

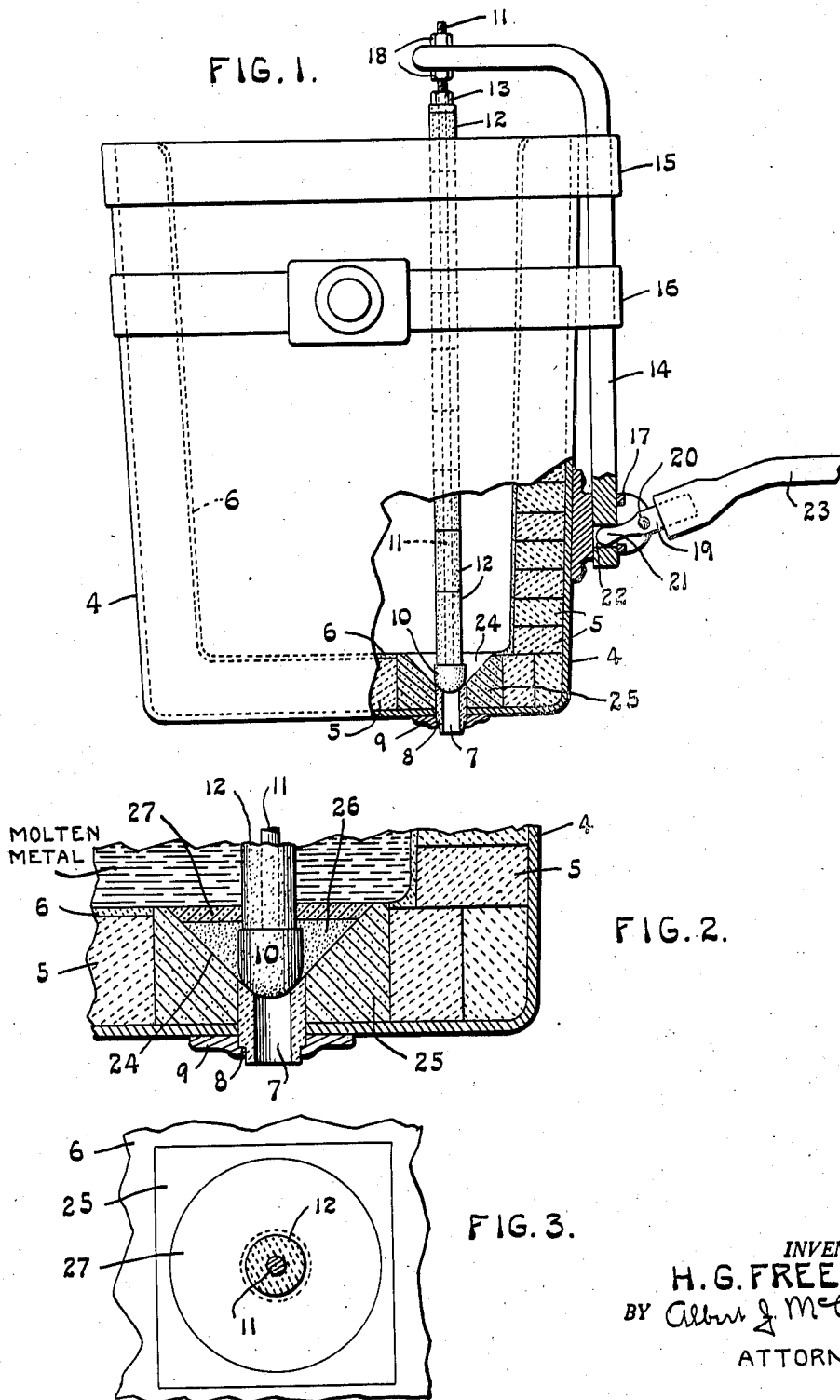
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LADLE FOR MOLTEN METAL AND METHOD OF SEALING CLOSURES THEREIN

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LADLE FOR MOLTEN METAL AND METHOD
OF SEALING CLOSURES THEREIN

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5 Claims. (Cl. 22—85)

This invention relates to ladles for molten metal and methods of sealing closures therein. Ladles of this kind are employed to carry molten metal from one location to another in a foundry or the like. The ladle is usually provided with an outlet nozzle in the bottom thereof and a stopper to control the flow of molten metal through the nozzle.

In many operations the molten metal is retained in the ladle for relatively long periods of time. For example in the treatment of certain types of metals, the molten metal may remain in the ladle for twenty to forty minutes. Under these and other conditions, it has been found that the molten metal around the stopper congeals or freezes, thereby preventing free movement of the stopper at the outlet nozzle.

