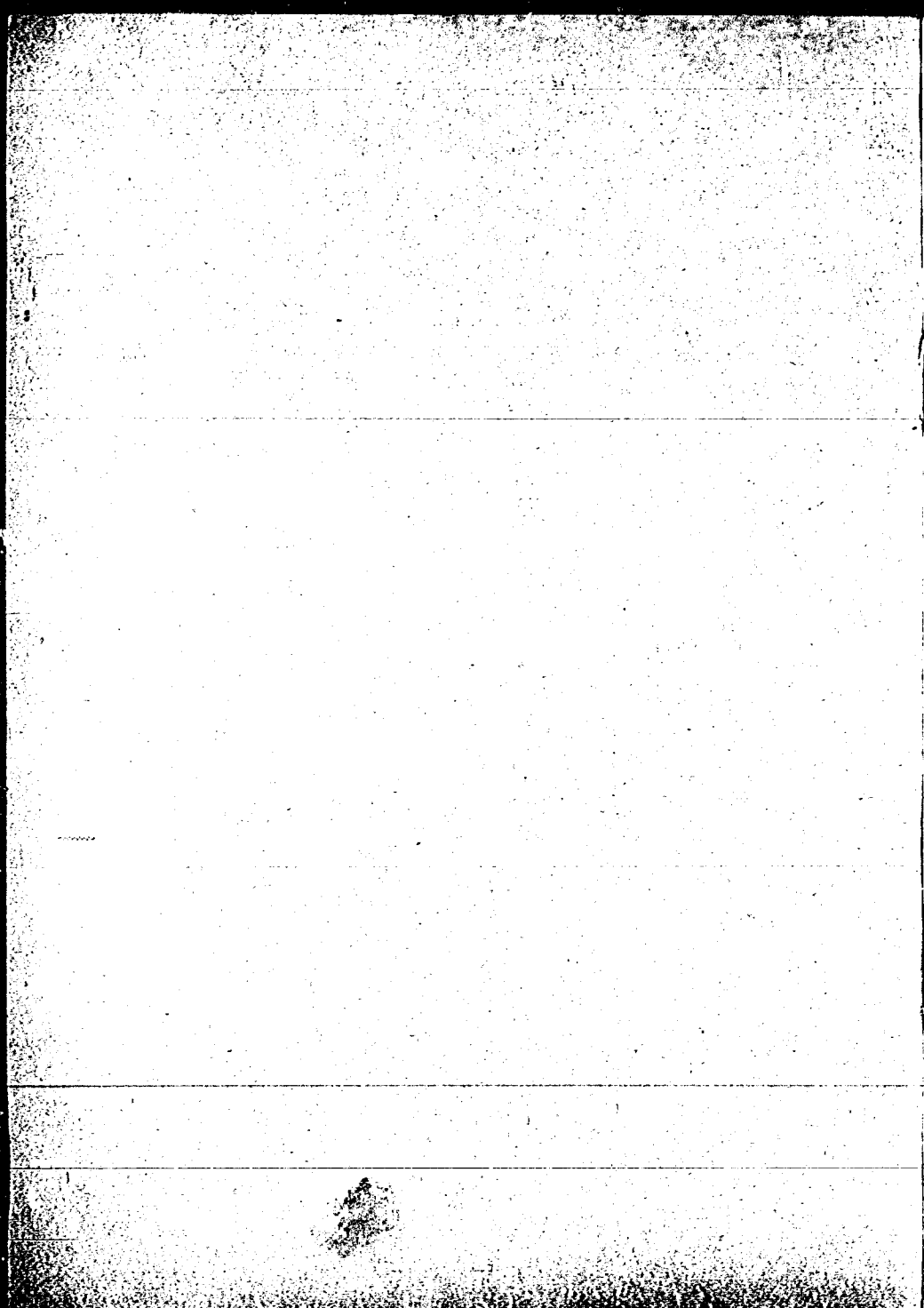

MUNITION RESOURCES COMMISSION

CANADA

HON. COL. THOS. CANTLEY, *Chairman*
GEO. C. MACKENZIE, *Secretary*

FIRST REPORT
OF
THE WORK OF THE COMMISSION

November, 1915, to February, 1918
inclusive

1918
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OTTAWA

To His Excellency Victor Christian William, Duke of Devonshire, Marquis of Hartington, Earl of Devonshire, Earl of Burlington, Baron Cavendish of Hardwicke, Baron Cavendish of Keighley, K.C., P.C., G.C.M.G., G.C.V.O., etc., etc., Governor General of Canada.

May it please your Excellency:

The undersigned has the honour to lay before your Excellency the First Report of the Munition Resources Commission.

Respectfully submitted,

THOMAS CANTLEY,
Chairman.

Ottawa, March 1, 1918.

OTTAWA, Feb. 28th, 1918.

SIR:

I have the honour to transmit herewith the first report of the Munition Resources Commission.

This contains a compilation of interim reports made to the Prime Minister from time to time, also descriptions of the field work and various investigations undertaken by the Commission.

I have the honour to be, Sir,
Your obedient servant,

GEORGE C. MACKENZIE,
Member and Secretary.

Hon. COLONEL THOMAS CANTLEY,
Chairman,
Munition Resources Commission.

CONTENTS

Orders in Council providing for the appointment of a Commission to make enquiries respecting the supply and sufficiency of war materials required for the production of munitions.

Certified copy of a Report of the Committee of the Privy Council, approved by His Royal Highness the Governor General on the 27th November, 1915.

The Committee of the Privy Council have had before them a report, dated 24th November, 1915, from the Right Honourable Sir Robert Laird Borden, the Prime Minister, stating that representations have been made to him urging the importance and desirability of an inquiry respecting the supply and sufficiency of raw materials in Canada required for the production of munitions of war and as to the best method of conserving the same.

The Prime Minister observes that the proposed inquiry involves considerations of an urgent nature and that it should be made forthwith.

The Committee, on the recommendation of the Right Honourable Sir Robert Laird Borden, the Prime Minister, advise that for the purpose of such inquiry, the following gentlemen be, under the provisions of Part I of the Inquiries Act, appointed Commissioners, viz.:—

Col. Thomas Cantley, of New Glasgow, Province of Nova Scotia, Manufacturer, Chairman;

Robert Hobson, of the City of Hamilton, Province of Ontario, Esquire, Manufacturer;

George C. Mackenzie, B.Sc., of the City of Ottawa, Province of Ontario, Mining Engineer; and

Honourable William C. Edwards, of the City of Ottawa, Province of Ontario, Manufacturer.

(*Sgd.*) RODOLPHE BOUDREAU,
Clerk of the Privy Council

Certified copy of a Report of the Committee of the Privy Council, approved by His Royal Highness the Governor General on the 30th November, 1915.

The Committee of the Privy Council, on the recommendation of the Right Honourable Sir Robert Laird Borden, Prime Minister, advise, with reference to the Order in Council of 27th November, 1915, appointing, under the provisions of Part I of the Inquiries Act, certain gentlemen as Commissioners to make inquiry respecting the supply and sufficiency of raw materials in Canada required for the production of munitions of war and as to the best method of conserving the same, that the undermentioned gentlemen be added to the personnel of the said Commission, viz.:—

E. Carnegie, Esquire, President of the Electric Steel and Metals Company of Welland, Ontario; and

George W. Watts, of the City of Toronto, Province of Ontario, Esquire, General Manager of the Canadian General Electric Company.

(*Sgd.*) RODOLPHE BOUDREAU,
Clerk of the Privy Council.

Text of the Commission

CANADA

ARTHUR.

[L.S.]

GEORGE THE FIFTH, by the Grace of God, of the United Kingdom of Great Britain and Ireland, and of the British Dominions beyond the Seas KING, Defender of the Faith, Emperor of India.

To all to whom these Presents shall come, or whom the same may in anywise concern,—GREETING:—

W. STUART EDWARDS,
Acting Deputy Minister of Justice,
Canada.

WHEREAS in and by Orders of Our Governor General in Council, bearing date the twenty-seventh and thirtieth days of November, in the year of Our Lord one thousand nine hundred and fifteen (copies of which are hereto annexed) provision has been made for an inquiry by Our Commissioners therein and hereinafter named respecting the supply and sufficiency of raw materials in Canada required for the production of munitions of war and as to the best method of conserving the same.

NOW KNOW YE, that by and with the advice of Our Privy Council for Canada, We do by these Presents nominate, constitute and appoint Thomas Cantley of the Town of New Glasgow, in the Province of Nova Scotia, Manufacturer; Robert Hobson, of the City of Hamilton, in the Province of Ontario, Manufacturer; George Cleghorn Mackenzie, of the City of Ottawa, in the said Province of Ontario, Mining Engineer; the Honourable William Cameron Edwards, of the City of Ottawa, in the Province of Ontario aforesaid, a Member of Our Senate of Canada; Ebenezer Carnegie, of the Town of Welland, in the said Province of Ontario, Esquire; and George W. Watts, of the City of Toronto, in the said Province of Ontario, Esquire; to be Our Commissioners to conduct such inquiry.

To have, hold, exercise and enjoy the said office, place and trust unto the said Thomas Cantley, Robert Hobson, George Cleghorn Mackenzie, William Cameron Edwards, Ebenezer Carnegie and George W. Watts, together with all the rights, powers, privileges and emoluments unto the said office, place and trust of right and by law appertaining during pleasure.

AND WE, in pursuance of the Statute in that behalf do hereby authorize and empower Our said Commissioners to engage the services of such accountants, engineers, technical advisers, or other experts, clerks, reporters and assistants, as they may deem necessary or advisable, also the services of Counsel to aid and assist Our said Commissioners in the inquiry, and also to have and exercise the other powers specified in Chap. 28, 2 George V, intituled "An Act to amend the Inquiries Act."

AND WE do by these presents nominate, constitute and appoint the said Thomas Cantley, Chairman of such Commission.

AND WE do hereby under the authority of the Revised Statutes respecting Inquiries concerning public matters, confer upon Our said Commissioners the power of summoning before them any witnesses and of requiring them to give evidence on oath, or on solemn affirmation, if they are

persons entitled to affirm in civil matters, and orally or in writing, and to produce such documents and things as Our said Commissioners shall deem requisite to the full investigation of the matters into which they are hereby appointed to examine.

AND WE do hereby require and direct Our said Commissioners to report to Our Governor General in Council the result of their investigation together with the evidence taken before them and any opinion they may see fit to express thereon.

IN TESTIMONY WHEREOF, We have caused these Our Letters to be made Patent, and the Great Seal of Canada to be hereunto affixed. WITNESS: Our Most Dear and Entirely Beloved Uncle and Most Faithful Counsellor, Field Marshal, His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, Earl of Sussex (in the Peerage of the United Kingdom); Prince of the United Kingdom of Great Britain and Ireland, Duke of Saxony, Prince of Saxe-Coburg and Gotha; Knight of Our Most Noble Order of the Garter; Knight of our Most Ancient and Most Noble Order of the Thistle; Knight of our Most Illustrious Order of Saint Patrick; One of our Most Honourable Privy Council; Great Master of our Most Honourable Order of the Bath; Knight Grand Commander of Our Most Exalted Order of the Star of India; Knight Grand Cross of Our Most Distinguished Order of Saint Michael and Saint George; Knight Grand Commander of Our Most Eminent Order of the Indian Empire; Knight Grand Cross of Our Royal Victorian Order; Our Personal Aide-de-Camp; Governor-General and Commander-in-Chief of Our Dominion of Canada.

At Our Government House, in Our City of Ottawa, this twenty-seventh day of November, in the year of Our Lord one thousand nine hundred and fifteen and in the sixth year of Our Reign.

By Command,

THOMAS MULVEY,
Under-Secretary of State.

REPORT OF THE COMMISSIONERS.

Object of the Commission

The Commission has been appointed for the purpose of instituting an enquiry respecting the supply and sufficiency of raw materials in Canada required for the production of munitions of war, and the best methods of conserving the same.

Acknowledgment due Department of Mines

In presenting this Report the Commission desires to express its appreciation of the hearty co-operation of many of the members of the Department of Mines in its work since its organization in November, 1915.

The services of the Secretary, who is also a member of the staff of the department, have been practically monopolized for the past two years, and while this has interfered to a considerable extent with his usefulness to the Mines Branch, both the Deputy Minister of Mines and the Director of the Mines Branch have most generously refrained from making any objections to the time he has devoted to the business of the Commission.

The Commission furthermore desires to thank the Department of Mines for placing the Departmental Chemical, Physical, and Ore Testing laboratories at its disposal, and thus rendering invaluable assistance in the many practical investigations undertaken during the survey of Canadian materials required for munition purposes.

Special Duties and Investigations

Tool Steel.—The supplies in Canada of special steels (known as high-speed steels) for tools used in manufacturing the iron and steel parts of shells and other munitions of war have been inadequate, owing to the restriction placed by the British Government on the export of such steels from the United Kingdom.

In order to relieve this situation it was arranged in January, 1916, through the office of the Prime Minister and at the request of the Colonial Secretary, that all orders placed in the United Kingdom for tools and high-speed steel required for bona fide munition work should pass through the office of the Commission at Ottawa for certification, and that on arrival of these certified orders in the United Kingdom they would receive the sympathetic attention of the Ministry of Munitions.

The Commission circularized the munition workers in Canada and secured from them an estimate of the tonnage of high-speed steel required for 1916 consumption. This estimate was forwarded to the Imperial Ministry of Munitions for its guidance regarding the probable consumption in this country for that year.

The certifications were originally intended to cover only tool steel and tools made from high-speed and carbon steels, required solely for the purpose of manufacturing munitions. However, additional restrictions placed by the British Government on exports from the United Kingdom made it difficult for other Canadian buyers to secure various supplies of which they were in urgent need, and the Commission was called upon to certify to the requirements of the Canadian Government railways, mining companies, and public corporations.

This procedure was followed from January, 1916, and a large number of orders from various munition manufacturers and others were passed through the office of the Commission for certification before being forwarded to England.

On February 24th, 1917, the Ottawa agent of the Eagle & Globe Co., of Montreal, complained that one of their orders, which had received certification from the Commission, had been returned to Canada with the statement that the order could not be filled until it had been duly authorized by the Department of Trade and Commerce of Canada.

