Mines; the number of loans from other libraries would otherwise be greatly increased.

Twenty-nine photostat copies of articles have been received from other libraries during the year, and 306 patent specifications have been purchased. The latter are particularly important in connection with the development of industrial researches being carried out in the National Research Laboratories.

The library has continued to house the library of the Royal Society of Canada and certain scientific sets belonging to the Library of Parliament. Recently certain books of the International Joint Commission have also been placed in the stacks. The co-operative arrangements with the above organizations are gratefully acknowledged.

During the year loans for use outside the library have increased to 3,248, in addition to the routine circulation of a large number of periodicals among the Council's scientific staff. Loans have been made to 18 other libraries, government departments and institutions. Through the co-operation of the Division of Physics and Engineering a photostat service is maintained whereby copies may be secured, at cost, of articles in the National Research Library.

Research Information Service

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

Increasing use is being made of the facilities of this branch, both by the scientific staff of the National Research Laboratories and the technical and scientific workers in the universities, research organizations and industries throughout the country. In fact, there has been such an increase in the number of inquiries that the staff has been quite incapable of dealing fully with all of them. Fortunately most of the inquiries received, especially those from the general public, are of such a character as to involve little or no search of the literature. Where possible, inquirers are directed for information to specific references available in libraries accessible to them, or books containing the information desired are sent as loans from the National Research Library. In many cases, however, the information asked for is not contained in any single book or periodical and it is necessary to prepare reports containing summaries of the literature and references to original articles in which more detailed information can be found. In a few cases, particularly those pertaining to important investigations under way or contemplated, it is necessary to prepare fairly complete summaries of the information available in the literature of the world. In the latter class are found a number of inquiries from committees or laboratory divisions of the National Research Council.

The following is a list of some of the more important reports prepared by this branch during the year under review:—

- Alcohol Fuel in Internal Combustion Engines, by A. C. Halferdahl.
(Revised report.)
- Analyses of Canadian Public Water Supplies (mimeographed), by C. A. MacConkey.
- Apparatus for Determining the Resistance of Materials to Abrasion, by M. E. Whalley.
- Canada Balsam, by M. E. Whalley.
- Chrome Poisoning, by M. E. Whalley.
- The Distribution of Thunderstorms and Frequency of Lightning Flashes; A Review, by R. Ruedy.
- Electrical, Acoustic and Thermal Insulation of Asphalt Layers, by R. Ruedy.
- Electrolytic Filter Condensers, by R. Ruedy.
- Elements of Wood Impregnation, by R. Ruedy.
- Flexible Steel for Belting, by A. C. Halferdahl.
- Jerusalem Artichoke, by M. E. Whalley.
- Insulators for Vacuum Tube and Radio Frequency Equipment, by R. Ruedy.
- Knock Inhibitors, by R. Ruedy.
- Malt (mimeographed), by C. A. MacConkey.
- Manufacture of Ammonium Chloride, by M. E. Whalley.
- The Manufacture of Charcoal from Fruit Pits, by M. E. Whalley.
- The Radium Situation, by A. C. Halferdahl.
- Recent Literature on Luminescence of Solids and Liquids in Ultra-violet Light, by R. Ruedy.
- Recent Work on Lithium and Its Uses, 1927–1933 (mimeographed), by R. Ruedy.
- Recipes for Making Cheeses, by M. E. Whalley.
- Recovery of Sulphur and Sulphur Dioxide from Metallurgical Gases and Sulphides, by A. C. Halferdahl.
- Refrigerating Machines Without Moving Parts—Preliminary Report, by R. Ruedy.
- Report on Projection Room Regulations and Practices, by a Committee of the National Research Council.
- Selenium (mimeographed), by C. A. MacConkey.
- The Service Testing of Power Cables, by R. Ruedy.
- Spruce Gum, by M. E. Whalley.
- Standards for Judging Dressed Poultry, by M. E. Whalley.
- Steam-pipe Coverings, by R. Ruedy.
- Sulphurized Oils, by C. A. MacConkey.
- A Summary of Recent Papers on B.C.G., by M. E. Whalley.
- Utilization of Tobacco Waste (mimeographed), by M. E. Whalley.
- Vitamin Potency of Cod Liver Oils, by M. E. Whalley.

Publications

W. W. THOMSON, G. A. LEDINGHAM, MISS D. DESBARRES

The following publications have been issued during the year:—

Canadian Journal of Research (12 issues, two volumes)	1,324 pages
Sixteenth Annual Report of the National Research Council	113 pages
Report No. 28, The Comparative Feeding Values for Live-stock of Barley, Oats, Wheat, Rye and Corn, by E. W. Crampton	107 pages

Prior to the establishment of the Canadian Journal of Research, the National Research Council issued two series of publications, "reports," describing investigational work of original character carried out by or for the Council, and technical "bulletins" covering studies of the literature or summarizing the information available on specific subjects, the latter being comparable to reports now being prepared by the Research Information Service. The research publications of the Council have now been largely replaced by the Canadian Journal of Research, which offers a more suitable medium for the purpose of making known to the scientific world the results of the Council's work. The Journal is not limited, however, to scientific papers covering work supported by the Council, but is open also to suitable papers by any Canadian investigators.

Of the 121 papers published in the Canadian Journal of Research in the year ending March 31, 1934, 31 were written by members of the Council's staff and describe work carried out in the National Research Laboratories; the authors of 33 papers received financial assistance from the Council for the work described, and the remaining 57 dealt with work carried out by other Canadian investigators, usually in universities or by government departments.

Previous to the establishment of the Journal it was necessary to send a large proportion of Canadian scientific papers to the United States and Great Britain for publication and as a result Canada lost much of the credit which should have been hers.

At present the Canadian Journal of Research is not confined to any particular branch or branches of science, any research papers of suitable quality being acceptable. In view of the fact that its field is so broad, however, the Council is giving consideration to the possibility of dividing the Journal into three or four parts, to be issued separately as monthly or bi-monthly periodicals. Such a change, it has been ascertained, would be welcomed both by contributors and subscribers. In this connection it is of interest to know that of the 121 papers published during the year, 47 were in the field of biology and agriculture, 51 in that of chemistry and 23 in those of physics and engineering.

In addition to the above publications handled by the permanent editorial staff at Ottawa, there were issued in Vancouver, by the staff of the Fifth Pacific Science Congress, a Congress Guide and Scientific Program of 116 pages, three excursion guide books with a total of 138 pages and abstracts of the scientific papers presented at the congress, comprising a total of about 400 pages. A large amount of work was done in the preparation for publication of the more than 500 manuscripts presented at the congress, which it is expected to publish in the latter part of 1934.

Outside Research Activities

F. E. LATHE, S. J. COOK, A. C. HALFERDAHL

In general it has been necessary for the National Research Council to restrict to a considerable extent its outside research activities, as a consequence of which there has been some decrease upon the demands made upon the staff for secretarial and other duties performed in this connection, and a further decrease is contemplated during the succeeding year. The holding of the Fifth Pacific Science Congress in Victoria and Vancouver in May and June, 1933, however, greatly increased the duties of those of the staff charged with secretarial and editorial duties in connection therewith. An account of the congress will be found in this report beginning on page 108.

SUMMARY OF ACTIVITIES OF ASSOCIATE COMMITTEES

Associate Committee on Agriculture

Co-operating organizations:

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

In recent years Canadian agriculture has been passing through a very serious crisis. In the rehabilitation of the industry and in laying the foundations for future progress there is urgent need for the scientific investigation of many pressing problems. The Associate Committee on Agriculture, by virtue of the national character of its membership, can view these problems as they affect the agriculture of Canada as a whole and by free interchange of information regarding the research programs of the co-operating institutions can aid in the prevention of unnecessary duplication of effort and expense. The committee has also the special function of advising the Council with regard to the assistance which it can give to the development of agricultural research and through suggestions and constructive criticism to extend the usefulness of the National Research Laboratories.

The third meeting of the committee was held in November, 1933. At the request of the chairman, the members submitted statements of the research problems in agriculture considered of importance by the staffs of the co-operating institutions. These statements formed the basis for discussion. In several cases, it was disclosed that active work is proceeding in one institution on problems suggested by another, and so duplication of effort was prevented. Other problems were found to be of purely local significance and the responsibility of the local institution for their solution was made clear. Several problems of importance to all sections of the country were presented and in these cases the committee made recommendations of the steps to be taken to initiate co-ordinated and comprehensive action. For example, several members stressed the desirability of the investigation of cold storage problems. It was recommended that the National Research Council should call a conference of those interested, to formulate and co-ordinate a dominion-wide program of cold-storage investigation. As a result, the field of investigation has been apportioned among the institutions possessing the necessary equipment, and arrangements have been made for a co-operative attack on common problems. Active research under this scheme is now under way.

A statement of the activities of the various associate committees of the National Research Council, which are carrying on work in the field of agri-

culture, and of the research on agricultural problems in progress in the National Research Laboratories, was presented to the committee, and suggestions were made for the development of the work.

A progress report covering the activities of the Research Committee of the Canadian Society of Technical Agriculturists was read. Copies of the reports on "Entomological Research Projects in Progress in the Dominion of Canada, 1933," and on "Research and Experimental Projects in Dairying under way in Canada, 1933 Survey" prepared by the society were tabled for the information of the committee.

The relation of the Council to other Canadian research organizations was fully discussed. The chairman stated that it has always been the desire of the Council to stimulate and assist research in the university and other laboratories throughout Canada, and that the Council has no desire or intention of attempting to centralize all research work in agriculture in its laboratories. Attention was called to the fact that notwithstanding the difficult financial situation which has recently existed, the National Research Council has rendered considerable assistance toward researches in the field of agriculture in outside institutions, more particularly in connection with the large co-operative investigations which have been in progress for a number of years, such as those under the associate committees on Field Crop Diseases, Grain Research, Parasitology, Tuberculosis, Weed Control, Wool, etc.

Associate Committee on Asbestos

Co-operating organizations:

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

The seventh general meeting of the associate committee was held in Sherbrooke on January 29, 1934. Most of the discussions referred to researches and testing under way in the National Research Laboratories and are reported under the Division of Chemistry, page 32. Satisfaction was expressed by the industrial representatives at the quality of the work being carried out in the laboratories by Messrs. Wolochow and van Winsen under the direction of Dr. G. S. Whitby.

An important part of the committee's work during the year had to do with the Quebec standard testing machine and in particular the nature of the screens used. For the purpose of studying this question a special committee had been set up under the chairmanship of Mr. H. A. Smith. This committee arranged for and supervised tests of various fibres on the commercial and standard machines using brass, iron and stainless steel screens. Final specifications for all details of a standard machine were eventually agreed upon and arrangements were made for the distribution of drawings of the standard machine by the National Research Council.

Steps were taken looking to closer co-operation between the industry and the research staff. It was agreed that there should be at least one general meeting held each year in Ottawa, in order that the members might have the opportunity of seeing work under way in the National Research Laboratories. The Quebec Asbestos Producers Association was also invited to send a representative to each meeting of an internal committee on asbestos research formed at Ottawa.

Associate Committee on Chemical Standards

Buyers and users of chemicals and chemical products in Canada have depended in the past upon standards developed in other countries.

In the export field, manufacturers of Canadian products have had to meet the requirements of the users in the countries to which their products have been exported. Importations of chemicals and allied products into Canada, except in a few instances, have not been subjected to the same restrictions.

As forecast in the annual report for 1932-33, the Associate Committee on Chemical Standards set up by the National Research Council to study this problem made a survey during the year just closed to determine the extent to which materials are purchased or sold in Canada on the basis of chemical specifications. Replies to this inquiry indicated a rather cordial appreciation on the part of the manufacturers of the fact that the National Research Council had embarked on this field of study. On the other hand, many of the letters emphasized the necessity of giving full consideration to the work done by trade associations in devising standards, and others expressed the opinion that the relative smallness of the market for chemical materials in Canada militated against the establishment of many significant standards.

Investigation by the committee showed that standards have been established by many organizations, both public and private, in other countries to govern the quality of chemical products which appear in the list of Canadian manufactures. A preliminary survey indicated that standards of this kind have been created in other countries for more than 150 chemical products which are made in Canada. It follows that if any of these 150 products are exported to any of the countries which have established specific standards of quality and grade, the Canadian product will be required to meet the foreign standard. Similarly, if Canada imports a given material from several different countries it might easily happen that a variety of different grades or qualities could be introduced into the Canadian market under a common name with nothing to distinguish the one from the other. Thus the importance of establishing definite chemical standards for the protection of the purchasing public is apparent.

Many products are still described in purchase orders as "good quality," "commercial grade," "technical" and in other ways that are not capable of precise definition; in effect, the descriptions in each case mean only the product of the company with whom the order is placed. Indeed, it is quite usual for a buyer to specify a particular company's product because he knows that it is suitable for his purpose. It was thought that a national organization such as the associate committee could do useful work by bringing all these practices under review and that by this means chemical standards for specific grades and uses, which would be acceptable to buyers and manufacturers alike, might be established.

In the field of drugs and pharmaceuticals, the British Pharmacopoeia, the United States Pharmacopoeia, the Codex, the Canadian Formulary and the National Formulary are the accepted authorities in Canada. Drugs and medicines are required under the Food and Drugs Act to meet the specifications prescribed in these standard references.

But there are a great many products made from chemical raw materials for which no national specifications exist, such as soaps, oils (animal, fish, mineral and vegetable), paints, adhesives, dyestuffs, extracts and essences,

inks, insecticides, and pulp and paper products. In these it will be recognized that two types of standards are involved:

- (a) Basic standards relating to the composition of the chemical raw materials used;
- (b) Secondary standards defining the compounded or manufactured products.

Of these the first is fundamental. Standards for recognized chemical products must be known before the composition of manufactured or compounded materials made from such chemicals can be defined satisfactorily. Whether it will be either possible or desirable to create national standards of this secondary type will depend upon a number of factors that have still to be investigated.

The associate committee has established close working relations with the British Standards Institution and obtains from that organization copies of the draft specifications for all chemical products before the standards are definitely established. These draft specifications are being brought to the attention of interested Canadian manufacturers for comment and criticism and their views are being communicated to the British Standards Institution. To date upwards of 25 tentative specifications have been received from Great Britain and have been submitted to firms in Canada, who have manifested considerable interest in the matter. The advantage of this connection with the British Standards Institution is that Canadian manufacturers through the Associate Committee on Chemical Standards are being afforded an opportunity of expressing their views as to the suitability of proposed British standard specifications. When these standards relate to products which are made in Canada the importance of the liaison is obvious.

It was also found that certain organizations have developed standards for the guidance of their members. For example, the American Wood Preservers Association has established trade specifications for such commodities as toluol, xylol, creosote oil, tar acid oil, and technical grade phenol, and these standards are accepted and used in the creosoting and wood treatment plants throughout America; similarly other trade associations have established certain standards with respect to products that are used by their members.

Incidental to, but of fundamental importance in the establishment of standards, is the determination of satisfactory methods of analysis. As yet not much progress has been made in this field but its importance is recognized and information is being kept up to date with reference to developments in analytical procedure.

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

Alberta Department of Mines

Alberta Research Council

American Society for Testing Materials, Sectional Committee on
the Classification of Coal

Federal Department of Mines

In the interests of economy the Council decided to call no meeting of this committee during the year. Much work has, however, been carried out by correspondence. The Ottawa group has held two meetings and representatives have been sent to two meetings of the American committee, with which the closest co-operation has been maintained.

Meetings of the American committee and of several subcommittees were held in Pittsburgh in October, 1933, and Messrs. B. R. MacKay, J. H. H. Nicolls and F. E. Lathe were sent to these meetings as representatives of the associate committee. At these meetings reports were presented of progress in laboratory investigations under way in both the United States and Canada, and the bearing of the new information upon the subject of coal classification was discussed. The first report was presented of the Subcommittee on Nomenclature, a subject which of necessity is closely bound up with the questions of groups or classes of coals and boundary lines.

At the annual meeting of the American Institute of Mining and Metallurgical Engineers, held in New York in February, 1934, considerable attention was given to papers on coal classification, some of which were prepared by Messrs. E. Stansfield and R. E. Gilmore, members of the Canadian committee in attendance at that meeting. At the committee meetings held in conjunction with this gathering, decision was reached to pass on to the American Society for Testing Materials and American Standards Association, the sponsoring organizations, a tentative system of coal classification which received the general approval of those in attendance.

The recommended system of scientific classification, which has not yet been finally considered by the Canadian committee, involves the establishment of four main classes, anthracitic, bituminous, sub-bituminous and lignitic, each of which is subdivided into groups according to the composition and properties of the coals. This classification is to be made on the basis of pure coal, that is, coal with the mineral matter eliminated by calculation. Coals of 69% fixed carbon or under are to be classified on the basis of dried samples, those of lower fixed carbon content on the basis of the natural bed moisture. Full details are given in the Report of the Sectional Committee on Classification of Coals published by the American Society for Testing Materials.

Much experimental work has been carried out during the year by the Dominion Department of Mines and the Alberta Research Council. Mr. R. E. Gilmore and associates have continued their general researches on coal and in particular have carried out a series of tests on agglomeration. Dr. B. R. MacKay of the Geological Survey has extended his studies of the western coal fields, in which coal classification has been one of the primary considerations, and has made investigations on the nature of the coal deposits of Cape Breton. Prof. Edgar Stansfield, working with financial assistance from the Alberta and National Research Councils, has continued his standardization of testing procedure. He has also investigated the effect of humidity on weathering tests, the oxidation of coal and its ignition temperature.

Associate Committee on Electrical Measuring Instruments

Co-operating organization:

Electricity and Gas Inspection Service, Department of Trade and Commerce

The sixth meeting of the associate committee was held in Ottawa on August 21, 1933, being the first since the spring of 1931. In the meantime a subcommittee and a special committee appointed by the Council had given consideration to definitions of derived units used in the measurement of electricity. This question was very fully discussed at the meeting, as it was considered important to define accurately the units upon which a large part of the work of the committee was to be based. Prof. Price submitted import-

ant considerations touching the question of definitions of certain alternating current units, such as "reactive power," "kilovoltampere," etc. The special committee presented a recommendation regarding the acceptance of the unit "var," which was before the International Electrochemical Commission. After a long discussion it was finally agreed that the matter be referred for further study to a subcommittee with Prof. H. W. Price as chairman, and Professors C. V. Christie, V. G. Smith and G. A. Wallace as members. Pending a final decision it was agreed to accept tentatively the recommendations of the special committee.

Dr. Boyle and Mr. Grant, of the Division of Physics and Engineering, reported upon the investigation carried out on the re-seal period of watt-hour meters. This involved the testing of 3,000 meters in 18 cities and towns across Canada. A report on the subject was in preparation for the Minister of Trade and Commerce.

Dr. Boyle and Mr. Ballard reported to the committee on the work of the Special Committee on Electrical Units and Regulations, which is closely related to the work of the associate committee. Four specifications, which had been issued by the committee, were distributed to those present, as follows:

- Watt-hour and Ampere-hour Meters
- Demand Meters
- Curve Drawing Instruments
- Instrument Transformers and Phase Shifters

An account of the work of this special committee will be found on page 110 of this report.

The committee was informed that reports had been prepared by Dr. Ruedy of the Division of Research Information on Recent Work on Frequency Regulation in Power Systems and The Service Testing of Power Cables. A number of copies of these reports were distributed.

Associate Committee on Engineering Standards

The primary object of the committee's work is to set up standards for the guidance of Canadian industry. These standards, the observance of which is purely voluntary, are nevertheless being widely adopted by provincial and municipal governments and industrial firms throughout the Dominion. In the establishment of standards, manufacturers and consumers are called together in conference and jointly agree upon such standards as are believed to represent the best practice in the particular industry concerned. The adoption of standards of manufacture or practice normally results in products of higher quality, reduced cost of manufacture, reduction or elimination of fire and health hazards, decrease in number of sizes and shapes, and other benefits which accrue to manufacturers and middlemen and are in large part passed on to consumers.

