# United States Patent [19]

**Pargeter et al.**

[11] **3,877,933**

[45] **Apr. 15, 1975**


[54] **METALLURGICAL ADDITION PRODUCT**


[75] Inventors: **John K. Pargeter**, New York, N.Y.; **Loris M. Diran**, Hackensack; **Francis J. Hennion**, Prospect Park, both of N.J.

[73] Assignee: **The International Nickel Company, Inc.**, New York, N.Y.



[22] Filed: **Sept. 21, 1973**

[21] Appl. No.: **399,467**

[52] **U.S. Cl.** ..... **75/129**; 75/53; 75/93 G; 75/94

[51] **Int. Cl.** ..... **C22c 1/00**; C22b 9/10

[58] **Field of Search** ..... 75/52–58, 82, 75/94, 3–5, 129, 93 G



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,275,449 | 8/1918 | Lemon | 75/93 G |
| 2,086,756 | 7/1937 | Whitaker | 75/53 |
| 2,333,741 | 11/1943 | Reeder | 75/53 |
| 2,397,418 | 3/1946 | Howard | 75/56 |
| 2,550,735 | 5/1951 | Tour | 75/93 G |
| 2,698,229 | 12/1954 | Lindsley | 75/82 |
| 2,881,068 | 4/1959 | Bergh | 75/53 |
| 2,913,337 | 11/1959 | Kretz | 75/56 |
| 3,272,616 | 9/1966 | Queneau | 75/82 |
| 3,436,209 | 1/1969 | Lojas | 75/53 |
| 3,459,540 | 8/1969 | Tisdale | 75/129 |
| 3,681,050 | 8/1972 | Kazufusa | 75/53 |
| 3,769,002 | 10/1973 | O'Neill | 75/82 |



*Primary Examiner*—L. Dewayne Rutledge
*Assistant Examiner*—Peter D. Rosenberg



[57] **ABSTRACT**

A metallurgical charge product comprising a package containing an intimate mixture of nickel oxide sinter and petroleum coke.


**7 Claims, No Drawings**

# METALLURGICAL ADDITION PRODUCT

The present invention is concerned with a product useful in the formulation of metal furnace charges and, more particularly, with a product for make up of nickel content in furnace charges for manufacture of stainless steel and other nickel containing products.

It is well known in the art that nickel in various forms including oxide sinter has been used to provide the nickel content for stainless steel meltdown charges. Recently, a number of manufacturers of stainless steel and other chromium-containing alloys have adopted the practice as described in U.S. Pat. No. 3,046,107 to Nelson et al. July 24, 1962 and in U.S. Pat. No. 3,252,790 to Krivsky, May 24, 1966 of decarburizing chromium-containing alloy metals by means of mixtures of argon and oxygen with the relative proportion of argon being increased as the percentage of carbon in the melt decreases. According to some workers in the field, the advent of this process, known as the AOD process, has made it less desirable to include oxidic forms of nickel in stainless steel charges. The present application is directed to a novel means whereby a nickel oxide sinter product can be used with advantage in stainless steel charges as well as in charges for other alloys containing chromium.

The invention is also directed to a means for overcoming the objections to use of nickel oxide sinter in the foundry industry where there is a growing trend to induction furnace melting. Such furnaces are not suitable for use with nickel oxide as a source of nickel because they are unable to handle slag or a violent boil caused by reduction of nickel oxide by carbon in the presence of a molten phase. A further serious objection to the use of nickel oxide sinter in foundry operations is the reaction of readily oxidizable elements in the scrap charged to the furnace with the oxygen in nickel oxide sinter. In the highly competitive foundry industry, there is a strong desire to preserve all alloying element units contained in the scrap in order to minimize addition of high-cost ferro-alloys and other forms of alloying elements. The present application is directed toward a novel means whereby nickel oxide sinter can be used to advantage in the foundry industry where, until now, only purer forms of nickel were suitable.

It is a object of the invention to provide a means involving a packaged product and process whereby nickel oxide sinter can be employed as charge material in meltdown of stainless steel compositions adapted to be refined by the AOD process.

Other objects and advantages will become apparent from the following description.

Generally speaking, the present invention contemplates a package thermally resistant to but permeable to gas at temperatures of about 600°C. to about 1000°C., non-contaminating with respect to a chromium-containing alloy metals and containing particulate nickel oxide sinter and a quantity of finely divided petroleum coke in an amount about stoichiometrically equivalent for reducing purposes to said nickel oxide sinter, intimately mixed with and adhered to said nickel oxide sinter.

For purposes of this specification and claims the term "nickel oxide sinter" means a product having a chemistry of about 5 percent to 25 percent (by weight) of oxygen balance essentially nickel (or nickel and iron), that is, the stoichiometrical composition of NiO and nickel-rich modifications thereof marketed in the physical form of granules or powder:



The term "petroleum coke" means the residue from the destructive distillation of petroleum.

In using the product of the present invention, the package is placed along with scrap iron or steel, ferrochrome and the like in an arc or induction furnace, in a location away from the direct heat of the arc or other heating means and preferably in the middle of or near the top of the charge. Power for meltdown is then applied resulting in heating the package. In the temperature range of about 600°C. to about 1000°C. the petroleum coke (or volatiles released therefrom) reacts with the nickel oxide sinter in the confines of the package to reduce the nickel oxide to metallic nickel and produces a carbon oxide-containing gas which escapes from the package. The packaged product is highly advantageous in that it avoids segregation of high melting nickel oxide in the bath. It avoids loss of alloy ingredients such as silicon and chromium by eliminating need for reduction of nickel oxide by these elements. It minimizes slag formation. It is a source of heat and simultaneously it produces a gas during melt-down which can aid in protecting the charge from undue oxidation. Those skilled in the art will note that the temperature range of reduction within the package confines i.e., a maximum of about 1000°C. to 1100°C. is lower than the usual melting range of stainless steels. Thus when the stainless steel (or other chromium-containing, nickel-containing alloy) is fully melted the packaged product is essentially all metallic nickel.

