CANADA

DEPARTMENT OF MINES

MINES BRANCH

Hon W. Templeman, Minister; A. P. Low, LL.D., Deputy Minister;
Eugene Haanel, Ph.D., Director.

SUMMARY REPORT

OF THE

MINES BRANCH

FOR THE FISCAL YEAR

1907-8

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1908

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To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G.C.M.G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY:

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII., Chapter 29, section 18, the Summary Report of the work done by the Mines Branch during the fiscal year ending March 31, 1908.

W. TEMPLEMAN,
Minister of Mines.

Hon. WM. TEMPLEMAN,
Minister of Mines,
Ottawa.

SIR,—I have the honour to submit herewith, the Director's Summary Report of the work done by the Mines Branch during the fiscal year ending March 31, 1908.

I am, sir, your obedient servant,

J. F. WHITEAVES,
Acting Deputy Minister.

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SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES

FOR THE FISCAL YEAR 1907-8

J. F. WHITEAVES, Esq., LL.D., F.R.S.C., &c.,
Acting Deputy Minister,
Department of Mines.

SIR,—I have the honour to submit the Summary Report of the Mines Branch, of the Department of Mines, for the fiscal year ending March 31, 1908.

The Geology and Mines Act, section 18, provides that, 'the Directors of the branches shall, as soon as may be after the close of each calendar year, make summary reports of the proceedings and work of their respective branches for the year.' The reasons for submitting the report of the Mines Branch for the fiscal year are as follows: (1) a number of the officers engaged in the field did not return to the office until after the close of the calendar year; (2) the report of the Assay Office—which includes the disbursements made in the purchase of gold bullion, and maintenance of the office—can not be made out until all the facts relating to the conduct of the Assay Office for the fiscal year are in my possession.

TRANSFER OF THE MINES BRANCH OF THE DEPARTMENT OF THE INTERIOR TO THE DEPARTMENT OF MINES—AND PARTIAL ORGANIZATION THEREOF.

By an Order in Council dated May 15, 1907, the Mines Branch was transferred from the Department of the Interior to the Department of Mines; together with the following persons employed in connexion with the said Branch:—

Permanent Staff—

Haanel, Eugene—Superintendent of Mines
Nyström, Erik—Mining Engineer.

Temporary Staff—

Lindeman, Einar—Mining Engineer.
Haanel, B. F.—Mining Engineer.
Leverin, Harold A.—Chemist.
Purcell, A. F.—Messenger.
Orme, Miss J.—Stenographer and Typist.
Roger, Harold—Laboratory Assistant.

By an Order in Council dated May 28, 1907, I received my appointment as Director of the Mines Branch, to date from May 3, 1907.

By an Order in Council dated June 19, 1907, Mr. John McLeish, Mrs. W. Sparks, and Miss G. C. MacGregor—then employed in the statistical office of the Geological Survey Branch—were assigned to the Mines Branch.

On November 29, 1907, the chemistry section of the Department of Mines—as well as the following technical officers—were transferred by an Order in Council, from the Geological Survey, to the Mines Branch: Messrs. Theophile Denis, F. G. Wait, M. F. Connor, and W. W. Leach.

FIELD WORK.

IRON ORE DEPOSITS.

During the past year, iron ore deposits in certain districts have been investigated, and the results are given in the following Monograph, and Reports:—

In Preparation—

Monograph on Chrome Iron Ore Deposits of Eastern Townships—by Fritz Cirkel, M.E.

Report on the Iron Ore Deposits of Western Ontario—By F. Hillé, M.E.

In the Press—

Report on Iron Ore Deposits of Nova Scotia, (Part I.)—by Dr. J. E. Woodman.

Nearly Ready for the Press—

Report on the Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers—by Fritz Cirkel, M.E.

Investigations in British Columbia.

The high prices of pig iron, and other merchantable irons, in British Columbia, due to the long hauls necessary to convey these materials from the centres of production, rendered it desirable in the interest of the Province, to furnish such information regarding the iron ore deposits; coking-coal deposits, and fluxes on the Pacific coast —both as to extent and quality—as will encourage the investment of capital for the exploitation of these resources.

Hitherto, no serious investigations as to the probable tonnage, or average quality of the ore, in any of the local deposits, had been made; but judging from the reports of the provincial government, some of the properties on the coast of Vancouver Island, and other islands in the vicinity, seemed worthy of special attention.

Mr. Einar Lindeman—member of the staff of the Mines Branch—was therefore instructed to proceed to British Columbia, and make an investigation of such iron ore deposits on Vancouver Island as are favourably situated in regard to communication; and then to make a more detailed examination of two or more of the most promising, commercially. In the event of these deposits proving to be magnetite, and the terrane found to be suitable, Mr. Lindeman was instructed to make a magnetometric survey of the same. If this ,and further investigations, furnish evidence of the existence on the coast of extensive iron ore deposits, in comparatively close proximity to an assured supply of fluxes, and of coal suitable for the manufacture of metallurgical coke; all capable of economic transportation to industrial centres, then, invaluable information will have been furnished to prospective investors who are interested in the establishing of an Iron Industry in British Columbia.

Mr. Lindeman's report shows that, as regards the ore supply, the deposits on Texada island, at Head bay, Klaanch river, and Quinsam river on Vancouver Island, are of sufficient magnitude to furnish ore to a blast furnace for a number of years. The coal output of the collieries on Vancouver Island, for 1907, is estimated at 1,325,000 tons, with coke production of about 17,000 tons. The coke contains from 15 per cent to 16 per cent of ash; but by a more careful separation of the shale, the ash could be reduced to about 12 per cent. The limestone deposits are of great extent, and unusual purity, hence provide an inexhaustible supply of excellent fluxing material.

The deposits of iron ore, coal, and limestone, being adjacent to the coast, are favourably situated for transportation; and since navigation is open all the year round, shipment can be made direct to a furnace located anywhere on the coast line. As regards material, and transportation, therefore, the conditions for the establishment of an Iron Industry on the Pacific coast are favourable. The only drawback is that, labour charges are higher in British Columbia than in the other provinces of the Dominion. Hence, seeing that the market in British Columbia for manufactured iron will for years be a limited quantity, and the United States import duty of $4 per ton on pig iron will render exportation to that country doubtful, it may be necessary to find a market for the surplus product elsewhere.

Iron Mine on the Nipisiguit river, near Bathurst, N.B.

This iron ore deposit, situated fifteen miles from Bathurst, N.B., has been investigated by Mr. Einar Lindeman—who made a magnetic survey of it. The results of this investigation furnish a demonstration of the great utility of magnetometric surveys of magnetite deposits; inasmuch as it has been discovered thereby, that the commercial value of the property does not consist in the deposits he had been instructed to investigate; but more particularly in a large deposit on the other side of Austin brook; discovered during the progress of the magnetic survey of group No. 1, described in the Summary Report of the Superintendent of Mines, 1906-07. It is the discovery of the extent of this deposit that has given the real value to the property. Had the survey been limited to the deposits already known, it is not likely that these would have been considered of sufficient importance for exploitation. The proving of the property was effected by boring; the location of the bore-holes having been determined by Mr. Lindeman from indications of the magnetometric survey.

The property has now been sold to a wealthy and enterprising syndicate; and operations will be commenced at once.

Iron Ore Property near Kinnears Mills, Megantic County, Que.

Upon receiving an appeal from the new owner of the above-mentioned iron ore property, Mr. B. F. Haanel was instructed to inspect the boring operations then in progress, with a view of ascertaining if the work was being done in accordance with his official recommendation made in June, 1905. His report shows that, the methods being employed were altogether inadequate to form a rational opinion as to the value of the property.

Examination of Reported Occurrences of Iron Ore at Penetanguishene, Ont.

In compliance with instructions from the Honourable Minister of Mines—who had received a petition signed by many of the prominent citizens of Penetanguishene —Mr. B. F. Haanel was sent to make an examination of the alleged occurrences of iron ore deposits in and about Penetanguishene, Simcoe county, Ont., and if deemed necessary, to undertake a magnetometric survey of the same. The investigation was conducted in September, and the report in the appendix shows that, in no instance, was there any indication of a disturbance of the earth's magnetic field, occasioned by a magnetic ore deposit; hence precluded the making of a magnetic survey. The investigator, moreover, is of opinion that, the mound of bog ore discovered, originated as a deposit from a nearby spring—dried up long ago: a reasonable deduction, since another spring some miles away, is still actively depositing iron oxide, in the form of a cone shaped mound similar to the one in question; while the reddish discoloration to be seen on stream banks, and by the roadsides everywhere, is manifestly due to the minute particles of iron oxide carried in the drainage waters from the ferruginous Potsdam sandstone in the terraced beaches in the neighbourhood. The general conclusion being that, at Penetanguishene and immediate vicinity, there are no iron ore deposits of economic importance.

THE PEAT INDUSTRY.

The following petition—signed by a large number of influential residents in different sections of the Dominion, asking for a thorough investigation of the peat deposits of the country, by the Mines Branch—was addressed to the Honourable Frank Oliver, Minister of the Interior, and afterwards transferred for action to the Honourable W. Templeman, Minister of Mines.

(Petition.)

June 12, 1906.

The Honourable Frank Oliver,
Minister of the Interior,
Ottawa.

Sir,—In view of the valuable practical work that is being done by the Mines Branch of your Department, in making known the economic possibilities of many of the natural resources of the country, we, the undersigned residents of various sections of the Dominion interested in the development of our fuel resources, would respectfully direct your attention to the important field of investigation afforded by the extensive peat deposits of Canada, and would strongly urge that this subject be made a matter of early and special inquiry by your Department.

Our imports of coal and coke aggregate about $20,000,000 per annum. Not only are they increasing in quantity, but prices are advancing also, thus constituting an enormous and growing drain on the wealth of the country. To retain a portion of this money at home for the employment of our own people, as well as to lessen our dependence upon a foreign country, should, we submit, be regarded as an object of the greatest national importance.

Our fuel supply, to so great an extent, being derived from outside sources, is subject to be seriously interfered with, or even entirely cut off at any time by labour conditions, combinations of capital, or political exigencies, and other causes wholly beyond our control. This is a vital weakness of our industrial and transportation systems, especially in Ontario and Quebec, which are without coal measures.

Apart from this, the growing cost of the domestic fuel supply is becoming yearly a more serious problem to a large portion of the community in these provinces. These facts, together with the rapidly decreasing quantities, and increasing cost of wood, render the early investigation of other possible sources of fuel supply imperative.

Several European governments, recognizing the importance of this matter, have for some time past assisted in the development of the peat industry, with the result that a considerable portion of the fuel supply for domestic and industrial purposes in those countries is now derived from this source. Russia alone produces about 4,000,000 tons of peat fuel per annum; while, under the policy above referred to, Sweden, Holland and Germany have also become large producers. Conditions in Canada are in many ways identical with those in Sweden, and there appears to be no satisfactory reason why the success of that country should not be equally attained by Canada.

It is a matter of common knowledge that large deposits of peat exist at many accessible points in Canada, and a number of efforts have been made by private capital to turn these to account. The results of these efforts have been more or less unsatisfactory in the past, owing in some cases to faulty methods of working, in others to lack of experience of the operators, defective knowledge of the difficulties to be overcome, or want of the necessary capital to cope with these successfully.

We, therefore, believe it would be in the public interest that the Mines Branch of your Department be, at an early date, instructed to make a thorough investigation, with a view to obtaining such reliable information as to situation, extent, capability of drainage, and best methods of working available bogs; together with the quality, character, calorific value, &c., of the peat contained in them, as may aid in the intelligent development of this valuable resource, and we will be glad to place at the disposal of the Department any facts in our possession, or to take any action in our power which may be conducive to this result.

We have the honour to be, sir,

Respectfully yours,

(Signatures.)

INVESTIGATION ORDERED.

In view of this petition, dated May 6, 1907, and in consideration of the recent improvements made in gas producers and gas engines, which has opened up a new field for the utilization of peat and lignite for power purposes, I recommended in a memorandum dated May 6, 1907, that Mr. Erik Nyström—an engineer on the staff of the Mines Branch—be appointed to investigate the Peat Industry in Europe; and that on his return he act as Government expert on the subject of peat and lignite; to give advice to prospective manufacturers of peat fuel, and to assist them in the making of plans for their plants, and for the drainage of their bogs; also to give effect to the petition presented, by commencing an investigation of the more easily accessible peat bogs; to determine and map their extent; ascertain their depth, and best methods of draining, and operating, together with the quantity, character, and calorific value of the peat contained therein.

The following were the instructions given to Mr. Nyström regarding the investigation of the Peat Industry in Europe:—

OTTAWA, May 14, 1907.

SIR,—You are instructed to proceed at the earliest moment to Sweden, Norway, Finland, Denmark, Germany, Holland and Ireland, for the purpose of studying and reporting upon the peat industry in these countries. It will be your duty to familiarize yourself with the methods, processes, and machinery employed in the commercial production of fuel from peat, and lignite; and such other exploitations of peat bogs as lead to commercial products.

This examination is undertaken in the interest of the peat industry of Canada, and it will, therefore, be your duty also to ascertain all facts relating to costs of production; to procure photographs, drawings and plans of machinery, and apparatus used; and obtain information regarding patents issued to the different inventors of processes and machinery, the countries where they have been issued and full particulars thereof.

You are further instructed to visit the peat laboratories of such countries as have established them, familiarize yourself with the methods employed for determining the value and class of peat, and report upon these methods and the apparatus, equipment and arrangement of these laboratories.

(Signed) EUGENE HAANEL,
Superintendent of Mines.

PRODUCTION OF NITRATES FROM PEAT.

In connexion with the utilization of peat bogs, some most interesting experiments have been conducted in France, by Messrs. Müntz and Lainé, on the use of peat in the production of nitrates on an industrial scale, and the results of these researches have been published in a bulletin presented before the French 'Académie des Sciences.'

Owing to the approaching exhaustion of the famous Chilean nitrate beds, the production of this material in large quantities, at low cost, is becoming a very important question. The uses of nitrates are very varied, the most important ones being their application to agriculture, and their entering to a large extent into the manufacture of explosives and war ammunition.

After long and careful experimentation, the authors of the bulletin have presented results which promise to open a new era in the production of nitrates. They conclude that, by passing weak solutions of ammonium sulphate over peat beds specially prepared to set up an intensified action of nitrification, the yield of nitrates is one thousand times greater than by the old methods of nitre-beds, in which nitrification was always regarded as a slow and tedious process.

So interesting have these results appeared, that a somewhat extensive abstract of the bulletin has been given farther on in the report. It will be seen that under certain conditions, one acre of peat bog may be made to produce 300 to 350 tons of nitrate of sodium.

Moreover, I have entered into correspondence with the authors of the bulletin, and with other scientists who are carrying on similar research work, with the view of studying the applicability of such process to the exploitation of our Canadian peat bogs.

In considering the utilization of peat for the production of nitrogenous compounds, the fact has not been overlooked that, sulphate of ammonia is a by-product of coke ovens and gas producers using peat and soft coal, and that from this source it is comparatively inexpensive.

The commercial importance of an extensive nitrates industry in Canada, may be inferred from the following reliable Montreal press announcement on May 26, 1908:—

"Remarkable Cargo from Chili to the St. Lawrence—6,400 tons Nitrate of Soda to be transhipped here for Chicago.

Something new in cargoes for the St. Lawrence route has been secured by P. Warwick Ferns, being a consignment of nitrate of soda, and which is due to arrive in the port of Montreal about the middle of June.

The nitrate of soda is a Chilian product, and is used extensively in the manufacture of explosives and fertilizers. There is a large business carried on between Chili and the United States in this material, and hitherto it has been shipped directly to American ports, going to New Orleans, Philadelphia and Baltimore, and from these places being transhipped to points of manufacture.

Not a single cargo of nitrate of soda has ever been conveyed to a Canadian port, the present venture being in the nature of an experiment, which, if it succeeds, will mean that the St. Lawrence route will capture a considerable share of a lucrative trade.

It had been the custom to ship to the United States ports mentioned, than tranship by rail. The first cargo to come to Montreal will be transhipped by lake carriers to Chicago, Marquette and Aston, the particular advantage being that by an all-water haul and one change, a lower rate can be quoted as against the higher rail haulage charges.

SS. *Taurus* will be the vessel to bring the cargo to Montreal. She will sail from Iquique and proceed directly. She is chartered to carry 64,000 bags of the nitrate: a dead weight of 6,400 tons. The cargo is for the E. I. Du Pont de Nemours Powder Company, a firm which annually handles 350,000 tons of the material.

To reship the cargo of the *Taurus*, four lake boats will be required.

The advantage suggested by the use of the St. Lawrence route is that the steaming distance from Iquique to Montreal is but little different from that between the Chilian port and New Orleans. To reach the latter place it is necessary to swing through the Carribean sea, and then enter the Gulf of Mexico, the two distances about equalizing, while from the Canadian port there is the additional advantage of the St. Lawrence canals inland."

That one Chicago firm alone, should use 350,000 tons of nitrate of sodium, yearly, is evidence of the magnitude of this trade in North America; and the advantages to be gained by the early establishment in Canada of modern plants for the utilization of the immense peat resources of the country, in the manufacture of nitrates.

Peat and Lignite Fuelss Investigation of Gas Producer Systems.

The rapidly vanishing deposits of anthracite coal, as well as the limited deposits of bituminous coal in sight in the United States, and the consequent necessity of an economic supply of fuel for commercial purposes in central Canada has called for an immediate inquiry as to the best substitutes for coal fields. Ontario, having immense resources of peat, it has been deemed advisable to thoroughly investigate the best means of economically using this material for low grade fuel. With this object in view, it has been decided to install in Ottawa an experimental, fuel testing plant, to be operated and conducted by the Mines Branch. And in order to make this new testing station as economically perfect as possible, it was decided to undertake a survey of existing systems. To this end Mr. B. F. Haanel was instructed to make an itinerary in the United States, which he did in the autumn: inspecting gas engine, and gas producer plants of repute in New York, Chicago, &c. The valuable, practical data gathered, is found in his report, which appears in the appendix.

ELECTRIC SMELTING.

The great interest taken at the present time in Europe, on the subject of electric smelting, is manifested not alone by the appointment during last summer of two commissions—one by Austria-Hungary, and the other by the Norwegian government, to investigate the progress which has been made in the application of the electro-thermic process to the smelting of iron ores, and the making of steel—but by the extensive experiments in progress in Sweden, and by the very large number of patents which are being taken out for different designs of electric furnaces. In this connexion it may be well to point out that, in but a few cases have these inventions reached even the experimental stage; and it must be insisted on, that no electric process—unless it has been tried by competent parties, and confirmed by facts and figures given regarding output and energy consumed—is deserving of confidence by the public. Astounding claims are frequently made by inventors for the efficiency of their processes, and furnaces.

The real progress made in electric smelting is confined at present to the application of the electro-thermic process in the production of high class steels; the increase in the capacity of the Heroult furnace, and the increase of the power factor and capacity of the Kjellin furnace. In consequence of which, the electric process is gradually displacing the crucible process in the manufacture of high grade steels, and the different alloy steels which have in recent years come into use.

THE LASH STEEL PROCESS.

Of the lately invented systems for making steel, the Lash Process, which is being tried at Niagara Falls, deserves to be specially mentioned. The inventors give the following account of the process:—

The Lash Steel Process.—The Canadian Lash Steel Process Company, Limited.—
The Electric Furnace.

In the numerous experiments that have been made with the object of producing steel direct from iron ore, one of the most serious problems was that of heating the furnace charge to the necessary temperature. In the blast furnace this is readily accomplished by mixing with the ore an excess of carbon so that a part acts as reducing agent and a part as fuel, which gives the necessary heat by combustion in the blast. It is possible to make a mixture of ore and carbon where the latter is only present in the proportions necessary for reduction, to place this mixture in a suitable container, and then to heat the latter by means of the combustion of fuel so as to obtain an iron having the desired percentage of carbon; but such a process is not commercially feasible. In order to produce iron from the ore in a commercial manner it appears to be necessary to generate the heat in the charge itself.

The production of electric energy at a relatively low price, and the consequent developments in the design of electric furnace, led to the hope that the problem of the direct production of steel might be solved. Theoretically, it should be possible to place in an electric furnace a mixture of ore with only that amount of carbon necessary for reducing, and for the proper carbon content in the metal to turn out the desired grade of steel. Experiment, however, has shown that this is not commercially feasible because of technical difficulties which quickly appear when the attempt is made.

Successful experiments with the 'Lash Process' in the case of the open-hearth furnace, on a commercial scale, have indicated the possibility of its application to an electric furnace process.

In this process finely divided ore is intimately mixed with carbon, a certain quantity of finely divided carboniferous iron, such as cast iron borings, or granulated pig iron, sawdust and fluxes suitable for the ore under treatment. The mixture is then ready for charging, either loose or in briquetted form, and in general it may be said that it must simply be heated to a sufficiently high temperature in order to obtain the steel.

The working of the process can perhaps be best explained by comparison with the open-hearth 'Ore Process,' which consists in first forming a bath of molten pig iron, and then adding thereto a sufficient amount of ore (Iron oxide) to reduce the carbon content of the metal to the desired amount. The oxygen of the ore combines with a certain amount of the carbon in the pig iron, forming carbon monoxide gas, and the iron of the ore is set free to mix with the bath of molten metal. Following this method we may work up together a mixture of approximately 75 per cent pig iron and 25 per cent ore. But, in the Lash Process, these proportions are very different, for instead of treating a large excess of pig iron with a relatively small amount of ore, we can use a large proportion of ore with a smaller proportion of carboniferous iron.

Turning now to a more detailed examination of the Lash Process, a typical mixture has the following percentage composition:—

Iron ore	54
Cast iron borings, or granulated pig iron	27
Sawdust	4
Limestone	4
Coal tar	3
Coke	8
	100

All the constituents of this composition are in a fine state of division intimately mixed, and when heated to a sufficiently high temperature the chemical reaction between the carbonaceous material and the ore proceeds readily, the iron oxide being reduced by the carbon, forming carbon monoxide gas and metallic iron. The function of the sawdust in the mixture is to make it porous, since at an early stage of the heating the sawdust carbonizes and leaves the mass in a porous state, permitting the easy escape of the gases formed during the reaction.

If we imagine the Lash mixture given above, heated to a high temperature, it is easy to see that the reactions that occur are similar to those found in the open-hearth furnace, using the ore process. The cast iron borings correspond to the molten bath of pig iron, and react with the ore, but the latter being in large excess it is necessary to supply a certain amount of free carbon, in the form of coke, to supply sufficient carbon for the complete reduction of ore.

It is perfectly obvious where the great economy of the Lash Process is found, since the proportion of ore to pig iron is very much greater than in the ordinary open-hearth process, where a large amount of pig iron, and a relatively small amount of ore, or a mixture of pig iron and scrap, must be used. But, briefly, the Lash Process is a method whereby a large amount of relatively cheap iron in the form of ore may be used to replace more expensive pig iron or scrap.

Now, in using the Lash mixture in the open-hearth furnace, it is necessary to have a bath of molten metal, for were it to be charged into an empty open-hearth furnace it would not be practicable to heat it to the reacting temperature without losing carbon in the mixture by combustion. If, however, the charge is put into an electric furnace, no difficulty of this kind is met with, since the gas in an electric furnace is neutral, in contradistinction to the oxidizing atmosphere of an open-hearth furnace.

Experiments, using the Lash mixture, have been made in the electric furnace on a small scale, and the results have been very successful. In these experiments no bath of pig iron was used, but the mixture was heated alone in an electric furnace. It was found that the yield of metal amounted to 98 per cent of the metallic content of the mixture. Using electric energy as a source of heat is in general more expensive than heating by fuel, in spite of the fact that the heat generated is used much more efficiently in the electric than in fuel furnaces; but the economy in the electric furnace is found in the saving of pig iron, which must be used in the open-hearth process.

Thus, the average cost of the regular open-hearth furnace for Canada, to produce 100 tons of ingots, is as follows:—

(Charging materials at cost, and pig metal charged hot)—

65 tons pig iron at $15	$ 975 00	95 per cent metallic	61·75 tons.
43·50 " scrap at $16	696 00	99 " "	43·06 "
2 " lump ore at $5	10 00	60 " "	1·20 "
½ " Ferro at $60	30 00		
		Total contents	106·00 "
Total cost char ge	$1,711 00		
Credit 2 tons scrapat $16	32 00		
	$1,679 00		

Cost per ton	$16 79
Cost Conversions	4 00
Total cost Ingots per ton	$20 79

If, on the other hand, the electric furnace is used, we would have the following figures:—

181 tons mixture at $5.96	$1,078 76	58 per cent metallic	104·98 tons.
2 " lump ore at $5	10 00	60 " "	1·2 "
0·5 " Ferro at $60	30 00		
		Total contents	106·18 "
Total cost charge	$ 1,118 76		
Credit 2 tons scrap at $16	32 00		
	$1,086 76		

Cost per ton	$ 10 87
Electric power	3 25
Electroids	0 10
Conversion	2 00
	$16 22

* Cost of materials, Oct. 1907.

The best results in the practice of the United States Steel Corporation, charging hot pig metal and other materials at cost, are as follows:—

Regular Open-hearth Charge.

65 tons molten pig at $12	$ 780 00	95 per cent metallic	61·75 tons.
43·50 " scrap at $16	696 00	99 " "	43·06 "
2 " lump ore at $5	10 00	60 " "	1·20 "
" Ferro at $60	30 00		
		Total contents	106·00 "
Total cost charge	$1,516 00		
Credit 2 tons scrap at $16	32 00		
	$1,484 00		

Cost per ton	$ 14 84
Conversion	2 00
Total cost Ingots per ton	$ 16 84

(Cost of materials, Oct. 1907.)

Now the experimental work carried out in the electric furnace for the reduction of iron ore indicates that the cost of conversion should be as low or less than $3.95 per ton, and arrangements have, therefore, been made to test various electric furnaces, with the object of finding out those forms to which the Lash Process is applicable.

Recapitulation.

The electric furnace cannot be used at the present time for the direct production of steel, owing to certain technical difficulties.

But, by applying the Lash Process for the production of steel in the open-hearth furnace, with suitable modifications for the electric furnace, it is believed that the problem can be solved.

Therefore, in all cases where, for whatever reason, the use of the electric furnace rather than fuel furnaces is desirable, steel may be produced directly from the ore in the electric furnace.

Respectfully submitted,

THE CANADIAN LASH STEEL PROCESS CO., LTD.
THE LASH STEEL PROCESS CO.

Mechanical Improvements, and the Utilization of Waste Gases: Swedish Experiments.

Although the experiments made at Sault Ste. Marie, under Government auspices, have settled the metallurgy of the Electric Process, and have demonstrated the important fact that sulphur up to 2 per cent can be almost completely eliminated, the furnace with its interior electrode did not permit either the satisfactory application of labour saving machinery for charging, or the proper collection or utilization of the carbon monoxide evolved.

Experiments have been conducted in Sweden during the last winter, (1907-8), with a view of overcoming these difficulties: the sum of 200,000 kronas being appropriated for the purpose. Reliable information just to hand indicates that, the Electro Metal Co., of Sweden, have—after experimentation with different reduction furnaces—achieved satisfactory results with the latest type of the series of furnaces tried, hence they are now constructing on a larger scale a furnace of 700 h. p.

The above mentioned Company have recently delivered to a firm in Brazil one induction furnace for steel manufacture, of 250-300 h. p., (50 periods) designed for a charge of 1,000 kilos. This Company also builds electrode furnaces for steel making. Of this type, two, having a capacity of 1,000 and 500 kilos., respectively, are at present under construction; and a larger one for 5,000 kilos. charge, will shortly be commenced.

Experiments with Furnace on New Principle, and on a Commercial Scale, at Welland, Ont.

The Electric Metals Co., Limited, who have erected a plant at Welland, Ontario, and are at present engaged in the making of ferros: using for the purpose iron pyrites cinders, are at present building an electric furnace on a new principle, for the smelting of iron ores. The furnace is of 500 h. p. capacity, and is being built at the expense of Dr. Heroult. If successful, larger furnaces will immediately be built. It is the intention of the Company to spare no effort in bringing to a successful issue the construction of a thoroughly commercial iron-ore melting furnace.