The associate committee is also the main committee of the Canadian Engineering Standards Association, an incorporated body which receives financial support about equally from the National Research Council and from member firms. This committee is now composed of 53 members, of whom the following are representatives of the National Research Council, Dr. H. M. Tory, Dr. A. Frigon, Dr. R. W. Boyle, Mr. F. E. Lathe and Mr. J. H. Parkin.

The work of the association is carried on by various committees, the members of which give their services without any remuneration whatever. The executive work is done by a paid secretary and staff. During the year under review the offices of the association were moved to the National Research Laboratories, Sussex Street, Ottawa.

NEW PUBLICATIONS

There have been eight publications issued during the year, as follows:

B35-1933 (July, 1933)—Established List of Binder Head Screws.

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

C22.2 No. 5-1934 (March, 1934)—Construction and Test of Service-entrance and Branch-circuit Breakers.

C22.2 No. 6-1933 (December, 1933)—Construction and Test of Electric Clocks.

C22.2 No. 7-1933 (September, 1933)—Construction and Test of Portable Electric Displays and Incandescent Lamp Signs.

C22.2 No. 9-1933 (December, 1933)—Construction and Test of Electric Fixtures.

C22.2 No. 10-1933 (September, 1933)—Construction and Test of Electric Floor-surfacing and Cleaning Machines.

C22.2 No. 11-1934 (March, 1934)—Construction and Test of Fractional Horsepower Motors.

C22.2 No. 12-1934 (March, 1934)—Construction and Test of Electric Portable Lighting Devices (Portables).

These specifications outline conditions which must be met to secure approval of sale of the particular type of apparatus in Canada and have been prepared with the full co-operation of interested manufacturers, insurance interests and inspection departments.

CIVIL ENGINEERING AND CONSTRUCTION

Building Materials. The special panel of the general committee on building materials appointed to consider standard sizes for building brick has been active, and a questionnaire was issued in which the suggestion was made that there be set up two standard sizes covering common brick and face brick. The establishment of a standard brick is almost universally favored, and after consideration of the replies received it has finally been decided to recommend one size of brick for all purposes. A special report has been prepared and submitted to the panel on brick sizes and later on will be submitted to the committee on building materials.

Steel Construction. Following up a report which was made by the committee on standards at the Imperial Economic Conference in Ottawa in 1932, consideration has been given to specifications for steel. A joint panel of the C.E.S.A. committees on bridges and buildings has been in operation during the year and has held three meetings. It has finally been decided to organize a new sectional committee on steel construction and the joint panel has been constituted a subcommittee of this sectional committee and as such has held one meeting. The organization of the new sectional committee is practically completed. Special attention will be paid to the specifications for steel, especially the use of high carbon steel which will allow the use of higher working stresses. Under the subcommittee three panels have been organized dealing with steel bridges, steel buildings and structural steel welding, and all these panels are now at work.

MECHANICAL ENGINEERING

Screw Products. The established list of binder head screws has now been published and it is hoped shortly to publish the standard for machine carriage and plow bolts, as up-to-date information has been received.

Information on standards for wood screws and small rivets is being obtained but the first draft of specifications has not yet been prepared.

Safety Code for Mechanical Refrigeration. A committee has now been organized to prepare a safety code for mechanical refrigeration with special attention to conditions affecting health, this being emphasized by the Dominion Department of Public Health.

Oil Burner Regulations. At the request of the National Research Council a committee to prepare draft regulations for oil burners has been organized. It held its first meeting in June, 1933. A special panel was appointed to deal with atmospheric oil burners and a conference with manufacturers was held in September, 1933. As a result a first draft covering definitions and construction has been prepared. Another panel to deal with power-operated burners was appointed and a conference with manufacturers was held in March, 1934, at which a preliminary draft was discussed. A revised draft is now being prepared.

Fuel Oil. In connection with the work on oil burners it has been decided to give consideration to a specification for fuel oil, and a conference with the oil manufacturers was held in March, 1934, when it was decided to prepare a preliminary draft.

ELECTRICAL WORK

Canadian Electrical Code, Part I. The special committee on code revisions has been preparing material for the third edition of the Canadian Electrical Code. Preliminary drafts were sent out to the different provincial code committees and a meeting of the special committee was held in Toronto in March at which it was decided to send out a complete revised draft to the committee for approval.

Canadian Electrical Code, Part II. This covers essential requirements and minimum standards for electrical equipment. The work is carried on by a special panel which prepares approval specifications. This work has been very active owing to the change in the arrangements for testing and approval which took effect on January 1, 1932, whereby the Underwriters Laboratories, of Chicago, practically withdrew from the Canadian field. Twenty-six specifications have been under consideration, eleven of which have been published (seven as indicated above) and others will soon be ready for publication. The panel on specifications held 15 meetings during the year to discuss draft specifications. These included specifications for service-entrance and branch-circuit breakers, fractional horsepower motors and portable electric lighting devices which have now been published. Consideration was also given to specifications for enclosed switches, capacitors (electrical condensers), transformers for luminous-tube signs and oil-burner ignition equipment, industrial control equipment in non-hazardous locations, electric heating pads, cable for luminous-tube signs and oil-burner ignition equipment, outlet boxes, soldering lugs, motor-operated blowers and stokers, cord sets, gasoline measuring and discharge devices. Other specifications which are in draft form cover insulated conductors for power-operated radio devices, oil circuit breakers, automatic controllers of small capacity and dust-tight equipment.

Canadian Electrical Code, Part III. This deals with outside wiring rules. Drafts covering definitions and principles for inductive co-ordination and principles and practices covering radio interference have been prepared and circulated to the special panel on outside wiring rules. A draft of principles and practices for the protection of underground structures from the effect of stray currents has been prepared by a special sub-panel and will shortly be submitted to the panel for approval. In connection with overhead systems a special report prepared by the railway group has been submitted to the special sub-panel for comment. No report is yet available on underground systems.

Electricity Meters. The draft specifications for a.c. watthour meters and demand meters were considered at a meeting of the committee held in June, 1933, but these drafts have not yet been finally approved.

Insulated Power Cable. Comments have been received on the report prepared by a special panel on lead-covered paper-insulated cable and a second report on armoring for cable has been issued, but a draft specification has not yet been sent out for approval.

Enameled Magnet Wire. A committee has been organized, and one meeting was held during the year. A preliminary draft has been sent out to the committee for comment.

Oil Circuit Breakers. A committee has been organized and its first meeting was held in February, 1934. At this meeting a special panel was appointed to co-operate with the panel on specifications under Part II of the Canadian Electrical Code to consider a draft specification for oil circuit breakers. Another panel has been appointed to consider the necessary arrangements for testing facilities which are not now generally available in Canada.

Bulletins to Electrical Manufacturers. A system of bulletins has been inaugurated under which advance information is given of changes in test requirements or proposed revisions to the Canadian Electrical Code. Under this system seven bulletins have been issued during the year.

FERROUS METALS

Heavy Steel Shaft Forgings. The committee has held two meetings during the year to consider a draft specification. A revised draft has been issued and is before the committee for comment.

SALE OF PUBLICATIONS

There has been no diminution in the sale of C.E.S.A. publications during the year, which indicates that they are serving a useful purpose in industry. There has also been considerable sale of specifications issued by the British Standards Institution.

Associate Committee on Field Crop Diseases

(Western Section)

Co-operating organizations:

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

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

As a measure of economy, the committee decided not to hold a full meeting in 1934, the first break in 10 years. It was essential, however, to hold a meeting of representatives of the Subcommittee on Plant Breeding and the Grain Research Committee to deal with the results of the co-operative tests of new varieties. The second joint conference of these two groups was held in the Dominion Rust Laboratory, Winnipeg, on April 6, 1934. Other members of the committee for the most part contributed summaries of their activities and results obtained during the year. These were compiled, mimeographed and distributed by the Council, so that members might be informed of all progress, even in the absence of the usual meeting.

THE CO-OPERATIVE TEST OF NEW WHEAT VARIETIES

The most important activity of the Subcommittee on Plant Breeding was the continuation of the co-operative test of 32 promising new varieties, together with four old varieties for comparison, at 13 places in the prairie provinces. Comprehensive milling and baking data were obtained through the co-operation of the Associate Committee on Grain Research. The quality tests conducted in the cereal research laboratories of the Cereal Division, Ottawa, the Board of Grain Commissioners, Winnipeg, and the Universities of Alberta and Saskatchewan, included studies of grade, weight per bushel, protein content, yellow pigmentation and experimental baking tests by various procedures designed to reveal the baking characteristics under a wide range of conditions.

Several of the new varieties showed excellent quality coupled with desirable agronomic characters and resistance to rust and other diseases. Arrangements were made to multiply the seed of some of the new varieties so that grain will be available in the fall for commercial milling and baking tests as an added safeguard before distributing the new varieties to wheat producers.

A number of the new varieties in the test were discarded, primarily on the basis of the data obtained from the quality tests. A few new ones were added for the 1934 tests and also two additional old ones for comparison, namely, Garnet and Early Triumph. The other four old varieties are Marquis, Reward, Ceres and Huron. The 1934 co-operative test will contain 25 varieties and will be grown at 15 stations in the prairie provinces.

(Data compiled by Dr. C. H. Goulden and Dr. W. F. Geddes.)

THE CANADIAN PLANT DISEASE SURVEY FOR 1933

The thirteenth annual report of the Canadian Plant Disease Survey has been compiled and distributed by the Division of Botany of the Dominion Experimental Farms.

In accordance with the suggestion for improving the survey, as contained in the Report of the Subcommittee on Plant Disease Survey and in the dis-

cussion of this report before the associate committee last year, two new sections have been added to the report, namely, "New or noteworthy diseases" and "The weather and its influence on plant diseases."

The cereal rusts were of little importance throughout western Canada in 1933. Wheat stem rust occurred only in traces and caused no appreciable damage. Stem rust was equally scarce on other cereals. Leaf rust of wheat caused some damage in northern Manitoba.

The cereal smuts were not prevalent in western Canada in 1933. Bunt has fallen in prevalence for three consecutive years. Loose smut of wheat has become less prevalent in western Canada but has become very prevalent in Prince Edward Island.

Take-all was found to be fairly abundant on the prairies only where moisture was sufficient to carry the crop to maturity. The *Helminthosporium-Fusarium* foot rot, however, was widespread in dry areas. Browning root rot was severe early in June in parts of Saskatchewan. Where rain was plentiful, recovery from severe injury was rapid, while in the dry areas the symptoms soon merged into those of drought. A new foot rot of oats was found in Alberta.

Fire blight of apples was reported from Saskatoon. Alfalfa in the past has not been affected with downy mildew to a degree where it was very noticeable in the field. The Lytton strain which was recently introduced was severely affected while other varieties were only slightly so.

(Survey compiled by I. L. Connors.)

RESEARCH IN ALBERTA

Dominion Laboratory of Plant Pathology, Edmonton

In rotation studies at seven stations in Saskatchewan and Alberta it was found that foot rot damage of wheat is significantly reduced where wheat follows summerfallow, oats or sweet clover, or where it is sown late. It is increased where wheat follows wheat, barley or western rye grass. Moisture and other factors of the environment were more effective than the crop sequence in modifying the relative prevalence of *Helminthosporium* and *Fusarium* foot-rotting fungi.

Over 100 varieties and strains of wheat were tested in a disease garden for resistance to the common foot-rotting fungi. Definite varietal differences in resistance have not been observed. The relation of various fertilizers to the development of the disease is also being studied.

A new root rot of oats and wheat has been found in the Edmonton district during the past season. *Fusarium equiseti* and *Colletotrichum graminicolum* are commonly associated with the disease and have proved to be pathogenic.

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

University of Alberta

The saprophytic development of *Helminthosporium sativum* was studied in various soil media by measuring the carbon dioxide given off in respiration and using it as an index of fungal activity. Podsol soil was a less favorable medium than either black or brown soils; no apparent difference existed between the latter two. The addition of crop residues to the soil increased the activity of the fungus, the increase being roughly proportional to the nitrogen content of the plant residues. The addition of nitrogen, potassium

and phosphorus as chemicals to the soil did not measurably affect the activity of the fungus. A greater number of spores was produced on soil containing crop residues than on soil alone, or on soil fertilized with chemicals. Sporulation was greater on black soil than on brown or podsol soils.

Field observations indicated that Reward is highly susceptible to basal glume rot; Ceres, Hope, Caesium, Canus and Red Bobs moderately susceptible, and Marquis under similar conditions relatively free from the disease. Dull, cloudy weather and shade favored the development of the disease. It was most severe at 24° C. and in the early stages of head development.

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

During the 1933 season approximately 150 varieties and hybrid strains of spring wheat were tested for bunt reaction. The degree of infection was considerably higher in 1933 than in 1932. Several of the new varieties in the Co-operative Spring Wheat Nursery proved to be highly resistant to bunt infection. Fifteen white wheats being tested for general adaptability to gray wooded soils and suitability for pastry flour were found to be highly susceptible to both bunt and stem rust.

The more commonly grown varieties of oats, Victory and Banner, are very susceptible to covered smut. The earlier varieties, Alaska, Legacy and White Cross, appeared to be relatively more resistant. O.A.C. No. 144 and Markton were highly resistant. Promising resistant hybrid lines, of the Victory type, are being increased for further testing.

Smooth-awned selections from the Trebi × Glabron cross to the number of 375 were tested in 1933. Approximately 50 of these were strong strawed, early maturing and smut free, and these appear quite promising.

The foot-rot studies were carried out as in previous years, special attention being given to the new varieties from the wheat co-operative test. Considerable differences occur in varietal reaction.

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

RESEARCH IN MANITOBA

Dominion Rust Laboratory, Winnipeg

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

In hybridization studies between wheat rust *Puccinia graminis tritici* and oat rust *Puccinia graminis avenae*, interfertility was found to be rather low. The hybrid rust inherited certain of the pathogenic qualities of both parent forms in that it is capable of attacking to some extent certain varieties of both wheat and oats. The host range of the hybrid form is somewhat narrower in oat varieties than that of the oat rust parent, and is decidedly narrower on wheat varieties than that of the wheat rust parent.

No significant differences in dust development could be detected on wheat plants supplied with excess of nitrates, potassium and phosphorus. Potassium increased the reaction of Acme durum wheat to mildew from thoroughly susceptible to highly resistant.

In earlier work it has been shown that the rapidly growing tissues of the wheat plant are decidedly more susceptible to stem rust than the older tissues. The osmotic pressure of the young tissues was found to be about 4.5 atmospheres higher than that of the older tissues. The sugar content

of the young tissues was found also to be considerably greater than that of the older tissues, especially in the content of hexose sugars. Varieties without a differential reaction between old and new tissues showed the same relations in osmotic pressure and sugar content, consequently it is doubtful that there is any relation between rust reaction and sugar content.

Temperature has been found an important modifying factor in the reaction of wheat varieties to various physiologic forms of leaf rust *P. triticina*. A study of the reaction to rust of different varieties at different temperatures showed that they fall naturally into three groups.

Effective and practical methods for producing artificial foot-rot epidemics with *Fusarium* and *Helminthosporium* were developed. Best results were obtained with *Fusarium* when a spore-suspension was applied to the seed, and with *Helminthosporium* when both a spore-suspension was applied to the seed and oat-hull inoculum to the soil. It appears that a method of infesting field plots is required, suitable to each specific organism.

Certain seed treatments controlled seedling blight and foot rot of cereals to a marked degree in the greenhouse, while others were quite ineffective. The differences were not as significant in the field and no yield differences were observed as a result of the treatments. Of the fungicides tested, Ceresan gave the most promising results. Some preliminary experiments in which the fungicides were applied to the soil gave highly significant results and demonstrated the possibility of reducing losses in cereals caused by foot-rotting fungi.

Plots treated with complete fertilizer (N.P.K.) had the least amount of foot rot of wheat, but yield was not significantly influenced by any of the fertilizers in the same experiments.

Experiments have demonstrated that bunt spores may overwinter in the soil in western Canada. Spring wheat sown on land, at Winnipeg, which had been contaminated with bunt-spores the previous autumn, became infected. Fall plowing should reduce the viability of the spores and lessen the chances of infection. New Improved Ceresan gave excellent control of bunt of wheat and covered smuts of oats and barley.

There is a considerable variation in the average number of sporidia produced by spores of different bunt collections. In one collection of *Tilletia tritici* they varied from 4 to 21. Both *T. tritici* and *T. laevis* have been found to be heterothallic. Hybridization occurs readily between the two species.

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

Since the natural epidemics of smudge on wheat have in most years been insufficient for varietal testing, a controlled test was developed. Suspensions of conidia of *Helminthosporium sativum* were placed within the florets. The results from the controlled test were highly correlated with those from the field test in a year when natural smudge infection was high.

A study has been made of methods of estimating wheat quality in the early stages of plant breeding material. At the present time it appears that a knowledge of the total protein content and the amount of carotin in the flour would be of the greatest value. These two characters are being studied in a cross between one of the rust resistant hybrids and Marquis. Thus far there is strong evidence of transgressive segregation for both characters.

In the oat breeding work, strains have been produced which are resistant to stem rust. Resistance to smut and crown rust are now being added to these strains by further crossing.

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

RESEARCH IN ONTARIO

National Research Laboratories

For reports on the biochemistry of rust resistance and the organic constituents of wheat leaves which may be related thereto, see under Division of Biology and Agriculture, page 27.

RESEARCH IN SASKATCHEWAN

Dominion Laboratory of Plant Pathology, Saskatoon

The results from the studies on take-all indicate that this disease tends to decrease as good farming practices are adopted and that it may be controlled by suitable crop rotations. Great variation in virulence of strains of *Ophiobolus graminis* has been noted. A strain (No. 2) which was quite aggressive in both greenhouse and field tests for six years failed to produce infections in 1933. The variability in virulence is being studied further.

The dry spore-suspension method of inoculation was found to be practicable in large plot tests at Indian Head. Marquis wheat inoculated in this manner with *Helminthosporium sativum* showed a reduction in yield of 6%. Banner oats inoculated with *Fusarium culmorum* showed a reduction of 17.6%.

In the studies on barley seed discolorations special attention is being given to a form of *Helminthosporium*. The fungus did not sporulate readily unless exposed for two or three weeks to a temperature of about 6° C. The culms, leaves and seeds were all successfully inoculated.

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

University of Saskatchewan

Under the very dry conditions existing at Saskatoon in 1933 none of the lines in the co-operative wheat nursery were significantly higher in yield than Marquis, while four lines were lower. Owing to the drought the results from the special nurseries, foot rot, frost, bunt, etc., were not sufficiently conclusive to be of value in eliminating varieties.

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

Associate Committee on Fire Hazard Testing

In order to render fully effective the work of the recently established laboratories for the testing and approval of fire-hazardous material, and equipment for fire prevention, detection, control and suppression, a close liaison is essential between the laboratory staff and those concerned with such material in the field. To afford this liaison, the establishment of the Associate Committee on Fire Hazard Testing was approved by the Council at its meeting on November 4, 1932. The function of the committee is, in brief, to offer comments, suggestions or criticisms of regulations, test codes, standards, test results and recommendations of the laboratories, based on observation and practical experience of the members in the field, and to act in general in an advisory capacity in connection with the work of the fire hazard testing laboratories.

The first meeting of the committee was held in Ottawa on October 11, 1933. At this meeting the organization, functions and procedure of the committee were discussed. It is proposed to carry on the work of the committee principally by correspondence, with a small executive committee composed of members resident in or near Ottawa to deal with urgent matters.

