UNITED STATES PATENT OFFICE.

JULES GARNIER, OF PARIS, FRANCE.

IMPROVEMENT IN WORKING NICKEL ORES AND MANUFACTURE OF NICKEL.

Specification forming part of Letters Patent No. **210,020,** dated November 19, 1878; application filed February 2, 1877; patented in England, March 20, 1876.

To all whom it may concern:

Be it known that I, JULES GARNIER, of Paris, France, civil engineer, have invented Improvements in the Manufacture of Nickel and its alloys from its oxides or silicates or other salts; and I do hereby declare that the following is a full, clear, and exact description of the same.

My invention relates to improvements in the manufacture of nickel and its alloys, the nickel being extracted from ores having a base of oxide of nickel.

Since the working on a large scale of the ores with a base of oxide of nickel, known as "Garnierite," which I was the first to discover in New Caledonia, I have, after many experiments, invented a simple metallurgical treatment of these ores, which I will proceed to describe, it being understood that the process is also applicable to all ores of nickel similar to those of New Caledonia.

I. *Nature of the Ores.*—The ores of New Caledonia are hydrosilicates of nickel and of magnesia. Chromium is frequently met with, and likewise manganese and cobalt, which, associated with iron, form small black veins and specks, distributed in the ore. The quantity of iron contained in the ore often equals and even exceeds that of the nickel. The peculiar composition of the above ores and their congeners has led me to devise a metallurgical treatment which has for its principal object the elimination of the iron, because unless the iron be eliminated the molten slag would carry off the particles of nickel, while, when the iron is in the slag, it flows off freely, leaving the carbureted nickel in the furnace. To this end I proceed in two principal operations, viz:

A. Fusion, with reduction of the ore, to obtain a crude product in which, without the addition of sulphur or sulphides, the nickel and the greater part of the other metals which accompany it are concentrated. This is a peculiar product quite new in metallurgy, to which I have given the name of "carbureted nickel," its characteristic composition being also shown by the following average analysis: Nickel, 60.90; iron, 32.35; silicon, 0.85; carbon, 3.40; sulphur, 1.50=99.00.

B. Refining the carburet to obtain nickel, both pure and alloyed.

I will now describe the practical working of the above process.

II. *Fusion of the Ore to Obtain the Carbureted Nickel.*—The ores are first pulverized and sorted in the usual way, the hard lumps being allowed to pass, while the friable portions are ground up and added to the dust and agglomerated with the flux. In the case of ores of New Caledonia, which are very silicious, I add about forty per cent. in weight of limestone. The charges of nickel and flux are placed alternately with the fuel in a reducing-furnace supplied with a hot or cold blast through one or several tuyeres. I first commenced with a furnace 4.50 meters in height, with cold blast through two tuyeres, and, although difficult to work and requiring much fuel, I succeeded in regularly casting the carbureted nickel. I have since then increased the height of the furnaces to eight meters and supplied them with a blast heated to 400° centigrade. The area of the furnace is so calculated as to afford the silica ample time to combine with the lime, the magnesia, and the other bases; but, on the other hand, so that the oxide of iron accompanying the oxide of nickel shall not be entirely reduced, but a portion be allowed to pass into the slag, I have found, by experience, that the form and area of the furnace is only of importance from the point of economy in working, as all furnaces which are of about four meters in height and over will produce carbureted nickel. As regards fuel, wood, charcoal, coke, and even coal, may be employed. When using wood-charcoal in a furnace of little height I charge with equal weight of ore and charcoal, the proportion of fuel being only fifty per cent. of the weight of the ore, or even forty per cent. when higher furnaces and a hot blast are employed. The advantage of employing charcoal is that a purer and more easily refined carbureted nickel may be obtained. The difference in the cost of the fuels

is, however, the chief consideration. With fuels containing much sulphur, such as coke and coal, I use as much as five hundred kilograms of limestone-flux per ton of ore, and I add very pure oxides of manganese to the melted mass, so as to have one or two per cent. of manganese in the slag. In this way the greater part of the sulphur in the fuel passes away into the slag in the form of a basic compound of lime.

It is unnecessary to mention that the scoriæ, rich in nickel, produced in the later steps of the refining process, hereinafter referred to, are again passed through the above furnaces, and that, if it is desired to produce alloys of nickel and copper, the ores of nickel are mixed with natural oxides or carbonates of copper.

