United States Patent [19]

Fehling et al.

[11] **3,779,742**

[45] **Dec. 18, 1973**

[54] **METHOD OF REMELTING A FROZEN METAL PLUG IN THE CERAMIC NOZZLE OF A METALLURGICAL VESSEL**

[75] Inventors: **Hans-Reinhard Fehling**, Zug, Switzerland; **Horst Hase**, Wiesbaden; **Hans-Joachim Kutzer**, Wiesbaden-Rambach, both of Germany

[73] Assignee: **Didier-Werke A.G.**, Wiesbaden, Germany

[22] Filed: **Oct. 16, 1970**

[21] Appl. No.: **81,289**

[30] **Foreign Application Priority Data**

Dec. 4, 1969 Germany .... P 19 60 801.6

[52] **U.S. Cl.** **75/46,** 75/20, 164/121
[51] **Int. Cl.** **C21c 7/00**
[58] **Field of Search** 75/27, 41, 45, 46; 266/42; 164/136, 281, 337

[56] **References Cited**

UNITED STATES PATENTS

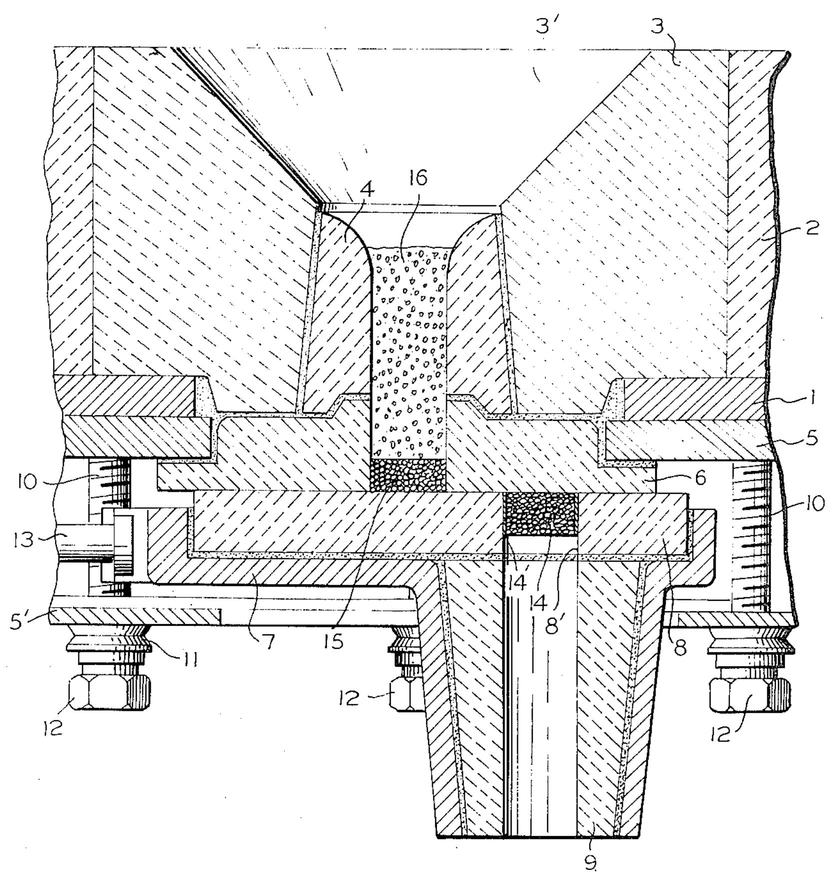
1,880,242	10/1932	Dickson	266/42
3,581,948	6/1971	Detalle	266/42 X
623,239	4/1899	Deissler	75/27
2,500,097	3/1950	Soffel	75/27 X
2,791,815	5/1957	Kinnear	75/27 X
968,350	8/1910	Harrison	75/27 X
2,563,131	8/1951	Old	75/41 X
2,717,204	9/1955	Noddin et al.	75/27 X
1,637,619	8/1927	Lucas	75/27
2,024,132	12/1935	Sander	75/27