The remainder of the meeting was devoted to a thorough discussion of the regulations, standards, test procedure and test results pertaining to domestic oil burners of both the atmospheric (gravity) and automatic (pressure) types. A number of contentious points were discussed with certain of the manufacturers, at an adjourned meeting on October 12, 1933.

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
Federal Department of Mines
University of Alberta

The seventh meeting of the committee was held in Ottawa on March 26, 1934, under the chairmanship of Dr. H. M. Tory. Nearly all members of the committee were present and in addition those actively engaged in research on all projects under the committee.

As previously, the committee has been concerned chiefly with the possible utilization of the enormous amount of gas going to waste in the Turner valley, Alberta. While through the work of the Alberta Commission on Natural Gas the wastage has been largely reduced, the amount still being burned in the valley is so large as to justify the best efforts of the committee.

Mr. P. V. Rosewarne of the Department of Mines presented a report on tests made previously in the Turner valley. While no tests in this field had been possible in 1933, the department has continued its survey of natural gas in the various fields throughout Canada. One field carefully studied as a possible source of helium was that lying along the north shore of Lake Erie. While the helium content of the natural gas in that area was higher than that of the Alberta natural gas, the quantities available are relatively small and there appears to be no special area of rich gas. Further, all the gas in this area is in demand for use in nearby towns.

Dr. Boomer reported on his work carried out at the University of Alberta with the joint financial support of the Alberta and National Research Councils. In general the report covered the progress made in a continuation of researches which have been under way for some time. Commercial possibilities were not clearly indicated, although it was felt that under slightly more favorable conditions several of the researches would possess commercial significance. It was agreed to recommend to the National Research Council that financial support be extended to this work for at least another year.

The committee discussed at length the extensive work on natural gas being carried out in the National Research Laboratories, reported under the Division of Chemistry, page 37. A number of important developments were discussed, of which details are being made public in a series of papers published in the Canadian Journal of Research.

Associate Committee on Grain Research

Co-operating organizations:

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

Under the auspices of the committee, joint investigations looking to the maintenance of the high quality of Canadian wheat and the improvement of methods of testing have been continued. This work last year included four main projects:

1. Frost injury.
2. Methods of harvesting.
3. Quality of new wheat varieties.
4. Methods for the determination of moisture in grain.

In addition to these projects, members of the committee have co-operated from time to time in carrying out experiments reported by the individual laboratories. The laboratories co-operating with the committee have continued to work on fundamental problems arising out of the co-operative program.

Fourteen papers of the committee's series were published during the year, making the total number 48. The second volume of Grain Research Papers containing Papers 21 to 35 was issued.

JOINT INVESTIGATIONS

Frost Injury of Wheat

During the year, the results of the annual survey of the quality of frosted wheat for the three crop years, 1930 to 1932 inclusive, have been submitted to statistical analysis and a report is in preparation. The surveys are being continued.

Methods of Harvesting

The survey of the moisture and grade of wheat harvested by different methods was continued in Manitoba and Saskatchewan. As a result of this survey and that conducted in 1932 it was found that swathed wheat suffers more weathering damage than either stook-threshed or straight combined grain. The results of the 1932 survey have been published (Can. J. Research, 9 : 486-501) and a report on the 1933 survey is now in preparation.

The experiments on the rate of drying of standing grain were continued at the Universities of Alberta, Saskatchewan and Manitoba and the report of this work is now in preparation.

The principal conclusion from this study was that ripe, dry, standing wheat does not become tough overnight as a result of the higher relative humidity except when the wheat is at a moisture content only slightly below the lower limit of the tough range. When wheat has dried down below 13.5% moisture it does not become tough overnight in normal clear weather. The rate of ripening at Edmonton appears to make that district totally unsuited for the use of combines.

Quality of New Wheat Varieties

The co-operating laboratories tested the milling and baking quality of 32 new varieties of wheat grown at 10 places in the prairie provinces. These varieties were compared with four established varieties grown at the same places as reference standards. Five of the new varieties were found to be satisfactory.

In connection with this project a number of the more widely grown, established varieties are being further studied in order to obtain more detailed information regarding their characteristics.

Methods for Determining Moisture in Grain

A joint investigation of methods of determining the moisture content of grain was undertaken by the National Research Laboratories and the Laboratory of the Board of Grain Commissioners, primarily to ascertain the utility and accuracy of certain rapid methods, including five electrical moisture meters, which constitute the latest development in this connection. Rapid analytical methods studied were the 130° C. air oven and the Brown-Duvel, while the electrical meters tested consisted of the Burton-Pitt, Davies, Limbrick, and Tag-Heppenstall hand- and motor-operated instruments.

The experimental part of the investigation was carried out in the Laboratory of the Board of Grain Commissioners, Winnipeg. A large number of samples of wheat, oats, barley and durum wheat, covering the entire range of moisture content and grade normally met with in commercial practice, were collected, and the moisture content of a subsection of each sample was determined simultaneously by all the above methods, and also by the vacuum oven, which was adopted as a standard. Provision was made for the statistical estimation of sampling errors, errors of method, and errors of observation. The temperature and humidity coefficients of the electrical meters were also determined. In all, over 8000 observations were made in duplicate.

The accuracy of the standard vacuum oven method was found to be affected by daily variations and by differences between ovens as well as by experimental and sampling errors. Two methods of grinding were employed in connection with the air-oven, the Wiley mill proving superior to the Hobart grinder. The Brown-Duvel method, as operated by the Laboratory of the Board of Grain Commissioners, was found to be more accurate than the air oven. Both underestimate the true moisture content, the deficit in general increasing with the absolute moisture, but this systematic bias may be eliminated by the use of linear correction equations. Statistical analysis of the performance of the electrical meters is proceeding.

GRAIN RESEARCH IN THE LABORATORY OF THE BOARD OF GRAIN
COMMISSIONERS

With the appointment of Dr. W. F. Geddes as Chemist-in-Charge at the Laboratory of the Board of Grain Commissioners the durum wheat laboratory established by the committee has been moved to that laboratory. This transfer has necessarily interfered with the progress of the work. During the year several improvements were made in the cabinet for drying alimentary pastes, which make possible more precise control of the relative humidity during the curing process.

In co-operation with the Cereal Division of the Department of Agriculture, the carotinoid pigments of wheat have been studied spectrophotometrically. The amount of these pigments is one of the factors determining the commercial value of wheat, hence information with regard to them is of vital importance to plant breeders. A colorimetric method for the determination of carotin in wheat flour, requiring only simple apparatus and technique, has been developed. The results compare favorably in accuracy with those obtained by the spectrophotometer. Spectral studies have been made on a series of samples of rust spores submitted by the Dominion Rust Research Laboratory. In co-operation with this laboratory, methods of determining the carotin content using small samples of wheat are being worked out. Such methods would be of inestimable value to the plant breeder by enabling him to discard highly pigmented selections early in the breeding program.

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

GRAIN RESEARCH BY THE CEREAL DIVISION, DOMINION EXPERIMENTAL FARMS

Wheat. In addition to the work of evaluating the milling and baking qualities of all new wheat selections and hybrids produced by the Dominion Experimental Farms system, including those developed at its special breeding establishment at Winnipeg (The Dominion Rust Research Laboratory) several special studies in this field have been undertaken. Thus, in 1933-34 quality tests were conducted on a group of 170 "rust hybrids" from the 1933 crop produced at the Winnipeg laboratory and at the branch farm at Brandon. Another group of 31 "rust hybrids," including three of the leading rust resistant wheat productions in the United States, two from the University of Manitoba and eight from the University of Saskatchewan, together with five other varieties of wheat grown at 10 points in the three prairie provinces, were tested for quality co-operatively, as already noted.

A group of promising early-maturing varieties of wheat originating from crosses made at Ottawa have been subjected to critical quality studies during the past year. The material, in this case, was grown here and at certain of the western stations. The above study is being continued in a still more exacting manner.

Marquis, Reward, Garnet, Red Bobs and Ceres, the most commonly grown varieties of spring wheat in western Canada, are being subjected to a more critical test than has formerly been attempted. Plots of these varieties originating from the same seed source in each case, are being grown at 350 points in 1934 over a wider range of environment than ever before, and on soil not in as high a state of fertility as that generally found at Dominion experimental stations or provincial institutions. Quality tests along with field observations will be used in determining the areas to which each variety is best adapted.

The influence of environment on the carotinoid pigment content of hard red spring wheat has been studied extensively. A paper reporting results to date will be published by the division shortly.

Some progress has been made in the study of methods for evaluating wheat flours suitable for the soft wheat flour trade. Bread and cake tests were employed in a series of flours from winter wheat varieties grown at Harrow, Ontario. This work is being extended to include viscosity, wheat meal and other tests.

The effect of artificial fertilizers on the quality of Marquis and Reward wheat has been studied in co-operation with the Dominion experimental stations at Beaverlodge and Scott. The results of these studies are recorded briefly in the 1931-33 Report of the Dominion Cerealists.

Barley. Malting tests have been conducted of varieties of barley grown at the Dominion experimental stations from Prince Edward Island to British Columbia, in co-operation with the University of Manitoba.

This work is being extended on a comprehensive scale in 1934 in the prairie provinces, in order to provide information which may indicate those districts which are best suited to the production of high class malting barley. Thus, plots of a select group of barley varieties are being grown at 350 points in the three provinces. These plots will be carefully harvested and composites made up district by district for malting and other tests. It is thus hoped eventually to obtain data upon which a barley zonation map may be constructed.

The malting tests referred to above will be conducted chiefly by the malting laboratory at the Manitoba Agricultural College, Winnipeg, to which work the division contributes financially.

Peas. The problem of determining the factors which influence the boiling qualities of peas has been receiving considerable attention on the part of certain divisional officials during recent years. This problem has proved to be quite an involved one, and, while progress seems to have been made, further work is necessary before anything very definite can be reported.

Flax. The breeding of superior varieties of seed-producing flax involves tests of both the quantity and the quality of the oil normally produced by each. Such tests have been conducted for the division during the past three years, by the Grain Research Laboratory of the Board of Grain Commissioners, Winnipeg.

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

GRAIN RESEARCH AT THE UNIVERSITY OF ALBERTA

The work on the relation between the nutrition and quality of wheat carried on between 1931 and 1933 led to the conclusion that nitrogen supply alone was not responsible for variations in wheat quality except as related to the total quantity of protein. Other work has shown that nutrient supply affects quality, so a preliminary investigation on the effect of potassium nutrition was undertaken during the past year. Limiting potassium supply reduced the total amount of nitrogen absorbed and injured the quality of the grain produced. The latter effect was greatest where the uptake of potassium was confined to the first month of growth.

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

Preliminary work on the quality and composition of wheat produced on black and gray soils, and the keeping quality of flour milled from these wheats has been carried out during the past year. The original quality of wheat grown on black soil is better than that of the same varieties grown on the gray or wooded soils, but varieties differ in their quality on the latter to a greater extent than they do on the black soil. The flour from some wheat varieties grown on gray soil does not appear to keep as well as that from other varieties nor as well as that from the same varieties grown on the black soil.

(Investigation under the direction of Dr. O. S. Aamodt and Dr. A. G. McCalla.)

The studies on the residual effects of timothy, brome, western rye grass and alfalfa on the yield and quality of wheat have been continued. The after effect of alfalfa was still apparent even on those plots which had produced five crops of wheat. The protein content of the wheat on the alfalfa plots was higher than that of any of the wheat samples produced on the plots on which the grasses had been grown. The series of samples from the 48 plots was interesting in another respect, as the protein content and loaf volume of the bread baked by the bromate formula were very closely correlated, the correlation coefficient being $+ .942 \pm .011$.

The quality studies on material supplied from the rotations conducted by the Pathology Division of the Department of Field Crops have been continued.

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

Throughout the investigation of the residual effects of grasses and alfalfa, soil analyses and microbiological studies have been conducted by the Department of Soils.

In 1933, soil analyses were restricted to the block of plots broken in the summer of 1932 and a nearby fallow plot. The western rye grass plots were omitted because of root-rot infection.

Under the first crop of wheat following sods, the nitrates were highest in the alfalfa plots. This was especially evident at the last date of sampling when the timothy and brome plots contained only traces of nitrate. The differences between the brome and timothy plots are probably not significant. In the latter part of the season (August) the nitrates were, as usual, higher in the supplementary fallow plot than in any other plot.

Generally speaking, the differences between the bacterial counts of the different plot soils were not very significant.

It was again observed, under the first crop of wheat following sods, that large *Mucor* colonies predominated on the nutrient agar plates inoculated with soil from the alfalfa plots. The differences between the other plots are of doubtful significance.

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

Studies were made on the effect of hardening wheat plants prior to exposure to severe conditions of atmospheric drought. The hardening process consisted of either growing the plants under conditions of reduced soil moisture, or exposing them to limited periods of atmospheric drought. Plants receiving this preliminary treatment suffered considerably less leaf and culm injury, and showed much more rapid recovery than did the non-hardened plants.

A study was made of the reaction of seven wheat varieties to windburn when exposed in the earlier stages of growth (late stooling to early shooting). Extreme susceptibility to windburn was exhibited by the durum wheats, Pentad and Kubanka, whereas Milturum and Canus possessed a high degree of resistance. Baart ranked next to the durums in the matter of susceptibility, followed by Federation and Red Bobs No. 222 in the order named.

In a preliminary investigation of primary root development, the drought-resistant varieties Milturum and Caesium were found to possess more highly branched systems than either Marquis or Reward. In a later test, carried out under unfavorable growing conditions, the durum varieties, Pentad and Pelissier, excelled in production of primary roots, averaging approximately five roots per plant. Milturum, Caesium and Baart average over four roots per plant, while Marquis, Red Bobs No. 222, Garnet, Reward, Federation and Canus averaged from 3.2 to 3.6. Of the varieties tested, Reliance showed the poorest development of primary roots from the point of view of numbers (averaging only three per plant), but was superior in the degree of root branching. Other varieties deserving mention in this regard are Caesium, Milturum, Pentad and Pelissier.

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

New preparations for treating seed grain are appearing on the market and this has raised the question as to their relative merits. Comparative tests, with formaldehyde as a reference standard, have been made regarding their effectiveness in controlling the covered smuts of wheat and barley and the covered and loose smuts of oats. Of the preparations tested, new improved Ceresan dust compared most favorably with formaldehyde in cost and in effectiveness in controlling covered smut of wheat. It has a considerable advantage in that it appears to have no tendency to injure the seed of wheat. New improved Ceresan had considerable advantage over copper carbonate also in that it may be safely used on oats and barley.

A study of seed injury by formaldehyde showed that this is increased by low soil temperatures, and that there are wide varietal differences in susceptibility. Injury by formaldehyde predisposed the plants to injury by foot rots. For control of bunt in wheat it was found that the concentration of formaldehyde could be reduced from the commonly recommended 1 : 320 to 1 : 440 without much loss of efficiency and with less danger of seed injury. Various other factors affecting the safety and efficiency of the treatment have been studied.

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

GRAIN RESEARCH AT THE UNIVERSITY OF MANITOBA

Studies on the relation between baking quality and the quantities of protein extractable from experimentally milled flour by various inorganic salt solutions have been extended to include the effect of variations in ash content on the extractability of the proteins. The results indicate that variations in the quantities of protein extractable by given salt solutions are not appreciably influenced by the percentage of total or water soluble ash in the flour.

The nature of the carotinoid pigments of red spring wheat is being investigated and the results indicate that a considerable percentage of the total pigments present consists of xanthophyll.

An improved technique for the determination of total, water-soluble, and lipide phosphorus in wheat flour and fermenting bread doughs has been developed, and the methods are being applied to the determination of the changes occurring in the percentages of water soluble and lipide phosphorus during dough fermentation, with and without the use of potassium bromate in the bread formula.

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

GRAIN RESEARCH AT THE UNIVERSITY OF SASKATCHEWAN

The study of heating and respiration of damp wheat was carried further during the past year and sufficient information is now at hand to warrant large scale tests when suitable material becomes available. The application of carbon tetrachloride vapor for prevention of mould-growth and heating has proved satisfactory on a laboratory scale. Baking tests made on wheat exposed for long periods to carbon tetrachloride vapor indicated that there was no damage attributable to this treatment. During the processes of drying, milling and baking, the odor disappears and therefore it is considered suitable for the prevention of heating in commercial grain.

In an attempt to improve the accuracy of the baking test two new-type experimental baking ovens have been designed and built and are being subjected to preliminary tests in respect to uniformity of temperature during the baking period.

A comprehensive study of baking formulas has been carried on with a view to finding a formula that will give an estimate of maximum strength of wheats. Such a formula, involving elimination of diastatic activity of the flour as a limiting factor, and ensuring proper development of the gluten, has been chosen as a result of this work and it is planned to subject it to more extensive investigation by the collaborating laboratories.

Further studies on formulas, particularly those involving long fermentation periods, are in progress, but at present the only conclusion justified by

the data is that the ordinary method of fermentation—tolerance testing—is quite unsuitable for estimating the quality of western Canadian hard red spring wheats.

Methods for estimating glutamic and aspartic acids in gluten proteins were studied, with the result that a fairly reliable procedure for glutamic acid has been selected. This estimation can be fitted into the Van Slyke procedure without much extra work. Some further investigation is necessary in order to reduce the time required, but the method seems promising and is being studied more critically. To date the attempts to get a reasonably rapid method for aspartic acid have not been encouraging. In the course of this work a modification of the regular method for determining ammonia-nitrogen was used, with considerable saving of time and a slight gain in accuracy. This also is being subjected at present to a more critical examination.

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

NOTE.—Grain researches in the National Research Laboratories will be found summarized in the Report of the Division of Biology and Agriculture, page 24.

Associate Committee on Laundry Research

Co-operating organization:

Eastern Canadian Laundryowners' Association

No meeting of the committee has been held during the year under review but the work of the laundry laboratory in the Division of Chemistry has continued to serve the industry. An outline of the work done in this laboratory will be found on page 38.

In order to secure additional funds to provide a laboratory assistant for the laundry investigation, the Eastern Canadian Laundryowners' Association appointed a Research Fund Committee consisting of two representatives of the industry and one representative of the National Research Council. This committee has been in touch with all commercial power laundries in Canada. Financial support has been secured from laundries in every province, usually on a basis of the volume of business done. The support received in this way has made possible the securing of a laboratory assistant.

That the results of the investigation carried out in the National Research Laboratories have been of value to the laundry industry in Canada is indicated by increases up to 25% obtained by individual laundries in the efficiency of dirt removal. At the same time, many laundries have reduced the loss of tensile strength in washing by 70–80%. These results, of benefit alike to the laundryowners and to the general public, are in addition to the solution of a large number of specific problems submitted by individual laundries.

It is now proposed to organize the support of the power laundries on a permanent basis.

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories Limited
Federal Department of Mines

During the year the committee has been reorganized to include a larger proportion of the research staffs of the organizations co-operating in this

investigation. Meetings have been held at frequent intervals and the program of research has been constantly widened in order to take full advantage of the laboratory developments. As previously, the greater part of the work has been carried out in the National Research Laboratories and this has been summarized in the report of the Division of Chemistry on page 35.

As stated in the last annual report, the refractory brick developed in this investigation are now being made commercially and are coming into use in both England and Canada. In addition to their application in the metallurgical industries, for which they were primarily designed, it is being found that their special properties make them particularly useful in other applications where conditions are severe, as in boiler settings. They are found to be especially resistant to the action of the ash of Nova Scotia coal and therefore meet a real need in eastern Canada.

