(April 11th, 1938)

The Canadian Research Council and Industry

By Maj. Gen. A. G. L. McNaughton

Chairman T. D'Arcy Leonard:—Gentlemen, we welcome back to the Canadian Club today one whose absence has been altogether too long, and who now holds the position of president of the National Research Council, General McNaughton. Swept from the Chair of Mathematics of McGill University to the command of a battery of Artillery at the beginning of the Great War, his ability was so outstanding that he became attached to the Imperial General Staff, and it was he who developed the system of Counter Battery, fire, that was used for the first time at Vimy Ridge, twenty-one years ago. Eighteen years ago General McNaughton addressed this club, and I do not think, that any of those who heard him, will ever forget that address. In it he told the remarkable story of the achievements of the Canadian Artillery in the last hundred days of the war. Today he comes to tell us of the achievements of peace, and I am sure that, as you listen to him today, you will agree that his record in connection with the National Research Council, is no less remarkable than his record in the War.

General McNaughton:—Mr. Chairman and Gentlemen: Just over nineteen years ago, I had the privilege of addressing the members of this Club and of recounting to you something of the experiences of the Canadian Artillery in the Great War. Last week I re-read the manuscript of that address, and it struck me that there were a number of matters referred to, which are probably of even more vital importance to Canada today, than they were then. On several large questions of defence I endeavoured to indicate the

views of our War Experienced Officers as to the course we should follow, and the action which we should take in order that our proper interests might be preserved, but for reasons, partly connected with the revulsion of sentiment following a stupendous effort to surmount a great danger, and partly due to the dislocation of the civil lives and connections of those who had this experience, it is perhaps needless to say that the voices of the senior members of the staff of the Canadian Corps have commanded little influence in the councils of the nation, and that the courses advocated at that time were not taken. On the contrary our defence preparation was reduced to the second degree, by which I mean that the objective set the military staff was not the creation of an army but merely the preservation of a small nucleus around which it was hoped the defence resources of the nation could be crystalized without too much loss of time.

It is only now beginning to come about that public opinion in this country is awakening to the dangers and demanding the safeguards which in the early post war period were clearly apparent only to those with actual experience of war.

Today I am to talk to you about research and its relation to industry, and I do most sincerely hope that the considerations which I will endeavour to place before you will not require two decades to become accepted, for I can assure you that these matters are just as vital to the continued existence and prosperity of the Dominion of Canada and all its provinces as are those questions of the armed forces of which I spoke to you in 1920.

Your President and your Secretary have told me that your interest lies principally in the work of the National Research Council as an aid to industry and, in consequence, in the very limited time which is available to me today, it is to this aspect that I will endeavour to give particular attention, but I must ask you to realize that direct aid to, and cooperation with, industry, is only one of the many sides of our work and responsibilities, and that even this so-called practical work is conditioned by and dependent upon other work of a more theoretical, or as we prefer to say more "fundamental", character.

Like most other phases of national life, it is not possible to grasp the significance of industrial research as an abstract question apart from the situation in which it comes to be important and the circumstances in which it developed. I hope therefore that you will bear with me for a few moments while I briefly sketch to you the history of the Council, and outline the organization which Parliament has created, the problems which have been assigned for solution, and our plans to meet the ever increasing needs of industry in Canada.

By industry I mean not only manufacturers but the primary producers as well for a large proportion of our endeavours is naturally directed to the problems of agriculture and of forestry, etc. I feel that there are many aspects of our work which are of particular interest to this community and that if our laboratories are to extend the special services which are available the first step is to tell you something of what we have to offer.

At the present time, the staff of the Council, together with those working under our Committees on special investigations which are in progress, comprises a total of 230 men and women, of whom 93 are graduates or post-graduates.

