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DELIVERED AT  
LUNCHEON  
OF  
CANADIAN SOCIETY OF  
CIVIL ENGINEERS  
(OTTAWA BRANCH)

BY

COLONEL DAVID CARNEGIE

M. INST. C.E.,

MEMBER AND ORDNANCE ADVISOR IMPERIAL MUNITIONS BOARD



CHATEAU LAURIER, APRIL 26, 1917

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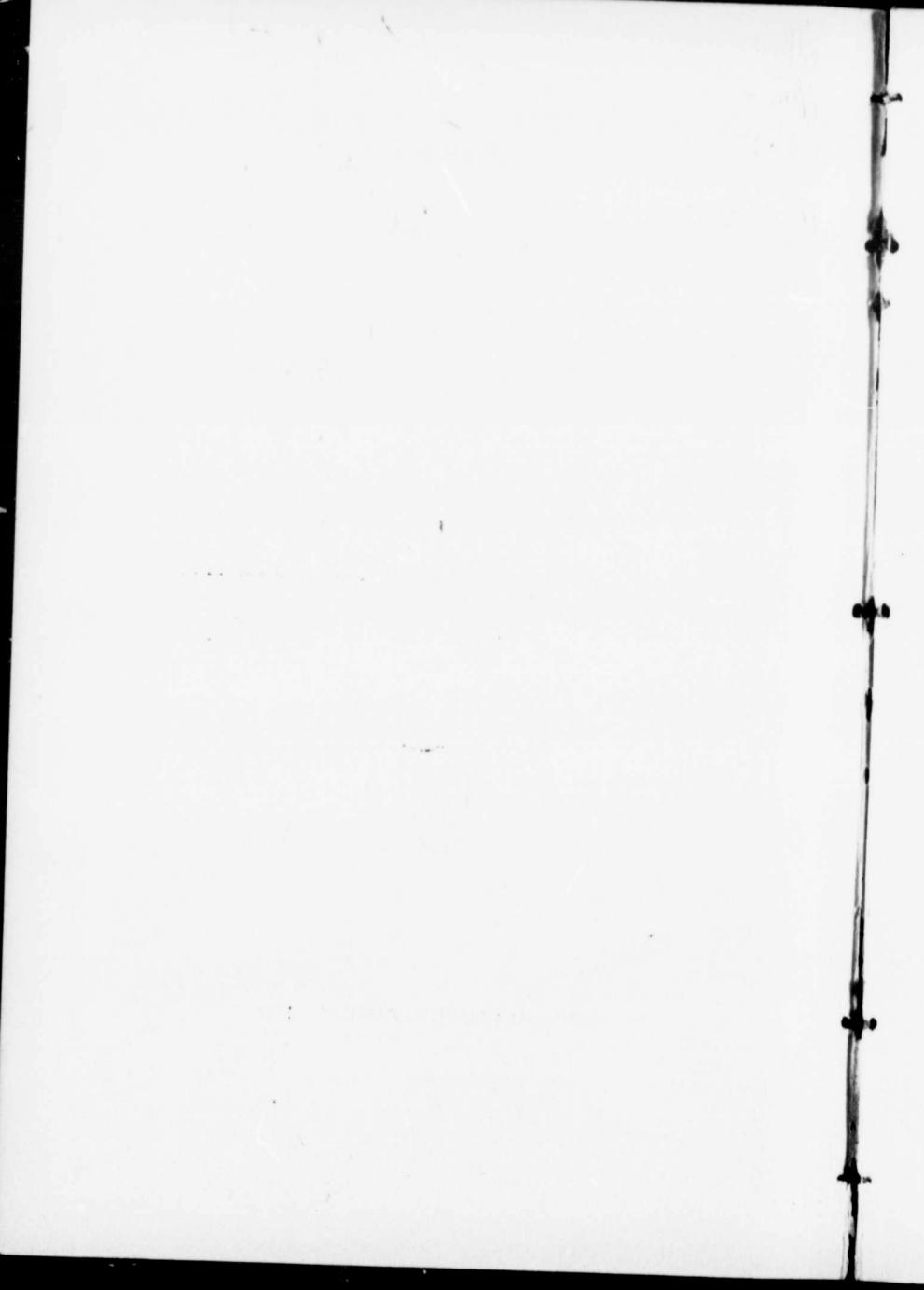
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THE MANUFACTURE OF MUNITIONS  
IN CANADA  
AND THE  
PERMANENT ASSETS TO CANADIAN  
INDUSTRY RESULTING  
THEREFROM