The Company own some 40 acres of land south of the town of Welland, with a frontage of over half a mile on the east side of the Welland canal, and within easy communication with the Michigan Central, Grank Trunk, Canadian Pacific, and Wabash railways.

The works are located on the north side of the property: consisting at present of a large steel building, in which are placed the electric furnaces; with sample room for raw material, crushing plant, &c. The transformer room, with tower for the entrance of the high tension current wires, is built against the main building. Other separate buildings consist of stores, offices, and an electrode plant, in which latter, electrodes of excellent quality are being made. The transformer capacity is at present 7,000 h. p. The President,—R. H. Wolff, of New York city—and Vice-President, R. Turnbull, of St. Catharines, Ont., are the agents of Dr. Heroult on this continent. The Company, however, is an independent corporation.

Desulphurization of Raw Material in the Kjellin Furnace.

Dr. A. Schmidt, of Zurich, has made the interesting observation that, the important factor in the desulphurization of the bath in the Kjellin steel furnace, when the ore process is employed, is to be ascribed not to the high temperature of the bath, nor to the nature of the slag, but to the iron oxides added, and to the specific influence of the alternating current: which produces molecular oscillations in the bath, rendering the combination of the oxygen of the added ore, and the sulphur contained in the bath, more active; and that the resulting SO_2 passes off in the form of gas. In the experiments made at Sault Ste. Marie in the smelting of sulphurous ores, I was surprised at the volumes of sulphur dioxide escaping during the operation of slagging. If this explanation offered by Dr. Schmidt of the cause of the desulphurization of the bath is correct, then, as he himself states, a continuous current would not, under like conditions as to bath and addition of iron oxide, be effective in producing desulphurization.

Comparative Merits of Induction Furnaces.

In the appendix will be found an able critique by Mr. A. Grönwall—a Swedish authority on Electro-metallurgy—on the respective types of induction furnaces employed at the present time in the production of steel.

New Electric Furnaces Installed in Canada.

An Induction furnace—Snyder's patent—has been erected at Nelson, B.C., for the production of lead bullion and commercial spelter—in one operation. The electrical energy for operating this plant is being delivered from Bonnington Falls, at a specially low rate for the first year.

MINING AND METALLURGICAL INDUSTRY OF CANADA.

In accordance with the provisions of Section 6 (a) the Geology and Mines Act: 'to collect and publish full statistics of the mineral production, and of the mining and metallurgical industries of Canada,' a first attempt has been made to gather material for such report.

The following are the persons who have been appointed in connexion with this work:—

Yukon Territory:	D. D. Cairnes.
British Columbia, Alberta, Saskatchewan and Manitoba:	R. R. Hedley.
Ontario:	Fritz Cirkel and J. J. Bell

Quebec:	J. W. Bell.
Nova Scotia and New Brunswick:	W. F. Jennison, of Jennison & Dahl.

Instructions were given, to report only upon producing mines, or mines having expectation of early shipment, and upon metallurgical plants in active operation; the information obtained, and submitted, to be the result of personal visitation to the respective mines and plants.

In gathering the necessary material for this report, many difficulties were encountered in getting satisfactory, and complete data about certain of the industries —as regards processes, prices, etc.; while in a number of instances it was practically impossible to obtain from the local officials, complete information as to the personnel of the various industrial corporations; since the head offices—a number of which are in other countries—alone possess the records; and from some of these the facts could not be elicited, even by correspondence.

The rapid progress being made in the development of the mining and metallurgical industries, together with the constantly changing conditions as regards labour, market, and prices, will necessitate the publication of annual supplementary statements, in order to bring the original report up-to-date; and will subsequently call for the issuance of a complete new report, embodying these important changes, and additional technical information.

YUKON TERRITORY.

(*D. D. Cairnes.*)

About two months were spent by Mr. D. D. Cairnes, during the latter part of last season, (1907) in the Yukon Territory: gathering information as to the extent and condition of the mining and metallurgical industries therein.

In the Dawson district, Mr. Cairnes had to depend to a considerable extent on mine-managers, superintendents, &c., for the necessary information as to company organization, details of installation and equipment, number of men employed, costs of operation, etc.; but he says that in all cases ,and in every possible way ,assistance was readily given.

All the properties reported upon—except a few in outlying districts—were visited personally, hence the facts given were obtained by actual observation on the spot; supplemented by carefully sifted information gathered from all available sources. The data collected, indicates the conditions in the entire Yukon Territory, with the exception of the copper deposits at Whitehorse.

The following is a short account of the present state of the Mineral Industry in the districts reported upon.

Only two of the silver-gold properties in the Windy Arm district were being operated. One of these is likely to be a producer in the near future. It is expected that work on others will be resumed during the coming season. The quartz properties on Williams creek, Livingstone creek, and others in the vicinity of Dawson, although promising, are all, as yet, strictly in the prospect stage.

Large areas of lignite, and bituminous coal, have been found in different parts of the Yukon; accessible either by boat, or rail. Last season, only two mines were in operation, producing respectively about 9,000 and 8,000 tons.

By far the greater part of the placer gold of the Yukon comes from the Klondike district. A very small amount is derived from the Kluane district. The remainder is from Livingstone creek—a tributary of the Big Solomon river—which, for several years has had an increasing production; the output last season amounting to $100,000—approximately. Other undeveloped creeks in the vicinity promise to be equally productive.

The gold output of the Klondike district last season (1907) was comparatively low—for a number of reasons. The richest parts of the creeks have been worked over, and most of the gold won by very primitive methods of operation; hence the properties so exploited have by no means been exhausted. The time has arrived, however, for the introduction of more modern, up-to-date, and systematic methods of working and management. By so doing, the remaining gold from the still rich, vast areas of gravels in the northern Yukon, may be recovered.

For the reason assigned, a great portion of the Dawson district is now in the intermediate stage: where it does not pay to work the claims by former methods; and where the owners, in many cases, are undecided as to which method to adopt. The Yukon Gold Company (The Guggenheims) now own practically all the more important gravels on Bonanza, Eldorado, and Hunker creeks, and their tributaries. To work their vast holdings economically, the above-mentioned Company are spending several millions of dollars on modern installations: including dredges, newly designed electrically driven mechanical elevators, construction of ditches and flumes, building of dams, &c. While these improvements are being made, very little gold is actually being won. Moreover, last season was unusually dry; so that on the properties in a workable condition—especially those with hydraulic installations—water for operating purposes was obtainable for only a short period.

On some of the creeks tributary to the Indian river, there was, during the last season, considerable renewed activity; due to the staking of virgin portions of the creeks, formerly considered too low grade. These portions—particularly on Dominion creek above Granville, and those near the mouth of Sulphur creek—have been proved to contain gold in paying quantities, when worked by modern methods.

Another striking feature noticed last season was, the staking of new creeks; such as Clear, and Black Hills, the latter being staked from head to mouth. It is believed that the values found are very encouraging.

So that, although the days of the individual placer miner in the Klondike are practically at an end—at least on the older creeks—the country is by no means nearly worked out: and a continued large gold production may be expected for many years to come. When the installations of the Yukon Gold Company are completed, a considerable increase over the last fiscal year's production ($2,820,011.55—computed at $15 per ounce: which is less than its real value) is anticipated. It is true that certain of the older creeks have been practically worked out by the present methods of operation; but newer systems of working are being discovered, and new fields being found. The Stuart river and its tributaries will, judging by last year's prospecting, yield much more than heretofore.

BRITISH COLUMBIA, ALBERTA, SASKATCHEWAN, AND MANITOBA.

(*J. J. Hedley*).

The report of Mr. Hedley shows that, in 1907 there was much activity in the mining and metallurgical industries of the western provinces, until November, when the financial depression caused a serious check to new enterprises; though many of the well established industries weathered the storm, or resumed operations after a short cessation.

It appears that, as in the Yukon Territory, so in British Columbia—particularly at Atlin, and in the Cariboo district—the individual placer industry is being superseded by companies working the low grade areas of gold bearing gravels on a large scale, and with more modern appliances: all having the promise of an increasingly profitable industry. While the new pioneer camps in the north-western interior are said to be very encouraging.

At the coast, the principal industries are the smelting works of the Tyee Copper Company at Ladysmith, which has built up a considerable custom business; and the mines, concentrator, and smelter of the Britannia Syndicate.

In the interior of the Boundary country, economic progress is reported in the cheapening of working costs, in both mining and smelting. In this district, also, the financial depression, together with high prices and wages, caused a stagnation of production, and of trade. Rossland camp has re-established its industries steadily and definitely; although the profit margins are small. The mining of gold-copper ore shows marked development. In the shafts, levels are being opened 2,000 feet below the surface—practically the level of the Columbia river.

At Trail, the smelter—which has been steadily improved as regards equipment and operating facilities—is evidently doing a profitable business in the smelting of not only gold-copper ores from Rossland, and the Boundary; but ores of lead, silver, and gold also. Base bullion from the lead furnace is desilverized and refined at the Electrolytic Refinery nearby, which has a capacity of 80 tons daily. The products of this celebrated refinery are: pig lead of exceptional purity, lead pipe of all sizes, refined silver, gold, and antimony, as well as copper sulphate.

The companies producing silver-lead, are very limited in number:—

Over 1,000 tons	= 7
Between 100 and 1,000 tons	=18
One car load or more	about 50
Only a few tons	=20

Many of these properties situated in the Slocan, are in a position to produce a fair tonnage of galena ores, but are not operating; since the market for zinc ore in Canada is limited, while the high tariff makes shipment to the United States practically prohibitory.

The old Blue Bell mine has been developed with such satisfactory results, that a complete modern concentrating plant has been installed. In East Kootenay, the development on the St. Eugene mine has been very extensive; and the concentrating mill has been so effectually improved, that low grade ores in large tonnage are being handled with great economic advantage.

As a result of practical experiments in Vancouver, and elsewhere, an electric smelter is in process of erection at Nelson, in which it is proposed to treat mixed argentiferous lead-zinc ores; with a view of producing lead bullion and commercial spelter in one operation. Electrical energy, for power purposes, will be furnished from Bonnington falls.

In the Crowsnest Pass, bituminous coal field, old mines are being re-equipped, and new ones opened; so that there will soon be an abundant coal supply from that region. In the anthracite field—on the main line through Alberta—coal is not only being mined in greater quantity; but existing mines are being more extensively developed, and the best modern equipment for dressing, is being installed. The briquetting product of the plant at Bankhead, in the Rockies, has created such a demand, that the company has doubled its installation. Owing to the fact that, lignite fields depend largely on cold weather for a market, they were not as active as usual at the end of 1907. The coal fields of Vancouver Island continue at about the same rate of production, though the demand far exceeds the supply. New companies are, however, exploiting promising areas, so that an increasing supply may be anticipated.

Two companies are actively developing coal areas in the Nicola valley: one of which is already producing steam coal of excellent quality. At Princeton, one company is fully equipped for the mining and production of high grade lignite, as soon as the railroad—now within twenty-five miles—reaches the camp.

Cement was being produced at the end of the year by two companies: one situated on Vancouver Island, B.C., and the other at Calgary, Alberta; while a modernly equipped plant has recently been completed at Exshaw near Banff, and another is under erection near Blairmore in the Crowsnest pass.

The brick, and building material industry generally, was very active: the demand in Alberta calling for shipment to long distances. Two sand lime brick industries have been established, one at the coast, another at Regina, Sask., and a third in contemplation at Edmonton, Alta.

ONTARIO.

(*Fritz Cirkel.*)

The report of Mr. Fritz Crickel shows that, the mining and metallurgical industries of Ontario are in a flourishing condition. Of special interest are his statements regarding the iron, steel, and copper industries, and the Cobalt mining camp.

There are now established in Ontario, seven blast furnaces, with a total capacity of 1,300 tons of pig iron per day: representing an increase of 400 tons per day over 1906. This increased output is due to the blowing in of the new furnaces of the Atikokan Iron Works at Port Arthur, and to the enlargement of the plant at Hamilton.

In the operation of these furnaces, it is important to note the preference given to Canadian, over foreign ores. The Atikokan Company use ores from the Atikokon iron range almost entirely; while the Moose Mountain iron mine, having extensive deposits of high grade iron ore, will be in a position to ship to every blast furnace in Ontario in the spring of 1908.

Five works are engaged in the production of iron and steel castings: two of which are manufacturing steel. Two complete steel plants, equipped with six basic, open hearth furnaces, and a number of Bessemer converters, were in active operation in 1907.

An interesting feature in connexion with the various manufactures of iron in the province of Ontario, is the marked increase in the production of malleable cast iron. In a paper read recently before the Institution of Engineers and Ship Builders, Scotland, March 17. 1908. Mr. William Herbert Hatfield points out the largely increased application of malleable cast iron, in the metal trades generally—especially in the United States: and emphasizes the fact that, the maximum tensile stress in this kind of iron is very high: having practically twice the strength of ordinary cast iron; while its malleability and ductility, permits of easy work in the machine shops. Malleable cast iron is made by melting suitable pig iron, either in a reverberatory, or open-hearth furnace, and casting the same into moulds. These castings are then subjected to a process of annealing, in order to effect the requisite malleability. The finished article, if properly manufactured, possesses all the advantages of cast iron, since the low melting point of pig iron allows the most intricate and difficult casting to be made.

Malleable cast iron can be made practically free from blow holes, the composition of it ensuring the perfect exclusion of the gases; which, in steel castings, very often cause much trouble.

In the province of Ontario, eight companies are now engaged in the manufacture of malleable cast iron. Five of the latter produced in 1907, 20,700 tons: their daily combined capacity being 105 tons. The total production of pig iron for the same year was 275,508 tons.

This rising industry seems to promise well for the future, as the ease with which malleable cast iron is manufactured, together with its comparatively high tensile strength, and ideal working qualities in the machine shops, renders it very suitable for the smaller working parts in machinery, where heretofore, steel—manufactured by bessemerizing, or by the open-hearth process—was used.

Developments during the past year in the Cobalt camp, have been largely with a view to opening the mines to proper depth, and preparing stopes to permit of uninterrupted operations during the winter; instead of gophering the rich narrow veins. There are now twenty shipping mines in the camp, and a few others will soon be added to the list. The total production for 1907, is approximately 28,000,000 pounds, having an estimated value of about $6,000,000; but the smelting facilities for Cobalt ores are still inadequate. The only plant which treats Cobalt ores in Ontario, and then, only a certain class of ore, is the reduction plant of the Canadian Copper Company at Copper Cliff. When the old plant at Deloro, Ont., is remodelled, Cobalt ores will be treated there also. The plant of the Montreal Reduction and Refining Company, at Trout lake, near North Bay, is not yet in operation.

The Copper-Nickel Industry of the Sudbury district, continues in a flourishing condition. The smelting works of the Canadian Copper Company, with the addition of the new Bessemer plant now in course of erection, will be the largest of their kind in the world. In the first nine months of 1907, they treated not less than 230,000 tons of copper-nickel ore; or 1,000 tons of ore per day, approximately.

Of special interest is the activity displayed all along the copper bearing formation which follows the line of the Canadian Pacific railway from Victoria Mines to Sault Ste. Marie, and also along the line of the Central Ontario railway.

Quite a number of copper properties have been opened; and although most of them are only prospects, the outlook is so encouraging for the future, that it is deemed advisable to have this district further investigated by a competent engineer. There are already three shipping mines, and quite a number will be added as soon as there are proper smelting facilities.

The erection of copper smelters at Sault Ste. Marie, Ont., is in contemplation, also at Thessalon, Ont., on the 'Soo' branch of the Canadian Pacific railway.

The new oil and gas fields near Tilbury, on the Niagara peninsula, are producing now, more oil from about 250 wells, than the old Petrolia field with its 6,500 wells.

Judging from the report of Mr. Cirkel, this Tilbury field will likely extend towards the south as far as Lake Erie; it is, therefore, very probable that new wells will be established, thus adding considerably to the present production.

A statistical abstract of Mr. Cirkel's report, gives the following interesting figures as to the number of producing companies engaged in the Mining, Metallurgical, and allied industries:—

Iron and steel	13
Copper	5
Copper nickel	2
Iron ores	3
Silver cobalt	24
Gold	5
Natural gas	15
Petroleum, about	300
Salt	12
Cement	18
Potteries and sand	24
Brick and tile factories	280
Miscellaneous mines	20
	721

Mr. Cirkel was assisted by Mr. J. J. Bell of Toronto, who visited and reported on all potteries, brick and tile factories in the province.

Clay Industries.—The investigation of the clay industries in the province of Ontario was commenced by Mr. J. J. Bell, on July 10, 1907. From that date to the 26th of December, Mr. Bell visited all the brickyards and tile factories in the province. Using Toronto as a centre for his various excursions, he visited upwards of 300 brick and tile yards, and all the potteries—with the exception of one very small establishment. Also, six sewer-pipe works; six plants where sand-lime bricks are manufactured, and four where artificial stone is made. In addition to these, Mr. Bell visited a large number of lime works, stone quarries, and cement block and brick works; as well as several salt, cement, and peat works.

In November, Mr. Bell attended the Clay Products Manufacturers' Convention at Ottawa, where he gathered valuable information and data; all of which, together with particulars and descriptions of the respective works and establishments visited, are fully detailed in his report.

QUEBEC.

(*J. W. Bell.*)

The report of Mr. J. W. Bell indicates that, the mining and milling of asbestos is the most important mineral industry in the province, which is confined in the Eastern Townships, to the serpentine areas of a mountain belt extending from the boundary of Vermont to the extreme limit of the Gaspé peninsula. The Thetford, and Black Lake serpentine areas, and a small detached area near East Broughton, are, however, first in importance; since they contain the workable deposits. The greater portion of the crude asbestos produced, is derived from thhe Thetford mines, whilst the output from Black lake and Broughton is chiefly milled product.

Commercial and other conditions in 1907, were very favourable, hence there was a considerably increased production, viz., 90,537 tons—asbestos, 62,018; asbestic, 28,519—and at the same time, an advance in price. Over 6,000 men are engaged in the asbestos industry in the province.

At the present time, only two mines are actively engaged in the production of copper ore, namely, those of the Eustis Mining Company, and the Nicholls Chemical Company: both operating at Capelton, near Sherbrooke. At the same time, much activity is being manifested in the development of promising prospects in the above-mentioned, and other districts. The copper ore production last year amounted to 30,000 tons—approximately: carrying from 1½ per cent to 6 per cent copper, small values in gold and silver, and from 25 per cent to 40 per cent sulphur—which latter is turned to account in the manufacture of sulphuric acid. The copper industry employs 250 men.

Bog iron ore is mined by two companies operating in the St. Lawrence valley, near Three Rivers. About 5,000 tons of high grade, brown hematite ore, containing approximately 51 per cent of metallic iron, was dredged out of the bed of Lac-a-la-Tortue last year. This coke ore—which is deposited yearly—is one of the most remarkable examples of modern iron ore formation. Dredging is undertaken continuously for ten years, during which time some 50,000 tons of coke ore is taken from the lake bottom. The pig iron product of these ore on account of its high tenacity, and non-oxidizing qualities, is used for propellor blades, etc.; while 'the harder grades have been used for over fifty years as the basis of practically all the chilled iron railway car wheels made in Canada; the life of wheels made from this metal, surpassing all the best records of the American railways. The metal is also used for chilled rolls: and for this purpose, is shipped regularly to Pittsburgh, and finds a market also in various engineering establishments on the continent of Europe.' At the end of every decade, the lake is given a rest of from four to five years. The last rest terminated in 1905. The total production of bog ore in 1907, was approximately 22,500 tons, and the industry employed 100 persons.

Progress has been made in the mining of chrome iron ore, which is carried on in the Eastern Townships by four companies. The fiscal returns for 1907-8 show a production of 7,196 tons of this ore, most of which is marketed in the United States, for use in the lining of basic, open-hearth steel furnaces; and, as ferro-chromium from the blast furnace, in the manufacture of railway tires, springs, armour piercing projectiles, etc.

Referring to the mica industry, Mr. Bell points out that, phlogopite, or amber mica, is a variety peculiar to Canada, and in Quebec occurs in the region north of Ottawa. In this industry 275 men are employed, and the production of thumb trimmed and split mica, last year, was 550,000 pounds.

The other metallic, and non-metallic products of the province are: zinc, natural gas, cement, lime, stone, bricks, tiles, etc., all of which are dealt with in Mr. J. W. Bell's report.

NOVA SCOTIA AND NEW BRUNSWICK.

(W. F. Jennison.)

The contribution of Mr. Jennison to the general report on the mining and metallurgical industries of Canada—dealing particularly with conditions in Nova Scotia, and New Brunswick—shows that, the enviable reputation which the Maritime Provinces have long held as mineral producing sections of the Dominion—especially bituminous coal—is being well sustained. The gypsum deposits are said to be, as regards quantity and variety of quality, the most extensive in existence: and are only in the primary stage of development. In addition to these resources, an appreciable commerce is being carried on in the metallic ores of iron, gold, and antimony; also in dolomite, limestone, fluorspar, and other materials used in metallurgical processes, besides clays, building stones, etc. In the manufacture of steel on a large scale and by approved modern methods, Nova Scotia has shown, and is showing, great enterprise.

Coal.—The coal fields of Nova Scotia cover an area of about 725 sq. miles, and are located in four divisions: Cape Breton, Pictou, Inverness, and Cumberland districts. All these fields are practically on the tide water, which gives a transport advantage possessed by no other district on the American continent. The output for the provincial fiscal year ending September 30, 1907, was 5,720,660 tons; upon which a royalty of $650,341.32 was received. This industry gave employment to 11,500 miners alone. The coal mined in Nova Scotia is almost exclusively bituminous, of excellent steaming quality, and mostly coking. In some cases, notably in the northern field of the Cumberland district, the slack is being utilized for the generation of electricity: used for power and lighting purposes in the neighbouring towns.

In New Brunswick, bituminous coal has been mined for over 200 years. The total production in 1907 was: 48,000 tons; the greater part of which—outside domestic consumption—is used by the Intercolonial railway.

Gold.—The gold fields of Nova Scotia have been known since 1860. The report indicates, that at one time this gold field, occupying the Atlantic half of the province, was very popular, a large number of mines, or prospects, having been opened out and worked. The total amount of material crushed from 1862 to 1907 inclusive was 1,915,039 tons; yielding a total output of 887,886 ozs., 11 dwt., 22 grs. Of late there has been a considerable falling off in interest and enterprise, the total output of gold for 1907 was 13,687 ozs., 6 dwt., 20 grs., from 64,657 tons of material crushed. Upon this, the provincial government of Nova Scotia received a Royalty of 2 per cent, on all milled gold, valued at $19 per oz. It should be pointed out, however, that the values indicated do not represent the intrinsic worth of the gold won from the ores by the primitive methods of extraction employed. But as in the far west, so in the east, more up-to-date apparatus, and modern machinery are being installed. And two operating companies are mentioned as being distinctive in this respect, viz., Boston and Richardson of Guysboro, and Micmac of Lunenburg, where the highest economy is being practised. It is safely predicted that, these object lessons in economic production, will give an impetus to the gold mining industry of the province.

Gypsum.—The extensive gypsum deposits of Nova Scotia and New Brunswick have hitherto attracted little attention, although this material—used as plaster—is becoming of increasing importance in the industrial world. The actual extent of the deposits is unknown, but it is safe to say that they cover hundreds of square miles. In many places the outcrops may be traced for miles in length: at some points they show an exposed height of 200 feet. Practically the whole production in crude condition, is exported into the United States. Many years ago the manufacture of gypsum in Nova Scotia was an important industry; at the present time only one firm (The Albert Manufacturing Co., Hillsboro) attempts to supply the market with the manufactured product. The reason for this decline is, that the United States placed a practically prohibitive tariff on manufactured gypsum, letting the raw material go free; hence the mills were forced to close down. At the present time this valuable mineral asset is being exploited almost entirely by American capitalists, who control the output of crude gypsum and give little encouragement for local manufacturing. The commercial value of this mineral may be inferred from its varied use. (1) Alabaster, or satin spar for ornaments. (2) As land 'plaster' for fertilizing. (3) Glass and porcelain. (4) As a disinfectant on account of its absorptive properties. (5) Plastering walls. (6) Moulds for coins, statuary and pottery. (7) Binding broken limbs. (8) In dentistry for mouth impressions. (9) Cornices, mouldings. (10) Finishing plate glass. (11) Alabastine and similar wall washes, etc.

Iron Ores.—The iron ores of Nova Scotia are not confined to any particular horizon; but are found in more or less quantities in fifteen out of the eighteen counties. On only two, however, are operations active, viz., Londonderry, Colchester, and at Torbrook, Annapolis. At the former mine about 125 men are employed producing brown hematite, and carbonate ores, of 48·06 and 17·55 per cent iron contents respectively. At the latter place, the Annapolis Mining Company Limited, own about 5,000 acres of iron ore lands free from government royalty, because the lands were granted prior to the date of the Crown Lands Reserve Act. The Torbrook mine produces about 300 tons per day. The total production of iron ores in Nova Scotia, 1907, was 87,479 tons.

Antimony.—Antimony is known in only one district of Nova Scotia, viz., West Gore, Hants county. The ore occurs as stibnite, is auriferous, containing gold values as high as $200 per ton. In only one case—where a cross vein of quartz occurs—is there any free gold. Assays of high grade ores from the south vein, have 60·29 per cent antimony, and 2·66 oz. of gold per ton. Mixed ore and rocks cost $2.50 per ton. No. 1 mill ore equals $4 per ton. No. 1 ore alone—charging everything but development work against it—costs $40 per ton. Payment for ore is generally made per unit of antimony. No allowance is made for gold unless the ore carries over one-half ounce per ton. The price during the past year has varied from three shillings to twelve shillings per unit. About 50 men are employed in the Nova Scotia field.

In New Brunswick antimony has been known to exist since 1863. It occurs at Prince William, York county, 10 miles from Harvey station, on the Canadian Pacific railway, in the form of stibnite and native antimony. Though the occurrences are similar, they have not the gold bearing value of the Nova Scotia field. Shipments to Swansea, in January, 1907, gave the following analysis:—

Antimony	58·38 per cent.
Gold	2·24 oz. per ton.
Silver	1·75 "

The company operating the New Brunswick plant, is progressive, for it is about to install a dry method concentrating plant, bringing into use the system of separation by means of air blasts.

Limestones.—The limestone industry for general trade is practically confined to one district, viz., Marble mountain, Inverness, N.S., from whence it is shipped as raw stone to Prince Edward Island for burning, or consumed by the pulp mills of the country. Stone for building is sold f.o.b. at 75 cents per ton (2,240 lbs.). Stone for pulp mills is sold f.o.b., at $1 per ton. Prices for lime average about $5 per ton (10 bls. equal one ton) f.o.b., with price of package added. About 35 men are employed in this industry at Inverness. Two other quarries are operated by the Dominion Iron and Steel Company, Limited, and the Nova Scotia Steel and Coal Company, Limited, for flux purposes in the steel works.

Building Stone.—In both Nova Scotia and New Brunswick, granite and sandstone are mined extensively as building stones; since the Carboniferous formations, ranging in thickness from a few inches to nine feet, and having a variety of colours, are peculiarly suited for this purpose. In 1907, the depression in the building trade both of Canada and the United States, affected commerce in building stone business very materially, hence the production was comparatively small.

Brick Clays.—The trade of brick making has hitherto been a lucrative business in both provinces, since there is an unlimited supply of excellent clays for this purpose.

Metallurgical Industry.—Nova Scotia has for years been pre-eminent as a steel producing province. The principal operating establishments are the Dominion Iron and Steel Company; the Nova Scotia Steel and Coal Company, and the Londonderry Iron and Mining Company. The plant of the first named Company, is located at Sydney, Cape Breton, and covers over 440 acres. The works proper, consist of four blast furnaces 85 feet high and 20 feet bosh; ten 50 ton open-hearth tilting furnaces, a 35 inch blooming mill, and pit furnaces; a rail mill of 1,000 tons capacity; a rod mill of 600 tons capacity, and 500 Otto-Hoffman coke ovens in which all the by-products are saved, having a total capacity of 1,600 tons of coke per day. Another feature is a large foundry, also a well equipped machine shop, etc., capable of taking care of all mill and furnace work. Moreover, in connexion with these works, are about 47 miles of railway track, together with complete ore handling equipment, and receiving and shipping piers on the shore. In addition to this combination of manufacturing facilities the Company control their own ore and coal mines, limestone quarries, etc., rendering their organization one of the most complete in existence. This Company was incorporated in 1899, and is capitalized at $20,000,000; and produced in 1906, as follows:—

Pig iron	235,331	tons.
Billets and blooms	17,145	"
Rails	101,245	"
Wire rods	45,553	"

A commendable feature about this unique steel making plant is, that the employees are housed in 250 tenements of neat design, equipped with all modern hygienic improvements.