Primary Examiner—L. Dewayne Rutledge
Assistant Examiner—M. J. Andrews
Attorney—Wenderoth, Lind & Ponack

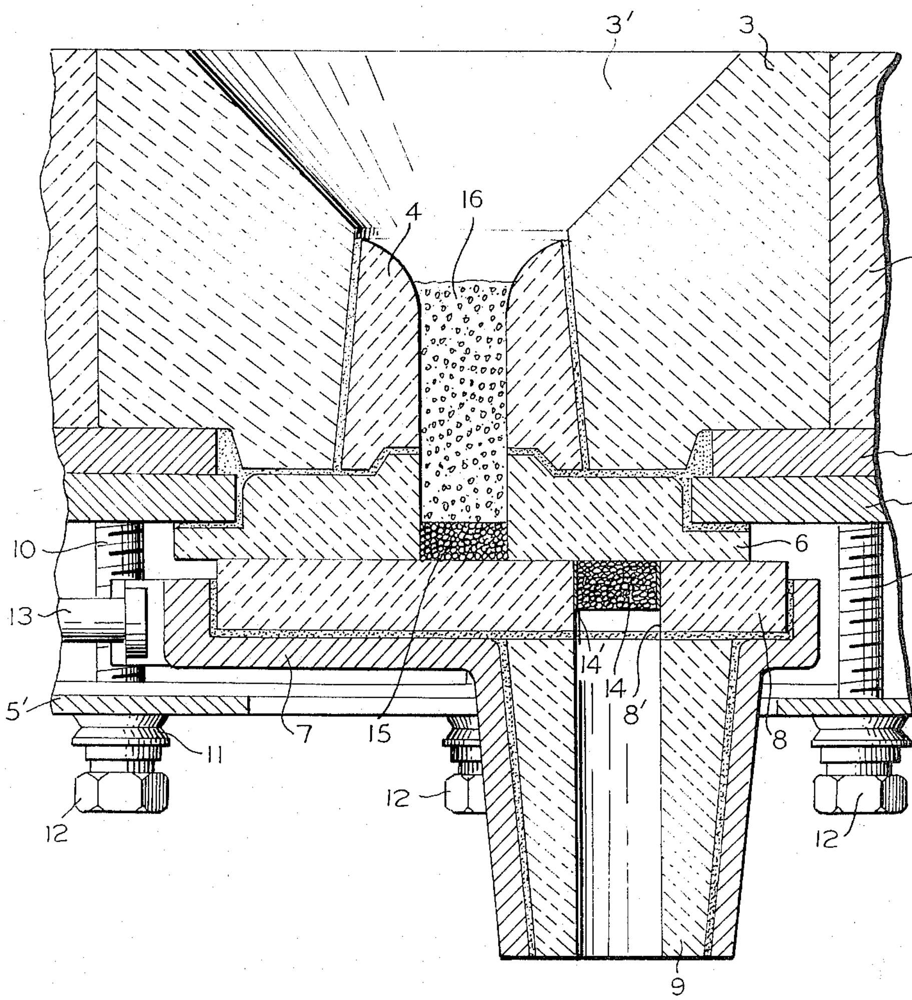
[57] **ABSTRACT**

A method of remelting a frozen metal plug in the ceramic nozzle of a metallurgical vessel, particularly a pouring ladle equipped with means for controlling the nozzle. An exothermic material that ignites at a temperature below the freezing temperature of the metal melt, is introduced into the outlet orifice of the closed nozzle.