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Mr. Chairman and members of the Canadian Society of Civil Engineers, when Mr. Gale invited me to be your guest and address your society today I deliberately shrank from the honor he wished to confer on me, feeling quite unable to say anything that would be of helpful interest to you. I could not, however, escape Mr. Gale's special pleading, particularly when he suggested that I, as a member of your own profession, should regard the opportunity as a duty. My friend Mr. Flavelle, the esteemed chairman of our Board, who I am glad is with us today, was no less pressing, and here I am, with a subject far too big to touch even the fringe of it.

Well, gentlemen believe me, I very heartily appreciate your kind hospitality, and hope you will bear with me while I read my remarks, as I think by so doing I shall cover more ground in the limited time at our disposal.

I should like to refer first to Canada's capacity to produce Munitions; second, to the permanent assets to Canadian industry from munition work; and third, to the responsibility of engineers in developing these assets.

CANADA'S CAPACITY TO PRODUCE MUNITIONS.

In September, 1914, when General Sir Sam Hughes undertook the first order for shrapnel shells, Canada's capacity to produce shells amounted to 340 18-Pr. shrapnel shells per week. These were made at the Dominion Arsenal, Quebec. The capacity of Canadian factories today approximates 400,000 18-Pr. shrapnel complete rounds per week, including cartridge cases, primers, fuses and propellants. In addition to this amazing output there is a weekly capacity in Canada for nearly 400,000 high explosive shells, ranging in sizes from 18-Pr. to 9.2", making an approximate total weekly output of 800,000 shells. This

large output, along with other supplies made independently, require about:—

25,000	tons of steel per week
2,500	“ brass
750	“ copper
250	“ zinc
1,500	“ lead
200	“ antimony.
150	“ resin
Several tons	of ferro-molybdenum.
500	tons of cordite
500	“ trinitrotoluol
300	“ nitrocellulose powder.

Over 300,000 boxes are required for these shipments per week, and about  $3\frac{1}{4}$  million lineal feet of board are used in making these boxes.

#### THE VALUE OF THE PRODUCTS.

The weekly value of these products can only be understood by people who have learned to think in millions.

The total value of orders for munitions placed in Canada approaches eight hundred million dollars, and the value of the munitions shipped is close upon five hundred million dollars. (Hear, hear.)

#### FIRST ORDER PLACED FOR MUNITIONS.

When the first order for 200,000 empty shrapnel shells was undertaken no one had any idea of the magnitude of the work, the foundation of which was then laid. That order, which required over six months to complete, represented eleven years' work at the rate of output of the Dominion Arsenal. The present weekly output of 400,000 18-Pr. shrapnel shells from Canadian factories is equal to twenty-two years output from the Dominion Arsenal.

The uncertainty of securing material for the first order, of the right quality and in sufficient quantity, together with the difficulty in obtaining machinery and skilled labor to produce shells which would pass inspection and gun proof, made even the most courageous manufacturer hesitate to undertake the work without having the assurance of the Canadian Government that they would bear any financial loss incurred in the venture.

They were not to be condemned for such caution, as the financial condition of many of the manufacturers at that time would not permit of any speculation as to the results. While all the manufacturers who were approached to undertake the work were moved by the spirit of patriotism, some of them turned from the proposal, considering the risk of installing new plant, etc., too great for such a small order, and without the slightest assurance that any further orders would be placed in Canada. Months later, however, when the more venturesome manufacturers had made a success of shell making and more shells were required, no difficulty was found in getting sufficient manufacturers to undertake the work.

#### THE POLICY OF THE SHELL COMMITTEE.

Instead of placing orders for the complete shells with each manufacturer, an arrangement was made whereby manufacturers whose domestic trade most nearly approached that required in producing the component parts of the shells were asked to undertake the work. Such parts, when finally inspected, were assembled and finished at the works of other manufacturers, who had to instal machinery and plant for the purpose. The manufacturers were therefore not called upon to carry the responsibility for the purchase and inspection of any of the materials used in the shells.