On consultation with the Department of Trade and Commerce the Secretary was informed that the Imperial Government had, in December, 1916, instituted what had been called "Local Priority Authorities" for the Overseas Dominions, and that the Department of Trade and Commerce of Canada had been asked to act as the Local Priority Authority for this Dominion. This regulation and the means whereby it became operative are explained in the following copy of a letter from the Deputy Minister of Trade and Commerce, addressed to Edgar R. Jones, Esq., Priority Branch, 1 Caxton St., Westminster, London, Eng.:—

DEPARTMENT OF TRADE AND COMMERCE,
OTTAWA, February 26th, 1917.

DEAR SIR,

I am directed by the Right Honourable Sir George E. Foster, Minister of Trade and Commerce, to acknowledge receipt of your letter of the 23rd ultimo, No. 94645.

In reply, I am instructed by the Minister to say

1. The functions of a Local Priority Committee for Canada will be discharged by the Department of Trade and Commerce at Ottawa, and applications for priority assistance will be signed by the undersigned Deputy Minister or such officer as may act for him.

2. A supply of forms of application for priority assistance will be printed at once, and sample copies sent to you as soon as they are available. One or two slight departures have been made from the draft form enclosed with your letter of the 23rd ultimo, in order to suit conditions in Canada. Question No. 12, asking for name and address of the United Kingdom manufacturer of the order referred to in the application, has been added, as we have previously found this information useful.

3. We shall require Canadian firms to fill out these forms in quadruplicate; one copy to be certified to by myself and returned to the firm to be attached to their order; two copies to be certified and sent direct by this Department to the Ministry of Munitions in London; and one copy to be retained on the files of this Department.

4. Each application will receive a Canadian Priority Serial Number, and a record of all applications will be kept in this Department in a book which will be procured for that purpose.

5. As soon as the necessary forms are ready, the undersigned will cause a general announcement to be made in the Canadian press, and also in this Department's Weekly Bulletin, that no applica-

tions for Priority Permits from Canada will henceforth be considered by the British Ministry of Munitions except upon the receipt of the proper forms duly countersigned by an authorized officer of this Department.

6. I note that in urgent and important cases orders may be placed by cable; and in such cases the cable will contain the reference number of the application, which will follow by mail.

7. We note that the cable address of the Priority Branch is "Municax" London. Please note that my cable address is "Comagent" Ottawa. Should it be found necessary to communicate in cipher at any time, the Imperial Government Code may be used.

8. I note that confidential memoranda will be issued by the Ministry of Munitions from time to time, giving information in regard to any new restrictions or orders, and will have these carefully kept on file here.

9. In case of articles directly required for war work, I will arrange to have the correctness of the applicants' statements certified to on the application forms by the Imperial Munitions Board at Ottawa, whenever possible.

10. The plan outlined above can be put into operation as soon as this Department receives a supply of the necessary forms, which are now being printed and should be ready in a few days. A number of cases which have been referred to us by the Canadian High Commissioner in London still remain to be disposed of; and in these cases we are procuring the usual affidavits from the Canadian firms interested, and returning them to the High Commissioner. We shall continue to follow this plan with any future enquiries we receive from the High Commissioner, as we understand that you will inform him as soon as you are ready to advise British firms to direct their Canadian customers to send their applications for priority certificates through this Department, and that, after that, no further orders will be referred to us by the High Commissioner.

11. I shall be glad to receive any further suggestions or instructions that the Ministry of Munitions may wish to put forward at any time.

Yours truly,

(*Sgd.*) F. C. T. O'HARA.
Deputy Minister

The Secretary wrote to the Prime Minister's office on March 6th, 1917, stating that the Commission had received no official communication from the Prime Minister cancelling the arrangement previously entered into at the request of the Colonial Secretary. No reply having been received to this letter, and the Secretary finding that the Commission's certification on Canadian orders was no longer required it was assumed that the Government desired no further action in this matter by the Commission.

Scrap Steel.—On December 7th. 1915, the Commission wrote the Honourable Dr. Reid, Minister of Customs, advising him that there would in all probability be a shortage of scrap steel in Canada for purposes of manufacturing munitions and that the export of all scrap should be prohibited during the period of the present war. This recommendation was accepted and an embargo was placed by the Minister of Customs on the export of all scrap steel. On January 13th, 1916, the Department of Customs was advised that the following classes of scrap iron and steel should be allowed to be exported under special license.

Plate scrap less than 3-16 in., not bundled.
Wrought iron and pipe scrap.

Tin plate scrap.
Scrap rails 26 ft. and over.
Old bridges intact.
Old railway turn-tables.

The embargo on the export of scrap iron and steel, with the exception of the above classes, was in operation during 1916 until the month of September, when, owing to the fact that turnings and borings resulting from the manufacture of shells had accumulated throughout the country in tonnages exceeding the requirements of the steel plants, special licenses were issued for the export of 10,000 tons of this light scrap. The export of 10,000 tons did not, however, relieve congestion, and in October it was found necessary to advise the Department of Customs that turnings and borings might be exported under license up to December 31st, 1916. Approximately 50,000 tons were thus exported.

During the last week in December, 1916, a very careful survey of the whole situation was undertaken, and after consultation with the Imperial Munitions Board the Secretary telegraphed all munition manufacturers throughout the country that on and after January 1st, 1917, exports under license would be discontinued.

Upon receipt of these telegrams, sent after advice and with the consent of the Imperial Munitions Board, the munition manufacturers brought sufficient pressure to bear upon the Government to effect the export under license of turnings and borings from January 13th, forward.

Between January 13th and 31st, 1917, the Department of Customs issued licenses for the export of 343 tons of scrap iron and 5,590 tons of scrap steel; and it was arranged that the Department of Customs should furnish the Commission with monthly returns showing the tonnage of scrap iron and scrap steel exported.

The Commission having instructed Mr. J. Dix Fraser, of Port Arthur, to investigate and report upon the general scrap situation, was furnished on January 10th, 1917, with Mr. Fraser's report, which will be found in Appendix A.

In view of the fact that shell steel is not produced in Canada west of Sault Ste. Marie, the Department of Customs, on the advice of the Commission, granted licenses during the latter half of 1916 for the export of all turnings and borings and such other scrap materials as could not be absorbed in the country west of the Great Lakes; and in December, 1916, the Commission made a further recommendation that all classes of scrap from points west of and including Port Arthur should be allowed export under license. In January, 1917, certain rolling-mill interests in Manitoba and Alberta were successful in securing an embargo on the export of all classes of steel scrap, with the exception of borings and turnings, from the Provinces of Manitoba, Saskatchewan, and Alberta. It should be noted in this connection that this embargo was placed purely from commercial motives and had no bearing whatsoever on the production of shell steel.

Companies in Canada making shell steel made considerable progress during 1917 in their methods of using turnings, borings, and other light scrap, so that at

the present time the steel companies are in a position to absorb a much larger quantity of this material than was thought possible at the time Mr. Fraser's report was made.

Increased capacity for the re-melting of light scrap was offset by the advance of from 30 to 50 per cent in prices for this material during the time it was exported under license, and the Commission, being apprehensive that the continued export of this class of scrap would curtail the production of shell steel, made the following recommendation to the Imperial Munitions Board:—

(Excerpts from memorandum addressed to Imperial Munitions Board, dated January 8th, 1917.)

PROPOSAL REGARDING SCRAP STEEL

The embargo against the export of Canadian scrap steel to the United States has operated to the dissatisfaction of Canadian scrap producers in that they claim that they are being discriminated against in the matter of prices for this scrap, declaring that the American prices are on the average above Canadian and that with the embargo in force the Canadian steel companies are enabled to buy this scrap much below its full value.

Messrs. E. Carnegie and G. C. Mackenzie of this Commission have discussed the problem under three different headings as follows:—

1st. The embargo should remain in force and applications for license to export should be refused for the reason that such scrap steel is required for munition purposes and that should a large amount of scrap steel accumulate the embargo be lifted temporarily to relieve congestion.

This proposition was dismissed without much discussion, as being too crude and apparently unworkable.

2nd. The Canadian steel makers be asked to pay the going price in the United States as stated from time to time in the "Iron Age" and the "Iron Trade Review" with freights equalized.

This proposition was decided to be "too complicated, as there was quite a wide difference in the prices for scrap quoted at various iron and steel centres in the United States, and it would require a very nice adjustment to fix the price at which steel scrap should be sold at Sault Ste. Marie, Hamilton, Montreal, and Sydney, N.S., so that both the steel maker and the scrap producer would feel that they were being dealt with fairly.

3rd. That the Imperial Munitions Board should undertake to purchase the scrap outright from the scrap producer and sell and move it to the steel maker.

This proposition would seem to be the most workable of the three as it would take the question of price out of the hands of the producer and steel maker altogether, and in all probability would satisfy both the scrap producer and the steel maker, as any profits accruing would then be to the credit of the Imperial Government. The proposition is outlined roughly as follows:—

(a) That the Imperial Munitions Board would buy, f.o.b. scrap producers,—
Turnings and borings ..... at $ 7 per ton.
18-pounder shell ends ..... at $10 " "
Heavy melting scrap ..... at $15 " "

(b) The Imperial Munitions Board would sell to the steel manufacturers, f.o.b., their works,—
Turnings and borings ..... at $10 per ton.
18-pounder shell ends ..... at $13 " "
Heavy melting scrap ..... at $18 " "

(c) The above prices allow the Imperial Munitions Board $3 per ton on each class of material to pay deliveries to steel works. This item we think should prove amply sufficient in the majority of transactions.

(*d*) Should excess tonnage of scrap accumulate at any point from whatever cause, the Imperial Munitions Board may export such excess tonnage under license.

(*e*) It is suggested that the above prices would apply only to points in Ontario, Quebec, New Brunswick, and Nova Scotia; the provinces of Manitoba, Saskatchewan, Alberta, and British Columbia would of necessity have to be dealt with under a different schedule adjusted to meet the western demand and supply.

(*f*) The proposal would mean that the Imperial Munitions Board would organize a scrap steel department which would buy the scrap as fast as it is made and move it to the steel plants as it is required, excess production being exported at the discretion of the Board.

In replying to the above memorandum the Chairman of the Imperial Munitions Board stated that the purchase of scrap steel was not a natural function for the Board to discharge, but advised that a meeting of the steel manufacturers and scrap producers would be helpful in arriving at some decision. This meeting was held at the Imperial Munitions Board in Ottawa on February 27th, the Secretary of the Commission being invited to attend. The meeting was addressed by the Chairman and the Ordnance Advisor of the Board; who explained that while the Board did not care to actively participate in the handling or disposal of scrap steel it desired that the machining companies and the steel producers should, if possible, come to some terms of agreement so that a larger tonnage of this scrap might be retained in Canada. It was proposed by the representative of the John Ingalls Co., of Toronto, that the machining companies should sell to Canadian steel makers their turnings and borings, f.o.b. the works of the machining companies, for $1 per ton less than the ruling market price in the United States. This proposal was, however, not favourably received by some of the representatives at the meeting.

It was pointed out by the Chairman of the Board that if a lower price could be agreed upon it was possible that the production of steel would be increased; but one or two of the steel representatives maintained that a reduction in price would not affect the production, as the tonnage that could be produced in Canada was now practically at a maximum. The meeting adjourned after some argument on both sides and without any definite action being taken.

In April, 1917, a number of the steel makers organized what was known as the "Shell Scrap Bureau," having for its object the purchase of a sufficient quantity of scrap from machining plants and scrap dealers to meet the steel makers' requirements. The Bureau was capitalized at $100,000, of which each of the steel companies interested subscribed an amount proportionate to the percentage of its requirements estimated for a period of six months. The Bureau endeavoured to buy sufficient scrap to fill the steel companies' requirements, in no instance paying more than $12 and $24 per gross ton, respectively, for turnings or heavy scrap, f.o.b. the machining plant or the dealer's yard.

This arrangement continued in force until February 1st, 1918, at which date the Shell Scrap Bureau was absorbed by the Shell Scrap Department of the Imperial Munitions Board, which had been organized for this purpose.

This action was taken at the instigation of the steel makers, who felt that not all the scrap was being made available for the shell steel which they were supplying on contracts placed with them by the Imperial Munitions Board.

All machining and assembling orders placed in the provinces of Ontario and Quebec on which contractors are working at present, contain a clause by which the contractors must sell to the Imperial Munitions Board, at $24 and $12 per gross ton, respectively, f.o.b. cars their works, the heavy scrap and steel turnings produced on the orders.

The Scrap Steel Department of the Board, taking into account the number of shells under contract from the machiners and assemblers in Ontario and Quebec to February 1st, 1918, and assuming that 45 per cent. of the weight of the forgings would be available in the form of scrap, estimated the amount of scrap which would accumulate at the machining and assembling plants during the month of February. They also estimated the ingot production of the steel makers in Ontario and Quebec (omitting the Algoma Steel Corporation) and the percentage of turnings and heavy scrap which would be used in the production of shell steel ingots. With these figures they have endeavoured to distribute the February scrap production so as to meet the immediate needs of the shell steel makers with due consideration for the stock of scrap which the makers had on hand at February 1st.

The Scrap Steel Department of the Board have forwarded orders to the machiners and assemblers for their approximate output of scrap for the month, against which they invoice their shipments. The material thus invoiced is in turn charged to the steel companies, who receive it at the prices paid to the machiner and assembler plus freight charges. Each week a report is received from the machiners and assemblers covering the amount of scrap shipped during the previous week, and in this way the Department is enabled to keep in close touch with the scrap production.

It has been the policy of the Scrap Steel Department to ignore the dealers, realizing that allowing them to handle scrap from our machining and assembling plants would endanger the principles which prompted the Board to take over the scrap business, namely—preventing inflation of prices incorporated in contracts, and guarding against the possibility of scrap which should be available for our shell steel makers finding its way into other hands.

On April 20th, 1917, the Department of Customs instructed Collectors of Customs in Ontario and Quebec to suspend the issuance of licenses for scrap steel turnings and borings, and on July 12th authority to issue licenses for these materials was withdrawn from all ports.

Copper and Nickel.—The Commission, being aware of the conditions under which ores of copper and nickel are mined and partially manufactured in Canada and then exported to the United States for refining and marketing, collected

all information obtainable, including a report from Mr. J. E. McAllister on the cost of refining copper in Ontario which will be found in Appendix B.

This information was presented to the Government, together with resolutions recommending that definite action should be taken in order to insure the establishment of copper and nickel refineries in Canada.

