

and usually those near a harbor. Many mines that were once worked are now abandoned, including the Bornet, which has the record of having been the largest producer. The production of the larger mines is decreasing, and mines such as the Emma, in more inaccessible situations are now being opened, necessitating the extension of the railways farther into the interior of the island. There is no evidence to show that any of the new nickel mines are larger than some of the old ones, or that ore can be produced more cheaply from them.

The essence of the whole matter in so far as competition from New Caledonia in the open market is concerned, is the cost of the refined nickel produced from its ores. More than a dozen years ago the cost was approximately 19 cents a pound. Immediately prior to the war it had not been lowered. At present with excessive freight rates and increased prices for supplies, the cost is much increased. As long as the price of nickel remains about the same as it has been during recent years, New Caledonia will have an important industry. It will probably expand to some extent, owing especially to the activities of the newer of the two companies that are shipping ore and smelting on the island. But there is no good reason for believing that the competition with Ontario will become any stronger than it has been in the past. Should the price of nickel fall to 25 cents a pound or less, New Caledonia will have difficulty in keeping her mines in operation.

While it is true that Ontario has no monopoly, it possesses many advantages over all competitors, even under the present conditions of the market as to prices and trade connections. In any keen competition as to prices it is doubtful whether any other locality at present known or suggested could compete with Ontario. It is a matter of record that at one time of low prices the leading New Caledonia company was compelled to suspend all dividends. It may be doubtful, further, whether anything but an arrangement of the market between the great interests can prevent the complete domination of the world's trade by the nickel industry of Ontario making the best use of its exceptional resources.

Refining Processes.

There are three processes, which may be described as standard methods, in use for the refining of nickel from ores like those of Sudbury. These are (1) the Orford process, employed for the treatment of the matte produced by the Canadian Copper Company, (2) the Mond process, and (3) the Electrolytic process. For all these processes, the production of a matte is essential. Matte is made by substantially the same method for all three.

The Orford Process.

The Orford Process is the oldest of the three. It is cheap to operate, and permits of a large output in a confined space, but it does not recover more than a small proportion of the precious metals present in the ores, and there is reason to think that losses of nickel and copper are heavier than in either of the other two processes.

In the Orford process, the matte is smelted with sodium sulphate and carbonaceous matter, such as coal or coke, so that a large proportion of the copper is separated as a double sulphide of copper and sodium, when tapped from the furnace; this separates as an upper layer above a matte which is much richer in nickel and poorer in copper than the original matte. A repetition of the smelting of this highly nickeliferous matte results in a further separation of copper in

the same way, so that finally, the bulk of the copper is obtained as a slag (which is smelted to produce blister copper) together with a matte so rich in nickel and so poor in copper that, after being roasted and leached with acid, to remove the remainder of the copper which it contains, it can be smelted in a reverberatory furnace, for the production of metallic nickel. The leaching processes result in the production of a considerable amount of copper sulphate and nickel sulphate. The former is treated for the production of metallic copper, but the latter is, to a considerable extent, crystallized out, and either treated electrolytically for the production of high-grade electrolytic nickel, or sold as nickel sulphate or as the double sulphate of nickel and ammonium for electro-plating and other purposes.

The Orford process, being partly chemical, produces large quantities of noxious effluents. At the Bayonne works over 150 million gallons are annually run into the sea. The plans for the new works at Port Colborne, Ontario, provide for the elimination of this discharge.

The Mond Process.

The Mond Process treats a matte of somewhat different composition, because, although it contains about the same total quantity of nickel and copper, the relative proportions of the two are very different. The matte from the Canadian Copper Company averages about 54 per cent. nickel and 25 per cent. copper, whereas that from the Mond Nickel Company is much richer in copper and averages about 41 per cent. nickel and 41 per cent. copper. These differences are due to the composition of the ores treated by the two companies. The matte is refined at Clydach in Wales. In this process there are probably the smallest losses either of nickel, copper, or the precious metals.

The process comprises roasting to remove the sulphur, leaching with sulphuric acid to obtain a large proportion of the copper, which is ultimately crystallized out and sold as copper sulphate, and the reduction of the oxides of nickel together with the small quantity of copper left in the roasted and leached matte with producer gas, which reduces the iron, copper and nickel to the form of finely divided metal. This material is next treated in a vertical chamber or tower with producer gas at a special temperature, by means of which the nickel is converted into a volatile compound known as nickel carbonyl. This passes to another chamber or tower, where it is exposed to a higher temperature, whereby it is decomposed so that the metallic nickel is deposited on a number of slowly descending grains of nickel previously added in the form of small shot. The residues from the first treatment are either again treated with sulphuric acid to remove the copper and iron, or are smelted again, after which the nickel they contain is recovered by repetition of the treatment. The residues are finally separated and sold for their precious metal contents. The nickel produced is of high purity, and has an excellent reputation.

It may be mentioned that the leaching described as being done upon the original roasted matte, dissolves a considerable quantity of nickel as well as of copper. This is recovered and sold as nickel sulphate, or as nickel ammonium sulphate, for electro-plating and other purposes. The Mond Nickel Company does not make or sell any metallic copper.

The Hybinette Process.

The Hybinette Process, employed in Norway, and about to be employed in Ontario by the British America Nickel Corporation, deposits the nickel electrolytically, using soluble anodes made from partly roasted nickel copper matte. The copper is obtained