The plant of the Nova Scotia Steel and Coal Company, is situated at New Glasgow, N.S. The coal and iron mining properties are very extensive: located at Sydney, Trenton, and Belle Isle. The last named area is reputed to contain 6,000,000 tons of red hematite iron ore, with vessel shipping facilities of 1,500 tons per hour. The blast furnace (100 tons per day capacity) is at Ferona, while the steel smelting furnaces, and rolling mills, are at Trenton. The steel works at New Glasgow, have four Siemens open-hearth furnaces of 45 to 50 tons capacity—the output being about 150 tons of steel ingots per day; which are worked up into sheets, bars, and forgings. The Company was originally founded in 1882, and under the last reorganization is capitalized at $7,000,000. Last year the production was as follows:—

Pig iron	57,818	tons.
Steel	53,632	"
Coal (Sydney)	632,163	"
Coal (Pictou)	36,700	"
Iron ore	387,840	"
Limestone and dolomite	57,543	"

Total number of men employed, 4,210.

The Londonderry Iron and Mining Company, Limited, was incorporated in 1902, with an authorized capital of $1,000,000, and on its 30,000 acres of freehold lands, are mines containing large quantities of low sulphur and low phosphorus ores; and these ore bodies, it is claimed, have been traced through the entire length of the property. The general operating plant consists of one blast furnace, 75 feet high, and 18 feet bosh, having hot-blast regenerative stoves, and all necessary accessories. The ore crushing and mixing plant is one of the most modern and economic installations in the country. The Company has also, ninety-seven Bee-hive coke ovens, having a capacity of 150 tons per day; together with a Robinson coal washer, of 400 tons capacity per day. Railways of both narrow, and standard gauge connect all mines with the works, giving short, direct haul, and hence low freight rate. Allied to the pig iron works, is a pipe foundry, where cast iron water pipes are manufactured, and supplied to the cities and towns in the Maritime Provinces.

This somewhat lengthy abstract of Mr. Jennison's report will serve to give a good general idea of the extent and importance of the mineral and metal trades in the Maritime Provinces, and at the same time, obviate the necessity of a preliminary report.

COAL TESTS AT McGILL UNIVERSITY.

A systematic investigation of the coals of the Dominion was undertaken a little over a year ago by the Geological Survey, and is now being continued by the Mines Branch—with the assistance of certain specialists. Sufficient progress has already been made to justify the expectation that the main work on the coals of the Dominion will be completed by the end of next year.

The intention is to obtain a representative sample lot of coal from each important seam in each district, and to subject each of the samples so obtained to an exhaustive series of economic and chemical tests. The economic tests include coal washing, and, when necessary, dry cleaning; followed by boiler tests on the washed, and also on the original unwashed coal. Other portions are to be treated in gas producers, and the gas used in suitable gas engines provided with devices for measuring the power developed. It is proposed also to carry out coking tests on washed and unwashed portions of such coals as are suitable for the manufacture of coke.

In connexion with the above economic tests, a complete series of chemical analyses, and calorimetrical determinations, will be made of all coals. Analyses will also be made of the products of each washing and coking operation, and of the gases from the boiler and producer tests.

The Director has been able to secure the co-operation of the Mining and Mechanical Engineering Departments of McGill University, and thus to obtain not only competent technical assistance and a trained staff of experts and mechanics, but also to get the free use of admirably equipped laboratories.

A gas producer and gas engine plant of the most recent type have been purchased, and installed in a temporary fire-proof structure, which has been built close to the mining laboratories at McGill. To supplement the McGill equipment, other necessary and special apparatus have also been purchased.

The investigation is under the general direction of Dr. J. B. Porter, Professor of Mining Engineering, McGill University, who is individually responsible for the sampling, coaling, washing, and chemical work. The conduct of the boiler tests and producer gas engine experiments has been put in the hands of Mr. R. J. Durley, Professor of Mechanical Engineering, McGill University. The several portions of the work are conducted as follows:—

The economic tests indicated above are being carried out on a scale of approximately 40-50 h.p., and the periods of not less than one day. This scale has been adopted as being at once large enough to ensure practical service conditions, and yet small enough to be of value to a community which, in general, makes much more use of small than of large power plants.

Samples are taken by Mr. Theophile Denis of the permanent staff of the Mines Branch. Mr. Denis visits and examines each mine to be sampled, and has a ten ton lot of coal selected, sacked, and shipped under his own personal supervision. In taking this lot, he uses every precaution to secure average coal, and, as a check on the main lot, he personally secures a smaller sample, which he seals and sends direct to the chemist.

The main sample on arrival at the testing plant is unsacked, crushed to go through a two-inch screen, mixed thoroughly on a large cement sampling floor, sampled for the chemist, and then re-sacked and set out for treatment. This sampling is in charge of Mr. C. Landry, Chief Mechanic of the Mining Department of McGill University.

The coal washing is done in the McGill ore dressing laboratory; the apparatus used being a standard two compartment slide motion jig, built for the Department by the Fraser & Chalmers Company. This jig has been specially remodelled for coal washing work, and is provided with automatic feed and side discharge devices for automatically removing the slate and other impurities. The purified coal overflows into a drainage box in which it is collected and dried. The fine material passing down through the sieves is collected, and is either re-treated or wasted, depending upon its composition. Each of the tests is made on a lot of between three or four tons: which is first crushed, then sized, and then jigged in three separate portions—coarse, intermediate and fine—in order to secure the most accurate possible work. The products both of coal and waste are all recovered, weighed and sampled; but the coarse and fine products are mixed before sending them to the boilers. The coal washing work is checked by a series of tests with heavy solutions, followed by ash determinations. It would, of course, be possible in a laboratory to do extremely thorough washing at an expense disproportionate to the value of the coal; but this is not attempted, the aim being to reproduce commercial conditions. From a series of comparative tests made between laboratory work, and coal washing in standard plants, it is evident that this end has been attained, and the tests as carried on may be taken to represent average commercial work. The coal testing, under the direct supervision of Dr. Porter, has been carried out by Mr. H. F. Strangways and Mr. C. Landry.

Boiler Tests.

During June, July, and August, 1907, a series of thirty boiler trials were conducted in the boiler room of the Department of Mechanical Engineering, McGill University, on coal samples Nos. 1 to 16 (most of which were tested a second time after having been washed) the same boiler being used throughout. The equipment employed in these tests included a Babcock and Wilcox boiler, having 639 square feet of heating surface, and 16·79 square feet of grate area, an independent feed pump, weighing tanks, and standard scales for water and coal; together with the necessary apparatus for determining moisture in steam, analysing flue gases, and observing pressures and temperatures. Provision was made for supplying steam under the grate, and also for working under forced draft if required. The same pattern of fixed grate bars was used throughout the tests, and had air spaces, the area of which was 30 per cent of the total grate area. If different grate bars had been used for different grades of fuel, better economy in some instances would probably have been obtained; but it was felt that by using the same grate throughout, the tests would be more completely comparable with one another.

Before commencing the tests, the boiler was thoroughly scaled, cleaned and tested, and all brick-work around the furnace was rebuilt. Preliminary trials were then made with a standard coal (George creek), which showed that the whole equipment was in good order. The series of regular tests was then begun, the same fireman being employed throughout. It was not found possible to make more than one boiler trial with each sample of coal, and it was decided that in every case the same evaporation of 2,000 pounds of water per hour should be aimed at; this being a rate at which the boiler was known to give nearly its best efficiency. The results of the tests show, therefore, the rate at which each sample of coal had to be burnt in order to furnish a certain supply of steam. As a check, the heat losses in every case were determined as far as possible. All the tests were at least of ten hours duration, and the boiler tubes were, of course, cleaned before each run.

Since the practical working of a coal in the fire has a great bearing on its industrial value as a fuel, continuous notes were made of such points as the condition and thickness of the fire, the nature and amount of ash and clinker formed, the frequency of sluicing and cleaning the fire, and the method of firing found most suitable for each particular fuel.

It is proposed this year to carry out a further series of tests with the same boiler, and by the same methods.

The testing staff, under the general supervision of Mr. R. J. Durley, comprised:—

Mr. J. W. Hayward—in charge of the tests.
Mr. J. Blizard and Mr. D. W. Munn—observers and computers.

Mr. E. Stansfield and Mr. H. F. Strangways also gave considerable assistance.

The actual working of the boiler and auxiliaries was in the hands of:—

F. Balmfirth—in charge of the boiler plant, and J. Hoult—fireman.

Gas Engine and Producer Work.

The greater part of the summer of 1907 was spent in constructing the engine and producer house, and in installing and erecting the gas engine and producer equipment. Owing to the non-delivery of several important apparatus until September, it was not possible to carry out any producer tests. The plant is now nearly complete: the main engine and auxiliary machinery have been tried out; and standardizing tests are now being made as opportunity occurs. It is expected that the whole will be ready to commence regular tests by June 1st.

In deciding on the gas engine and producers to be installed, it was felt that a large producer and engine should not be used; since it is well known that the practical difficulties of working gas producers for power purposes are less in large than in small plants. Hence, it was desired to test, among other points, the suitability of the various Canadian coals for employment in a gas engine and producer plant of a size not beyond the means or needs of the small power consumer. An engine capable of giving 40 b. h. p. was, therefore, chosen. The equipment now in working order includes:—

One 40 B.H.P. horizontal gas engine, 220 R.P.M., single cylinder 12″ diameter, by 20″ stroke. (National Gas Engine Co., Manchester, England.)
One friction brake capable of taking 50 B.H.P.
One standard suction producer (for anthracite coals), with wet and dry scrubbers. (National Gas Engine Co.)
One special Sturtevant gas exhauster.
One tar extracting machine.
One standard gas meter (Pittsburg Meter Co.)
One steel gasometer, capacity 400 cubic feet,

together with the necessary apparatus for gas analysis: indicators, counters, gas calorimeters, electric and other thermometers, and accessories. Preliminary standardizing tests have shown that, on a twenty-four hour run at full load, the plant has a consumption of under 1·3 lbs. of coke per b. h. p., per hour; the calorific value of the coke being 12,800 B.T.U., per pound.

There is also on order, and nearly ready for test, a second producer, of the down draft type, which will be used for such fuels as cannot be burnt in the suction type producer.

This plant was designed, and its installation carried out, under the supervision of Professor R. J. Durley, and the preliminary tests made by Mr. J. W. Hayward. The machinery and its operation have been placed in charge of Mr. J. S. Gardiner, who will superintend the working during the forthcoming tests.

In connexion with this plant it is to be observed that, when, in the early part of 1907, the coal tests were decided upon, no maker could be found who would guarantee the operation of a small gas producer on bituminous coals of the kind met with in many parts of Canada, containing as they do, a large percentage of volatile matter. A producer capable of working only with lignite could have been ordered at that time, but would have been useless for much of the work to be done. It was, therefore, necessary to spend much time in further investigation, and this has led to unavoidable delay in the commencement of the tests. It is possible that unforeseen difficulties may still stand in the way of the utilization of certain of the coals to be tested, but it is believed that the two producers, with the aid of the tar extracting and gas cleaning apparatus now installed, will be capable of giving power gas from any kind of coal likely to be submitted for test.

The coking tests will be deferred until a later date, as it is desirable to first complete the general investigation: analysing and testing the coals as above outlined. It is proposed to have the coking experiments done under separate supervision at one of the large modern coking plants; as laboratory tests on coking have not proved reliable, even when carried out on a very large scale.

The chemical work is done in Dr. Porter's private laboratory, which has been set apart for this exclusive service. In addition to the regular equipment of the laboratory, calorimeters by Ostwald and Boys have been procured, and such other special apparatus as has been found necessary to make the equipment as complete as possible for the investigation of fuels. The chief chemist is Mr. Edgar Stansfield, M.Sc.

Owing to the very tardy deliveries of some of the machinery and apparatus ordered from abroad, and delays due to the disastrous fires which occurred at McGill last April, it was impossible to get work started as promptly as had been hoped; but, nevertheless, the results for the year are very encouraging. Mr. Denis has visited Nova Scotia and New Brunswick, and has taken altogether nineteen samples, aggregating about 175 tons. These samples have all been tested in the boiler plant. Of the coals thus far received, twelve have been sufficiently impure to require washing. These twelve have been washed and the washed material tested in the boiler plant.

This work completes the examination of coals from the eastern section; with the exception of the properties controlled by the Dominion Coal Company—which Company will furnish material during the present year. It is expected to be able to examine the coals from the western fields next season.

There have been completed to date—counting duplicate runs—fourteen washing tests, thirty boiler tests, and a very large number of chemical analyses. In addition to this regular work, there have been numerous experimental operations for the purpose of adjusting and testing apparatus, and for arriving at standard methods of high accuracy. At least three-fifths of all the work done thus far has been of this character.

It may be noted that all colliery managers have offered the Department every facility in taking samples, and have given the coal free of charge.

The railway companies have hauled the coal free in all cases, and have thus relieved the Department from what would otherwise have been a very serious item of expense.

CHEMICAL LABORATORIES.

The two laboratories in connexion with the Department of Mines: one in the Geological Survey Branch building, Sussex Street, conducted by Mr. F. G. Wait, assisted by Mr. M. F. Connor; and the other in the Mines Branch building, Wellington street, conducted by Mr. Harold A. Leverin, have done effective work during the past year. In the former—from November 28, 1908: the date of transfer—140 specimens were examined and reported upon; while in the latter—during the whole year—460 samples were received, and analysed quantitatively: this being in addition to the examination of numerous specimens sent in for identification.

The Wellington Street laboratory, which was established for essentially practical work, has been equipped with complete apparatus for the assaying of gold and silver. For this particular work, as well as in the analysis of iron ores generally, Mr. Leverin's facilities are superior to those available in the Sussex Street laboratory; but it should be pointed out that, much of the work done in the latter place, consists of complicated and time-absorbing rock analyses.

The establishment of a second laboratory, equipped with modern apparatus for electro-chemical analysis, and rapid determinations of the common ores; together with up-to-date instruments, etc., for necessary research work, has brought forth gratifying results; while the combination of the two laboratories has proved to be a harmonious and economic arrangement.

STATISTICS OF MINERAL RESOURCES.

The combined reports of the Division of Mineral Resources and Statistics: one, a statement of the specific work done by the Division—the other, a preliminary statistical report on the mineral production of Canada in 1907 (already issued in pamphlet form)—show that, while the work accomplished is of national importance, interesting alike to manufacturer, investor, and the general public, it is manifestly only in its initial stages, and if improved and augmented along the lines indicated in Mr. McLeish's statement, is destined to be an invaluable factor in contributing to the country's growth in commerce and industry. The Division has been greatly inconvenienced during the past year, through the decrease in the number of technical officers on the staff, viz., from three to one. And although the commerce and trade of the Dominion have been increasing with rapid strides, and hence entail additional labour in compiling the necessary data of progress, there has been no increase in the clerical staff, which consists of two clerks only. If the work of the Division is to keep pace with the development of the mineral and metal resources of the Dominion, and the statistics published are to be comprehensive, exhaustive, and thoroughly reliable, it will be necessary, not only to increase the present office staff, but to organize a sectional field force for the gathering of statistical data, on mining and metallurgical industries; fuels and non-metallic minerals—such as asbestos, gypsum, salt, abrasives, etc., and structural materials—including clay products of all kinds.

The suggestions of the chief of the Division of Mineral Resources and Statistics are the result of repeated conversations had with him, and therefore, have my unqualified endorsation.

DOMINION OF CANADA ASSAY OFFICE.

VANCOUVER, B.C., May 13, 1908.

During the fiscal year ended March 31, 1908, 46,540·25 ounces of bullion, valued at $751,693·97, were received and assayed. These deposits were derived from the following sources:—

Source.	Deposits.	Weights.		Value.
		Before melting.	After melting.	
	No.	Oz.	Oz.	$ cts.
Yukon	70	9,108·12	8,937·23	150,592 21
British Columbia	396	34,347·69	33,403·98	553,458 53
Northwest Territories	2	67·14	57·24	1,054 37
Ontario	2	36·23	32·61	393 25
Alaska	12	2,981·07	2,974·79	45,835 61
	482	46,540·25	45,405 85	751,693 97

	Oz.
Weight before melting	46,540·25
Weight after melting	45,405·85
Loss by melting	1,134·40
Loss percentage by melting	2·4374

The following table shows the business done by the Assay Office since its establishment:—

Fiscal Year.	Deposits.	Weights.	Value.
	No.	Oz.	$ cts.
1901–2	671	69,925·67	1,153,014 50
1902–3	509	36,295·69	568,888 19
1903–4	381	24,516·36	385,152 00
1904–5	443	29,573·73	462,939 75
1905–6	345	21,050·83	337,820 59
1906–7 (9 months)	269	20,695·84	336,675 65
1907–8	482	46,540·25	751,693 97

The following is a statement of difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office from April 1, 1907, to March 31, 1908:—

Value bars, Seattle Assay Office..................	$774,720 01
Value bars, Dominion of Canada Assay Office.........	773,726 55
	993 46
Less—Profits chargeable to 1906-7..............	47 83
Difference in favour of Dominion of Canada Assay Office..........................	$945 63

Statement of Deposits of Gold and Earnings.

Deposits of gold..........................		$773,726 55
Less—Bar purchased in 1906-7 on hand March 31, 1907, and included in above..................		22,032 67
Net deposits, 1907-8..........................		$751,693 88
Earnings—		
Value of sweeps sold to Jos. Mayer & Bros...	$371 73	
" silver recovered from solution sold to Jos. Mayer & Bros............	69 69	
" residue and cornets sold to Assay Office, Seattle....................	1,085 74	
" 85 empty Winchester bottles sold to B. C. Assay and Chemical Supply Co.	12 75	
For three special assays..............	7 50	
	$1,547 41	
Difference between amount paid and received for bullion....................	945 63	
		$2,493 04
Percentage of net expenses to deposit........	1·43187	

The following is a statement of appropriation, receipts and expenditure for the year ended March 31, 1908, and shows the unexpended balance to be $5,236.66.

	Appropriation.	Expenditure.
Appropriation 1907-08..........................	$16,000 00	
Receipts per the foregoing statement.............	1,547 41	
Difference between amount paid and received for bullion..	945 63	
Rent account..............................		$2,100 00
Fuel account..............................		322 51
Power and light...........................		139 51
Postage and telegrams......................		86 76
Telephone................................		66 20
Express charges...........................		629 92

	Appropriation.	Expenditure.
Assayers supplies.		250 50
Printing and stationery.		53 28
Premium on bonds.		570 00
Contingencies.		108 51
Wages—		
G. Middleton.		2,500 00
J. B. Farquhar.		1,700 00
D. Robinson.		1,500 00
Thos. Evans.		429 19
E. Tierney.		820 00
A. Kaye.		1,600 00
G. B. Palmer.		345 00
C. Fitch.		35 00
Balance.		5,236 66
	$18,493 04	$18,493 04

Unexpended balance March 31, 1908, $5,236.66.

Inventory of Residues and Supplies on Hand in Assayer's Department, March 31, 1908.

Proof gold.	15·28 oz.
Proof silver (large discs).	110·02 "
" (small discs).	37·29 "
Cupels, about.	8,000
Bone-ash, about.	10 lbs.

1 Winchester, NH_4 HO.
$\frac{1}{3}$ " HCL.
14 " HNO_3.
8 spare muffles.
50 2½″ scorifiers.
10 4″ "
9 fireclay muffle supports.
24 " plugs.
13 " end pieces.
8 " doors.
100 lbs. C.P. lead foil.

J. B. Farquhar,
Chief Assayer.

Supplies on hand in the Melting Department.

3	sets of linings, with supports and covers complete, for No.			1	furnace.
3	"	"	"	2	"
2	"	"	"	4½	"
2	"	"	"	7	"

35	graphite crucibles..............................	No. 10
50	"	16
61	"	30
23	"	40
65	" ....marked	° ° ° °
6	crucible covers..............................	16
10	"	35
11	"	50
2	graphite stirrers.	
9	lbs. pot. nitrate.	
60	lbs. carb. soda.	
69	lbs. borax glass.	

D. Robinson,
Chief Melter.

Changes in Assay Office Staff.

Mr. Geo. McCaw, assistant melter and janitor, resigned on account of ill health, April 9, 1907.

Mr. Thos. Evans, appointed to succeed him on May 22, 1907. Resigned November 13 1907. Succeeded by Mr. G. B. Palmer.

Proposed New Assay Building.

The rent paid for the building occupied by the Dominion of Canada Assay Office in Vancouver, B.C.—since its establishment in 1901, is as follows:—

July 1901 to July 1906 at $1,200 per annum.
July 1906 to July 1908 at $2,100 per annum.

Present lease for 17 months from July 1, 1908, at $2,700 per annum.

During the seven years of occupancy the rent has increased 125 per cent.

In view of this high rental, it was deemed advisable to take a lease for seventeen months only, and I strongly recommend that, in the meantime, steps be taken to establish the Assay Office in permanent quarters, by the purchase of a suitable lot, and the erection of a properly designed fire-proof building.

Proposed Transfer of Gold to the Royal Mint at Ottawa.

When the original plans for the Royal Mint of Canada were first prepared, I recommended in a memorandum to the Hon. W. S. Fielding, Minister of Finance—under date November 5, 1901—that provision be made for a refinery in connexion with same. This suggestion was based upon the following reasons: (1) That there are no refineries in Canada. (2) That the only available bullion coming to the Mint from Canadian sources, would be unparted bars from the assay offices of the Dominion: representing gold dust and nuggets from the gold bearing districts: averaging 725 fine, and containing silver, copper, and other base metals. (3) That this alloyed bullion would have to be sent to the refineries of either the United States or Great Britain for conversion into fine bars suitable for coinage. (4) That this plan would prove to be very inconvenient, if not impracticable; hence the proposed establishment of a refinery at Ottawa. This recommendation is now to be carried out, and instead of the unparted bars of gold from the Dominion Assay Office in Vancouver, B.C., being sold to the Seattle Refinery of the United States government, I recommend that this bullion be—in the near future—transferred to the proposed refinery in connexion with the Royal Mint at Ottawa.

REPORT OF THE ACCOUNTANT.

Statement of Appropriation and Expenditure by Mines Branch, for year ending March 31, 1908, showing Unexpended Balance to be $16,027.64.

	Appropriation.	*Expenditure.*
Amount voted by Parliament	$55,000 00	
Civil government salaries		$3,991 66
Publication of reports		246 24
Travelling expenses		187 30
Peat pulping machine		297 57
Publication of maps		409 22
Investigation *re* gas producers		236 53
Furniture account		99 83
Investigations *re* copper deposits		30 40
Laboratory		2,161 31
Miscellaneous		338 97
Wages		17,987 25
Instruments		2,020 15
Printing and stationery		1,045 29
Books and periodicals		355 17
Investigations *re* iron ores		2,221 48
Investigations *re* peat and coals		1,282 52
Mineral statistics		900 96
Mining and metallurgical industries		4,902 19
Mapping material		258 32
Balance unexpended and lapsed		16,027 64
	$55,000 00	$55,000 00

Jno. Marshall,
Accountant, Dept. of Mines.

During the year, numerous requests were received from all parts, for information on the mining and metallurgical industries of the Dominion; on reported mineral occurrences and deposits and for advice on the economic smelting of ores: particularly by the electro-thermic process. The correspondence for the fiscal year ending March 31, 1908, amounted to 3,772 communications received, and 2,706 letters sent out—not including the correspondence in connexion with the Division of Mineral Resources and Statistics.

I have the honour to be, sir,

Your obedient servant,

EUGENE HAANEL,

Director of Mines.

PRELIMINARY REPORT ON THE IRON ORE DEPOSITS OF VANCOUVER AND TEXADA ISLANDS.

April 2, 1908.

Dr. EUGENE HAANEL,
Director of Mines
Department of Mines,
Ottawa.

SIR,—In accordance with your instructions to make an investigation of the iron ore deposits on the coast of British Columbia, with a view to furnishing information for an eventual iron industry, I left Ottawa, June 2, 1907, for Victoria, B.C., to get information regarding localities of reported iron ore occurrences. I desire to express my appreciation of the unfailing courtesy of Mr. W. F. Robertson, Provincial Mineralogist, and all others who have given aid and information in connexion with my work.

In attempting to give a description of the iron ore occurrences of the coast, one is immediately confronted with the fact that, with very few exceptions, the locations have not received any more development than the mining law of the Province compels the holder to do. The development work done is, therefore, limited to surface strippings, shallow open cuts and tunnels. This is quite natural; for as long as the property owners had no positive assurance of a market for their iron ore, they could not, or would not, invest more capital in developing their claims than was necessary to meet the requirements of the mining laws. Since this development, these claims were crown granted, and have been allowed to remain untouched. As a result, trails have become overgrown by brush; making it in some places difficult even for a person well acquainted with the locality to find the locations.

The districts visited were:—

Sooke, Gordon river, Sarita, Cooper island, Severals claims in Alberni canal, Anderson lake, Seshart, Maggie lake, Kennedy lake, Head bay (Nootka sound), West arm (Quatsino sound), June group, Ingersoll river, Klaanch river, Quinsam river, Salt Spring island, and the Iron Mines (Texada island).

In this report, only those properties which are more likely in the near future, to be commercially important will be dealt with: leaving the others visited, for the final report. Some of these latter may possibly, by further development, prove to be of some commercial value, while others have absolutely no features to indicate that they will be iron ore producers.

GENERAL NATURE OF ORE DEPOSITS.

With the exception of the bog ore deposits at Quatsino sound, and a small deposit of hematite on Salt Spring island, which in places seems to change into magnetite, all the properties visited show magnetite. There is, moreover, a remarkable similarity amongst these different deposits of magnetite, so far as geological conditions are concerned. They all are in the immediate vicinity of crystalline limestone, if not in contact with it, and occur where it is in close proximity to igneous rocks.

The examination of the main geological features of Vancouver island was made in 1885 by the late Dr. G. M. Dawson, and I beg to refer you to the report of the Geological Survey of Canada for 1886 for the geological description.

The magnetites of the coast are high in iron, and few, if any, have a phosphorus content exceeding 0·05 per cent, in most cases considerably below this figure. On the other hand, they are, as a rule, high in sulphur, though not to such an extent as to render them unfit for smelting.

Gordon River District.

The Gordon river flows from the north into Port Renfrew, or Port San Juan, as it is locally known, which is about sixty miles from Victoria on the west coast of Vancouver island. Up this river and its principal tributaries, the country rocks are chiefly crystalline limestones and igneous rocks, of which granites and diorites are most in evidence. A considerable number of mineral locations covering showings of magnetite have been made here, but many of them will not prove of sufficient body to warrant mining, and seem to have been staked, more for the purpose of keeping other parties out of the field than for their ore contents. On the other hand, some promising prospects were noticed, on two of which more development had been done than one usually finds to be the case on the island.

The Baden-Powell and Little Bobs mineral claims are situated up the Gordon valley about seven miles from salt water. An outcrop of magnetite is found on the flank of a ridge, along which it can be traced for 350 feet. In several places on the ridge a sharp contact between the ore and the granite was observed. About ninety feet below this contact a tunnel 114 feet long had been run directly into the hill, showing magnetite for its full length, with the exception of a diorite dike eight feet wide about thirty feet from the mouth of the tunnel.

An average sample of the ore taken along the tunnel gave the following analysis:—

	Per cent.
Silica	8·88
Iron	58·30
Sulphur	2·75
Phosphorus	0·013

About thirty-five or forty feet below this tunnel another tunnel had been run in the same direction for 114 feet into the hill, going through limestone and diorite. The last few feet, however, show magnetite dipping in towards the hill.