Mr. McAllister stated that in preparing this report he had consulted with the foremost copper and nickel metallurgists in America at their plants in New Jersey; that these metallurgists had gone carefully over his figures and had assured him that he had arrived at conclusions as near the truth as could possibly be expected without actually building and operating a plant. Therefore he was satisfied that his report could be relied upon as an expression of the opinions of the best authorities on this continent.

In discussing general features Mr. McAllister pointed out that whereas the cost of refining copper at this hypothetical plant had worked out to a figure of $13 a ton, the New Jersey plants were doing the same for $8 a ton. This discrepancy was due almost entirely to the fact that the cost figures of the Canadian plant were based on a capacity of only 50,000 tons of copper annually, whereas the cost figures for the American plants were the result of operations on a scale of 100,000 to 150,000 tons annually. He was of the opinion, however, that a Canadian plant of the same capacity as the American plants would not be able to refine for the same cost, i.e. $8 a ton, because there were other factors which assisted the American plants and which could not be expected in connection with a Canadian refinery for some length of time, such as a highly organized and trained staff, cheap and rapid transportation of all raw materials and supplies, and a better labour market. It was true that the American plants were not securing their electric power for as low a figure as the Canadian refinery could expect from the Niagara power companies. Nevertheless, this advantage of the Canadian plant would be more than offset by the other items mentioned above, and he did not consider that a Canadian plant under the most favourable circumstances and with a capacity of 150,000 tons a year could refine copper for much below $10 a ton.

Resolutions Presented to the Government on February 24, 1916.

With respect to the Refining of Copper in Canada.

Whereas this Commission being in possession of the facts relating to the copper production of Canada showing that almost the entire production of our mines in the shape of copper ore and of our smelters in the shape of blister copper and matte is being exported to the United States for purposes of refining the same, and that this copper exported for refining purposes is available only to the Canadian and British consumer at prices fixed by these smelting companies in the United States; and

Whereas the Canadian production in the form of ore, matte, and blister copper for the year 1915 was believed to be 105,000,000 pounds, and the requirements of the Dominion for munition purposes during the same period was practically 91,000,000 pounds; and

WHEREAS it is estimated that the production of the Dominion for the calendar year 1916 may possibly be 150,000,000 pounds, and the country's requirements for munition purposes during this calendar year will probably be not less than 150,000,000 pounds, in addition to which the ordinary commercial demands of the country are considerable; and

WHEREAS there is always a possibility of the United States being drawn into the war, which would mean that the Government of that country might prohibit the export of copper in any form to Canada; and

WHEREAS the export in bond of Canadian blister copper, matte, and ore to the United States for refining purposes, to be returned to Canada, would in all probability be most unsatisfactory under war conditions;

IT IS RESOLVED that this Commission place itself on record as being strongly impressed with the urgent necessity of remedying the situation at the earliest possible moment, and we respectfully suggest that the Government of Canada, by legislative enactment or otherwise, offer inducement which will insure the erection of the necessary works for purposes of refining the total production of Canadian copper.

With respect to the Refining of Nickel in Canada.

WHEREAS this Commission being informed that The International Nickel Company of New York has stated that it is their intention to establish a refinery in Canada for the production of refined nickel from the ores of the Sudbury district in amount sufficient to meet the requirements of the British Empire; and

WHEREAS approximately 85 per cent of the nickel produced from the mines in Sudbury has been refined by the above mentioned Company in the United States; and

WHEREAS it is well known that the countries now at war with the British Empire have obtained a large portion of their supply of nickel from ores mined in Canada and refined in the United States; and

WHEREAS the world's production of nickel for the year 1913 was in the following proportion:—

Canada	71 per cent.[1]
New Caledonia	26 "
Norway, Prussia, and Greece	3 "

and assuming that New Caledonia did not increase its production for that year, the Canadian output in 1915 would approximate 80 per cent of the world's supply;

IT IS RESOLVED that this Commission urge the Canadian Government to insist upon the International Nickel Company proceeding with the instant establishment in Canada of sufficient refinery capacity to provide an adequate supply of nickel for the Empire's requirements, and further desire to point out that climatic conditions present no adequate cause for failure to proceed with the installation of such a refinery immediately.

In acknowledging receipt of the Commission's resolutions the Premier stated that the International Nickel Company of New York, U.S.A., had on January 7th, 1916, signified their intention of granting the request of the Canadian Government to the end that a nickel refinery be erected in the Dominion of such initial capacity as to secure a product of finished nickel sufficient for the requirements of the British Empire.

[1]Canadian production increased considerably in 1915.

In subsequent discussion of this matter the Commission was made aware that the British America Nickel Corporation, Limited, a company composed entirely of Canadian and British capitalists, had submitted a proposal to the Canadian Government in the spring of 1914 which would insure the British Empire's requirements of refined nickel being produced in Canada and incidentally the production at the same time of a considerable tonnage of refined copper. The Canadian Government had not accepted this proposal, and the Corporation, having failed to finance its undertaking in the United States, had postponed indefinitely the erection of smelters and refineries.

RESOLUTION PRESENTED TO THE GOVERNMENT ON APRIL 17TH, 1916, WITH RESPECT TO THE REFINING OF COPPER AND NICKEL IN CANADA.

WHEREAS this Commission has presented certain resolutions to the Government on the subject of the refining of nickel and copper in Canada; and

WHEREAS such resolutions were acknowledged and the Commission asked to secure further information on the subject that would enable the Government to take steps to insure the refining in Canada of the above metals; and

WHEREAS the Commission has learned upon investigation that the total Canadian copper production disassociated from nickel is at present insufficient to insure the economic operation of a refinery for copper alone; and

WHEREAS the Commission is of the opinion that the establishment of a nickel refinery, independent of the International Nickel Company, would provide the establishment of a copper refinery in connection therewith; and would undoubtedly greatly stimulate the development and operation of a number of the smaller Canadian copper mines which in consequence of lack of Canadian smelting and refining facilities have now no market for their ores; and

WHEREAS the Commission being informed through a letter dated March 17th, 1915, addressed to Colonel Carnegie of the Shell Committee, at Montreal, that the British America Nickel Corporation stated that they had developed a nickel and copper deposit containing eleven millions of tons and did submit a plan to the Government whereby on the guaranteeing of certain securities the Corporation would be prepared to construct and operate in Canada a refinery for the production of nickel and copper from these ores;

IT IS RESOLVED that the Commission recommend that the Government communicate with the British America Nickel Corporation to ascertain if this proposal is still feasible, and if so, such aid be given by the Dominion Government by way of temporary advance of capital, guarantee of securities, or otherwise, as will insure the establishment of such refining plants.

The Premier acknowledged receipt of the above resolution and stated that it would be laid before Council at an early date; but in so far as the Commission is aware the Government took no action.

In the early fall of 1916 the British America Nickel Corporation announced that it had secured sufficient funds to enable it to erect smelters and refineries for the production of both nickel and copper in Canada. It is understood that the British Government is the principal shareholder of this Corporation.

About the same time the International Nickel Company made definite announcement that Port Colborne, Ontario, had been selected as the site for its Canadian refinery, and began construction forthwith.

Mineral Investigations

Work of Field Officers and Others.—The Commission has investigated a great number of mines, prospects, and occurrences, of certain minerals essential for the production of munitions. This work has been done by Mr. J. C. Gwillim, Professor of Mining Engineering, Queens University, Kingston, Ont.; Dr. W. F. Ferrier, Consulting Mining Engineer and Geologist, Toronto, Ont., and Dr. W. L. Uglow, Mining Engineer and Geologist, Kingston, Ont., who were engaged directly by the Commission.

In addition to the work of the regular field officers of the Commission, certain special investigations were undertaken from time to time by members of the staff of the Department of Mines, whose services were placed at the disposal of the Commission by the department. The late Dr. C. C. Cairns reported on tungsten in the Yukon and the Maritime Provinces; Mr. C. Camsell on molybdenite in Quebec, and tungsten in New Brunswick and Nova Scotia; Dr. A. O. Hayes and Mr. E. R. Fairbault investigated certain occurrences of manganese, tungsten, molybdenum, and zinc, in Nova Scotia; Mr. S. E. Slipper reported on an occurrence of manganese in southern Alberta; Mr. M. F. Bancroft examined certain manganese deposits in central British Columbia; and Mr. C. S. Parsons, assisted by Dr. Uglow, made detailed examinations of certain bog manganese ores in New Brunswick.

Important laboratory work was undertaken by Mr. J. Keele, Mr. F. G. Wait, and Mr. H. C. Mabee.

Mr. J. C. Gwillim was instructed to proceed to British Columbia in the fall of 1916 for the purpose of reporting on the possibility of increased production of the ores of molybdenum, tungsten, and zinc. In the summer and fall of 1917 he undertook the examination of numerous molybdenum occurrences in the provinces of Ontario, Quebec, and Nova Scotia. He also investigated certain chromite deposits in Quebec, and tungsten and manganese mines in New Brunswick and Nova Scotia.

Complete reports on his work, illustrated with maps, photographs, and line drawings, have been filed with the Commission, but publication in full at this time is undesirable from the point of economy. It is probable, however, that arrangements will be made with the Department of Mines to publish the reports at a later date.

In August, 1917, the services of Dr. W. F. Ferrier, of Toronto, were secured by the Commission to investigate and report upon the possibility of discovering deposits of bauxite, an ore of aluminum, in the Interior Plateau region of British Columbia. Dr. Ferrier has briefly summarized his field work in Appendix C,

from which it will be noted that although he was unsuccessful in actually locating a deposit of this mineral, he is of the opinion that the geological conditions in this section of the country are such that bauxite may yet be found. Dr. Ferrier's work for the Commission in this particular has stimulated to no little extent the search for bauxite by individual prospectors, particularly in British Columbia, and it is within the range of possibility that some discovery may be made as a result of the Commission's initiative.

Aluminum.—Bauxite, the principal ore of the metal aluminum, has not been found in Canada up to the present time, but, as already stated, on the engagement of Dr. Ferrier in the fall of 1917 he devoted his time, during the short period then remaining for field work, chiefly to a reconnaissance for that mineral in British Columbia.

The extensive works of the Northern Aluminum Company at Shawinigan Falls, Que., are producing aluminum from ores imported from the United States and France (formerly also from Germany). A mill for the manufacture of wire and cables is also operated by the same company.

Bauxite is also used in the manufacture of aluminum salts, bauxite bricks, and the artificial abrasive "alundum" (fused alumina).

The metal aluminum has become of late years familiar to everyone through its introduction in the form of kitchen utensils. Its use in other forms is, however, not so well known. Several thousand tons of aluminum wire have been used in the points of the modern long-tapered rifle bullets. The copper-nickel sheath has a small pellet of aluminum inserted in its point, the remaining space being filled with lead in the usual manner. The bullet is not a "dum-dum" bullet, because the aluminum is harder than the lead which it displaces and thus tends to prevent "mushrooming" or spreading of the nose of the bullet on impact. The device is said to give a flatter trajectory and increased accuracy of fire.

Time-fuses for shrapnel are made of aluminum in place of brass, several million having been put into shells made in the United States for the Russian Government. Machine guns of the air-cooled type use aluminum radiators. Aerial construction has absorbed large quantities of aluminum.

The explosive "ammonal," consisting of powdered aluminum and ammonium nitrate, is being used in large quantities by all combatants in the present war.

Large quantities of aluminum wire are now used instead of copper in the manufacture of electric power-line cables. Aluminum dust is being extensively used in place of zinc dust for the precipitation of gold and silver from cyanide solutions.

Chromium.—Metallic chromium has no direct use, but raw chromite and chromium salts have a variety of applications. Owing to its great heat-resisting qualities, chromite is used as a basic refractory lining for furnaces, in the form of manufactured bricks or lumps of ore. It withstands wide changes of temperature and resists the attack of molten metals. For refractories, ore with 35 to 45 per cent of chromic oxide can be used.

Ferro-chrome is extensively used in the manufacture of steel for armour plates, armour-piercing projectiles, mining machinery, automobiles, high-speed tool steel, etc. Chrome steels containing one or two per cent of chromium are distinguished by their great hardness.

The largest producers of chromite are Rhodesia, United States, New Caledonia, and Canada. The United States produces about 25 per cent of its requirements, importing the balance from abroad. Canada exported over 10,000 tons to the United States in 1916 and more than doubled that tonnage during the past year. Practically the total Canadian output is taken by the United States, and there is every prospect that 1918 requirements will exceed the supply.

The price of the ore at present is about $1.20 per unit (1 per cent of a ton) of chromic oxide in ores containing not less than 40 per cent chromic oxide.

At the direction of the Secretary, Mr. J. C. Gwillim visited the Black Lake district in Megantic county, Quebec, during the fall of 1917, and reported upon the possibilities of stimulating the mining of chromite. He found that the war price of approximately $1.20 per unit of chromic oxide had effected an increase in the production, but he considered that experimental testing to ascertain the best method of concentrating these ores would be of great value. Acting on his advice the Quebec Asbestos & Chrome Company, St. Cyr, Que., forwarded a carload of ore to the Testing Laboratories of the Department of Mines at Ottawa, from which a high grade chromite concentrate containing approximately 48 per cent chromic acid was made.

The result of this test has awakened the interest of some other producers in the district and it is possible that the Department of Mines will be asked to undertake additional experiments. Incidentally, the result of this test has encouraged the Quebec Asbestos & Chrome Company to at once proceed with the erection of a concentrating mill.

The Secretary has drawn the attention of the Imperial Munitions Board to the production of chromite ores in Quebec, and also to the fact t t the British Ministry of Munitions was conserving supplies of chrome ores a: ferro-chrome in England. It was pointed out to the Board that, should the Ministry so desire, it would not be difficult to reserve the Canadian chrome ore for the use of the Ministry instead of allowing it to be exported to the United States. Incidentally, should the Ministry become interested in the proposal, this might lead to the establishment of electric furnaces in Quebec for the production of ferro-chrome. The British Ministry of Munitions has not yet replied to this proposal.

Magnesite.—Magnesite is a basic refractory mineral essential for lining open-hearth and high-temperature electric steel furnaces. Until 1915 the Canadian production of this mineral was very small. 340 tons were produced in 1914 as against 58,000 tons in 1917.

The war having shut off all supplies of Austrian and Grecian magnesite from Canada and the United States, attention was turned to the occurrences of magnesite in the vicinity of Grenville, Que., and prospecting soon developed the

fact that there was considerable magnesite available. The rock is sufficiently high in magnesia to enable the shippers to meet a requirement of approximately 85 per cent magnesium carbonate with less than 13 per cent of lime.

