

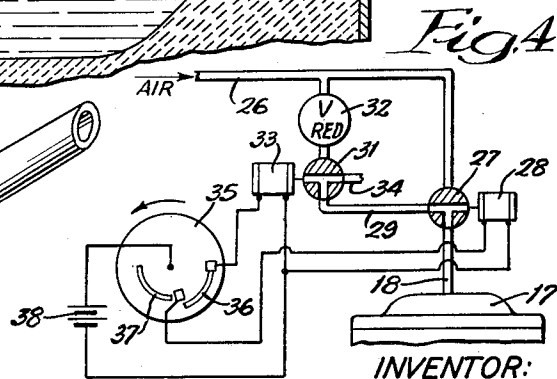
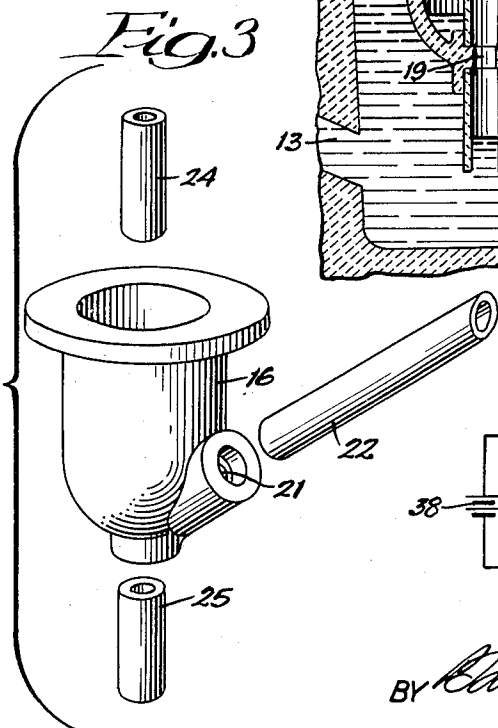
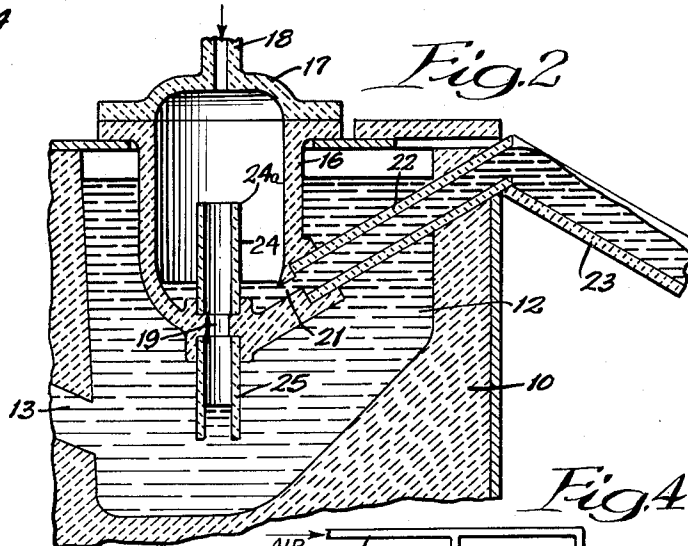
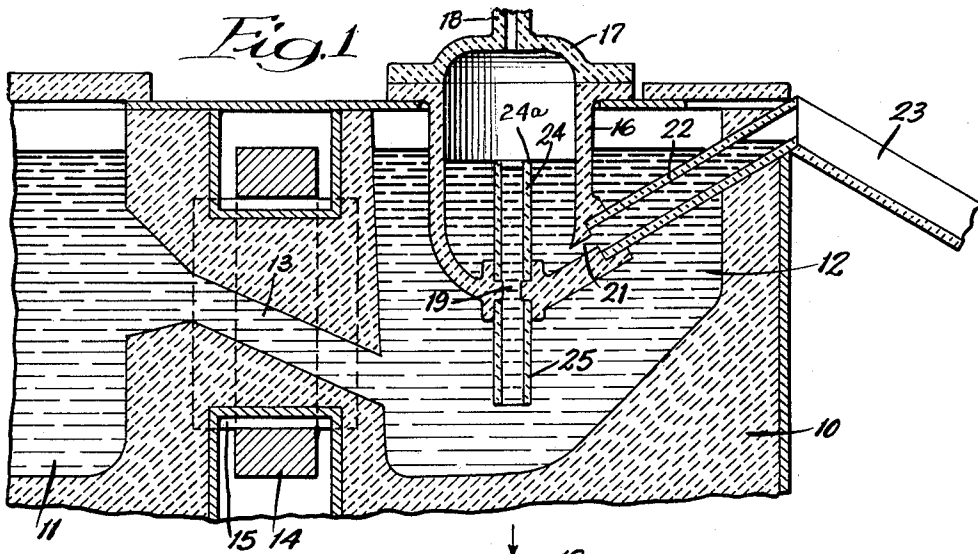
Aug. 12, 1958