8 Claims, 1 Drawing Figure



PATENTED DEC 18 1973 3,779,742



INVENTORS
HORST HASE
HANS-JOACHIM KUTZER
HANS-REINHARD FEHLING

BY Wenderoth, Lind & Ponack
ATTORNEYS

METHOD OF REMELTING A FROZEN METAL PLUG IN THE CERAMIC NOZZLE OF A METALLURGICAL VESSEL

The invention relates to a method of remelting a frozen metal plug blocking the ceramic pouring nozzle of a metallurgical vessel, such as of a ladle of the kind used principally in steel foundries or of a metallurgical vessel having a pouring nozzle associated with control means such as a sliding gate.

It is a frequent and familiar occurrence in metal casting processes of different kinds, such as in chill casting, continuous casting and so forth, especially when pouring begins, for the liquid melt to have undesirably formed a frozen plug in the pouring nozzle. This solidified layer of metal must then be remelted before casting can begin. For this purpose it is the conventional practice, particularly in steel works, to open the "frozen" nozzle or its outlet orifice by burning out the obstructing plug with the aid of an oxygen lance which supplies oxygen. The refractory ceramic material of the nozzle or of parts of the nozzle is thereby exposed to the high temperatures of about 2000° C that exist in the environment of an oxygen flame which is relatively broad and subjects the material to high thermal stress, leading to premature wear. These deleterious effects are also promoted by the considerable difficulty of manually controlling the process of burning out the plug with oxygen. This must be performed more by touch than by direct vision.

An object of the present invention seeks to overcome these troubles and to provide a method that will reliably permit a frozen metal plug in the outlet orifice of ceramic nozzles to be remelted without exposing the ceramic parts to excessive thermal stress and thereby softening them prematurely.

For achieving this object the present invention proposes to introduce into the open outlet orifice of the closed nozzle an exothermic material that ignites at a temperature below the solidification point of the metal, preferably a mixture of aluminium and a reducible higher metal oxide.

When the nozzle is opened the exothermic material is ignited by the radiant heat of the frozen metal melt and the heat of combustion of about 2,500°C which is then evolved melts the frozen metal plug without any external action being needed.

When a metallurgical vessel fitted with a sliding gate nozzle for controlling the pouring rate from the vessel and for closing the orifice completely is used, it is preferred that the exothermic material should be introduced into the outlet orifice of the movable sliding plate when the latter is closed. It has been found convenient to introduce the exothermic material in the form of a pressing or casting, particularly in the form of a cylindrical pellet. According to another feature of the invention oxidants that have the effect of reducing the temperature of ignition, such as perchlorate of potassium, nitrate of soda or peroxide of barium, may be added to the exothermic material of aluminium in mixture with a reducible metal oxide. Moreover, for improving ignitability and combustibility combustible exothermically reacting substances, such as carbon and/or magnesium may also be added to the exothermic mixture. In order to permit the exothermic mixture to be compressed or cast in a particular shape it is also an advantage to include in the exothermic mixture a readily combustible, preferably vaporisable binder, such as paraffin, colophony or a synthetic resin. It has been found that a particularly effective exothermic material according to the invention is a mixture comprising 7 to 15 percent by weight of potassium perchlorate, 1.5 to 4 percent by weight of carbon, 5 to 10 percent by weight of magnesium, 38 to 41 percent by weight of aluminium and 38 to 41 percent by weight of iron oxide with the addition of a binder, particularly a phenolic resin, in quantities of 4 to 5 percent of the total weight of the mixture. In order to improve the ignitability of the exothermic mixture the surface of the mixture facing the melt may bear a thin layer of barium peroxide or potassium perchlorate mixed with sulphur in the proportion of 2 : 1.

Yet another feature of the invention comprises, prior to the vessel being charged with the metal melt and after the pouring nozzle has been closed, filling into that part of the outlet orifice (entry bush) with which the metal melt makes direct contact when the vessel is charged, with a layer of iron chips covered with a layer of calcium-silicon or ferrosilicon. This has the advantage that the refractory parts of the pouring nozzle and the adjoining refractory parts are heated up by the liberated heat of solution and thereby counteract heat loss by the liquid melt and hence freezing of the melt in the nozzle entry.

