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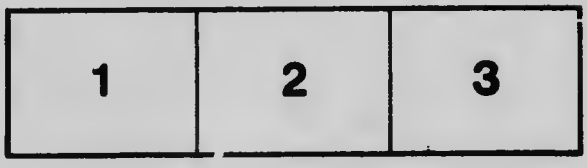

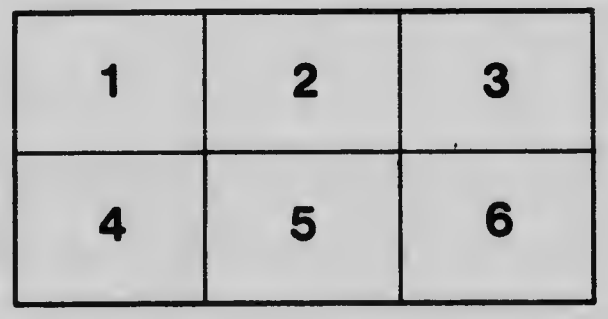

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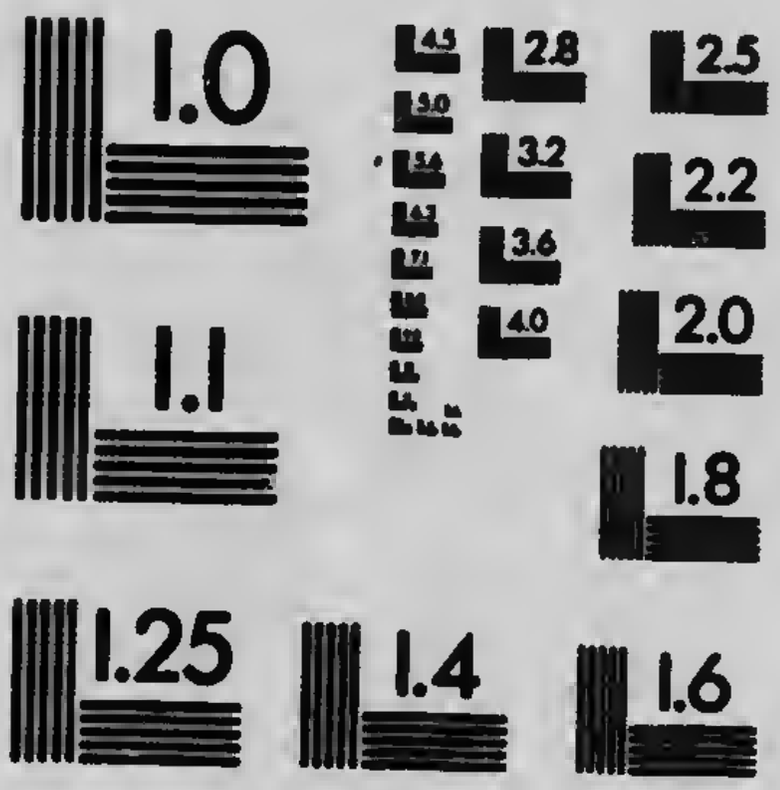

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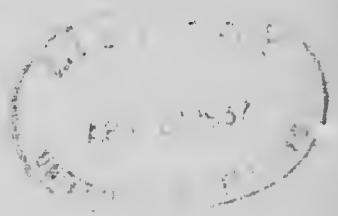
BY W. R. LANG

(REPRINTED FROM THE TRANSACTIONS OF THE CANADIAN INSTITUTE, VOL. VIII.)



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THE CHEMICAL INDUSTRIES OF THE DOMINION.

BY W. R. LANG, D.Sc.,

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF TORONTO.

(*Read 10th December*, 1904).

(*Completed for publication, April*, 1905).

PREFACE.

MUCH of this paper appeared about two years ago in the *Journal of the Society of Chemical Industry*.* Recently it was communicated by request to the Canadian Institute after having been revised and, in a measure, brought up to date. A closer scrutiny of the subject matter, however, led to the conclusion that entire revisal and rewriting were necessary in order that it might present the condition of the chemical industries of the Dominion as they are at the time of publication. Every effort has been made to do this as far as possible, and the writer hopes that any shortcomings will be brought to his notice.

In writing on such a subject as the Chemical Industries of Canada, two main considerations have been kept in mind; firstly, that the development of the industrial resources of the Dominion during the past decade has been phenomenal, and secondly, that the extent of these developments is only fully understood by a few. While it is impossible to discuss *all* the industries in which chemical operations and reactions are made use of, an attempt has been made to select processes in some cases peculiar to the country, but notably the industries which owe their development to the natural mineral and vegetable resources, and to the widely scattered water power obtainable in the Dominion.

The subjects taken up may be classified as follows:—

I.—Common Salt and Alkali.
II.—The Extraction and Refining of Metals.
III.—The Manufacture of Leather.
IV—Sulphuric Acid, Acetic Acid, Wood Alcohol, Charcoal, and Ammonia
V.—Soap and Glycerine.
VI.—Refined Chemicals and Drugs.
VII.—Fertilizers.

* Journal of the Society of Chemical Industry, May 15th 1903

VIII.—Coal-Tar and Asphalt.
IX.—Calcium Carbide, Carborundum, Corundum and Graphite.
X.—The Cement and Plaster Industry.
XI.—The Beet-Sugar Industry.
XII.—Natural Gas and Petroleum.
XIII.—Pulp and Paper.
XIV.—Asbestos and Mica

I.—COMMON SALT, ALKALI AND CHLORINE COMPOUNDS.

Sodium chloride is found in the upper silurian beds in Ontario, and in the Devonian in Manitoba and Athabasca; salt springs also occur in Cape Breton and in New Brunswick, but these are comparatively unimportant sources of supply. In Ontario the salt area stretches through the counties of Middlesex, Huron, Bruce, and Lambton, large deposits being found along the shore of Lake Huron from Kincardine to Windsor. At Goderich there is a deposit 126 feet thick, and at Windsor a bed extending to a depth of 1,672 feet passes through four beds of rock salt of an aggregate thickness of 392 feet.[1] The salt is obtained by evaporation, and is of an excellent quality. The following comparison serves to illustrate the purity of the natural product.[2]

	Natural Salt of Goderich, Ontario.	Natural Salt of Cheshire, (England.)
	Per Cent.	Per Cent.
Sodium chloride	99.687	96.70
Calcium chloride	0.032	0.68
Magnesium Chloride	0.095	0.00
Calcium sulphate	0.090	0.25
Moisture	0.079	0.63
Insoluble matter	0.017	1.74
	100.000	100.000
Total Impurities	0.234	2.67

The total production of salt in Canada was valued in 1892 at $162,000, in 1901 at $262,328, and in 1903 at $334,000.[3 bis.]

Apart from its use as a seasoning and as a preservative, common salt is employed in the electrolytic preparation of caustic soda and bleaching compounds.

The alkali and bleaching powder industries throughout the world

(1) W. Hodgson Ellis, M.B., in "A Handbook of Canada," 1897.
(2) Wilmott, A.B., "Some Minor Minerals of Canada," 1897.
(3 *bis.*) Statistical Year Book, 1903.

are at the present time in an unsettled condition, mainly owing to the advent of electrolytic methods.[3] Wherever cheap water power is available, however, electrolytic processes will be rapidly developed, provided the raw material is obtainable within a reasonable distance.

II.—THE EXTRACTION AND REFINING OF METALS.

Almost every province in the Dominion possesses valuable mineral resources; these are rapidly being exploited, and among the metals produced in quantity may be mentioned iron, copper, lead and silver, nickel, arsenic, antimony, and, lastly, aluminum. These metals are found in the form of native iron, magnetic iron ore, iron pyrites, hæmatite, native copper, chalcopyrite, galena, native silver and ores of silver, nickeliferous pyrrhotite, gold, sulphide of antimony, and arsenical pyrites

IRON.

The iron ores of the Dominion occur at varied intervals, from Vancouver Island on the west to Cape Breton Island and Newfoundland on the east. In Nova Scotia there are particularly rich deposits, and in close contiguity to them are found the necessary materials for [illegible]ing. Hæmatites, too, are found in all parts of Canada. One of the notable deposits of specular iron is at Hull, near Ottawa, which assays 64 to 68 per cent, of metallic iron. In the Appendix (Appendix I.) will be found more particulars regarding the iron ores of the Dominion.

The Canadian iron industry dates back to the establishment of the St. Maurice forges by the French Government in 1737. Many other small plants were subsequently built, as at Batiscan, Hull, and Bois de Paul all in Quebec; at Furnace Falls, Mormondale, Marmora, etc., in Ontario at Woodstock, in New Brunswick; and at Moose River, Nictaux, and Bloomfield, in Nova Scotia. They all subsequently failed, however, in consequence of the competition of Great Britain and the United States. This early failure was due as much as anything else to lack of enterprise, capital, and proper shipping facilities. The modern development of the industry may be said to date from the introduction of a protective duty on iron in 1887. The granting of bounties by the Dominion and Ontario Governments has also assisted largely in bringing about the present condition of the iron and steel industries.[4] The annual aggregate capacity of the completed and unfinished furnaces in the Dominion in 1903 was

(3) Chem. Tr. J., 23.8.02, 6.9.02, and 24.1.03.

(4) Dominion bounty on pig iron, $3 per ton produced. Ontario bounty $1 per ton on pig iron produced from Ontario ores, and 50 cents on ores not obtained in the Province; the rate of $1 to be only paid up to 25,000 tons. Bounty is at present largely reduced owing to increased production.

close on 1,000,000 gross tons.[5] Much of the iron produced is now being made into steel[6] by the Bessemer process. At Sault Ste. Marie there is an extensive plant with a capacity of 200,000 tons of ingots and 180,000 tons of finished products. There, steel rails are being made to the extent of 500 tons a day. This company has its own blast furnaces, and undertakes all the processes, metallurgical and mechanical, through which the metal goes in its conversion from ore to finished product.

At Collingwood, Ontario, the Northern Iron and Steel Company, which recently acquired the works of the Cramp Steel Company, have two 20-ton open hearth furnaces besides rolling mills from which will be turned out material suitable for machinists' and blacksmiths' use, finished steel bars, angles, fish plates, tie plates and small sections such as are used by many manufacturers. The Gilchrist Thomas is the process employed, a process which allows of ores containing phosphorus, for example, to be profitably converted into good uniform steel. The ten inch mill at the Collingwood works is equipped with underground tunnels and turtle-backs for the purpose of continuous rolling, that is to say, a bar of steel will be looped from one pass of the rolls into another pass: thus a mill of this description is enabled to roll rods and long bars. The furnaces are of the latest standard design, having air cooled end blocks and slag pockets with the regenerators under the charging platform, which is of steel and concrete.[7] Recently the company has begun to convert, by "cold-drawing," steel bars into wire of various gauges.