Whenever, the molten metal congeals around the stopper, it is difficult, and dangerous, to remove the stopper from the nozzle. Frequently, in the efforts to free the stopper from the nozzle the operating mechanism for the stopper is broken, requiring relatively costly repairs. Moreover, whenever, a stopper is forcibly pulled away from congealed metal, this metal around the nozzle and on the stopper, tends to prevent effective closing of the stopper, thereby permitting the highly heated molten metal to continue to flow from the nozzle. This undesirable flow of molten metal not only results in waste, but is a source of serious danger to workmen adjacent to the ladle.

To my own knowledge, the foregoing conditions have existed in large scale commercial procedures for the past twenty years. An outstanding factor of this perplexing old problem appears in the fact that ordinary ladles contain many tons of highly heated molten metal, for example 60 tons, and the generally accepted methods of forcibly releasing the stoppers involve serious risks of personal injuries to the operators, as well as very substantial economic losses.

An illustration of a common practice appears in the use of a rod or bar inserted into the bottom of the discharge nozzle to forcibly displace the stopper from its seat. The lower end of this bar is held in contact with a rigid abutment, such as a large plank or the upper edge of a mold, while the crane which supports the ladle is operated to lower the ladle onto the rod or bar in the discharge nozzle. The weight of many tons is thus manipulated to push the stopper from its seat, and when this occurs, there is a sudden and uncontrolled rush of molten metal, under high pressure, through the discharge nozzle. A

large percentage of the molten metal is immediately splashed in almost all directions, instead of being discharged into a mold, and in actual practice, this commonly used expedient involves the presence of persons dangerously close to the uncontrolled stream of molten metal.

Therefore, an object of the present invention is to provide a simple and effective means for eliminating said hazards and losses. More specifically stated, an object is to create an entirely feasible and inexpensive method of positively excluding molten metal from the lower end portion of the stopper which contacts with the discharge nozzle. A further object is to produce a condition wherein the molten metal near the stopper is insulated from the relatively cool air in the discharge nozzle, thereby overcoming a condition which usually causes the molten metal to freeze or solidify at the stopper.

In the preferred form of the invention, these objects are accomplished by separating the lower end portion of the stopper from the hot zone of the molten metal, and forming a sealing crust above the nozzle and around the stopper, so as to positively exclude the molten metal from said end portion of the stopper.

With the foregoing and other objects in view, the invention comprises the novel method and the construction, combination and arrangement of parts hereinafter described and illustrated in the accompanying drawing. However, it is to be understood that the invention extends to modifications and variations within the scope of terms employed in the claims hereunto appended.

Fig. 1 is a side elevation, partly in section, illustrating a ladle for molten metal having a cavity at the bottom to receive a stopper.

Fig. 2 is a fragmentary section on a larger scale, showing the lower portion of a stopper sealed from the zone of the molten metal.

Fig. 3 is a top view of a sealing crust around the stopper, showing portions of the bottom of the ladle around the crust.

The ladle shown in the drawing comprises an outer metal shell 4, and a refractory brick lining 5 having a coating of refractory clay 6 on its inner face. As shown in Fig. 1 the ladle is open at the top to receive molten metal, such as steel. The bottom of the ladle is provided with a tubular nozzle 7 for the discharge of molten metal from the ladle.

The nozzle 7, which is preferably made of a refractory material, is located in an opening at the bottom of the ladle, as shown in Fig. 1. The lower portion of the nozzle 7 projects beyond the

shell 4 and is provided with a shoulder 8 seated on a plate 9. This plate 9 is secured to the bottom of the shell 4 to prevent downward displacement of the nozzle.

As an illustration of a means for controlling the discharge of molten metal through the nozzle 7, I have shown a long vertical stopper including a head 10 at the bottom movable into and out of engagement with a beveled seat at the upper end of the nozzle 7.

The stopper head 10 may be made of refractory material, such as graphite. This head 10 is secured to the lower end of a metal rod 11 which extends upwardly through the open top of the ladle. To protect the rod 11 from the intense heat of the molten metal, the portion of the rod located in the ladle is surrounded by a plurality of refractory sleeves 12. The upper portion of the rod 11 is threaded to receive a nut 13 which secures the sleeves 12 on the rod.

I will now refer to the operating means for moving the stopper head 10 into and out of engagement with the beveled seat at the inlet of the nozzle 7. A bar 14 is slidably mounted in guides 15, 16 and 17 which are secured to the outer face of the shell 4. The upper portion of the bar 14 extends laterally over the ladle, and is secured to the rod 11 by means of nuts 18. It will be understood that by imparting an upward motion to the bar 14, the refractory head 10 will be raised off its seat to permit the discharge of molten metal from the ladle. Thereafter, a downward movement of the bar 14 will again seat the head 10 to stop the flow of molten metal.