For this purpose it has proved desirable, prior to the vessel being charged with liquid melt and after the pouring nozzle has been closed, to fill into that part of the outlet orifice (bush) with which the metal melt makes direct contact first a layer of iron chips and then a layer of aluminium and iron oxide, mixed with iron chips. In order to enable these mixtures that provide heat of solution to be conveniently introduced from the outside through the vessel wall into the outlet orifice, the layers of iron chips and calcium silicon or ferrosilicon or possibly aluminium, iron oxide and iron chips, may be enclosed in a sleeve of readily combustible material that is conveniently insertable into the outlet orifice, for instance in the form of a prefabricated cardboard cartridge.

An embodiment of the invention is illustratively shown in a cross section of the outlet portion of a ladle in the drawing and will be hereinafter described in greater detail:

1 is the metal casing of the bottom part of a pouring ladle provided with a sliding gate nozzle shown in longitudinal section. The casing is provided with a refractory lining **2** that covers the sides and the floor of the ladle. The metal casing **1** as well as the refractory lining **2** contain an opening in the bottom of the ladle for the discharge therethrough of the liquid melt. This opening contains an externally rectangular orifice brick **3** with a funnel-shaped entry orifice **3'** adjoining a divergent part containing an entry bush **4** which is embedded in mortar and likewise consists of refractory material.

The sliding gate which serves for controlling the pouring rate, and which can be completely closed, substantially comprises a cast iron plate **5** bolted to the metal casing **1** of the ladle bottom and provided with a removable cover **5'**, an orifice plate **6** of refractory material provided with a central orifice and secured axially from below to the entry bush and the orifice brick, as well as a cast iron supporting shell **7** bearing a sliding plate **8** likewise provided with an orifice and a downwardly adjoining outlet bush **9** both of refractory material embedded in a refractory mortar. The sliding plate including the bearing shell and the outlet bush are slidably displaceably kept in contact wih the fixed orifice plate **6** by bolts **10** engaging the ladle casing and nuts bearing against the cover with the interposition of springs. The bearing shell **7**, the sliding plate **8** and the outlet bush **9** are slidably displaceable parallel to the ladle bottom by means of a hydraulic actuator drive which, as indicated at **13**, is linked to the bearing shell.

An igniting pellet **14** which is compacted from an exothermic mixture, is prior to assembly and fitting of the sliding gate to the ladle floor inserted from above into the free orifice **8'** of the sliding plate so that it ends flush with the sliding surface. In order to ensure a good fit of the pellet in the orifice it is wrapped in a self-adhering paper tape **14'** which takes up the tolerational clearance between the pellet and the orifice wall. When the sliding gate has been fitted the sliding plate remains in closed position, as illustrated.

Before the liquid melt is charged into the ladle a layer of iron chips **15** about **2** cms thick is deposited through a funnel into the orifice in the plate **6.** A layer **16** of calcium silicon (CaSi) is then superimposed until the bore of the entry bush **4** is also filled. The two layers may also be filled into a cardboard sleeve which in external diameter conforms with the internal diameter of the orifice and this cardboard sleeve may then be introduced into the orifice polate **6** from below before the sliding plate **8** is fixed in place. When the ladle is filled with the liquid melt the layers previously introduced into the entry bush and the orifice plate likewise melt and by releasing their heat of solution they help to heat up the refractory material of these two components. They thus form a useful heat bridge between the liquid metal melt and the sliding plate.

When it is desired to pour the metal, the hydraulic actuator pulls the sliding plate to the left in the drawing until the outlet orifice **8'** and the exothermic igniting pellet **14** contained therein register with the orifice in the fixed plate **6** and makes contact with the metal plug it contains. In about one minute the exothermic material of the igniting pellet will have reached the required igniting temperature of about 400°C and it will then burn away at a combustion temperature of about 2,500°C. Any frozen parts of the melt lodging in the orifices of the fixed plate and the entry bush will liquefy and the desired pour from the ladle can proceed without a further hitch.