While there are gaps in our organization, both as regards personnel and equipment, of which we are very conscious, and which must be filled as requirements develop and as opportunities permit, nevertheless the Council's laboratories are now reasonably equipped for the usual type of problem which is presented. The staff includes experienced chemists, who can analyze materials of any nature, who know how to synthesize new substances and develop the processes of manufacture — physicists, who can deal with measurements of length, mass, time and volume, with that exactness which is now required for industry—experts in electricity, in heat, in optics, and in acoustics—bacteriologists, who know about molds and fermentations, and the precautions which must be taken in the care of food in transport and cold storage—experts on grain, and cytologists versed in the knowledge of Mendel's law, and in the development of new species—engineers on mechanical problems with knowledge of the complexities of the difficult calculations

required in aerodynamics and hydrodynamics — persons experienced in the special art of extracting and coordinating all information available in the literature,—skilled designers, who take the ideas suggested for new devices and develop them into apparatus which is practically realizable, and last, but not least, a well equipped workshop in which these new instruments can be constructed to a degree of precision and of finish which compares favourably with the best that Europe can turn out.

The staff is organized in six Divisions: Biology and Agriculture, of which special mention is made in the Act—Chemistry—Physics and Electrical Engineering—Mechanical Engineering—Research Information—and Administration. Personnel can be grouped with complete freedom on particular problems as needs indicate.

The Research Council is now just twenty-one years of age, for it was first set up in 1916 as a result of a need made evident by war-time necessities. It traces back to very small beginnings, and indeed it was not until the changing times and circumstances, which mark the post-war period, that there was any general realization of the utter inadequacy of the provision which had been made for industrial research in Canada, whether under the auspices of Government or of Industry itself. As a result of the pressure of public opinion which developed, the matter was repeatedly considered in Parliament, and, eventually, under the guidance of the late Honourable T. A. Lowe, the Research Council Act was passed in 1924. This Act was largely drafted by the late Hume Cronyn, and to his foresight I pay tribute today, for despite the experience of the years that have intervened, we have found no need to alter a syllable of the Charter which was then made law. It is to the late Honourable Jas. Malcolm that we owe our new laboratories, which were commenced in 1930 and opened in 1932, at the time of the Imperial Economic Conference.

The National Research Council consists of fifteen members, selected for terms of three years from among men prominent in scientific work in Canadian Universities or in Canadian industry. The Council is required by statute to meet at least four times annually in Ottawa. There is a

President appointed by the Governor-in-Council for a term of years, who reports directly to the Privy Council Committee on Scientific and Industrial Research, of which the Honourable W. D. Euler is the Chairman. The Council's membership is broadly representative of all parts of Canada, and includes persons qualified to speak authoritatively on education, science, industry, labour, business and finance.

The members of our Council from the City of Toronto are Sir Frederick Banting, who heads our recently established Committee on Medical Research, and Dr. E. F. Burton, Dean of the Department of Physics of the University of Toronto. In the industrial field from Ontario our membership includes Mr. W. R. Campbell, President of the Ford Motor Company of Canada, and Mr. R. J. Tallon, Secretary-Treasurer of the Trades and Labour Congress of Canada.

The Council is a body corporate, capable of suing and of being sued, of acquiring and holding money and property, and of administering trusts related to science and research. By statute, the Council, in addition to certain specific duties set forth in the Act "shall have charge of all matters affecting scientific and industrial research in Canada which may be assigned to it by the Committee" of the Privy Council.

From the precise wording of the Research Council Act it is evident that Parliament did not intend that the Council should be regarded as a Department of State, and in a consideration of the activities which have been undertaken it is important to realize not only the advantages which flow from its setup as a chartered corporation with very considerable autonomy but also the implicit limitations on the kind of work which can properly be undertaken under these conditions. For example, it would be quite wrong for the Council to undertake the administration of an Act of Parliament where matters of government policy requiring the day-by-day attention of a Minister would be involved, for it would be impracticable to wait for the Council to express its opinion and make its recommendations at one of its quarterly meetings; and I am very glad to say that we have not that kind of a Council which would be content to give its concurrence or approval after the event.