The Canada Iron Furnace Company has its principal plant at Midland, Ontario, besides several other smaller establishments in various parts of Quebec. The Midland furnace was erected during 1899-1900 on a property about 100 acres in extent, situated on the north shore of the Midland Bay. The furnace proper has a capacity of from 120 to 140 tons a day of "Midland Brand" Foundry Malleable Bessemer and Bessemer Pig Iron, and is marketed almost entirely in Ontario. The raw materials used are coke, iron ores and limestone. The coke is obtained from the Connellsville district in Pennsylvania, and is brought in by rail. The iron ores are brought in by vessel from Canadian and United States ports on Lake Superior and also Lake Michigan. The limestone is obtained from the company's own quarry, which is about 130 acres in extent, situated about three milles from the furnace. This material is brought to the furnace by scows in the summer and by teams in the winter.[8]

(5) In a letter from Mr. T. W. Gibson, Director of the Ontario Bureau of Mines, the following figures are given for 1903:

Pig Iron produced in Ontario		87,004	tons.
Steel	" "	15,229	"
Pig Iron	" Canada	265,418	"
Steel	" "	232,641	"

(6) Dominion bounty on steel, $3 per ton; $2 per ton on steel from foreign ores.
(7) Letter from Mr. J. A. Currie.
(8) Letter from Mr. A. C. Adams, Midland.

On the eastern seaboard of the Dominion are situated the works of the Dominion Iron and Steel Company, begun in 1899. Coal and limestone are found comparatively near at hand, the farthest afield mine from which the coal supply is drawn being twenty-five miles distant, while the nearest one is six miles. Nearly all the iron ore at present used is brought from mines owned by the company on Great Belle Island in Conception Bay, Newfoundland, some 400 miles from Sydney. This mine is estimated to contain 28 million tons of available ore, besides areas under the sea, which are believed to be very extensive. Analyses of the ore show it to contain fifty per cent. of iron, little sulphur, but rather too much silica, aluminium, and phosphorus. The result is a pig iron too high in phosphorus, but during the subsequent conversion of the pig into steel in open hearth furnaces, this impurity is eliminated, and a fine quality of steel produced. For the best kind of pig iron, it is necessary to mix other ores with it, and for this purpose Cuban, Spanish, and Swedish ores are used, the result being a low phosphorus pig. Indications of large deposits of high-grade ores have been found both in Nova Scotia and Cape Breton, which, when fully developed, will in a great measure replace the foreign ores.

Limestone is obtained from the company's quarries at the Bras d'Or Lakes, about eighty-five miles, by water, from the works. It is a stone of good quality, and is found in large deposits; it acts well with the Newfoundland ore and the Cape Breton coke[8 *bis*.] The works contain four blast-furnaces capable of yielding 1,000 tons of pig iron per day; the furnace gases are utilized also to the utmost, being used to heat the blast and also to raise steam. The iron produced is partly cast into pigs and in part conveyed in a molten condition direct to the open-hearth furnaces, where it is converted into steel. Of these there are ten in number of the H. H. Campbell type of tilting basic open-hearth furnaces, having a capacity of fifty tons each. A very complete arrangement of testing the steel at intervals is in vogue, and of stamping each ingot with special marks so that the consumer can ascertain from the company at any time every particular regarding the analysis and making of the piece.

The gases produced in the coke ovens are used in the opening hearth furnaces, the other bye-products, namely, coal-tar and ammonia, being also collected. The ammonia is converted into sulphate of ammonium by neutralizing it with sulphuric acid—which can be obtained from the pyrites separated from the coal in the preliminary grinding and washing processes to which it is subjected, and is principally exported to the United States, the West Indies, and Glasgow.

(8 *bis*.) The daily shipment is 1,500 tons.

Canadian-made steel is largely exported to the United States from where it returns to this country in the form of rails and other finished products; but it is intended that this feature of the steel industry will shortly be transferred to Canadian territory. Sydney is extremely well situated as a seaport, being nearer to England than is New York, and, strange as it may appear, to the ports of South America and South Africa.[9] As far as the geographical position is concerned, therefore, Sydney possesses many advantages, while the masterly and liberal way in which the iron and steel industry has been organized and developed, points to a bright future for it in Canada.[10]

A new plant has been erected near North Sydney by the Nova Scotia Steel Company, who have at present works at Ferrona, with a limited supply of ore near at hand. Hence they import largely from Newfoundland. Their steel works are at present at New Glasgow, but a new plant is under construction at Sydney (1903), Their output, which is sold almost exclusively in Canada, approximates 100 tons of pig-iron per day and the same amount of steel.[10 *bis.*]

COPPER.

The production of refined copper can hardly be classed among the chemical industries of the Dominion, as practically only the first stage in its extraction of the metal is reached, namely, the making of copper matte, which is exported to the United States to be refined. As will be seen below, however, the refining of this metal is now being carried on in British Columbia.

Copper ores occur in great abundance, and constitute one of the most important mineral resources of the country. These are distributed over large tracts in Ontario, Quebec, Nova Scotia, and New Brunswick. The deposits consist of native copper and sulphides, the former confined principally to the Lake Superior region, the latter being more widely diffused,

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	Miles.
(9) Sydney Harbour to Liverpool (*via* South of Ireland)	2,307
New York Harbour to Liverpool	3,110
Sydney Harbour to Pernambuco	3,567
New York Harbour to Pernambuco	3,696
Sydney Harbour to Cape Town	6,467
New York Harbour to Cape Town	6,787

These figures were supplied to me by Mr. Watson Griffin, who obtained them from Captain W. H. Smith, R.N.R., Halifax. The distances from New York were compiled by the United States Commission of Navigation.

(10) Mr. Watson Griffin, who kindly supplied me with material from which the above description of the Sydney operations was written, mentioned also that a leading Scottish iron and steel magnate told him that, everything considered, Sydney, in regard to raw materials, nearness to the mark and the excellent equipment it possessed, would be the finest steel manufactory in the world. Watson Griffin, "Dominion Steel and Coal Co., Sydney;" Montreal, 1902. Watson Griffin, "The Front Door of Canada;" Montreal, 1899.

(10 *bis.*) The production of pig iron in 1903 amounted to 265,418 tons, as compared to 47,000 tons in 1893, while the proportion of the home product to the total consumption of pig was 76 per cent. in 1903 as compared with 42 per cent. in 1893.

but notably in the Sudbury region, Ontario, where it occurs with nickel. The production of copper, other than the native copper near Lake Superior, is dependent for the most part on that of this latter metal.

The British Columbia Copper Company is now turning out about seven million (7,000,000) pounds of copper a year and has an excellent converter plant at its mine. This copper is produced at a cost of about 9½ cents a pound. The product from the converter is blister copper and is sent to New York to the Nicholls Chemical Company to be refined. The Montreal and Boston Copper Company is now producing about 3,000,000 pounds of copper and is selling its matte to the British Columbia Company. The Granby Company is producing about 15,000,000 pounds of copper a year, at a cost of around 9½ cents, laid down in new York.[11]

Some idea of the advances made in the production of copper matte may be had from the fact that in 1893 the production amounted to 8,000,000 pounds, while 1903 showed an output of 43,000,000 pounds.[11 *bis.*]

Mr. A. P. Turner of the Canadian Copper Company at Copper Cliff, Ontario, has furnished some interesting particulars regarding the production of copper as carried on at the works of this company, which controls about 20,000 acres of mineral lands in the nickel district extending from Garson Township in the District of Nipissing, south-west to Drury Township in the District of Algoma, in the Province of Ontario. The company began operations in 1887, and at present is mining and smelting about 700 tons of ore per day. The ore is a mixture of nickeliferous pyrrhotite, pentlandite, chalcopyrite and diorite. The nickel in this pyrrhotite replaces about two to four per cent. of the iron. Copper occurs in the form of copper pyrites. The ore contains no arsenic or antimony, but small traces of gold, platinum and palladium. An average assay of the different mines is about two per cent. copper and four per cent. nickel.

The company has designed and just finished at Copper Cliff, a new smelting and power plant, in which are combined the latest and best improvements in the smelting world. There are larger plants, but it is doubtful if there is another in which are assembled so many up-to-date conveniences for every part of the work.

NICKEL.

The first discovery of nickeliferous deposits was made in 1883 near Sudbury, in the district of Algoma, Ontario. Previous to the discovery of nickel in this country, the French colony at New Caledonia practically

(11) Letter from Mr. F. P. Clappison.
(11 *bis.*) Statistical Year Book, 1903.

contributed the world's supply of the metal, though supplemented, in a small degree, by the Gap Mine in Pennsylvania, and by a few isolated mines in Norway and Hungary. Professor Coleman[12] states that the Sudbury ores consist of a mixture of pyrrhotite (magnetic pyrites) and copper pyrites, and in this resemble the gold ores of Rossland. In order to obtain the metal the ore is smelted into a matte, containing from twelve to twenty per cent. of nickel and about the same amount of copper, is "Bessemerized" into a regulus containing about forty per cent. of nickel and is shipped to Clydach in Wales, where its nickel content is extracted and refined by the process invented by Dr. Ludwig Mond, F.R.S., and which bears his name. The chemical principle on which this process is based is the formation, at temperatures of about 50° C., of a volatile colourless gaseous compound of nickel and carbon monoxide of composition Ni_4CO, which, on being subjected to a temperature of 180° C., decomposes, leaving metallic nickel and liberating the carbon monoxide. The product thus obtained contains between 99.4 and 99.8 per cent. of nickel. The Mond Nickel Company is the only company refining nickel within the British Empire, and it is interesting to note that at the recent St. Louis Exhibition Dr. Mond was awarded the gold medal for his process, the company receiving a similar honour struck in silver.[13] Nickel from Canadian ores is now being used in the manufacture of armour plate in constructing ships for His Majesty's navy.

What is known as the Orford or alkaline sulphide process of refining nickel is the one by which the Canadian Copper Company's mattes are treated at Constable Hook, N.J., by the Orford Copper Company. As this company (now forming part of the International Nickel Company) is the chief producer, the bulk of the nickel ores of Ontario are refined by the Orford process. An electrolytic refinery erected by the Canadian Copper Company at Cleveland, Ohio, was operated for a short time only, but shut down in 1902.[14]

The Orford Copper Company is also producing *palladium*. This metal belongs to the platinum group, and is found associated with it. The Sudbury ores are said to contain from one tenth of an ounce to one ounce per ton, and Dr. Joseph Wharton, in an article recently published [14 *bis*,] prophesies a future production of palladium from these deposits. Palladium is an interesting metal, not only from the chemist's point of view, but also from an industrial one, as its physical properties, hardness, etc., and the difficulty with which it is attacked and tarnished at atmos-

(12) 8th Report of Bureau of Mines, Ontario, page 106.

(13) A full account of the Mond Nickel Process will be found in the 8th Report, Bureau of Mines, Ontario.

(14) Letter from Mr. T. W. Gibson, Director of the Bureau of Mines, Ont.

(14 *bis*.) "Hardware and Metal," Dec. 3rd, 1904.

pheric temperatures, render it eminently suitable for replacing silver as a reflecting surface on optical instruments, for plating the finely cut scales on instruments of precision and for alloys.

ALUMINUM.