For the preparation of the igniting pellet the following pulverulent materials are mixed: 11.8 percent by weight of $KC10_4$, 39.0 percent by weight of Al, 39.0 percent by weight of Fe_2O_3, 7.5 percent by weight of Mg and 2.7 percent by weight of *C*. To this mixture is added a phenolic resin binder in quantities of about 4.5 percent of the weight of the total mixture and then compacted in a suitable mould into the required cylindrical pellet shape.

The igniting reaction of the pellet is characterized by three consecutively proceeding reactions, each reaction providing the heat required for reaching the temperature level at which the next reaction proceeds.

The overall reaction can be represented as follows: $3\ C + 2\ Mg + 2\ KC10_4 + 4\ Al + 2\ Fe_2O_3 \rightarrow 3\ CO_2 + 2\ MgO + 2\ KC1 + 2\ Al_2O_3 + 4\ Fe$ which comprises the three following consecutively proceeding individual reactions:

1. $3\ C + 3\ 0_2 \rightarrow 3\ CO_2 + 292\ kcal$

2. $2\ Mg + 2\ 0 \rightarrow 2\ MgO + 290\ kcal$
3. $4\ Al + 2\ Fe_2O_3 \rightarrow 2\ Al_2O_3 + 4\ Fe + 363\ kcal$

We claim:

1. A method of remelting a frozen plug of metal formed in the stationary orifices of the pouring nozzle of a pouring ladle for pouring molten metal, said pouring ladle having an entry orifice and being equipped with a gate nozzle including a fixed plate having an orifice aligned with said entry orifice and a movable plate having an outlet orifice which at an open position aligns with said entry orifice and at a closed position closes said entry orifice, said method comprising the steps of:

moving said movable plate to said closed position;

charging said ladle with hot molten metal;

introducing into said outlet orifice of said movable plate an exothermic material which is ignitable at a temperature below the freezing temperature of said molten metal whereby said exothermic material is isolated from the heat of said molten metal; and

moving said movable plate into said open position, whereby said exothermic material is ignited by said heat of said molten metal and said frozen plug of metal is melted by the heat of ignition of said exothermic material.

2. A method as claimed in claim **1,** wherein said exothermic material is a mixture of aluminium and a reducible higher metal oxide.

3. A method as claimed in claim **1,** wherein prior to the ladle being charged with said molten metal and after said step of moving said movable plate to said closed position, a layer of iron chips covered with a layer of aluminum and iron oxide mixed with iron chips is introduced into said entry orifice and said orifice of said fixed plate to contact that portion of said pouring nozzle which is directly contacted by said molten metal when the ladle is charged.

4. A method as claimed in claim **1,** wherein said exothermic material is insertable into said outlet orifice in the form of a cylindrical pellet.

5. A method as claimed in claim **1,** wherein prior to the ladle being charged with said molten metal and after said step of moving said movable plate to said closed position, a layer of iron chips covered with a layer of calcium silicon is introduced into said entry orifice and said orifice of said fixed plate to contact that portion of said pouring nozzle which is directly contacted by said molten metal when the ladle is charged.

6. A method as claimed in claim **5,** wherein said iron chips and calcium silicon are placed in a sleeve of easily combustible material, and said sleeve is introduced into said entry orifice and said orifice of said fixed plate.

7. A method as claimed in claim **1,** wherein prior to the ladle being charged with said molten metal and after said step of moving said movable plate to said closed position, a layer of iron chips covered with a layer of ferrosilicon is introduced into said entry orifice and said orifice of said fixed plate to contact that portion of said pouring nozzle which is directly contacted by said molten metal when the ladle is charged.

8. A method as claimed in claim **7** wherein said iron chips and ferrosilicon are placed in a sleeve of easily combustible material, said sleeve is introduced into said entry orifice and said orifice of said fixed plate.

* * * * *