While the brick experiments carried out in the ceramic laboratories of the Department of Mines were temporarily discontinued during the experimental brick manufacture on commercial plants, these laboratory experiments have now been resumed. Efforts are being made to secure additional information which will be applicable to commercial practice and to evaluate from the point of view of brick manufacture the new products of the associated researches.

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

Associate Committee on Oceanography

Co-operating organizations:

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

During the first quarter of the year 1933-34 the efforts of the Associate Committee on Oceanography, acting as the Committee on Oceanography for the Fifth Pacific Science Congress, were centered on the preparation and carrying out of the program for the congress.

Owing to the hearty co-operation of oceanographers throughout the Pacific area, the results were particularly gratifying. The staff of the Biological Station, Nanaimo, and of the Oceanographic Laboratories of the University of Washington, and almost the entire staff of Scripps Institution, Hopkins Marine Station, International Fisheries Commission and the Fisheries Experimental Station, Prince Rupert, as well as individuals from several other institutions around the Pacific, attended at least a good proportion of the congress meetings. More than one hundred papers, bearing directly on oceanographic problems, were presented at the scientific meetings, most of which had direct significance for Canadian oceanography. Of even greater importance was the more intimate discussion through personal contacts. Assuredly, oceanography, as it affects the west coast of Canada, had never before received such concentrated attention.

One illustration may serve to show the value of such personal contacts. Through association at the congress between members of the staffs of the Biological Board and of the Hydrographic Survey, arrangements were made for members of the staff of the Nanaimo Biological Station to carry out oceanographic researches during the summers of 1933 and 1934 on the Hydrographic Survey steamer William J. Stewart. It is hoped that this co-operative arrangement may be continued.

The effect of reductions in financial appropriations for oceanographic work on the west coast has been serious, but it has been possible to continue with all the main projects sufficiently to prevent the loss in value of the data already collected. With the exception of the co-operation mentioned above, no extensive new work has been undertaken. New minor problems are always coming to hand and very often the attention given to them brings about far-reaching results.

During the year some of the members of the staff at the Pacific coast stations have been granted leave of absence for study. These men thus become better qualified, and the efficiency of the staff is thereby increased. At the same time they use the data on Pacific problems as the basis for research.

The chairman of the committee spent some days at the Oceanographic Laboratories of the University of Washington at Friday Harbor, during August, getting acquainted with the latest developments there.

In December, he accepted an invitation to accompany the Hancock Expedition to the Revilla Gigedo islands, the Galapagos islands and the mainland of America from Guayaquil, Ecuador, to San Diego, California. This expedition was largely biological, but other phases of oceanography were not entirely neglected. Advantage was taken of the opportunity to visit the laboratory at Barro Colorado, C.Z., Scripps Institution, La Jolla, University of Southern California, Los Angeles, and the University of California at Berkeley.

There is every evidence that the continued co-operation among the institutions carrying on oceanographic work on the Pacific coast of Canada and the United States is adding immensely to the efficacy of the attack on the larger problems that the ocean presents.

Associate Committee on Parasitology

Co-operating organizations:

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

This committee differs from all other associate committees of the National Research Council in that it was appointed jointly by the Council and by McGill University, for the purpose of co-ordinating and directing the work of the Institute of Parasitology recently established at Macdonald College. A complete statement of the considerations which led to the establishment of this Institute, also as to its functions and organization, will be found in the annual report of the Council for the preceding year.

Two meetings of the committee were held during the year under review. The financial support given by the Empire Marketing Board ended September 30, 1933, on the termination of the activities of that Board, and the entire operating budget of the Institute has, since that date, been provided by the National Research Council. The capital cost of the new building in which the Institute is housed was provided by the Department of Agriculture of the province of Quebec, through a grant made to McGill University for that purpose.

That the Institute has been in very active operation, is indicated by the following report prepared by the Director, Dr. T. W. M. Cameron.

REPORT ON THE WORK OF THE INSTITUTE OF PARASITOLOGY FROM APRIL 1,
1933, TO MARCH 31, 1934*Building*

During the year, as part of the plan for its gradual completion, a new wing was added to the building. This wing has three floors corresponding with the existing floors. The basement provides accommodation for sheep and other farm animals, together with a post-mortem room. The ground floor contains two animal rooms, intended for breeding small laboratory animals, a small galley for cooking and a store-room for hay, straw and grain. The upper floor contains one large and one small room for experimental animals, an aquarium (fitted with an aerating pump) for the housing and breeding of molluscs, arthropods and fish, which act as vectors of parasites, and two small constant-temperature rooms (heated by steam), one of which maintains a temperature of 40° C., the other 25° C. This extra accommodation has permitted a considerable extension of the work but it is even now insufficient for present needs.

Visitors

A considerable number of scientists have visited the Institute during the year, including, among others, Sir Daniel Hall, Sir John Russell of England, and Professor E. I. Kraus of Chicago.

Library

The library is being maintained, and the Institute now possesses, in addition to the important parasitological periodicals, a classified card summary of all papers on parasitology appearing since January, 1932. This is being kept up to date. The Institute also receives monthly from the Imperial Bureau of Agricultural Parasitology a loose-leaf list of all papers noted by the Bureau in its work. As this amounts to about 1,000 papers yearly, this service is of very great value in the work.

Teaching

During this past year Mr. D. Cameron, B.S.A., has been studying parasitology as a minor subject to entomology for the degree of Ph.D., Dr. Kingscote of the Ontario Veterinary College studied at the Institute for a fortnight during the summer and Dr. J. W. Rutledge attended a short course of instruction on his appointment to the superintendentship to the Kootenay National Park, B.C.

During the winter, the Director of the Institute gave a short extension course in parasitology at McGill University. He also delivered addresses at the following meetings:—

Annual Meeting of the Central Canadian Veterinary Association, Ottawa, April, 1933.

Annual Meeting of the Prince Edward Island Veterinary Association, Charlottetown, July, 1933.

Annual Meeting of the American Society for the Advancement of Science and the American Association of Parasitology, Boston, Mass., December, 1933.

Annual Meeting of the Ontario Veterinary Society, Toronto, January, 1934.

Farmers' Week Meetings, Charlottetown, Prince Edward Island, March, 1934.

The Science Association of the National Research Council, Ottawa, February, 1934.

In addition he broadcasted an address over CKAC on "Parasites of Domesticated Animals" under the auspices of the Provincial Hour on September 15, 1933. In November, 1933, Dr. Parnell addressed the Young Men's Canadian Club of Montreal on "Animal Parasites in Northeast Canada." Dr. Swales gave two lectures with laboratory periods to plant pathology classes.

During the year, teaching collections of the more important parasites of stock in Quebec were presented to:—

Ecole de Médecine Vétérinaire, Institut Agricole d'Oka, La Trappe, Que.

Ecole Supérieure d'Agriculture, Ste. Anne de la Pocatière, Que.

Survey

During July, Dr. Parnell, by kind permission of the Department of the Interior, accompanied the "Nascopie" on the first part of the Eastern Arctic Expedition, 1933, and made arrangements for the collection of material on the north and west coasts of Quebec, as well as in Labrador and Baffin Island. Large garbage cans and a supply of formalin were left at each collecting station, and a small amount of material collected was brought back by the "Nascopie" and "N.B. McLean" last year. Most of it, however, will be brought back by the "Nascopie" this year. Arrangements have also been made with Indian agents and paper and pulp firms in Quebec to send material this summer. In this way, thanks to the enthusiastic co-operation of the R.C.M.P., the Department of the Interior, the Hudson's Bay Company and Revillon Frères, material has been promised from over 80 stations in or around Quebec.

The preliminary results of this portion of the survey showed that *Oxyuris* was heavy among the Eskimos; that dogs, which are the most important animals in the north, are heavily parasitized with hookworms, ascarids, fish-carried flukes and fish-carried tapeworms; that hydatid cysts are common in moose, and that lemmings and rabbits, which are of great importance in the causation of "fur cycles," are heavily parasitized.

Dr. A. E. Cameron has made arrangements with packing plants throughout the Dominion to have parasitic material sent to the Institute and in this way a considerable advance has already been made in our knowledge of the distribution of the parasites of stock animals in Canada. The results of this portion of the survey are in progress of preparation for the press and will form the third part of Dr. Swales' series of survey articles in the Canadian Journal of Research.

Thanks to the co-operation of the Parks Branch, Dr. Swales was able to continue his investigations on fluke and other diseases in Buffalo Park, Wainwright, and to extend it to include other wild ruminants in neighboring areas. The examination of caribou, moose, mountain deer, wapiti, yak, bison and antelope show that these animals harbor many parasites not only important to themselves but communicable to domesticated ruminants. It has shown also that internal parasites are of paramount importance to the health of wild animals in our national parks.

Material has also been received from numerous individuals throughout Canada, from Vancouver Island to Nova Scotia and Prince Edward Island. Particularly must be mentioned the assistance of Dr. E. A. Watson of the Animal Diseases Research Institute at Hull, who has handed over its collection of parasites of domesticated animals, and of Dr. R. G. Law of the Experimental Fur Farm at Kirkfield, Ontario, who has forwarded to the Institute several valuable collections of parasites of fur-animals, several of which are

new to Canada. Arrangements have also been made with the Zoological Gardens, Charlesbourg, Quebec, to send to the Institute parasitic material from animals which die there; faecal examinations of living animals are being made regularly to detect the presence of parasites.

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

Dr. Parnell has completed his small-scale trials with urine as a lethal agent against horse sclerostomes and sheep strongyles. He found that, even when diluted with 50% water, it was rapidly fatal to both eggs and larvae in faeces. Larger-scale experiments have been started to determine its applicability to farm practice. Small-scale experiments were also carried out with various artificial fertilizers mixed with manures; nitrate of soda, sulphate of ammonia and muriate of potash, were all found to have lethal properties, but these are relatively slight in solution. Urea, however, both dry and in solution, appears to be even more effective than urine for this purpose. These experiments are being continued. This work should prove to be of considerable practical importance in providing fundamental data necessary to control, under stable conditions, what is undoubtedly the most important pathological condition of horses in all civilized countries.

Dr. Swales continued his investigations on the liver fluke problem in Alberta. Although he has not yet been successful in implicating the normal intermediate host of *F. magna*, considerable progress has been made with the investigations; a number of forms have been definitely excluded and studies are in progress on the bionomics of the others. He has investigated the bionomics of the egg and first free larval stage of the fluke. The parasite has been recorded for the first time from a deer in Ontario. During his visit to Alberta, he studied the parasites of wild ducks there and has described the male of *Tetrameres crami*, a nematode of considerable importance occurring in the proventriculus of ducks in many parts of the Dominion. Investigations on its life history and control are now in progress.

The investigation on nodular disease of sheep has been continued and an attempt has been made to obtain a pure infection of the parasite in lambs for clinical and pathological study.

A commencement has been made with the work on *Ascaris* in pigs and the preliminary work shows that this parasite is of the utmost importance in the raising of bacon-type hogs in eastern Canada. The object of this study is to determine the most effective means of control of the parasite under Canadian farm conditions.

A comparative pathological study of the peritoneal lesions of tuberculosis in cattle and those of the relatively harmless round worm, *Setaria labiato-papillosa*, has been completed. Owing to the macroscopic resemblance of the lesions caused by the latter to those of tuberculosis, differential diagnoses between them is of great practical importance in meat inspection.

Other work includes the commencement of a monograph on the important round worm genus *Ostertagia* of ruminants, and studies on the parasites of ruffed and pintail grouse, and of muskrats.

Mr. H. J. Griffiths has continued his work in the field and in the laboratory on *Fasciola hepatica*. This dangerous parasite appears to be quite widespread in the lower St. Lawrence area, as well as in the maritimes. His work has consisted of investigations on the eggs and free larval stages and

in attempting to infect local snails. He has been successful in transferring the infection from Canadian sheep to rabbits, using, however, snails received from Oregon. Owing to lack of information about the bionomics of Canadian snails, considerable difficulty has been encountered in the laboratory breeding of clean snails. How necessary this is, is shown by the fact that larval stages of a frog trematode were still being discharged by "wild" snails collected in lower Quebec and kept alive for eight months in the aquarium. The knowledge thus gained has been of considerable value and it is hoped to implicate definitely the common Canadian host (or hosts) this spring.

In addition, Mr. Griffiths has been engaged on analyses of sheep and other faeces for the presence of worms.

Dr. Conklin's Report

During the past year the Department of Animal Pathology in conjunction with the Provincial Department of Agriculture has supervised the treating of all pure blood flocks in this province for internal parasites. The flocks were given two treatments during the season by veterinarians in the employ of the Provincial Department. Faecal samples were taken from each farm and the character of the infestation was determined from these samples. Post-mortem examinations were conducted on many farms.

The flock owners were advised concerning the management of their flock in an attempt to reduce the spread of parasitic diseases. Reports received during the winter months from experts in this branch of animal husbandry state that the flocks in the province have shown a marked improvement since the initiation of the campaign against parasites as instituted in 1930.

Demonstrations of the damage caused by parasites have been made at various exhibitions and by means of local conferences.

During the late winter and early spring, 1934, 10 horse-breeding syndicates were organized as units to be treated for the removal of "bots." These units were subjected to a survey at the time of treatment of the animals and all animals upon each farm, whether pure-breds or not, have been treated. The results were highly satisfactory to all concerned. The work has served as a stimulus to owners of horses in other districts, as shown by letters received from practicing veterinarians.

During the year numerous other species of animals have been examined by autopsies and, in the routine of work relative to disease prevention, it was observed that parasitic infestations are very heavy in all classes of stock in this province.

Coccidiosis of the bovine species was observed and diagnosed in Nova Scotia.

Verminous infestation of the equine placenta was noted recently by a member of this department. This condition has apparently not previously been recorded.

The fluke situation in the lower St. Lawrence region appears to be extensive. During the past winter there has been an increase in the number of cattle infected at the time of slaughter.

Other Work

The Director has commenced a study on the effect of eosinophiles (produced by the presence of helminths) on the production of fibrous tissue and the neutralizing of foreign proteins. He has also commenced experiments on the *in vitro* cultivation of round-worms. For this purpose an "artificial

intestine" has been designed in order to attempt to determine the material on which those parasites feed. He is also conducting experiments on the life-history of *Soboliphyme*, a peculiar round-worm of the glutton, marten, and the cat, which is related to the very pathogenic kidney-worm of mink and dogs.

During the year he has completed the manuscript of a text-book on "The Internal Parasites of Domesticated Animals," which will be published this summer by Messrs. A. and C. Black of England and the Macmillan Companies of Canada and the United States.

Published papers:

- Cameron, T. W. M. The Bursate Lungworms of Domesticated Animals. I.B.A.P. Monograph, 36 pages.
- Cameron, T. W. M. Comparative Pathology of Helminths. Vet. Rec. 12 : 325-331.
- Cameron, T. W. M. The Important Helminth Parasites of Stock in the British Empire. Vet. J. 89 : 505-514.
- Cameron, T. W. M. Parasites of Domesticated Animals. J. Agr. Hort. 37, October, 1933.
- Cameron, T. W. M. Warbles in Cattle. J. Agr. Hort. 37, March, 1934.
- Cameron, T. W. M. The Internal Parasites of Horses: A Survey. Vet. J. 90 : 43-48.
- Cameron, T. W. M. and Parnell, I. W. The Internal Parasites of Land Mammals in Scotland. Proc. Roy. Phys. Soc. 22 : 133-154.
- Cameron, T. W. M. and Parnell, I. W. Some Observations on the Ecology of Scottish Herbivores and Carnivores. Scottish Naturalist, Sept.-Oct. 1933.
- Swales, W. E. *Tetrameres crami* sp. nov., a Nematode Parasitizing the Proventriculus of a Domestic Duck in Canada. Can. J. Research, 8 : 334-336. 1933.
- Swales, W. E. A Review of Canadian Helminthology.
- I. The Present Status of the Helminth Parasites of Domesticated and Semi-domesticated Mammals and Economically Important Birds in Canada, as Determined from Work Published Prior to 1933. Can. J. Research, 8 : 468-477. 1933.
 - II. Additions to Part I, as Determined from a Study of Parasitic Helminths Collected in Canada. Can. J. Research, 8 : 478-482.
- Swales, W. E. The Enemies Within our Wild Ducks. Rod and Gun, 35(9) : 12-13.

Additional papers are in press or in publication.

Associate Committee on Patents and Awards

No meeting of the associate committee has been held during the year under review, but work has been continued under various subcommittees appointed by the Council. Additional subcommittees have been appointed to deal with the questions of boat stability and biological patents.

During the year 15 patents have been granted and three additional applications have been filed. A considerable number of additional applications are also in preparation.

Associate Committee on Radio Research

Co-operating organizations:

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

The second meeting of the executive committee was held on October 18, 1933, to discuss the program of research to be inaugurated, in view of the reorganization of the radio section. It was decided to begin work on three main problems, namely, atmospheric, measurements and standards, and wave propagation. It was realized that it would be desirable to carry on work on direction finders and antennas, but owing to present lack of staff these items must await future developments.

Work on atmospheric was to be confined to measuring the direction of arrival of atmospheric by the use of a cathode ray direction finder and an automatic directional recorder. The Department of National Defence is particularly interested in the results, because it is hoped that by locating the sources of atmospheric some added information can be obtained regarding the progress of storms. This information will be of use in meteorological forecasting and consequently of service in aeronautics.

The first station for making these observations has been established at the Rockcliffe aerodrome, the field huts having been provided by the Department of National Defence. With one station, only directions of disturbances can be obtained; with two similar stations, it should be possible to locate the actual source of the disturbances, as is being done in England. Records are to be accumulated for a time, after which the desirability of establishing a second station will be considered.

With regard to radio standards and measurements, a policy of slowly acquiring precision standards, as required, was adopted. Other work permitting, as much time as possible is to be devoted to the construction of apparatus for making the usual measurements. At present the laboratories are equipped to measure inductance and capacity using a Campbell mutual inductometer as a reference standard. Equipment has been added to measure the characteristics of intervalve transformers. Standard radio frequencies are obtained directly from the primary standard of the Canadian Radio Broadcasting Commission.

In the matter of wave propagation, it was felt that little could be done at present other than to take automatic records of heights of the ionosphere and to modify the apparatus, when convenient, to obtain automatic records of the ionization in the upper atmosphere. Preliminary measurements have been made and the apparatus is under construction.

Associate Committee on Radiology

This committee met for organization on November 14, 1933. Its purpose is to promote: (a) the establishment and maintenance of relevant scientific standards; (b) the use of these standards in practical radiology; (c) the dissemination of technical information on radiation sources and equipment in regard to their selection and use; (d) the development of equipment and

methods; (e) the co-operation of physicists and physicians and institutions which can further the objectives of the committee; (f) safety from over-exposure, incorrect irradiation and electric shock, etc.

An executive and a technical panel were selected of members living near Ottawa to reduce traveling expenses incurred by meetings. The technical panel met on May 18, 1934.

The committee plans to issue reports on radium and X-ray standards, modern methods of measurement of dosage and quality of radiation, safety, and equipment. Some of these are now in preparation.

The committee is considering methods of facilitating the frequent dosage calibration and checking of radiological equipment in parts of the country remote from Ottawa.

Radium standards were provided in the National Research Laboratories before the organization of this committee. Standards of X-radiation have just been installed and should be in use shortly.

Associate Committee on Survey Research

Co-operating organizations:

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

The annual report of the National Research Council for the year 1932-33 summarized the considerations which led to the appointment of an Associate Committee on Survey Research just prior to the opening of the year under review. Two meetings of the committee were held during the year, the first on May 29, 1933, and the second on December 19, 1933.

At the first meeting, the procedure to be followed by the committee in carrying on its work was decided upon, and the minutes of a conference, which had been held during the preceding month to consider the co-ordination of experimental work on new methods of survey and the recommendations of an executive committee established at the conference, were carefully reviewed and subcommittees were appointed to undertake active work on approved projects. At the second meeting reports were presented by the various subcommittees and additional problems requiring attention by the committee were discussed.