The extraction and refining of aluminum has in recent years, owing to the advent of electricity developed from cheap water power, become an important industry. At Shawinigan Falls, Quebec, are situated the Canadian works of the Northern Aluminium Company, a sub-company of the Pittsburgh Reduction Company, which also has two large factories at Niagara Falls, N.Y. The raw material, bauxite, is obtained from Alabama, Arkansas and Georgia, in the United States. The process employed is the Hall[15] process, and is a combined electrolytic and electric furnace one. The native aluminum hydroxide is first purified by mixing with sufficient carbon to reduce all impurities in it to the metallic state, the resulting iron, mixed with titanium and silicon, forming a slag after melting the mass in an electric furnace. An alternating current of low voltage is used, and the purified alumina separates out above the slag in an almost chemically pure condition. The alumina thus purified is then electrolyzed in a bath containing cryolite at a temperature of from 850° to 900° C. The action of the current sets free aluminum and oxygen, the latter uniting with the carbon anodes to form carbonic oxide. The metal is run into rough ingots weighing twenty pounds each, and is stated to contain, on an average, 99.5 per cent. of aluminum.[16] The principal portion of the product at Shawinigan is shipped in the form of ingots, although there is in addition a wire mill where aluminum wire and cable for electrical conductors are made.

The production of the Quebec works is probably 9,500 pounds per day, the value in 1902 being approximately $1,043,250.[17] It may safely be said that the three works of this company between them produce one-half of the world's supply.

LEAD AND SILVER.

These metals are derived principally from the mines of British Columbia, but there are also deposits of galena along the shores of Lake Superior, the ore from which is sent to Niagara Falls, N.Y., for reduction. The British Columbia ore is a high grade one, carrying from 25 to 300 ounces of silver to the ton. At Trail, in British Columbia, the Canadian Smelt-

(15) Dr. J. W. Richards in "Electro-Chemical Industry," Oct., 1902.
(16) *Ibid.* (Average value of product is 31 cents per pound).
(17) Canadian Mining Rev., March, 1903.

ing Works have recently begun to produce commercial lead, stated to be of 99.9 per cent. purity,[18] by means of the Bett's process, which is an electrolytic one.

The Hall Mining and Smelting Works, whose Canadian headquarters are at Nelson, British Columbia, are smelting lead ores which are obtained in the Slocan and Kootenay Lakes. They employ blast furnaces, a considerable portion of the ore being first roasted in hand or mechanical furnaces, and the product of the latter briquetted. The principal markets for the pig lead are the Orient, England, and Canada, though the home market is somewhat handicapped by the present arrangement of duties, which allows the importation of foreign corroded lead at a lower rate than that imposed on pig-lead. With a revisal of the duties a greatly increased development and revival of the lead and smelting industries is anticipated.[19] *bis.*

In 1894 the amount of silver exported, in ores, concentrates, or otherwise, was 629,655 ounces, while in 1901 the quantity had risen to over 4,000,000 ounces.[19] Despite these figures, the *Monetary Times*, Toronto, of date January 16th, 1903, says, "The silver-lead production of British Columbia is severely handicapped by the adverse competition of the United States, the European and Mexican products. The tariff is unfavourable; a higher one would be quite beneficial to the industry."

During the session of 1903 the Parliament of Canada provided for the payment of a bounty of 75c. per hundred pounds on lead smelted in Canada from Canadian ores, the maximum amount of bounty payable in any one year being $500,000, and the rate subject to proportionate reduction when the standard price of pig lead in London, England, exceeds £12 10s. per ton of 2,240 pounds. This provision has led to the revival of silver-lead mining in British Columbia. A small plant for smelting lead has been erected at Bannockburn, Ont., to be used on the non-argentiferous ores of that locality.[19 *bis.*]

ARSENIC.

A not unimportent metal found in considerable quantities in Ontario is arsenic; the chief form in which it occurs is arsenical pyrites (mispickel), which also contains gold. Its manufacture was begun by the Canadian Goldfields, Limited, at their Delora Mine, Hastings County, Ontario, in 1899. Attempts had been made, extending over the previous twenty years or so, to extract the gold from the ore found there, and, after the mine had experienced some vicissitudes, the present company acquired

(18) Letter from the Business Manager, Hall Mining and Smelting Co., Nelson, B.
(19) Statistical Year Book of Canada, 1901.
(19 *bis.*) Letter from M.. .. W. Gibson.

it and obtained the rights (1896) for Ontario to the Sulman-Tweed patents (bromo-cyanide process), working it with only a modified degree of success for a couple of years, when the installation of improved machinery and the adoption of a combination of amalgamation and leaching with bromo-cyanide resulted in the recovery of arsenic from the mispickel concentrates. To accomplish this the concentrates are heated to a high temperature in specially constructed cylindrical revolving calciners, and the resulting impure arsenious oxide evolved is condensed in hermetically sealed brick chambers.[20] The crude arsenic is refined by sublimation, and contains from 99.6 to 100 per cent. arsenious oxide, the main impurity being silica in a finely divided condition.[21] It is exported chiefly to the United States, where it is used for making "Paris Green," etc. The output has increased from 113,477 pounds in 1899 to 1,347,000 pounds in 1901.[21] In time and with proper development Ontario should be able to supply the entire demand for arsenic on the continent of America.

Auriferous mispickel mines are being opened up at Lake Temagami, and concentrating works are in course of erection. The process of refining the arsenic will be an electrical one. The ores of the Haileybury region, not far distant, discovered last year, contain 60 or 65 per cent. of arsenic, but are more valuable for their other constituents, including silver, cobalt and nickel.[19] *bis*.

ANTIMONY.

This metal might almost be said to occupy the position of a by-product in the extraction of gold. At Rawdon, in Nova Scotia, the ore (stibnite) is auriferous, and from 1898 to 1901 no refined antimony was produced, the stibnite being mined for the sake of its more precious contents[22]. It is also found in Quebec, and recent reports indicate deposits of ore in several localities of Ontario and British Columbia. The output in 1891 had fallen to $60. In 1902 the refining of the metal was renewed.

GOLD.

Gold is mined to a small extent in Ontario, in Nova Scotia and Quebec. Gold deposits are also found in the Kootenay district, B.C., in Cariboo, B.C., and in the Yukon. In the Rossland district the ore is a cupriferous pyrrhotite under a diorite cap, and from Trail on the Columbia River, where the

(20) C. Kirkegaard, in Eng. and Mining J., Jan. 31, 1903.

(21) Bureau of Mines Report, Ontario, 1901.

(22) Assays of two ores give, according to the Nova Scotia Mines Report, 1901.—

	I. Per cent.	II. Per cent.
Antimony	45.75	18.21
Gold (oz. per ton)	2.48	0.23
Silver (oz. per ton)	0.10	0.13

ore is smelted, the gold-copper matte produced is shipped to Montana for refining purposes. There is also a smelter at Nelson for the ore of the Hall mine. The Yukon territory covers in a general way the district north of Canboo, south of the Arctic Ocean, and lying between the Mackenzie River and the Alaska-Canada boundary. Gold has been known to exist there since 1864, and has been worked intermittently since 1873. Forty Mile River, a tributary of the Yukon, was discovered to carry coarse gold in 1886, and ten years later, what is known as the Klondike, was found to contain gold also, It was first discovered on Bonanza and Eldorado creeks;[23] the news of this discovery spread far and wide, and active prospecting was the result. There are about 1,400 miles of Canadian Yukon streams, on all of which gold can be found. Mr. Ogilvie, former Canadian commissioner in the Yukon, estimates that an area of 125,000 square miles is gold bearing.[24] The former difficulties of reaching the Yukon have now been overcome; a telegraph line has also been laid by the Canadian Government from Skagway, on the coast, to Dawson. The gold is found and worked in the gravel deposits of the valleys and on their adjacent slopes, and it has been estimated that gold to the value of 95,000,000 dols. will be produced from these deposits in the next few years.[25]

The gold fields of Nova Scotia occupy the entire Atlantic coast line, and contain gold in combination with sulphides and arsenides of iron, but mostly in the free state. The following table will best convey the output of gold from Canada and its distribution.[26]

	1892	1901
	Dols.	Dols.
Ontario	7,118	243,022
Saskatchewan, N.W.T.	98,006	5,000
Yukon	.....	12,000,000[27]
Quebec	12,887	3,000
British Columbia	399,525	5,596,700
Nova Scotia	389,965	604,500
Total	907,601	18,962,222

The gold production for the Yukon in 1902 was 12,018,561 dols.; according to the United States Mints it was 14,525,275.[28]

The total output of gold in Canada in the years 1893, 1900 and 1903 amounted respectively to $976,603, $27,908,153, and $18,834,373. The figures for 1904 are not yet available.

(23) "Official Guide to the Klondike," by William Ogilvie.
(24) *Ibid.*
(25) Report of the Canadian Commission in the Yukon.
(26) Statistical Year Books, 1892-1902.
(27) Letters from Mr. B. E. Walker, General Manager, the Canadian Bank of Commerce.
(28) Letter from Hon. Clifford Sifton, Minister of Interior, Ottawa.

III.—THE MANUFACTURE OF LEATHER.

The manufacture of leather has, during the last thirty years, occupied quite a prominent position in Ontario and Quebec, and, during the past few years, through the stimulus from a larger home market and increasing sales to foreign markets, has grown greatly. As compared with a decade ago the value of the leather produced in the country may safely be said to have doubled. There are from eighteen to twenty large establishments in operation and fully fifty small ones. No tanning is done in the North-West Territories, and practically none in British Columbia. Bark, chrome, and combination tanning methods are employed, the spent bark being utilized in large establishments in specially constructed furnaces. Though the United States may be said to lead the world in the extent of leather produced, the quality of the Canadian product is not surpassed. The Canadian specialties are hemlock sole and harness, black and coloured shoe leathers, coloured and fancy side leathers for the bag, trunk and saddle trades. In Toronto there are several sheep-skin tanneries as well.

Speaking generally Quebec supplies the cheapest grades of leathers, chiefly black; Ontario the better finished lines both black and coloured. A portion of the American patterned machinery employed and formerly imported is now being manufactured in the Dominion, such as bark mills, fleshing machines, glazing jacks, drums and presses; but the most expensive and elaborate machinery is still made in the United States. The import duty on machinery is 25 per cent. The manufacture of hemlock extract in New Brunswick has already had a beginning, and will doubtless grow as the prices of bark and labour advance.

IV.—SULPHURIC ACID, ACETIC ACID, WOOD ALCOHOL, CHARCOAL AND AMMONIA.

The manufacture of commercial sulphuric acid has not yet been developed to the extent that the quantity of sulphur found throughout the Dominion would justify. There is enough sulphur in Canada to supply the entire home market with acid and even to develop a considerable export trade. Only a few firms, however, are engaged in the trade, and a large portion of their product is used in the refining of Canadian petroleum, some five million pounds being annually consumed for this purpose. Quebec, Ontario, and British Columbia are each represented in the acid industry. It is probable that the construction of electrolytic lead smelters will lead to the sulphur dioxide obtained from the galena being made into sulphuric acid, as is done at the Electric Lead Reduction Company's works at Niagara Falls, N.Y., where, it is stated, the sulphuric acid produced

yields a financial return sufficient to cover the entire cost of the process.

At London, Ontario, the Canada Chemical Manufacturing Company turns out about fifteen tons of sulphuric acid per day; brimstone, imported from the States, is used, and is preferred to the Sicilian sulphur. This company does not use pyrites on account of the arsenic it contains. The process employed is the chamber one, indeed, as far as the writer knows, the "contact" process has not yet been tried in Canada. Sulphuric acid is used by many manufacturers, such as tack, screw, nail, leather and fertilizer makers, wholesale druggists, dyers and oil-refiners. Phosphates of calcium and sodium are also made by this company, native phosphates and the animal charcoal (bone black) rejected by sugar refiners serving as sources of phosphorus. The acid phosphate of calcium is employed in the baking-powder trade instead of cream of tartar, and is claimed to be less costly, to keep better, and to restore to the flour the phosphates which, by the modern methods of milling, have been removed from the wheat.