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2,846,740

FURNACE LADLING APPARATUS

Filed Sept. 17, 1956



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FURNACE LADLING APPARATUS

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Application September 17, 1956, Serial No. 610,077

7 Claims. (Cl. 22—79)

This invention relates to furnace ladling apparatus, and more particularly to apparatus for discharging controlled amounts of molten metal from a furnace.

Heretofore it has been proposed to discharge or ladle molten metal from a furnace by applying gas or air pressure to the surface of the metal in the furnace chamber or in a crucible in the furnace chamber to force the metal through an upwardly extending discharge tube projecting out through the upper portion of the furnace chamber. When a separate crucible is used, or when the furnace is of the multiple chamber type, the gas pressure tends to force the metal from the crucible or ladling chamber of the furnace back into the furnace. The use of valving to prevent such flow is difficult and is not satisfactory, and the presence of backflow tends to vary the quantity of metal discharged through the discharge passage.

Furthermore, all such apparatus is subject to a varying rate of discharge responsive to changes in the level of molten metal in the furnace. Attempts to overcome this difficulty heretofore have resulted in complex systems which are expensive to build and difficult to maintain in proper operation.

It is accordingly one of the objects of the present invention to provide furnace ladling apparatus which discharges accurately measured quantities of molten metal at each operation without the use of valves or other moving parts.

Another object is to provide furnace ladling apparatus in which the quantity of molten metal discharged at each operation is uniform regardless of variations in the level of molten metal in the furnace.

Still another object is to provide furnace ladling apparatus in which the metal is discharged from a separate crucible in the furnace chamber, and backflow of metal from the crucible to the furnace chamber is prevented without the use of valves or other moving parts.

According to one feature of the invention, a vertical passage extends downwardly from the inlet opening to the crucible to trap metal in the crucible which is forced out through the discharge tube whose inlet end is below the inlet opening. The passage is of such length, or may be provided with a downward extension, to produce sufficient head to prevent backflow of pressure to the furnace chamber during the discharge operation.

According to another feature, the inlet opening to the crucible is of smaller diameter than the tube to limit bubbling or violent agitation of the metal as it flows into the crucible.

A further object is to provide a furnace ladling apparatus in which the supply of fluid pressure to the crucible is controlled automatically in a cycle by which the chamber is first vented to permit metal to flow into it, second, is subjected to a low pressure sufficient to reduce the metal level to the top of the filling tube, and third, is subjected to a high pressure to force out the desired quantity of molten metal.

The above and other objects and features of the inven-

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tion will be more readily apparent from the following description when read in connection with the accompanying drawing, in which:

Figure 1 is a partial sectional view of a furnace equipped with ladling apparatus embodying the invention;

Figure 2 is a partial section similar to Figure 1 showing the apparatus during a discharge operation;

Figure 3 is a disassembled perspective view of the crucible; and

Figure 4 is a diagrammatic view of the control circuit.

While the ladling apparatus of the present invention can be used with any desired type of melting or holding furnace, it is illustrated in Figures 1 and 2 as applied to a furnace of the type more particularly disclosed in the patent to Lillienberg, No. 2,648,715. This furnace is a double chamber induction furnace having a ceramic body 10 formed with a charging chamber 11 and a pouring or ladling chamber 12. The chambers are connected by two or more submerged channels 13 which are threaded by a primary core 14 carrying a winding 15 which is energized by alternating current to induce a secondary melting current in the metal in the chambers and channels. In normal operation of a furnace of this type the metal to be melted or held is charged in the chamber 11 and molten metal is discharged from the chamber 12.