On consideration of the question of infra-red and color photography, in view of the rapid developments which have taken place recently, particularly in the United States and Great Britain, in decreasing the exposures required for infra-red plates, thus making their use in aircraft feasible, and hence opening the way to a very large and important application in Canada, and since the developments in color photography promise much in differentiating tree and rock colors, it was decided to appoint a subcommittee to study these questions. This subcommittee has been directed to study developments in this field, to investigate application of these developments to Canadian problems and to recommend such experiments and researches as they may consider advisable. Definite progress in this work was reported at the second meeting of the main committee, and the subcommittee is continuing its activities.

The problem of contouring and determining relief from air photographs with a minimum of ground control has not yet been satisfactorily solved, and research on this subject is most important if air photographs are to yield their full value for mapping in Canada, and since approximate methods, using only simple apparatus, and exact methods, necessitating the use of elaborate optical-mechanical machines, both require further study, it was decided to appoint a subcommittee to deal with problems in this field. The main committee at its second meeting was informed by the subcommittee that two reports had been published and that experimental work is under way on approximate contouring for small-scale maps using a skeleton height control rapidly obtained. The subcommittee also reported on various other investigations which they had carried on and made several definite recommendations respecting their work.

The committee also gave consideration to the problem of photographic aeroplanes. In view of the fact that most of the photographic flying in Canada necessitates the use of aircraft suitable for landing on water, thus introducing complications in applying oblique aerial photography efficiently and economically, or the multi-lens camera, the need for an improved type of aeroplane for photographic purposes has long been felt. Unfortunately, however, the variance of the requirements makes the subject a difficult one, but on the other hand the vast economies and improved efficiency which are possible, makes the matter urgent. Consequently, it was decided to establish a subcommittee to study various types of aeroplanes available for photographic work in Canada, or designs for a new type of aeroplane to be constructed, and to recommend aircraft to meet the conditions and requirements for photographic flying in Canada. At the second meeting of the main committee this subcommittee reported that the new multi-camera mount which had been designed and used during the past year, permitted oblique photography of the mapping type to be taken from an ordinary cabin seaplane such as is employed on vertical photographic operations. The subcommittee was, consequently, of the opinion that the immediate need for a new type of photographic aircraft has been removed, but it is keeping in touch with new designs in aircraft with a view to relying for replacements on commercial types of machines.

On consideration of the problem of aerial camera auxiliaries and the testing of film and photographic materials, it was pointed out that in connection with the use of air photographs for survey work, the record of certain data, such as height, interval of exposures, etc., is important, and that there is need for investigation regarding apparatus for automatically recording such data and also for approximately determining tilts. Attention was also called to the fact that the stability or otherwise of photographic materials has an important bearing on the possible accuracy of survey from air photographs. It was, consequently, decided to appoint a subcommittee to study and report on problems in this field. At the meeting of the main committee in December this subcommittee submitted a program of specific investigations which it proposed to undertake, and this was approved.

The application of air survey in the fields of forestry and lumbering is extremely important, and while much has been done in classification and typing work and in cruising, location of logging camps and roads, etc., there is great need for further experimentation and research, particularly relating to the taking of a forestry inventory of Canada. Both of these fields are of vital interest both to government departments and to commercial organizations. The committee therefore considered whether a subcommittee on the application of air survey to forestry and lumbering should be appointed. The

committee was informed that the Forest Service is particularly concerned with inventory investigations, aerial timber cruising, through interpretation of air photographs, and the use of infra-red and other special emulsions in differentiating between the various greens. When the matter had been carefully considered, it was decided that the addition of a representative of the Forest Service to the subcommittee on infra-red and color photography would best serve the requirements for work in this field.

Associate Committee on Trail Smelter Smoke

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

Associate Committee on Tuberculosis

Co-operating organizations:

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

While no meeting of the associate committee has been held in the year under review, reports of the numerous investigations under way were presented at a conference of the directors of tuberculosis research and executive officers at Ottawa, which was held on April 23-24, 1934, shortly after the close of the fiscal year. The following brief statements summarize the reports presented to the committee.

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

Experiments with B.C.G. (*Bacillus Calmette-Guérin*) have been continued since 1925 without financial assistance from the committee. Each year one or more groups of calves were inoculated with B.C.G. administered subcutaneously into the dewlap, and groups of unvaccinated calves were used as controls, both the vaccinated and unvaccinated groups being subsequently exposed to contact with active cases of tuberculosis over long periods. Necropsies have been conducted on 54 vaccinated and 56 unvaccinated animals, all of which had been maintained under similar conditions. The proportion of animals remaining macroscopically free from tuberculosis was the same in both cases, 16.6%. Of the vaccinated animals affected with the disease, 50% showed lesions of the caseo-purulent type as against 10% for the unvaccinated, lesions of the caseo-calcareous or calcified types being 50 and 90%, respectively.

An experiment has recently been carried out with 174 guinea pigs which were divided into seven groups. Following inoculation with virulent bovine tubercle bacilli, lesions in the tracheo-bronchial glands appeared in 21, 25 and 42 days, respectively, in groups unvaccinated, inoculated with avian

bacilli and inoculated with dead bacilli, while no lesions were visible in 92 days in the group vaccinated with B.C.G. About 20 animals of each group were kept until the first death from tuberculosis was recorded, which occurred in 59, 77, 126 and 150 days, respectively, for the four classes of animals. While the vaccines used, and B.C.G. in particular, served to retard the dissemination of the virulent organisms, it appeared that death resulted just as rapidly in all the groups once tuberculosis had become established.

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

Tuberculosis Research at the Fort Qu'Appelle Indian Health Unit

In order to determine the value of practical preventive health measures in reducing the morbidity and mortality of tuberculosis among the Indians, the Qu'Appelle Indian Health Unit was formed in 1930 with the financial support of the National Research Council, the Department of Indian Affairs and the Saskatchewan Anti-tuberculosis League. The results of this demonstration up to the present have been very encouraging.

It has been shown that the most important undertaking in the eradication of human tuberculosis is the identification of spreaders and their segregation. An investigation disclosed the fact that in the public schools children with unhealed lung lesions, whether active or healing, were possible sources of infection, and the segregation of these, as well as those suffering from gross tubercular lesions, reduced the percentage of infection in two schools in the research area from 92.2% in 1927 to 58.5% in 1933.

The investigation also showed that the highest death rate among the Indians occurred in the first four years of life. This emphasized the necessity for prophylactic treatment. Following the recommendation of the committee, vaccination with B.C.G. has been started, every second child in a family of vaccinated children being kept as a control. Some time will be necessary to demonstrate the value of this treatment.

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

Tuberculosis Research at the Queen Alexandra Sanatorium

Work has been carried out during the year without financial assistance from the Associate Committee on Tuberculosis.

The sanatorium has recently secured the services of Dr. J. L. Blaisdell as pathologist. Further technical assistance is needed. Numerous additions have been made to the clinical laboratory facilities, including equipment for tissue section.

The following studies are in an advanced state:—

- (1) A simplified method for correcting the erythrocyte sedimentation test for the effect of cell volume.
- (2) The choice of anticoagulants for the erythrocyte sedimentation test; an examination of the Rourke-Ernstene technique.
- (3) The desirability of correcting the erythrocyte sedimentation rate for the effects of cell volume.
- (4) A note on the technique of creatinin determination.
- (5) The measurement of the thorax for radiography of the lungs.
- (6) The mechanics of respiration.
- (7) The mechanical effects on the lung of elastic hypertension.
- (8) The association of atelectasis with chronic pulmonary disease.

- (9) An analysis of the causes of bronchiectasis.
- (10) The radiographic characters of bronchiectasis.
- (11) The measurement of cardiac size in roentgenograms of the lung fields.
- (12) Observations on the life history of pulmonary tuberculosis from serial roentgenograms.

In co-operation with the Department of Physics of the University of Western Ontario studies are being made of physical problems relating to radiology. These include an investigation of ionization chambers for the quantitative measurement of X-radiation, methods of synchronizing X-ray exposures with the phase of the cardiac cycle and the design of a photometer for the measurement of mean density in large X-ray films.

Some work has also been done on the measurement and control of sharpness, radiability contact and density in X-ray films. These studies, which are physical in character but medical in purpose, aim at the definition of the technical characteristics of films necessary for the identification of shadow. Work on these problems has been temporarily discontinued owing to the lack of sufficient assistance.

Published papers:

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

Andrus, P. M. and Hambleton, A. The Efficiency of X-ray Stereoscopy as Influenced by the Method of Trip of the Tube. *Radiology*, 22 : 174-180. 1933.

Andrus, P. M. A New Method for the Radiographic Exploration of the Mediastinum and Concealed Portions of the Pulmonary Fields. *Radiology*, 23 : 97-101. 1933.

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

TUBERCULOSIS RESEARCH AT QUEEN'S UNIVERSITY

The work at Queen's University, which has been carried out during the year without the financial support of the committee, has been directed along three principal lines, summarized below.

Previous work having demonstrated that colony variation in the acid-fast group of bacilli is accompanied by variation in the content of antigen, it was decided to investigate the rate of response of animals to repeated injections of heat-killed "S" and "R" ("smooth" and "rough," respectively) organisms and to infection with tubercle bacilli. Three groups of 78 rabbits were inoculated with heat-killed tubercle bacilli of the two types and the antibody response was measured at short intervals. As an end result of the treatment rabbits given the S vaccine gave an average S/R index of 1.74, while those given the R vaccine gave an index of only 1.23. Nevertheless, the initial reaction to the two forms is the same, and only after continued treatment does the striking difference appear in the responses. This suggests that the initial reaction is to the species antigen, presumably alike in both cases, but that later there is a response to a specific S antigen.

A preliminary study has been made to determine whether there are any considerable differences in the chemical constitution of the antigenic substances. This study included proteins, lipoids and carbohydrates. Antisera

prepared against killed S and R tubercle bacilli were shown to give precipitin reactions with all chemical fractions made from the same organisms. None of the chemical fractions studied were specific for one type only, although the protein fraction exhibited a higher degree of differentiation between the S and R types than did the other fractions studied.

An examination was made of sera from 330 cases of preliminary tuberculosis and antigens from S and R tubercle bacilli. The procedure has been to determine quantitatively the amount of complement fixation by an arbitrary volume of the patient's serum and a slight excess of an antigen prepared from S tubercle bacilli and then to repeat the reaction in the same manner with an antigen prepared from R tubercle bacilli.

The results were studied in the light of clinical histories on the basis of favorable and unfavorable cases. The mean of the S/R indices for the favorable cases was 1.27 against more than 1.75 for the unfavorable. These results, coupled with observations on the subsequent history of the cases, indicate that high S/R indices are associated with acute disease, and low indices with either the very early stages, the healing stages or the terminal stage of the disease.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF ALBERTA

This work has been directed for some years towards finding definite answers to the questions whether B.C.G. as administered by various methods is harmless to cattle and whether it confers resistance upon animals exposed to tubercular infection. The first of these questions can now be answered with some assurance and evidence is being accumulated in regard to the second, but a complete answer to the second cannot be obtained for some years. In relation to the second question valuable information is being accumulated as to the possibility of building up from infected stock a herd of vaccinated animals and of maintaining them in good health.

Experiments reported several years ago indicated that calves vaccinated orally with B.C.G. and subsequently isolated from contact with tubercular animals did not develop the disease. In view of the major importance of this question, however, the experiments have been repeated in modified form and on a larger scale. Of the animals used in these later experiments there now remain 49 vaccinated animals and 42 controls, all born in the fall of 1931. The animals were vaccinated at birth both intravenously and subcutaneously and were later revaccinated subcutaneously. At two and a half years of age both vaccinated animals and controls were entirely free from tuberculosis, as determined by the tuberculin test. The evidence therefore appears to be conclusive that vaccination with B.C.G. by the various methods used is entirely harmless. As a consequence of these findings this phase of the investigation is being discontinued.

In the Ponoka herd are now 108 vaccinated animals, of which 28 have been vaccinated by the double method and 17 revaccinated subcutaneously, all living in intimate contact with animals affected with tuberculosis. The Oliver herd contains 75 vaccinated animals of which 30 were vaccinated by the double method and 17 later vaccinated subcutaneously. The total of vaccinated animals in the two herds is 183. During the year, 28 animals have been added to these herds and 19 have been eliminated, of which 18 came to autopsy. Of these 18, only two have shown macroscopic lesions of

tuberculosis. Microscopic findings are not yet available, but past experience suggests that these will largely confirm the macroscopic observations. These results are regarded as very encouraging.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF MONTREAL

The work under way at the University of Montreal is the first attempt made in Canada to determine the effect of the vaccination of children with B.C.G. This investigation, which has now been carried on for several years, followed extensive experiments in the vaccination of children in France and elsewhere, and the technique of preparing and administering the vaccine were obtained directly from the staff of the Pasteur Institute.

The vaccination of children was begun in 1926. To the end of 1933 a total of 3,607 babies had been vaccinated with B.C.G., of whom 1,037 were added during the past year. Experience in vaccination of children leads to the conclusion that B.C.G. is completely innocuous. Since this result was anticipated from the pioneer work in France, the greatest interest lies in the degree of resistance conferred by the use of the vaccine, and especially in the protection afforded to children living in contact with known or suspected cases of tuberculosis.

Of the 437 vaccinated children from one to twelve months of age living in contact with positive or suspected cases of tuberculosis, 34 have died from all causes, a general mortality of 78 per 1000, as against 71 deaths amongst 631 unvaccinated controls, a rate of 112 per 1000. Children from one to six years of age showed death rates over the whole period of 54 and 64, respectively. Considering children of all ages from one month upwards, the total mortality was 27.3% lower for the vaccinated children. The contrast between the vaccinated children and the controls is still more striking if only the deaths from tuberculosis are taken into consideration, these being 73% lower for the vaccinated children one to twelve months of age and 56% lower for those from one to six years, an average for children of all ages of 68% in favor of those vaccinated. If the comparison is further limited so as to include only those children in contact with positive sputum cases, the percentage in favor of B.C.G. vaccination is 73.5%.

It is of almost equal interest to consider the present state of health of the children still living but in contact with cases of active tuberculosis. Of these, 1.4% of the vaccinated and 6.5% of the unvaccinated are apparently suffering from tuberculosis, a majority in favor of the vaccinated of 78.5%.

Future work will include continued observations of the vaccinated and unvaccinated children and will attempt to determine the extent and duration of the resistance conferred by B.C.G.

The B.C.G. laboratory of the University of Montreal is the only one in Canada used for the preparing of this vaccine for human beings. The utmost care is used to prevent accidental contamination of the vaccine. The B.C.G. laboratory is situated far from hospitals and other possible sources of contamination and no virulent strain of bacilli is ever kept in the same building. The staff is required to undergo frequent periodical examinations in order to ensure their complete freedom from tuberculosis, and the preparation of the B.C.G. vaccine is their only occupation.

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

TUBERCULOSIS RESEARCH AT THE UNIVERSITY OF TORONTO

Work has been continued on the incidence of bovine tuberculosis in man. From the beginning of the investigation a total of 585 cases of tuberculosis have been examined and the conclusion has been reached that bovine tuberculosis is a factor of considerable importance. In children under 14 years of age 14.5% of the cases studied proved to be infected with tuberculosis of the bovine type. The morbidity from this form of the disease is therefore relatively high; mortality, on the other hand, is relatively low in children, being only 8% in the cases observed. In 92% of the cases the patients apparently made an uneventful recovery. In adults the percentage of bovine infection discovered was only 2.5%, but 25% of the cases proved fatal.

The investigation has further shown that bovine tuberculosis is milk-borne and can therefore be prevented by pasteurization. The effect of this treatment is shown by the fact that not one of the 58 cases of bovine tuberculosis found originated in the city of Toronto, where pasteurization of milk is required by law.

While the lesions caused by bovine tubercle bacilli in a large proportion of the cases affected the cervical and mesenteric glands, the investigation has shown that lesions may be found in any of the organs or tissues and that clinically they cannot be distinguished from those of the human type.

Numerous attempts have been made to change the type characteristics of tubercle bacilli by passage through the bodies of different animals. The results of carefully conducted experiments were uniformly negative from the standpoint of mutation of type. An effort is now being made to determine whether it is possible to restore the virulence of certain atypical strains of the organism by rapid direct animal passage.

(Investigations 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

When the Associate Committee on Weed Control was organized in the fall of 1929 a three-year program of research was contemplated, with a review at the end of that time of the progress made and a reconsideration of the requirements of the situation. Unfortunately, at the end of the period in question it became necessary for the National Research Council to reduce materially the amount placed at the disposal of the committee. Under such circumstances it is gratifying to be able to report that the importance of the work under way had been so fully demonstrated that funds became available from federal and provincial departments of agriculture and other sources to such an extent that a large proportion of the investigations have been continued. Other projects have been so rounded out that the information originally sought has been made available. In fact, it may be said that at no time in the past has there been such widespread interest in weed control and such an appreciation of the losses incurred directly and indirectly owing to weeds. These losses in western Canada alone have been estimated by a member of the committee to amount to more than \$170,000,000 annually.

In order to make a maximum amount available for research during the year, the regular annual meeting of the associate committee was dispensed with, but it is hoped that it will be possible to call the members together for occasional consultation. In the meantime, a statement summarizing investigations carried out by the various groups working in co-operation is being prepared for distribution to all members of the committee and other interested parties.

During the year the following publication of the associate committee appeared and a number of others are now in preparation:

Competitive Efficiency of Weeds and Cereal Crops, by T. K. Pavlychenko and J. B. Harrington. *Can. J. Research*, 10 : 77-94. 1934.

Brief summaries of the reports submitted by the various co-operating groups are given below.

WEED INVESTIGATIONS OF THE FEDERAL DEPARTMENT OF AGRICULTURE

Weed eradication projects carried on without financial assistance from the committee are in progress on the Central Experimental Farm in Ottawa and on 20 of the branch experimental farms throughout Canada.

On the Central Experimental Farm an area has been set aside for the sole purpose of conducting weed eradication experiments. The first projects to be undertaken in Ottawa were the eradication of mustard and couch grass, because these were considered to be the worst weeds in the Ottawa district. In the year 1933 an additional area was set aside to be used for studying methods of eradicating 26 of the most common weeds found in eastern Canada. The plots in this area were infested with weeds in the fall of 1933 and eradication treatments will be commenced in 1934 on all except the perennial weeds, which will be allowed to become well established before commencing treatment. In planning the procedure of the weed eradication experiments, it was thought advisable to make provision for the periodical infestation of plots so that the same treatments could be carried on continuously for as many years as considered necessary. The general sequence to be followed in the eradication experiments with perennial weeds will be the application of various treatments in the first year, observation during the second year of the effect of the previous year's treatment, with reinfestation in the fall and free growth of weeds during the third year.

An area on which eradication experiments with perennial sow thistle will be conducted has already been set aside at the experimental farm at Kapuskasing, Ontario. Various methods of eradication are now being tested. The same procedure with regard to reinfestation will be followed at Kapuskasing as at Ottawa. On all the other branch experimental farms the treatments are applied on fields already infested with weeds and periodical reinfestation is not followed. Since many experiments are in progress in regard to rotations, cultural methods and commercial fertilizers, an opportunity is afforded for observing the effects of the various treatments on weed control.

Many of the experiments have not been in progress for a sufficient length of time to warrant definite statements regarding the results obtained. It appears, however, that applications of fertilizer, rates of seeding, crop rotation, and cultivation after harvest, are treatments which have a marked influence on the control of weeds.