Sulphites, bisulphites, crude acetic acid from the grey acetate of lime, chlorides of zinc and iron and Glauber s salts are likewise made.

By the destructiye distillation of wood, acetic acid, wood alcohol and charcoal are obtained; hence Canada, with its enormous supply of wood of all kinds, should be able to take a prominent place in the production of acetic acid and wood spirit. At the present time the residual charcoal from the retorts does not find a ready market, owing to the comparatively high rates for transport as compared with other fuels, weight for weight. The outlook in this direction is, however, brightening. Among the firms engaged in this manufacture might be mentioned the Standard Chemical Company, with plants at Fenelon Falls, Deseronto and Longford, Ontario, and Cookshire, Quebec; the Canada Paint Company, Montreal and Toronto; and the Lake Superior Power Company, which is said to have the largest retort plant in the world. Very keen competition has to be faced in this connection with the United States, as a combination of some 175 manufacturers practically controls the market. The crude acetate of lime produced in the distillation process is converted into acetic acid, some of which is sold for dye and colour-making purposes, while a considerable portion is exported to Europe and Australia.

The wood alcohol, obtained at the same time as the acetic acid, supplies the home market and is also exported largely to Great Britain, France, Germany, Holland, Japan, and Australia. It may be of interest to know that timber is imported from Canada by makers of wood alcohol in the United States.[29]

(29) Mr. Webster, of the Standard Chemical Co.

The total production of ammonia from all the gas liquors obtained in the destructive distillation of coal throughout the Dominion is, the writer is informed by Mr. J. G. Harvey of Toronto, about 235,000 pounds of a 28° Beaumé solution. As this quantity is in excess of what is required to supply the Canadian market by some 100,000 pounds, that amount is exported to the States. Besides the numerous trade preparations of ammonia used for household and other purposes, "aqua ammonia" and anhydrous liquid ammonia are the two principal forms in which it is prepared. The process consists in mixing milk-of-lime in suitably constructed vessels with the ammoniacal gas liquor, agitating and heating with steam and conducting the liberated ammonia through more milk-of-lime, through a drip-tank and, in succession, through oil, charcoal purifiers, caustic alkali and finally to tanks of distilled water kept cool by running water, where the gas is absorbed and the ammonia of commerce thus obtained. Manufacturers claim that the amount of water required to be used during the process reduces the profits considerably, as the gas-liquors are of a poor quality, seldom exceeding 1½° Twaddle. Anhydrous ammonia is produced from the "aqua ammonia" by a series of fractional distillations, is liquefied by pressure and stored in hundred pound welded iron cylinders. It contains 99 per cent. liquid NH^3, and finds its principal use as a refrigerant.

V.—SOAP AND GLYCERINE.

SOAP.

The soap industry in Canada is growing rapidly; at the present time some fifteen large concerns are in operation, employing in all about 2,000 hands. A branch of the well-known firm whose headquarters are at Port Sunlight near Liverpool, was recently started in Toronto, with an annual capacity of 10,000 tons. Their products are similar to those made at their other works, and their raw materials are procured from Africa, the United States, and locally (tallow). They own islands in the Pacific from which they import cocoanut oil.

Many other firms are also manufacturers on a large scale and produce all grades, from the cheapest textile and laundry soaps to the finer qualities of toilet soaps. Great advances have taken place in the industry during the past ten years, particularly in the making of the latter. The same system of manufacture obtains in England. The raw materials are mainly cocoanut oil, palm oil, and tallow, the first two in a large measure superseding the last mentioned. The market for Canadian made soap is limited, the home market is supplied and a large export trade is done with the West Indies and Australia. The competition of the United States is felt more

than that of England or France. In 1902 the value of the soap produced was approximately $3,000,000.[30]

GLYCERINE.

This necessary bye-product in the manufacture of soap is refined in some cases by the producers themselves; others sell it to firms engaged more particularly in the refining trade. Among these might be mentioned the St. Henri Chemical Company, of Montreal, who buy waste lyes from the soap manufacturers, recover the salt from the lye, refine the glycerine, and sell to the makers of nitro-glycerine. The capacity of these works is 10,000,000 pounds of waste lye yearly.[31]

VI.—REFINED CHEMICALS AND DRUGS.

There are very few makers of refined chemicals in the Dominion. The small demand for pure chemicals is mainly accountable for the lack of local manufacturers, the market being necessarily a small one, and most buyers of pure chemicals for laboratory uses are apt to demand articles of the make of one or other of the large and old established German or English houses. One can hardly doubt but that the Canadian maker must desire a higher tariff on imported material. Of heavier chemicals, however, the Canadian Process Co. has recently begun the manufacture and the work is proving very successful. Such products are bisulphite, sulphide, thiosulphate (hyposulphite), sulphite and sulphate of soda, lime, and zinc salts, lactic acid, casein, etc. Messrs. Lyman Bros. and Company are continuing to extend along the lines of refined chemicals, their gold and silver salts being much in demand. Along with these they produce and refine such high grade chemicals as chloroform, ether, iodide of potassium, bromides, scale preparations, iron and zinc salts, acids of phosphorus, syrups, tinctures, and flavouring extracts. Most of the raw materials are imported. In the drug department this firm has probably the best grinding machinery in Canada, where, besides their own work, they do a considerable amount of grinding for other firms. In the strictly pharmaceutical business, Messrs. Parke, Davis and Company, Walkerville; H. K. Wampole, Toronto; F. Stearns, Windsor; and John Wyeth and Bro., Montreal, have manufacturing establishments. Recently the brand "Made in Canada" has been much in evidence, and many buyers prefer such goods, even if they are slightly more expensive, to the imported article.

A few years ago the Liquid Carbonate Company of Toronto commenced the manufacture of carbon dioxide on a commercial scale, and is now

(30) Mr. Knight, of the Sunlight Soap Co.
(31) Letter from the President of the Company.

producing some two tons a day. The methods employed for obtaining the gas are from the action of an acid, such as sulphuric acid, on chalk, dolomite or sodium carbonate, and by the combustion of coke, while it is also got as a bye-product from the fermentation vats in breweries. The gas, after being washed and purified, is compressed, cooled, and in liquid form is forced into steel cylinders at a pressure of from sixty to eighty atmospheres. (The cylinders are tested to a pressure of over two hundred atmospheres). This liquid gas finds a market from the Atlantic to the Pacific, and is used for aerating mineral and artificial waters, for forcing beer from barrels in the cellar to a higher level, and at the same time preserving it from deterioration. It is also used in the refining of sugar, as a motive power in spraying trees with a germicidal solution, and in the laboratory for producing low temperature mixtures. Numerous useful bye-products are a consequence of the process of production of carbonic acid, such as fine clay used by paper-makers, Epsom salts and Glauber's salts—all of which are employed in many industries and command a ready sale.

VII.—FERTILIZERS.

Mineral phosphates, in the form of apatite, are found in the Ottawa Valley, Ontario, but the deposits have not been worked for several years. About 1891, in which year the phosphates mined were valued at $50,000, a falling off began in the output of this mineral, which continued up to 1902, when the amount mined was hardly worth recording. This industry is on the increase again, however, and last year saw a production valued at some $8,000. This state of affairs has been brought about mainly by the large supply of easily-worked phosphates found in Florida and Carolina, U.S.A., much of which is obtained by dredging. It may be mentioned, however, that a certain amount of apatite is made use of in the Province of Quebec by the Buckingham Electric Reduction Company, who manufacture phosphorus therefrom.[32]

Sulphate of ammonia is manufactured at the works of the Dominion Iron and Steel Company, Sydney, N.S., whose products are supplied to dealers and others engaged in the fertilizer business. The ammoniacal liquors of the Quebec, Ottawa and Toronto Gasworks are worked up at the latter city by the Michigan Ammonia Company.[33] In Montreal, one firm at least, makes sulphate of ammonia, and at one time the gas works there utilized their own liquors for its production. Latterly, however, the gas liquor was exported, to be dealt with by a firm in the United States.

Quite a number of other fertilizers are produced in the Dominion from

(32) Minerals of Quebec: published by the Provincial Government.
(33) Letter from Mr. Macfarlane, Chief Analyst to the Inland Revenue Department.

refuse matter, such as blood, tankage, bones, and offal, besides natural phosphates. Ontario, New Brunswick, Quebec, Nova Scotia, Prince Edward Island, and British Columbia, all produce fertilizers, more or less.[34]

VIII.—COAL-TAR AND ASPHALT.

Very little tar distillation is carried on in the Dominion, owing mainly to the tar produced in the gasworks being too thick for treatment with any degree of success. It is mainly used for saturating paper, which is employed largely as a waterproofing material by builders. Some is boiled down into pitch, but about one half of the tar produced is exported to the United States. There is a small distilling plant at Hamilton, Ontario, which the writer understands, was, up to eighteen months ago, the only one of its kind from which coal-tar oils were produced in Canada. The Dominion Iron and Steel Company at Sydney obtain a considerable quantity of coal tar from their coke-ovens. This, at one time, found a market in the States, in Montreal and other points in Canada, but recently arrangements were made with an English chemical company to locate at Sydney with a view to utilizing all the coal-tar produced from the coke-ovens. The works, which are one of the largest on the continent, are now in operation and doing a large business in Canada, Europe and the United States; the demand for the company's products in Canada is not sufficient, hence the European and American exports. The present products are pitch and the various grades of benzol, creosote-oil and carbolic acid.[35] Large extensions are looked for from this company, which will be guided by the motto *festina lente*, and as opportunity offers, will branch into the production of other commercial commodities arising out of coal-tar and its distillation products.

ASPHALT.

Asphalt occurs naturally in several varieties as albertite, found in King's and Albert Counties, N.B., and as maltha, one of the stiffer petroleum compounds, which is not of much importance however, being almost too hard for use in street paving. Up to 1898, albertite was employed in gas-making, and much of it was shipped to the United states; but the original supply is now exhausted.

IX.—CALCIUM CARBIDE, CARBORUNDUM, CORUNDUM, AND GRAPHITE.

CALCIUM CARBIDE.

The production of this substance on a manufacturing scale dates back only to the year 1891, when Mr. T. L. Willson, of the Willson Aluminum

(34) Inland Revenue Bulletin, No. 81, 1902.
(35) Letter from Mr. John Craven, Sydney, 2nd Feb., 1905.

Works, at Spray, N.C., accidentally obtained carbide whilst trying to reduce lime by carbon in the electric furnace. Instead of metallic calcium resulting—which was to be employed in preparing aluminum—a hard, almost black, substance was got which reacted violently with water, giving lime and an inflammable gas clearly recognizable as acetylene. The author was privileged, through the courtesy of Lord Kelvin, to have at one time in his possession some pieces of the first carbide made by Mr. Willson at Spray. Acetylene being a powerful illuminating agent and readily obtained from carbide, the development of the carbide industry on a commercial scale followed this discovery as a natural consequence. The industry has progressed by leaps and bounds during the past decade, in Europe even to the extent of over-production.[36] Two carbide works are in operation in Canada using water as their source of power, the Ottawa Carbide Company, and another important company is the Shawinigan Carbide Company of Shawinigan Falls, Quebec. The process of manufacturing consists in fusing together burned lime and ground coke in the electric furnace; the temperature required is not so high as that needed in other operations for which the electric furnace is employed, notably the making of carborundum and graphite. The reaction taking place in the furnace results in a transference of the oxygen of the lime to a portion of the carbon with the formation of carbon monoxide and carbide of calcium.