They were also supplied with a complete set of inspection gauges to guide them in making or obtaining manufacturing gauges and in the standard of finish required by the Government inspectors.

While the manufacturers were relieved of these responsibilities, the cost of production was reduced and the quality of output improved by purchasing the materials through one agency instead of many, and by standardising the inspection of work in supplying the gauges to all makers.

#### NON-COMPETITIVE PRICES.

All manufacturers were paid the same price for the same work. No competition was admitted amongst them, except the rivalry to excel each other in making the largest output that would pass Government inspection. This policy united the manufacturers without restricting inventive skill, ingenuity of design, and new methods of individual works management. It promoted a spirit of comradeship amongst them, and an exchange

of visits to their works. Freely were new ideas for cheapening and improving the quality of production used by all.

#### EFFORTS OF MANUFACTURERS AND EMPLOYEES.

General Sir Alexander Bertram, whose name will ever be remembered as chairman of the Shell Committee, could tell you better than I can of the strenuous efforts made at the outset to obtain suitable plant, efficient machinery and accurate tools for factory operations. Greater still, however, was the struggle in securing and training labor for the manufacture, treatment and subsequent machining of the materials. Records of these early accomplishments are worthy of the historian's pen.

The greatest of all progress, however, has been made perhaps by the workers themselves. The spirit of comradeship which permeated the employers was reflected in the efforts put forth by the workers. By diligent work many of them acquired a skill in the use of gauges and in the manipulation of machines and tools which has surpassed their own expectations. It is a fact that today the Canadian workers have become so skilled in the art of shell manufacture that their speed and quality of output would arouse the admiration of the oldest and most capable machinists in England. (Applause.)

#### THE AMOUNT AND VALUE OF THE PLANT EMPLOYED IN PRODUCING MUNITIONS.

Looking again at the magnitude of munitions work in Canada today, we see 650 factories engaged in 144 towns scattered throughout every Province of the Dominion except Prince Edward Island. Cities as far apart as St. John, Newfoundland, and Victoria, B.C., (a distance approximating 4,500 miles) are contributing to the output. Manufacturers from almost every industry in Canada have turned their attention to the production of munitions, and it is gratifying to record that few of them have failed in producing the standard of work required.

Some idea of the amount of plant and machinery installed can be obtained when it is remembered that apart from the large increase in the number of steel making furnaces which have been installed since the war commenced, there are 26 contractors making shell forgings, with a total forging press capacity of 61,000 tons. This tonnage is represented by 162 forging presses, the largest having a pressure of 1,500 tons and the smallest 200 tons. In order to feed these presses with steel for forgings,

200 furnaces have been built. The presses are driven by 120 sets of pumps, having a total electric capacity of 21,000 H.P. The approximate value of shell forging plant machinery installed is estimated at \$5,000,000.00.

Coming to the plants for the machining and assembling of shells and the manufacture of component parts, there have been installed over 18,000 machines and 90,000 H.P. to drive them, the estimated cost approximating \$35,000,000.00.

#### GAUGE PRODUCTION.

One can hardly mention this subject without being reminded of the almost insuperable difficulties which were presented in the early days of the war in obtaining gauges for munitions. We can never thank the United States manufacturers sufficiently for what they did in coming to our aid at that time. (Applause). The special skill in making gauges to the limits of accuracy required could not then be found in Canada. Today there are at least twenty factories producing gauges in Canada, and while we are not independant of help from the States, some idea of the magnitude of the work can be understood from the monthly bill, which amounts to over \$150,000.00 for new gauges.

During the month of March about 10,000 new gauges and checks were imported, the usual accuracy called for on a gauge is 3/10 thousandths of an inch, and for a check 1/10 thousand.

An army of over 5,000 examiners are engaged upon inspection under the direction of Colonel Edwards and his staff of officers.

#### PRODUCTION OF COPPER, ZINC AND OTHER METALS.

In addition to the production of steel, the manufacture of forgings, the machining and assembling of shells and the manufacture of cartridge cases, fuses, primers, and other components, the mining and metallurgy of metals for munitions manufacture have played an important part in Canada. Copper and zinc are now refined in the Dominion instead of being sent in the form of concentrates of zinc and copper matte to the United States for refining there. Copper products, such as copper bands, are now being manufactured in Canada on a commercial basis. Brass cartridge case material, so difficult to obtain in the early months of the war, is now being made successfully in Canada. Other metals, such as lead, antimony, arsenic, tungsten, molybdenum and aluminum, have been produced for munitions.