The *Sirdar* mineral claim is situated two miles farther up the valley, and is very similar to the Baden-Powell and Little Bobs. The magnetite outcrops along the face and brow of a ridge for about 160 feet. About fifty feet below the top of the ridge a tunnel had been run 103 feet into the hill, showing the width of the ore to be about eighty-two feet. An average sample taken along the tunnel gave the following analysis:—

	Per cent.
Silica	8·52
Iron	56·57
Sulphur	2·75
Phosphorus	0·121

The *Conqueror* mineral claim is situated a little farther up the valley on Bugaboo creek, which flows into the Gordon river. The claim is some nine miles from the navigable water of Port San Juan. A solid body of magnetite about forty feet high is exposed in the canyon of the creek, and over which the creek forms a water fall. The ore has a maximum width of about sixty-three feet on the east side of the creek, but becomes narrower on the west side. On the east side, the ore body is stripped for about eighty feet from the creek to where it runs into the gravel bank. At the foot of the bluff a tunnel fourteen feet long had been run into the ore, showing solid magnetite. A sample taken along the tunnel gave the following analysis:—

	Per cent.
Silica	4·51
Iron	67·09
Sulphur	1·60
Phosphorus	0·009

On the up stream side the ore body is confined by a diorite dike, six feet wide, crossing the creek nearly at right angles. Beyond this dike, outcrops of magnetite were noticed on both banks of the creek for a distance of about sixty feet, and on the east side for fifteen feet farther. Here, in several places, the ore seems to lie as a blanket on top of a green igneous rock. A couple of hundred feet east of the creek some outcrops of magnetite were reported to have been struck by strippings, but the workings had caved in at the time of my visit. Between these strippings and the creek a strong magnetic attraction was noticed in several places. From the existing development, it was, however, impossible by a superficial examination to get any exact information as to the extent of the ore body, or bodies, as the solid formation is effectually covered by a sandy loam. A magnetometric survey would undoubtedly give a large amount of information here.

The same may be said about the *David* mineral claim, east of the Conqueror, and adjoining Sirdar on the west side. Within a distance of 400 feet along a slope, some strippings have exposed a good magnetite in several places, but do not give sufficient information to warrant an estimate of the extent of the ore.

Head Bay.

Head bay forms the upper end of Tlupana arm, Nootka sound. On a ridge running north-west and south-east, four outcrops of magnetite can be seen at intervals along a contact of crystalline limestone and diorite, about a mile from the deep water of the bay. These outcrops are from 170 to 200 feet long, and from 40 to 55 feet maximum width. A little farther south, several smaller outcrops were noted, showing that there is, undoubtedly, strong mineralization by iron here. Up to the present time, no work has been done to show the extent of the ore, with the exception of one place where some stripping had been done, and an open cut made into the ore, showing the width to be about fifty-five feet. The ore here is of an excellent character, a sample taken along the open cut giving the following analysis:—

	Per cent.
Silica	6·10
Iron	66·17
Sulphur	0·017
Phosphorus	0·016

West Arm Quatsino Sound.

The country north of the west arm of Quatsino sound, has, during the last few years, attracted much attention, owing to the discoveries at several points, of limonite in the form of bog ore. Many of the claims staked do not show any indication which can warrant the supposition that the ore is in commercial quantities, but must be considered as another case of undue prominence being given to minute objects.

I wish to mention a group of claims which give the best showings of bog ore, more on account of the character of ore than their importance as shown by surface indication. These claims are situated about one mile from navigable waters, five miles west of Coal harbour. They lie in and on the border of swampy basins, and partly on the ranges of hills adjoining these. The ore has been exposed by some strippings and open cuts, and a number of outcrops are also visible in the banks of some small creeks. The ore in these bogs owes its origin to the alteration of iron pyrites, with which the surrounding hills are heavily charged. Although bog ore deposits have been utilized under favourable conditions in certain parts of Canada and other countries; here, as the overlying soil is in many places quite deep, and the ore often mixed with peat, stumps, etc., which must—at least in part—be removed from the ore, economic exploitation is, in my opinion, somewhat doubtful. Whether the extent and thickness of ore would warrant the cost of mining, only a systematic drilling of the properties can determine.

Average samples of the ore from two locations gave the following analyses:

	I. Per cent.	II. Per cent.
Insoluble matter	2·32	1·40
Iron	54·46	56·97
Sulphur	0·150	0·447
Phosphorus	0·038	0·038

Klaanch River.

Nimpkish lake, which is about fifteen miles long and one mile wide, empties through Nimpkish river into Broughton strait, at a point directly opposite Albert bay. The Iron Crown mineral claim is situated about seven miles up the Klaanch river, which flows northwest into the south end of Nimpkish lake. An exposure of magnetite extends along the face of the river bank for some 180 feet. The height of the bank is about eighty or one hundred feet, forming at same points, cliffs of magnetite twenty-five to thirty feet high. The top of the bank is covered with soil, and no work had been done to ascertain the width of the deposit; but to judge from the magnetometric survey made, the width at the south end may be estimated at not less than one hundred feet, decreasing towards the north. A sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter	4·12
Iron	64·23
Sulphur	0·233
Phosphorus	0·008

Farther up the hill, about 650 feet from the river, several showings of magnetite occur along the ridge, indicating the length of the deposit to be about 360 feet. The width may be estimated at sixty feet. An average sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter	5·30
Iron	63·89
Sulphur	0·017
Phosphorus	0·010

No more outcrops were visible, but the magnetic curves north of these two deposits show two others, one of which is about 480 feet in length. A chart of vertical magnetic intensity showing the extent and location of these will accompany the full report.

Quinsam River.

The Quinsam river is a tributary to the Campbell river, which flows into the strait of Georgia at a point about thirty-five miles north of Comox, and directly opposite the south end of Valdes island. The mineral claims are situated up the Quinsam river, about thirteen miles from the coast. Magnetite outcrops on the north bank of the river, in a bluff about eighty feet high. Part of the face of this bluff has been stripped for fifty-three feet in width, showing solid magnetite, without having uncovered the contacts with the country rock. About forty feet above the river a tunnel had been driven into the hill, following the strike of the ore. The tunnel was sixty-six feet long, entirely in magnetite.

A sample taken along the tunnel gave the following analysis:—

	Per cent.
Insoluble matter	7·00
Iron	56·45
Sulphur	0·530
Phosphorus	0·014
Copper	0·700

Another sample taken across the face of the bluff above the tunnel gave the following analysis:—

	Per cent.
Insoluble matter	11·00
Iron	59·77
Sulphur	0·533
Phosphorus	0·024

Following the crest of the ridge in a NNW. direction, some outcrops and surface strippings were noted, showing the ore to be continuous for a distance of about 350 feet. The ore is generally free from admixture with country rock, though containing some sulphides of copper and iron. On the south side of the river some small outcrops of magnetite may be seen along the slope, and strong magnetic attraction observed in several places. The deposits being covered with soil, the extent of the ore could not be observed without a more detailed magnetometric study, of which the time did not permit. A few hundred feet farther up the valley, a seam of coal outcrops on the north bank of the river.

Texada Island.

The iron ore deposits which occur on the western slope of Texada island, from three to four miles north of Gillies bay, have been known for many years, and were taken up for iron mining as early as 1875. The principal ore deposits are on the Prescott, Paxton, and Lake properties.

The *Prescott* has received the most development, and has during several years, shipped ore to Irondale, Washington. The magnetite outcrops about 850 feet from the shore, in a big bluff on the brow of a steep, rocky hill, at the contact between granite and crystalline limestone. The deposit has been opened at three levels. At an elevation of 365 feet an open cut had been made into the hill, showing magnetite penetrated by granite dikes. Sulphides of copper and iron are also common here. The second level is situated forty feet above. A considerable amount of ore has been taken out from an open cut, which shows, now, a face of magnetite forty feet wide, and about one hundred feet high.

The ore here includes small patches of calcite and fragments of volcanic rocks, forming in places a species of ore breccia. More or less sulphides of copper and iron are also present.

A sample of the ore dump gave the following analysis:

	Per cent.
Insoluble matter	6·46
Iron	62·57
Sulphur	0·403
Phosphorus	0·024

The third level is situated sixty feet above the second, at an elevation of 465 feet above sea level. The face of the quarry is about fifty feet high and fifty feet wide, showing the same kind of ore as at the second level. The thickness of this ore body, can be estimated at about eighty feet. A sample of the ore gave:—

	Per cent.
Insoluble matter	12·00
Iron	58·76
Sulphur	0·113
Phosphorus	0·011

About 430 feet below the top of the bluff, at about 130 feet above sea level, a tunnel had been run into the hill under the quarry. The length of the tunnel is 630 feet, going through granite and felsitic rocks, and showing solid magnetite for the last seventy-five feet on the west side of the tunnel, and for forty-five feet on the east side. A sample of the ore taken along the tunnel, gave the following analysis:—

	Per cent.
Insoluble matter	4·37
Iron	63·27
Sulphur	0·347
Phosphorus	0·006
Copper	0·09

From the Prescott mine the contact between the limestone and the eruptive rocks may be followed for about 1,200 feet farther up the hill, and after making a sharp bend, down hill again for about 800 feet; it then takes a more easterly direction, making some windings to the Paxton mine, and thence to the Lake mine. Strong magnetic attraction in some places, and numerous outcrops of magnetite were noted along this contact, some of them reaching a width of about seventy feet. As the rock formation is to a great extent covered by soil, the magnitude of these deposits could not be ascertained; but the character of these contact-deposits on the borders of the granite indicates the importance of closely examining the contact of the eruptive rocks with limestone. On account of the lateness of the season, a magnetic survey could not be performed.

The *Paxton* mine is situated about 3,500 feet east of the Prescott mine. An outcrop of magnetite extends along the face of a ridge for some 500 feet. Two open cuts had been run into the hill, passing through granite—which seems to form the hanging wall—and then into ore. From the face of the east cut, a tunnel forty-five feet long, shows solid magnetite, carrying some sulphides of copper and iron.

A sample taken along the tunnel, gave the following analysis:—

	Per cent.
Silica	4·47
Iron	64·48
Sulphur	1·87
Phosphorus	0·002
Copper	0·22

The *Lake* mine is situated about 1,300 feet to the east of the Paxton. The ore can be traced along the face and brow of a ridge for some 200 feet. The height of the ore bluff is about eighty feet, with a maximum width on the surface of about 100 feet. Crystalline limestone forms the footwall, and a diorite overlies the ore in places. An open cut had been made in the ore body, showing a good clean magnetite. About 1,000 tons of ore are reported to have been shipped last summer. An average sample of the ore gave the following analysis:—

	Per cent.
Silica	8·33
Iron	59·57
Sulphur	0·137
Phosphorus	0·024
Copper	0·08

From what has been said, it may be understood that it is impossible from present developments to give actual figures as to the ore in sight, without doing injury to the owners of certain properties; but with a fuller development, the better properties should be capable of supplying a modern blast furnace for many years. A well equipped and properly managed plant, using these magnetites, thoroughly roasted, could produce a good quality of pig iron.

FUEL.

In regard to fuel, the east coast of Vancouver Island has a good supply of coal. The output from the collieries is estimated for the year, at 1,325,000 tons of coal. During the year, about 17,000 tons of coke were made. The Provincial Mineralogist of British Columbia reports the coke to contain from 15 per cent to 16 per cent ash; but thinks that, by a more careful separation of shale from the coal, the ash could be reduced to about 12 per cent with very low phosphorus contents.

FLUXES.

The limestones frequently met with on the coast are exceptionally pure, and free from deleterious elements, and offer, therefore, a good flux. The supply may be said to be practically unlimited. An analysis made at the laboratory of the Department of Mines gave:—

	Per cent.
Insoluble matter	1·0
Iron oxide and alumina	0·5
Calcium carbonate	97·0
Magnesium carbonate	0·7

TRANSPORTATION.

Cheap transportation of the raw materials is one of the most important factors in a successful iron industry. The many inlets which indent the coast and the islands of British Columbia, offer great advantage to transportation; as the iron ores, limestone, and coal deposits are situated in nearly all cases close to these navigable waters. Navigation being open the year round, offers still another advantage to the blast furnace man and the miner; saving them from large expenditure in stocking and rehandling the raw materials. It may, therefore, be said that the coast of British Columbia is singularly fortunate as regards cheap assembling of raw materials.

LABOUR AND MARKET.

So far, the conditions have been found favourable for the establishing of an iron industry on the coast; but when the question of labour and market is considered, the matter is somewhat different. The cost of labour is higher in British Columbia than in the other provinces of the Dominion, and this province may not, for some years to come, have a sufficient market to support an iron industry. A large market is certainly offered by the western United States, but is protected by a custom duty of $4 per ton on pig iron. It is questionable therefore, whether it would be possible for a British Columbia smelter to compete in the American market—under present conditions—with other iron producers of the world.

Not having had the opportunity, as yet, to gather sufficient information and figures in regard to this matter, I propose to take up the question at greater length in my full report.

Yours respectfully,

(Signed) EINAR LINDEMAN.

INVESTIGATION OF CERTAIN ALLEGED IRON ORE DEPOSITS IN QUEBEC AND ONTARIO.

(Report of B. F. Haanel, B.Sc.)

OTTAWA, January 11, 1908.

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—In accordance with your instructions, I visited—on June 3, 1907, the iron property of Dr. James R. Reed, of Reedsdale, Que., situated near Kinnears Mills, Megantic county, Quebec; for the purpose of examining the work done in diamond drilling.

On September 8, I left for Penetanguishene, Ont., to examine, and, if possible, make a magnetic survey of some alleged iron ore deposits; and, on October 9, went to Cairnside, Que., to investigate reported occurrences of iron ore.

Owing to the work of editing the monographs on 'Graphite,' and on 'The Iron Ore Deposits along the Ottawa and Gatineau rivers,' by Fritz Cirkel, M.E., it was impossible to carry out the original work planned for the summer months, viz., the examination of the iron ore deposits along the Kingston, and Pembroke railway; and Central Ontario railway; to complete the report of the iron ore deposits of Ontario. The following is a detailed report of the above-mentioned field work:—

Iron Ore Property near Kinnears Mills, Megantic County, Que.

Two years ago, having made a magnetic survey of this property—completed about June 22, 1905—I prepared a preliminary map of the vertical intensity of the ore field, on which was located the position for a drill hole, necessary to determine the value of this iron ore deposit. Up to the present time the owner has not done any drilling or boring, to prove the value of the property. In January, 1907, however, an option to buy, was given to a Chicago party, with the understanding that 500 feet of diamond drill holes would be put down. This option was soon after sold to Mr. Drummond, who began work with a Sullivan diamond drill.

After several week's boring, the operator succeeded in putting down only 115 feet of holes; and as these bore-holes were not placed according to the directions on the official map, the owner began to doubt whether his property was being properly proved; hence, the application to the Department of Mines.

Upon arriving at Kinnears Mills, I found that the men had been ordered to stop work, and that the drill, and auxiliary machinery had been taken off the property, and moved to the railway station—a distance of some ten miles.

The two holes drilled, consisted of one vertical, close to an outcrop, and the other, situated about 250 feet north-west and 60 feet south from this, drilled at an angle of 45°, or perpendicular to the dip of the ore body.

Accurate measurements of the positions of these two holes were taken, and indicated on the map in the office of the Mines Branch, showing the vertical intensity of the general deposit.

As the cores taken from the holes had been packed, and sent to Montreal, there was no opportunity of forming an opinion as to the justification of putting down the holes in the positions mentioned above; although the second hole was placed very near the position originally indicated on the map, and which would—if put down to a sufficient depth—have determined the extension of the deposit in depth, and the feasibility of further development.

According to a resident of Kinnears Mills, who was employed by the man operating the drill, the first hole penetrated 25 feet of schistose rock and some calcite, and about 40 feet of magnetite, after which the foot wall, consisting of schist, was struck.

The second hole penetrated 15 feet of schist, when the work was stopped.

Judging by means of the work done, no rational conclusion as to the value of the property could possibly be adduced—even if the drill cores had been available for examination; since the only hole which might have been of use in helping to form an opinion, was only put down to a depth of 15 feet: not deep enough to penetrate even the hanging wall of the deposit.

Examination of Reported Occurrences of Iron Ore at Penetanguishene, Ont.

Following your directions, I went on September 8, 1907, to Penetanguishene, Ont., to make an examination, and if necessary, a magnetic survey of some occurrences of iron ore, said to exist there.

The properties on which there was reported to be iron ore, were lot F, con. 19, Simcoe county, Tiney township, about eight miles from the town of Penetanguishene; and Park lot 53, west of Park street, within the town of Penetanguishene.

It was found that both the above-mentioned lots, as well as the country in the vicinity, were entirely free from magnetic disturbance due to the presence of a magnetic ore body, and hence precluded the possibility of a magnetic survey.

In the first lot examined—Park lot 53, in the town of Penetanguishene, near the Grand Trunk Railway tracks, which run through the lot—was a spring which carried in solution a small amount of iron, precipitated as yellow ochre on the bottom and sides of the small rivulet which was discharged from it. This yellow ochre was too small in amount to render it of any commercial importance.

Surrounding this lot, No. 53, on the south, and east, and three or four hundred feet from the spring, were terraced beaches, presumably covered by Lake Huron in past ages. As these beaches contain some hematitic, and magnetic iron sands, it is evident that the iron carried in solution by the water issuing from the spring, had its origin in the beaches; having been leached out by the action of rain, and the melting of snows.

About 2,000 feet from Georgian bay, on lot F, con. 19, Simcoe county, there is a deposit of bog iron ore, or paint ore, on the side of the hill. Similar patches occur on different parts of this hill, and two samples from the most promising were selected for analysis: one a light yellow, and the other a reddish brown earthy bog ore. (See following analysis).

On the top of this hill is a bog filled with roots, decomposed leaves, etc., which was once covered with large trees—elm, pine and oaks; but these have been cut down, leaving only a few trees, not suitable for lumber. A hole dug 4 or 5 feet deep, slowly filled with water, and revealed nothing more than a dark soil below. On the side of the hill containing the deposits of bog ore, a shovel put down about a foot in several places, proved the thickness of the bog ore to be not more than 12 inches in maximum thickness.

About 2,000 feet from this bog, traces of hematitic, and magnetic iron sands could be seen along the beach washed by the waters of Georgian bay; and although no traces of these sands were discovered in the above-mentioned hill, or elevated land, it is probable that the deposits of bog iron ore referred to, were also leached out by rain and the melting of snows, as in the case of the lot previously examined in the town of Penetanguishene.

Owing to the thick vegetation and underbrush covering the side of the hill, it was not possible to form an estimate of the extent of the deposit, or determine whether deposits other than those visible exist. Stripping will have to be done, or shallow test pits put down, in several places, in order to thoroughly prove this property; but from general indications it would not be advisable to spend much money thereon.

The following are the analyses of the two samples selected:—

Sample No. 1, colour yellow—

	Per cent.
Fe	37·52
S	·122
P	·150

Sample No. 2, colour dark reddish brown—

	Per cent.
Fe	38·06
S	·102
P	·179

Occurrences of Bog Iron Ore at Cairnside, Quebec.

According to information received at the Office, from the party who found the deposit of iron ore at this place, the dip needle used by him indicated the existence of a magnetic field, but on testing the field very carefully in several places, I found no indication whatever of a disturbance of the earth's field occasioned by a magnetic ore deposit, the field being perfectly normal. This precluded the possibility of making a magneto-metric survey.

With the exception of limestone, which occurs two miles to the north-west of this place, Potsdam sandstone is the only rock met with for many miles. The sandstone in the region is very easily disintegrated, and in places is metamorphosed to a quartzite. According to an analysis of a representative sample, the country rock carries 0·6 per cent of metallic iron.

The reported occurrence of the iron ore, consisting of a small cone-shaped mound which I found to be bog ore, is on the line between 865 and 866 of range 4, of Jamestown, St. Malachi de Ormstown parish, Chateauguay county, Quebec, and is located in a clay bed near a small creek or rivulet.

According to Mr. Greig, who owns this property, the small deposit of bog ore (Limonite) above referred to, was thrown out of a well which was found immediately adjoining, partially filled with earth and debris. In digging to a depth of a little more than a foot in the bottom of this well, a solid bed of clay was reached, and test pits put down in several parts of this field in the vicinity of the well, revealed the same bed of clay.

An examination of the mound of bog ore showed it to be the deposit of a spring long since dried up. Another spring a few miles from this one is still actively depositing an iron oxide in the form of a cone.

Along the roads can be seen a red discoloration due to the iron oxide deposited, and the earth in several places is coloured red by this means; but no deposit of iron ore of economic importance was found, or, in fact, any indication which would point to the existence of one.

As mentioned above, the country rock is easily disintegrated, and as it contains about 1 per cent of metallic iron, it is evident that the iron carried in solution by the drainage waters and deposited along the roads and in fields has its source in the ferruginous Potsdam sandstone.

CHEMICAL LABORATORY.

SUSSEX STREET SECTION.

(F. G. Wait, M.A., F.C.S., and M. F. Connor, B.Sc.)

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—Since the laboratory of the Geological Survey was placed under the direction of the Mines Branch, of the Department of Mines, 140 specimens have been examined and reported upon.

For convenience, these may be arranged as follows:—

I. FOSSIL FUELS, comprising

(1) *Lignite*, 6 samples, from

(*a*) Ontario—

i. Drift, or detrital matter, consisting of a mixture of small more or less rounded particles—⅜ of an inch or less in greatest diameter—of pyrite, lignite and fossil resin, said to have been taken at a point about five miles north of New Liskeard, Ont., where a very small quantity occurs scattered through, and embedded in, the clay subsoil. This material has, not improbably, been carried, by glaciers or other agencies, from the lignite, which occurs in the area drained by the Missinaibi river.

(*b*) Alberta—

i. Tp. 52, R. 7, west of 5th meridian.
ii. Tp. 52, R. 15, west of 5th meridian—'Wolf creek.'
iii. Tp. 53, R. 7, west of 5th meridian—'Jocks Crossing,' Pincher creek.
iv. Tp. 54, R. 16, west of 5th meridian—'McLeod river.'
v. Tp. 54, west of 5th meridian.

(2) *Lignitic coal*, 4 samples, from

(*a*) Alberta—

i. Coal creek, a tributary of Prairie creek, which is an affluent of the Athabaska river—samples from a thirty inch seam, being the first exposure at Genest's first stake.
i. From an eight foot seam at the same locality.
iii. North half Sec. 28, tp. 15, R. 27, west of 4th meridian.

(*b*) British Columbia—

i. Collins gulch.

(3) *Coal*. 22 samples, from

(*a*) Nova Scotia—

i. Richmond mine—three and a half miles from Port Richmond, Richmond county.
ii. Big Marsh, Antigonish county.

aa. An average sample of the whole of the five to eight foot seam.
bb. Selected fragments from the same exposure.

I. Fossil Fuels—*Continued.*

(*b*) Alberta—

i. Brazeau river, south-east of big seam; eight feet.
ii. Brazeau river—stream between the river and McEvoy's trail.
iii. South Brazeau river—'W. Gamble' claim—six samples.
iv. South Brazeau river—'Daly' claim.
v. Bighorn river—'H. B. McGiverin' claim—three samples.
vi. Sec. 9, tp. 7, R. 3, west of 5th meridian—three samples.

(*c*) British Columbia—

i. Skeena district, Morice river, 'Dockvill'. coal—three samples.
ii. Okanagan lake.

(4) *Semi-anthracite.* One sample, B.C.—locality not specified.

(5) *Anthracite.* One sample—
British Columbia—Hudson Bay mountain.

II. Iron Ores.

(*a*) Nova Scotia—
Limonite from Kingsbury, Lunenburg county.

(*b*) Ontario—
Magnetite from vicinity of Clarendon station (K. and P. R'y), Frontenac county.

III. Copper Ores.

(*a*) New Brunswick—
Vicinity of Dalhousie—Copper, metallic, 1·12 p.c.

(*b*) Quebec—
Shefford county—Metallic copper content—5·33 p.c.

IV. Brick and Pottery Clays.

(*a*) Manitoba—
i. Clay shales from LaRivière. Six samples.

(*b*) Alberta—
i. Vicinity of Medicine Hat.

(*c*) British Columbia—
i. Cascade mountain.

V. Natural Waters.

(*a*) Quebec—
i. From an artesian boring, in Ste. Cunegonde, a suburb of Montreal.

(*b*) British Columbia—
i. From a hot spring on a small island of the Queen Charlotte group.

VI. Furnace Assays for gold and silver, from

(*a*) Nova Scotia—
Three miles from James River station, Antigonish county.

(*b*) Ontario—
i. Montreal River district.
ii. Larder Lake district.

VI. FURNACE ASSAYS for gold and silver—*Continued.*

(*c*) British Columbia—

i. Hootalinqua river. Four samples of black sand obtained by washing the gravels of the river bed from the following points:—

(*a*) From a bar at Six Mile cabin, 6 miles from the mouth of the river.

(*b*) From O'Brien and Cumming's bar, about forty to forty-two miles from the river mouth.

(*c*) From a point about sixty miles up stream, and one mile below the mouth of Boswell river.

(*d*) About seventy miles up from mouth of the river.

Content, expressed in grains per cubic yard of gravel—calculated on the basis of 125 pans to the cubic yard:—

Sample.	Gold.	Silver.	Platinum.	Osmiridium.
a	98·6	20·2	2·3	trace
b	18·8	2·8	1·2	0·025
c	20·8	4·4	0·34	
d	15·6	2·4		

VII. MISCELLANEOUS.

Under this group are placed some eighty-five specimens of minerals and rocks, which were obtained in various parts of the Dominion, and required an examination, a description, or a partial analysis.

i. Of these, mention might be made of (i) a limestone from Guysboro' county, Nova Scotia, and

ii. A magnetite from a point not well defined, but situated some eighty miles west of Port Arthur, Ontario, near the line of the Canadian Northern railway.

VIII. ROCK ANALYSES.

Good progress has been made in the analyses of rock specimens, collected in

(*a*) Quebec, by J. A. Dresser, M.A.

(*b*) British Columbia, by R. W. Brock, M.A., and Dr. R. A. Daly.

In carrying out the work referred to in this summary, all that indicated under the headings 'Furnace assays' and 'Rock analyses' has been conducted by M. F. Connor, B. Sc.; whilst the remainder has been done by myself.

Respectfully submitted,

F. G. WAIT,
Chemist.

OTTAWA, March 31, 1908.

WELLINGTON STREET SECTION.

(Harold A. Leverin, M.E.)

Dr. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—The following is the report of my work since March 23, 1907.

Apart from numerous specimens sent to this laboratory for identification, 462 samples in all were received and analysed quantitatively. The larger part of these consisted of iron ores collected by the field staff: Dr. Woodman, Fritz Cirkel, M.E., and E. Lindeman, M.E. Eight complete iron ore analyses were made. Samples containing about 45 per cent and more in iron ore were generally analysed for silica, iron, sulphur, phosphorus, lime, magnesia, alumina, and titanium—if any. In sixty-five samples from diamond drill cores from Austin brook, N.B., only iron, insoluble matter, sulphur and phosphorus were determined, as the composition of the gangue had been determined the previous year. A number of samples of low grade iron ores contained less than 40 per cent iron, hence no other determinations were made in these cases.

The samples were of the following character:—

Iron ore	301	Cobalt ore	1
Gold and silver ore	38	Molybdenite	1
Chrome	32	Alloy	6
Copper	26	Limestone and dolomites	16
Iron pyrite	5	Clay	16
Nickel ore	2	Fuel	5
Platinum ore	2	Sandstone	3
Lead ore	2	Slag	2
Tin ore	2	Roasted iron pyrite	1
Antimony ore	1		
		Total	462

The number of determinations made were:—

Iron	315	Cobalt	2
Ferrous oxide	23	Tin	1
Gold	43	Antimony	1
Silver	38	Silica	94
Copper	42	Silicon	4
Manganese	6	Insoluble matter	108
Chromium	32	Sulphur	193
Titanium	29	Phosphorus	186
Lime	112	Combined water	4
Magnesia	112	Moisture (in fuel)	6
Alumina	92	Volatile matter (in fuel)	6
Nickel	4	Fixed carbon (in fuel)	6
Lead	3	Ash	6
Platinum	3	Heat value of fuel	3
Alkali	3		
			1,477

The laboratory, the installation of which was completed last spring, has been considerably improved during the year by additional valuable instruments and appliances. A complete outfit for gold and silver assaying has been installed, consisting of a muffle and a melting furnace on one iron table,—of American Gas Furnace Company's make, also a very sensitive Troemner Button Balance, and various tools. The air blast for the furnaces is supplied by a Rothwell blower.