It has always been supposed that the Canadian mineral, on account of its higher lime content, was inferior in quality to the European varieties. However, it has been demonstrated beyond question that Canadian magnesite when properly treated makes furnace linings comparable with the best Austrian magnesite linings hitherto used.

The Scottish-Canadian Magnesite Company, Ltd., has been mining magnesite for the last two years on its property in Grenville township, Argenteuil county, Quebec. The material shipped runs as high as 12 per cent lime, all rock with a higher percentage of lime (magnesite-dolomite) is rejected and piled in waste heaps. The sorted magnesite was shipped to the Harbison-Walker Refractories Company, Pittsburg, Pa., without any preliminary treatment.

We have been informed that the Harbison-Walker Company has recently cancelled its contract with the above mine owners as supplies are being drawn from deposits in the state of Washington, whence magnesite containing less than 3 per cent of lime can be secured.

The Scottish-Canadian Magnesite Company has been shipping raw magnesite to the cement works at Hull, Que., during the last six months. The magnesite is first hand-picked to eliminate impurities such as serpentine and dolomite. It is then put through a crusher and ball mill and ground to pass a 100 mesh screen. Five per cent of magnetite is added, this also being ground to 100 mesh. The magnetite is obtained from the dump at the old Forsyth iron mine at Ironsides, Que., and hauled in wagons to the cement plant at Hull, a distance of about 5 miles by road.

The ground mixture of raw magnesite and iron ore is fed into one of the rotary kilns ordinarily used for burning cement, and fired at a temperature of probably 2700° F.

The product which comes from the kiln is a dark brown, dense, hard, granular material, and appears to be completely dead burned.

About 35 tons of dead burned magnesite is produced daily in this manner, the bulk of which is shipped to Pittsburg, Pa., but some quantity is sent to Hamilton, and Sault Ste. Marie, Ont.

Some experiments were made by Mr. J. Keele at the laboratories of the Mines Branch, Department of Mines, on the sintered or dead burned magnesite produced at Hull.

Mr. Keele reports that a portion of this material, placed in a Hoskins electric resistance furnace, did not show any indication of fusion when submitted to a temperature which softened cone 34 (3290° F. or 1810° C.) and it appeared to stand this heat treatment as successfully as the base on which it rested. This base was a portion of a magnesite brick made by the Harbison-Walker Refractories Company in 1914, probably from Austrian magnesite.

The sintered magnesite from the furnace at Hull was then ground to pass a 12 mesh screen, and made into test bricklets in a hand press. Six per cent of calcined magnesite, made into a milk, was used as bonding material and appeared to give satisfactory results, as the brick could be easily handled from the press. These bricks were burned to cone 20 (1530° C.) in the electric kiln, and resulted in a compact, structurally sound bricklet, without any shrinkage whatever.

The tests are still incomplete, as it will be necessary to burn some of the bricklets to cone 26 (1650° C.) and note if any shrinkage occurs at that temperature.

The data obtained so far seem to show that the Grenville magnesite can be made into a marketable product ready for steel-furnace bottoms by grinding to 100 mesh, adding 5 per cent magnetite ore as a sintering material, and burning to about 2700° F. in the ordinary rotary furnaces of cement mills. It also appears that the sintered magnesite when ground and made into brick, using calcined magnesite (magnesite burned at a low temperature) as a bond, is satisfactory as far as temperatures up to cone 20 are concerned.

Experiments with these bricks at temperatures about cone 20, and on the adaptability of bonding materials other than calcined magnesite, are now in progress.

The Steel Company of Canada, at Hamilton, Ont., allowed the Secretary to inspect its methods of using Grenville magnesite, and the following notes detail the various operations.

The magnesite arrives at the steel furnaces in crude unburnt condition, in pieces up to 12 to 14 inches square, and in this condition, without any preliminary breaking or crushing, is partially calcined in a small coal-fired furnace. The furnace holds approximately 9 tons of raw material and this charge will be burnt sufficiently in 8 hours with a consumption of three tons of coal. No attempt is made to dead burn, but rather to calcine only, as one would burn limestone for the production of lime.

When discharging the calcined stone from the furnace it is spalled down to half inch size and smaller by means of flat pounding-hammers. These hammers are made up of a plate-shaped casting 6 or 8 inches in diameter, fixed to a piece of ordinary pipe for a handle. The hammer is used much in the same manner as a ramming-hammer. This method of breaking down the calcined stone is preferred to crushing, which would make too much dust.

After being calcined and broken as described, the magnesite is mixed with broken-up basic open-hearth slag which has been crushed to approximately one-half inch size, in proportions that vary between 15 to 40 per cent of slag and 85 to 60 per cent of burnt magnesite.

The calcined magnesite and broken slag are mixed on the floor facing the open-hearth furnaces by shoving a layer of slag over a layer of magnesite and then turning the whole over several times by means of shovels. The furnace to be lined is brought to a temperature of about 2700° to 2800° F. The mixture is then thrown in on the bottom of the hot furnace in small amounts, care being

taken to distribute the material evenly, and the bottom built up in successive layers until completed.

The essential requirements in putting in a bottom are that small amounts of the material should be put in every 15 minutes, that the furnace should start with a temperature sufficiently high to flux the material, and that this temperature should be maintained throughout the operation. A 75 ton open-hearth furnace will be lined in this manner at the Hamilton works in 4 days, and if care is taken the bottom will be equal in every respect to that obtained from the use of Austrian magnesite. The operation of putting in a bottom consisting of 40 per cent slag and 60 per cent magnesite, in a 75 ton furnace, was viewed during a recent visit to these works. Assurance was given that absolutely no trouble was experienced as long as ordinary care was exercised that the raw material was properly burned (not to a dead burn), and that an intimate mixture of the slag and magnesite was made preparatory to forming the bottom.

If the work is done carefully the bottom should last for a considerable time without any patching being required, but when patching is necessary it is usually put on with a mixture of 90 per cent calcined magnesite and 10 per cent slag.

As previously stated, the mineral magnesite is essential as a lining for steel furnaces whether the steel be produced for munitions or for ordinary commercial purposes. The most important deposits in North America, as regards transportation to the great steel-producing centres, are in Grenville township, Argenteuil county, Quebec. Certain deposits of hydromagnesite are found at Atlin, in northern British Columbia, but their inaccessability has so far prevented their utilization except for experimental purposes. They would, however, become active producers if steel works should be established on the Pacific coast. A deposit of magnesite recently discovered near Orangedale, Inverness county, Nova Scotia, has been acquired by the Nova Scotia Steel and Coal Company, who mined a small quantity for experimental purposes. The only serious competitors to the Grenville quarries are deposits situated in the States of Washington and California, and the cost of transportation of the western mineral to steel centres in the east favours the producers in Quebec.

Until 1914 Austria and Greece enjoyed practically a monopoly of the magnesite trade, and unless we are able to develop this relatively new Canadian mining industry to the point where it can meet competitors after the war, Austria and Greece will again dominate the production of this particular mineral.

Manganese.—Of all the metals employed in the production of alloy steels manganese is the most vital, since without its use it is impracticable to make good steel commercially; and since a small excess in the steel is not harmful, it has come to be the custom to add considerable quantities of it to practically all industrial steel. This has created a demand for manganese, preferably in the form of ferro-manganese. About 425,000 tons of ferro-manganese, which is about three quarters of one per cent of the weight of steel produced, is consumed per year at the present rate of steel production in North America. The principal

sources of supply for manganese ores before the war were Russia, India, and Brazil. The chief outlet for the Russian ore was through the Dardanelles, which fact has made Russian ore practically unobtainable since 1914. The ores of India and Brazil are available only in proportion to the shipping that may be released for their transportation. Therefore, the supplies necessary for steel production in North America have had to be obtained locally or transported with difficulty and at considerable cost from India and Brazil.

For the five years prior to January 1st, 1915, the price of 49 per cent manganese ore ranged from 24 to 26 cents per unit (1 per cent per ton) or approximately $12.50 a ton laid down at Pittsburg. For the same period the market price of ferro-manganese ranged from $40 to $65 a ton. Since war was declared the price for 49 per cent ore delivered at Pittsburg has risen steadily to $1 per unit, and the price for ferro-manganese has finally attained $250 a ton.

Probably the most important use of manganese ore aside from the steel industry is in the making of dry batteries. Some quantity is also consumed in the glass industry. These industries require a very high grade ore containing more than 80 per cent manganese dioxide and less than 1 per cent of iron.

Manganese in New Brunswick and Nova Scotia

The investigations with respect to supplies of manganese were carried out chiefly at the request of the Imperial Munitions Board, and are summarized briefly as follows.

At present there is no manganese mine in the Maritime Provinces, or indeed in Canada, developed to the point of steady production. Practically all recent tonnage has been derived from small mines at New Ross, Lunenburg county, Nova Scotia, producing only from one to two tons daily of very high grade ore, all of which is exported under license to the United States and sold to the glass and dry-battery manufacturers at prices ranging from $120 to $175 per ton.

There is no production in Nova Scotia or New Brunswick of ore suitable for the manufacture of ferro-manganese, but field work of the Commission has disclosed the possibility of securing some tonnage of low grade ores capable of concentration. The bog manganese ores found in New Brunswick have been carefully examined by the Commission, and while there is some tonnage of ore available for the production of spiegeleisen (an iron alloy containing less than 30 per cent manganese), they do not contain sufficient manganese for the production of ferro-manganese.

A deposit of banded manganese ore in sandstone has been prospected to some extent at Walton, Hants county, Nova Scotia. This ore contains about 15 per cent manganese, and experiments conducted at the Testing Laboratories of the Department of Mines, Ottawa, have demonstrated that it is possible to concentrate it to a product containing over 45 per cent manganese. It is expected that this concentrated product will produce high grade ferro-manganese in electric furnaces. This will be experimentally tested in the very near future.

The waste dumps at the New Ross mines in Lunenburg county were examined with a view to recovering manganese waste that had been thrown away after

selecting the high grade manganese ore already referred to. A carload sample shipment from these waste dumps was forwarded to Ottawa and concentrated at the Testing Laboratories of the Department of Mines. It yielded a concentrate containing approximately 30 per cent manganese and 30 per cent iron, which would be suitable for the manufacture of spiegeleisen only.

Manganese Ores of Alberta and British Columbia.

In the early summer of 1917 certain manganese deposits in southern Alberta were examined by the Geological Survey at the request of the Commission. The geologist who made the investigation reported the existence of some deposits, from calcareous springs, which contained less than 10 per cent of manganese. The deposits are not regarded as a valuable source of manganese ore.

Some activity has been displayed in developing an occurrence of manganese ore near Kaslo on Kootenay Lake, British Columbia. This locality was also examined for the Commission by the Geological Survey. Indications at first gave the impression of a small tonnage of 40 per cent ore, but subsequent development work has uncovered more ore, and the operators have secured license to export several hundred tons to the United States.

The Commission is about to undertake electric smelting experiments for the production of ferro-manganese and spiegeleisen from certain ores in New Brunswick and Nova Scotia, and it is expected that these experiments will demonstrate the feasibility of manufacturing spiegeleisen from the bog ores of New Brunswick and the concentrated ores from the dumps at New Ross. It is also expected that the concentrated ores from Walton, Hants county, Nova Scotia, can be smelted to a high grade ferro-manganese.

The Commission is indebted to the Electro Metals, Limited, of Welland, Ontario, for full particulars and suggestive advice on the construction and operation of electric furnaces for the smelting of manganese ores. The Electro Metals, Limited, was unable to undertake the experiments owing to other more pressing matters, but arrangements are pending with another electric smelting company whereby the company will provide facilities and power for the smelting of such samples of ore as are secured by the Commission. If desired, by paying the Commission for the ores supplied, the company may retain possession of any ferro-manganese produced.

Molybdenum.—This metal has received an unusual amount of attention during the past four years because of the hardening quality it imparts to steel.

In the peaceful arts the metal has found application as a constituent of tool steels, although its rival tungsten, because of an established production, has been preferred for this purpose. Molybdenum steels are being used in automobile construction and it is expected that the attention of steel workers will be directed towards more extensive application of these special alloys. Molybdenum wire is used in the manufacture of electric lamps and to a more limited extent in the scientific instrument trades. Salts of molybdenum form valuable chemical reagents and are also used for colouring pottery.

The world's production of molybdenum ores in 1917 was much greater than that of any previous year. In 1910 metallic molybdenum sold for about $1.50 a pound; while the present price of molybdenum wire is over $40 a pound, and ferro-molybdenum containing from 50 to 70 per cent molybdenum is valued at $4 per pound of molybdenum content.

In 1911 the Mines Branch, Department of Mines, published a report entitled "The Molybdenum Ores of Canada," by Dr. T. L. Walker, of Toronto University. This report described all the then known deposits of molybdenum ores in Canada. At the time it was published there was a comparatively small open demand for the metal. Prior to 1914 the chemical industries absorbed the greater part of the production, but we are beginning to learn that certain armour-manufacturing plants in Germany were even then making use of molybdenum in the manufacture of war munitions.

In 1911 the world's production came mostly from Australia, which in that year was credited with 121 tons. Norway produced 2½ tons and Canada practically nothing. In 1914 the Department of Mines again took up the subject, and made experiments in its Ore Dressing Laboratories on the concentration of molybdenum ores. In the spring of 1915 the department was in a position to offer its services to the Imperial Munitions Board to obtain supplies of this mineral should they be required by the Imperial authorities. The desirability of encouraging Canadian production was for several months impressed upon the Imperial authorities, but it was not until early in 1916 that the Imperial Munitions Board was authorized to purchase any considerable quantity of molybdenite in Canada.

The situation at that time was that only a very few of the known localities had been developed to the point of production, and because no facilities existed for milling or concentrating, the Imperial Munitions Board looked to the Department of Mines for assistance. The department responded by turning its Ore Testing Laboratory into practically a small commercial mill and, during 1916, from nearly 2,300 tons of ore received from various localities, produced 40·5 tons of molybdenite concentrate which was turned over to the Imperial Munitions Board at the official British price of $1.09 per pound of pure molybdenite, f.o.b. Ottawa. During 1917 the Department milled 1,600 tons of crude ore, producing 31·4 tons of molybdenite in the form of concentrate.