## PRODUCTION OF EXPLOSIVES.

Side by side with these developments there has grown a capacity for explosives even greater in proportion than that of metals. In order to complete what we call the fixed 13-Pr. round of ammunition, it is necessary to make cordite or nitrocellulose powder, and while experimental amounts of cordite had been produced before the war, Canada's capacity today approaches 1,000,000 lbs. per week of both cordite and nitrocellulose powder.

One of the principle explosives used for bursting shells, known as trinitrotoluol, has been made successfully in Canada for over two years from the by-products of the coke ovens. Today the production approaches 1,000,000 lbs. per week.

## NATIONAL FACTORIES.

Among the many contributing features of successful production today started by Mr. Flavelle soon after he became chairman of the Imperial Munitions Board was the creation of great national factories in Canada. In addition to stimulating and developing companies in Canada, he set in operation several national factories for the loading of fuses, the manufacture of gun cotton, acids, trinitrotoluol, acetone, cordite, nitrocellulose powder, aeroplanes and electric steel.

These factories are operated by separate companies, the entire stock of each company being held by the Imperial Munitions Board.

In this connection it is interesting to know that aeroplanes are being made in Canada at about the rate of one per day, and when the new factories are completed five per day are expected.

## ORGANIZATION OF MUNITIONS WORK.

Time does not permit me to tell of the organization which brought into existence and has maintained, through good and ill report, these industries, nor of the fellowship and comradeship, unsurpassed in quality and loyalty, of the devoted workers who have ungrudgingly worked with increasing diligence.

I have wondered, and still wonder, by what measure, or weights, or standards, I could value that quality of administrative genius which could with a daring unsurpassed in modesty and charm command some of the best intellects of Canada as with mesmeric power, to come forth from all kinds of influential

pursuits, sacrificing leisure and gain to work on the Munitions Board. There is some sort of mystic charm—"Piper of Hamelin" power, about our Chairman. He does not smoke either: and I believe he is a prohibitionist, although the records of the Rideau Club show that he likes cider. (Laughter.) I often told General Bertram in the old Shell Committee days that the heavy artistic pipe he had by him was responsible for that gift he possessed of soothing politicians and disappointed contractors.

I am told, I don't know if it is true or not, that Mr. Flavelle went to Lord Shaughnessy and said "I want your Purchasing Department." What! Do you want the railway to stop? You want me to give you the brains of the C.P.R.? I don't know what passed. Lord Shaughnessy did not stop the railroad, and our chairman got the brains. Oh, such brains too! All your dynamic theories of force have been upset. New standards of calibration are required. But that was not enough; our chairman touches a button in Toronto or Montreal and up comes a man from Toronto gifted in the art of doing things without a brass band. Nobody knows from where he taps his genius. The machinery he uses is painfully silent, but he always "gets there." He is just responsible for turning out over \$5,000,000 worth of work per week, and if you were to meet him you would never know that he had any connection with the Board.

Time forbids, or I should like to tell you of the socialists, radicals, liberals, advanced liberals, Tories, ancients and mystics, which gather round our festive board—all having passed the Sunday school tests. I don't know whether secretly or not Mr. Flavelle examines all his loyal subjects in Butler's "Analogy", Lubbock's "Tact", and Foster's "Decision of Character", but he has made a wonderful selection from high finance, astute commerce, gifted journalism, literature and poetry, all with a charm and harmony upon which Socrates would have delighted to discourse.

But I have wondered still, that after the first blush of the romance of munitions work had worn off they were still held with a devotion of lover to sweetheart. I have come to the conclusion that no tie but the tie of loyalty would hold that band of voluntary workers round the hub of the Transportation Building, particularly as the jaded mentality after weary months of high pressure cries out for the golf links.

There is not a department of the Canadian Government which has not come to our assistance when required. To the Mines Branch, the Department of the Interior, the Patents Office, the Conservation Commission, the Technical Societies, the Advisory Council on Research, and other scientific bodies, a very great debt of gratitude is due.