In order to obtain suitable current for electrolytic deposition of metals, a rotary transformer was put in to charge a storage battery of six cells of 2·5 volts each. For measuring the current one low reading voltmeter and amperemeter with scales respectively 0 – 15 volts and 0 – 5 amperes were purchased. The rheostat—of the ordinary circular coil of wire and lever type, enclosed in enamelled box—has a resistance of 20 ohms.

Yours respectfully,

H. A. LEVERIN,
Chemist.

OTTAWA, March 31, 1908.

REPORT OF A VISIT TO SOME GAS PRODUCER PLANTS IN AND AROUND NEW YORK CITY, AND TO THE UNIVERSITY OF ILLINOIS TESTING LABORATORY.

(*By B. F. Haanel, B. Sc.*)

In view of the proposed installation of an experimental fuel testing plant in connexion with the Mines Branch of the Department of Mines: and that this plant may be designed with due regard to economy, and the equipment modern in every respect, the writer visited a number of gas producer and gas engine plants in New York city and vicinity, also the testing laboratory of the University of Illinois. The metropolitan city of the United States was selected as a centre for the general investigation of existing systems, upon the advice of expert engineers and business men having special knowledge on this subject: who all agreed that, in New York the greatest number of the various types of producer plants could be seen, without entailing much travel, while the university testing laboratory inspected, was selected because it was reputed to have comparatively the best mechanical equipment for gas producer and gas engine testing; besides the additional advantage of having the State Experimental Fuel Testing Station within the university buildings.

The specific objects of this investigation were (1) to obtain accurate information with regard to the difficulties encountered in the practical operation of gas producers, and gas engines using producer gas. For this purpose, it was deemed desirable to inspect plants using bituminous, as well as those using anthracite coal—especially bituminous; since this coal has a similar mode of action in combustion, to lignite and peat: which fuels are to be mainly experimented upon in the proposed fuel testing plant, (2) to obtain reliable data concerning the practical working, and the methods of testing gas engines, including a knowledge of the latest apparatus employed for measuring the volume, quantity, and power of gas.

At the outset, several days were spent in the New York offices of the Westinghouse Machine Company—one of the largest manufacturers of gas engines and gas producers. The officers of this Company generously furnished a list of the power plants in and around New York city, using producer gas; together with a detailed description of their own system of gas engines and auxiliary equipment; and at the same time imparted valuable information with regard to notable installations by other makers, both near and far. In addition, much valuable data was given on modern methods of systematically sampling and measuring gas.

Other New York firms visited, were, the Industrial Gas Company—manufacturers of gas producers, the Rotary Meter Company, and Messrs. Eimer and Amend.

PLANTS VISITED AROUND NEW YORK CITY.

(1) Atha Tool Company, Newark, N.J.
(2) Rockland Electric Company, Hillburn, N.Y.
(3) Erie R. R. Power house, Jersey City, N.J.
(4) American Watch Case Company, Jersey City, N.J.
(5) Strobel and Crane, Newark, N.J.

Atha Tool Company, Newark, N.J.—The installation here, consists of two Loomis-Pettibone gas producers, which furnish both water-gas and producer gas: the former being used for heating; the latter for power purposes.

This producer is of the down-draft type, and consists of two cylindrical, plate iron shells, lined with fire brick, placed side by side, and connected at the tops by a fire-brick lined pipe. The tops are provided with charging holes which can be closed or opened at will. Pipes, fitted with valves, lead from the bottoms of these producers to the bottom of an economizer, which is simply a vertical, tubular boiler.

When making producer gas, the charging holes of the producers, and the valves of both pipes leading to the economizer are opened, a downward draft is then created by means of an exhauster, which draws in atmospheric air through the charging holes in the producer top, down through the fuel bed, where the oxygen in its downward course combines with the carbon of the fuel, to form carbon monoxide. This gas (CO), is drawn through the bottom of the producer into the economizer, through which it ascends, and is discharged at the top, into a scrubber, and from thence is finally drawn into a gas holder. The hot gases in passing through the economizer meet a large surface presented by the vertical tubes within the economizer shell; and the water which fills these tubes absorbs part of the sensible heat of the gas, and is vapourized, the sensible heat of the gases at the same time being much reduced.

When the fuel bed becomes incandescent, the top of the producer is closed, also one of the valves connecting the bottom of the producer with the economizer. The steam generated in the economizer is then admitted under pressure through the bottom of the producer; and in passing through the incandescent fuel, is decomposed—forming water gas.

This process of making water gas, and producer-gas respectively, is alternated at intervals of about five minutes according to the quality and quantity of gas required.

The plant was originally intended for the making of water-gas only; but recently a power plant consisting of four vertical Westinghouse gas engines, direct-connected to electric generators, was installed, having a combined capacity of 539 h.p.

The engineer in charge of the producer plant, made the statement that, twice as much producer gas was allowed to escape into the air as was required to run the entire plant. This, however, could not be verified.

The producers were fired with high grade bituminous (Pocahontas) coal. No trouble was experienced with the formation of clinkers, and poking was seldom resorted to.

In order to determine the heat value of the gas, a Junker's calorimeter was installed; but this has been discarded. The quality, and heat value of the gas is now determined by the colour of the flame of the gas generated.

No reliable figures concerning coal consumption, nor the number of hours the engine is run, could be obtained, hence no estimate of the fuel efficiency of the plant could be made But, even though data could be obtained, it would be of little value, since two kinds of gas are being made and it is quite impossible to determine the amount of gas escaping into the air.

The engines ran very smoothly, required little attention, and no trouble was observed from back firing, or premature ignition; demonstrating the fact that, the producers were furnishing a gas of uniform quality, and well suited to the engines.

Rockland Electric Company, Hillburn, N.Y.—This plant is equipped with three sets of Loomis-Pettibone producers, similar to those described above; it will be only necessary, therefore, to describe some interesting details peculiar to this installation.

While the plant was originally designed to furnish both water gas, and producer gas, for heating and power to the iron works in the vicinity, it is now used for generating producer gas only, for power purposes.

Steam is only blown into the producer to break up the formation of clinkers, and to keep the fuel bed soft; and this is said to be necessary only once a day; and sometimes, only once a week. The producers are operated by down draft entirely; the economizers taking no part in the formation of the gas.

The economizer connected with one of the producers has been stripped of its tubes, and lined with fire brick; the gases being drawn through the fuel bed into the bottom of this receiver, (formerly economizer) and thence to the scrubbers. This receiver could be dispensed with entirely; in which case the two producers would operate independently of each other: in other words, would constitute two separate units. The economizer shell was left intact, and lined with fire brick in order to save as much expense as possible in making the necessary alterations. It is true this receiver tends—to a very small extent—to lower the temperature of the hot gases, and at the same time allows some of the dust in the gas to settle in the bottom.

With this new arrangement, the producers will be dependent on some external source for steam to be blown into the fuel beds in the event of clinkering badly. For this purpose, a small horizontal boiler close by, will furnish the necessary steam.

When visiting this plant, the alterations above referred to were being made; consequently, under these unusual conditions, no reliable data derived from the normal working of same could be obtained. The attendant in charge of the producer plant is confident, however, that the change will be beneficial.

The two producers which were in operation at the time of the writer's visit, were giving entire satisfaction; poking was required only occasionally, and no clinkers of large size were being formed.

The quality, and heat value of the gas—determined by means of the optical qualities of its flame—appeared to be rather lean; the heat value is, however, said to be fairly high, and gives good results when burnt in the gas engines.

It was impossible—for the reason indicated—to obtain any reliable information from the attendants as to the coal consumption, analysis of the coal, and the load upon the engines; but apparently the producers were not forced at all; in fact were under-loaded rather than over-loaded. In this case, the producer would work much cooler than when working up to full-load, or over-load. Since no moisture is being introduced—other than that contained in the air and coal—it is natural to suppose that whenever worked hard, the producers would become too hot to be operated efficiently, or else become exceedingly difficult to handle.

The cooling apparatus of this plant was not designed to cool gas as hot as would be furnished under the above conditions; the gas would, therefore, be too hot to prove effective in the gas engine. It is safe to assume that, a producer operated without the introduction of additional moisture, cannot on account of the high sensible heat of the gas, prove a successful medium for the generation of gas for power purposes.

The engine equipment consists of two, double cylinder, double acting, Westinghouse gas engines, of approximately 600 h. p. each, direct-connected to Westinghouse electric generators. This is the main equipment.

Besides these engines, there are two Westinghouse, double acting gas engines of old model, of about 300 h.p.—each direct-connected to electric generators—and one, vertical, Westinghouse gas engine of about 125 h. p., used for driving the exciter. The former engines are used when the two large units are closed down for repairs, or for other reasons; and to help out when the load becomes excessive. The entire installation has a sum total of 2,100 horse power.

While visiting this plant, the two large engines, and the smaller one driving the exciter, were running smoothly, requiring no attention for regulating air supply, etc. No premature ignitions, or back firing were noticeable, and the writer was informed that no trouble from this source was experienced.

The gas furnished by these producers seems well suited to this particular type of engine, and the load they normally carry; but, as previously mentioned, trouble might, and probably would, be occasioned when the producers were over-loaded, or even run to their full capacity; since without the use of steam, or moisture other than that contained in the fuel and air, the temperatures in the producers would become excessive, causing fusion of the coal and walls of the producers; and the formation of large, unmanageable clinkers; thus producing uneven combustion, and as a consequence, poor, lean gas. Such a plant, in the writer's opinion, could not operate efficiently under any circumstances.

ANTHRACITE PRODUCERS.

Erie Railroad Power House, Jersey City, N.J.—Two 'Wood,' pressure producers of old model, using anthracite coal, of pea size, furnish gas to the gas engines for the electric light and air compressor plant.

The two producers are automatically fed, and require the attention of only one man per shift. A small vertical boiler furnishes steam. The valve in the live steam pipe leading from the boiler to the producers, is automatically controlled by means of a rope attached to a lever on the steam valve: which passes over a pulley above the valve, thence over a pulley on the top-work of the gas-holder, the free end being attached to the moveable part of the gas holder. The end of the rope attached to the lever of the steam valve, is provided with a weight which keeps the line taut; so that any movement of the gas holder, in either an upward, or downward direction, is immediately transmitted to the steam valve. Thus the steam entering the producers is gradually shut off as the gas holder fills, and is gradually opened as the gas holder empties. By this simple device, just enough steam is admitted to furnish the required amount of gas needed to run the engines.

The gas generated is forced into the scrubbers, coolers, and gas holder, by means of the pressure of the steam.

The tops of the producers are furnished with poke holes, provided with heavy caps to prevent the escape of gas. When necessary to poke the fuel bed, in order to break up clinkers, or distribute the fuel evenly, the steam is shut off, and the caps covering the poke holes removed. During the writer's visit, this process was not resorted to, and he was told that the attendant seldom had to poke the fires.

Steam is furnished to the producers at a pressure of about 90 pounds.

The producers are not continuous in their working; for their operation has to be suspended whenever the ash pit doors—situated in all cases at the extreme bottom of the producers—are opened for the removal of the ashes.

This plant worked smoothly, requiring but little attention, and furnished gas of good quality—but there is trouble, sometimes, with back firing and premature ignition; due probably to the content of hydrogen being too high. This trouble, however, is not serious. The plant has been in operation for some years, and seems to give satisfaction.

The engine equipment consists of one, 85 h. p. Westinghouse gas engine; and two horizontal 'Otto' gas engines, of rather old type.

American Watch Case Company, Jersey City, N.J.—This installation consists of one Suction gas producer, of Industrial Gas Company type—using anthracite coal, (pea size); furnishing gas for both heating, and power. In this producer the air is drawn down through the hot fuel bed of the gas producer, thus generating producer gas by means of the suction of the gas engine piston. The operation of a suction producer is similar to that of a down-draft producer: in which the air is drawn through the producer by means of an exhauster; but the term 'suction producer' is applied only to those which employ the suction stroke of the gas engine for creating the draft through the producer.

An evaporator is a distinctive feature of the Industrial Gas Company's producer. The hot gases drawn through the fuel bed of this producer pass first through the evaporator, imparting some of their sensible heat to the water trays in its interior. These trays are so arranged, that water is continually flowing over them. In this way a certain amount of water vapour is formed, which mixes with the atmospheric air drawn over these trays, and passes into, and through the producer.

The gases, after passing through the producer, enter a scrubber, and cooler, in which the gases are cleaned, and their sensible heat further reduced.

After passing through these different apparatus, the gas is said to be very clean, and causes no trouble to valves, etc., when burnt in the gas engine.

This type of producer, is furnished with a water seal bottom, which renders its operation continuous; i.e., it is not necessary to discontinue operations when removing ashes, as is the case with all the producers previously described.

A Westinghouse vertical gas engine, using the gas from this producer, furnishes power for various purposes.

Unfortunately, this plant was not in operation at the time of my visit; and as it had been installed only a very short time, little information, or data, concerning the working could be obtained.

Strobel and Crane, Newark, N.J.—The plant here, consists of an anthracite, suction producer, of like design to that last described; except in one detail.

The capacity is about 100 horse-power, and supplies gas for a 100 h.p. Westinghouse, vertical gas engine.

Instead of a water seal bottom, this producer is furnished with a closed ash pit; thus rendering its operation intermittent. In this particular only, does this producer differ from the one last mentioned.

One attendant not only looks after the producer and gas engine, but also operates a lathe.

It is necessary to charge the producer about once every two hours; and for this purpose, a bucket holding about two hundred pounds of coal is hoisted over the feeding hopper, and emptied into it. This hopper is provided with a bell operated by a steel bar; thus preventing both the escape of gas, and admission of atmospheric air.

This producer, also that last described, are furnished with poke holes, provided with heavy caps.

Inasmuch as the writer was unable to make, or witness any tests on this, or the other producers described, the following results of a four weeks' continuous test on a 500 horse-power horizontal gas engine, Westinghouse type, and a R.D. Wood bituminous producer, installed at the plant of the American Locomotive Company, Richmond, Virginia, is added.

This test was independently made, in the interest of the Company for which it was installed; hence may be regarded as unbiased as far as the manufacturers are concerned.

DETAILS OF PLANT.

Engine.—Westinghouse double-acting horizontal type, two cylinders, 23½ inch x 33 inch, two impulses given to a crank shaft at each revolution. Total weight of gas engine, 175,000 pounds.

Producer.—R. D. Wood, Tennessee type (Bell's evaporator, Rotary tar extractor).

Guarantee—

1·92 lbs. of coal	per K.W.H.	at full	load	300	K.W.
2·10	"	"	¾	"	225	"
2·64	"	"	½	"	150	"

Producer gas to have minimum heat value of not less than 120 effective B.T.U. per cubic foot, at 62° F., and thirty inches mercury; and to be free from injurious amounts of tar, water, dust and sulphur. Gas to be supplied at not less than four inches water pressure, and at a temperature not exceeding 100° F. All gas delivered to have 70½ per cent of effective heat value of coal gasified in the producer. 70½ per cent represents the efficiency of the producer.

Measurements.

Measurements of power were taken at the switchboard in the engine-room from the Thompson Recording Wattmeter, No. 1231395, type E, 1200 amperes, 250 volts. This instrument was calibrated July 31, 1907, at the testing laboratory, Twelfth Street station, of the Virginia Passenger and Power Company.

Test.

The test extended over four consecutive weeks, six days per week.

First week under ½ load.
Second week under ¾ load.
Last two weeks under full load.

Coal.

The coal record was handled as follows:—Each wheelbarrow full of coal was weighed as it was brought down upon the producer platform, and a small sample of coal was taken from it. From the samples accumulated during the day's run, an average sample of about two quarts was taken, placed in a sealed jar, and shipped to the laboratory for analysis. The analysis of samples of coal are shown in the following table:—

Average Analysis of Coal.

B. T. U.	14703
	Per cent.
Volatile matter	22·80
Moisture	·299
Fixed carbon	72·396
Ash	4·465
Sulphur	1·001

RESULTS.

Test commenced 7 a.m., August 12, and ended at 12 noon, September 7, a period of 629 consecutive hours. Actual time operated during the test was 484 hours—223 hours was full load, 125 hours three-quarter load, and 136 hours one-half load. Total kilowatt hours produced was 119,900. Total coal consumed during operation 217,206·44 pounds. Total coal consumed during test (coal during week-end shut down added) 222,319·14 pounds. During the period of actual operation 1·811 pounds of coal burned per kilowatt hour. During the entire test, 1·885 pounds coal burned per kilowatt hour (including priming, i.e., standby coal).

GENERAL.

Tar produced at full load during 223 hours operation, 443 gallons. Ash produced during 223 hours operation at full load, 66 cubic feet. Gas engine jacket water, average rate of flow in gallons per hour during 223 hours, full load, 2990. Water condensed in gas main during 223 hours at full load, 382·25 gallons.

The engine operated during the entire test without a single shut down—except those regularly scheduled at the week-ends.

ECONOMY.

GAS ENGINE TEST RECAPITULATION.

—	Priming coal.	Production coal.	K. W. H.	Test — Lbs. coal per K. W. H.	Guarantee — Lbs. coal per K. W. H.	Load K. W.	Actual average load.	Hours actual operation.
Week Aug. 12–17 inc......		47,775	21,710	2·01	2·64	150	159·6	136
Priming Aug. 19........	1,697							
Week Aug. 19–24 inc......		54,143	28,540	1·89	2·10	225	228·3	125
Priming Aug. 26........	1,769							
Week Aug. 26–31 inc......		63,691	38,460	1·66	1·92	300	307·6	125
Priming Aug. 31.... ...	146							
" Sept. 1........	288							
" Sept. 3........	491							
" Sept. 3	722							
Week Sept. 3-7 inc...	1,697	51,498	31,190	1·65	1·92	300	319·2	98
	5,113	217,206	119,900	1·81 Priming not inc. 1·86 Priming inc.			247	484

	K. W.	Hours operated.	Coal gasified.	K. W. H. produced.	Average load.	Lbs. coal per K. W. H.	Guarantee.
Full load..........................	300	223	115,289	69,650	312·33	1·6539	1·92
Three-quarter load..........	225	125	54,142·86	28,540	228·3	1·8970	2·10
Half load..........................	150	136	47,774·58	21,710	159·63	2·2005	2·64

The above memorandum of test results was furnished by one of the engineers to the Westinghouse Machine Company, 10 Bridge street, New York city; and is incorporated here, for the purpose of showing the economy that may reasonably be expected when using a bituminous coal over a long period of actual operations at various loads; although the particular coal used was of a very high grade.

Rotary Meter.

A volume of gas, subject to varying pressures—such as exists in a suction gas producer plant—is very difficult to measure, except when passed into a gasometer. This it is often desirable to dispense with, for the sake of economy, or other reasons. When the gas is passed into a gasometer, any effective gas meter is capable of measuring the quantity of gas flowing from the gas holder into the engine. To take the place of a gasometer, the Rotary Meter Company have put on the market a rotary meter, coupled to an anti-pulsator, which equalizes the gas pressure before entering the meter proper.

When this meter, and anti-pulsator is used in a gas engine installation—using gas from the city main, for example—it is said that, the gas bags can be dispensed with, and in certain cases even the engine governor. As to the possibility of using such a meter in connexion with a suction gas producer plant, no definite information, or data could be obtained at the New York office of the Rotary Meter Company. They had no such meter on exhibit; but reference was given to the Canadian agents of this Company—The Economical Gas Apparatus and Construction Company, 269 Front street, East, Toronto, Ont. An expert engineer of the Westinghouse Machine Company gave it as his opinion that a rotary meter might be suitable for measuring gas in a suction producer plant.

The rotary meter takes up little room—much less than the ordinary meter, and runs for a long period with gas containing dust and tarry matter, without requiring cleaning. This meter is reputed to be an accurate machine for its purpose.

JUNKER'S GAS CALORIMETER.

In almost all commercial concerns using gas for heating or power purposes, whether producer gas, natural gas, or city gas, the Junker calorimeter is used for determining the heat value, *i.e.*, the number of calories produced per unit of volume of the gas.

The determination of the heat value of combustible gases takes place in this calorimeter by a state of permanency being established in the same: in which the heat developed from a constantly burning flame is entirely transmitted to an evenly flowing stream of water. The operation of this calorimeter is thus continuous, *i.e.*, the heat value of the gas continuously burnt in the calorimeter, can be calculated with but little trouble at any moment, or whenever desired.

Since this investigation took place, one of these calorimeters has been purchased, and will be used in connexion with the fuel testing experiments to be officially conducted in Ottawa at the plant of the Mines Branch.

University of Illinois Testing Laboratory.—This institution is equipped with a 60 h. p. Otto suction producer, and a 10 h. p. horizontal Otto gas engine, also a large Sargent, double cylinder, tandem, complete expansion engine, for making producer and gas engine tests.

Up to date the gas producer has been used only for making gas to drive the Otto engine. The large Sargent gas engine, at the time of the writer's visit, had not yet been connected up.

No tests were being made on the producer and gas engine during the writer's visit; but the head of the department of mechanical engineering, and Director of the State Experimental Fuel station, very kindly instructed his assistants to furnish all the information at their disposal concerning the testing of producers, and gas engines.

Mr. C. M. Garland, Instructor in Mechanical Engineering, kindly furnished the following forms for the making of a producer and gas engine test:—

Form for Gas Engine Test.

Data and results of test of. . . . . .gas engine.
By. . . . .
Object of test. . . . .

Dimensions of Engine.

Rated h. p. at. . . . .
Diameter of piston. . . . .
Area of piston. . . . .
Length of stroke. . . . .
Piston displacement. . . . .
Clearance. . . . .
Diameter piston rod. . . . .
Diameter crank pin. . . . .
Scale of indicator spring. . . . .
Length of brake arm. . . . .
Duration of trial, hrs. . . . .
Brake load, lbs. . . . .
Gas, total cubic feet. . . . .
Gas, cu. ft. per hr. at 32° F. and 14·7 lbs. (by meter).
Air, total cubic feet. . . . .
Air, per hr. cu. ft. at 32° F. and 14·7 lbs. . . . .

Ratio air to gas by weight..............................
Jacket water, total lbs..............................
" per hr. lbs..............................
" temperature entering..............................
" temperature leaving..............................
Exhaust gas. Temperature..............................
Room temperature..............................
Revolutions, total..............................
" per hour..............................
" per minute..............................
Explosions, total..............................
" per hour..............................
" per minute..............................
Gas weight of a cu. ft. (Determined from volume and analysis; or by weighing).
Air weight of a cu. ft.
Mixture weight of a cu. ft.
Specific heat, gas (calculated from specific heat of different components as given by analysis).
Specific heat of air..............................

Specific heat exhaust gas (calculated as above, from analysis), B.T.U. of gas per cubic foot at 32° F. and 14·7 pounds.

Results.

Maximum pressure, pounds per square inch..............................
Compression, pounds per square inch..............................
M.E.P. forward stroke..............................
M.E.P. compression stroke (determined by special test or from the regular indicator card).
I.H.P. ....
B.H.P. ....
Friction H.P. ....
Mechanical efficiency ....
Weight of gas per hour, pounds..............................
" air " " ....
Gas per I.H.P. Hr. at 32°, and 14·7 pounds cubic foot..............................
" " pounds..............................
" B.H.P. Hr. " " cubic foot..............................
" " pounds..............................
B.T.U. in gas ....
B.T.U.'s supplied per hour..............................
" absorbed by jacket = weight × rise in temperature.
" " " per cent..............................
" " exhaust = weight × specific heat × rise in temperature + B.T.U. in mixture present + B.T.U. in unburned Co. and H.
" in exhaust, per cent..............................
" per I.H.P. ....
" " I.H.P., per cent. ....
" " B.H.P. ....
" " B.H.P., per cent. ....
" absorbed in friction ....
" lost by radiation, etc., (determined by differences)..............................
" " per cent ....
" per I.H.P. Hr. ....
" " B.H.P. Hr. ....

Thermal efficiency from I.H.P..............................
" " B.H.P. ....

FORM FOR GAS PRODUCER TEST.

Data to be taken.

1. Weight of coal fired.
2. Weight of water used or evaporated from boiler or economizer.
3. Weight of ash.
4. Ultimate analysis of coal and heating value. Analysis of ash.
5. Cubic feet of air supplied.
6. Cubic feet of gas given off.
7. Analysis of gases given off.
8. Determination of the heating value of the gases.
9. Determination of the moisture in the gases.
10. Determination of tar and dust in the gases.
11. Temperature of room.
12. Temperature of gases leaving producer.
13. Temperature of gases leaving scrubber.
14. Weight of scrubber water used.
15. Temperature of scrubber water entering.
16. Temperature of scrubber water leaving.

Principal Quantities to be Calculated.

(*a*) Dimensions of producer.
(*b*) Coal per hour.
(*c*) Coal per square foot of grate surface per hour.
(*d*) Steam or water used per pound of coal.
(*e*) Cubic feet of air supplied per pound of coal.
(*f*) Weight of air supplied per pound of coal.
(*g*) Cubic feet of gas given off per pound of coal.
(*h*) Heating value of the gas per cubic foot.
(*i*) Total heat in coal.
(*j*) Total heat in gas.
(*k*) Efficiency of producer $= \frac{\text{Heat in gas}}{\text{Heat supplied by coal}}$.
(*l*) Heat lost in scrubber.
(*m*) Heat lost in Co_2 in gas.
(*n*) Unaccounted for loss.

In the foregoing form, the water is supposed to be vapourized by the sensible heat of the gases passing through the economizer, or vapourizer; but if this vapour is supplied from some independent source, the coal consumed in vapourizing the water passing into the producer, must enter into the calculation, as part of the total coal consumed.

Also, if the down draft is created by means of an exhauster, driven by a motor, or other power, independently of the heat produced by the coal consumed in the producer, then, the coal equivalent of the energy absorbed in doing this work must be added to the total coal consumed, and the coal equivalent of the energy absorbed in pumping and forcing the water through the scrubbers and coolers, must be added to the total coal consumed in the producer.

The head of the Department of Applied Chemistry, Professor S. W. Parr, explained the methods in vogue at the Illinois State Experimental Fuel station, of collecting samples of fuel for analysis, and gave the writer the opportunity of observing the determinations of the calorific value of many samples of coal, both by the Atwater Bomb calorimeter and the Parr Standard calorimeter.

The samples of coal are obtained at the mines from the surface of car lots ready for shipment, in amounts varying from 40 to 50 pounds, and shipped in sacks to the laboratory.

Immediately upon receipt of the material, it is reduced by quartering in the usual manner. A chuck sample, buckwheat size, is taken, and another part is ground to pass through a 100-mesh sieve, and sealed in a 'lightning' fruit jar.

In cases where time is an important factor in the determination of the calorific value of fuels, the Parr calorimeter is specially suited, because it is very easy to manipulate, and is independent of external sources of oxygen. The oxygen required for the complete combustion of the coal is derived from sodium peroxide, united with the sample of fuel. The sample of fuel, and the sodium peroxide, are placed in the bomb, and mixed together by shaking.

The determinations by this calorimeter are said to check within 50 to 60 units with those of the Atwater Bomb calorimeter, which is sufficiently accurate for almost all classes of work, except where extreme requirement is desired.

While it was not the purpose of the writer to inspect experimental plants in order to collect data on the behaviour of fuels when burned under a boiler; nevertheless, the interpolation of a few notes made on this branch of the testing laboratory of the University of Illinois may be of some value.

The equipment for making boiler tests, with different kinds of fuels, and the arrangement of apparatus, etc., is excellent.

The boiler plant is a very large one, and consists of boilers of the most approved design. Most of these steam generators are equipped with automatic stoking devices, with which, highly successful results have been achieved.

The problem of abating the smoke nuisance, has been studied here, and the experiments in this direction have demonstrated the fact that, by proper stoking the dense clouds of smoke issuing from the boiler stacks can be very materially decreased, and in most cases entirely avoided.

The boilers are admirably arranged for the taking of samples of flue gas, etc. And, as the laboratory for the analysis of these samples is placed on a balcony, or suspended floor, situated very near the boilers, the gas samples can be drawn therefrom, directly, by means of a system of piping connecting the boiler to the laboratory.