On the other hand, research is usually a question of sustained effort over a period of years, and, once direction to undertake a particular investigation has been given by the Privy Council Committee, the matter usually requires no more discussion from the point of view of public policy until the results have been obtained and are available for application. The organization of research, the review of progress from time to time, and the adaptation of programmes are questions which must in any case be dealt with by scientists, and, in consequence, it is effective and efficient that the Council should be charged with the full responsibility for the administration of these matters.

There is another and perhaps more important advantage which comes from the type of organization which has been prescribed, and that is the facility which it presents for co-operation and collaboration with the scientific services maintained by Departments of State as a necessary consequence of the administrative duties with which they are charged.

There is another equally important advantage in relation to industry for, as a chartered corporation, we can meet our associates in the commercial field on even terms, and our ways of doing business, of negotiating agreements and securing approval for contracts are the ways to which they are accustomed, and not the unfamiliar mysteries and intricacies of the usual political and departmental organization. You will realize the importance of this when I tell you that already a very substantial part of our funds comes directly from industry in payment for services rendered in the way of tests and reports or for research work being carried out on particular questions.

It is quite impossible in the limited time at my disposal today to give you any really comprehensive picture of the facilities in our laboratories and their equipment so I must content myself with giving you a general description of some few subjects selected to indicate the very broad field which our organization embraces.

The first is plant hormones — these very remarkable chemical substances which, in minute quantities, exercise

control over the vital processes of living matter. Two groups of these substances are known in nature, the auxins and the hetroauxins. The first has so far eluded chemical analysis but the second has been shown to be a well-known chemical compound called indolil acetic acid. Two of the three homologues of this substance were synthesized for the first time and introduced to science by Dr. Manske of our Division of Chemistry, who has also developed improved processes for the manufacture of the other compounds in the group and their analogues and derivatives. The merit of his work has been widely recognized and his name commands an important place in the history of the subject.

For several years, and while these substances and their effects were a sort of scientific curiosity, the Council was content to limit our part to the furnishing of small supplies, which went all over the world to plant breeders, and others interested in experimenting with the physiological effects. Our officers kept themselves informed of the results which were being obtained, notably by the Boyce Thompson Institute for Plant Research in New York, but, apart from suggestion, we took no active part in the biological work until last year when it had become apparent that, in the proper use of these substances, there lay a possible answer to several problems which faced this country: would wheat selectively treated with hormones develop with sufficient rapidity to get ahead of the weeds? Would it become established in the early spring so as to better withstand a later drought and resist soil drifting? Would it ripen earlier? Would the yield be increased? Could slips from plants and trees of economic importance, which normally only grow from seed, be induced to root?

Then, Dr. Grace, also of the Division of Chemistry, who was working on fungicidal dust for the treatment of seed wheat to prevent smut, conceived the idea that these hormones which had previously been used in dilute liquid solutions only—a process quite practicable on a laboratory scale but impossible for general use—could be applied mixed with an inert dust as a carrier, or possibly finely ground fertilizer could be used for this purpose. The significance of this conception was apparent, and he was asked to proceed

to test his ideas forthwith. The Chairman of the Federal District Commission supplied us with thousands of cuttings of a wide variety of plants, the Experimental Farm under Dr. Archibald co-operated, and shortly we had quite definite proof of possibilities.

Since this work had now assumed a biological aspect, we took advantage of the elasticity of our organization and transferred the staff concerned to the Division of Biology and Agriculture, where they would be in daily contact with the experts in allied lines. The Council, in collaboration with the Department of Agriculture and the Department of Mines and Resources, responsible for forestry, organized a committee representative of all interests in the Dominion Service to act as a medium for the planning and direction of the further experiments required, and this work is now in hand. This coming summer, in co-operation with the chemical companies most concerned, the proved results of the laboratory studies will be tested in the field on a very large scale, and by this time next year we should be able to report the applications which are of economic importance and significance in the solutions of our special problems. Meanwhile, Dr. Cambron, of the Division of Chemistry, has made a further contribution. The hormone of the greatest potential importance was very expensive to produce so he was asked to develop a new and cheaper method. He has been successful and the cost has fallen from many hundreds of dollars per pound to a few cents so, when we want this substance in quantities, the cost will not be any bar to its use.