## PERMANENT ASSETS TO CANADIAN INDUSTRY.

Hurrying from these few facts about the output of munitions in Canada, without even touching upon what would be a fascinating subject to you as engineers (I mean the scientific processes involved) and also leaving entirely out of consideration the gruesome purpose in actual warfare for which the munitions are required, I pass on to consider the value of this unholy business as a permanent asset to Canadian industry. I should like to divide the total value of the permanent assets as I view them, into two parts. The first resulting from the standardization of products; the second from the standardization of skill.

## 1ST.—THE STANDARDIZATION OF PRODUCT.

No component part of munitions, however insignificant, has been made or accepted on the old principle of "good enough." Every part has been supplied to drawing and specification, with rigid examination, analysis and test before acceptance.

I think I am safe in saying that there is no industry in Canada which has been occupied in the manufacture of munitions, but has passed through a process of refinement, which will leave it in a better condition when it returns to domestic pursuits after the war. If you review the great industries of Canada it will be difficult to find one which has not been actively contributing to the output of munitions.

Industries such as the iron and steel; the metals and metal products; refractory materials and fuels; lumber and timber; leather; textiles; paper; chemicals and other minor industries, have called into being processes and plant which could be adapted for munitions, and have also added new processes, new equipment and new skill where these were required.

In addition to the employment and adaptation of existing industries for munitions manufacture, entirely new industries have been brought into activity. The manufacture of munitions has given an abiding impetus to the mining and subsequent operations in the production of coal, iron, copper, nickel, zinc, molybdenum, antimony, aluminum and other metals.

The chemical industries have been accelerated by utilizing the waste products of the coke ovens for the manufacture of high explosives. These waste products after the war will be turned, by ingenuity and skill, into valuable domestic products.

The electro chemical industries, such as the refining of copper, zinc and lead, have been initiated and will remain as a commercial asset. The electro-thermic processes for the production of ferro alloys, such as ferro-silicon, ferro manganese, ferro-molyb-

denum, aluminum, magnesium and other metals, have produced standardized products.

It has been a costly, and sometimes bitter training, but it has been done ungrudgingly and with great patience, and as a result the standard of Canadian products today is greater than ever before. (Applause.)

#### 2ND.—STANDARDIZATION OF SKILL.

The widespread knowledge of new processes, involving the scientific study of metals, the flow of materials, and their physical chemical and metallurgical values, has been such that one can hardly imagine it would have been possible for the universities and technical schools of Canada to have provided such instruction, in the course of many years, which has been crowded into as many months. Every workshop has been a school of training in standardizing its skill. Every factory in which steel is made and forged is now partly or fully equipped with the means for measuring temperatures and intelligently discovering the value of the materials with which they are working. In every workshop in the different Provinces of Canada where shrapnel shells are made, the scientific treatment of steel is known. There is hardly a town of any importance in which the use of precision instruments and gauges for measuring shells and their component parts do not exist.

It is difficult to assess the value of this skill to Canadian industry, in which over 250,000 workers have become skilled in the art of such processes and the manipulation of such tools and gauges. It is more surprising still to know that nearly 12,000 women have become skilled in this work. (Applause.) Never in the history of the world has there been such an incentive to acquire such skill for a purpose the like of which our civilization should be ashamed, but which is nevertheless an asset which will be of great value in the peaceful commercial industries for the expansion of Canada.

#### CONTRIBUTING FACTOR IN THE STANDARDIZATION OF SKILL.

The mental processes which have been silently at work developing character while the hands of the workers have been acquiring precision in the use of tools and gauges, are factors in the life of the individual worker which cannot be overlooked. Canada has shown a rare capacity during this great war, comparable in some measure with the vastness of its territory.

I have just referred to the great skill and ingenuity displayed by Canadian munition workers with the standard of which you

have just cause to be proud. But there has been during the past 2½ years a growth of character without which all skill and ingenuity would be soulless. I refer to that moral fibre in the character of the worker which has shown such fine courage and unflinching endurance. (Applause.) This fibrous character has through the ages "Transformed the malady of thought into a bounding hope." It is this moral fibre which has given courage, energy, patience and unselfishness to the worn-out workers. It has inspired a quality and amount of inventive genius hitherto unknown in Canada. It has fostered harmony in some measure between employer and employee. It has brought our gentle women into touch with the struggles of the toilers and enabled them to understand and share their burdens. It has dignified labor while ennobling the character of those who have made sacrifices to fill the places of our boys who have "Crossed the bar."