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

WEED INVESTIGATIONS BY THE ALBERTA DEPARTMENT OF AGRICULTURE

Weed experiments in the year under review have been largely confined to the eradication of leafy spurge and hoary cress.

Leafy spurge is one of the newer weeds in Alberta, but it appears to be gaining ground rapidly and since it is a difficult weed to control it is important that attention be given to it before it becomes firmly established. Preliminary experiments were undertaken to determine the approximate quantities of herbicides required to effect satisfactory control of leafy spurge, both on cultivated land and on uncultivated areas. It was found that three applications of sodium chlorate at rates of 1.5, 2.0 and 2.5 pounds per 100 square feet were sufficient to kill over 98% of the weeds in patches occurring in winter rye. This was considered quite satisfactory, as the remainder would be readily destroyed in normal tillage operations. On uncultivated land one pound per 100 square feet destroyed nearly all the weeds and 1.5 pounds and larger applications effected a 100% kill. Applications both as spray and as dust were satisfactory. Where the weeds have been long established and undisturbed heavier applications may be necessary. Commercial herbicides were found effective when applied at rates of two to four pounds per 100 square feet, which are in excess of the rates recommended by the manufacturers.

Hoary cress was found quite resistant to common herbicides, as in previous experiments. In 1931 an application of 2.5 pounds of sodium chlorate on 100 square feet had been insufficient to destroy it completely. Recent experiments with four and five pounds per unit area have also been unsatisfactory in that incomplete eradication was effected, although the growth of weeds was reduced to the extent of 97 or 98%.

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

WEED INVESTIGATIONS IN MANITOBA

Research on weeds during the last two years has taken on a more general character and considerable time has been spent on the immediate problems of the farmers, as they have been submitted to the department. The work has been entirely supported by funds subscribed by the North-Western Grain Dealers.

Some time has been spent in preparing for publication a series of pamphlets on the more practical application of weed control. The following have already been issued:—

Pamphlet No. 1, Farmers of Western Canada in Account with Farm Weeds.

Pamphlet No. 2, Couch Grass and Its Control.

Pamphlet No. 3, The Control of Perennial Sow Thistle.

Pamphlet No. 4, The Control of Canada Thistle.

The various projects previously reported to the associate committee have been carried somewhat further and new lines of investigation have been explored with respect to chemicals, but without any conclusive results up to the present. Some preliminary work has been done on the morphology and physiology of wild oats and leafy spurge.

With the co-operation of the Dominion Seed Branch and the Manitoba Department of Agriculture a weed treatment survey has been conducted which bids fair to give information upon which to plan an investigation on

seed cleaning. A taxonomic service has been carried out, particularly for the weed inspectors. Further information has been gathered on the distribution of the worst weeds in Manitoba and especially on the spread of Russian thistle. Additional data have been secured on actual losses due to weed infestation.

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

WEED INVESTIGATIONS OF THE SASKATCHEWAN DEPARTMENT OF AGRICULTURE

These investigations, previously supported financially by the committee, have been carried out during the year under review without additional assistance.

Heavier seeding of grain than usual has been tried for the purpose of hindering the development of annual weeds, especially mustard and stink-weed, the early growth of which is less rapid than that of the grain seedlings. Preliminary data indicate that a substantial increase in crop can be secured by this method.

Spraying with sulphuric acid has been continued in an effort to destroy annual weeds in wheat. Results show that spraying must be done very soon after the crop has formed its second leaf. Any delay after that time means a reduction in yield of grain harvested, because the weeds take up the soil moisture and crowd the wheat, and because the crop later appears to become more susceptible to the action of acid.

Ammonium phosphate has been sown with wheat on weedy land and the growth of both wheat and weeds was found to be stimulated. The early sown wheat gave a substantial increase in the yield of grain and a decrease in yield of weeds when this fertilizer was applied, but the results were not favorable when the crop was sown late. When no fertilizer was applied, late seeding gave the best results on both clean and weedy plots, particularly the former.

Barley is generally considered one of the best crops for smothering weeds and for that reason its growth is often recommended on weedy land. Experiments in 1933 nevertheless showed a marked reduction in the yield of barley where weed growth was heavy.

Harrowing as a method of weed control in growing crops was found to have limitations, due to the fact that the soil is often in an unfavorable condition for cultivation when the crop and weeds are at the proper stage of growth. For the best results harrowing should be carried out shortly after the emergence of the crop.

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

The spread of micro-organisms in the soil is a subject which has aroused the interest not only of plant bacteriologists but also of those interested in general biology and agriculture. The typical "fairy rings" of lawns and pastures have aroused curiosity for centuries but only comparatively recent knowledge has shed light on the cause and nature of the phenomenon. These rings are now known to be due to the growth of certain fungi.

Take all of wheat occurs in spots which appear gradually to enlarge, thus indicating a lateral spread of the fungus in the soil. Foot rot does not exhibit this tendency to a similar degree, although it is possible that it may

occur. It seemed important to ascertain if this spread could take place in bare unsterilized soil, or if the presence of living vegetation was necessary for such horizontal extension to occur. The results indicate that take-all can spread laterally when unsterilized soil is occupied by living susceptible plants, such as quack grass, western rye grass and wheat, but not in bare unsterilized soil such as the black soil of the Edmonton district. The results of foot rot were inconclusive in this respect.

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

Work has been continued on the decomposition and movement of herbicides in soils and their effects on microbiological activity and subsequent crop growth.

In experiments continued over a period of four years, it has been found that sodium chlorate applied to uncropped land generally reduces the yield in the following season and slightly reduces the yield in the second season, but not thereafter. Sulphuric acid, copper sulphate and sodium dichromate had no toxic effect in the season following that in which they were applied. Sodium thiocyanate reduced crop yields in the year following that in which it was used. Light applications of this herbicide were not found to affect nitrification but heavy applications apparently had an injurious effect upon micro-organisms, since nitrification decreased.

(Investigation under the direction of Dr. J. D. Newton and Dr. F. A. Wyatt.)

WEED INVESTIGATIONS AT THE UNIVERSITY OF SASKATCHEWAN

Weed investigations carried on during the year have comprised seven different projects, in which were included more than 30 different annual and several perennial weeds and 16 varieties of cereals.

In an investigation of the relative rates of growth of annual weeds and cereal crops, it was determined that cereal seeds germinated under more severe drought conditions than those of the dicotyledonous weeds tested and grew under conditions of equal moisture much more rapidly at the early seedling stage, while at the later growth stages weeds developed a much greater assimilation leaf surface than the cereal crops. In general an abundance of top growth was found to indicate a high degree of vigor and of competitive efficiency.

Detailed studies were made of the growth of the roots of poverty weed and it was found that under favorable conditions they could spread radially at a rate of seven feet per year. The anatomy of the roots is such that the xylem is well protected against drought and putrefaction processes, probably as a result of which the roots are viable in the ground for four or more years. No shoots developing at a greater depth than 20 in. ever appeared above ground, but deep runners frequently came close to the surface and thus facilitated the appearance of shoots.

Summer fallowing was tried for the eradication of wild oats in a heavily infested area, but the season proved almost too dry for the germination of the seeds. Wild oat seeds buried four years at a depth of six to seven feet were found to be viable to the extent of 0.5 to 2.5%. Experiments indicated that wild oats should be cut for hay not later than the day of heading in order to obviate the possibility that the hay might produce viable seed. New wild oat seeds were found to germinate only to the extent of 30% in the season of growth, but 100% in the following spring.

In cultural treatments the concentration of fibre and carbohydrates in the roots was found to be a reliable criterion of their condition. Shallow tillage sufficient to inhibit top growth was found to eradicate perennial sow thistle, quack grass and Canada thistle in 10 to 12, 14 to 18 and 18 weeks, respectively, under favorable conditions. Such cultivation proved inexpensive and left the soil in a favorable condition in respect to moisture-holding capacity.

An investigation was made of competition between annual and perennial weeds and cereal and forage crops, and studies were also made of the root systems of single plants without competition. An enormous amount of work was involved in these investigations, but the results when complete will, it is believed, be of the greatest interest and utility.

The effect of depth of seeding on the germination of seeds of 12 annual weeds has now been observed for three or four years. The results indicate that annual weeds can be divided into several distinct groups with respect to their ability to germinate and emerge from different depths. The variation between different varieties is great; for example, Russian thistle germinated best directly on the surface and never at a depth greater than one inch, while wild oats germinated to a depth of 12 inches. These results will be of great value as a guide in tillage. Shallow tillage is in general to be recommended for the control of annual weeds.

Experiments were begun on the effect of seven different herbicides in Canada thistle. Sodium chlorate and arsenic pentoxide effected a 100% kill; the results of treatment by other chemicals cannot be determined until next season.

(Investigation under the direction of Dr. J. B. Harrington and Mr. T. K. Pavlychenko.)

WEED INVESTIGATIONS IN THE NATIONAL RESEARCH LABORATORIES

Investigations carried out in the National Research Laboratories under the direction of Dr. R. Newton are outlined in the report of the Division of Biology and Agriculture, page 26.

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)

In view of the urgent necessity for economy there has been no general meeting of the associate committee during the year under review. Members of the Section on Wool Growing, however, met in Calgary on June 19, 1933, to receive reports of wool growing projects under way and plan for further work.

Dr. Fairfield reported further on his flock of purebred and grade Corriedales maintained at the Lethbridge Experimental Station without financial

assistance from the committee. He was also supplementing the cross-breeding experiments financed by the committee at Cardston by supplying rams for crossing with a flock of 600 fine-wooled sheep. Wool produced by this cross was of excellent quality and the lambs possessed good mutton characteristics.

The committee's cross-breeding experiments at Cardston with Corriedale-Rambouillet crosses and Rambouillet controls were outlined by Prof. J. P. Sackville. This work having been under way for some years, several crosses had been produced with different proportions of the blood of the two breeds. Arrangements were made for special grading tests of wool from each of these crosses, the grading to be carried out at the warehouse of the Canadian Co-operative Wool Growers, Limited, at Weston, Ontario, in the fall of 1933. It was also agreed that the committee of Messrs. Fairfield, Sackville and Shaw should continue to supervise this experiment in the hope of reaching definite recommendations regarding a breeding policy to be followed in western Canada.

Unfortunately for the Cardston experiment there had been a shortage of feed in that district, rendering it necessary to send the lambs to Edmonton to be prepared for market. Prof. Sackville reported that the results from the point of view of mutton quality were very distinctly favorable to the Corriedale-Rambouillet crosses.

Prof. Sackville's own work at the University of Alberta was briefly summarized. His experiments included work intended to reveal the effect on wool of variations in humidity, temperature, time of shearing, plane of nutrition and protein and mineral content of feed. In most cases, the results indicated that these factors did not markedly affect the quality of the wool produced. Sheep maintained on a low plane of nutrition yielded less wool than those on a high plane but the wool was not definitely of inferior quality. Very careful grading and extended laboratory tests over a period of years were required to reveal the significance of the various environmental and other conditions being studied.

Working with relatively small flocks, Dean Shaw at the University of Saskatchewan has been experimenting several years in an effort to determine the value of the crosses of certain breeds with fine-wooled sheep. He reported that in addition to the English Leicester and Romney Marsh breeds, previously indicated as undesirable in this cross, he was now prepared to eliminate also the Cheviot. On the other hand, both the Ryeland and Corriedale crosses gave decided encouragement, taking into consideration not only the wool and mutton produced, but also the questions of hardiness, number of progeny and suitability for western conditions.

Preliminary consideration was given to a report of a small committee appointed to consider a suggestion that a comprehensive breeding program be undertaken, with the object of developing a new breed or cross of particular value under ranch conditions in western Canada. It was agreed that the matter should be further considered but that this larger project should be postponed pending further experiments on a small scale.

The committee decided to continue the special grading of fleeces from all experimental flocks. It was recommended that as many as possible of those in charge of the investigations should witness the grading tests.

As indicated in the last annual report, complete manufacturing tests using Alberta wool, including some from the experimental flocks, have been made through the co-operation of the Hespeler mill of Dominion Woollens

and Worsteds. Four different pieces were made up for men's suits and a considerable part of the cloth was sold to members of the committee and other interested persons in order that information might be secured as to the suitability of Alberta wool for this purpose. This work has amply demonstrated the fitness of Canadian wool for the manufacture of fine cloths; in fact, the only complaint received has been that the wool used was unnecessarily fine. It is satisfactory to be able to report that Canadian manufacturers are now more appreciative of the quality of Canadian wool and are using it in increasing quantities.

Pending receipt of a definite recommendation from the Canadian Woollen and Knit Goods Manufacturers' Association, systematic research on manufacturing processes has not yet been undertaken in the National Research Laboratories. Much work has, however, been done on wool from the experimental flocks, especially those from the University of Alberta. This work is described under the report of the Division of Chemistry on page 44.

SPECIAL COMMITTEES

Executive Committee of the Fifth Pacific Science Congress

The Fifth Pacific Science Congress was held in Victoria and Vancouver, B.C., Canada, June 1-15, 1933. Attendance records showed the names of 418 delegates including nine each of whom represented institutions in two different countries, so that 409 persons were actually present. The preponderance of home members, as usual, was considerable, but 17 different countries were represented by delegates distributed as follows: Canada, 259; United States, 101; Japan, 16; China, 6; Hawaii, 6; Australia, 5; Great Britain, 4; Hong Kong, 3; Mexico, Netherlands and Netherlands Indies, 3 each; Argentina, France and Guatemala, 2 each, Philippine Islands, Straits Settlements and Federated Malay States, and Sweden, 1 each.

In point of attendance, the Fifth Pacific Science Congress compared favorably with its predecessors, and the number of scientific papers read was more than 500, or approximately one-half as many as the total number presented at all preceding congresses.

Delegates and officers in charge of the scientific activities were unanimous in expressing their satisfaction with the material presented by the several contributors to the scientific program and in voicing their appreciation of the opportunities afforded by the congress for the interchange of thought among the representatives from the various parts of the vast Pacific region. Great praise was given on every hand to the executive committee, for the well-knit program of papers that had been arranged for the consideration of the delegates, and to the officers of the congress and the citizens of Victoria and Vancouver and the staff of the University of British Columbia whose plans for the entertainment of the visiting members, both in scientific sessions and in social functions, were carried through to the entire satisfaction of all concerned.

It may fairly be said that the Fifth Pacific Science Congress fully sustained the high ideals of the Pacific Science Association, as expressed in the constitution, which defines the purpose of the association as follows:—

- (a) To initiate and promote co-operation in the study of scientific problems relating to the Pacific region, more particularly those affecting the prosperity and well-being of Pacific peoples;
- (b) To strengthen the bonds of peace among Pacific peoples by promoting a feeling of brotherhood among the scientists of all the Pacific countries.

His Honor the Lieutenant-Governor of British Columbia officiated at the opening meeting in Victoria on June 1, when a large and representative assembly filled the spacious ballroom of the Empress Hotel. The President's address, and speeches by foreign delegates, were features of this session, the proceedings of which were broadcast over a coast-to-coast network of Canadian radio stations, and also given extensive notices in the press.

Scientific meetings occupied the time of congress members from 9 a.m. to 12 a.m. and from 2 p.m. to 4 p.m. each day throughout the two-weeks' period. Local excursions to points of scientific interest followed the afternoon sessions. On several occasions longer trips made it necessary to cancel the afternoon technical session in order to give the visitors a better opportunity to see something of the industrial and natural features of interest, as for example when the entire congress party spent a Saturday afternoon and evening on Grouse Mountain, and again on a tour of Vancouver harbor, to inspect the elevators, cold storage plants, mills, and shipping facilities.

Full hospitality was extended by the congress to all official members, this designation being applied to all delegates who had been accredited by their respective governments, as well as to honorary members, members of the executive committee, chairmen of sections and committees, chairmen and secretaries of the standing committees appointed at the fourth congress, and one or two others, who had been especially invited to attend the congress because of the value of their contributions to the *Proceedings*.

Reduced rates for hotel accommodation and meals were made available to all other delegates.

In planning the scientific program, the executive committee followed the policy laid down at previous congresses, and arranged for six symposium meetings for the discussion of topics of general interest to the delegates as a whole. Each of the two main divisions—biological sciences and physical sciences—arranged for two further symposium meetings, thus providing for ten general meetings in all. These were scheduled for the morning sessions, and the afternoons were reserved for sectional meetings in which more specialized studies were considered.

Throughout the organization of the scientific program *the aim of the committee in charge was to obtain a conspectus of the current situation in respect to particular fields of work and to indicate new openings for research that would be likely to yield profitable results.*

For example, an attempt was made in the program of the Section on Animal Diseases to determine the nature and extent of the prevalent diseases of animals in the countries of the Pacific, to appraise the value of the research work that had been done in this connection, and to survey the possibilities along various lines for further work looking to the better control of the common diseases and the suppression of those that threaten to become epidemic.

Similarly, in the congress symposium meetings the papers were designed to evaluate the recent advances in the application of scientific knowledge to the basic industries of agriculture, fisheries, mining and forestry, while another series of papers sought to bring under review the work of the meteorologists in all parts of the Pacific, on problems of first importance to navigation and communication. Trade of the Pacific countries was reviewed at one of the sectional meetings and a careful study was made of the international movements of commodities by way of the Pacific ocean. Out of this study came several practical suggestions for the improvement of trade and the extension of commerce over the commercial routes joining the countries of the Pacific basin.

In the general sessions suitable provision was made for the consideration of the reports submitted by the several standing committees appointed at the preceding congress in Java. Two among these may be singled out for special mention, notably the report of the Standing Committee on the Protection of Nature and the report of the Standing Committee on Oceanography, both of which made important contributions to the *Proceedings*.

Indo-China having expressed a wish to withdraw its invitation for the sixth congress, the Pacific Science Council appointed a Hold-over Committee consisting of representatives of all countries that had taken an active part in the work of the Pacific Science Association. The purpose of this committee was to seek a place in which to hold the next congress.

A feature of the congress was the appointment of a special committee to make recommendations regarding the subjects of study on which information was desired for the sixth congress. This was in addition to the appointment of a number of standing committees, each of which was charged with a specified assignment on which to report.

Looking toward the continuation of the work of the Association in future, the congress passed a series of 25 resolutions at the final general business meeting.

Following the two weeks of technical sessions, the foreign delegates were taken on a short tour of the interior of British Columbia where they saw the world's largest lead-zinc mine at Kimberley, metallurgical and chemical plants at Trail, power developments on the Kootenay River, oil and gas fields in the Turner valley, Alberta, as well as the magnificent scenery through the Canadian Rockies and a glimpse of the great interior plains where agriculture is the leading industry.

The *Proceedings* of the congress, now in press, will be published during 1934. Comprising five stout volumes containing approximately 4400 pages, these will constitute a record of achievement in recent scientific investigations in the Pacific area of great value to students and research workers in this domain.

The Fifth Pacific Science Congress is generally recognized as having been one of the most important international assemblies of scientists ever convened in Canada.

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service, Department of Trade and Commerce

The committee's specifications for approval of type of the various electricity measuring devices have now had official recognition for several months. In the case of the specifications dealing with instrument transformers, certain minor changes appeared to be advisable and the revisions recommended by the committee have been approved by the Council. In all its work in connection with these specifications, the committee has been in close contact with the manufacturers and utilities.

One of the committee's duties has been the preparation of definitions for any electrical units which were deemed necessary for measuring electricity. Up to the present time, the committee's recommendations have covered practically all commercial phases of electrical measurement except certain quantities in alternating current circuits which involve quadrature components. In view of the fact that the Council's Associate Committee on Electrical Measuring Instruments has devoted considerable thought to the measurement and billing of electric service on the basis of volt-amperes or volt-ampere-hours, and the extent to which the billing should be influenced by the power factor, the special committee is not attempting to define such units until definite decisions have been reached by the associate committee.