Early in 1917 two of the largest mines—the Dominion Molybdenite Company at Quyon, Que., and the Renfrew Molybdenum Mines, Limited, Mount St. Patrick, Ont.—installed concentrating mills which have been in operation ever since. The total Canadian production of molybdenite for the year 1916 is estimated to have been slightly over 80 tons, while Australia was credited with 132 tons and Norway with approximately 100 tons. For the year 1917 conditions have probably changed. Canada produced in the neighbourhood of 140 tons, but no figures are available for either Australia or Norway.

From the beginning of the war until the end of 1917, molybdenite, metallic molybdenum, its alloys and salts, were under an embargo in Canada which

prohibited their export to any country outside the British Empire. All sales of ores from the British Empire made to the Imperial authorities were based on the official price of 105 shillings per unit (1 per cent of a long ton) of the pure mineral, delivered f.o.b. Liverpool.

The prices in countries outside the Empire were always higher than the official British quotations. The open market price in the United States during 1917 was approximately $2.25 per pound of pure mineral delivered at buyer's works. Canadian producers contended that this difference in price unduly favoured production outside the Empire. The British Government was, however, securing practically all its requirements within the Empire, and the higher price in the United States was chiefly due to the inadequate supply in that country.

During the first week of January, 1918, the Imperial Munitions Board was informed that the immediate requirements of the British Government were supplied and that the Canadian production might be exported under license to the United States and France.

At the present time the principal Canadian producers are The Dominion Molybdenite Company, Limited, Quyon, Que., which disposed of the greater part of its product up to the end of 1917 to the Imperial Munitions Board; and the Renfrew Molybdenum Mines, Limited, Mount St. Patrick, Ont., which exports its total production to France. The Dominion Molybdenite Company sold its product to the Imperial Munitions Board in the form of ferro-molybdenum made in electric furnaces at smelter plants situated in Orillia and Belleville, Ont.

Another property, not developed to the point of either the Dominion or Renfrew mines, is that owned by the Wood-Molybdenite Company, Limited, situated on Squaw lake, Pontiac county, Quebec, some 30 miles north of Shawville. This promises to become a producer before the end of the present year.

There are properties in British Columbia, Ontario, Quebec, and Nova Scotia, some of which have produced a little ore while others are merely prospects. Amongst these may be mentioned that of the Molybdenum Mining and Reduction Co. Limited, on Alice arm, Observatory inlet; the Molly mine, on Lost creek, Nelson mining division; the Index mine, Lillooet mining division, all in British Columbia. Other less important discoveries have been made at Stave lake, Pitt river, and Grand Prairie. In Ontario small producers are the Spain mine, Renfrew county; the Chisholm mine, Addington county; the Lilico-Burrows mine, Haliburton county; the Horscroft mine, Victoria county; the O'Brien mine, Renfrew county, and some others. In Quebec there are the Chaput and Hughes, the Davis, the Chabot, and the Chatelane, all in Pontiac county. In Nova Scotia properties have been developed at New Ross, Lunenburg county, and at Gabarus bay, Cape Breton, and small shipments made. Attention has recently been directed to certain deposits in Manitoba, more particularly to those in the vicinity of Falcon lake.

The establishment of the new molybdenum ferro-alloy industry in Canada is important. Canada, with her abundant hydro-electric power, should take an

important position in the electric-furnace production of all classes of ferro-alloys.

Some difficulty was experienced in persuading the Imperial authorities to accept ferro-molybdenum instead of the raw mineral. It was contended that English smelters were equipped to handle the ores and therefore a duplication of these facilities in Canada was unnecessary. This objection was met by pointing out the desirability of manufacturing the ferro-alloy in this country because it allowed the Canadian producer a larger profit on his undertaking.

Tungsten.—The metal tungsten is of primary importance because of certain valuable qualities it imparts to steel when alloyed with it. Its principal use at the present time is in the manufacture of high-speed tool steels so essential for the rapid production of all forms of projectiles, ordnance, and similar munitions.

Tungsten has, so far, distanced its rival molybdenum in this particular field because supplies of its crude ores were more readily obtainable; but the known tungsten resources of the world are limited, and molybdenum production has increased several hundred per cent during the past two years, so that the relative importance of the two metals may eventually be reversed.

Tungsten enters into the manufacture of armour plate, armour-piercing projectiles, gun liners, and aeroplane engines. It is also used in filaments for electric light bulbs. Alloyed with aluminum it is employed in automobile construction, and with aluminum and copper in propeller blades. It is an important constituent of a new tool alloy called "stellite." With molybdenum it forms an alloy used in dentistry as a substitute for platinum.

In 1915 the British Government commandeered all supplies of tungsten concentrates within the Empire at a fixed price of 55 shillings ($13.50) per unit (1 per cent of a long ton) of contained tungstic acid. In the United States the open market quotations have fluctuated considerably during the past five years. Before the war the highest price was $15 per unit (1 per cent of a short ton), but in the spring of 1916 the price rose above $90 per unit.

At the close of April, however, the price dropped considerably, and by the early part of 1917 had reached $17.50 per unit for concentrates carrying 60 per cent tungstic acid. Towards the end of 1917 the market tightened again, and at the present time tungsten concentrates are selling for approximately $24 per unit.

Tungsten in British Columbia and the Yukon

There have been no important developments since Dr. T. L. Walker's "Report on the Tungsten Ores of Canada" was published by the Mines Branch in 1909.

The occurrences there described in the Kootenay Belle, Granite-Poorman, and Meteor mines, West Kootenay district, and that on St. Mary creek, East Kootenay district, were enquired into, and no developments of commercial value seem likely.

There has been no production from the deposit on Hardscrabble creek in the Cariboo district, but the property has been further developed and kept open.

At the time of Dr. Walker's inspection "the mine was idle, but from those interested it was learned that a shaft had been sunk about 30 feet in the rock and drifting along the tungsten zone had been carried about 50 or 60 feet."

Mr. W. F. Robertson, Provincial Mineralogist of British Columbia, entered these workings, which are below the creek level, and inspected them as far as conditions would allow, the rock faces showing small veins or veinlets of scheelite.

Mr. J. A. Macpherson of the Cariboo-Chisholm Creek Mining Co. Ltd., Van Winkle, B.C., writing on November 24, 1916, describes this property and appends a sketch of the workings. He states that the deposit is eleven miles from Barkerville, 50 miles from Quesnel, and 6 miles from the main Cariboo road. From further examination and analysis since Dr. Walker's inspection he finds "the zone of payable ore containing about 10 per cent tungstic acid will be 12 feet in width; oxidized ore in the new tunnel work 17·9 per cent WO_3; general value of the sides of the new tunnel 12·3 per cent WO_3. The property was put in first-class shape in September, 1915."

Dr. W. F. Ferrier reported to Mr. J. C. Gwillim the occurrence of wolframite at the head of Mud Creek on Rocher Déboulé mountains, near Hazelton, which has been described by Mr. J. D. Galloway in the Report of the Minister of Mines, British Columbia, for 1916. It is there stated that the wolframite is distributed through mineralized stringers from 3 inches to 2½ feet in width which occur in veins in the granite.

A few hundred pounds of scheelite and wolframite have been shipped from placer workings in the Yukon, and more may be saved during the coming season. The late Dr. Cairnes has presented information on this subject in the Summary Report of the Geological Survey for the year 1916.

Tungsten in New Brunswick and Nova Scotia

The most productive Canadian sources of tungsten minerals have been Burnt Hill brook in central New Brunswick and the Moose River district in Nova Scotia.

The mines at Burnt Hill brook have been operated intermittently since 1915, the first shipment of some 15 tons of wolframite concentrates being made to New York in January, 1918. The locality was visited in 1916 by Dr. C. Camsell and the late Dr. Cairnes at the request of the Commission, and described in the Summary Report of the Geological Survey for that year. Mr. J. C. Gwillim also inspected the property in the fall of 1917 and reported the existence of some tonnage of wolframite ore, but he considered that the operators could not afford to produce concentrates at the official British price of 55 shillings per unit.

The Burnt Hill mines are at present inactive, although it is understood that the owners contemplate resuming operations in the near future.

The Moose River mines in Nova Scotia recorded a small shipment of scheelite in 1913, but since that year very little effort has been made to increase produc-

tion. It is doubtful if the comparatively low grade ores of this district will pay to work, even at the present New York price of $24 per unit.

The demand for tungsten ores will likely continue, but Canadian tungsten mines worked for tungsten alone appear to be rare, and the supply depends on the price offered. A high price brings out accumulations, such as by-products from other ores; old dumps are re-worked, and the mining of neglected occurrences in many operating and abandoned mines is undertaken. In Canada the mining of tungsten ores from known localities offers little encouragement at a price of 55 shillings per unit.

As far as we have noted, the Canadian ores of tungsten average less in quantity and in grade than molybdenum ores, and are about half as valuable at the present time in the British Empire. Few people recognize tungsten minerals, and they are easily overlooked unless they accumulate in sluice boxes or upon mill tables.

Zinc.—During his field work in British Columbia Professor J. C. Gwillim visited the producing zinc mines and the smelter at Trail, for the purpose of ascertaining the possibility of increasing the production of zinc ore in the immediate future.

Heretofore the chief source of zinc has been the by-product zinc blende of the British Columbia silver-lead mines in the Slocan, which usually carries silver in varying quantities somewhat increasing its value.

The blende is not in sufficient quantity or purity for the usual retorting in Belgian ovens. There has been too much of it to be ignored by the mine owners, and too little of it to make an attractive source of supply for the smelters.

This condition has been investigated by spelter producers and committees, all of whom seem to have arrived at the conclusion that such ores of zinc were unsuited to the ordinary retorting processes and that the supply is not sufficient to justify the establishment of retort smelters in British Columbia, especially under the existing conditions of high fuel and labour costs.

The matter is reviewed in the "Report of the Commission appointed to investigate the Zinc Resources of British Columbia, and the conditions affecting their exploitation," and in a report by Dr. A W. G. Wilson on "Production of spelter in Canada," both published by the Mines Branch in 1906 and 1916, respectively. Some of the features which must be considered with the stimulation of increased prices for spelter and the desire of producers to reduce their own zinc ores instead of marketing them in the United States at little or no profit, are: (1) A desire to make the most of the undesirable blende by-product of the silver-lead mines; (2) The establishment of an electrolytic refinery at Trail, B.C., which promises in time to offer a better market than American smelters; (3) The large existing reserves of complex zinc ores which it is expected can be treated at Trail; (4) The probability of new discoveries now that complex or dirty zinc ores are within the possibility of a profitable market.

Memorandum and Proposals for Increased Exploitation of Canadian Mineral Resources

The Commission having undertaken a review of the mineral production of Canada as affecting the manufacture of munitions, submitted the following memorandum and proposals for the consideration of the Government:—

The Canadian munition industry is based upon the production of a variety of minerals that are essential for the manufacture of war munitions, and while it is undesirable from the point of brevity to list and describe all of these requirements, a few of the outstanding and more important minerals are enumerated and commented upon.

Iron.—Canada continues to be an unimportant factor in the production of iron ores, notwithstanding the fact that prices for ores of iron have increased considerably during the past two years. Some little activity is evident in the Ottawa Valley district and several dumps from old workings have been gone over and the better part of the ore removed, but beyond this no actual re-working of abandoned mines has been attempted.

The total production of Canadian ores for 1917 was 215,000 tons, practically all of which was derived from the Helen and Magpie mines of the Algoma Steel Corporation, in the Michipicoten district, Ontario.

The people of British Columbia have been making an effort to awaken interest in the establishment of an iron industry in that province, and while it can be shown that ores of merchantable quality exist, and that there is a supply of both fuel and limestone for smelting purposes, there is a notable hesitancy on the part of capital to launch such an undertaking. This condition is perhaps due to the fact that British Columbia does not at present possess a sufficient market to absorb the products of such an industry, and the success of the venture would perhaps rest with the ability of the operators to market their product in the neighbouring states of Washington, Oregon, and California.

Copper.—The total production of copper in 1917 is estimated to be 56,500 short tons, contained in ores, blister copper, or matte.

The installation of the copper-nickel refineries now under construction in Ontario for the International Nickel Company at Port Colborne and the British America Nickel Corporation at Sudbury, is not yet completed, but it is expected that some production of these refined metals will be forthcoming during the next year.

Nickel.—The production of Canadian nickel, all in the form of matte, from the smelteries of the International Nickel Company at Copper Cliff, Ont., and the Mond Nickel Company at Coniston, Ont., will amount to approximately 42,400 short tons. This production is estimated to be well over 80 per cent of the world's supply. At the present time all of this matte is exported to the United States and Great Britain for refining purposes, but with the completion of the refineries now being installed by the International Nickel Company and the British America Nickel Corporation, Canada will, in 1918, commence the production of refined nickel within the Dominion.

Lead.—The lead production for 1917, estimated at 17,000 tons, will be greater than that of 1916, but complete returns are not available.

Lead bullion was produced chiefly by the Consolidated Mining and Smelting Company at Trail, B.C., with small contributions from smelters at Kingston and Galetta, Ont.

Zinc.—The zinc production for 1917, estimated as recoverable metal from ores refined in Canada and exported, was 15,500 short tons.

The establishment of an electrolytic zinc refinery at Trail, B.C. has been a step forward in placing the metallurgy of this metal in Canada on a similar basis to that of lead and copper. The production of refined zinc at Trail for the year is estimated at 10,250 short tons.

Molybdenum.—The production of molybdenite for 1917 is estimated to have been 145 short tons, valued at $290,122, of which 40·37 tons, or 27·83 per cent, was exported to France and the United States, the balance being converted to ferro-molybdenum in this country. The amount of ferro-molybdenum produced during the year is placed at 74·56 short tons, containing 68·13 per cent of metallic molybdenum valued at $336,700.

Tungsten.—Canada has so far been a negligible factor in the production of tungsten ores. A small shipment was recorded in 1913 from the Moose River district in Nova Scotia, but since that year no production of any size has been made.

A deposit of tungsten ore has undergone development since 1916 at Burnt Hill brook, in central New Brunswick, and some production of concentrate was made during 1917 from this property. The Moose River deposits in Nova Scotia were not operated, but some small production is expected from the Yukon Territory, where tungsten minerals have been found in the sluice boxes of the placer gold miners.

Chromium.—Canada is one of the important producing countries of chrome ore, which is so urgently required at the present time for the manufacture of special steels entering munitions.

The production of Canadian mines for 1917 was 23,327 tons, valued at $572,115, practically the whole of which was exported to the United States in the form of crude ore and concentrates. It is highly important that the output of the Quebec mines be increased considerably during the present year.

