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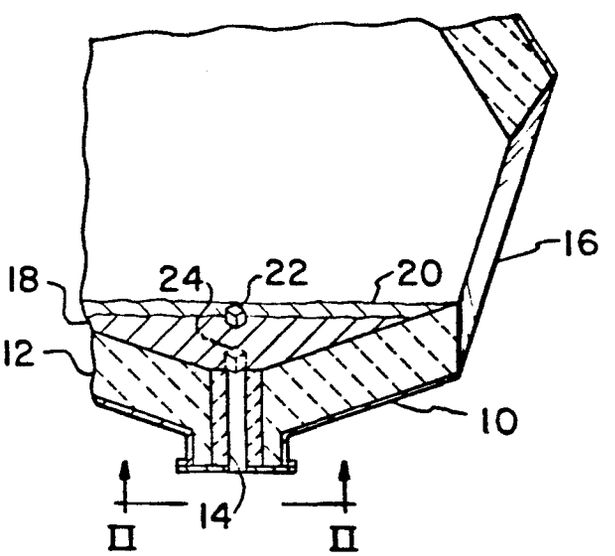
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(54) Method of minimizing slag carryover.

(57) The method relates to minimizing slag carryover when draining molten metal from a furnace. A polyhedral-shaped body (22) having density intermediate that of the slag (20) and metal (18) is thrown onto the surface of the slag within a restricted area over the furnace taphole (14). The body will float at the slag-metal interface, and tend to lodge with one of its corners projecting into the taphole as the final portion of remaining metal drains out of the furnace. The shape of the body and its dimensions are selected so as to only partially block the taphole opening, causing flaring of the stream so as to signal a furnace operator of the impending flow of slag from the furnace. The operator then shuts off flow to prevent carryover of slag onto the molten metal already tapped. Since only the edges of the body contact the taphole, of the body does not become welded to the wall of the taphole and therefore is easily dislodged without loss of time between heats.



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DESCRIPTION

METHOD OF MINIMIZING SLAG CARRYOVER

This invention relates to a method of minimizing slag carryover during tapping of molten metal from a furnace.

It is desirable in order to improve ladle addition recoveries and deoxidation control in steelmaking to minimize carryover of slag with the molten metal as it is tapped from the furnace. Various stopper devices have been used for plugging the taphole of BOP and Q-BOP furnaces to prevent drainage of slag at the beginning of the tap when the furnace is first tilted downward to drain the metal out. However, most of the slag gets into the ladle as a result of becoming entrained with the metal in a vortex which forms at the taphole entrance as the final portion of metal is drained from the furnace.

Two different approaches have been made toward solving this latter problem. In one, a device located on the exterior of the furnace is actuated to physically cut off the stream as slag begins to flow out of the taphole. A second approach has been to insert into the furnace a

floatable stopper which floats at the slag-metal interface and becomes lodged in the taphole. However, these floatable stoppers have the disadvantage that they tend to weld to the wall of the taphole and are difficult to dislodge, requiring burning with an oxygen lance. This also increases wear in the taphole itself. Examples of prior floatable stoppers are shown in Stahl Und Eisen, Volume 90, pages 257-263 and Japanese Patent Application 47-20803.

According to the present invention, there is provided a method of minimizing slag carryover upon draining molten metal from a furnace through a taphole, comprising dropping onto the surface of molten slag and metal in said furnace, within an area above said taphole, a body having a density intermediate that of the molten metal and slag in said furnace and having a cross-section of minimum dimension greater than the maximum dimension of the cross-section of the opening of said taphole, draining molten metal from the furnace through the taphole opening, and then shutting off flow through said taphole so as to prevent carryover of slag onto the molten metal already tapped from the furnace, characterized in that said body has equilateral generally planar faces, the intersections of which

are adapted to lodge in the taphole so that said body blocks 20 to 80 percent of the taphole opening when said body becomes lodged in said taphole opening, and the method includes monitoring the condition of the stream emerging from said taphole so as to obtain an indication of flaring of said stream when said body lodges in the taphole.

For use in steelmaking a body having a density of .12 to .22 pounds per cubic inch (3320 to 6090 kg/m^3) is preferred. The body is of a material substantially indissoluble in the molten metal and slag.