Much excellent work has been done by this Institution along the lines of improving the efficiency of the steam generator, and steam engine, but as yet, very little has been done in the direction of improving the gas producer, and gas engine.

Now that the available coal supply—once looked upon as inexhaustible—is rapidly decreasing, the interest of the State governments in the United States, possessing fuel deposits of some kind, has been awakened to the necessity of discovering more economical methods in the use of fuel; and many of these States are already considering the advisability of establishing experimental fuel testing stations, whose function it will be, to determine by experimentation, the most effective methods of converting the potential energy stored in the different natural fuels, into useful work.

Seeing that wood cannot now be considered a source of fuel; and that the anthracite coal deposits of the United States will probably be exhausted in about fifty years; while the bituminous deposits in North America are being rapidly depleted, the importance of conducting experiments for the purpose of discovering a substitute for, or of decreasing the extravagant waste of, our fuel resources, cannot be overestimated.

REPORT ON THE WORK OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

(John McLeish, B.A.)

This Division was transferred from the Geological Survey Branch to the Mines Branch on June 19, 1907. Its functions are described in paragraph (*a*), section 6, of 'The Geology and Mines Act,' of 1907, viz., 'to collect and publish full statistics of the mineral production, and of the mining and metallurgical industries of Canada, and such data regarding the economic minerals of Canada as relate to the processes and activities connected with their utilization, and to collect and preserve all available records of mines and mining works in Canada.'

Formerly, part of the work specified above, had been undertaken in the Geological Survey, by the Division of Mineral Statistics and Mines—known latterly, as the Mines section. This section was organized in 1886, and its duties were described in paragraph (*d*), section 5, of the Acts respecting the Department of the Geological Survey.

The routine work of the Division during 1907 has been carried on much as usual, though under some difficulties; due (1) to the absence on sick leave for six months in the early part of the year of Mr. Ingall, Mining Engineer to the Geological Survey, in charge of the Mines section; (2) to the temporary disorganization caused by the transfer of the records, files, and general equipment of the Division, from the Museum building on Sussex street, to the Thistle building on Wellington street; and generally the reduction in the numerical strength of the staff; Mr. Ingall having remained as a field officer in the Geological Survey.

In January, blank forms for statistical returns, were, in accordance with the usual custom, sent out to mining companies throughout Canada, and by March 1, sufficient information had been received to compile the summary of the mineral production in Canada, in 1906—subject to revision; which was at once printed, and distributed. In connexion with the early publication of this preliminary report, acknowledgments are due to the various provincial mining Bureaus for their hearty co-operation in furnishing estimates of the mineral production in the several provinces; also to several of the railway corporations, for furnishing statements of the shipments of ores from stations on their lines. Although the figures of output are subject to some variation in the final report—necessarily published much later in the year, the early publication of the material in this form is very useful; since the statistics, and general résumé of the mining progress given, furnish a fairly approximate estimate of the mineral output during the year.

Previous to the publication of this preliminary report, there was completed, and distributed on February 24,—to those immediately interested—a statement covering the production, sales and imports, etc., of Portland cement during 1906, and previous years. This statement was very favourably received by the cement manufacturers, and others; and a similar method of procedure might with great advantage be followed in other lines of the mineral industry. Comparative promptness on the part of mining operators, however, is essential to success in this class of work; as it can easily be seen that one or two delinquent correspondents may easily delay for days or weeks the issue of a whole report

It is the desire, and object of the Department, not only to furnish the public with the means of obtaining a broad knowledge of Canada's mining industries and resources and to supply information that shall attract and assist the investment of capital in the development of these resources; but also, to be of as great service as possible to those directly interested in our mining industries.

The annual report of the Mines section for the year 1905, was completed and sent to the printer on or about the 14th of January. The proofs were corrected and revised by the officers of the section, and the completed report distributed about the 29th of July.

The decrease in the strength of the staff, as a result of the transfer of the work from the Geological Survey—where it consisted of three technical officers and two clerks—has contributed to the delay in the compilation of the final report on the mineral industries of Canada during 1906. The material, however, is well in hand, and should shortly be ready for publication.

In addition to the collection and compilation of mining statistics, and the preparation of the annual reports, the attention of the staff is required in several important directions: such as keeping up-to-date, a general index of mineral occurrences; selecting and clipping from the mining and general press information pertaining to mining development, and filing the same for convenient reference. The Division is also called upon to furnish information, in reply to inquiries, on all kinds of technical matters pertaining to the mineral deposits and mineral industries of the country. These are often so extended in their scope as to require considerable time for their preparation. Amongst the minerals, or ores which have been particularly sought during the year, may be mentioned the following: titanium ore, arsenical pyrites, garnets, gypsum, magnesite, rubies, rutile, talc, dolomite, marbles, granite, refractory clays, etc.

No field work has been undertaken by officers of the Division, in its behalf, during 1907.

The mining industry has shown a very large growth during the past ten years: the value of the output having increased from a little over twenty-two million dollars in 1896, to almost eighty million dollars in 1906, and the Department is being constantly called upon year after year, to furnish greater information concerning every feature of this development.

In view of the organization of the Department of Mines, with a Mines Branch devoted particularly to economic work, and the transfer to this Branch from the Geological Survey of the work of this Division, it would, perhaps, be advisable to record here, something of what has been done in the past in this line of work, and to point out the direction in which it may be improved, and made of much greater value to the public.

In the past, the appropriation available, and the strength of the staff, were never sufficient to enable the officers in charge of the Division, to properly carry out the functions devolving upon them; and while probably the best was done which the means at hand, and the difficulties of the situation would permit, a great deal more should be accomplished, and it now devolves upon the reorganized branch to inaugurate a much more vigorous policy of action in order to increase the efficiency of the work already begun, and to extend its scope, necessitated by the growth and expansion of the mining industry.

The Division of Mineral Statistics and Mines of the Geological Survey was organized in 1886, and annual statistical reports of the mineral industries of Canada have been issued by the Division since that time. These reports furnished not only statistics of mineral production of the year under consideration; but annually repeated in tabular form the statistics collected during the previous years; for the purpose of showing the growth of the industries. The reports also contain all available information as to exports and imports of minerals and ores, and metallurgical products. These reports, moreover, usually included information concerning mining development in some of the important mining centres throughout Canada, as well as information as to markets and prices when such was available: together with lists of producers of some of the important mineral products.

The work of the Division may be described in greater detail as follows:—

THE COLLECTION OF STATISTICS.

Lists of producers are prepared each year, and circulars sent out to those requesting a return of their mineral production. If necessary, the request is repeated by additional circular letters or telegrams.

When important producers still remain unheard from, a personal application by a special agent would be advisable. As an exception to the above general method, it should be explained that statistics of coal, and gold production in Nova Scotia, are obtained by agreement through the Provincial Department of Mines, and statistics of the production of metallic ores in British Columbia are obtained through the courtesy of the Provincial Mineralogist of that province.

A proposal has been made, though not yet carried into effect, for co-operation with the Mining Bureau of the Province of Ontario in the collecting of mining statistics of that province.*

It might be well here to refer to the fact that, each of the provinces in Canada, with the exception of Prince Edward Island, and New Brunswick, provides for the collection and publication of statistics of mineral production, more or less complete. With the exception of that already mentioned, there is as yet, no co-operation between any of these provinces and the Dominion government in the matter of collecting and publishing these statistics. Such different styles of questions are asked, covering different years, that the figures of production published by the provinces seldom agree with those compiled in this Division; hence, while each may be approximately correct from its own particular point of view, the result is somewhat disconcerting to the inquirer who consults the differing reports.

It is, therefore, greatly to be desired that, methods should be devised, if possible, whereby these reports might be made more uniform in their statistical contents, besides avoiding the unnecessary duplication of effort in the collection of the material.

The statistical information contained in the reports of this Division, while probably as complete for some minerals, or mineral products, as it is possible to obtain such information at the present time, and under present conditions, is nevertheless for other products, open to considerable improvement.

More detailed records of metallurgical products, such as iron, and steel, etc., might with advantage be obtained and published; while statistics of the production of some of the structural materials, such as the clay products, lime, and the output of stone quarries, etc., might now be secured with greater completeness. The earlier attempts to obtain statistics of these products, met with indifferent success; owing partly to the wide-spread distribution of the industries over a large extent of territory, and to the large numbers of those who operated on a very small scale, and who in many cases either would not, or could not, furnish the information desired. Conditions, however, have greatly changed. These industries are now being concentrated into larger units, and our efforts to obtain returns during the past year or two, have met with much more encouraging success.

Much improvement might also be made by the addition of statistics of production in foreign countries so as to show the world's consumption and the sources of supply. The use of graphic tables for exhibiting products, exports, imports, prices, etc., might also be considerably extended. Information as to prices paid by smelters, for metallic ores, should be published whenever available, and in many other ways the reports might be made of greater value to the mining public.

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* (See Summary Report of the Geological Survey Department for 1906, page 7.)

INDEX TO MINERAL OCCURRENCES.

This comprises a card index system of references to Canadian mineral occurrences contained in the reports of the Dominion Department of Mines; the various provincial mines reports, and the proceedings of mining and geological societies. This index is arranged under the headings of the metals, and non-metallic minerals of economic importance.

As a considerable amount of mining and geological literature is annually published, a good deal of time is required to keep the index up-to-date; but it forms a very useful and valuable list of economic mineral occurrences, as well as references to the sources from which information concerning them can be secured.

MINERAL OCCURRENCE RECORD FILES.

This is an amplification of the card index mentioned above, and arranged in the same general order. Instead of references, however, it is designed to contain actual records of mining development obtained from all sources, such as through correspondence, field investigations, etc., and clippings from the mining press. It is a convenient method also for the filing of mining plans, annual reports of mining companies, photographic prints, etc., in fact, all classes of records pertaining to mining work.

Unfortunately, the lack of systematic field work in the past has resulted in the information available, being far from complete. This condition will, no doubt, be largely remedied by the field work now being done under the direction of the Mines Branch in connexion with the collection of information about Canadian mines. But in the future, to keep such records up-to-date, will require regular periodical field investigation.

CLIPPING SYSTEM FOR MINING INFORMATION.

Copies of most of the mining papers published in Canada, as well as a selection from the general press, are received, and carefully scanned; clippings being made of all interesting material referring to mining subjects. The information obtained in this way, serves to keep the Division informed as to the trend of mining development throughout the country; particularly in districts not visited by officers of the Department. As the inauguration of new industries is usually recorded in the press in some way or other, the clipping system presents an additional and important means of keeping our lists of mining operators up-to-date. All information obtained through the clipping system, which appears to be authentic, and of future value, is subsequently filed with the mineral occurrence records.

This source of information might be greatly extended, and improved, by increasing the number of papers under review, and devoting more time to the classification of the material gathered than we are now able to do.

In conclusion, it may be said that, while the necessity for regular field work in order to 'collect and preserve all available records of mines and mining works in Canada' has already been pointed out, personal visits to mining localities, and mining operators, are also necessary in order that officers of the Division may secure the essential details of production, mining costs, markets, etc., which are so necessary to a proper understanding of statistics. At best the information secured by means of circulars, and correspondence, is general and superficial, and should be supplemented by field inquiry.

The number of officers whose time should be devoted to collection of information in the field, will depend to a large extent on the amount of detail it is considered necessary to secure, as well as on the amount of appropriation to be devoted to the purpose. The different mineral industries could be apportioned amongst the staff as follows: one man might devote his attention to the metallic ores and metallurgical industries; a second to the fuels and other non-metallic minerals, such as asbestos, gypsum, salt, abrasives, etc., while a third could keep informed concerning the structural material industries, such as the clay products of all kinds, building and other stone, the cement industries, etc. Structural materials form an extremely important class of mineral products in a growing country like Canada, and are deserving of great attention. As the strength of the staff increased, the work could be further subdivided; the work of each officer on a specific subject, being limited in extent; but increased in the detail of its investigation.

With respect to the office work, an immediate increase in the clerical staff is necessary if the work at present undertaken is to be efficiently carried on; and when systematic field work is undertaken, additional clerical assistance will undoubtedly be required in connexion therewith.

Our new office quarters are much better lighted, and better furnished than the old; but somewhat smaller in actual floor space, so that we are still rather cramped for room.

JOHN MCLEISH.

OTTAWA, March 27, 1908.

II.—STATISTICAL REPORT.

DIVISION OF MINERAL RESOURCES AND STATISTICS.
March 27, 1908.

DR. EUGENE HAANEL,
Director of Mines,
Ottawa.

SIR,—I beg to submit herewith the annual preliminary report on the mineral production of Canada in 1907.

The figures of production given are, of necessity, subject to revision, since at this time, in many instances, producers of metallic ores have not themselves received complete returns from smelters. For these and other reasons, estimates have to be made. It is hoped, however, that this preliminary statement may serve to give a general idea of the gross output of the mineral industry during the year.

When more complete information is available, the annual report will be prepared. It will contain the final statistics in greater detail, as well as information relating to exploration, development, prices, markets, imports and exports, etc.

Acknowledgments are due to the various operators who have promptly furnished statements of their production, to the Provincial Mineralogist of British Columbia

for a complete preliminary statement of mineral production in that province, and to the other provincial mining bureaus for assistance kindly rendered.

I am, sir, your obedient servant,

JOHN MCLEISH.

Preliminary Report on the Mineral Production of Canada in 1907.

(Subject to revision.)

Product.		Quantity. (a)	Value. (b)
METALLIC.			$
Antimony ore	Tons.	2,016	65,000
Copper	Lbs.	57,381,746	11,478,614
Gold—Yukon $3,150,000			
" All other 5,114,765			8,264,765
Iron ore (exports) (c)	Tons.	25,901	45,907
Pig iron from Canadian ore (d)	"	107,599	1,982,307
Lead (e)	Lbs.	47,565,000	2,532,836
Nickel (f)	"	21,189,793	9,535,407
Silver (g)	Oz.	12,750,044	8,329,221
Cobalt, zinc, and other metallic products			200,000
Total metallic			42,434,087
NON-METALLIC.			$
Arsenic (refined)	Lbs.	660,080	36,210
Asbestos	Short tons.	62,018	2,482,984
Asbestic	"	28,519	22,059
Chromite	"	7,196	72,901
Coal	"	10,510,961	24,560,238
Peat	"	50	200
Corundum	"	1,892	177,922
Feldspar	"	12,584	29,809
Graphite	"	579	16,000
Grindstones	"	5,382	46,876
Gypsum	"	475,508	642,470
Limestone for flux in iron furnaces	"	359,503	298,097
Mica	"		333,022
Mineral Pigments—Barytes	"	2,016	4,500
" " Ochres	"	5,828	35,570
Mineral water	Galls.	250,985	110,524
Natural gas (h)			748,581
Petroleum (i)	Bls.	788,872	1,057,088
Phosphate	Tons.	750	5,514
Pyrites	"	39,133	189,353
Salt	"	72,697	342,315
Talc	"	1,534	4,602
Tripolite	"	30	225
Total			31,217,060

(a) Quantity of product sold or shipped.

(b) The metals, copper, lead, nickel and silver, are, for statistical and comparative purposes, valued at the final average value of the refined metal in New York. Pig iron is valued at the furnace, and non-metallic products at the mine or point of shipment.

(c) Copper contents of ore, matte, etc., at 20·004 cents per pound.

(d) The total production of pig iron in Canada in 1907 was 651,962 short tons, valued at $9,125,226, of which it is estimated about 107,599 tons valued at $1,982,307 should be attributed to Canadian ore, and 544,363 tons, valued at $7,142,919 to the ore imported.

(e) Lead contents of ore matte, etc., at 5·325 cents per lb.

(f) Nickel contents of matte shipped at 45 cents per lb.

(g) Silver contents of ore, etc., at 65·327 cents per lb.

(h) Gross return from sale of gas. Additional returns increase this item to $803,908.

(i) Deduced from the amount paid in bounties and valued at $1.34 per barrel.

(Subject to revision.)

Production.		Quantity. (a)	Value. (b)
STRUCTURAL MATERIALS AND CLAY PRODUCTS.			$
Cement—natural rock	Bls.	5,775	4,043
" Portland	"	2,368,593	3,374,428
Flagstones	Sq. yds.	3,000	2,550
Sands and gravels (exports)	Tons.	298,095	119,853
Sewer pipe		......	1,211,000
Slate	Squares.	4,335	20,056
Building material, including bricks, building stone, lime, etc., estimated on the basis of production in 1906		....	7,500,000
Total structural materials and clay products		....	12,232,330
Total all other non-metallic		....	31,217,060
Total non-metallic		....	43,449,390
Total metallic		....	42,434,087
Estimated value of mineral products not returned		....	300,000
Total, 1907		....	86,183,477

ANNUAL PRODUCTION SINCE 1886.

1886	10,221,255	1897	28,485,023
1887	10,321,331	1898	38,412,431
1888	12,518,894	1899	49,234,005
1889	14,013,113	1900	64,420,983
1890	16,763,353	1901	65,804,611
1891	18,976,616	1902	63,211,634
1892	16,623,415	1903	61,740,513
1893	20,035,082	1904	60,073,897
1894	19,931,158	1905	69,525,170
1895	20,505,917	1906	79,057,308
1896	22,474,256	1907	86,183,477

REMARKS.

The early months of 1907, and even well along past the middle of the year, was a period specially marked by great activity in all branches of commerce, and the mining industry shared with other commercial undertakings the beneficial results of increasing prosperity. The outlook was, for a mineral production, far beyond all previous records. But excessive prosperity brought about its own depression, since within a few months of the close of the year, a rapid change took place. Whereas before, the transportation companies were unable to take care of the business offering, work was so plentiful that labour became scarce and high in price, the demand for commodities so great, that in the case of the metals, prices rose to figures seldom before reached; in one short month exactly the reverse conditions were in evidence; railway cars became idle for want of freight, labouring men were glad to accept reductions in pay and keep their jobs, and the prices of the metals fell with rapidity. Fortunately, however, for us in Canada, the financial stringency has not had such serious results as with our friends across the border, and although in some of the mineral industries it was found necessary to cease operations, some of these have already resumed, and the great mass of the mining industry still continues to enjoy a conservative and steady progress. Fortunately this change of conditions occurred too late in the year to seriously affect the expected increase in mineral output. Thus it is that we are enabled to record a substantial increase of over nine per cent in the mineral production in 1907 as compared with 1906. The total value of the output, valued according to the methods adopted in this branch since its inception, was about $86,183,477, the largest output the Canadian mining industry has yet attained.

As might be expected, however, increases in production are not shown uniformly throughout all the mining industries.

There are some decreases to record, such for instance as in gold and lead, and in a number of products of lesser relative importance, such as corundum, feldspar, graphite, etc., but these are more than counterbalanced by the large increases in pig iron, silver, asbestos, coal, natural gas, petroleum and Portland cement.

The two following tables will illustrate these features more explicity, the first showing the total increases or decreases in value of some of the more important products, and the second, the percentage increase or decrease in quantity as well as in value.

Product.	Increase.	Decrease.
	$	$
Copper	758,170	
Gold, Yukon		2,450,000
Gold, all other		780,436
Pig iron, (from Canadian ore)	257,907	
Lead		556,351
Nickel	586,573	
Silver	2,669,766	
Other metallic products	137,930	
Asbestos	444,900	
Chromite		18,958
Coal	4,828,219	
Corundum		27,051
Gypsum		824
Natural gas	182,160	
Petroleum	295,328	
Portland cement	210,021	
Other net increases	588,815	
	10,959,789	3,833,620
Total increase	7,126,169	

Product.	Quantity.		Value.	
	Increase.	Decrease.	Increase.	Decrease.
	p. c.	p. c.	p. c.	p. c.
Metallic—				
Copper	3·18		7·07	
Gold				28·10
Pig iron (from Canadian ore only)	2·79		14·95	
Pig iron (from both home and imported ore	8·94		16·64	
Lead		12·89		18·01
Nickel		1·40	6·55	
Silver	56·47		47·17	
Non-metallic—				
Asbestos and asbestic	10·16		21·59	
Coal	7·66		24·47	
Corundum		16·79		13·19
Feldspar		25·75		27·10
Gypsum	13·55			·13
Natural gas			31·21	
Petroleum	38·45		38·77	
Portland cement	11·74		6·63	

It will be observed that a slight increase is shown in copper output, a decrease in British Columbia being more than offset by an increase in the copper contents of the Sudbury nickel-copper ores. A very large decrease in gold production—over 28 per cent—practically represents a falling off in every district, with the possible exception of Nova Scotia.

In pig iron production, a substantial increase is indicated. New furnaces were in operation at Hamilton and Port Arthur. The production of lead was less by about 13 per cent. Nickel shows but little change. The output of silver was over 50 per cent greater than in 1906, and this despite a falling off in British Columbia, the large increase being entirely due to the shipments from the Cobalt district.

Amongst the non-metallic products, the asbestos industry shows substantial progress, an increase of 10 per cent in quantity, with higher prices. Coal mining also shows a steady growth in all fields, with higher prices realized. Natural gas and petroleum production also show large increases, and this is particularly gratifying as indicating that these fields in Ontario have not yet reached the exhaustion point. Portland cement, with incomplete returns, shows an increase of nearly 12 per cent.

It becomes interesting at times to compare the relative importance of the various industries in respect of their total values, and the following table has been compiled to show for the years 1907 and 1906, the position in the scale of importance of a number of mineral products, constituting together about 95 per cent of the total.

1906.		1907.	
Products.	—	Products.	—
1. Coal	24·93	1. Coal	28·498
2. Gold	15·03	2. Copper	13·318
3. Copper	13·74	3. Nickel	11·064
4. Nickel	11·19	4. Silver	9·664
5. Brick, stone, and lime	8·00	5. Gold	9·589
6. Silver	7·15	6. Brick, stone, and lime	8·702
7. Cement	3·96	7. Cement	3·915
8. Lead	3·83	8. Lead	2·938
9. Asbestos	2·49	9. Asbestos	2·906
10. Pig iron (from Canadian ore)	2·16	10. Pig iron (from Canadian ore)	2·300
11. Petroleum	·95	11. Petroleum	1·226
12. Gypsum	·74	12. Natural gas	·888
		13. Gypsum	·745

Gold.—Four years ago gold was relatively the most valuable mineral product in Canada, but in 1907 it has fallen to fifth place. A continual shrinkage has taken place in the output of the Yukon from $22,275,000 in 1900, to about $3,150,000 in 1907. The effect of this shrinkage was to some extent lessened by the continued increase from British Columbia, but in 1907 this province also shows a falling off both in placer and lode output, a decrease of over 13 per cent. Less than half as much gold was obtained from the Yukon in 1907 as in 1906. Of the total gold output in 1907, about 47 per cent was obtained from placer and hydraulic workings, and 53 per cent from sulphuret and quartz ores.

Silver.—About 12,750,044 ounces of silver were contained in ore shipments in 1907 as compared with 8,473,379 ounces in 1906, an increase of over 50 per cent. Over 99 per cent of the production in 1907 was derived from the provinces of Ontario and British Columbia, and about 77 per cent from the Cobalt district of Ontario alone.

The price of refined silver varied considerably during the year. The average monthly price reached its highest in February, at 68·835 cents per ounce, falling slightly in April and May, and increasing to over 68 cents again in July and August, but falling rapidly during the balance of the year to an average of 54·565 cents in December. The average of the year was 65·327 cents as compared with an average of 66·791 cents in 1906.

The rapid development of the Cobalt district has brought the province of Ontario to the front as a silver producer, and although complete returns have not yet been received from the smelters, close estimates have been made by the mine owners. Returns from 24 shipping mines show the ore shipped as approximately 14,557 tons, containing 9,914,056 ounces of silver. At the average price of refined silver, for the year, this would be worth $6,476,555 and it represents an average return of 681 ounces of silver, or $444.87 per ton of ore shipped.

There was a slightly smaller output of silver in British Columbia in 1907, a falling off of probably about 200,000 ounces.

It may be noted that there was a larger amount of silver in ore, etc., entered for export than the records of production show, the excess being over 2,000,000 ounces. The exports for the 12 months, according to the Customs Department returns, were 14,813,735 ounces valued at $9,941,849, an average value per ounce of 67·11 cents.

Copper.—The aggregate production of copper, 1907, was about 57,381,746 pounds, an increase of 3 per cent over 1906.

The copper mines of the Boundary district of British Columbia, as well as others in the Nelson and Coast districts, were closed down in November, and although some of them resumed again after a few weeks, the total output for the province was somewhat less than in 1906. This decrease, however, has been more than met by the increased output of copper from the Sudbury ores of Ontario (see under nickel). Of the total production in 1907, over 72 per cent was obtained from British Columbia mines, and 19 per cent from Ontario.

The price of copper varied greatly during the year. In March the average monthly price of electrolytic copper in New York was 25·065 cents per pound. In July this had fallen to 21·130 cents, and to 13·169 cents in October. The average for the year was 20·004 cents, as compared with 19·278 cents in 1906.

The total exports of copper in ore matte and other forms were, according to Customs Department returns, 27,194 tons.

Lead.—All the production recorded was mined in the province of British Columbia. The output is less than that obtained in 1906 by nearly 13 per cent. A considerably less tonnage was shipped from East Kootenay mines, with probably an increased output from West Kootenay.

No bounty was paid during 1907 on lead ore, but in December the price of lead had fallen to a point at which bounty could be claimed.

The exports of lead in ore, etc., during the year were 10,989 tons, and of pig lead, etc., 1,807 tons, or a total of 12,796 tons.

As with the metals, silver and copper, the price of lead also fluctuated widely during the year. In New York, for the first five months of the year, the prices held steadily at 6 cents per pound, then steadily decreased, the average for December being 3·658 cents, and the average for the year 5·325 cents, as compared with 5·657 cents in 1906.

On the London market the highest quotation during the year was £22 2s. 6d., and the lowest £13 per long ton, a difference between highest and lowest of over £9.

Nickel.—With the exception of the nickel contained in the ores shipped from the Cobalt district, the production of nickel in Canada is derived entirely from the well-known nickel-copper deposits of the Sudbury district. The output has been increasing steadily for a number of years, although the actual amount of nickel contained in matte shipped in 1907 is somewhat less than in 1906. Two companies are carrying on active operations: The Mond Nickel Co., at Victoria Mines, and the Canadian Copper Co., at Copper Cliff. The ore is first roasted and then smelted to a Bessemer matte containing from 77 to 80 per cent of the combined metals, copper and nickel, which is shipped to the United States and Great Britain for refining.

The following were the aggregate results of the operations on the nickel-copper deposits of Ontario in 1906 and 1907:—

	1906.	1907.
	Tons of 2,000 lbs.	Tons of 2,000 lbs.
Ore mined	343,814	351,916
Ore smelted	340,059	359,076
Bessemer matte produced	20,364	22,041
" " shipped	20,310	22,025
Copper contents of matte shipped	5,265	6,996
Nickel contents of matte shipped	10,745	10,095
Spot value of matte shipped	$ 4,628,011	$ 3,289,382
Wages paid	1,117,420	1,278,694
Men employed ... Number.	1,417	1,660

According to Customs returns, exports of nickel in matte, etc., were for twelve months ending December 31, as follows:—

	1906.	1907.
	Pounds.	Pounds.
To Great Britain	2,716,892	2,518,338
To United States	17,936,953	16,857,997
	20,653,845	19,376,335

The price of refined nickel, according to the *Engineering and Mining Journal*, of New York, remained fairly steady throughout the year. The uniform weekly statement being that 'for large lots, New York, the chief producer quotes 45 to 50 cents per pound, according to size and terms of order. For small quantities 50 to 65 cents, same delivery.'

It will be noted, however, in the above statistics of production, that the matte shipped in 1907 is valued at a much lower rate than in 1906, although the average prices of both copper and nickel, according to quotations, were slightly higher in 1907.

The above figures of nickel production do not include the nickel contents of the silver-cobalt ores from Cobalt district, complete statistics of which have not been obtained by this Department. The shippers of silver-cobalt ores receive practically no returns for the nickel contents, although these amounted in 1906 to about 3 per cent of the ore shipped, according to returns published by the Ontario Bureau of Mines.

Zinc.—No official statistics regarding zinc ore production in British Columbia are to hand, and the zinc smelter at Frank, Alta., has not been in operation during the year. A few tons of zinc ore were mined in Ontario.