One morning recently a mother while working in one of the munition factories received news that her boy had been killed at the front. For a moment she was stunned, and had the deepest sympathy of her fellow-workers. Instead of collapsing into grief under the shock, and giving up her work, she set her face resolutely and worked with almost supernatural strength. Her employer informed me that she produced more shells that day than on any previous day.

This war, with all its horrors, savagery and sacrifices, has had its ennobling effects, producing absolute and timeless qualities beyond the power of oxidation. Science has discovered no solvent powerful enough for them. They are outside the engineers' specifications and tests. They are engraved on the heart, and beyond the decay of moth and rust. The moral fibre in Canadian industry has provided better conditions in the works, and has brought into prominence welfare work of inestimable value. Signs are not wanting that it will increase facilities for the education of the workers and establish a community of interests between masters and men which exalt humanity above self-interest. If my vision of the future is not distorted this same moral fibre in both the employer and employed is going to quicken "Man's devouring need of liberty." If awakened Canada, with its vast territory, 31 times greater than the United Kingdom, and with its natural resources of almost immeasurable value, is to utilize its possessions, it must shake off the fetters that bind it to systems which are opposed to a full and free industrial, technical and general education of the people. (Hear, hear.)

Professor Henry Drummond has said that "To surround captives with statues and pictures, to offer them that are bound

a higher wage, or a cleaner street or a few more cubic feet of air per head, is solemn trifling. It is a cleaner soul they want, purer air, or any air at all, for their higher selves." "To grow up in complacent belief that God has no business in this great groaning world of humanity, except to attend to a few saved souls, is the negation of all religion."

I want to emphasize this valuable standardized product, specified on tables of stone thousands of years ago and which has been wrought by an unseen Hand into the character of the Canadian worker, for I believe it is the fundamental asset which must permeate any real accomplishment. It has been said that "No man will work hard sewing diamonds on tissue paper"—the value of the object of the sacrifice determines the willingness of the individual to pay the cost. This moral quality cannot be purchased by money; it is far outside the money standards, it's a heart quality. (Applause.) If such qualities could be bought by money a few gambles in real estate or a day's luck on the stock exchange might qualify the vulgar, ruthless and immoral. I go back to my country's poet, and hear him say:

"Nae pleasures nor treasures,  
Can make us happy lang,  
The heart's aye the pert aye,  
That makes us right or wrang."  
(Applause.)

#### THE RESPONSIBILITY OF THE ENGINEERS IN DEVELOPING THESE PERMANENT ASSETS.

Gentlemen, ours is an honorable profession; one crowded with vistas of research and delights the like of which even the angels might envy. This war has awakened the slumbering forces in the human mind and brought into activity engineering genius unequaled in quality hitherto. Your great waterfalls have been transformed by your skill into the most resourceful agency of power, without which we would have hopelessly failed in reaching the output of munitions named. Your skill has mined, smelted and fabricated the many metals which have proved to be of such value for munitions. The great engineering plants which have been brought into being by your skill are monuments of industry which must not be allowed to rust when this war is over. There is a great responsibility resting on you as engineers and leaders of industrial thought and action. It is greater today than ever before in the history of Canada. (Hear, hear.) The opportunity given to you of taking and intelligently using and

directing these assets of which I have spoken is of vital importance to Canada's successful industrial development. There is no need to wait for royal commissions. Power and authority are vested in yourselves; nothing will be too great for you if you see your opportunity, and if you have faith in the engineering talent of Canada. The man who was afraid and went and hid his talent in the earth brought forth the most scathing reproof ever uttered.

If I were to venture to suggest a programme for your immediate consideration. I would advise you to classify and value the engineering skill of your societies with the object of forming in Canada from their membership small committees of scientific, technical and commercial men, who would be responsible for obtaining statistics from the accumulated reports of commissions and numerous supplies of information stored in Government Departments and elsewhere relating to the best standardized processes, equipments and plants for the development of the industry they represented. Each committee would therefore become the recognized source of classified information, to whom manufacturers could with confidence refer for any help and advice required.