The ladling apparatus of the present invention comprises a crucible 16 made of refractory material and supported in the upper part of the pouring chamber 12 to project downwardly into the molten metal therein. The top of the crucible is closed by a cover 17 to which an air or gas connection 18 extends to supply air or gas under pressure to the upper part of the crucible. In its lower part the crucible is formed with a relatively restricted opening 19 and a discharge opening 21 extending through one side thereof. Metal in the crucible is adapted to be forced out the discharge opening by gas or air pressure and to flow through a discharge tube 22 which communicates with the discharge opening 21 and extends upwardly to project through the side wall of the furnace chamber 12 at a level above the normal level of molten metal in the chamber. Molten metal flowing through the discharge tube 22 may flow into a trough 23 or may be forced directly into a mold which is placed in communication with the outer end of the discharge tube.

To control the amount of metal forced through the discharge tube and to prevent backflow of pressure to the chamber 12 from the crucible, a vertical passage shown as a tube 24 communicating with the opening 19 extends upwardly into the crucible to a level below the normal level of molten metal in the chamber 12 and terminates in an inlet opening 24a in the crucible above the level of the discharge opening 21. The tube 24 is preferably of larger diameter than the opening 19 to minimize boiling or agitation of the molten metal as it flows through the opening 19 and tube into the crucible. In some cases where the crucible is relatively shallow, a second tube 25 may be provided communicating with the opening 19 and extending downward therefrom into the chamber 12 to a point near the bottom thereof. The tube 25 provides a substantial head of molten metal between the level of metal in the chamber 12 and the upper part of the crucible, so that pressure in the crucible cannot blow back through the tubes into the chamber 12.

In operation of the apparatus with molten metal in the chambers 11 and 12 substantially to the level shown, and with no pressure present in the upper part of the crucible, metal will flow by gravity from the chamber 12 through the tubes 24 and 25 and the opening 19 into the crucible to the same level as the metal in the chamber 12. Pref-

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erably, the length of the tube 24 is selected to be slightly below the normal metal level and about 3 inches below the metal level in the embodiment shown and described. The furnace is normally so operated that its level will never fall below the inlet opening 24a and will normally be approximately 4 inches below the upper end of the discharge tube 22.

After the crucible is filled, a relatively low air or gas pressure is supplied thereto through the conduit 18 to depress the level of metal in the crucible to or slightly below the inlet opening 24a. This condition is illustrated in Figure 1 wherein the level in the crucible is shown at the inlet opening 24a and below the level in chamber 12, while the level in the discharge tube 22 is above the level in the chamber 12 but below the upper end of the discharge tube.

In a practical operating furnace it has been found that this low pressure may satisfactorily be 6 ounces of pressure which with aluminum will produce a variation in head of $3\frac{3}{4}$ inches. Thus when the 6 ounce pressure is applied, the difference in level between the inside of the crucible and the discharge tube 22 will be $3\frac{3}{4}$ inches, and the difference in level between the metal inside the tube 24 and in the chamber 12 will be $3\frac{3}{4}$ inches. It will be seen that even though there are fluctuations in the level in the chamber 12, the crucible 16 will always be filled to exactly the same level, and the metal will stand in the discharge tube 22 at exactly the same level, even though the level within the tube 24 and in the chamber 12 may fluctuate.

The apparatus is now ready for a discharge operation and a higher discharge pressure on the order of 20 ounces is applied to the crucible through the conduit 18. This pressure will force the metal trapped within the crucible by the tube 24 out through the discharge tube 22, and since there is no blow-back of pressure, as explained hereinafter, and there is precisely the same quantity of metal in the crucible and discharge tube at precisely the same level during each operation, a very accurate quantity of metal may be discharged by controlling the value of the discharge pressure and the time it is effective.

It has been found, for example, in a practical operation that by utilizing 20 ounces of pressure and controlling the time of its application, accurately measured quantities of molten metal can be discharged at each operation varying in quantity from on the order of 1 pound to 30 pounds or more. During the discharge operation the metal level within the vertical passage formed by the tubes 24 and 25 will be depressed, as illustrated in Figure 2, but the vertical length of this passage is made great enough so that the pressure cannot force the metal completely out of the passage due to the head between the bottom of the passage and the level of metal in the chamber 12. There is thus no escape of pressure, and the interior of the crucible is always subjected to precisely the same discharge pressure during a ladling operation.