The present market value of carbide affords considerable profit to its manufacturers, and the increasing popularity of acetylene as an illuminant ensures a brighter future for the industry. In Ontario several towns have already had acetylene installed for house and street lighting, the gas being generated at a central station and distributed in pipes to the consumers.[37] At the generating station the gas is purified by a special process before use, which obviates all the disadvantages inseparable from the employment of small generators—automatic or otherwise—by individuals, who in most cases have neither the time nor the scientific skill necessary for the proper production of the gas, simple as it may appear at first sight.

CARBORUNDUM.

Ten years ago the very name "carborundum" was unknown; it is due entirely to the advance made in the development of electrical power, obtained from the immense waterfalls of the American continent, that this as well as other materials are now in daily use throughout the world.

(36) Italy alone possesses enough carbide plants to supply the whole of Europe. Dr. J. W Richards, in "Electro-chemical Industry" Sept. 1902.

(37) Worked under patents held by the Burgess Gas Process Co., Canadian Pat. 73,040 Sept. 10 1901; Eng. Pat. 241, Jan. 3, 1901; Amer. Pat. 701,995, June 10, 1902.

The history of carborundum, may well be likened to that of carbide, its discovery being accidental. Mr. E. C. Acheson, whose patents are employed in this industry, was endeavouring to obtain crystals of carbon by melting together clay and carbon, the latter of which it was hoped might crystallize from the resulting reduced aluminum. Hard crystals were found after the fused mass had cooled, the component parts of which were concluded to be carbon and aluminum, and for which he invented the name "carborundum." Analysis, however, proved the new substance to contain silicon and carbon, and only a small quantity of alumina. Further experiments were made with mixtures of sand, carbon and salt as a fluxing agent, and large crystalline masses of carborundum were obtained. The substance thus formed corresponds to the formula CSi, is extremely hard, and is used in place of emery and corundum. In the manufacturing process the materials employed are sand, coke, salt, and sawdust; the coke is reduced to kernels of a certain size, to be used for making the "core," and other portions are ground to a fine powder for mixing with the charge of sand and salt. The original form of furnace was fitted with a pair of carbon terminals, which could be moved longitudinally, and was essentially an arc furnace, the chemical changes taking place being due to the high temperature of the arc passing between the carbon terminals. In 1895 this form was abandoned and a continuous electrical connection made between the terminals by the introduction of a "core" of granulated coke. By regulating the diameter of the core it could be heated to a sufficiently high temperature to convert the surrounding mixtures into carborundum. In the modern form of furnace the brick ends and carbon electrodes, with the necessary terminals for connecting up the current, are the only permanent portions. The charge, consisting of sand, finely-ground coke, and sawdust,—added to render the mixture more porous and consequently allow the gaseous products to pass through the mass—is placed in the furnace till it is on a level with the lower edge of the carbon electrodes. The coke "core " is then filled in, made into cylindrical form by hand, and finally surrounded at its sides and on the top by the remainder of the charge. Care is taken to prevent the mixture coming in contact with the carbon terminals, and necessary retaining walls are built up of bricks as the charging operation is proceeded with. The current is passed for thirty-six hours, and after cooling, the walls are taken down, unused "charge" raked off, and the outer crust of carborundum exposed. A cross section of the contents of the furnace presents many interesting characteristics. In the centre is the core, which has been, to a large extent, converted into amorphous carbon and graphite. From this there radiate beautifully coloured carborundum crystals to a distance of from ten to twelve inches. Next a thin inner crust of amorphous carborundum of a light green colour is met with, then the outer crust, also

amorphous, and beyond this, the unchanged mixture.[38] A curious effect is observed near the core, where the temperature is highest; here are found crystals of carborundum, from which the intense heat has volatilized the silicon, leaving "skeleton" crystals of graphite, while the silicon, passing outwards oxidizes to silica, and often presents the appearance of spun glass. Silicon itself has been found in the cracks in the bed of the furnace.[39] The carborundum is finally crushed, washed, and graded for the market.

Carborundum has a lower specific gravity than emery, and finds its principal application in the manufacture of wheels, stones, razor hones, rubbing bricks for marble dressing, paper, and cloth. The Canadian works of the Carborundum Company were destroyed by fire in 1903 and have not been re-built. This plant was comparatively small, only operating 200 horse-power. The factory, however, supplied the Canadian market, thus avoiding the payment of duty. The writer was informed by Mr. Acheson that most of the Canadian product was exported to Scotland, to be used there in finishing granite. The estimated cost of the crude crystals is 2.5 cents per pound, that of the treated powder, 4.5 cents per pound, while the selling price averages 9 cents per pound.

CORUNDUM.

The natural corundum industry of Ontario, which is of recent origin, is, however, now steadily growing in amount and value of output. The production of corundum in 1901 had a value of $53,115, and in 1903, $106,332, and in 1904 over $3,000,000.[40] The chief producing company, the Canada Corundum Company, has just completed a new mill of greatly enlarged capacity, and the other operating concern, which formerly exported the corundum-bearing rock to the United States, after cobbing it merely, is now crushing and treating it on the spot. Two additional companies are in process of organization for producing corundum.[41]

To the Canada Corundum Company, of which Mr. B. A. C. Craig is the president, may be accorded the credit of having placed the natural corundum industry of Ontario on a firm basis. Craig Mountain is said to be the largest deposit of corundum in the world. The hardness of this substance has long been known, and under the name of emery it has, in an impure state, been used as an abrasive agent. The product of this mine is said to contain from 95 per cent. to 98 per cent. crystalline alumina, and from letters the writer has seen, its hardness and cutting qualities seem

(38) Illustrated Catalogue No. III., Carborundum Company, N.Y.
(39) Electro-Chemical Industry, Vol. I., No. 2.
(40) Letter from Mr. B. A. C. Craig, President of the Canada Corundum Company.
(41) See 19 *bis*.

to have recommended it to consumers alike in Europe and on the American continent. Results are always the best tests of the efficiency of any agent, and the rapidly increasing market that Ontario's corundum is finding is sufficient evidence of the quality of this material. The Craig Mine is now putting out about ten tons a day, and the management confidently expect a considerable increase in the spring.[42]

GRAPHITE.

Though no company for the manufacture of graphite has yet been capitalized in Canada, the production of it by the Acheson process is carried on to a small extent in the Canadian branch of the Carborundum Company at Niagara Falls. The formation of the "skeleton" crystals referred to above suggested making use of the decomposition of carborundum for making graphite itself. The inventor's patents include the production of graphite in the form of pure electric-light carbon, by subjecting impure carbon to a high temperature for a sufficient length of time to volatilize the impurities;[43] the conversion of carbon into graphite by mixing with such metallic oxides as would be capable of forming metallic carbides, to be subsequently decomposed;[44] the conversion into graphite of such natural carbonaceous materials as contain uniformly intermixed through them metallic oxides sufficient to produce carbide, and thence graphite.[45] These processes throw considerable light on the scientific principles underlying the formation of this substance.[46]

X.—THE CEMENT AND PLASTER INDUSTRY.

The manufacture of Portland cement is mainly confined to Ontario, though one establishment—the Crescent Cement Works—is situated at Longue Pointe, in the Province of Quebec. In Ontario there are some fourteen companies and eight factories in operation, and throughout this Province are found the necessary raw materials (clay and marl) of an excellent quality. The development of the industry has been rapid, and has all taken place within the past few years. The most improved method of procedure is as follows: the marl is thoroughly mixed, mechanically, with water into a thin paste, and the same operation is performed with the clay. The two fluids are mixed thoroughly in the required proportions, and in a pasty condition are pumped into steel rotary calciners, about seventy feet in length and six feet in diameter, set at a slight angle to the

(42) See note 40. An account of the Corundum Industry of Ontario will be found in the "Canadian Mining Review," Vol. XXIII, No. 10, (1904).

(43) U.S. Pat. 542,982 of July 23, 1895.

(44) U.S. Pat. 568,323 of Sept. 29, 1896, and No. 617,979 of Jan. 17, 1899.

(45) U.S. Pat. 645,285 of March 13, 1900.

(46) Electro Chemical Industry, Vol. I., No. 2.

horizontal. These rotary calciners are the great feature of the Canadian cement plants. This form of kiln is originally of English origin, but has only been brought to its present effective condition since its introduction to this country. In the interior of the kiln are "channel-irons" running from end to end. At the lower end fuel is introduced in a particular manner, and the burning gases pass through the entire length of the kiln, and are allowed to escape at the upper extremity. At this latter end is introduced the "slurry" of the mixed ingredients, which becomes dried and finally calcined in the slow passage from one end to the other. The revolving irons carry the "slurry" up with them as they rise, and on reaching the top it falls, under the action of gravity, through the burning gases, being subjected at the hottest part to a temperature of 3,000° F., when combination takes place between the constituents of the fused mass, and the resulting "clinker" emerges into the vessel destined for its reception. The drying and calcining is thus performed in one operation, and no preliminary pressing of the material into bricks is required.[47] At the works of the National Portland Cement Company, recently erected at Durham, Ont., a great saving of time is effected by cooling the clinker in vessels drawn by an endless chain through a stream of water below the ground level. After cooling in this manner it is ground to a fine powder, and packed in bags or barrels ready for use. The whole operation by this process occupies only eight hours, a period of time which will be appreciated by all acquainted with the older methods. At Durham the raw materials are brought from the natural deposits, which are close at hand, calcined, cooled, ground and packed by means of a continuous series of mechanical conveyers from one part of the establishment to the other. This company has another plant in course of erection at Hull, P.Q., on the Ottawa River, which is intended to supply the Eastern Canadian market.