The laboratory has been steadily securing precision standards of electrical measurement as well as the necessary instruments and apparatus for making comparisons against these standards. Prior to this fiscal year, all Canadian legal primary standards of electrical measurement were deposited in the laboratories of the Electricity and Gas Inspection Service of the Department of Trade and Commerce. The Council's laboratory now has certain precise standards of potential difference and resistance, some of which have been certified by the National Physical Laboratory in England and others by the United States Bureau of Standards. The laboratory maintains very accurate and uniform temperature control on these standards and is equipped with apparatus to make precise comparisons, consequently a higher order of accuracy and reliability in such measurements may be expected. The Council has therefore declared these standards to be the legal primary standards of Canada.

SUMMARY OF REPORTS ON ASSISTED RESEARCHES

Each recipient of a grant from the National Research Council is required to submit annually a report of the progress of the research work being carried out under his direction. Summaries of such reports will be found below. In addition, the Council has published during the year in the Canadian Journal of Research scientific papers giving the detailed results of many such investigations. References to other recently published papers will be found at the end of a number of the summaries.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 63.

Gas and Water Content of Trees and the Sinkage Problem

Co-operating organization:

McGill University

Previous study of life processes of trees suggested that data on soil temperatures might provide further information on the general problem. Apparatus for the measurement of soil temperatures has been assembled and will be installed during the summer.

As a check on collected evidence indicating an apparent absence of seasonal change in the water content of jack pine, spruce and balsam in the province of Quebec, the same methods were applied to European larch and Scots pine in the New Forest, England, through the co-operation of the Forestry Commissioners of Great Britain. While the results showed considerable variability, the averages indicated no significant changes in water content during the summer season.

Preliminary studies on seasonal changes in food reserves of birch are also in progress and it is hoped to correlate these with changes in water content, with sap flow and with other activities of the tree.

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

The Flora of Eastern Canada

Co-operating organization:

University of Montreal

A comprehensive survey of the flora of eastern Canada has been under way for some years. In the past season it has been carried on in both Quebec and Ontario in order to ascertain what relation exists between the flora of the Great Lakes and that of the lower sections of the St. Lawrence River. Many doubtful points have thereby been cleared up.

The results obtained in the investigation to date will shortly be published.

(Investigation under the direction of Fr. Marie-Victorin, University of Montreal.)

Microbiology of Quebec Soils

Co-operating organization:

Macdonald College

Studies have been made of microbiological and associated factors in virgin podsol soils from the Laurentian area and from the lowlands south of the St. Lawrence River. The results show that in physical condition, evolution of carbon dioxide, bacterial numbers and decomposition of urea the separate horizons of these soils resemble those of the Appalachian upland soils discussed in a previous report. In one soil nitrification did not occur in the organic matter horizon. This soil bore coniferous trees while the other soils supported a deciduous population. It is suggested that the failure of nitrification in this case may be due to the presence of certain chemical compounds which have been found associated with "beechwood" soils elsewhere.

In the gradient of biological factors the podsol soils differed from a normal virgin clay soil. The successive horizons of the podsol soils showed more marked differences, notably in rate of evolution of carbon dioxide and in bacterial numbers. In the clay soils also, the carbon dioxide gradient was more regular than the bacterial numbers, while in the podsol soils this was not the case.

The addition of a soluble organic compound to podsol soils resulted in an increase in bacterial numbers, followed by a decrease after the compound had been consumed. This indicates that these soils are capable of decomposing much additional organic matter. However, the organic compound was decomposed slightly more rapidly in samples of representative uncultivated Quebec soils. The explanation of this slight but consistent difference demands further investigation.

Bacteria capable of decomposing cellulose, phenol and urea have been isolated from virgin soils of Quebec and these organisms resemble morphologically bacteria found in cultivated soils. Anaerobic forms of nitrogen-fixing bacteria and bacteria which reduce nitrates were also found.

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

The Relative Rigidity of Welded and Riveted Connections

Co-operating organization:

School of Engineering Research, University of Toronto

Although the use of welded connections in steel structures of all kinds is increasing rapidly, very few reliable data have been available as to the mechanical characteristics of such connections. This question is of importance from the point of view of safety as well as of economy.

The present comprehensive studies, which have been under way for some years, were undertaken to investigate the following distinct aspects of joint rigidity:—

- (a) The relative capacity under gravity load of beam-girder and beam-column connections for developing beam restraint, or continuity, designed with a view to reducing the required weight of the connected beam.
- (b) The relative values of certain typical connections in resisting the deformation of a frame due to lateral loads, either in one direction or subject to reversal.

Two series of specimens were fabricated and tested in relation to plain rating beams. The first series, designed for the purpose of studying beam continuity, consisted of ten 9-in., 20.5-lb. Bethlehem beam double-cantilever specimens, employing five different types of welded connections. The second, designed primarily for the study of wind bracing rigidity, consisted of twelve 18-in., 47-lb. Carnegie beam double-cantilever specimens with three different types of connections. These types included the welded T, the welded gusset and, for comparison, the riveted T. For half the specimens of the second series the connections were to a central transverse plate simulating the web of a column, and for the other half to the flanges of a 12 by 12-in., 110-lb. H-column.

Coefficients of restraint, that is, the ratio of actual to 100% restraint, were ascertained by determining end slope angles with the aid of a special type of longitudinal extensometer attached to the beam flanges. Although, for convenience, the specimens were tested as double-cantilevers the results were readily transformed to be applicable to the partially restrained beams simulated by the specimens.

Story drift angles, that is, the angle through which the columns of a building subjected to horizontal force would tilt in one story of height due to the deformation of the connections, were ascertained by utilizing the end slope angles mentioned above and the observed deflections of the specimens. The results for the specimens were transformed by calculation to be applicable to a 20-ft. bay of an actual building.

Broadly stated, the results obtained in the study of the connections tested were:—

(1) Welded connections as ordinarily designed for end restraint fall short of the ideal value of 0.75 for the coefficient of restraint by from 10 to 25%.

(2) Both welded and riveted connections designed primarily for capacity wind moment develop a coefficient of restraint in excess of the most economical value (0.75) required to resist gravity loads only.

(3) A beam welded to a column web may develop less story drift angle than would a plain beam integral with the column. T's riveted to a column flange may, for a 20-ft. bay, give rise to a lineal drift of as much as 0.36 in. per 12-ft. story under a capacity wind in one direction, while welded T's under the same conditions showed 0.09 in. and welded gussets only 0.03 in.

(4) In the connections designed for beam continuity only, the compression attachment was in all cases more yielding than the tension one. Transfer of axial compression by longitudinal welds to the edges of a thin flange introduces much yield due to horizontal shear in the flange.

(5) In wind connections either to a column web or to a column flange, the top and bottom attachments, under capacity reversing load, gave approximately equal total longitudinal deformations for each of the three types.

(6) From a third to a half of the flexural slope in a connection to an unstayed column flange may be charged to the deformation of the column flange.

(7) In wind connections to an unstayed column flange the welded connections gave regional flexural slopes from 17 to 63% of the corresponding ones developed in the riveted T-connections, depending on the region, or longitudinal zone. Consequently, the welded connections were definitely stiffer than the riveted ones in all regions.

(8) The aggregate longitudinal elastic deformation in tension for capacity reversing load was greater than the aggregate deformation in compression, the maximum excess being 70%. This was for the riveted T-connection to a column web.

(9) For the riveted T's a large part of the longitudinal deformation was non-elastic slip. It amounted to 31% for the connection to a column web and 46% for a connection to a column flange.

(10) Welding of stiffeners to the column flanges reduced the longitudinal deformation of the welded T and the welded gusset connections to 75 and 85% of their previous values, respectively.

(11) For the specimens designed for beam continuity only, the ratios of the test factor of safety to the design factor of safety, based on an estimated ultimate strength of 10,000 lb. per lineal inch of $\frac{3}{8}$ -inch. fillet weld with uniform distribution of stress, varied from 0.65 to 0.97.

(12) For the specimens designed primarily as wind connections, the ratio of test factor of safety to design factor of safety, based on assumed uniform stress distribution, varied from 0.88 to 0.98 for the riveted specimens, from 0.49 to 0.83 for the welded T-specimens and from 1.06 to 1.29 for the welded gusset plate specimens. It is thus evident that non-uniformity of stress, which obviously existed to a marked degree for the welded T-connections, may cause the capacity of certain types of connections to fall considerably below that estimated on the basis of uniform distribution.

(Investigation under the direction of Prof. C. R. Young.)

Impact Resistance of Nickel Steels at Low Temperatures

Co-operating organization:

University of Alberta

The quality of steel known as impact resistance is an important factor in the safety of transportation, particularly in cold countries, such as Canada.

In this investigation it has been found that by heat treating nickel steels the resistance to impact at low temperature is largely increased. This increased resistance is related to the micro-structure of the heat-treated steel. It is thus possible to obtain greater safety, and also to utilize smaller sizes of materials in machines and structures with the same degree of safety, by using heat treated nickel steels, than by using ordinary steels of larger dimensions and weight.

(Investigation under the direction of Dr. A. E. Cameron, University of Alberta.)

Surface Energy of Solids

Co-operating organization:

McGill University

When a solid body is cut into smaller pieces, a large part of the work done is transformed into heat and sound, and another part is stored up in the new surfaces formed. This latter fraction, though small, raises the vapor pressure of the solid and renders small pieces more soluble than large ones. By finely powdering a crystal of ordinary salt, the surface energy is brought to a measurable value. Thus, when salt is dissolved, powdered material absorbs less heat for complete dissolution than a single piece of salt of the same weight.

In order to obtain finely divided salt, the material may be heated in a platinum retort and the vapor blown by dry air into a long tube ending in a settling cylinder. The surface of one gram of salt is increased in this way from about 3.6 sq. cm. to about 100,000. The heat absorbed from the surroundings when the fine salt is dissolved in water at 25° C. is about 12 cal. per mole (58.5 gr.) less than that of coarsely ground material, which requires about 1000 calories at low concentrations. The surface energy of solid sodium chloride must therefore be of the order of 400 ergs per sq. cm.

A rotating calorimeter constructed of sterling silver sheet was used in this investigation, the stirring being obtained by rotating the whole vessel. The temperature was measured by radiation thermocouples.

Published papers:

Lipsett, S. G., Johnson, F. M. G. and Maass, O. The Surface Energy and the Heat of Solution of Solid Sodium Chloride. *J. Am. Chem. Soc.* 49 : 925-943. 1927.

Lipsett, S. G., Johnson, F. M. G. and Maass, O. A New Type of Rotating Adiabatic Calorimeter. The Surface Energy and Heat of Solution of Sodium Chloride II. *J. Am. Chem. Soc.* 49 : 1940-1949. 1927.

Lipsett, S. G., Johnson, F. M. G. and Maass, O. A Micro Calorimeter. *J. Am. Chem. Soc.* 50 : 1030-1033. 1928.

Lipsett, S. G., Johnson, F. M. G. and Maass, O. The Surface Energy of Solid Sodium Chloride III. The Heat of Finely Ground Sodium Chloride. *J. Am. Chem. Soc.* 50 : 2701-2703. 1928.

(Investigation under the direction of Dr. F. M. G. Johnson and Dr. O. Maass, McGill University.)

The Spectrum of Ionized Columbium

Co-operating organization:

University of Alberta

In its compounds columbium, a metal resembling tantalum, but much less abundant, is most often pentavalent, that is, it acts as an atom having lost five negative charges. This atom or ion is difficult to obtain and study in the free state, but when an electric discharge is produced in a vacuum between two small pieces of metallic columbium, and the spectrum is studied, using a glass grating with 30,000 lines to the inch, it is found that wave-lengths emitted by the columbium ion Cb V, having lost four negative charges, appear with great intensity. The method employed to locate these wave-lengths among others produced by impurities, such as carbon, nitrogen and oxygen, is to use the well-known method of plotting, against the atomic numbers, the frequencies of the corresponding radiations from ions of rubidium, strontium, ytterbium, and zirconium. The curves obtained are nearly straight lines and can be extended to columbium.

Another important aid in choosing the correct lines is the theory of the separation of regular doublets. The resonance doublet of the ion lies at wave-lengths 1877.35 and 1857.36Å, that is, in a region where quartz loses its transparency. About a dozen more wave-lengths can be identified and classified in the region of shorter wave-lengths.

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

The Profiles of Helium Lines in B-type Stars

Co-operating organizations:

Dominion Astrophysical Observatory

McGill University

National Research Council, Washington

In the spectrum of many of the hottest or B-type stars very broad absorption lines are found near the positions occupied by the wave-lengths of the diffuse series. The absorption is stronger on the side of the short wave-lengths, and the profile of the absorption line indicates a complex structure. A detailed study shows that part of the effect is due to a strong electric field existing near the atoms which absorb light; this field displaces the regular absorption line to the side of long wave-lengths. Part of the absorption is due to the fact that new lines are absorbed in an electric field; in the case of the diffuse series of helium these lines are to be expected on the side of the short wave-lengths, their number increasing by unity at each step from a lower to a higher group of lines.

Electric fields reaching a strength of over 100,000 volts per cm. must exist in the absorbing layer of these stars. Not all the broadening of the absorption lines, however, can be ascribed to the electric fields; a residual strong helium line or band, one to two angstroms from the main line, remains to be accounted for. It is in all probability due to a Doppler shift caused by rapid motion of the absorbing atoms in a direction toward the observer with velocities of the order of 75 to 100 kilometres per second. According to this spectroscopic analysis the ionized layer of the hot stars must be the seat of strong space charge fields produced by the electrons set free at high temperatures, while streams of helium gas are emitted from the star and rush through the relatively steady layer at velocities of close to 60 miles per second.

(Investigation under the direction of Dr. J. S. Foster, McGill University.)

APPENDICES

APPENDIX A

17 Scholarships held during the year 1933-1934

FELLOWSHIPS

Grantee	Graduated	Where Held	Subject of Research
Sydney Bateson.....	B.Sc., Dalhousie University.	Department of Physics, University of Toronto, Toronto, Ont.	Hyperfine structure.
Edna Marie Hearne....	B.A., M.A., Queen's University.	Department of Cytology and Genetics, McGill University, Montreal, Que.	Chromosome structure.
H. B. Marshall.....	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Isolation and structure of alkali lignin.
R. D. McDonald.....	B.Sc., M.Sc., Queen's University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The kinetics of the thermal decomposition of gaseous methyl iodide.
J. H. L. Truscott.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Plant Pathology, University of Toronto, Toronto, Ont.	Root parasites of Canadian soils.

STUDENTSHIPS

Grantee	Graduated	Where Held	Subject of Research
A. M. Crooker.....	B.A., M.A., McMaster University.	Department of Physics, University of Toronto, Toronto, Ont.	The hyperfine structure of Pb III and IV.
S. M. Dockerty.....	B.A., Dalhousie University.	Department of Physics, University of Toronto, Toronto, Ont.	The specific heats of various metals at low temperatures.
B. G. Gardiner.....	B.A., M.A., Queen's University.	Department of Bacteriology, Queen's University, Kingston, Ont.	The relation between cohesive force and sensitization phenomena.
Dominique Gauvin.....	B.A., L.Sc., Laval University.	Department of Organic Chemistry, Laval University, Quebec, Que.	Studies on tri-indene and tristylene.
R. W. McKay.....	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Ionic solutions.
Allan C. Young.....	B.A., M.A., University of British Columbia.	Department of Physics, University of Toronto, Toronto, Ont.	Magnetic effects at low temperatures.

BURSARIES

Grantee	Graduated	Where Held	Subject of Research
E. Percy Aikman.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	The binding of oxygen atoms.
P. E. Gishler.....	B.Sc., M.Sc., University of Alberta.	Department of Physical Chemistry, McGill University, Montreal, Que.	Investigation of the system calcium oxide, sulphur dioxide and water in the presence of pulp.
T. J. G. Henry.....	B.Sc., University of Saskatchewan.	Department of Physics, University of Saskatchewan, Saskatoon, Sask.	Adsorption of argon on potassium chloride.
F. C. MacIntosh.....	B.A., M.A., Dalhousie University.	Department of Physiology, McGill University, Montreal, Que.	Hormonal mechanisms governing the activity of the digestive glands.
Herbert E. Morris.....	B.Sc., M.Sc., University of Alberta.	Department of Physical Chemistry, McGill University, Montreal, Que.	The investigation of discontinuities at the critical temperature.
Joseph C. Pullman.....	B.Sc., Mount Allison University.	Department of Chemistry, McGill University, Montreal, Que.	The synthesis and properties of long-chain polyethylene ether glycols.

APPENDIX B

Researches in Progress During 1933-34 Under Associate Committees and Under Grants in Aid of Research

Subject of Research	Directed by	Co-operating Organizations
The utilization of Canadian high magnesium dolomite	Associate Committee on Magnesian Products	Federal Department of Mines; Canadian Refractories, Ltd.
Damage caused by smoke fumes from the Trail smelters	Associate Committee on Trail Smelter Smoke	British Columbia Department of Agriculture; Federal Department of Agriculture; Federal Forest Service.
Problems of the grain industry	Associate Committee on Grain Research	Board of Grain Commissioners, Winnipeg; Dominion Department of Agriculture; University of Manitoba; University of Alberta; University of Saskatchewan; McGill University.
Tuberculosis in man and animals	Associate Committee on Tuberculosis	Department of Bacteriology, University of Alberta; Department of Pathology and Bacteriology, University of Toronto; Department of Bacteriology, Queen's University; Faculty of Medicine, University of Montreal; Queen Alexandra Sanatorium, London, Ont. Fort Qu'Appelle Sanatorium, Fort San, Sask.; Federal Department of Agriculture.
Problems of the wool industry	Associate Committee on Wool	Dominion Department of Agriculture; University of Alberta; University of Saskatchewan; Canadian Co-operative Wool Growers; Canadian Woollen and Knit Goods Manufacturers' Association; Wool Industries' Research Association (Great Britain).
Chemical control of weeds	Associate Committee on Weed Control	University of Alberta; University of Saskatchewan; University of Manitoba; Alberta Department of Agriculture; Federal Department of Agriculture; Manitoba Department of Agriculture; Saskatchewan Department of Agriculture.
Animal parasites	Associate Committee on Parasitology	Federal Department of Agriculture; Imperial Bureau of Agricultural Parasitology McGill University; Quebec Department of Agriculture.
Engineering standardization	Associate Committee on Engineering Standards	
Foot- and root-rot diseases of crop plants	Associate Committee on Field Crop Diseases	University of Alberta; University of Manitoba; University of Saskatchewan; Federal Department of Agriculture.
Investigations in connection with the total eclipse of the sun in 1932	Associate Committee on Radio	Canadian Marconi Company; McGill University; Northern Electric Company; Canadian Radio Broadcasting Commission Radio Branch, Department of Marine; University of Montreal.
Standardization of classification and analysis of coal	Associate Committee on Coal Classification and Analysis	Alberta Department of Mines; Alberta Research Council; American Society for Testing Materials; Sectional Committee on the Classification of Coal; Federal Department of Mines.
Natural gas.....	Associate Committee on Gas Research	Alberta Research Council; Calgary Institute of Technology; Federal Department of Mines; University of Alberta.
Utilization of Canadian iron ores	Associate Committee on Iron Ores	Steel Company of Canada, Hamilton.
Wireworms and false wireworms....	Prof. E. H. Strickland.....	Department of Entomology, University of Alberta, Edmonton, Alta.