Iron Ore.—The total shipments of iron ore from mines in Canada, in 1907, were 310,996 short tons, valued at the mine at $662,441, as compared with 248,831 tons, valued at $589,206 in 1906. Of the total shipments in 1907 there was shipped to destinations in Canada 283,543 tons, and to the United States 27,453 tons.

Pig Iron.—The total production of pig iron in Canada in 1907, from both Canadian and imported ores, according to direct returns from nine companies operating

16 furnaces, was 651,962 short tons, valued at $9,125,226, an increase of nearly 9 per cent in quantity over the amount made in 1906. These figures do not include ferro-products made in electric furnaces. Of the total output of pig iron last year 10,047 tons were made with charcoal as fuel, and 641,915 tons with coke.

The amount of Canadian ore, including mill cinder, etc., used was 244,104 tons, while the quantity of imported ore used was 1,117,260 tons. The total amount of coke used during the year was 847,150 short tons, valued at $3,383,223, of which 520,068 tons, valued at $1,652,125, was made in Canada, and 327,082 tons, valued at $1,731,098, imported from the United States. The quantity of limestone flux charged was 498,462 tons.

Steel.—Returns from seven companies making steel showed a total output during the year of ingots and castings of 706,982 short tons, valued at $16,612,590. Of this amount 685,229 tons were ingots, and 21,753 tons castings. Of the ingots made 225,989 tons were Bessemer steel, and 459,240 tons open-hearth. All of the castings, with the exception of 1,151 tons, were open-hearth steel.

Iron and Steel Bounties.—Following is a statement of the bounties paid on iron and steel during the calendar year 1907, as kindly furnished by the Trade and Commerce Department:—

	Quantity on which Bounty was paid.	Bounty.
	Tons.	$ cts.
Pig iron, made from Canadian ore	95,914·97	201,421 47
" " imported ore	537,803·45	591,583 80
Total pig iron	633,718·42	793,005 27
Steel ingots	666,589·87	1,099,873 37
Steel wire rods	68,738·22	412,417 26
Total bounty paid on iron and steel		2,305,295 90

Asbestos.—Returns of shipments of asbestos from the Eastern Townships, province of Quebec, were received from twelve operating companies, who employed about 2,175 men in mines and mills and paid in wages, $840,684. In addition to these, four other companies were making extensive preparations for active mining and milling in 1908.

The total shipments divided into crude and mill stock were, in 1906 and 1907, as follows:—

	1906.		1907.	
	Tons.	Value.	Tons.	Value.
		$		$
Crude	3,793	626,895	4,338	830,632
Mill stock	55,490	1,343,983	57,680	1,652,352
Total asbestos	59,283	1,970,878	62,018	2,482,984
Asbestic and asbestic sand	20,127	17,230	28,519	22,059
Total products	79,410	1,988,108	90,537	2,505,043

Exports of asbestos, according to customs returns, were:—

	Tons.	Value.
		$
Twelve months ending December, 1906	59,864	1,689,257
" " " 1907	56,753	1,669,299

The special features of interest regarding the industry during the year have been an increased output, higher prices realized for the product, further consolidation of mining interests, the introduction of electric power by the Shawenegan Power Company, and the continued successful working of the East Broughton district, which is chiefly a fibre producer.

Coal and Coke.—Each of the coal-mining provinces contributed an increased output to the coal production in Canada in 1907. The total sales and shipments of coal, including colliery consumption and coal used in making coke, were 10,510,961 short tons, an increase of more than 7 per cent as compared with 1906. Of the total, Nova Scotia contributed over 60 per cent, Saskatchewan and Alberta over 16 per cent, and British Columbia over 23 per cent. Alberta shows the largest proportional increase, viz., 23 per cent, and British Columbia next, with an increase of over 13 per cent.

The production by provinces was approximately as follows, the figures, of course, being still subject to correction:—

—	Tons of 2,000 lbs.	Value.
		$
Nova Scotia	6,337,632	12,731,850
New Brunswick	34,584	77,814
Saskatchewan	153,914	259,019
Alberta	1,534,001	3,819,587
Yukon	15,000	60,000
British Columbia	2,435,830	7,611,968
Total	10,510,961	24,560,238

The total production of coke in 1907 was approximately 842,004 short tons, valued at $3,485,533. This is made in ovens in Nova Scotia, Alberta and British Columbia. At the end of the year there were in Nova Scotia about 654 ovens in operation and 173 idle, and in Alberta and British Columbia, on the same date, 850 in operation and 582 idle.

Petroleum and Natural Gas.—The production of petroleum is as usual practically all derived from the Ontario peninsula. Direct returns from the producers have not been obtained, but the production has been estimated on the basis of the bounty of 1½ cents per gallon paid by the Dominion government.

The total bounty paid in 1907 was $414,157.89, representing a production of 788,872 barrels, compared with a bounty of $299,120.36 paid in 1906, representing a production of 569,753 barrels. An increased production in 1907 of over 38 per cent is, therefore, shown.

Natural gas was produced and sold in Quebec province in the vicinity of Louisville; in the Niagara peninsula and southern portion of the province of Ontario, and at Medicine Hat, Alberta; the sales from the Ontario fields constituting over 91 per cent of the total.

The total receipts from gas sold in 1907 show an increase of about 31 per cent over the receipts of 1906, and are now larger than at any time since the gas was first used. About 440 wells were producing gas in 1907, of which 114 were bored during the year.

Portland Cement.—Complete statistics have not yet been received, two companies having not yet been heard from. The figures given below for 1907 are, therefore, subject to this correction, and when complete returns are received, will be increased by an amount probably not exceeding 4 or 5 per cent.

The total quantity of cement made in the fifteen plants from which returns were received, was 2,413,513 barrels, as compared with a total of 2,152,562 barrels made in 1906, showing an increase of 260,951 barrels or over 12 per cent. The total sales were 2,368,593 barrels, as compared with 2,119,764 barrels in 1906, an increase of 248,829 barrels or over 11 per cent. The total daily capacity of the fifteen companies making returns was about 12,400 barrels, the other two companies having a daily capacity of 1,900 barrels, making a total capacity of 14,300 barrels per day. These companies are distributed as follows:—One in Nova Scotia, one in Quebec, thirteen in Ontario, one in Alberta and one in British Columbia. At least six other plants were in course of construction with a total proposed daily capacity of from 10,000 to 12,000 barrels.

Of the seventeen producing companies, twelve use marl and clay, four use limestone and clay, and one uses blast furnace slag. One other company, now in liquidation but with completed plant, made cement from marl. Of the six plants being erected, four at least propose to use limestone.

Detailed statistics of production in 1906 and 1907 are as follows:—

———	1906.	1907.
	Barrels.	Barrels.
Portland cement sold	2,119,764	2,368,593
" manufactured	2,152,562	2,413,513
Stock on hand, January 1	269,553	299,015
" " December 31	302,356	343,935
Value of cement sold	$3,164,807	$3,574,828

The average price per barrel at the works in 1907 was $1.43, as compared with $1.49 in 1906, and $1.42 in 1905.

The imports of Portland cement into Canada in 1907 were:—

———	Cwt.	Value.
		$
Six months ending June	732,684	277,133
" " December	1,621,520	560,387
The year 1907	2,354,204	837,520

This is equivalent to 672,630 barrels of 350 pounds each, at an average price per barrel of $1·245. The duty is 12½ cents per hundred pounds. The imports in 1906 were equivalent to 694,503 barrels, valued at $778,706, or an average price per barrel of $1.12.

There is very little cement exported from Canada. The consumption is, therefore, practically represented by the Canadian sales, together with the imports.

Following is an estimate of the consumption of Portland cement for the past seven years:—

Year	Canadian.	Imported.	Total.
	Barrels.	Barrels.	Barrels.
1901	317,066	555,900	872,966
1902	594,594	544,954	1,139,548
1903	627,741	773,678	1,401,419
1904	910,358	784,630	1,694,988
1905	1,346,548	917,558	2,264,106
1906	2,119,764	694,503	2,814,267
1907	2,368,593	672,630	3,041,223

EXPORTS OF THE PRODUCTS OF THE MINE, YEAR 1907

(Compiled from Trade and Navigation Monthly Statements.)

Products.		Quantity.	Value.
			$
Arsenic	Lbs.	613,504	10,850
Asbestos	Tons.	56,753	1,669,299
Barytes	Cwt.	550	2,750
Chromite	Tons.	892	19,800
Coal	"	1,894,074	4,879,564
Feldspar	"	12,068	37,932
Gold		....	8,029,603
Gypsum	Tons.	375,026	424,794
Copper, fine in ore, etc	Lbs.	54,651,452	8,742,133
" black or coarse and in pigs	"	36,998	7,476
Lead, in ore, etc	"	21,978,177	865,941
" pig, etc	"	3,613,706	163,957
Nickel, in ore, etc	"	19,376,335	2,280,374
Silver, in ore, etc	Oz.	14,813,735	9,941,849
Platinum, in ore concentrates, etc	"	242	4,864
Mica	Lbs.	1,117,010	422,172
Mineral pigments	"	382,624	10,043
Mineral water	Galls.	2,877	1,913
Oil—			
Crude	"	1,125	102
Refined	"	3,132	575
Ores—			
Antimony	Tons.	1,327	37,807
Iron	"	25,901	45,907
Manganese	"	1	22
Other ores	"	11,232	428,250
Phosphate		....	....
Plumbago	Cwt.	2,415	3,036
Pyrites	Tons.	25,056	80,139
Salt	Lbs.	2,222,542	7,709
Sand and gravel	Tons.	298,095	119,853
Stone, ornamental	"	153	1,262
" building	"	225	1,825
" for manufacture of grindstones	"	460	5,154
Other products of the mines		....	190,720
Manufactures—			
Bricks	M.	802	6,193
Aluminium, in bars, etc	Lbs.	5,478,203	1,109,353
" manufactured		....	1,499
Cement		....	9,618
Clay, manufactures of		....	369
Coke	Tons.	70,617	320,357
Grindstones, manufactured		....	32,534
Gypsum, ground		....	557
Iron and steel—			
Stoves	No.	698	8,077
Castings, N.E.S.		....	33,595
Pig iron	Tons.	439	13,504
Machinery (Linotype machines), 9 months		....	33,926
" N.E.S		....	436,793
Sewing machines	No.	4,193	77,232
Typewriters	"	5,430	163,719
Hardware (tools, etc.), 9 months		....	48,909
" N.E.S.		....	128,417
Scrap iron and steel	Cwt.	229,229	185,430
Steel and manufactures of		....	477,766
Lime		....	55,903
Metals, N.O.P		....	63,700
Plumbago, manufactures of		....	2,847
Stone, ornamental		....	3,576
" building		....	657

APPENDIX I.

COMPARISON OF INDUCTION FURNACES AT PRESENT EMPLOYED FOR THE PRODUCTION OF STEEL.

(By A. Grönwall, Electrical and Metallurgical Engineer, Ludvika, Sweden.)

The principle of the induction furnace is, as is well known, that the iron bath forms the secondary circuit of a transformer, and that it is heated by means of the electric current induced therein.

The iron bath forms only one winding, and the current induced, is therefore, as many times larger than the primary current as the numbers of windings in the primary coil. In the construction of an induction furnace, the phase displacement, and the losses of heat, must be made as small as possible, in order that a good efficiency may be obtained.

For such furnaces, the following approximate formula can be used:—

$$\text{tang. } \Phi = \frac{c \times n}{w}\left(\frac{1}{Wp} + \frac{1}{Ws}\right)$$

where: Φ = angle of phase displacement.
c = constant.
n = number of cycles per second (frequency).
w = ohmic resistance of the bath.
Wp = magnetic resistance of the primary leakage field.
Ws = magnetic resistance of the secondary leakage field.

According to this formula the power factor is increased by:

(1) decreasing the frequency.
(2) increasing the ohmic resistance of the bath, by increasing the length of the bath, and decreasing its section.
(3) increasing the resistance of the two leakage fields, by decreasing the area enclosed by the bath.

The induction furnaces which so far have been in practical operation, are those designed by Kjellin, Frick, Rochling, and the Electro-Metal Company.

In the following comparison between these furnaces, an attempt will be made to investigate as to what degree the electrical requirements are fulfilled.

The furnaces designed by Kjellin, and Frick, have the primary coil placed around the leg of the transformer, which is surrounded by the bath.

Kjellin places the primary coil at the same height as the bath, and inside same; while Frick has the primary coil placed either above or below the bath. Both these designers use a ring-shaped crucible. In accordance with the above formula, the furnace has to be designed in such a manner that, the bath has great length; but at the same time incloses only a small area. The circle is, however, that geometrical figure which incloses the largest area with a certain length of periphery, hence these furnaces are designed contrary to the foregoing formula.

In the Kjellin furnace the primary coil is placed comparatively close to the bath whereby the insulation is easily damaged in cases where no special cooling arrangement is provided. On this account, Kjellin places a water-cooled jacket between the primary coil and the crucible. This protection requires a comparatively large space, thus increasing the area enclosed by the bath, and thereby also the phase displacement.

Furnaces of this construction, and of even larger capacity, can be obtained either by increasing the diameter of the crucible, or by increasing the section of the bath. In the former case, the increase of the area inclosed by the bath, and in the latter case the decrease of the ohmic resistance, decreases the power factor.

For small furnaces of this type, a current of 15 to 25 cycles may be used; for larger furnaces (4 to 6 tons charge) the frequency has to be decreased to about 5 cycles per second.

This low frequency necessitates the employment of expensive electrical machinery.

The induction furnace at Volklingen designed by Rochling has an 8-shaped crucible. The two legs of the transformer—each provided with a coil—are surrounded by the baths, and communicate by means of a broad groove placed between the legs of the transformer. The furnace has also two carbon electrodes, placed opposite each other at each end of the groove. The iron bath is consequently heated by the current supplied by these electrodes, as well as by the induced current. The electrodes consist of iron plates on which are stamped a mixture of magnesite, and carbon. The object of the carbon in this mixture is to increase the conductivity; but the amount of carbon used must be small, in order that the electrode may not be dissolved by the iron bath.

The arrangement with an 8-shaped crucible does not cause any advantages from an electrical point of view, as compared with an ordinary induction furnace with ring-shaped crucible.

One may assume that the 8-shaped crucible is obtained by dividing the bath and the primary coil of a ring-shaped induction furnace in two equal parts by a horizontal plane, and moving one part to the other leg of the transformer. By such an arrangement no electrical changes occur, and the power factor is not increased. The radiation losses are, however, about twice as large as before, and the efficiency of the furnace is decreased. The arrangement with carbon electrodes increases the power factor; but decreases the efficiency on account of the energy lost by the electrical resistance of these electrodes.

Several attempts have been made to construct an electric furnace in the same manner as an open-hearth furnace, with the electrodes placed in the two opposite walls, similar to the Rochling furnace; but without transformers. A furnace of this kind would certainly be ideal; but the attempts made have been failures, owing to the fact that, the current required must be of a very low voltage; on account of the low resistance of the molten iron, as well as the relatively short length and large section of the bath.

In my opinion, a combination of an electrode furnace, and an induction furnace of low efficiency, is not satisfactory. The total efficiency of such a furnace must be lower than that of other electric furnaces of like capacity.

The Electro-metal Company, of Sweden, has designed an induction furnace which has a bath consisting of two parts. One part of the bath forms an open ring close around the leg of the transformer; while the other part consists of two parallel grooves connected with each other, and with the circular groove in such a manner, that a continuous groove is obtained.

This form of crucible permits a relatively great length of bath; but at the same time the area enclosed is comparatively small. On account of the great length of the bath, the cross-section can be made relatively small, while the ohmic resistance is increased. The furnace is consequently constructed in accordance with the conditions required by the theoretical formula.

The primary coil is placed around the outer leg of the transformer, which is a great advantage. In this case, the coil designed for a current of high voltage, needs no special protection from the heat radiating from the crucible; and no danger of the workmen touching the live wire needs to be feared. This method of placing the primary coil around the outer leg of the transformer is made possible by a compensation arrangement, consisting of two copper coils, designed for a current of low voltage, and thus easily insulated, even for high temperatures. In order to decrease the leakage from the transformer core, the sheets of iron or lamellæ are put together in such a manner, that wherever the leaking lines of force try to escape from the iron core, they are forced to pass through a smaller, or greater number of these lamellæ. According to observations made, the leaking lines of force emanate chiefly from the edges of the lamellæ. Owing to the 'screening action' which the iron sheets exercise in a transformer constructed on the above principle, this leakage is considerably decreased.

The induction furnace possesses many advantages over the ordinary crucible furnace. The electrical energy required is so small, that even with relatively high-priced power the electric furnace is more economical than a crucible furnace. In the induction furnace, as well as in the crucible furnace, the iron is protected from impurities; for neither the carbon nor the gases come in contact with the metal. In the electric furnace, however, the slag, and gases, are more easily and completely separated from the molten metal, on account of the vibrations caused by the alternanations of the current. Finally, a more homogeneous product, at the required tapping temperature, is obtained from an electric furnace of suitable size, than from a great number of small crucibles. With crucibles, it is difficult to obtain the same temperature in all the crucibles, and when pouring the contents the metal is more exposed to the air.

APPENDIX II.

ABSTRACT SHOWING RESULTS OF EXPERIMENTS IN INTENSIFIED NITRIFICATION BY MEANS OF PEAT BEDS.

(MM. Müntz and Lainé.)

The experiments on the process of nitrification were carried on with the view of establishing plants, or nitre beds for the production of nitrate on a large scale, by methods more expeditious, and giving larger yields than by the old processes.

These studies were not undertaken with the object of applying the principle to agriculture; for it is not very important that available (or soluble) nitrates be given direct to the land, since the soil to which is added nitrogenous matters itself undertakes their transformation into nitrates. Our main object has been the production of nitrogen—(nitrates) necessary for the manufacture of war ammunition—(explosives).

It was thought that great progress would be made by the establishment of artificial fields (or beds) for nitrification; based on the introduction of nitrogen in the form of ammoniacal salts, such as by-products from the manufacture of gas, and coke, and the distillation of scavenging matter.

In all the experiments carried on with soils, moulds (artificial soils obtained by a mixture of calcareo-siliceous earth, horse manure, and leaves), and various kinds of peats, without the addition of ammoniacal salts, only a very small production of nitrate was obtained; the proportion of which would be negligible as compared with the quantity of nitrate which could be produced in the same period by the addition of ammoniacal salts.

The following tables give results obtained from these preliminary experiments, which were carried on from October 26, 1905, to March 21, 1906. The various earths were kept moist, and stirred regularly.

—	Nitrogen in Nitric State. Oz. per 10 lbs.		Quantity of nitrogen oxidized in 85 days. Oz. per 10 lbs.
	December 26, 1905.	March 21, 1906.	
Garden earth	·00352	·01232	·00880
Siliceous-calcareous earth	·00304	·00608	·00304
Mould	·01136	·03904	·02768
Clayey earth	·00304	·00512	·00208
Calcareous earth	·00144	·00416	·00272

With peat to which calcium carbonate had been added—affording, therefore, the most favourable conditions—similar results were obtained.

—	Period of Nitrification.	Nitrogen oxidized. Oz. per 10 lbs.
Compact peat from Yonne	257 days	·00256
Mossy peat from Yonne	257 "	·00608
Mossy peat from Holland	257 "	·00256
Mossy peat from Somme	175 "	·00816
Compact peat from Somme	175 "	·00416

Therefore, humic nitrogen from black compact peat, is practically inert towards micro-organisms. In surface mossy peat, it is rather more available (assimilable) although for the purpose in view, the quantity is negligible.

The objection may be made that, in such experiments nitrifying agencies are not very active: i.e., a lack of nitrifying ferments.

To answer this objection, the following experiments were made on mould, mossy peat from Somme, and compact peat from Somme. The two last named were finely divided, moistened, and carbonate of lime added. One series was set to nitrify without the addition of foreign ferment. Another was set with the addition of 1 per cent of mould in state of forced or intensified nitrification.

Again, a third and fourth series were respectively sterilized by heating to 230° F.; then to one was added ordinary mould, and to the other 1 per cent of mould under intensified nitrification.

After 178 days the materials were tested for oxidized nitrogen.

—	Nitrogen, Oxidized per 10 lbs.			
	Without addition.	Not Sterilized.	Sterilized.	
		1 p.c. of mould intensively.	Mixed with 1 p.c. ordinary mould.	1 p.c. of mould by intensified nitrification.
	oz.	oz.	oz.	oz.
Mould	·06576	·06944	·08928	·10016
Mossy peat	·01408	·02000	·02538	·02416
Compact peat	·02432	·02624	·04688	·04160

Concentration of Ammoniacal Solutions in the Liquids Held by Soils.

It is very interesting to note the activity of the nitrifying ferments, when accompanied by ammoniacal salts, which confirms the previous observations of scientists who have made studies of the process of nitrification in saline solutions of varied strengths. MM. Boullanger and Massol have shown that, in solutions holding more than 1·24 oz. of ammonium sulphate per gallon, nitrification does not reach completion, and that it is stopped when the proportion is greater than 6·5 to 8 oz. per gallon.

Reference has been made to the reasons which led to the experiments on the introduction of ammoniacal salts as raw material in the production of nitrate; but it is a well-known fact that these salts, when employed in large doses, actually impede nitrification. It was, therefore, very interesting to determine the optimum dose of ammoniacal salts which could be used to obtain the most intense formation of nitre.

Experiments were made on samples of the following earths:—

	Per Cent of Water.
Garden earth	21·85
Silico-calcareous earth	15·42
Mould (artificial)	53·90
Clayey earth	16·20
Calcareous earth	12·59

The results indicate that, the concentration of ammonium sulphate has no marked effect on the progress of nitrification if it does not exceed a limit of 1·44 oz. per gallon of the water contained by the soil.

This is confirmed by previous experiments, in which the process of nitrification still went on when the water of impregnation contained as much as 8 oz. per gallon.

In establishing nitre beds based on the principle of the transformation of amonium sulphate, the rule to be followed for the addition of ammoniacal salt is not the proportion of earth brought into action; but the proportion of water held by the earth. The solid earth enters into the process only so far as its capacity for water is concerned; while those which can retain a larger amount without being submerged, are capable of receiving larger proportions of ammoniacal salts. In fact, the action of nitrification has to be considered independently of the earthy particles; which only act as supports for the development of nitrifying organisms.

Thus, in an earth containing only 12 per cent of water, a proportion of 1 oz. per 10 lbs. of earth should not be exceeded; whereas in an earth capable of retaining 50 per cent of water, a proportion of 5 oz. per 10 lbs. may be used without impeding nitrification.

In practice, the optimum proportion should be much below these figures to obtain the maximum intensity of nitrification. For earth containing 12 per cent water, the amount should be about 2 oz. of ammonium sulphate per 10 lbs. For earth capable of retaining 50 per cent of water it may reach 6 oz. per 10 lbs. Therefore, the humic earths capable of retaining 60, and sometimes 80 per cent of water, are particularly well adapted for the enrichment in ammonium sulphate—without the risk of a decrease of the oxidizing phenomena.

Substitution of Peat for Soils and Moulds.

After having experimented on the active part performed by organic materials in intensified, or forced nitrification, we thought that peat, which is in large proportion composed of these moulds, offered a good base for nitrification.

Instead of operating on various soils, and on garden mould, as in previous researches, peat, on which a few experiments had been made as to its adaptability as a nitrifying medium, was operated on.

The following materials were taken:—

(1) A compact peat from Yonne, containing 57·93 per cent water.
(2) A mossy peat from Yonne, containing 68·26 per cent water.
(3) A moss litter from Holland, containing 59·60 per cent water.

To these peats had been added 100 ounces of Meudon chalk, 5 ounces phosphate of lime, 1 ounce potassium sulphate, and 50 ounces of garden soil, per 10 pounds of peat. Further, sulphate of ammonium was added, which was replaced as nitrification proceeded.

On April 9, 1906, these were started, and analyses resulted as follows:—

—	Oxidized Nitrogen per 10 lbs.		
	Compact peat.	Mossy peat.	Moss litter.
		Oz. per 10 lbs.	
April 28	·33952	·40672	·48064
May 23	·59984	·61424	·67296
August 2	1·69936	1·35072	1·59728

This shows a very intense nitrification, manifestly superior to that undergone by even the mould, and corresponding to an increase of:—

—	Oz. per 10 lbs.		
	Compact peat.	Mossy peat.	Moss litter.
	oz.	oz.	oz.
Oxidized nitrogen per day	·01584	·01040	·01296
Corresponding to nitrate of lime per day	·09280	·06096	·07600

By continuing to add ammoniacal salts, the enrichment reached the following figures:—

—	Oz. per 10 lbs.		
	Compact.	Mossy.	Moss litter.
Oxidized nitrogen per 10 lbs.	1·83360	1·89008	1·74624
= to nitrate of lime	10·73600	11 05760	10·21760

and the limit of enrichment was not reached even then.

It will be seen, therefore, that peat constitutes a more active medium for nitrifying beds, than soils, or even moulds. As its value as a merchantable product is practically nil, it could be substituted with great advantage for material usually employed in the making up of nitrifying beds.

Therefore, peat offers the best medium for forced (or intensified) nitrification, and it should constitute the basis of nitrifying beds of high yield.

A cubic yard of peat gives by dessication, 590 pounds of dry matter, containing two per cent nitrogen. Considering a thickness of forty inches in peat bogs, an area of two and a half acres would contain 165,000 pounds of nitrogen in an inert state.

It is apparent from the results of these experiments that, nitre beds of peat yield results as good, or even better than mould; and as there exist practically inexhaustible quantities of this material, its use in the establishment of nitre beds is strongly recommended. Both the surface mossy peat and the underlying compact peat are suitable for the purpose; provided that the proportion of earth in this last mentioned material be not too high.

Installation.

Seeing that peat, as taken from the bogs, generally contains considerable water, and is rather friable, it can easily be finely divided, and brought to the texture of gardener's mould.

Peat, as a rule, does not contain carbonate of lime, hence it is necessary to add some of this material—to the extent of 10 per cent. The carbonate of lime should be as rich, and pure as possible: i.e., it should not contain much clay, or silicates. The friable chalk, which mainly constitutes the rocks of Champagne, France, and, generally speaking, rocks of the Cretaceous formation, are suitable.

This material should be as finely divided as possible. It would also be advisable to add about one per cent of phosphate of lime, the effect of which is very marked in the development of micro-organisms.

The mixture of peat, and calcareous matter, after being made homogeneous, should be brought to a state of moisture—best determined by the hand. It should have the feeling of well-drained gardener's mould; but be sufficiently moist that a handful of it when squeezed in the hand, shall remain coherent, and not fall to pieces on releasing the pressure. This means a proportion of 55 to 60 per cent of moisture in weight. After the starting of the nitre bed, this degree of moisture must be maintained by sprinkling water over it, and mixing, to distribute it evenly throughout the mass. This will, moreover, ensure aeration, and the multiplication of the nitrifying organisms. Peat in its natural state contains these fermenting agents, and to ensure their preponderance over the other micro-organisms, it will be sufficient to supply them with ammoniacal salts and to ensure favourable conditions as to aeration, temperature and moisture. As these organisms are not very active at the beginning, a great deal of time may be gained by adding material from another nitre bed in full activity. For this purpose, it would be advisable to add to the peat about one per cent of material in active nitrification.

The mixture thus prepared, should be placed where it can be heated to the necessary temperature, preferably on a cemented or paved floor, which, by its non-porosity and smoothness, would decrease the liability of counteracting agents to take a hold.

A heap should be made, analogous to those employed in mushroom culture. Its thickness should not be over 40 inches. As to temperature, it should be kept between 77° and 83° Fahr. It is better to keep this low temperature; although the degree of heat most favourable to the development of pure nitrifying ferments is about 97° F.; but this temperature is also favourable to the antagonistic ferments. It has been noticed, in the course of our experiments, that the more abundant these antagonistic agencies are, the further from 97° F. should the temperature be kept.

The most favourable conditions are, then, (1) the abundance of organic matter, favouring the development of nitrifying elements, and (2) a sufficiently low temperature to check the development of antagonistic elements.

Maintenance and Culture.