Several articles have appeared lately in the public press[48] pointing out that a possible over-production of cement may be the result of the numerous large concerns which are already in operation or are about to be started. Whether or not this will take place in the immediate future depends, naturally, on the general prosperity of the country and the consequent demand for building materials. Certainly cement has gained considerable reputation as a substitute for stone, as can be seen by the extent to which it is made use of by architects. It can be readily moulded into any form and may then be dressed to represent the natural article. If it can ever oust stone and brick from their present position depends, not only on its comparative cost, but on the quality of cement put out by manufacturers. One case of a collapse due to an admixture of a single bag of inferior material and the whole fabric of the cement industry

(47) The Portland Cement Industry: "Queen's Quarterly," Jan. 1903.
(48) "*The Globe*," Toronto, March, 1903, and other papers.

as supplying a substitute for the older building materials, will be in danger of a similar fate. The total output of Portland cement in 1902 was valued at 1,028,618 dols.,[49] and in 1903 at 1,166,497 dols.[50]

Gypsum is found in considerable quantities in Nova Scotia and New Brunswick. At Windsor, N.S., there are immense deposits; the beds found in the vicinity of Hillsborough, N.B., are, however, very large and of great purity, and form the basis of the most extensive operations.[51] It is also found in Ontario, and plaster works are located at Paris in that Province. In 1901 active operations were begun at Gypsumville, Manitoba. The industry, however is principally located in New Brunswick. Drawbacks in the way of freight charges, inadequate shipping facilities, and the competition offered by manufacturers of plaster of Paris in the United States, kept the industry from developing until the Intercolonial Railway was opened and the increased duty on American plaster imposed, when the New Brunswick plaster, quarried and prepared at Hillsborough, came to be firmly established on the Canadian Market. In manufacturing plaster of Paris, the stone is first dried in the air and ground—not burned in lumps as is still done to a considerable extent in England and on the Continent of Europe, and the pulverized material subjected to a process of calcination in kettles, of a capacity of sixty barrels of 300 pounds of the calcined plaster, furnished with lids and stirring arms which keep the material in constant motion. When the required temperature has been reached (285° F.), the plaster is removed and packed in paper-lined barrels for market. Analysis of the Hillsborough gypsum shows it to be 99.88 per cent. $CaSO_4$.[52] The principal markets for plaster of Paris are Canada, the United States, and South Africa, while the crude gypsum is exported largely to New York and other portions of the States, being used for making plaster for walls and ceilings.[53] According to the Geological Survey Reports for 1902, the gypsum produced in Canada during that year amounted to over 332,000 tons, valued at 356,317 dols.

XI.—CARBOHYDRATES: (A) THE REFINING OF SUGAR; THE BEET-SUGAR INDUSTRY.

The hoped-for developments in the production of sugar from beets in Ontario and Southern Alberta, referred to in the first edition of this paper (1903) have not come up to the expectations either of the writer or of the public as will be seen from the sequel. Statistics show that during

(49) Geological Survey of Canada: Mineral Products, 1902.
(50) Stattisical Year Book, 1903.
(51) Geological Survey of Canada: The Mineral Resources of New Brunswick, 1899.
(52) Analysis by A. A. Breneman, of New York, in Mineral Resources of New Brunswick, Geological Survey of Canada, 1899.
(53) Letter from the Manager, Albert Manufacturing Co.

the last decade cane sugar has increased in production about 200 per cent. Judging from present appearances, and allowing for some slight tariff alterations, the increase in Canada should soon be in proportion to that of other countries.[54]

Raw sugar is imported from Cuba, the West Indies, Java, Manila, the Brazils, Mauritius, and the Continent of Europe. The most improved machinery and processes are employed, refined sugars and syrups being the staple products,

Belgium supplies to Canada the largest proportion of sugar, the imports from that country amounting in 1901 to 127,931,553 pounds; from Germany in the same year 83,941,290 pounds entered the country, the total imports being 336,694,833 pounds valued at close on $8,000,000.[55]

BEET SUGAR.

The most interesting point connected with the sugar industry is the way in which the production of sugar from beets cultivated on Canadian soil has become, in the past few years, an important factor in the country's progress. As far back as 1872 the Dominion Government sent a special agent to Europe to make a study of the industry. A bounty of $25,000 afterwards increased to $70,000 was offered by the Quebec Government in 1875 to the first successful factory to be established in a situation approved by the Government. This led to the establishment of a company known as the Union Sucriere du Canada, which, in 1881, erected the first of four proposed factories at Berthierville, Que.[56] This establishment was unsuccessful and only operated for a few days, mainly owing to the failure of the beet crop. After passing into other hands the plant was bought by an American company and removed to Eddy, New Mexico.[57] Another company was, in the same year, organized at Farnham, P.Q., not far from Montreal, which after some vicissitudes, did not deem its success sufficient to warrant a continuation of its operations, so sold its plant to a company at Rome, N.Y., in 1897. A third company, known as the Pioneer Beet Company started operations in 1881, at Coaticook, P.Q.,[59] and was successful in part, receiving a subsidy of 35,000 dols. from the Government, but it, too, closed its doors in 1883. The causes to which these failures may be attributed were lack of capital and enterprise, and the indisposition of the farmers to cultivate beets. The Agricultural Department of the Provincial Governments, however, continued experimenting with various kinds of beets and studied the conditions most favour-

(54) Letter from Mr. D. A. Gordon, President of the Wallaceburg Sugar Company.
(55) Essay, Mr. Read, University of Toronto.
(56) Report of Dominion Government on beet sugar manufacture in Canada.
(57) Letter from the Manager of the Dresden Sugar Co., Ontario, now removed to Michigan.

able to their successful growth. For some years past the Ontario Agricultural College at Guelph has, as a consequence of the excellent results obtained at their experimental stations, been carrying on an educational campaign among the farmers of the Province. As a result of this the quality and tonnage of beets now grown in different parts of Ontario surpass those of many American States. The climate of this Province, with its sunshine and long autumns, is peculiarly favorable to the cultivation of the beet, which takes about four months and a half to reach maturity. It requires, however, to be demonstrated to the farmers that the cultivation of beets will pay them better than other land produce before the requisite supply of suitable material will be obtained. That the profits are large can be gathered from the fact that wheat yields in Ontario $15 an acre per annum, oats, $9.74, and beets for sugar, $60. In the last case the cost of production is necessarily large, owing to a great amount of labour being required, but, all the same the profits to the farmer should, with skilful treatment, be at least $30 per acre per annum. The beet tops are of value as a fertilizing agent owing to the salts they contain, and find a use also as a food for cattle. In 1901 beets were grown —under instructions from the Agricultural Department—in fifteen districts of Ontario, and the average yield per acre was over seventeen tons of a high quality of beets which gave an average of 15.6 per cent. of sugar of an average purity of 87.7 per cent. All this points to a future for Ontario as a sugar-producing country; this fact has been fully realized by the Provincial Government, which offered a bounty of $275,000 for three years,[58] and at its recent session extended this bounty for a further period of two years, to be distributed among factories according to the amount produced. Four companies were organized a few years ago, namely, the Wiarton Beet Sugar Company (capital $500,000) which has since been shut down; the Dresden Sugar Company (capital $600,000) which has now removed its factory to Michigan; the Wallaceburg Sugar Company (capital $500,000) and the Ontario Sugar Company, of Berlin (capital $1,000,000); each of these companies received a bonus from the town where it was situated, averaging $28,000. The capitalization of a company engaged in this industry depends entirely on the size of the plant, a general estimate of $1,000 per ton of beets per day may be considered a fair calculation of what would be required.

Two companies only are thus in the field this year, and it seems reasonable to expect that both factories will increase their output over that of 1903. The nearness, geographically speaking, of the Wallaceburg and Dresden concerns to one another—some nine miles apart only—militated against their success, and it is to be hoped that now the former is, so to speak, alone, it will do better than heretofore.

(58) 1, Edw. VII., Cap. II, (1901).

Beet sugar factories have also been established in Alberta, in the North-West Territories of Canada. Since 1893, an area of about 300,000 acres has been made productive by means of the irrigation system of the Canadian North-West Irrigation Company, and a portion of this area has been utilized for beet cultivation, principally by the Mormon settlers. The most important factory has been established by the Knight Sugar Company at Raymond, south of Lethbridge, on the Canadian Pacific Railway. The capital of this company is $1,000,000. The area intended to be planted with beets is 3,000 acres, and the daily capacity of the factory will be 400 tons of beets per day. The only difficulty which the industry is encountering in the North-West is the scarcity of labour.[59] This is due partly to the scanty settlement of the country, and partly to the superior attractions of the mining regions, which are situated at no great distance.

A plentiful water supply, lime, and source of power, are necessary for the profitable prosecution of the industry; all this has been carefully considered in locating the factories enumerated above, steam power being employed for pumping and the working of all machinery. There is room for many more factories in the Dominion; according to Dr. A. B. Shuttleworth, Chief Agriculturalist to the Ontario Sugar Company, whose name is indissolubly connected with the development of beet cultivation, it would require over thirty refineries each of 600 tons capacity to supply the home market alone.[60]

The working season of a factory runs for about 100 days, operating continuously. The cost of the sugar is from three to three and a half cents per pound, and the profits to the makers are estimated at fifty cents per ton of beets used. This would mean that in a factory of 500 tons capacity, working for 100 days, the profits would amount to $25,000.

The scope of this article does not allow of any detailed consideration of the working process by which the sugar is extracted frm the sliced beets and crystalized. New proceses are being employed for utilizing the residual molasses. This is treated for the recovery of the sugar in some part, and also for the production of alcohol by fermentation. An American company in 1901 produced 915,000 gallons of alcohol in this way, of a quality considered to be quite equal to the grain product. Another new process is that of the manufacture of syrup from the beet instead of sugar; forty gallons of this can be obtained from a ton of beets, which, at thirty cents a gallon, means a return of $12 per ton of material used, while the product in sugar yields only from $7 to $8 per ton of beets. The

(59) Letter from Manager of works at Raymond.
(60) Berlin News Record, Nov. 8, 1902.

beet-pulp refuse is also being largely used as a food for live stock, for which purpose it is extremely suitable owing to its nitrogen contents. In this connection a new process has been introduced for drying the pulp, which entails an expenditure of $5 per ton, but, as the dried pulp is sold at $6.25 per ton, a clear profit of $1.25 is thus secured to the manufacturer.[61]

The production of sugar from Canadian grown beets is a new and, it is to be hoped, rising industry which offers great scope for some co-operative arrangements between the companies and the farmers. It should give an impetus to agriculture, afford employment to thousands of unskilled workpeople, and, as an important industry, be a lasting benefit to the country. Whether or not the growing of beets will become popular remains to be seen; the present quality is as yet not so good as was expected, but much may yet be done in the way of improvement by careful cultivation.

The following communication, dated March 6th, 1903, from Mr. George Elsey, manager of the Dresden Sugar Company, conveys some idea of the position of the industry from the point of view of the manufacturer and its possible future:

"At the present time there were four factories which operated this last season, and from what we are able to learn the results were as satisfactory as could be expected under the existing conditions, that is, the rain fall last summer damaged the beet crop from fifty to sixty per cent., both in the United States and in Canada. The balance of the crop, on account of wet weather, cost considerably more to raise than what was necessary. It was unfortunate that this should occur in the first season that the factories were started in Canada, as it was very disappointing, but most of the farmers have told us that they were surprised at the amount of rain the beet would stand, and in several instances where they could harvest the beet crop, the corn and other crops were ruined. After we have had a seasonable year and it will be demonstrated to the farmers that there is more money in raising sugar beets than any other crop that grows, the four factories now in existence will get their supply of beets within hauling distance of the factories. . . . Our farmers know well that the Michigan farmers obtain about a dollar a ton more for their beets than they do, and they also understand that it has cost as much in money and labour to raise a ton of beets in Canada as it does in Michigan or any part of the United States. They therefore feel dissatisfied, and are clamouring for more money, which the companies would be glad to pay if they could sell their sugar for the same price as the American Beet Sugar refineries. The present Canadian sugar tariff is such that it would not allow any

(61) In the above I have drawn largely from an essay on the beet-sugar industry by Mr. E. R. Read, a student in the Department of Political Science, University of Toronto, who kindly placed his papers at my disposal. Also from Dr. Shuttleworth's article in the "*Berlin News Record*," 1902.

more sugar refineries to be built in Canada. The companies that are already here have the experience of what this tariff can do. It allows sugar that has been refined in the United States to be shipped in here and undersell Canadian refined sugar, which means a loss to the refineries and to the Canadian people. It allows raw beet sugar to be imported at a price that will prevent the farmers from taking hold of the beet industry as they should. Canada is sending to Germany and other foreign countries about $1,000,000 per month for raw beet sugar, and the naturally yearly increase of consumption is about eight per cent, so that the future of the sugar beet industry, under a proper tariff, would be a lasting one and a great benefit to the farming community."

