Patented Sept. 14, 1926. 1,599,424

UNITED STATES PATENT OFFICE.

OTTO LELLEP, OF EGYPT, PENNSYLVANIA, ASSIGNOR TO THE INTERNATIONAL NICKEL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

REFINING NICKEL MATTE AND NICKEL-COPPER MATTE.

No Drawing. Application filed April 7, 1923. Serial No. 630,618.

The object of my invention is to provide an improved method of eliminating sulphur from nickel matte or nickel-copper matte, or molten nickel-copper alloy or nickel, by blowing through the molten bath or over the molten bath a hot gas or mixture of gases. This invention supplements my Patent No. 1,278,176 of September 10, 1918, which provided a new method of reducing nickel sulphide by the reaction with nickel oxide or other oxidizing agents, which is useful in the refining of nickel matte or of nickel-copper matte, and the present invention provides a simplified method for carrying out my process in a single operation.

My method provides for the formation of metal oxide in the molten bath and for the accurate control of such formation for assisting in the elimination of sulphur present in the bath either as sulphide or as sulphur dioxide.

My invention further provides for the reduction of metal oxide either of nickel or of copper, in the molten bath, when such oxide has been formed in the process of eliminating sulphur.

My method provides for a repeated alternation of the condition of the molten bath, first oxidizing it to the saturation point for the oxide and then reducing it till free of oxide. In this way my process achieves the elimination of sulphur content down to any point required in commercial nickel or copper-nickel alloy.

In carrying out my process it is necessary to produce and maintain a temperature in the bath of metal not lower than the melting point of Monel metal or 1380° C., the maximum temperature may be 1750° C. but a temperature of about 1500° C. for nickel-copper and 1600° C. for nickel is preferable.

This temperature may be produced and maintained by any suitable method such as heating up a converter charged with cold matte or molten matte by means of a blast composed of a mixture of air and a suitable fuel in about theoretical proportions; or by heating up a reverberatory furnace charged with cold matte or with molten matte from a converter or any other source and acting on the surface of the metal by fire gases.

My invention further provides for the control of temperature of the bath and the oxidizing or reducing character of the blast by control of the proportion of fuel mixed with the air.

My present invention may be carried out in two types of apparatus in a simple, economical and practical way. One type of apparatus for carrying out the process is a modified converter like that used in the concentration of copper-nickel matte. The other type of apparatus is a low arch reverberatory furnace, preferably of the regenerative-type. The choice of apparatus used in carrying out my invention depends on local conditions, such as kind of fuel available and its cost. To carry out the process in the converter heat must be provided to raise the converter temperature and to maintain it at preferably about 1500° C. for Monel metal and 1600° C. for nickel. For this purpose, during the last stage of converting beginning with the moment when the matte is sufficiently refined from iron, I mix with the air blast a suitable amount of a fuel which may be gaseous, liquid, or powdered such as natural gas, blue water gas, kerosene or oil vapor, or any suitable liquid fuel preferably atomized, or any suitable powdered fuel such as powdered coal, charcoal or coke. It is highly desirable that the fuel be intimately mixed with the air. Such a mixture when it strikes the liquid metal which is already at a high temperature burns almost instantaneously and supplies the necessary additional heat.

To introduce gaseous fuel into the blast the pipe supplying the tuyères may be provided with a mixing T with suitable connections for air and gas or each individual tuyère may be provided with a gas supply. To introduce liquid fuel into the blast this fuel may be transformed into a vapor and may then be introduced in the same way as a gas. In case the liquid fuel such as fuel oil does not vaporize completely without leaving a carbonaceous residue, this fuel may be sprayed through a suitable atomizing or spraying nozzle into the air blast, the temperature of which has previously been raised to a point below the ignition point of the fuel. In this way it is possible to transform even heavier hydrocarbons into a fine mist suspended in the air. The liquid fuel may be sprayed through a suitable pipe or nozzle into the common air sup-

ply pipe or into each individual tuyère. Powdered fuel may be introduced by any suitable means into the blast.

In any case means should be provided to supply through the tuyères as complete and fine a mixture of fuel and air as is possible, to insure a practically instantaneous combustion as soon as the mixture leaves the comparatively cool tuyère and strikes against the white hot metal. To prevent the mixture from back-firing the tuyères should be kept comparatively cool either by air or water cooling and the velocity of the fuel and air mixture should be above the velocity of flame propagation. To obtain an air cooling effect on the tuyère body, this body may be provided with a number of ribs or flanges to conduct and radiate the heat to the air, and may be made of a heavy casting projecting through the converter shell about half way into the converter lining. Similar tuyères or burners are used in some gas furnaces which burn homogeneous mixtures of gas and air. Usual cleaning and observation holes should be provided to enable a punching of the tuyère when necessary.

To provide water cooling of the tuyères, a space for water circulation should be left inside of the tuyère casting and suitable connections for the water inlet and outlet. The coverter should be basically lined.