To illustrate the wide diversity in the character of our work I now turn to the science of radiology. We are interested in radiology from two points of view—medical and industrial. In the medical field the Council carries the responsibility of standardizing the meters and other apparatus used for the measurement of x-ray dosage, which is administered to patients in Canadian Hospitals for the treatment of cancer and other diseases with which humanity is afflicted. It is most important that these measurements be made with exactitude for you will realize that on the one hand under dosage is ineffective as a curative and, on the other, that over dosage means death, or at the least very painful and long enduring burns and other disorders.

With the development of x-ray technique, voltages have been pushed higher and higher, and it is now not unusual for equipment of 400,000 volts to be in actual use in hospital clinics. The Council must go well beyond current practice so we have installed equipment for 600,000 volts, designed and built by our own staff and now operating. The experts in this field who assembled last fall at Chicago indicated a prospective practical development in Medical Radiology to over a million volts so in our design we have made provision to go to a million and a quarter, as and when this becomes necessary. I would say that to purchase our apparatus abroad, which would have been necessary, for no Canadian manufacturer is equipped to produce this equipment, an expenditure of over $80,000 would have been required, but taking advantage of the particular knowledge of Dr. Laurence, who is in charge of our work, and the facilities of our own workshops we have got by, with an appropriation of $25,000, of which some money is still left. Further, since the *amour-propre* and prestige of those who will operate it is at stake, I am quite certain that our maintenance and operating charges will be far lower than with purchased equipment. The equipment is now working and I am confident, we will obtain the results we seek.

With 600,000 volts, x-ray pictures can be taken through about 7½ or 8 inches of steel so that we can find the flaws, if they exist, in the largest castings of forgings in use by industry. However, as it happens, it is not in this very high voltage field that most of our work for industry lies at present but in the comparatively low range of 70 or 80,000 volts used for the examination of light alloy castings which go into the construction of aircraft. People's lives depend on these and a hidden flaw would spell disaster. Today, the Department of Transport have made the 100% x-ray examination of these castings mandatory, and we have underwritten this decision. With the rapid development of aircraft construction which is now taking place, we have to handle some thousands of castings each month, and we shall continue to do so, until we can train the specialists for the industries concerned, so that they can do this work themselves.

I may say that without the facilities of the Council for x-ray examination, the Canadian aircraft industry would have had a very bad time starting up, for, to begin with, we found it necessary to reject over 90% of the superficially perfect castings submitted to us. Our experts have been able to point the way to the necessary improvements in foundry-practices and manufacturing technique, and today the figures of rejections are very much reduced.

In connection with radiology, I might mention that substantially all the world's new supplies of radium, either for medical or industrial use, now go through our laboratories for test and certification. Without the certificate of a national organization of known impartiality and competence, it would be practically impossible to sell this great Canadian product in the markets of the world.

As a last example, again to illustrate another totally different aspect of our work, I turn to the question of refractories to tell you of a piece of work which was initiated a dozen years ago, and which after long and patient effort has now proved eminently successful, both from the scientific and commercial points of view, as I think you will agree when I give you the figures of costs and results.

In pre-war years, our steel industry made extensive use of a refractory furnace lining, which had its origin in Austria. The war cut off those supplies and a native industry was able to develop, on a basis of the high prices which could be obtained, in the absence of a competitive product, but, with the coming of Peace, the Austrian supplies were again available and shortly the local industry faced extinction. In consequence, a delegation went to the Honourable Mr. Fielding, then Minister of Finance, to ask for a high protective tariff. Mr. Fielding refused but offered to make a special grant to the Research Council so that work could be undertaken looking to a reduction in cost, and improvement in quality, of the Canadian material. This offer was accepted, the relations between the Council and the Companies placed on an organized basis, and research commenced. By 1932 results began to be secured, these were seized on by the Company and turned to account, and all through the depression there was steady development. By

1936, there had been a five-fold increase in employment in the plants over 1932, and, as the fuel used is Nova Scotia coal, and the other materials are largely of native origin, the benefits to employment in Canada have been widely distributed and multiplied.