The body preferably has a maximum dimension in any direction of five to twelve inches (13 to 30cm) and is adapted to block 20 and 80 percent of a round taphole opening having a diameter of four to ten inches (10 to 25cm.) when an intersection of the faces of the body is lodged centrally therein. Thus, when the final portion of metal starts to flow out of the furnace, the body will tend to lodge in the taphole, causing the stream to flare since the hole is only partially blocked. The flaring stream acts as a signal to a furnace operator that slag will start to flow soon. Thus, the operator may shut off flow, preventing slag carryover onto the metal in the ladle. A primary advantage of the

polyhedral-shaped device is that it does not become permanently lodged in the taphole and does not require burning with an oxygen lance in order to remove it from the taphole.

The body may have faces all of the same shape and size. A cuboid shape is preferred. The body may be of refractory material having solid metal particles distributed therein to increase its density. The metal particles may be shot or fibers or both, the latter serving to increase cohesiveness of the body. Preferably, carbon steel shot is used whereas the fibers are of stainless steel composition.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a cross-section of a furnace tilted into tapping position for draining molten metal through a taphole of the furnace and showing the location of a floating stopper, and

Figure 2 is a schematic illustration of how the floating stopper lodges in the taphole.

Referring to Figure 1, a steelmaking converter 10 is shown having a refractory lining 12 and a taphole 14 located near the mouth 16 of the converter vessel. The vessel is shown tilted

downwardly from its normal upright position, so that molten metal 18 and slag 20 will drain therefrom. A cube 22, having been dropped into the furnace contents above the taphole, is shown floating at the slag-metal interface during the tap and before being drawn into dotted position 24 by vortex action towards the end of the tap. Referring to Figure 2, which is an enlarged section taken along the line II-II of Figure 1, the cube 22 is shown lodged in the taphole 14 and only partially blocking the taphole opening. For a six-inch (15cm.) diameter taphole, a cube 7 or 8 inches (18 or 20cm.) on each face has been found to work satisfactorily. A seven inch (18cm.) cube is preferred. It will block about 40 percent of the cross-section of a six-inch (15cm.) diameter taphole.

The cube may be of any refractory material resistant to dissolution in the metal and slag, at least sufficiently to maintain the minimum dimensions necessary for lodging in the taphole. Castable refractory is preferred. Seven-inch (18cm.) cubes having a density of from 0.15 to 0.17 lbs/in.^{3}, (4150 to 4710 kg/m^3) have been used although any density between that of the slag and metal should suffice. For example, molten steel has a density of about 0.25 lbs/in.^{3} (6920 kg/m^3), whereas steelmaking slags have density of about 0.10 lbs/in.^{3} (2770 kg/m^3). Shown below are examples of mixtures used for making typical cubes:

TABLE I

CUBE A 7 inches (18 cm.) on each side with density of 0.15 lbs/in.^{3}(4150 kg/m^3)

	Weight lbs.	kg.
Refractory Cement	7.6	3.4
Fine Iron-Ore Concentrate	15.2	6.9
Steel Shot	28.6	13.0
Water	2.5	1.1
Stainless Steel Fibers	1.5	0.7

CUBE B 7 inches (18cm.) on each side with density of 0.17 lbs/in.^{3} (4710 kg/m^3)

	Weight lbs.	kg.
Refractory Cement	5.2	2.4
Fine Iron-Ore Concentrate	10.4	4.7
Steel Shot	42.7	19.4
Water	2.5	1.1
Stainless Steel Fibers	1.5	0.7

The steel shot is of a type readily available and is used for increasing the density of the cube. Iron ore is used since it reacts with carbon in the steel bath and indicates where the submerged cube is located. The stainless steel fibers tend to bind the refractory preventing the cube from breaking apart prematurely. Of course, it is

desirable to completely dry the cubes in order to remove moisture which reacts with the metal, causing the cubes to crack and break.

It is important that the cube be dropped into a restricted area over the taphole so as to assure its being carried by fluid currents in the metal during tap into an area directly over the taphole so that it will lodge therein. It has been found that the angle of downward tilt of BOP or Q-BOP furnace at the end of tap, if tilted so as to obtain the maximum rate of draining metal, varies from about 88° to 103° from vertical. The range of angles is due to various factors such as erosion of the furnace lining and solid slag or metal buildup at the furnace mouth. It has been found that reasonable estimates of the location of the taphole can be made by calculating the horizontal distance of the taphole from the furnace trunnions for various angles of tilt of the furnace. The location of the taphole from the trunnions at the end of tap will vary over about four feet (1.2m). Thus it has been found best to insert the cube in the middle of the calculated four-foot (1.2m) distance. This can be accomplished by various means from floor level at a location adjacent the furnace mouth.