Manganese.—There is a very small production of manganese ores in this country, although there remains a possibility that certain low grade deposits in the Maritime Provinces may eventually, by concentration methods, become of some importance.

Recommendations

It may be stated that the development of the country's mineral resources rests almost entirely with that portion of the public interested in mining, and while a relatively small percentage of the Canadian mining public are in a position to acquire the technical knowledge and capital required for mineral exploitation, by far the larger part are without capital, and quite unable to secure technical advice. It follows naturally that the mining public of the United States, being much larger in point of numbers and therefore possessing a preponderance of both capital and technical ability, is in a better position to exploit Canadian mineral resources than are the Canadians themselves, with the result that United States capital and technical direction dominate in the mineral production of Canada.

With the view, therefore, of rendering assistance to the mining industry of Canada, more particularly that portion of the industry concerned with munition supply, the Commission would recommend that means be taken to educate the general mining public in all matters directly concerning the mining of minerals and their preparation for the market. To carry out this educational programme to best advantage the Commission advises the establishment of additional technical laboratories, modeled after the existing testing laboratories of the Department of Mines.

The Department of Mines testing laboratories at Ottawa were installed with a view to educating the public in matters connected with the development of the mineral resources of the country. These laboratories are thoroughly equipped to examine, test, and report upon the value of metallic ores, coals, oils, non-metallic minerals, and structural materials. The value of these laboratories to the public is beyond question, and the fact that during the past five years the staff and equipment has had to be increased over one hundred per cent in order to keep up with requirements indicates that the service is appreciated.

The laboratories have also been of great value to the Imperial Munitions Board in the securing of supplies of molybdenite for export to the Allied Governments, and have rendered continuous service in the physical and chemical examination of materials entering munitions.

The Commission is of the opinion that although the present laboratories of the Department of Mines in Ottawa have rendered valuable service to the country, their field of utility would be

very largely increased through the establishment of branch laboratories in Nova Scotia and British Columbia. That the installation of such branch laboratories would materially assist in mineral production, cannot be questioned. The small mine owners and prospectors in the above provinces would be enabled to take full advantage of the facilities offered, which they are now unable to do owing to the excessive cost of forwarding large bulk samples to Ottawa for testing purposes.

It is recommended that in addition to the present installation of the Department of Mines in Ottawa, two additional research and testing laboratories be installed—one in Nova Scotia, and one in British Columbia, and furthermore, that the capacity of the present parent laboratory in Ottawa be doubled.

It is proposed that these laboratories should be an extension and under the control of the Departmental laboratories in Ottawa, and should be officered by the staff of the Department of Mines. Each laboratory should be fully equipped to deal with all the more important problems in connection with the utilization of mineral resources, and in order that the public should gain the fullest possible advantage from the installation of these laboratories, they should be operated somewhat on the following lines:

In all cases the work of the laboratories should be free to the public under the following conditions:—

(a) Samples should be delivered, carriage paid, to the laboratories, and should consist of, except in special cases, at least one ton (2,000 lbs.) of the material requiring examination.

(b) All products resulting from the examination of materials submitted should become the property of the laboratories, unless otherwise arranged.

(c) All reports of such tests, examinations, assays, etc., should be incorporated and published in the annual report of the Department of Mines.

In making these recommendations the Commission would respectfully draw the attention of the Government to the fact that the proposals do not call for any new organization, but rather for an enlargement of the present equipment, staff, and scope of the Department of Mines; and in view of the great importance of the mineral industry, being second only to that of agriculture, and because of its close relation to munitions supply, the Commission would solicit the earnest consideration of the Government for the proposals contained herein.

Inventory of Canadian Mineral Resources

The Secretary of the Canadian Mining Institute wrote the Commission in October, 1917, stating that the American Institute of Mining Engineers had invited the Institute to prepare an inventory of Canadian minerals required for war purposes in collaboration with the War Minerals Committee of the United States, and proposed that the Commission undertake the work. The proposal was accepted by the Commission, and, after consultation with various members of the Department of Mines, circulars asking for their assistance were printed and distributed to all members of the Canadian Mining Institute. It was fully recognized by the Commission that possibly over ninety per cent of the desired information could be secured from the published reports of the Department of Mines and the various Provincial Bureaus, but it was decided that if by issuing these circulars information leading to the operation of even one or two mineral despoits was secured, the trouble and expense would be fully justified.

It is intended to card index as completely as possible the mineral resources of the Dominion, more particularly those required for munition purposes. At

the conclusion of his field work, Dr. Ferrier undertook this work, which is being carried on with the assistance of the staff of the Department of Mines. The index will eventually be handed over to the Department of Mines, and if the department is able to amplify the work, as it should, to include the whole mineral resources of the Dominion, the file will become of inestimable value as the central source of information which is now scattered throughout the numerous reports and departmental records.

Incidentally, the making of this mineral file will facilitate the object of the proposed Imperial Mineral Resources Bureau in London, Eng., and the preparation of a duplicate file for the London bureau should be kept in view.

Advisory Services of the Commission

The services of the Commission have always been freely placed at the disposal of the Imperial Munitions Board for the securing of raw materials entering munitions. That this service has been appreciated is evident from the fact that since its organization the Commission, through its Secretary, has continuously supplied advice and information which would otherwise have been difficult to quickly obtain.

The Commission has in addition lent assistance to all who applied for advice or assistance in the production of munitions. One instance may be cited—the Electro Metals Limited, of Welland, Ont., is the only firm producing ferro-silicon on a large scale, also carbon electrodes for electric furnaces, within the British Empire. That ferro-silicon is an absolute requirement in the steel industry is well known and needs no comment. This company has been and is at present seriously embarrassed through lack of electric power to operate its plant to full capacity, and it is in some measure due to the efforts put forth by the Commission that the Electro Metals, Limited, is enabled to continue manufacturing without shut-downs or serious loss of time.

Meetings of the Commission

Regular meetings of the Commission are held at Ottawa from time to time for transacting business and dealing with certain important matters affecting the war. Complete records are kept of all proceedings, meetings, and business transacted, so that a comprehensive report of the work of the Commission may be rendered at the termination of the war, if required.

APPENDIX A

Steel Scrap Investigation

BY

J. DIX FRASER

PORT ARTHUR, ONTARIO,
January 10, 1917.

George C. Mackenzie, Esq.,
Secretary,
Canadian Munition Resources Commission,
Ottawa, Canada.

DEAR SIR:

In accordance with your letter of September 30 asking me to investigate the steel scrap situation in Canada in relation to embargo in force and verbal agreement arrived at with you in Ottawa, October 13, 1916, I herewith submit outline of trip and information received to date.

Outline of Trip.—It was agreed I should visit all munition plants in Canada and discuss steel scrap conditions with the owners or managers and obtain as much information as possible along other lines, but having a bearing on the scrap in connection with the manufacturing of shells.

Starting at Toronto, November 2, I called on twenty-two out of the twenty-six plants making shells in that city, and basing my opinion on information received, decided it would be a waste of time and expense to visit all the plants in Canada, as reliable information could be obtained by visiting representative munition plants at the important centres throughout the country. Acting on this opinion, I wrote asking if you agreed with me to send out a circular covering twelve questions and any additional questions you might suggest, to all shell makers. You agreed with my suggestion and sent out the following circular containing fourteen questions:—

(1) Give size and average output of shells per month.
(2) Total tons scrap turnings made per month.
(3) Total tons shell ends and heavy scrap per month.
(4) Selling price scrap turnings f.o.b. cars works.
(5) Selling price shell ends f.o.b. cars works.
(6) Freight rates to nearest Canadian steel works.
(7) Freight rates to nearest American steel works.

(8) Total tons scrap turnings on hand.

(9) Total tons shell ends on hand.

(10) Can you sell all the scrap turnings you make in Canada at fair market price with embargo in force?

(11) Can you sell all the shell ends you make in Canada at fair market price with embargo in force?

(12) Do you dispose of your scrap to Canadian steel works or to Canadian scrap dealers?

(13) If Canadian steel works have declined to take your scrap borings and turnings, what reason do they advance for such refusal?

(14) What is your opinion *re* embargo on steel scrap?

The above questions cover the line of discussion I had with shell people and answers received through the mail.

After finishing my work in Toronto, I visited the principal cities and towns between Hamilton, St. Catharines, Windsor, and Guelph, this territory covering one of the most important parts of Ontario. I also visited points east of Winnipeg to Montreal, and Montreal east through Nova Scotia, making in all twenty-seven cities and towns and sixty-seven plants visited. The information obtained during this trip together with data received direct from munition plants represents in my opinion as reliable information as it is possible to get in connection with the scrap business.

Answers received to Questions asked.—Up to January 4 the following information has been received:—

SHELL ENDS AND HEAVY SCRAP

	Circulars sent	Replies received	Tons made monthly	Average price at works	Tons on hand
Nova Scotia	10	6	3,387	$11.67	560
New Brunswick	8	4	78	11.62	35
Quebec	40	24	1,742	12.58	268
Ontario	113	88	3,135	14.15	1,007
Manitoba	8	4	24	12.50	24
Saskatchewan	1	1	5	.....	25
Alberta	10	3	26	6.27	31
Newfoundland	1	1	8	5.00	..

BORINGS AND TURNINGS

	Circulars sent	Replies received	Tons made monthly	Average price at works	Tons on hand
Nova Scotia	10	6	923	$4.42	1,300
New Brunswick	8	4	270	4.62	50
Quebec	40	24	8,564	4.62	2,174
Ontario	113	88	9,655	5.45	2,825·5
Manitoba	8	4	057·5	4.44	55
Saskatchewan	1	1	50	....	800
Alberta	10	3	97·5	3.18	185
Newfoundland	1	1	40	2.00	...

Summary of Answers.—Out of 191 circulars sent out, 131 replies received gave the following:—

131 Munition Plants	Per month	Rate per year
Total capacity shells (all kinds)	2,000,000	24,000,000
Total tons shell ends and heavy scrap	8,404	100,860
Total tons shell ends in stock	1,950	
Average price per ton f.o.b. works	$10.54	
Total tons steel turnings made	20,357	244,284
Total tons steel turnings in stock	7,390	
Average price per ton f.o.b. works	$4.10	

If we assume the 60 munition plants not answering questions average the same output as 131 received, then we would have:—

191 Munition Plants	Per month	Rate per year
Total capacity shells (all kinds)	2,900,000	34,800,000
Total tons shell ends and heavy scrap	12,200	146,400
Total tons shell ends in stock		
Total tons steel turnings made	29,500	354,000
Total tons steel turnings in stock		

Scrap Storage.—The total scrap carried in stock at munition plants is comparatively small, due largely to the fact that there is very little storage capacity. Arrangements exist with local dealers to remove scrap daily, or several times a

week as the case demands. This prevents congestion at the shell plants, but scrap dealers may carry a large stock not covered by this report.

Questions 10, 11, and 14.—Eighty per cent of the replies answered "No" to question 10.—"Can you sell all the scrap turnings you make in Canada at fair market price with embargo in force?"

Seventy per cent of replies received answered "Yes" to question 11.—"Can you sell all the shell ends you make in Canada at fair market price with embargo in force?"

There has been no serious complaint about shell ends and the general opinion is this scrap can all be sold at a fair price with embargo in force.

The opinion expressed by a very large majority of shell makers is against the embargo on shell turnings unless it is a distinct advantage to the steel makers in the production of shell steel, and then always provided the steel manufacturer pays a fair market price. For all turnings produced over and above Canada's requirements no embargo should be placed on turnings going into the United States.

Opinions re Embargo by Prominent Men.—While this report will not permit of detailed opinions on this important question, a few may be given by representative men and companies.

MR. F. P. JONES, General Manager, Canada Cement Co., Montreal:—"In my opinion no embargo should be placed on steel turnings, but there should be one on shell ends and all other classes of scrap."

MR. F. C. BROOKS, Vice-President, Canadian Fairbanks-Morse Co., Toronto:—"My opinion is we are forced to sell scrap at 30 per cent to 50 per cent under its value. We buy our material in the United States and have an arrangement whereby we are to sell the scrap back to them. We, however, cannot do this in face of an embargo and thereby lose on every ton sold here."

MR. GOLDIE, Goldie & McCullough, Galt, Ont.:—"Think embargo should be taken off steel turnings."

KERR & GOODWIN, Brantford, Ont.:—"We believe embargo should be lifted just as long as our manufacturers have more than they want."

TAYLOR FORBES CO., Guelph, Ont.:—"Embargo should be lifted as quickly as possible."

CANADIAN WESTINGHOUSE CO., Hamilton, Ont.:—"A good thing to keep scrap in country, but if embargo lifted could get better price."

CANADIAN GENERAL ELECTRIC CO., Toronto, Ont.:—"Our opinion is that conditions did not warrant embargo."

EASTERN STEEL CO., New Glasgow, N.S.:—"Embargo should be removed until steel makers pay fair price."

PHOENIX FOUNDRY & LOCOMOTIVE WORKS, St. John, N.B.:—"Embargo should be raised or steel companies should pay more for scrap or reduce the price of their product."

VULCAN IRON WORKS, Winnipeg, Man.:—"It seems there is more than enough scrap in Canada to meet requirements of eastern mills and we do not think as long as there is plenty of scrap to meet requirements an embargo should be placed on same."

DOMINION BRIDGE CO., Montreal, Que.:—"Should be lifted as regards turnings or anything else which cannot be disposed of in Canada."

MR. J. FRATER TAYLOR, President, Algoma Steel Corporation, Sault Ste. Marie, Ont.:—"Think embargo should be placed on all scrap during the war."

DOMINION STEEL FOUNDRY CO., Hamilton, Ont.:—"Embargo should be left on as it keeps the price down."
ELECTRIC STEEL AND METALS CO., Welland, Ont.:—"Should be left on to keep price down."

Steel turnings used and melting capacity.—In order to make a definite comparison of turnings produced and used in proximity to blast furnaces, steel works and foundries, we will divide Canada into four districts as follows:—

Maritime Provinces.—The total amount of steel turnings produced east of Campbellton, N.B., is approximately 1,800 tons per month or 21,600 tons per year. The present consumption of turnings in this district is 1,800 tons per month or 21,600 per year, while the total melting capacity based on 15 per cent turnings per ton pig iron and 30 per cent turnings per ton steel ingots—the percentage used at Hamilton—would be approximately 187,500 tons per year.