Subject of Research	Directed by	Co-operating Organizations
The action of alkali on cement and concrete	Prof. T. Thorvaldson.....	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.
Effect of radiant energy on protoplasm 1. Physical and chemical oceanography 2. Marine biology 3. Fish technology	Prof. A. H. Hutchinson.... Dr. C. McLean Fraser.....	Department of Botany, University of British Columbia, Vancouver, B.C. University of British Columbia; Biological Board of Canada; Dominion Meteorological Service.
Fungi.....	Prof. A. H. R. Buller.....	Department of Botany, University of Manitoba, Winnipeg, Man.
Mechanical properties of metals at low temperatures	Profs. I. F. Morrison and A. E. Cameron	Department of Mining Engineering, University of Alberta, Edmonton, Alta.
Ultra-violet spectroscopy with vacuum grating spectrograph	Dr. R. J. Lang and Prof. S. Smith	Department of Physics, University of Alberta, Edmonton, Alta.
Nervous actions underlying color vision and all sensory activities	Dr. F. Allen.....	Department of Physics, University of Manitoba, Winnipeg, Man.
Mineral deficiency of Quebec soils..	Dr. R. R. McKibbin.....	Department of Chemistry, Macdonald College, Quebec.
Surface energy of solids.....	Prof. F. M. G. Johnson and Dr. O. Maass	Department of Chemistry, McGill University, Montreal, Que.
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.....	Department of Physics, University of Alberta, Edmonton, Alta.
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.....	Department of Chemistry, McGill University, Montreal, Que.
Investigations on gas and water content of trees	Prof. R. D. Gibbs.....	Department of Botany, McGill University, Montreal, Que.
Microbiology of soil conditions in eastern Canada	Prof. P. H. H. Gray.....	Department of Bacteriology, Macdonald College, Que.
Parasites of the snowshoe rabbit...	Prof. R. A. Wardle.....	Department of Zoology, University of Manitoba, Winnipeg, Man.
The bark disease of the beech.....	Mr. Otto Schierbeck.....	Field work in forests of Nova Scotia.
Ripening of cheese.....	Dr. Blythe Eagles.....	Department of Dairying, University of British Columbia, Vancouver, B.C.
Stellar stark effects.....	Drs. J. S. Foster and A. V. Douglas	Macdonald Physics Laboratory, McGill University, Montreal.
Heights of Appleton and of Kennelly-Heaviside reflecting layers	Dr. A. S. Eve.....	Macdonald Physics Laboratory, McGill University, Montreal.

APPENDIX B (Part II)

Additional Researches Carried Out in Previous Years

Subject of Research	Grantee
The inheritance of earliness and lateness in wheat.....	Dr. W. P. Thompson.
Water requirements of crops in western soils.....	E. S. Hopkins.
The relation of bacteria to the quality of graded butter.....	Prof. W. Sadler.
Fungi.....	Dr. A. H. R. Buller.
Acidity and lime requirements of soils in Quebec and New Brunswick....	Dr. J. F. Snell.
The influence of acid in the soil on useful (nitrogen fixing) bacteria.....	Dr. F. C. Harrison.
Insulin-like substances in plants.....	Dr. J. B. Collip.
Action of pure salts on the structure and growth of vegetable cells.....	Prof. G. W. Scarth.
The influence of diet on the fur and health of captive foxes.....	Associate Committee on Nutritional Problems of the Fox Industry.
The resistance of plants to low temperatures.....	Prof. J. F. Lewis.
The biological origin of false wild oats.....	Prof. J. R. Fryer.
Life history and habits of the Tabanidae (horsefly).....	Prof. A. E. Cameron.
Study of the blood chemistry in animals with the super renal glands removed.....	Prof. J. B. Collip.
Investigation of the life history of the onion maggot.....	Prof. E. M. DuPorte.
The use of Canadian oils in ore concentration.....	Dr. J. B. Porter.
The extraction of benzene and toluene (valuable liquids) from coal gas...	Dr. H. S. Davis.
De-tarring of gas by electrical precipitation.....	Dr. J. G. Davidson.
Reduction of iron ores by gases.....	Dr. A. Stansfield.
A method of smelting titaniferous iron ores.....	Dr. C. W. Drury and A. F. G. Cadenhead.
The testing of oil shales in the field.....	Louis Simpson.
The treatment of silver-lead-zinc ores.....	Horace Freeman.
The preparation (production) of metallic barium.....	Prof. H. E. Bigelow.
Oil from shales.....	Prof. A. E. Flynn.
Alberta tar sands.....	Dr. A. Lehmann.
Lake Agassiz clay deposits.....	Prof. R. C. Wallace.
The microscopic examination of cement during hardening.....	F. M. Dawson.
Causation of cracks in concrete protective coating on iron and steel structures.....	Prof. P. Gillespie.
The corrosion of iron and steel in the soil.....	Prof. J. W. Shipley.
Investigation on the utilization of the resources of helium in Canada....	Associate Committee on Helium.
The properties and liquefaction of helium.....	Prof. J. C. McLennan.
Canadian waste sulphite liquor as a source of alcohol.....	Dr. V. K. Kriehle.
The discoloration of cured codfish.....	Dr. F. C. Harrison.
The discoloration of canned lobster.....	Dr. F. C. Harrison.
Artificial propagation of the sturgeon.....	Associate Biological Committee.
The food relations of certain minute organisms (Entomostraca) in the cultivation of fresh water fishes.....	Prof. A. B. Klugh.
Bacteria found in frozen fish.....	Dr. F. C. Harrison.
Nicotine from tobacco waste.....	Arthur D. Hone.
Utilization of milkweed.....	Dr. A. C. Neish.
Problems of industrial fatigue.....	Associate Committee on Industrial Fatigue.
The utilization of peat.....	Dept. of Mines.
Channel interference in wind channel testing.....	Prof. J. H. Parkin.
Interference in radio broadcast reception.....	Prof. T. R. Roseburgh.
Fog signalling.....	Prof. L. V. King.
Vitamines.....	Food Research Committee.
Surface tension in liquids and emulsions.....	Prof. J. C. McLennan.
Chemical reactions at high pressures.....	Prof. J. C. McLennan.
Conductivity and vapor pressure of salt solutions.....	Prof. A. N. Shaw.
Crystalline shapes of bicarbonate of soda.....	Prof. Paul Riou.
Investigation of 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.....	Lt.-Col. W. A. Steel.
Radium emanation.....	Dr. G. H. Henderson and Dr. D. A. McIntosh.
Dielectric losses in different classes of porcelain.....	Prof. A. V. Wendling.
Relation of silver ores to diabase.....	Dr. E. S. Moore.
Magnetic susceptibility of the alkali metals.....	Dr. A. S. Eve.
Chemical separation, identification and possible synthesis of antipressor substance from hepatic tissue.....	Dr. A. A. James.
Structure and growth of anchor ice.....	Dr. H. T. Barnes.
Effects of velocity on re-absorption rates.....	Prof. O. S. Gibbs.
Effect of ultra-violet rays on eggs, chicks and laying hens.....	F. C. Elford

Subject of Research	Grantee
Adhesion of ice to various surfaces of aeroplane structure.....	Dr. H. T. Barnes.
Sound analysis of carillon on Peace Tower.....	Prof. E. F. Burton.
The active principle of yeast.....	Prof. W. L. Miller.
Factors governing the milling and baking quality of wheat.....	Dr. R. Newton.
Ultrasonics (inaudible sound waves).....	Dr. R. W. Boyle.
Bacillary white diarrhoea in poultry.....	Prof. H. W. Hill and Prof. E. A. Lloyd.
Rotary derivatives of a boat type seaplane.....	Prof. J. H. Parkin.
Fog alarm research.....	Dr. L. V. King.
Glucosides of plants indigenous to western Canada.....	Prof. A. T. Cameron.
The habit and life history of the smaller mammals of the prairies.....	Mr. F. Neave.
Mistletoe, parasitic on jackpine.....	Miss E. S. Dowding.
Winter hardiness in crop plants.....	Dr. R. Newton.
The chemistry of fish curing.....	Dr. A. B. Macallum.
Researches in the field of low temperatures.....	Prof. J. C. McLennan.
Chlorination of methane gas.....	Prof. M. C. Boswell.
Designing and testing of a series of windmills for producing electric power on farms.....	Prof. J. H. Parkin.
Cause of the reversed blood pressure of fowls.....	Prof. O. S. Gibbs.
Experiments on catalysis.....	Dr. G. S. Whitby.
Best methods for obtaining accurate results in testing varieties, strains and treatments of grain.....	Associate Committee on Accurate Plot Work.
Reforestation experiments on cut-over and burnt-over lands.....	Associate Committee on New Brunswick Forest Problems.
Health hazards in spray painting.....	Associate Committee on Spray Painting.
The problem of slack barrels in apple exports.....	Associate Committee on Apple Slacks.
Destruction of wood piling by marine boring animals.....	Associate Biological Committee.
The inheritance of sugar and starch in Indian corn.....	Prof. H. F. Roberts.
Generation of electricity using a windmill as the prime mover.....	Prof. A. R. Greig.
Effects of certain reagents upon plants.....	Prof. R. O. Earl.
The effect of temperature and fatigue on the strength of castings.....	Prof. R. W. Moffatt.
The deterioration of rubber.....	Dr. G. S. Whitby.
Earth's nocturnal radiation in relation to weather.....	Dr. H. T. Barnes.
Cathode rays.....	Prof. J. A. Gray.
Development of a rapid electrical method of determining moisture in grain, timber, etc.....	Prof. E. F. Burton.
Investigation and preparation of yeast spores.....	Prof. W. L. Miller.
Measurement of the Joule effect of hydrogen, carbon dioxide and other gases.....	Dr. A. L. Clark.
Wind tunnel automatic speed control equipment.....	Prof. H. W. Price.
Raman effect.....	Dr. A. S. Eve.
Pressure variations inside the cylinders of the internal combustion engine.....	Dr. D. A. Keys.
Emission and absorption spectra in the infra-red and extreme ultra-violet region.....	Prof. J. C. McLennan.
Studies on humidity.....	Prof. A. N. Shaw.
Effects of electric and magnetic fields.....	Prof. J. S. Foster.
Investigation of gas laws.....	Dr. O. Maass.
The marine algae of the Canadian Atlantic coast.....	Prof. H. P. Bell.
The spectrum of the aurora and the light from the sky and its bearing on radio transmission.....	Prof. J. C. McLennan.
Power loss in dielectrics.....	Dr. H. J. MacLeod.
Cytological and histological investigations of alfalfa and clover.....	Prof. W. P. Thompson.
Chemical problems of the maple sugar industry.....	Dr. J. F. Snell.
Study of short radio waves.....	Prof. J. C. McLennan.
The conversion of starch to glucose.....	Prof. E. G. Young.
Unsaturated hydrocarbons as a source of chemical products.....	Dr. O. Maass.
The life cycle of fish tapeworm.....	Dr. D. Nicholson.
Relation of bacteria to incidence of feed flavors and stable odors in milk.....	Profs. H. M. King and W. Sadler.
Mineral constituents of the floral parts and young fruits of the apple.....	Prof. W. A. DeLong.
Indirect ultra-violet solar radiation and its distribution.....	Prof. R. C. Dearle.
Status of slough itch in Saskatchewan.....	Prof. L. G. Saunders.
Design and construction of apparatus for interpreting print, by touch, through the medium of the photo-electric cell.....	Dr. Frank Allen.
Diseases of animals.....	Associate Committee on Animal Diseases.
Heating and insulation of buildings.....	Associate Committee on Heating and Insulation.
Barley <i>versus</i> corn as a food for poultry.....	Prof. M. C. Herner.
Continuity of welded steel beams.....	Prof. C. R. Young.
Plant resources in eastern Canada.....	Prof. Marie-Victorin.
The effect of light on life processes.....	Drs. A. B. Klugh and W. R. Sawyer.
Experiments on the preparation of anthraquinone vat dyes.....	Dr. Paul E. Gagnon.
Electrostatic studies on milk and milk products.....	Prof. H. R. Thornton.
The lateral support of steel columns and struts.....	Prof. C. R. Young.

APPENDIX C

Publications of the National Research Council

ANNUAL REPORTS

Annual Reports for fiscal years 1916-1917 to 1933-34.

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. (Out of print).....	J. G. Davidson, Ph.D., 1918.
4.	Nicotine and Tobacco Waste. (Out of print).....	A. D. Hone, M.A., 1919.
5.	Canadian Waste Sulphite Liquor as a Source of Alcohol.....	V. K. Kriehle, 1919.
6.	An Investigation into the Question of Early Putrefaction of Eviscerated Fish in which the Gills have been Left.....	L. Gross, M.A., 1919.
7.	Survey of General Conditions of Industrial Hygiene in Toronto.....	The Associate Committee on Industrial Fatigue of the National Research Council, 1921.
8.	A Method of Smelting Titaniferous Iron Ore.....	W. M. Goodwin, 1921.
9.	Food Requirements of the Ranch Fox.....	G. E. Smith, B.A.Sc., 1921.
10.	Fuel Saving Possibilities in House Heating.....	L. M. Arkley and James Govan, 1922.
11.	The Red Discoloration of Cured Codfish.....	F. C. Harrison, D.Sc., F.R.S.C., and Miss Margaret E. Kennedy, B.A., M.Sc., 1922.
12.	The Discoloration, Smut or Blackening of Canned Lobster.....	F. C. Harrison, D.Sc., F.R.S.C., and E. G. Hood, Ph.D., 1923.
13.	Cultural Criteria for the Distinction of Wood-destroying Fungi.....	Clara W. Fritz, B.A., M.Sc., 1924.
14.	The Utilization of the Low Grade Iron Ores of Canada.....	Subcommittee on Iron Ores of the National Research Council, J. G. Morrow, Steel Company of Canada, Hamilton, Ontario, Chairman, 1924.
15.	Marine Borers on the Atlantic Coast of Canada.....	R. H. M'Gonigle, B.A., 1925.
16.	The Relation of Bacteria to the Quality of Graded Butter.....	Wilfred Sadler, N.D.D., B.S.A., M.Sc., and R. L. Vollum, M.A., 1926.
17.	The Mosquitoes of the Lower Fraser Valley, British Columbia, and their Control.....	Eric Hearle, M.Sc., 1926.
18.	Investigations on the Treatment of Nova Scotia Oil Shales.....	A. E. Flynn, A.R.S.M., 1926.
19.	Bacteriology of Certain Sea Fish.....	F. C. Harrison, D.Sc., F.R.S.C., 1926.
20.	Consideration of the Relation between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment.....	R. H. M'Gonigle, B.A., 1926.
21.	The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer.....	J. H. Fox, M.A., 1927.
22.	An Experimental Study of Sieving.....	J. B. Porter, Ph.D., D.Sc., 1928.
23.	The Storage of Apples in Air-cooled Warehouses in Nova Scotia.....	S. G. Lipsett, Ph.D., 1928.
24.	The Drying of Wheat.....	Associate Committee on Grain Research, 1929.
25.	The Drying of Wheat (Second report).....	E. Stansfield and W. H. Cook.
26.	Weed Survey of the Prairie Provinces.....	J. M. Manson.
27.	Weeds and Their Control.....	G. P. McRostie, L. E. Kirk, G. Godel, W. G. Smith and J. M. Manson.
28.	Comparative Feeding Values for Livestock of Barley, Oats, Wheat, Rye and Corn.....	Professor W. E. Crampton.

BULLETINS

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

The above are on sale at 25 cents per copy; except as noted. On orders of 50 or more copies of any individual specification a discount of twenty per cent (20%) is allowed. Copies will be sent postpaid on application to: The Secretary, Room 3004, National Research Building, Ottawa, Canada.

APPENDIX D

Publications of the Canadian Engineering Standards Association

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

No.	
A 1—1928	Standard Specification for Steel Railway Bridges (third edition). Price 50c
A1a—1928	Material Specifications, Steel Railway Bridges (second reprint). Price 15c
C 2—1929	Standards for Single-phase Distribution Transformers (second edition)
C 3—1924	Standard Specification for Galvanized Telegraph and Telephone Wire (reprint)
B 4—1921	Standard Specifications for Wire Rope for Mining, Dredging and Steam Shovel Purposes
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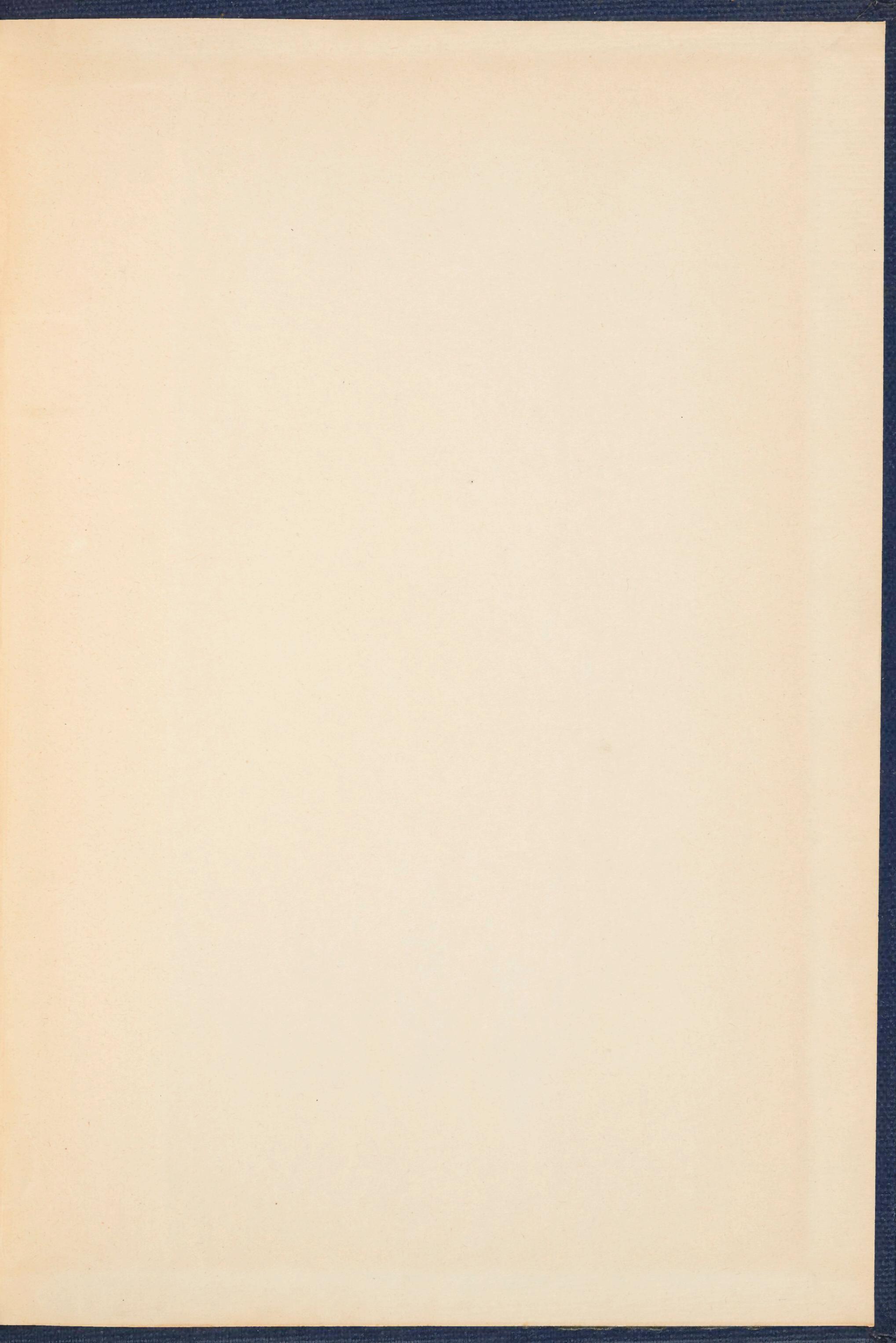
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