While the term "package" is intended to be sufficiently broad to include items such as self-supporting briquettes sintered flux-coated masses, etc., it is highly advantageous to employ as the package a simple ventable steel can having perforations, sealed for shipping purposes by a thermally decomposible seal, e.g., cardboard, polyethylene, etc. One major producer of nickel oxide sinter in Canada employs a steel can of 50 pounds (about 22.7 kg.) net for shipment of nickel oxide sinter containing about 75 percent by weight of nickel. It is specifically contemplated in accordance with the present invention to include in such a can finely divided petroleum coke in an amount of about 6¼ pounds (about 2.85 kg.) along with a small amount of an adhering agent, e.g., bunker C oil, in order to minimize segregation of the nickel oxide sinter and the petroleum coke. Of course other size cans can be used. For example, for use in induction furnaces a cylindrical, steel can of about 12.7cm diameter and about 15.2cm high is convenient. The can cover can be perforated and backed by a cardboard disk. When the can is heated along with the charge the cardboard disk chars thereby allowing for escape of gaseous products of reduction from the can. Upon melt-down the can forms part of the iron charge of the melt. With nickel oxide sinter containing about 75 percent by weight of nickel about 12 parts by weight of petroleum coke are used per 100 parts by weight of sinter. With nickel-oxide sinter containing about 90 percent by weight of nickel about 5 or 6 parts by weight of petroleum coke are used per 100 parts by weight of sinter. Also, if desired, reducible oxide other than nickel oxide sinter, e.g., FeO, $Fe_2O_3$, (Fe, Ni) $O_x$ (a product formed by roasting pentlandite), CoO or the like can be included in the package along with nickel oxide with an appropriate allowance of petroleum coke being made.

In order to give those skilled in the art a better understanding and appreciation of the invention, the following examples are given:

## EXAMPLE I

Fifty pounds (about 22.7 kg) of nickel oxide sinter containing about 75 percent by weight of nickel are wetted with a small amount of bunker C oil and mixed with 6 pounds (about 2.73 kg) of petroleum coke ground to pass through a 60 mesh (about 23 openings/cm) screen. The mixture is then packed in a ventable steel can having perforations covered over by a seal. The thus formed package along with others of the same form is introduced into an arc-furnace stainless steel charge in a position away from direct contact with the arc. Power is applied and at melt-down it is found that the stainless steel melt contains essentially all of the nickel charged as oxide sinter with very little loss of other more easily oxidizable elements to the slag.

## EXAMPLE II

A nickel-chromium-containing cast iron was melted in an induction furnace using as the charge nickel a briquette packaged mixture of 100 parts by weight of nickel oxide sinter containing about 75 percent nickel, about 12.5 parts by weight of petroleum coke and about 1 part by weight of methyl cellulose. The briquettes were placed in the upper portion of the charge and melt down was achieved after 50 minutes of power on. The casting appearance and quality was judged typical of the alloy. Nickel was recovered in the alloy to the extent of 99% and no loss of chromium originally present in the charge along with the nickel oxide sinter was detected. These percentage recoveries of nickel and chromium are typical of recoveries not only in cast iron melting but also in stainless steel melting. In three melts of type 304 stainless steel, chromium recoveries were between 96 percent and 100 percent and nickel recoveries were between 98.4 and 100 percent.

In carrying out the process of the present invention (i.e., using the novel packaged nickel oxide sinter product) it is important that the reaction of the nickel oxide and petroleum coke be essentially complete prior to the presence in the furnace of any significant amount of molten metal. If reduction of sinter is still proceeding when molten metal is present a dangerously violent boil can occur.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

We claim:

**1.** A metallurgical addition package comprising a ventable steel can permeable to gas at about 600°C. to about 1000°C., and non-contaminating with respect to a chromium-containing alloy melt packed with particulate nickel oxide sinter along with a quantity of finely divided petroleum coke in an amount stoichiometrically equivalent for reducing purposes to said nickel oxide, the petroleum coke being intimately mixed with and adherent to said particulate nickel oxide sinter.

**2.** A metallurgical process comprising charging a metallurgical addition package containing nickel oxide sinter and a quantity of petroleum coke stoichiometrically equivalent for reducing purposes to said nickel oxide sinter into a furnace along with other alloying ingredients and causing the nickel oxide sinter to be reduced by said petroleum coke in said package prior to the presence of any significant amount of molten metal in said furnace.

**3.** A product as in claim **1** wherein the nickel oxide sinter contains about 75 percent nickel by weight.

**4.** A product as in claim **1** which also contains a reducible metal oxide other than nickel oxide sinter.

**5.** A product as in claim **1** wherein the nickel oxide sinter contains about 90 percent nickel by weight.

**6.** A process as in claim **2** wherever the nickel oxide sinter contains about 75 percent nickel.

**7.** A process as in claim **2** wherein the nickel oxide sinter contains about 90 percent nickel.

* * * * *