The refined matte may be transferred into a separate converter provided with a blast of fuel and air either as solid or as a liquid or the usual matte concentration converter may be equipped with a blast of fuel mixed with air. In case solid cold "pigs" of refined matte are charged into the fuel heated converter the cold matte will first be molten down by the burning blast and then the temperature of the liquid matte is raised. Whether the same converter is used or a second converter, the procedure is the same. At the beginning, the amount of fuel is regulated to approximately the theoretical proportion as this proportion gives the highest flame temperature and heats up the matte most quickly. When the temperature is high enough so that no excessive free oxides are floating on the metal, a percentage of excess air may be provided by diminishing the flow of fuel. A lean flame has a stronger oxidizing effect and eliminates sulphur faster than a theoretical flame. The proportion of excess air, when the coverter has been heated up, may go as high as 70% and still maintain a temperature of 1500° C. because this excess air burns with the combined sulphur of the matte and this supplies a part of the heat. The sulphur is eliminated in this way rapidly until the metal analyses about 0.5% sulphur. To free the metal from this last trace of sulphur special measures must be taken as this sulphur seems to adhere to the nickel with a particular tenacity. If a large excess of air be blown into the bath the metal will oxidize rapidly and as the metal oxide is infusible at this temperature, solid crusts of metal oxide form on the surface of the bath, while more oxide will remain dissolved in the metal. As soon as the metal is saturated with the dissolved oxide and the sulphur content is reduced to about 0.5%, the blast should be made either neutral or reducing. It is probable that this last trace of sulphur in the metal is in the form of dissolved sulphur dioxide which may be washed out by any gas in contact with the metal. A neutral or reducing flame blown through the tuyères into the bath has this washing effect on the sulphur without over oxidizing the metal and at the same time maintaining the necessary high temperature of 1500° C., or 1600° C. Instead of a steady neutral flame the bath may be blown alternately, first with a slightly reducing flame until all the oxide is reduced to metal, and then with a sligthly oxidizing flame until all the metal is saturated with dissolved oxide. Continued alternation of reducing and oxidizing flame will finally free the bath from sulphur within the commercial limits found in Monel metal and nickel. The final trace of sulphur (below 0.5%) may be removed a little more quickly by alternate short blasts of reducing and oxidizing flame than by a steady neutral blast. By selecting a suitable temperature and character of blast the metal may be brought to any desired "pitch."

Instead of supplying the fuel and air blast together and carrying out the combustion of the fuel in the metal bath, the fuel may be burned inside the converter but on top of the metal.

The second type of apparatus in which the direct desulphurization of nickel or Monel metal matte may be carried out is a low arch reverberatory furnace. The arch of the furnace is built preferably low so that it may be close to the surface of the metal to obtain a strong rubbing action of the oxidizing flame on the matte. The usual construction of the curved arch above the hearth or the laboratory of the furnace makes the distance between the level surface of the metal and the curved roof of the furnace greater in the center and less at the sides. To distribute the fire gases evenly above the entire surface of the metal and bring the gases into closest contact with the metal any type of so-called flat arch is recommended in which the refractory material of the roof is suspended from any suitable construction and forms a flat roof parallel to the level of metal surface. The depth of the metal in the hearth is kept shallow to expose a maximum surface per minimum of metal weight.

The furnace is built preferably of the re-

generative type to conserve fuel. Any gaseous, liquid or solid fuel may be used. The process is carried out in much the same manner as in a converter. The matte is molten down or it is poured directly from the concentrating converter and is brought to the reaction temperature with a neutral or slightly oxidizing flame. Then a strongly oxidizing flame is applied to remove the bulk of the sulphur quickly. The same "washing out" method to remove the last traces of sulphur (below 0.5%) may be applied in the reverberatory furnace as was described for the converter. Furthermore it is desirable to stir up the metal and thus renew the surface of metal exposed to the refining action of the gases. For this purpose a pole may be inserted into the bath such as is used in the refining of copper, or the hearth may be provided with tuyères through which a gas may be blown into the bath of metal.

In comparison, the fuel consumption of the reverberatory regenerative furnace for this process is much more economical than the fuel consumption of the converter. The main heat loss in the converter process is the considerable amount of heat in the waste gases escaping at 1500° C. to 1600° C. In the regenerative furnace the fire gases escape at a temperature of about 350° C.

Having thus fully described my process, I claim:

1. In the process of eliminating sulphur from nickel matte or nickel-copper matte or metal, the steps consisting of treating the same in the molten state with a blast of air, and supplying additional heat to the reaction.

2. The method of eliminating sulphur below 1% from nickel or nickel-copper alloy in which the molten metal at a temperature between 1380° C. and 1750° C. is acted upon by a gas blast, said gas blast being alternately and periodically oxidizing and reducing in character.

3. In the process of eliminating sulphur from nickel matte or nickel-copper matte or metal, the steps consisting of treating the same in the molten state with a gaseous blast, and simultaneously burning combustible material in such relation as to supply further heat units to the operation.

4. In the process of eliminating sulphur from nickel matte or nickel-copper matte or metal, the step consisting of treating the same in the molten state with a blast containing a mixture of air and fuel.

5. In the process of eliminating sulphur from nickel matte or nickel-copper matte or metal, the steps consisting of treating the same in the molten state with a gaseous blast of an oxidizing character, and thereafter treating the same with a gaseous blast of substantially non-oxidizing character.

6. In the process of eliminating sulphur from nickel matte or nickel-copper matte or metal, the steps consisting of treating the material in the molten state with a mixture of air and fuel of an oxidizing character, and then treating the same with a mixture of air and fuel of a non-oxidizing character.

7. In the converting of nickel-containing matte, the steps consisting in oxidizing the sulphur while the matte is molten, and keeping the temperature above 1380° C. by supplying additional heat to the reaction.

OTTO LELLEP.