The means for raising and lowering the bar 14 includes a lever 19 pivoted at 20 to the lower guide 17. The lever 19 has a rounded end portion 21 extending into an opening 22 in the bar 14. The other end of the lever 19 is provided with a handle 23 for imparting motion through the lever 19 to the bar 14.

The ladle herein described is of a type in general use in foundries or the like, so I do not deem it necessary to show many of the usual details of construction.

It has long been known in this art that the molten metal in a ladle of the type herein disclosed has a tendency to solidify or freeze at the outlet nozzle, especially when the molten metal remains in the ladle for a relatively long period of time. This solidification of the metal at the outlet nozzle very frequently prevents or interferes with the proper operation of the stopper 10. Prior to my inventions, those skilled in the art have failed to successfully overcome this perplexing condition.

I have observed that under ordinary conditions, the relatively cool air entering through the outlet of the nozzle tends to cool the stopper head and upper portion of the nozzle, thereby tending to solidify the adjacent molten metal. I have also found that by creating the special conditions herein disclosed, I can positively eliminate the risk of solidifying metal at the bottom of the stopper.

In actual use of the invention in a full size ladle, having a capacity of about 60 tons of molten steel, I employed conveniently available, inexpensive, moist loam to form a flaring cavity 24 which extends upwardly from the top of the nozzle 7. A mass of this moist loam 25 was tamped into the bottom of the ladle, around the nozzle 7, and then shaped to form a beveled surface which flares upwardly from the beveled seat at the top of said nozzle. This shaped mass of

moist loam 25 was heated by a gas flame to remove moisture therefrom, while hardening the loam to provide a firm beveled face at the top, adapted to guide the stopper head 10 to its seat on the top of the nozzle 7. The stopper was then forced onto its seat to produce the condition shown in Fig. 1.

I then introduced a mass of dry sand 26 into the flaring cavity 24, around the lower end portion of the stopper. This dry sand may be gently packed into the cavity, merely to close excessive voids between the grains, and if any of the sand escapes through the discharge nozzle, the operator will adjust the stopper to avoid subsequent leakage of molten metal. Since this sand is dry, it does not require heating to remove moisture. However, the sand is loose, and in the absence of a firm confining closure, it would be scattered throughout molten metal which is thereafter forcibly introduced into the ladle. In other words, the dry sand 26 would be displaced from the cavity, and the molten metal would then contact directly with the lower portion of the stopper, at the top of the discharge nozzle 7.

Therefore, before introducing the molten metal into the ladle, I formed a sealing layer of relatively hard crust 27 on the mass of sand 26 and around the lower end portion of the long stopper. To produce this crust 27, I gently tamped the common, conventional, and inexpensive moist loam onto the dry sand, and smoothed the top face thereof, so as to provide a top surface approximately flush with the top of the flaring cavity 24, and likewise approximately flush with the usual refractory coating 6 in the bottom of the ladle. These operations produced a weak, moist seal, separating the lower end portion of the stopper from the hot zone of the molten metal.

I realized that the moisture in the seal would produce a sudden explosive force if exposed to highly heated molten metal, and that a suitable seal should be relatively hard and firm to resist the forces of the incoming molten metal, and that the seal should not be free to float in the molten metal. Therefore, the moist seal was heated for a few minutes by the commonly available gas flame, thereby converting it into a dry, hard sealing crust 27, nicely anchored in the top of the cavity 24 and around the lower portion of the stopper. Many tons of molten metal was then introduced into the ladle, without rupturing the firm crust 27. This crust positively separated the molten metal from the closure seat in the bottom wall of the ladle. It also resulted in an insulating value, tending to prevent the usual cooling which occurs when the molten metal lies adjacent to cool atmospheric air in the discharge nozzle 7.

Furthermore, the sealing crust did not interfere with the expected regulated discharge of molten metal from the ladle. This crust was very readily broken by imparting the usual forcible lifting movement to the stopper, so as to discharge the molten metal through the nozzle 7.

In the foregoing description I have referred to numerous specific conditions actually employed in successful large scale tests, wherein I employed the most convenient and inexpensive materials available at the place where the tests were conducted. However, it is to be understood that the scope of the patent is not limited to these specific conditions. For example, any suitable means may be employed to form a discharge port, instead of using the tubular nozzle 7, and the cavity 24 can be formed in any suitable manner

and may be of any desired shape. Instead of using dry sand at 26, one may more conveniently employ loose dry ashes, dust, dirt, or other suitable comminuted or granular material, surrounding head 10 of the stopper. Such material, or other heat resisting material, sealed in a cavity around the closure, is very desirable but not essential to success of broader aspects of the present invention.