The cube should also be inserted into the furnace just before a vortex forms as the final portion of metal starts to drain out. This time may be calculated from the estimated tonnage of metal contained in the furnace, the size and shape of the taphole in relation to metal bath so as to arrive at a critical tonnage of metal left in the furnace when vortexing will begin to occur. This critical tonnage may be calculated for conventional steelmaking BOP or Q-BOP vessels from a formula. Normally, it is preferred to add the cube within a calculated time of one to two minutes before all of the metal has drained from the furnace.

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CLAIMS

1. A method of minimizing slag carryover upon draining molten metal from a furnace through a taphole therein, said method comprising dropping onto the surface of molten slag and metal in said furnace, within an area above said taphole, a body having a density intermediate that of the molten metal and slag in said furnace and having a cross-section of minimum dimension greater than the maximum dimension of the cross-section of the opening of said taphole, draining molten metal from the furnace through the taphole opening, and then shutting off flow through said taphole so as to prevent carryover of slag onto the molten metal already tapped from the furnace, characterized in that said body has equilateral generally planar faces, the intersections of which are adapted to lodge in the taphole so that said body blocks 20 to 80 percent of the taphole opening when said body becomes lodged in said taphole opening, and the method includes monitoring the condition of the stream emerging from said taphole so as to obtain an indication of flaring of said stream when said body lodges in the taphole.

2. A method as claimed in claim 1, characterized in that said body is polyhedral.

3. A method as claimed in claim 2, characterized in that said body is cuboidal.

4. A method as claimed in claim 3, characterized in that said body is a cube.

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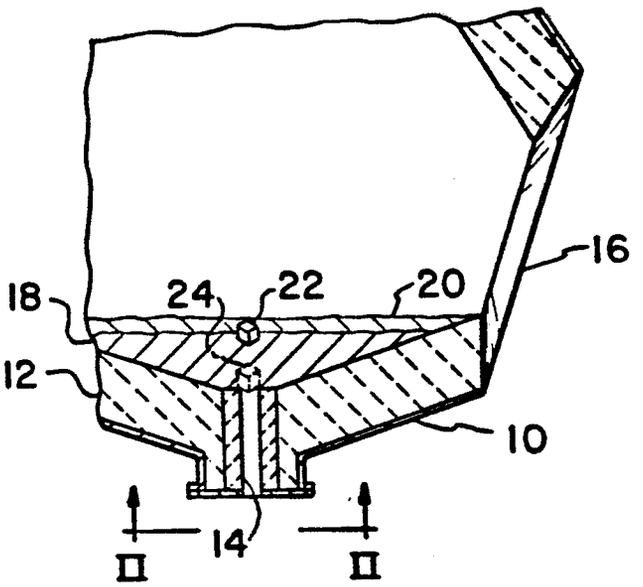


FIGURE 1

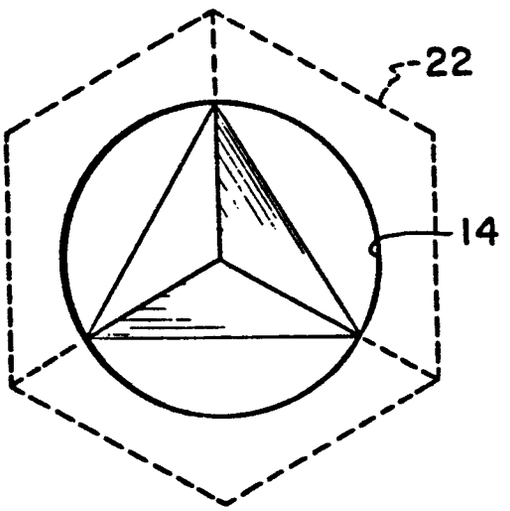


FIGURE 2

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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 30 2619

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	GB-A-1 142 439 (MANNESMANN) * Page 2, right-hand column *	1	C 21 C 5/46
Y	US-A-2 718 389 (R. PERRIN) * Column 2 *	1	
Y	Patent Abstracts of Japan vol. 1, no. 166, 27 December 1977 page 3686C77 & JP-A-52-107214	1	
P	Patent Abstracts of Japan vol. 6, no. 118, 2 July 1982 & JP-A-57-47814 (18.3.1982) (Cat. Y)	1	
A	Soviet Inventions Illustrated Week B 09, Section M 24 11 April 1979 & SU-A-590 340		TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	AT-B- 259 602 (VOEST)		C 21 C 5/46
A,D	JP-B-47 020 803		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	30-06-1983	SUTOR W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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