Quebec, Montreal, Ottawa.—Approximately 15,500 tons steel turnings are produced in this district per month or 186,000 tons per year. The present consumption is estimated at 3,000 tons per month or 36,000 tons per year, while the melting capacity is approximately 36,000 tons per year.

Toronto, Hamilton, Windsor.—Total turnings produced, 11,000 tons per month or 132,000 tons per year. Present consumption steel turnings—9,200 tons per month or 110,400 tons per year. Melting capacity for all blast furnaces, steel works, and foundries, based on Hamilton practice but using only 8 per cent scrap in Port Colborne furnace—9,300 tons per month or 111,600 tons per year.

Western Canada from Sudbury—Total steel scrap turnings produced in this district—1,200 tons per month or 14,400 tons per year. Present consumption 400 tons per month, or 4,800 tons per year. Total melting capacity, based on Hamilton practice, approximately 97,000 tons per year.

Summary of the Four Districts.—

Total maximum blast furnace, steel works and steel foundry melting capacity for steel turnings per year	432,000 tons
Net available melting capacity steel turnings within railway haul of munition plants per year	179,000 tons
Maximum amount steel turnings produced in Canada per year	354,000 tons
Surplus amount steel turnings produced over and above net melting capacity	175,000 tons

Attached to this report you will find five large sheets containing full details to the fourteen questions concerning scrap conditions in Canada, all of which is,

Respectfully submitted,

(*Sgd.*) J. DIX FRASER.

APPENDIX B

Construction and Operation of an Electrolytic Copper Refinery

BY

J. E. McALLISTER

The investigation, which is the subject of this report, has had for its object the determination of the cost of constructing and operating an electrolytic copper refinery in the Niagara Peninsula of Ontario, having a capacity of 50,000 tons of refined copper per annum.

The estimates which follow are based upon the data given under the head of "Basis," and arrive at a conclusion that the expenditure for constructing a plant of this type would amount to $1,502,800, and the cost of operating the same would be $13·112 per ton (of 2,000 lbs.) of refined copper produced.

In selecting the location of an industry of this type, the governing considerations are electric energy, temperate climate, fuel and other supplies, and labor conditions. Adequate transportation facilities are a necessity, and a location on tidewater possesses the obvious advantage of facility in receiving supplies by water freights, and in shipping the refined product by the same means. The location of a refinery, however, at or near that of the producing mines, does not possess distinct advantage, for the reason that the raw material coming in for refining would undoubtedly be a bessemerized product carrying 99 per cent copper. This could therefore be shipped from point of smelting to destination of the refined copper product under the one freight charge, the product being merely stopped for "refining in transit."

In compiling the following report the services, in a consulting capacity, have been utilized of Mr. R. W. Deacon, Superintendent of the United States Metals Refining Company at Chrome, New Jersey.

Conditions.—The refinery is to be equipped to handle 50,000 tons per annum of bessemerized copper (commonly known as blister copper) containing gold and silver, the output consisting of refined copper in the shape of wire bars, cakes or ingots; gold in the form of fine gold bars; and silver as fine silver bars.

The precious metal values carried by the blister copper will have their bearing upon the cost of operation, as should the gold contents run high, the speed of deposition of the copper must, for economic reasons, be retarded. On this account it is assumed that the blister copper will assay not over 100 ozs. of silver or 5 ozs. of gold to the ton, these quantities being within the range of the precious metals contained in ordinary blister copper production. The ground is also taken that the impurities in the blister do not consist of one seriously damaging element, such as arsenic or nickel, but are distributed over the various usual elements. It should be noted that blister copper, outside of these conditions, would require special treatment.

Basis.—The present cost of materials and labor in the Niagara Peninsula has in the main been used as a basis of calculation, and the following are the chief items which have entered into the same:—

Labor. A base rate of 22½ cents per hour on a ten-hour day for unskilled labor, from which all other rates are scaled.

Power. High tension alternating current power delivered at low tension terminals of transformers at the rate of $15 per H.P. year.

Structural steel. 5·5 cents per pound fabricated and delivered f.o.b. plant.

Copper. Rated at a quotation of 20 cents per pound for electrolytic wire bars.

Antimony lead. 13·5 cents per pound delivered.

Building brick. $13 per M. delivered.

Silicious refractory brick. $30 per M. delivered.

Machinery. Prices prevailing at the present time (March, 1916).

Bituminous coal. $4 per ton delivered.

Coke. $4.25 per ton delivered.

Cement. $1.35 per barrel delivered.

Lumber. Prices prevailing at the present time. ($25 to $35 per M., March, 1916).

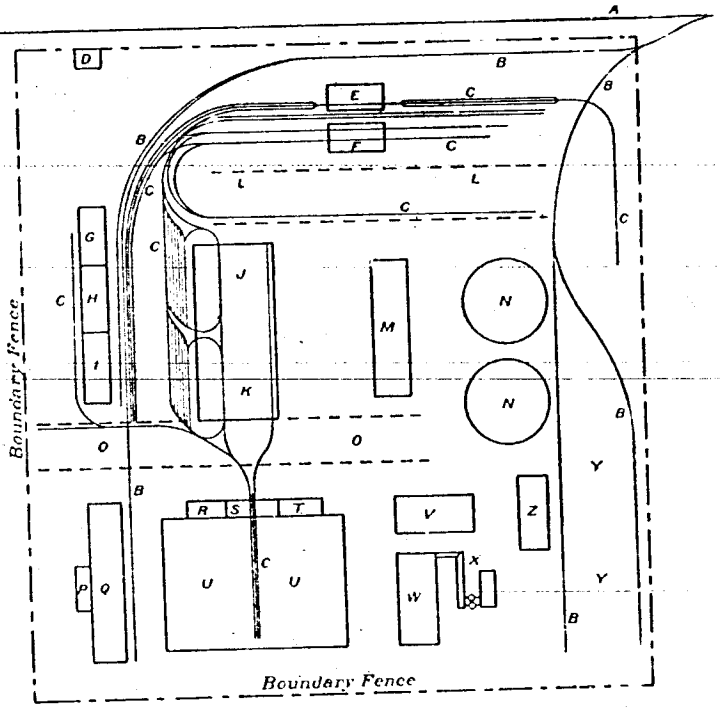
Plant Arrangement.—There is ample territory in the factory district of the Niagara Peninsula for the selection of a suitable site. A ground plan of a refinery of this capacity is given herewith (see Fig. 1), and under this arrangement the plant would occupy a space of approximately 22 acres.

Referring to this plan, it is to be noted that the incoming material is delivered into the plant by standard gauge railroad, the fuel to one side and the blister copper to the other. Subsequently the material is handled by an industrial railway system, operated by steam, and of either 24 or 30 inch gauge.

Following a shipment of blister copper through its various steps on this plan, it would be received over the railroad spur "B," weighed in the control weighing room "E," sampled in the sampling room "F," and then placed in the storage under the craneway "L," from which it is taken as required to the furnace building "K," and brought up to pitch in reverberatory furnaces, from which it is cast into anodes, the anodes being stored under the craneway "O." From this storage the anodes are delivered to the tank house "U," where the electrolytic copper is produced, leaving the tank house in the form of cathodes, and placed in storage under the craneway "O," from which point it is delivered to the reverberatory refining furnaces "J," where it is melted and cast into the form required by the consumer.

During the electrolytic action from anode to cathode, slimes are formed in the tanks consisting of the impurities contained in the blister copper, as well as its precious metals, these slimes being subsequently treated in the department "W," where the gold and silver are separated and turned out in the form of bars.

Fig. 1.—Ground Plan of Electrolytic Copper Refinery



LEGEND

A. Railroad, Main Line
B. Standard Gauge R.R. Tracks in plant
C. Industrial Railway—principal tracks
D. Time Clock, Office and Plant Entrance
E. Control Weighing Room
F. Sampling Room
G. Office
H. Laboratory
I. Warehouse
J. Furnace Building, Refined Copper End
K. " " Anode End
L. Storage Craneway for Refined and Blister Copper
M. Machine and Repair Shop
N. Bosh water Reservoirs
O. Storage Craneway for Anodes and Cathodes
P. Transformer House
Q. Power House
R. Circulating System Pump Room
S. Anode and Cathode Weighing Scales
T. Tank House, Heating Plant
U. Tank House
V. Regeneration Plant
W. Slimes Refinery
X. Slimes Refinery Flue System
Y. Coal and Coke Storage
Z. Cupola Furnace Bldg. for slag reclamation, etc

A small cupola furnace is added in which the slags from the reverberatory furnaces are treated, and their values recovered.

Plant Details.—In considering the equipment of the plant, its capacity permits of the installation of modern labor saving devices in each department. In this connection the cost of installation is governed by the balance which obtains between decreased operating cost and the amortization of construction expenditure incurred to acquire such decrease. Special apparatus should be installed for transferring blister copper from railroad to industrial cars, and refined copper from industrial to railroad cars.

In the scale house "E", tandem scales would be installed for control weighing of the blister, the one scale checking the other. The accuracy of these scales is of first importance and would be aided by their capacity being considerably in excess of the ordinary load. In this case the copper would probably be weighed in quantities of 5 tons, and the capacity of the scales should therefore not be less than 12 tons, or double the weight of the industrial railway car with its load.

After weighing, the blister copper proceeds to the sampling room, where it is sampled by drilling a half inch hole through each cake, for which purpose an ordinary drill press is used. After sampling, the blister copper is stored in the yard "L", from whence it proceeds to the anode furnace.

It is obviously necessary to maintain a sufficient quantity of sampled raw material in storage to permit of the continuous operation of the anode furnaces.

The furnace building "J K" should be of steel construction containing at one end two anode furnaces for melting the blister, and at the other, two refined-copper furnaces for melting and converting the cathode copper into merchantable form. Each anode unit would consist of a reverberatory furnace lined with silicious refractory brick, and having a capacity of 100 tons of copper per 24 hours. A sketch plan showing the approximate inside hearth dimensions is given herewith (see Fig. 2). It would be fired by slack coal and be fitted with a waste-heat boiler to conserve the heat for maintaining the necessary temperature required by operations in other buildings, this boiler being also equipped for auxiliary firing for use when the furnace is not in operation, thus saving a separate boiler installation.

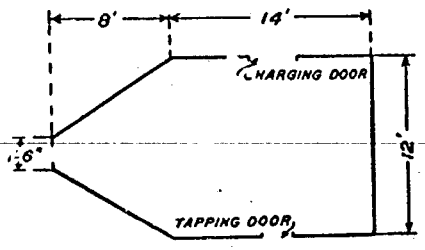


Fig. 2.

The raw material would be charged into the furnace on one side from the industrial railway by means of a charging crane, and the molten copper automatically tapped from the other into anode moulds, the furnace being served at this side by a Walker casting wheel and a 10 ton travelling crane.

The depth of the bath of molten metal for a furnace of this type would be from 21 to 24 inches, and a cycle of its operation throughout the 24-hour period would consist of:—

Charging	1½	hours.
Melting down	9	"
Refining and poling	7	"
Casting	6½	"
Total	24	hours.

A sufficient storage of coal fuel should be carried to cover two months operations of both the anode and refined copper furnaces.

It is necessary to maintain an excess of anodes in storage in order to feed the tank house, and for this purpose a storage yard is provided between the furnace house and the tank house.

In this same storage is also held the cathode copper as delivered from the tank house for melting in the refined copper furnaces, of which there are two, each being a duplicate of the reverberatory anode furnace with the same capacity, and equipped in the same manner with waste heat boilers, charging crane, and Walker casting wheel.

The tank house building should be a steel structure with either brick filled or concrete walls, and a fireproof heat insulating roof, and should be laid out in two bays housing 512 tanks, arranged into 16 sections of 32 tanks each, or 8 sections to each bay with a separate electrolytic circuit.

The circulation and heating systems are housed in annexes, and each bay should be provided with two 10-ton travelling cranes. The anodes would be lifted from the storage "O" by "finger" crane hooks in batches of about 30, placed in rack cars, transported by the industrial railroad to the tank house, and unloaded by travelling crane, which would also deposit each anode to its allotted space in the tanks.

Scales for interdepartment accounting are provided to weigh the incoming anodes and outgoing cathodes from the tank house.

The power house would be of steel frame with brick fill or concrete wall, and equipped with a hand power travelling crane to facilitate the handling of parts for repairs. In it would be installed five electrolytic units, each consisting of a motor generator set designed to give a constant current of 5,000 amperes at a varying voltage of from 60 to 115, four of these being arranged to work in groups of two in parallel, directly to the two separate circuits in the tank house. The fifth would be connected to act as a spare for any of the others.

All the plant in the power house would be motor driven, and in addition to the above units, it would contain bosh pumps, general service pumps, hydraulic pumps, fire pumps, motor generator set to supply D.C. to cranes, high pressure air compressors for the operating of handling devices, etc.

The slimes carrying the precious metals are transferred from the tank house to the slimes refinery, the latter being equipped with steel tanks, boiling tanks,

filter press, roaster, reverberatory furnace for production of doré bar, silver melting furnace, and gold crucible furnace. These three furnaces would be connected to an outside collecting flue system. It would also contain a motor generator set operating on 36 cells for the electrolytic parting of silver from gold, gold refining pots, bullion balance, and safety deposit vault for the storage of doré, fine silver and gold.

In addition there should be the emergency department, consisting of repair shops, machine, blacksmith, carpenter shops, etc., also a warehouse for supplies, plant office, laboratory equipped for the accurate control assays and determination of the various products of the different stages of operation. The equipment should also include a locomotive crane for the handling of fuel from the storage and other miscellaneous requirements.—

The plant should also be properly fenced, the operatives being passed by an attendant, both in coming in and going out. In this connection it is necessary to provide the slimes refinery with suitable accommodation so that operatives may change their clothing before entering and after leaving.