Again, comparing 1936 with 1932, in place of being an importer of a key material, vital to our steel industry, as a result of the specially high quality of the product, Canada had become a large exporter to the United States, Great Britain and the continent of Europe; the annual balance of trade being altered in our favour by *a million dollars.*

At the present time, the results to the Council by way of royalties are financing our costs in connection with the further research in hand, and we have every reason to expect that in due course all our former expenditures will be repaid.

To give an idea of the relative magnitude of other benefits, I would mention that the additional freight revenue to one of our railroads, which carries the products of this industry, now amounts annually to the equivalent of the total of our investment in the investigation to date, and the amount of money which comes into Canada each year, as a result of this one piece of work alone, is of the order of magnitude of the total being spent on the National Research Council *for all purposes.*

I do not claim that as yet we have many examples of industrial research which have proved so profitable to the country, the Council and the companies which have been associated with us, but I maintain that there are many opportunities which need to be developed in this way. We have every reason for confidence in the young scientists and engineers who are available, and we should not hesitate to essay to launch out and pioneer the new developments, for it is quite clear that the problems with which we are faced differ both in degree and in kind from those of any other country on earth, and if we wait for others to produce the answers we require, we shall wait in vain.

I have been speaking about the organization of the Research Council and of some of the work which is in hand

in an endeavour to give you an indication of our activities, and where and how the Council fits into the scheme of things as they are.

I do not claim any monopoly on research for the Council, on the contrary, I firmly believe in the benefit and wisdom of the establishment of organizations for research, both in the several industries, and under provincial and other auspices. We believe that, not nearly enough industrial research is being done in Canada, and that it is only when you have a corps of skilled workers locally that the problems requiring solution will come to the attention with that promptness, which is required for our safety. Also, there are many problems whose solution is impossible, apart from the environment in which they have been developed. The Council welcomes the opportunity of co-operating with organizations, such as the Ontario Research Foundation, and you may be quite sure there is no duplication of effort, for neither Dr. Speakman nor myself are inclined to waste the slim resources at our disposal in any such idle venture.

Before bringing my remarks to a close I would like to mention that in addition to the actual conduct of Research and Testing for, and in cooperation with, industry the Council is, as its charter requires, closely concerning itself with other movements and activities, related to the utilization of our natural resources and other advantages.

Through a system of scholarships, post-graduate training of promising young Canadian Research workers is being promoted to the end that industry may have available a sufficient supply of these key-men and women to meet their needs. Also on occasion, direct financial assistance is being given to investigations underway in the laboratories of the several Canadian Universities. Thus there comes about an intimate and friendly relation between the Council and the Institutions for higher scientific learning in this country, which is very much to the advantage of Canada.

In the field of Standardization we have a strong committee, which is actively engaged in the preparation of specifications for use by the purchasing branches of the Federal Government, so that unnecessary duplication of types of

materials and supplies may be eliminated in the interests of economy and ease of manufacture and production.

The work of this committee is correlated with that carried out in the field of Engineering Standards and Codes by the C.E.S.A., an autonomous body, set up by industry itself under a Dominion charter. The specifications prepared by both these bodies are now being widely used and I do hope that industrial companies will recognize their great interest in the C.E.S.A. in particular, and that they will extend and increase their support to the very excellent work, which is being done, both for them and for the public, by this association under the Chairmanship of Mr. J. G. Morrow of Hamilton.

In conclusion I would like to observe that the National Research Council *is dedicated to help industry* and to say that we stand ready and willing to make our not inconsiderable facilities available, *whenever and wherever required.*