If your inventory of classified ability were broad enough to include the fuller issues in developing the standard of products, skill and utilitarianism, I should utilize every willing member of your profession, making committees say of members not exceeding three, for the consideration and report of the following subjects.

1. Industrial, technical and commercial education for our boys and girls before and after leaving the day school.
2. The classification and valuation of labor.
3. The remuneration and hours of labour.
4. The direction and character of employment in classified industries.
5. The provision of methods for the prevention of unwholesome competition between manufacturers.
6. The provision of definite standards for checking the formation of doubtful companies.

Then with a central authority you could correlate the efforts and information of your scientific and industrial committees for a broader policy of universal trade.

By the consideration of some such programme those valuable assets which are now the heritage of the Canadian people will make this country prosperous. Canada has its opportunity to set the pace in the world's industry. Its finances were never better. Last year its exports exceeded its imports by



\$340,000,000.00. Its natural resources cry out to you for their development. It is a country in which there is a heritage of wealth far exceeding that with which our youthful imagination surrounded "Treasure Island." (Applause.) Your efforts in embracing these opportunities will be strengthened by a more complete education of the industrial workers, and by a heartier co-operation between the employers and employees.

A nation, said President Wilson, is as great and only as great, as its rank and file. Will you gentlemen see that the rank and file who make this nation, follow these lofty standards of education and sacrifice which make life great?

It would be terrible if we missed the way after such a struggle.

There is a great industrial war before us, for which we are unprepared.

This might have been avoided if a harmonious United Federation of the world's industrial councils were possible. No doubt the distant future will produce the genius for such an undertaking. Meanwhile we cannot escape the responsibility before us.

Since the war started the eyes of the world have been turned towards Germany. The history of the country, the characteristics of its people and the success with which for years prior to the war they flooded the markets of the world with products, the prices of which became almost a menace to all other manufacturing countries, have inspired a determination by the people of the competing countries to put their industrial houses in order to meet all reasonable competition. German militarism will be crushed before the Allies sheath their swords, but to crush the industrial spirit in the Germans which has made their country prosperous would be to destroy the very spirit we now seek to stimulate in ourselves. (Applause.) The industrial prosperity and triumph which put Germany before the war in the front rank of the world's commerce, can never be crushed, indeed it would be folly to attempt to crush it. The world demands the best from every nationality, and amongst the many lessons this war has taught the nations of the world is the very old and common one; that out of persistent and well balanced indomitable courage comes the ability which brings success.

Peace is coming; when it is declared the struggle for industrial supremacy will intensify in the German people. The very qualities of sacrifice, courage, endurance, enterprise and genius which this war has developed throughout Canada and the British Empire among our Allies and our foes, will not by any chance lose their value on the Germans, but on the contrary if, as we



believe, German military arrogance will be swept away, her industrial classes will by reason of the opposition to her commerce and trade, struggle to maintain a higher efficiency within her borders. Before many years the world's markets will be flooded again with products at much lower prices than it is even now possible to conceive, with the result that hate and prejudice to German goods will die away before a temptation so strong that the purchasing value of the wage earning classes will find it necessary to buy in the lowest markets although the products be from Germany.

One can imagine, judging from the procedure in the past, that since the war began the accumulation of products in Germany, the outlets for which have been closed, will be dumped in the world's markets immediately peace is declared with a new propaganda which these closed years have inspired. The very thrift which privation and sacrifice have demanded from the people will encourage even more than ever the utilization of every form of waste product.

Mr. Fleming in a paper which he read before the Royal Society of Arts on February 9th, 1916 said:—

“This war is a war quite as much of chemists and engineers as of soldiers and sailors, hence from the point of view of national security alone we must take steps to foster scientific investigations.”

Gentlemen,—I trust that we as engineers shall not have to say in years to come in the words of Tennyson when our opportunity has passed.

“It was my duty to have loved the highest  
It surely was my profit had I known,  
It would have been my pleasure had I seen.”

But rather may we say now, in the words of William Blake, slightly changed.

“I shall not cease from mental fight  
Nor shall my sword sleep in my hand  
Till I have built Jerusalem  
In Canada's green and pleasant land.”  
(Hearty Applause.)