XII.—NATURAL GAS AND PETROLEUM.

NATURAL GAS.

The existence of natural gas in Ontario was first discovered in 1889, being found in two well-defined areas, as the Essex county field and the Welland county field. It is chiefly near Buffalo, on Lake Erie, and near Windsor, Ontario, that the largest supplies are met with, though practically it may be got in nearly any part of the Niagara peninsula in small quantities. In 1901 there were 158 wells in operation, and 368 miles of piping were needed to distribute the gas. Much of the gas produced in Essex county was formerly led across the river to Detroit by pipe lines, but on representations made by the people of the Essex district to the effect that the supply of gas was not sufficient for home consumption, the Ontario Government passed an Order in Council in October, 1901, prohibiting the gas from the Essex field being exported to the States. None of the product of this natural gas field is therefore now being sent across the Detroit river; it is, however, still exported from the Welland field to the American side of the Niagara River, chiefly to Buffalo, N.Y. It may be mentioned that the landowners on whose farms the wells are located get their gas free in addition to being paid for the use of their lands.[62] The value of the gas produced in Ontario during the last ten years shows considerable fluctuations, being much less in 1903 than in the previous year, due, no doubt, to the Government prohibiting its export.[63]

PETROLEUM.

This is one of the chief mineral products of the Dominion, though as yet the output is not sufficient to meet Canada's needs. The principal seat of the industry is at present in Ontario, where commercial quantities

(62) Report of the Bureau of Mines, Ontario, 1902.
(63) Statistical Year Book of Canada 1903.

are found in the counties of Kent and Lambton. In the former there are two oil fields, one at Oil Springs, extending over 1,200 acres, and the other in the Petrolea district, 20 miles long by 2 wide.[64] In Lambton county the industry dates back to the year 1862. Petroleum is also found in Quebec, Nova Scotia, New Brunswick, and boring operations that have in recent years been carried on at Athabasca, near Edmonton, in the North-West Territories, point to a likelihood of that part of the country contributing largely to the future supply of mineral oil.

The industry is now one of the most highly organized in the Dominion; the system of drilling and pumping now used—the "jerker-line" system enables a well yielding from eight to ten gallons a day to be profitably worked. This system has gained for itself a world-wide reputation; it is used in Galicia, Russia, Afghanistan, Burmah, India, Italy, France, California, and Australia. Its advantages are numerous; a central engine can operate a large number of wells; on one property near Petrolea, 233 wells, scattered over an area of 400 acres, are worked by a single engine. It is estimated that to sink a well of about 500 feet in depth costs only $125.[65] In 1900, there were approximately 10,000 wells in operation, yielding on an average seventy-one barrels of oil each.

The refining side of the petroleum industry is largely in the hands of the Imperial Oil Company,[66] which some years ago absorbed several other concerns, and of the Canadian Oil Refining Company. The plant of the former at Sarnia has a capacity of 60,000 barrels of crude oil per month, and the market for their products reaches from Halifax to Vancouver. Many of the bye-products of the refining process find a market in England and in Spain. The latter company have erected an up-to date plant at Petrolea, on the site of one which was in operation some years ago, where all the products will be manufactured that modern science shows can be obtained from petroleum.[67] Improvements in methods of retorting have recently led to considerable quantity of the crude oil being used for gas making, three and a half million gallons being an estimate of the amount so employed.[67]

There has been a slight falling off in the production of oil during the past years; calculated as "crude" oil, the output in 1901 was 27 millions Imperial gallons, and in 1901 a little over 26½ millions.[68] In 1903 it fell to some 16 million gallons. A slow process of diminution seems to be going on in the area at present productive, and a falling off must be looked for

(64) The oil is found at depths varying from 370 to 400 feet.

(65) This and much of what is given here on natural gas and petroleum is from a paper by Mr. W. J. K. Vanston, read before the Canadian Section of the Society of Chemical Industry in Jan. 1903.

(66) Capital stock, $1,000,000.

(67) Bureau of Mines Report, Ontario, 1902.

(68) Statistical Year Book, 1903.

from year to year unless this is counteracted by an extension of the oil-bearing territories.[67] Probably, the field about to be exploited in the North-West will alter the position somewhat, and an increase in the output may be confidently looked for.[69]

XIII.—PULP AND PAPER.

PULP.

As timber is one of the chief natural products of the Dominion, it is only to be expected that Canada should figure largely in the wood pulp industry; the figures that might be given to indicate the number of cords of pulp-wood available throughout the country are so large that one could hardly grasp their real significance. The industry is not so young as many others that have been considered; in the census of 1871, no pulp-making plants are mentioned; in 1881, there appear five mills, employing 68 men, and having an output valued at $63,000; in 1891 there were 24, with a yield valued at more than a million dollars; while 1903 shows some 39 factories, from which the exported pulp alone amounted to over five million dollars.[70] The area of pulp-making operations is not confined to any one Province, New Brunswick, Nova Scotia, Quebec, Ontario, and British Columbia are all represented in the industry.

The principal woods employed for pulp-making are white and black spruce, balsam, poplar, and pine; spruce[71] and balsam are those most generally used, on account of the special quality of their fibre and their colour, pine being utilized mostly for chemical pulp. The two main varieties of the pulp are *mechanical* and *chemical*. The former is obtained by grinding spruce logs to powder, the logs being pressed against a rapidly revolving grindstone, with water constantly supplied to prevent the friction causing a rise in temperature. A liquid pulp is thus obtained from which the water is squeezed by hydraulic machinery, a pressure of many tons to the square inch being employed. The resulting pulp still contains water, however, to the extent of from 50 to 60 per cent., though some works—notably those at Sault Ste. Marie—have introduced a machine specially constructed for the purpose of removing this large excess of moisture. Where the pulp is to be made at once into paper, this drying process is unnecessary. The specially dried pulp resembles paper very closely in outward appearance.[72] Chemical pulp is prepared by disintegrating and

(69) Total value of products of petroleum in Ontario in 1901, $1,467,940, Bureau of Mines Report 1902.

(70) Statistical Year Book, 1903.

(71) In 1894 it was estimated that Canada contained between 38 and 40 per cent. of woodlands and forests, or about 1,400,000 square miles, one-half of this being spruce. The spruce area is thus 450 million acres. In all there are 4,500 million tons of pulpwood in sight. "Pulpwood of Canada." Pan-American Exhibition pamphlet, published by the Geological Survey, 1901.

(72) The Sault Ste. Marie Works used (1903) some 200 tons of spruce logs yielding 150 tons of pulp per day.

extracting the resinous matter from the wood —in the form of chips— by digestion with sulphur compounds, usually a weak solution of sulphurous acid, about a quarter of which is in the form of bisulphite of lime.[73] A soda chemical process is also employed by some makers. The sulphur used for the production of sulphurous acid is either imported from Sicily or obtained by burning pyrites. Chemical pulp possesses many advantages over mechanical pulp, though its manufacture is necessarily more expensive, and the yield per cord of wood, as compared with the latter, is much less.[74] It has a longer and tougher fibre, and the resinous matter being no longer contained in it, finds uses for qualities of paper for which the mechanical pulp would be unsuitable. The principal markets for pulp are Great Britain, the United States, France, Australia, and Japan. Much of it is used, however, locally for the manufacture of paper. In 1903 the requirements of Great Britain alone amounted to $12,000,000, a little over seven per cent. of her needs.

PAPER.

In many cases the producers of pulp also manufacture it into paper. The principal requisites for the paper industry are a plentiful supply of pulp-wood, good water and an abundance of it, and cheap power; all these can be found in many parts of Canada. The growth in the demand for paper of all kinds, news, wrapping, wall and the finer grades, was one of the features of last century—especially newspaper. The introduction of wood fibre into its manufacture has consequently enabled the supply to keep pace with the demand. The process of manufacture requires no description here; the secretary to a prominent Canadian firm states that originally they used rope as a raw material, then straw, which was abandoned for rags, and finally these gave place to chemical and ground wood-pulp. Previous to 1870 no wood whatever was used in the manufacture of paper in this country. Ground wood-pulp was introduced at that time and has since become the filling material of the cheaper grades of paper, being partly pasty and partly fibrous. Up to 1885 the real fibre—the framework of the paper —was supplied by rags. In 1885 sulphite pulp was introduced and has largely replaced rags, except in the higher grades of paper, in which linen is used, and in the very low grades, where straw is employed.[75]

The *Toronto Globe* of March 4th, 1903, in an article on the wood-pulp industry, gives the following statistics, which are of interest:—

	Tons.
Production of mechanical pulp in 1902	152,210
Production of sulphite pulp in 1902	76,72
Production of soda pulp in 1902	9,044

(73) Letter from Mr. Carl Riordan, Merritton, Ont.

(74) One ton of mechanical pulp requires a little over a cord of wood; one ton of chemical pulp requires a little over two cords of wood.

(75) Mines Report, P.Q., 1901.

XIV.—ASBESTOS AND MICA.

ASBESTOS.

This mineral occurs in large deposits in the "Eastern Townships" of Quebec, where it was first worked in 1878; from 1880 up to the present date the production of asbestos has increased steadily; the output that year is given as 380 tons, while in 1901 over 38,000 tons are recorded in the returns furnished by the producers. The world's supply of asbestos is, for the most part, obtained from Canada, and the Quebec deposits have in the past proved to be the most profitable mineral mined in the province. Thirteen mining companies are at work in this industry, which is principally carried on at Thetford, Lac Noir, and Danville, giving employment to approximately 1,000 men. Asbestos is shipped largely to Great Britain, the United States, Belgium, Germany and France.

MICA.

Another silicate found in Canada is mica, which, though occurring in small quantities, is a not unimportant industry; in Ontario there are several mines and a number of works where splitting, trimming, and sorting the material into saleable sizes is carried on. The Provinces of Ontario and Quebec produce the greater part of the mica used in the manufacture of electrical apparatus in the United States, and also export not inconsiderable quantities to Great Britain. The so-called "amber" mica, or phlogopite, is preferred for this use to other varieties on account of its superior flexibility and the thinness of the sheets into which it can be split. The mica mines of the General Electric Company in Ontario produce large quantities of mica annually, and the Company have trimming works at Sydenham and Perth. There are also important mica trimming plants in Kingston and Ottawa.[76]

CONCLUSION.

The new Canadian Niagara Power Company, whose works are in the course of construction at Niagara Falls should give a fresh impetus to the development of industrial chemistry locally. This will be the first company to produce power on the Canadian side of the Falls. A feature in the plant is the size of the generating units, each of which will have a capacity of 10,000 horse-power. They will be more economical than generators of 5,000 horse-hower, will occupy but little more space and their cost will be much less per horse-power in comparison. It is expected that the output of the company will be used principally for Canadian industries and for such public utiilities in the Province of Ontario as may be within reach of long-

(76) Letter from Mr. Thos. W. Gibson, Director of Bureau of Mines, Ontario.

distance transmission. The power on the American side is employed by some twenty or thirty firms engaged in such chemical industries as the manufacture of pulp and paper, silver plated goods, chlorate of potash, caustic alkali, salts of tin, carborundum, carbide, graphite, pure metallic lead, "alundum"—another emery substitute,—cereal food-stuffs, nitric acid and composite boards made from wood-pulp and flax-fibre. Judging from all this there should be a large increase in the number of chemical industries in this neighbourhood when the Canadian power station is completed and the current available from the Falls to Toronto.