Construction Costs.—These are segregated by departments, and also further into the various units that go to make up the same, and would be as follows:—

Furnace building	$ 67,500	
Two anode units	95,500	
Two refined copper units	92,200	
Four cranes, two service, two charging	40,600	
Auxiliary equipment	84,800	
Total Furnace Department		$380,600
Tank house building	127,000	
Sixteen 32-tank sections and circulation system and equipment	258,000	
Electrolytic circuit conductors, etc.	96,000	
Four service cranes	25,000	
Auxiliary apparatus	51,000	
Total Tank House Department		$557,000
Power house building and crane	$ 42,000	
Five electrolytic motor generator sets and equipment	116,000	
Motor driven pumps, etc.	32,200	
Auxiliary apparatus	30,200	
Total Power House Department		$220,400
Carried forward		$1,158,000

Brought forward		$1,158,000
Slimes refinery building	38,000	
Settling and boiling tanks, filter press and roaster	16,500	
Furnace and flue system	22,100	
Electrolytic parting cells and equipment	18,800	
Gold refining equipment	2,600	
Auxiliary apparatus	11,700	
Total Slimes Refining Department		$109,700
Shops building and equipment	31,000	
Office and laboratory and warehouse equipment	44,000	
Sampling apparatus	7,500	
Control weighing scales and housing	7,400	
Storage cranes, craneways and locomotive crane	36,700	
Receiving and shipping apparatus	3,600	
Industrial locomotives and cars	47,800	
Industrial tracks and railroad sidings	24,500	
Miscellaneous auxiliary apparatus	7,600	
Bluestone and acid necessary to make up electrolyte	25,000	
Total Miscellaneous		$235,100
Total		$1,502,800

Details of Operation.—The raw material handled by the plant will be almost entirely in the form of blister copper, consisting of cakes about 30 inches long by 20 inches wide and 3 inches thick. Its quantity and value is determined by the scale house, sampling room, and laboratory. It is first weighed and then sampled by drilling a half inch hole entirely through each slab. An ordinary drill press will be used for this purpose, and the slabs drilled alternately from top and bottom by the so-called checker-board method. The location of the hole drilled in each slab will be governed by a template covering the entire surface of the slab, and having a half inch hole in the center of each square inch. The holes in the template are numbered and used in consecutive rotation and templates are provided for both top and bottom surfaces of the slabs. The drillings from each shipping lot are put through a grinding machine, the quantity reduced by means of a splitting machine to about 5 lbs. in weight, which constitutes the sample. This should be ground and re-ground until all passes through a 16 mesh sieve. If the blister copper contains appreciable quantities of precious metals, the sample should subsequently be sifted through a 40 mesh sieve, and the coarse and fines kept separate in order to insure accuracy of the determination, as the precious metals have a tendency to stay with the larger particles.

Metal Losses.—In the manipulation of the various steps of refining the copper there will be unavoidable mechanical losses, which, however, will to some extent

not be in evidence, as there are corresponding mechanical losses in determining the values by assay. This is particularly the case where the blister copper contains minute quantities of gold, in which event the unavoidable loss in assaying will sometimes be greater than the proportionate loss in refining, and the gold recovery by the refinery will be more than 100 per cent of the amount as determined by assay.

In general, however, it is safe to figure that a plant of this type will operate with a recovery of:—

	per cent
Copper	99·6
Silver	100·0
Gold	100·0

Two methods of accounting for the incoming copper by the refinery are generally employed. The refinery will either pay for the blister copper with its contained precious metals, deducting sufficient to cover its metal losses and making a charge for refining, or else it will undertake to return to the shipper refined metals corresponding to those contained in the blister copper after deducting its refining charge. In the latter case the refining charge must include the metal losses of the refinery as well as the operating cost and profit.

Tank House.—This department must be kept at a uniform temperature of about 80° F., causing a tendency in cold weather to "sweating" on roof and walls, on account of the large amount of moisture evaporated from the electrolytic tanks. For this reason the heating should be preferably by the circulation of dry hot air to absorb the evaporated moisture. The tank solutions must be maintained at a temperature of approximately 150° F., the copper electrolyte consisting of about 4 per cent copper in the form of sulphate, together with about 12 per cent of free acid.

During the deposition of the copper the electrolyte becomes in course of time polluted by the impurities contained in the anode copper, on account of which periodically a certain amount of the electrolyte is drawn off and treated in the regenerating plant, the purified solution being returned to the copper electrolytic tanks.

The rate of deposition of copper on the cathode will be governed by the current density, which should not amount to more than 20 amperes per square foot of anode surface for copper carrying up to 100 ounces of gold and silver to the ton. Should the amount of precious metals be appreciably less, the current density may be increased up to say 30 amperes, thereby increasing the speed of deposition and shortening the time of operation, but should the deposition take place too quickly there is danger of occluding precious metals with the cathode copper.

A cycle of operations in the tanks at the 20 ampere current density would occupy from 3 to 4 weeks time.

One section of the tank house is devoted to the preparation of cathode starting sheets, for which purpose a copper plate coated on each side with oil or graphite

is used as a cathode blank, and a thin layer of copper deposited thereon by electrolysis. This is stripped off from each side and forms the cathode starting sheet.

In the routine operation the electrolytic tanks are first charged with anodes, and then hung with cathode starting sheets and the current started. It is kept on for a prescribed number of days, varying from 10 to 12; then the cathodes which have been formed on the starting sheets are removed, the solution lowered in the tanks, the anodes taken out temporarily, and the slimes removed and sent to the slimes refinery. The anodes are then replaced, fresh cathode starting sheets hung, and the current turned on for another period of 10 to 12 days, then the "pulling" is repeated, except that upon this occasion what is left of the anodes is removed and goes back as scrap to be re-melted in the anode furnaces. It will be seen, therefore, that for each anode going to the tanks, two cathodes of lighter weight are formed.

The theoretical deposition of the copper would be approximately ·062 lbs. of copper per ampere day and a current efficiency of at least 90 per cent should be acquired. The necessary pressure would be about 0·4 volts per tank, and upon this basis the rate of deposit should amount to about 6 lbs. of cathode copper per kilowatt hour.

Refined Copper.—The cathodes are weighed upon leaving the department, and stored, from which point they are fed to the refined copper furnace for melting into the shape required by the consumer, e.g., ingots, wire bars, cakes, etc.

Slimes Refinery.—The precious metal slimes reclaimed from the electrolytic tanks would amount to about 30 tons per month, containing about 440,000 ozs. of gold and silver. The slimes are first freed of the electrolyte by settling until they contain about 50 per cent moisture. They are then boiled with sulphuric acid to remove soluble copper, after which they are put through a filter press and roasted. This roasted product is combined with a portion of unroasted slimes to make up a furnace charge. The result will be the melting of about 20 tons per month of slimes containing from 15 to 25 per cent moisture, the melt taking place in a small reverberatory furnace, the product of which is doré bars.

These form the anodes for an electrolytic deposition, which takes place in an electrolyte slightly acidified with nitric acid, the silver being deposited on cathode blanks in crystalline form, and the gold settling as a black mud containing about equal quantities of gold and silver. The resulting silver crystals are scraped off the cathode blanks, washed and melted into fine silver bars.

The gold mud is purified by treatment with nitric acid to part the gold from the silver, the solution going back to the silver electrolytic tanks, and the gold sand melted with borax into fine gold bars.

Elapsed Time in Refining.—It has been pointed out that there should be a storage of blister copper maintained previous to the melting operation for the production of anodes, and also a storage of cathode copper between the tank

house and the final re-melting furnace. In addition to this, there is the time occupied by the operations in the furnace building and the tank building.

As a result of this, the time occupied by the plant under consideration between receiving the raw material and obtaining therefrom the metals in refined form would be from 50 to 60 days in the case of the copper, 65 to 75 days for the silver, and 70 to 80 days for the gold.

The value of the material, with its consequent interest loss during this elapsed time, must therefore be taken into consideration, either in the refining charge imposed by the plant, or in the form of a deferred date in paying for the incoming blister copper. The latter is the usual method, but the shipper is on the other hand entitled to draw upon the refinery, upon presentation of bill of lading, for from 90 to 95 per cent of the value of the shipment by paying the usual bank interest charge for the amount of the draft during the period agreed upon, which would correspond to approximately the elapsed time noted above.

It should also be noted that the settlement quotations, in the case of metals of fluctuating value like copper and silver, should be based on the market quotations at the time the refined metals are ready for sale, and not at the time the blister copper is shipped by the consignor. By this means the refinery protects itself from violent fluctuations in the price of copper.

Operating Costs.—In compiling the following costs of operation, it is assumed that metal losses, and also interest on payments advanced, will be taken care of in the charges made by the refinery. These items, therefore, need not be included. The costs have been figured in dollars per ton of refined copper on the basis of the unit of production of each department, and finally converted into a total cost for all operations, in each case segregating the amount for labor and material.

This would be the manner in which the actual operations of the plant would be recorded in order to keep track of the efficiency of the different departments.

A plant arranged as proposed, should safely acquire the following operating costs:—

	Labor	Material	Total per ton.
Anode making	$1·155	1·213	$2·368
Electrolytic refining	2·025	2·464	4·489
Refined copper casting	1·100	1·304	2·404
Slimes refining	·463	·461	·924
General expenses	·926	·464	1·390
Interest on investment (5%)		1·537	1·537
Total	$5·669	$7·443	$13·112 per ton of refined copper.

In order to indicate the expenditure of the refinery on various items, the above costs may be transposed to the following basis:—

Labor	$5·669
Material	1·332
Fuel	1·895
Power	1·301
Overhead	1·378
Interest on investment	1·537
Total	$13·112 per ton of refined copper.

Supplies.—The approximate monthly quantity of supplies used by the plant would be as follows:—

Electric power	1,465,000 K.W.H.
Soft coal	1,750 tons
Coke	140 tons
Fuel oil	10,000 gallons
Sulphuric acid	50 tons
Silicious brick	39,000 (9 inch equivalent)

Employees.—Exclusive of executives, clerks, and foremen, the operations of the plant would require about 350 men, divided in approximately the following proportions:—

Unskilled	110
Semi-skilled	155
Skilled (mechanics, power house men, etc.)	85
Total	350

(*Signed*) J. E. McALLISTER,
Consulting Engineer.

TORONTO, ONTARIO,
April 4th, 1916.

APPENDIX C

Summary of Field Work in British Columbia, Alberta, and Saskatchewan,

BY

W. F. FERRIER.

OTTAWA, January 7, 1918.

Geo. C. Mackenzie, Esq.,
Secretary,
Munition Resources Commission,
Ottawa.

DEAR SIR:

In accordance with your request I submit the following brief statement of my work in British Columbia, Alberta, and Saskatchewan, during 1917.

The field work commenced on September 6 nd ended on December 10. I had called your attention to the possibility of the occurrence of bauxite in Canada, and was instructed to devote my time chiefly to a search for this mineral. After careful consideration of various likely areas, the district covered by the Kamloops and Shuswap maps of the Geological Survey, in British Columbia, was selected as the most accessible at that late period of the year and as having most favourable geological conditions for the occurrence of bauxite.

This hydrous oxide of aluminum is the chief ore of the metal aluminum, for which the war has created an urgent demand. Another important war use of the mineral is in the manufacture of artificial abrasives for the finishing of guns, cartridge cases, and motor parts.

Bauxite occurs under a great variety of conditions. It frequently results from the decomposition of basalts in place, and this mode of occurrence would be the most probable one in that portion of the Interior Plateau region of British Columbia chosen for investigation, where these rocks are widely distributed.

As the available time for field work in the district was short, I decided that there was a better chance to find bauxite that season by doing reconnaissance work over as wide an area as possible than by making a more detailed examination of any one portion of it. It was too late in the year to undertake extended work at the higher altitudes.

Over 600 miles of roads and trails were traversed by automobile and on foot, the area examined comprising about 1000 square miles.

This is but a small fraction of the total areas in British Columbia alone which are worthy of investigation, and, although only negative results have thus far been obtained, the extreme decomposition of the basalts observed at many localities,

frequently resulting in the formation of clay, encourages me in the belief that bauxite may yet be found. The search should be continued, particularly around the old volcanic centres on the higher elevations.

I attended the meetings of the Western Branch of the Canadian Mining Institute at Merritt and Princeton, B.C. (at which the Hon. Mr. Burrell, Minister of Mines, was present) and drew attention to the possibility of the occurrence of bauxite in British Columbia, describing the different varieties of the mineral, their modes of occurrence, and uses. Specimens were exhibited, and distributed amongst engineers, miners, and prospectors. Much interest was shown, and whilst in the district and since my return to Ottawa a number of samples which it was thought might contain bauxite were received for determination. Sets of specimens representing various forms of bauxite were also distributed at Victoria, Lytton, Kamloops, Grand Forks, Nelson, and elsewhere.

Later in the season (December), in accordance with your instructions, I investigated reported occurrences of bauxite in southern Alberta and Saskatchewan. At one locality the material proved to be a shell-marl. The other locality could not be reached on account of a heavy snowfall.

In addition to the search for bauxite, various other mineral occurrences were investigated.

An examination was made of the manganese deposits in southeastern Alberta and southwestern Saskatchewan, about 45 miles southwest of Maple Creek, Sask. The manganese has been deposited by springs which have formed beds of calcareous tufa, in which the manganese for the most part occurs. The deposits are low-grade and small, and I do not regard them as being of economic value.

New work on the Tulameen platinum deposits was investigated, but reports of the results obtained were found to be much exaggerated. This year's production was somewhat under 200 ounces of platinum.

The claims of the Contact Consolidated Gold Mines, Limited, near Paulson, B.C., were examined. Here platinum has been reported to occur in the quartz veins and associated dykes. The results of the examination will be handed to you later when the necessary assays have been made.

A mineral which I found to contain strontium was handed to me in the field and is now being analysed. It was too late in the season to visit the locality.

The discovery of a deposit of fluorite was reported to me just as I was leaving British Columbia. It occurs on the North fork of the Kettle river, and the sample received proves to be of fine quality. If in commercial quantity it would be valuable for use as a flux in the manufacture of iron and steel, and in copper, lead, and silver smelters. It is also used in electrolytic refining of antimony and lead.

Information and samples were obtained of a large deposit of very fine-grained diatomaceous earth, of a pure white colour, at Deadman lake in the Kamloops district. Several polishing powders now on the market are composed of similar material.

A sample of "nickel-ore" was given to me at Keefer, B.C., and proved to be chromite. It is said to occur in the country west of Kanaka on the Fraser river, but I have not as yet ascertained the precise locality.

I have already furnished you with information regarding several new localities for molybdenite in British Columbia, some of which seem to be worthy of development.

The report of a discovery of potassium salts in the Nicola valley, B.C., which I was instructed to investigate, proved to be without foundation.

Cold weather and snowstorms in November and December hampered me in carrying on the field work, and I was unable to reach several mineral localities, which I had planned to visit, on account of the deep snow on the ground.

Yours respectfully,

(*Sgd.*) W. F. FERRIER.