III. *Refining Carbureted Nickel in the Reverberatory Furnace.*—The carbureted nickel is refined in the same way, whether for producing at once alloys of nickel and copper or pure metallic nickel, the only difference being in the temperature, which is necessarily lower in the case of an alloy of nickel and copper.

In refining carbureted nickel for the production of alloys of copper and nickel the operation is conducted upon the hearth of a reverberatory furnace similar to those used in refining copper, or one heated by gas on the Siemens system. This latter is much preferable, the operations being accelerated by the high temperature employed, and the products being more perfectly refined.

The furnace-hearth, which is of fire-brick, as usual, should be covered with ores having a base almost exclusively of oxide of nickel, a sufficient supply of which is obtained from the mine. The charge of carbureted nickel is placed upon the furnace-hearth with about thirty per cent. of copper, the whole weighing from twenty-five hundred to three thousand kilograms. The mass quickly fuses, and the bath soon presents a very lively reaction, jets of oxide of carbon disengage, the silicon is burned, and the manganese, and afterward the iron, are eliminated by oxidation.

To facilitate the oxidation, currents of air are admitted from time to time by partly opening the furnace-doors, or by other means, and the mass may then also be stirred. Metallic oxides are also added, such as oxide of copper, pure ores having a base of oxide of nickel, and especially oxides of manganese. These oxides are reduced in the midst of the fused mass at the expense of the bodies foreign to the nickel and copper it is desired to eliminate, and which are less oxidizable.

The oxides of nickel of the pure nickel ores answer very well, for besides the oxide of nickel, they possess the further advantage of introducing silica, which hastens the elimination of the oxides of iron and manganese. The surface of the bath is skimmed to remove the scoriæ, and trial portions are taken from time to time to ascertain, by a physical and chemical examination, the state of the operation. When only nickel and copper remain, it is run in the ordinary way.

The operation occupies from twenty-four to forty-eight hours, according to the skill of the workmen, the temperature, and the amount of impurities to be eliminated. The last scoriæ are rich in nickel and are carefully collected.

In refining carbureted nickel to obtain pure nickel the operation is conducted in the manner above described, except that no oxide of copper is used, and that the operation is conducted on the hearth of a reverberatory furnace heated by gas on the Siemens system, although the Ponsard and other systems will answer equally well.

The furnace I use will treat from two thousand to three thousand kilograms of carbureted nickel containing fifty or sixty per cent. of nickel. The rabbles employed are of nickel, and this is of especial importance toward the close of the operation, in order that impurities shall not be introduced into the bath, the temperature of which is sufficiently high to partially melt the rabbles. A short time before running the metal I add to the bath, for the purpose of properly tempering the nickel, about one or two per cent. of an alloy of nickel and manganese obtained in a crucible, for the purpose of freeing the bath of the oxides and slags which still remain in suspension. The nickel is then run in small ingots or in granular form.

Metallic nickel thus obtained is of a purity and quality hitherto unknown in commerce.

By "tempering" I mean so to treat the liquid metal that it will, when cold, be properly tempered.

It is found of advantage to divide the refining operation into two parts, whether for obtaining alloys or pure nickel. In the first operation the metal is refined until all but about two per cent. of the impurities, which consist chiefly of iron, sulphur, and scoriæ, are removed. The metal is then run into ingots, which are afterward introduced into a refining-furnace having a perfectly clean hearth, where the metal is brought to a high degree of purity.

I claim—

1. The process herein described of deoxidizing nickel in a furnace without deoxidizing the iron contained in the nickel ore by subjecting the pulverized ore, in the presence of limestone, to a blast within the furnace, thereby combining the silica, the magnesia, and other bases contained in the ore with the lime, and allowing the iron to pass off with the slag, substantially as specified.

2. The process herein described of sepa-

rating impurities from nickel during its treatment on a reverberatory furnace by passing currents of air into the furnace, and the simultaneous addition of pure ores having a base of oxide of nickel, substantially as specified.

3. The process herein described of tempering the refined nickel while melted, and of freeing the bath of the oxides and slags remaining in suspension, by the addition of an alloy of nickel and manganese to the bath of nickel or alloy of nickel while on the hearth of the reverberatory furnace or in a Bessemer converter, substantially as specified.

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Witnesses:
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