The subjects that have been considered in this paper do not by any means exhaust the catalogue of chemical industries in Canada. Many important manufactures have, for the reasons mentioned in the opening paragraph, been omitted. A short summary of these will suffice. Matches, for example, constitute an important and necessary article of daily use, and are made in enormous quantities, practically all that are used in Canada being manufactured in the country. Brewing and distilling are carried on extensively also, ale, lager beer, and stout being made, while Canadian rye whisky is known throughout the whole English speaking world: even a "Canadian Scotch" is produced at Perth, Ont.; brandy and champagne and other wines are made at Hamilton, Brantford, and Pelee Island, on Lake Erie. Fruit canning is one of the great industries of Wentworth and Essex Counties, Ont.; bacon packing and salmon canning may also be classed among those manufactures requiring the careful supervision of the skilled chemist. To the list may be added explosives of all kinds; blackings, varnishes, japans, lacquers, paints and shellac, foodstuffs and sauces; antitoxines for use in the practice of medicine are made by the Parke Davis Co. at Walkerville. Natural mineral waters are abundant, at St. Catherines, in British Columbia and in Quebec, while manufactured aerated waters are made in mostly all the important towns. The almost universal wearing of india rubber foot coverings during the winter season necessitates the production of large quantities of goods of this sort. Many large factories for this purpose are in existence from which rubber goods of a superior quality emanate; dyeing and calico-printing might also be mentioned as being in a flourishing condition. The attitude of manufacturers towards chemists has of late years been extremely favourable, and many have seen it to be to their advantage to employ men trained in our universities to investigate the processes and materials employed in their particular industries. So far their employment has been amply justified by the results, and it is to be hoped that more may be brought to see the profit to be gained by adopting scientific methods of work. The university man who has specialized in chemistry can assist the manufacturers in this by bringing to bear on the *rationale* of the technical processes the general scientific knowledge which he

has gained during his college course, and his experience of methods of research and manipulation; he can thus materially benefit his employer by improving the quality of his products or enabling him to turn out his goods at a cheaper rate. Let the manufacturer, be he dyer, tanner, pulp-maker, or ironmaster, indicate only that he is willing to find employment for men educated in the higher branches of scientific work, and the universities of the Dominion will supply them. Where chemical processes are used, it is essential for the prosperity of this country that all the available scientific knowledge should be brought to bear on them, in order that they may continue to improve and to develop even more than they have done in the past decade. Canada, with its immense natural resources, and its water power should, in time and with proper management and assistance in the lines indicated, become one of the largest producers of the world's supplies.

In conclusion, I wish to acknowledge the great assistance I received in preparing the previous edition of this paper, from Mr. Fred P. Clappison, B.A., then Fellow in Political Science in the University of Toronto, who gathered together for me from all quarters much of the information required for this short and imperfect account of the chemical industries of the Dominion. In particular his help in connection with the statistics contained in the text and in the appendices was invaluable. Much of what appeared before has been repeated, though many alterations, omissions and additions have been necessary. To the gentlemen who so kindly answered enquiries as to their particular industries and placed valuable material at my disposal I desire also to convey my hearty thanks.

APPENDIX I.

THE IRON ORES OF CANADA.

Nova Scotia.—Magnetites in enormous quantities at Nictaux, in Annapolis County, at Whyhogomah, in Inverness County. Specular and red hæmatite at Nictaux, Stewiacke, Pictou, Antigonish, Guysboro, East Bay, and many other points. Limonite, specular, spathic clay ironstone and hæmatite at Londonderry. Mineral fuel and fluxes are in close proximity throughout the whole district.[77]

Cape Breton.—Extensive deposits of brown hæmatite, magnetite, and spathic ores lying adjacent to the great coal-fields.[78]

New Brunswick.—Magnetite and bog ores. Coalfields at G: ge and hardwood throughout the Province.

Province of Quebec.—Very extensive deposits of bog and lake ores, extending from the Province of Ontario to Gaspe, Magnetite deposits especially good at Sherbrooke, Leeds, Sutton, St. Jerome, and in Pontiac County. Hardwood and limestone abundant. Deposits of chrome-ironstone found in 1895 in Coleraine. The "Eastern Townships" obtain iron by dredging in the Lac-a-la-Tortue. Magnetites at Hull, near Ottawa.[79]

Ontario.—Vast deposits from the Ottawa Valley to head of Lake Superior, comprising magnetite, red hæmatite, limonite, specular, and occasional bog ores. The Helen Mine, at Michipicoten, is said to be one of the richest in the world. There are also extensive forests of hardwood, especially suited for the production of charcoal, and fluxes in abundance.[80]

Manitoba.—Magnetite, hæmatite, and bog ore on Lake Winnipeg. Hardwood in adundance.[81]

British Columbia.—Magnetic ores at Texada Island and Cherry Tree Bluff. Coal and wood in plenty. Collieries at Nanaimo (Naval coaling station for H. M.'s ships), Wellington, and Comox. A recent discover[illegible] of large deposits of magnetite has been reported in the Boundary Region, which at present mainly finds a use as a flux.[82]

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(77) Nova Scotia Report of Mines, 1901.
(78) Report of Geological Survey.
(79) Mines and Minerals of Quebec, Dept. of Mines.
(80) Bureau of Mines Report, Ontario, 1901.
(81) Geological Survey of Canada, 11th Annual Report.
(82) Geological Survey of Canada, 11th Annual Report

APPENDIX II.—METALLIC PRODUCTION OF CANADA, 1892-1903.

Metals.	Value, 1892.	Value, 1897.	Value, 1901.	Value, 1902.	Value, 1903. ‡
Pig Iron.....	637,421 dols	53,796 tons.	1,212,113 dols. †	1,043,007 dols.	707,838 dols.
Copper in Mattes.....	818,580 " *	1,501,660 dols. *	6,096,581 " †	4,511,383 "	5,728,261 "
Nickel in Mattes.	1,399,176 " *	1,399,179 "	4,594,523 " *	5,025,903 "	5,002,204 "
Arsenic.	1,000 "	.....	41,676 " †	48,000 "	15,420 "
Gold.....	907,601 "	6,190,000 "	24,128,503 " †	21,336,667 "	18,834,490 "
Silver	193,441 "	2,613,173 "	3,265,354 " †	2,238,351 "	1,170,779 "
Aluminum.....	.....	.....	1,000,000 "	1,643,250 "	.....
Lead.....	49,422 "	1,396,853 "	2,249,387 " †	934,095 "	762,660 "

* Value of metal if refined.

† Statistical Year Book. 1903.

‡ Subject to revision. Mr. T. W. Gibson states that the total pig iron and steel produced in Ontario in 1903 amounted to 87.004 tons and 15,229 tons respectively; the whole of Canada yielded, during the same period, 265,418 tons of pig iron and 232,641 tons of steel.

APPENDIX III.‡—IRON AND STEEL PRODUCTION.

Company.	Plant at	Built.	Source of ore.	Employees, 1902.	Output in Tons.				Capacity of Furnaces in tons per day.		Capitalization.
					Pig Iron.			Steel.			
					1892.	1901.	1902.	1901.	1892.	1902.	
											Dols.
Canada Iron Furnace Co.	Midland, Ont.	1899	Ontario	..	..	18,948	..	..	..	..	1,000,000
	Radnor, Que.	..	Quebec	..	5,574	31,159	..	..	40	..	..
	Londonderry, N.S.	1887	N.S.	*	28,052	*	*	*	40,000 per ann.	150	..
Hamilton Steel & Iron Co.	Hamilton, Ont.	1896	Ontario and U.S.A.	1,000	1,000	..	51,701	9,473	†	..	1,500,000
Nova Scotia Steel and Iron Co.	New Glasgow, N.S.	..	N.S.	965	29,502	28,407	..	23,916	100	100 pig,	5,000,000
Deseronto IronCo.	Deseronto, Ont	..	U.S.A.	..	..	13.701	..	..	..	100 steel	..
Dominion Steel & Coal Co.	Sydney, N.S.	1901	Newfoundland.	6,000	†	27,643	191,259	86,424 (1902)	†	1,000 pig, 800 steel	33,000,000
John MacDougall and Co.	Drummondville, Que.	..	Quebec	..	..	793	..	..	6	..	..
Cramp Ontario Steel Co.	Collingwood, Ont.	1900	Ontario and foreign	†	..	..	..	..	..	200,000 per ann.	..
Lake Superior Power Co.	Sault Ste. Marie.	1901	Ontario	500	..	..	..	..	†	..	117,000,000

* Not in operation, due to repairs being made. † Not in operation. ‡ Prepared by Mr. F. P. Clappison in 1903, largely from private letters.

APPENDIX IV.*—PORTLAND CEMENT AND PLASTER OF PARIS.

Firm or Company.	Place.	Capital.	Capacity of Plant in barrels per annum.	Output, 1902	Date of Beginning Manufacturing.
		Dols.			
Canadian Cement Co.....	Longue Pointe, Que....	200,000	....	....	....
Canadian Portland Cement Co.	Deseronto, Ont.....	1,500,000	250,000	250,000	1893
Lakefield "	Lakefield, Ont.....	590,000	75,000	75,000	1902
Imperial "	Owen Sound, Ont....	250,000	50,000	50,000	1902
Grey and Bruce "	" "	100,000	30,000	20,000	1902
Owen Sound "	Shallow Lake, Ont....	199,000	100,000	100,000	....
Sun "	Owen Sound, Ont....	500,000	40,000	40,000	1902
National "	Durham, Ont.	1,000,000	300,000	....	1903
Hanover "	Hanover, Ont.....	150,000	30,000	30,000	....
		4,399,000			
Albert Manufacturing Co., (Plaster of Paris).....	Hillsboro', N.B.....	350,000	....	60,000	....

* See Note ‡ in Appendix III.

APPENDIX V.—SUGAR FROM BEET ROOTS.

Company.	Place.	Capital.	Began.	Output.* July 02—July 03	Output.* July 03—July 04.	Capacity in tons of beets per day.
		Dols.				
†Wiarton Beet Sugar Co.....	Wiarton, Ont. ...	500,000	1901	1,565,000 lbs.	981,000 lbs.	350
Ontario Sugar Co.....	Berlin, Ont.....	1,000,000	"	6,063,926 "	7,059,695 "	600
‡Dresden Sugar Co.....	Dresden, Ont.....	600,000	"	3,763,987 "	2,094,999 "	600
Wallaceburg Sugar Co.....	Wallaceburg, Ont.	500,000	"	3,606,604 "	4,230,422 "	700
Knight Sugar Co.....	Raymond, N.W.T.	1,000,000	"	.....	.....	300

* Letter from Mr. J. C. James, Deputy Minister of Agriculture, Ontario. † Now closed down. ‡ Removed to Michigan.