The nitre bed is now ready to receive the ammoniacal nitrogen. We use the sulphate, as it is the cheapest and the most profitable. The experiments have shown that nitrification could take place with solutions containing as much as 1·0 to 1·25 oz. of ammonium sulphate per gallon; but it is better not to use stronger solutions than ·125 to ·160 oz. In the particular case of a peat nitre bed containing 60 per cent moisture, the best results would probably be obtained by introducing ·48 oz. of ammonium sulphate per 10 pounds, which would give solutions of ·801 oz. per gallon per cubic yard of peat in nitrification—which weighs 850 to 925 pounds. Each time it would be necessary to use about 2·9 pounds of ammonium sulphate.

In the presence of this element, the nitrifying ferments, either pre-existing in the peat or added as 'seed' will find a particularly favourable field for their development. They will multiply, and by natural selection may give rise to more active organisms; but at all events they will assume a preponderating role among the organisms present in this medium.

By a series of analyses, the transformation of the ammoniacal nitrogen into oxidized nitrogen can be followed daily. As the latter grows, the ammoniacal nitrogen begins to disappear, and is entirely lost in a short time. If the supply of ammoniacal nitrogen were not renewed there would be a change in the role, or action of the micro-organisms; for lack of food the nitrifying agents would be overcome by the organisms which transform the oxidized nitrogen, or ammoniacal nitrogen into insoluble or gaseous products, and this would be lost to the nitrification process.

It is, therefore, very important to have ammoniacal nitrogen always present in the nitre bed. By frequent assays, a proportion of ·10 oz. ammoniacal nitrogen or ·5 oz. of ammonium sulphate per 10 lbs. of moist peat is ascertained to be present.

The best way to introduce the ammoniacal salts is to dissolve them in the water with which the nitre bed is sprinkled, to maintain the right degree of moisture.

The carbonate of lime first added has always a tendency to become exhausted, and care should be taken to have it always present in excess, which is indispensable to the process of nitrification, as its total disappearance would stop the conversion. It is used up with comparative rapidity. For the nitrification of one molecule of ammonium sulphate, it requires two molecules of calcium carbonate to saturate the sulphuric acid of the added sulphate, and the nitric acid of the nitrate formed. For every 4·66 oz. of sulphate of ammonium which disappears 7·10 oz. of calcium carbonate will be consumed.

Therefore, for every part of ammonium sulphate, about two parts of chalk containing 75 to 80 per cent of calcium carbonate, will require to be added. This addition need not be made as frequently as that of the ammonium sulphate, it is sufficient to occasionally ascertain that it is present in excess. To a small sample of the peat add a few drops of hydrochloric acid. If it sets up an active effervescence, then the calcium carbonate is in sufficient quantity, but the effervescence must not be in isolated spots in the peat, which might be caused by particles of carbonate of lime harder and more resisting than those suitable to sustain an intensified nitrification, as calcium carbonate in a very fine state of subdivision well distributed throughout the mass.

The sprinkling water in which the sulphate of ammonium is dissolved, and the calcium carbonate added, should be well and evenly distributed throughout the nitre-bed. This is effected by a stirring up of the peat, which operation, moreover, is necessary to ensure good aeration. Frequently, every day if possible, the beds should be stirred, subdivided as much as possible, and brought into contact with air.

With a spade, take from the side of the bed a slice some eighteen inches thick. This is to be disintegrated as much as possible, and placed eighteen inches farther; the upper part of the first bed being put on the floor, thus forming the bottom of the second bed. Proceed until the whole bed has been thoroughly stirred.

Such are the first operations in the establishment of nitre-beds; but tab should be kept on the progress of the process by analyses for nitrogen. An assay once a month is amply sufficient. The process of nitrification, which is very slow at the start, increases in intensity, and will have reached its normal rate at the end of one month.

From our researches the daily production of nitrified nitrogen is about ·016 oz. per 10 lbs. of moist peat; which corresponds to about 1·35 oz. of oxidized nitrogen, or 10 oz. of nitrate of potash per cubic metre of the nitre-bed.

From the second month this production is maintained until the solutions of nitrate of calcium become sufficiently concentrated to lessen the nitrification. This concentration corresponds to about 32 oz. of nitrate of potash per gallon; or 1·9 oz. per lb. of moist peat, or 110 lbs. per cubic yard of the peat bed. From the experiments conducted this result would be reached at the end of 170, to 180 days, or about six months. The nitre-bed having reached at this time the limit of enrichment, it becomes ripe for exploitation. This 'harvesting' should be done without delay: without waiting until nitrification has suspended altogether. For, when the process diminishes in intensity, the phenomenon which take place at the beginning, reappears, and results in the loss of nitrogen.

The leaching of the nitrified peat, offers no difficulty. It can be effected by the methods used in the case of the old artificial nitre-beds, which had reached a high degree of perfection. The methodical leaching yields a concentrated solution, showing about 15 degrees on Beaume's hydrometer, and containing 15 per cent of nitrate of calcium. We shall state later on how this can be treated for the production of nitric acid, or of nitrates of the alkalies.

It is not necessary to go to much labour to ensure a perfect leaching of the materials. These are used in the establishment of a new nitre-bed. It will be sufficient to roughly drain the peat to the required degree of moisture, and to add to it, if necessary, a new quantity of calcareous matter, and to put it into heaps as stated before.

By operating in this way, the same materials can be used several times over, which constitutes a considerable saving.

If we compare the yield which we obtain by this method, with the results of the old methods of nitrification, we are at once struck by the much greater yield. Formerly, in a good nitre-bed, the yield, after two years of nitrification, was five kilos. of saltpetre. With a good peat bed this quantity is obtained in twenty-four hours, which means a yield sixty times greater in the same period, for a nitre-bed of equal volume. There are no apparent reasons why this process could not be applied to the production of nitre in enormous quantities, by the establishment of nitre-beds which would yield 2,400,000 lbs. of saltpetre on an area of one acre, having a thickness of one yard.

Notwithstanding these comparatively large quantities, it was endeavoured to increase them by substituting for nitre-beds of earthy, or peaty matter, beds in which the ammoniacal solution flows continually over an oxidizing medium; made up of heaps of peat containing nitrifying organisms. These experiments have been very successful.

Nitre-beds Operating Continuously.

Formerly, nitrification was not conceived to be possible without earthy materials; since to their porosity was attributed the preponderating role of oxidation of the ammonia, and of the organic matters, which resulted in the formation of nitre. But MM. Schloesing and Müntz showed by their researches, that porosity was only a secondary condition, and that the process of nitrification was induced by a fermentation which went on in solutions which were sufficiently aerated. This phenomenon is increased in intensity when the liquid flows in a thin sheet in contact with air. This action is further increased when the materials over which the liquid flows offer an irregular surface, which multiplies its contact with the oxygen of the air.

This principle has been applied in the purification of sewerage water, and even of water supply, notably in England. Oxidizing fields have been established by making beds of clinkers and cinders (from combustion of bituminous coal), broken into fragments the size of walnuts, over which the waters to be purified are made to flow. The fragments of clinkers must become coated with colonies of active organisms, before the phenomenon of oxidation acquires its normal intensity: which becomes very active in a certain time.

It was endeavoured in the experiments to give this principle a partial application, for the production of nitrates in large quantities, in solutions much more concentrated, which could afterwards be treated for the extraction of saltpetre.

Experiments were made with broken cinders, and with bone black. Two glass bells of about 4·4 quarts capacity, with an opening at the bottom, were filled, one with broken cinders of the size of a filbert nut, and well washed, and the second with bone charcoal (refinery bone black), in coarse grains. These were moistened with nitrifiable solutions containing 0·4 oz. of ammonium sulphate per gallon, as well as the elements mentioned by M. Omeliansky, namely, phosphate of potassium, sea-salt, carbonate of magnesia; and to these was liberally added mud from soils. Through the two bells, maintained at a temperature of 86° to 95° F., a slow current of air was passed, induced by a water suction pump. Twice a day they were sprinkled with about 2·5 cubic inches of the nitrifying solution.

The action of nitrification was soon induced after having passed through the phases usually observed in liquid mediums. Nitrates first appeared, and after about ten days the liquids collected from the lower part of the vessels contained only very small proportions of ammonia. On the eleventh day after starting, the liquids contained per litre:—

——	Bone black.	Cinders.
Nitrogen in Nitrous state	·061 oz. per gal.	·059 oz. per gal.
" Nitric state	·0063 " "	trace.
" Ammoniacal state	·003 " "	·006 oz. per gal.

From the above, the bone black, and the cinders, seem to be equally suited as 'supports.' From this day, nitrates gradually disappeared from the two vessels, and were replaced by nitrates; and to the nitrifying solutions ammonium sulphate was added to bring the solution to a concentration of 1·2 oz. per gallon. The volume of liquid passed through in twenty-four hours was also increased, so as to attain a maximum production of nitrates in a given time. It was endeavoured to ascertain this maximum by frequent analyses of the nitric solutions.

The experiment was started on March 20, and hereunder some of the results are tabulated:—

Dates.	Strength of nitrifying solution per gal.	Val. passed in 24 hours.		Nitrogen oxidized per gal.		Nitrogen oxidized in 24 hours.	
		Bone charcoal.	Cinders.	Bone charcoal.	Cinders.	Bone black.	Cinders.
	oz.	oz.	cub. in.	oz.	oz.	grains.	grains.
May 17	1·20	9·76	4·88	·118	·186	1·820	1·435
June 27	1·20	14·64	4·88	·204	·183	4·738	1·404
July 3	1·20	21·96	21·96	·194	·134	6·744	4·630
" 11	1·20	29·28	29·28	·187	·105	8·657	4·848
" 17	1·60	21·96	21·96	·154	·069	5·355	2·393

From these figures several conclusions can be drawn. They show that with solutions stronger than 1·2 oz. ammonia sulphate per gallon, corresponding to ·224 ounce of ammoniacal nitrogen per gallon, the process of nitrification is notably decreased. Therefore, in practice, the concentration of nitrifying solutions cannot be increased.

With a proportion of 1·2 oz. per gallon, and with the speed of flow mentioned, nitrification of ammonium sulphate was not completed, for out of ·240 oz. of ammoniacal nitrogen used, only ·190 oz. were oxidized, even under the most favourable conditions. With the increase of concentration the quantity of nitrified nitrogen, instead of increasing, fell from ·190 oz. to ·145 oz.

These facts will have to be taken into consideration when operating with solutions flowing in sheets over porous material, or material with irregular surface, and to obtain a maximum intensity of nitrification the solution should not be stronger than ·190 oz. to ·240 oz. ammoniacal nitrogen per gallon.

By comparing the action of the cinders with that of the bone charcoal, we see that this last offers a more favourable support for nitrification. 4·4 quarts of cinders produced only 4·60 grains of nitric nitrogen in twenty-four hours, whereas the same volume of bone charcoal gave 8·64 grains.

These figures are sufficiently high to apply the process to the production of large quantities of nitrates, 5 litres of bone charcoal having produced in twenty-four hours 8·64 grains of nitric nitrogen, corresponding to ·127 oz. of nitrate of potash. One cubic yard would, therefore, produce 19·38 oz. of saltpetre per day.

This yield is about double that of the best nitre beds of peat or mould, on which experiments were carried on, and to which was added ammonium sulphate for intensified nitrification. Therefore, the continuous flow of ammoniacal liquids over the oxidizing field is superior to the nitre beds, even under intensified condition.

On the other hand, this process by bone charcoal presents drawbacks. This material is costly and the establishment of such a nitre plant would represent a large outlay. Also, the state of weakness of the solution would entail a considerable evaporation of water. The nitrified liquid does not hold much more than 1·45 oz. of saltpetre per gallon, which would considerably impair the value of the process of nitrification, in spite of its rapidity.

It is, however, expedient to endeavour to enrich these liquids in the proportion of nitrates, so as to diminish as much as possible the cost of concentration. We stated that the initial proportion of ammoniacal salts cannot be increased without decreasing the nitrifying activity; it is, however, well established that liquids rich in nitre will go on nitrifying after the addition of ammoniacal salts. MM. Boullanger and Massol have shown that, in a solution corresponding to 4 oz. of nitrate of potash per gallon, nitrification goes on without decreasing, so long as small quantities of ammoniacal salts are added; which are replaced as soon as they have disappeared. On the other hand, the present researches have shown that in nitre beds the maximum concentration attainable was much higher, and reached about 32 oz. of calcium nitrate per gallon.

It was, therefore, thought that, instead of evaporating the solution containing only one per cent of nitre, a quantity of ammoniacal salts—equal to the original tenor—might be introduced by pouring it over an oxidizing field; replacing each time the ammoniacal salt, up to the limit at which the proportion of nitre interferes with the process of nitrification.

This was not done by bone black, but with a peat medium, by which results even more satisfactory, and more practical were obtained.

The results obtained, show that this enrichment is possible, and that the process of nitrification by pouring, or flowing ammoniacal solutions over fields (solid supports), allows the production of large quantities of nitre in solutions sufficiently rich to be economically evaporated.

Peat from Holland was secured—very mossy in character: such as is used instead of straw for litter in stables. This was divided into fragments the size of a walnut, and soaked in a nitrified solution containing ·4 oz. of ammonium sulphate per gallon, to which had been added finely ground carbonate of lime, and a little garden earth.

This was introduced into a glass jar with opening at the bottom, and allowed to drain naturally; but so that the peat would retain the calcium carbonate. The jar was maintained at a temperature of 86° to 95° F., and a current of air was kept circulating through it. Each day it was sprinkled with 11 cubic inches of nitrifiable solution, containing ·4 oz. of ammonium sulphate per gallon, and the liquids collected were tried for the unnitrified ammonia.

The experiment was started on January 25. On February 3, nitrification was complete and the concentration of the sprinkling solution was increased to ·8 oz. and on February 15 further increased to 1·0 oz. At this time the organisms were sufficiently active to nitrify 22·9 cubic inches of the 1·0 oz. solution, without leaving any ammonia residue.

This first experiment shows that mossy peat can be used to replace bone black, and it was endeavoured to determine the power of nitrification of which peat is capable under the most favourable conditions.

INFLUENCE OF TEMPERATURE.

The experiments were made on two samples of peat very dissimilar in nature. One was the litter moss from Holland, the other was compact peat, advanced to a state of decomposition, from a bog at Andryes (Yonne). These samples—the first of which was thoroughly air-dried—were impregnated with a nitrified solution of ·4 oz. of ammonium sulphate per gallon, to which had been added 4·4 quarts of peat, 7·04 oz. of Meudon chalk and earth mould, to inoculate (introduce) with active organisms.

CONCLUSIONS.

From the series of experiments carried on it appears that: (1) During the period of development of the organisms, temperature has a marked effect, and the optimum is about 95° F. (2) During the period of active nitrification, temperature has not so marked an effect. Between 77° and 96° F., its influence does not vary much. In practice we would recommend keeping it between 80° and 82°.

STRENGTH OF AMMONIACAL SOLUTIONS.

In compact peat, up to a strength of 4·57 oz. of sulphate of ammonium per gallon, nitrification was not notably influenced by the proportion of the salt. With a solution of 6·40 oz., the activity slightly decreased; but it was still very active. With mossy peat a slight decrease was noticed above 1·20 oz. per gallon, but kept on actively with the 6·40 oz. solution. The limit of concentration which annuls nitrification was not reached. There is no object, however, in using stronger solutions than 1·20 oz. per gallon, as above this limit the quantity of nitrate formed has a slight tendency to decrease.

By using stronger solutions there would be an excess of un-nitrified ammonia, and in order to save it, the solutions would have to be sprinkled again over the nitre-bed; or else the ammonia would have to be recovered by distillation.

A certain portion of this ammonia is liberated by the calcium carbonate, from the ammonium sulphate, by a double decomposition; resulting in the formation of volatile ammonium carbonate, which will have a stronger tendency to volatilize in the more concentrated solutions.

INTENSITY OF NITRIFICATION IN PEAT MEDIUM.

The figures and experiments which precede, show the great adaptability of peat to serve as a support or medium for nitrification. The yields obtained are very high. The best results per unit of time and per unit of volume of the nitre-bed were obtained with solutions containing 1·2 oz. of ammonium sulphate per gallon.

On April 19, the following results were obtained by passing 89 cubic inches of this solution over 69 cubic inches of peat at a temperature of 96°.

——	Oxidized Nitrogen per gallon of solution.	Oxidized Nitrogen in 24 hours, per cubic decimetre of peat.	Nitrate of calcium per cubic yard of peat.
	Oz.	Oz. per cu. ft.	Lbs. per cu. yd.
Mossy peat ..	·100	·897	8·82
Compact peat....	·122	1·1	10·82

As compared with results obtained over bone black, the process of nitrification is ten times more intense over the peat.

To what can be attributed the favourable influence of peat on the activity of microbe colonies present in it? It is not to porosity, for the mossy peat, which is extremely porous, did not give results superior to those obtained from the compact peat, which was almost earthy. It must rather be ascribed to the presence in peat of humic organic matter, which constitutes a medium very favourable to the development of nitrifying ferments. It is also due to the particular rugosity of the surface, which affords a good hold to colonies of micro-organisms, and protects them from the current of the solutions, which might otherwise carry them away.

If we compare the quantities of nitre which can be obtained by this process with the yield of the old fashioned nitre-beds, an enormous difference is noticed; for, with an installation of the same importance, the yield of saltpetre would be about one thousandfold greater in the same time.

We can now foresee the possibility of transforming large quantities of ammoniacal salts into nitrates in a short time. But by using the method of constant flow of ammonium sulphate solution over peat, which serves as support for the nitrifying organisms, a stronger liquid than 1·2 oz. per gallon cannot be used; which, after passing over the peat, would give a liquid containing a little less than 1 per cent of nitrate of lime, and would entail evaporation of a great volume of water.

CONCENTRATION OF THE NITRATE OF LIME SOLUTIONS.

An endeavour was made to enrich the solutions by further nitrification. As mentioned above, this is possible even in solutions containing 32·05 oz. of nitrate of lime per gallon. The following course was adopted: To the solutions already nitrified by passing over the bed, a certain quantity of ammoniacal salt was added, and this was passed again over the same, or another nitrifying bed; the operation was repeated until a sufficient degree of concentration was obtained to allow of economic extraction. In other words, the liquids already nitrified were recharged with a further supply of ammoniacal salt and further submitted to the nitrifying process to enrich them gradually.

A series of jars, with opening at the bottom, were prepared. They were filled with pieces of peat, mixed with earthy mould charged with nitrifying ferments, and soaked in a mud of Meudon chalk, and a ·4 oz. solution of ammonium sulphate per gallon. These jars were then regularly sprinkled with a ·4 oz. solution until the process was well established. Then the concentration of the solutions was carried to ·8 oz., and later on to 1·2 oz. After this point was reached the experiment was carried on as follows:—

The first jar (A) was sprinkled with a solution containing 1·2 oz. of sulphate ammonium, and 2·56 oz. of Meudon chalk. The sprinkling was 30·5 cubic inches per day, poured in four parts. Each morning, to the 30·5 cubic inches, which had drained from the first jar (A), were added ·132 oz. of ammonium sulphate and ·264 oz. of chalk, and this was poured over the contents of jar (B). This was repeated in the case of the subsequent jars up to the eighth—the last of the series.

The enrichment was regular, and the results show that it could have been pushed farther.

OXIDIZED NITROGEN PER LITRE.

—	A.	B.	C.	D.	E.	F.	G.	H.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
October 2......	·200	·427	·756	·993	1·061	1·193	1·307	1·585
" 11......	·247	·406	·684	·890	1·096	1·260	1·412	1·595

This last content of 1·595 corresponds to 7·576 oz. of calcium nitrate per gallon. This is, therefore, still far from the 32 oz., from which point nitrification becomes impossible, and the number of jars could have been increased.

This experiment shows that solutions of nitrate could be obtained sufficiently concentrated to allow of an economic extraction.

ACCUMULATION OF PLASTER IN NITRE BEDS.

Nitre beds working continuously, receive large quantities of ammonium sulphate and of carbonate of lime. This causes the formation and accumulation of plaster. For each gallon of solution of 1·20 oz. of ammonium sulphate, 1·25 oz. of calcium sulphate will be formed, of which only one-quarter will be soluble. The balance is insoluble, and would be deposited on the peat forming the support. This would, in a short time, result in a notable decrease in the efficiency of the bed.

To obviate this, the simplest method is to eliminate the plaster from the solution before sprinkling. To achieve this, it will be sufficient to allow the nitrified solution to settle after the addition of the ammonium sulphate, and to use the supernatant liquids—which are solutions of ammonium nitrate—to be submitted to nitrification. Therefore, the first bed is the only one which would receive plaster. The subsequent beds will be free from it and can work indefinitely without fear of obstruction.

TRANSFORMATION OF NITRATE OF CALCIUM INTO NITRIC ACID AND ALKALINE NITRATES.

The artificial nitre beds yield us nitrate of calcium. For the manufacture of explosives it becomes necessary to transform it into nitric acid, which can be done by treatment with sulphuric acid, as in the case of sodium nitrate.

But this method might offer difficulties in practice, and would necessitate the modification of manufacturing plants; hence it might be more expedient to transform the calcium nitrate into an alkaline nitrate.

Treatment with potassium sulphate seems to be the best suited. Lime is eliminated in the state of insoluble sulphate, and the liquid freed from this calcium sulphate, and concentrated, yields directly pure crystals of potassium nitrate.

ESTABLISHMENT OF NITRE BEDS WITH CONTINUOUS PRODUCTION.

The foregoing researches have shown the possibility of working on a large scale, by pouring the ammoniacal liquids over peat beds properly prepared, and we are now in a position to formulate certain rules concerning the establishment of such plants.

First, comes the choice of peat best suited for the purpose. We have noticed that it does not make much difference whether mossy peat, or compact peat is used. In our experiments, we have mainly used surface peat, somewhat mossy, and this material appears to be the most practical, as it can be more easily obtained.

Earthy peat, easily powdered, must, of course, be avoided, as it would form mud or slime on being sprinkled with the solutions.

The proper peat should be broken into fragments the size of walnuts, or of eggs. This peat should be sufficiently drained; but it is not necessary to wait for a complete dessication. The pieces will be moistened with a weak nitrifiable solution containing ·32 oz. of ammonium sulphate per gallon; to which has been added finely pulverized chalk, and a little phosphate of lime. The whole should be well stirred to cause a complete absorption of the carbonate of calcium, of which ninety-two pounds may be added per cubic yard.

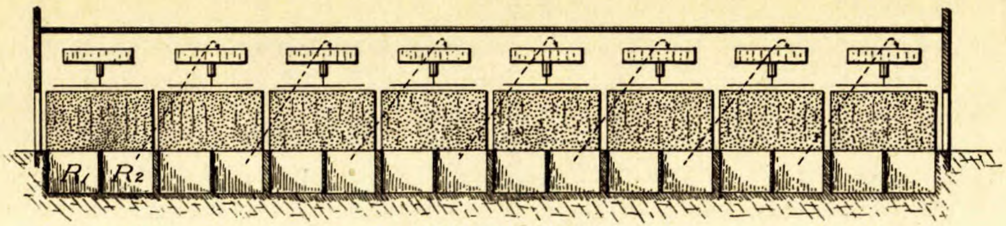
At the same time, material from a nitre bed in activity must be added. If not available, add good gardener's earth. Seventeen pounds of this should be added to each cubic yard of peat, and disposed in parallelopiped heaps six and a half feet thick; the other dimensions varying with the importance of the nitrifying bed. The sides could be held by strong wire netting. Aeration flues to be maintained in the heaps. Care must be taken to dispose the pieces of peat as loosely as possible, to ensure a good circulation of air.

The lower part of the heap should rest on a layer of broken cinders, or other inert material, to ensure easy drainage and access of air. The nitrifiable solution should be applied regularly at stated intervals. This may be done automatically by the aid of a self-starting syphon.

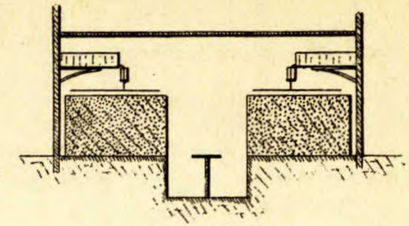
The nitrifiable solution should be weak at the start, as the multiplication of organisms is much weaker with strong solutions.

The sprinkling can be done at first with solutions containing ·4 oz. of ammonium sulphate, at the rate of 35 gallons per cubic yard of peat per twenty-four hours. As soon as the nitrification of liquids collected at the lower end is complete—that is when they are free from ammonia or nitrates—it can be successfully carried to ·8 oz., and later to 1·2 oz. This period of starting should take a month. After this, the nitre bed works regularly, and the volume of liquid daily sprinkled—containing 1·2 oz. of ammonium sulphate—may reach 175 gallons per cubic yard of peat.

The nitrified liquids are rather poor in nitrates. To enrich them, a series of peat beds will have to be established to take the nitrified solutions of the preceding ones, with addition of a new quantity of ammonium sulphate.



SECTIONAL ELEVATION.



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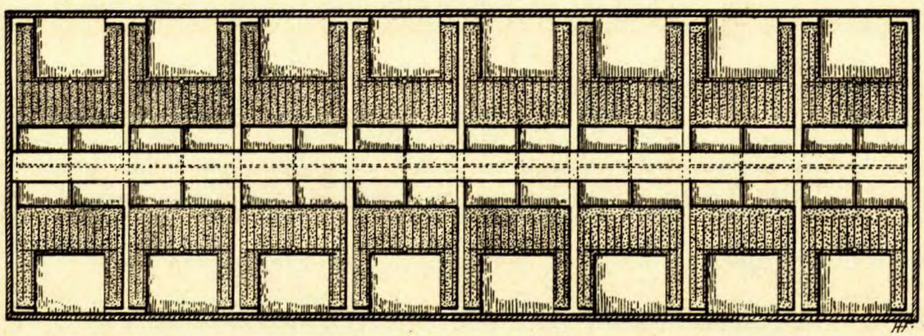

PLAN.

DIAGRAM OF PLANT FOR CONTINUOUS NITRIFICATION PROCESS, BY MEANS OF PEAT BEDS.
(from "La Nitrification Intensive," by Müntz and Lane.)

The diagram (p. 97) shows an installation of eight nitrifying beds. Below each one are two tanks or cisterns, respectively R_1 and R_2, to receive the liquids draining from the beds. When one of these reservoirs, say R_1, is full, 10·01 pounds of ammonium sulphate per 150 gallons of liquid is added, and dissolved by stirring. This produces an abundant precipitate of sulphate of lime, owing to the presence of the nitrate of lime. After settlement, the liquid is tapped into the second compartment, R_2, and only clear liquids are pumped into the upper tank, thus protecting the nitre beds from the clogging which the sulphate of lime would produce in them.

The carbonate of lime is gradually used up, and has to be replaced. This can be done by throwing on the surface of the nitre beds a slime of pulverized chalk. The proportion of chalk thus introduced should be double the quantity of ammonium sulphate. The nitre beds will be established in buildings where a temperature of 79° or 80° can be maintained.

To operate on a large scale would, of course, require the installation of pumps, etc., to handle the liquids.

CONCLUSIONS.

From the preceding pages it is seen that peat constitutes a nitrifying medium, or support, superior to all others, either for the installation of intermittent nitre beds, or of continuously producing plants.

Peat constitutes a fuel of a very low market price at the bog, and can be utilized to maintain the necessary heat, and steam for the plant.

Moreover, owing to the high proportion of nitrogen which it contains, and which can be recovered in the form of ammoniacal salts, peat can supply the raw materials necessary for the manufacture of nitrates.

This manufacture can, therefore, rely wholly for supplies on the exploitation of peat bogs; and to avoid transportation of material which has only a small market value, the nitrifying beds should if possible be installed on the bogs themselves.

An idea might be formed of the potentiality of such deposits by presenting a few figures. A bog with a superficies of 2,500 acres, and a mean depth of six feet, with a content of two per cent in nitrogen, could yield between 800,000 and 900,000 tons of nitrate of sodium. If we take into consideration the area of the peat bogs existing in France, these figures can safely be multiplied by 300 or 400. This is a reserve of nitrogen which would meet the wants of centuries to come.

Returning to the thought which first induced the undertaking of these studies, it is seen that in case France should be unable to obtain its supply of nitrates from the deposits of Chili, or India, the installation of nitre beds would enable it to produce all the nitre necessary for the manufacture of its explosives, and war ammunition.

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