The sealing crust is a more important factor, as it is the element which insures a separation of the closure seat from the hot zone of the molten metal. This crust can be very economically formed by the usual moist loam without resorting to the trouble and expense of arranging for special materials. However, so far as the present invention is concerned, it could be formed by any other suitable heat-resisting refractory material, including graphite, mortar, Portland cement, or mixtures of other materials, preferably but not essentially applied to the ladle in a plastic state to form a close fitting moist seal, and then baked to form a dry, hard crust between the closure seat and the hot zone of the molten metal.

I claim:

1. In the art of transmitting molten metal through a ladle having a discharge port at the bottom and a stopper provided with a closure at the bottom to be seated at said discharge port, the method of separating the lower end portion of said stopper from the hot zone of the molten metal which comprises forcing said lower end portion of the stopper onto its seat at said discharge port, forming a seal of moist plastic material at the bottom of the ladle, above said seat and around said stopper, heating said plastic material to remove moisture therefrom and at the same time convert it into a relatively hard crust, thereafter pouring molten metal into the ladle, said crust being between the hot zone of the molten metal and the lower portion of the stopper, and subsequently breaking said crust by imparting a lifting movement to said stopper, so as to release the molten metal.

2. In the art of transmitting molten metal through a ladle having a discharge port at the bottom and a manually operated stopper provided with a closure at its lower end to close the top of said discharge port, the method of separating the lower end portion of said stopper from the hot zone of the molten metal which comprises, forming in the bottom of said ladle a cavity extending upwardly from said discharge port, forcing the lower end of said stopper onto a seat at the upper end of said discharge port, introducing a mass of dry particles into said cavity and around the lower end portion of said stopper, forming a layer of moist loam on said mass of dry particles and around the stopper, to seal said dry material and the lower portion of the stopper in said cavity, heating said layer of moist loam to convert it into a sealing crust, thereafter pouring molten metal into the ladle, and subsequently breaking said sealing crust by imparting a lifting movement to said stopper, so as to discharge molten metal through said discharge port.

3. In the art of transmitting molten metal through a ladle having a discharge nozzle at the

bottom and a manually operated stopper provided with a closure at its lower end to close the top of said nozzle, the method of separating the lower end portion of said stopper from the hot zone of the molten metal which comprises, forming in the bottom of said ladle a cavity immediately above said nozzle, forcing the lower end of said stopper onto the upper end of said nozzle, introducing a mass of separating material into said cavity and around the lower end portion of said stopper, forming a layer of moist plastic material on said mass of separating material and around the stopper, to seal said separating material and the lower portion of the stopper in said cavity, heating said layer of moist plastic material to convert it into a sealing crust, thereafter pouring molten metal into the ladle, and subsequently breaking said sealing crust by imparting a lifting movement to said stopper, so as to discharge molten metal through said nozzle.

4. In the art of transmitting tons of molten metal through a ladle having a discharge nozzle at the bottom and a manually operated stopper provided with a closure head at its lower end to close the top of said nozzle, the method of separating the lower end portion of said stopper from the hot zone of the molten metal which comprises, tamping a mass of moist loam into the bottom of said ladle and around said nozzle, shaping the top of said tamped moist loam to form a flaring cavity extending upwardly from the top of said nozzle, heating said moist loam to remove moisture therefrom, forcing the lower end of said stopper onto the upper end of said nozzle, packing a mass of dry granular material into said flaring cavity and around the lower end portion of said stopper, forming a layer of moist loam on said mass of dry granular material and around the stopper, to seal said dry material and the lower portion of the stopper in said cavity, heating said layer of moist loam to convert it into a sealing crust, thereafter pouring tons of molten metal into the ladle, and subsequently breaking said sealing crust by imparting a forcible lifting movement to said stopper, so as to discharge molten metal through said nozzle.

5. In an apparatus for conveying tons of molten metal, a ladle having a discharge nozzle at the bottom, a manually operated stopper provided with a closure at its lower end to close the top of said nozzle, and means for sealing the lower end portion of said stopper from the hot zone of the molten metal which comprises, a flaring seat extending upwardly from the top of said nozzle to form a flaring cavity above the nozzle, the lower end of said stopper being seated upon the upper end of said nozzle, a mass of dry granular material located in said flaring cavity and around the lower end portion of said stopper, and a hardened crust of refractory heat-resisting material located on said mass of dry granular material and around the stopper, to seal said dry material and the lower portion of the stopper in said cavity, said stopper being movable upwardly to break said crust and release the sealed contents of said flaring cavity.

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