It will be understood that the crucible is never emptied to the point that the level therein will fall below the discharge opening 21 so that the air or gas can never blow out the discharge tube. As long as the discharge pressure in the crucible is less than the head between the level in the chamber and the lower or inlet end of the passage defined by the tubes 24 and 25, the pressure cannot blow back through the inlet passage and into the chamber. The pressure must, of course, be high enough to force the metal from the crucible out the discharge tube 22 and may be high enough to produce a relatively rapid flow as long as it is not high enough to blow back through the inlet passage. Thus for many furnaces the tube 25 may be omitted entirely, its use being desirable only when a high discharge pressure is used to produce a rapid discharge of metal.

Figure 4 illustrates diagrammatically a control circuit for effecting automatically the cycle of operations as described above. As shown in this figure, the conduit 18

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is connected to a source of air or gas under pressure indicated at 26 and which may be regulated to the discharge pressure of 20 ounces. The source is connected to the conduit 18 through a three-way valve 27 which is operated by a solenoid 28 to connect the conduit 18 either to the source 26 or to a by-pass conduit 29. The by-pass conduit is connected through a three-way valve 31 and a reducing valve 32 to the source 26. The three-way valve 31 is operated by a solenoid 33 to connect the pipe 29 either to an atmospheric vent 34 or to the reducing valve 32.

The solenoids 28 and 33 are controlled in an automatic cycle by a cycle switch which may be of any desired conventional construction, but which is shown as including a disc 35 driven counter-clockwise at constant speed and having conductive segments 36 and 37 thereon. The disc is connected to a source shown as a battery 38, although the source would normally be a transformer or the like, one side of which is connected to the solenoids 28 and 33. The other sides of the solenoids are connected to brushes which contact the strips 36 and 37 respectively. As the disc turns, a circuit will first be completed through the solenoid 33 to move the three-way valve 31 90° from the illustrated position to connect the reducing valve 32 through the three-way valve 27 to the crucible.

The reducing valve 32 may be adjusted to produce the desired low pressure such as 6 ounces to accomplish the first portion of the cycle as described above. As the disc continues to turn, the solenoid 33 will be de-energized to return the valve 31 to the position shown, and substantially simultaneously the solenoid 28 will be energized to turn the valve 27 to a position in which it connects the source 26 directly to the crucible. At this time full discharge pressure is applied to the crucible, and the metal therein will be discharged as described above. Upon further turning of the disc, the solenoid 28 will be de-energized and the crucible will be vented through the three-way valves 27 and 31 to allow metal to flow from the chamber 12 into the crucible. At this time the apparatus is in condition for a second cycle.

While one embodiment of the invention has been shown and described in detail, it will be understood that this is illustrative only and is not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. Furnace ladling apparatus comprising a hollow chamber to contain molten metal, a crucible in the chamber, means defining a vertically extending passage projecting at its lower end into the molten metal and terminating at its upper end in an inlet opening in the crucible above the bottom thereof, means defining an outlet opening in the crucible below the inlet opening, a discharge tube communicating with the outlet opening and extending upward therefrom to a level above the normal level of molten metal in the chamber, and means to apply fluid pressure to the upper part of the crucible to force metal in the crucible beneath the inlet opening through the outlet opening and discharge tube, said passage being of sufficient vertical height that fluid under the applied pressure will not blow past the molten metal therein.

2. The construction of claim 1 in which the passage includes a portion of reduced cross-sectional area below the inlet opening.

3. Furnace ladling apparatus comprising a furnace body defining a chamber to hold molten metal, a crucible fitting into the chamber to be partially immersed in the molten metal therein, the crucible having an inlet opening above its bottom, and a discharge opening below the inlet opening, a discharge tube communicating with the discharge opening and extending upwardly therefrom to a level above the normal level of molten metal in the chamber and discharging outside of the chamber, a tube communicating with the inlet opening and extending

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downward within the crucible through the lower part thereof, and means to apply fluid under pressure to the upper part of the crucible to force molten metal therein out the discharge tube, the last named tube being of such a vertical height that the head of molten metal above its lower end will be greater than the applied fluid pressure.

4. Furnace ladling apparatus comprising a furnace body defining a chamber to hold molten metal, a crucible extending down into the chamber to be partially immersed in the molten metal therein, the crucible having an inlet opening above the bottom of the crucible and a discharge opening below the inlet opening, a discharge tube communicating with the discharge opening and extending upward therefrom at an angle to horizontal to a level above the level of molten metal in the chamber and discharging outside of the chamber, means defining a passage communicating with the inlet opening and extending downward therefrom to a level below the level of the discharge opening, a cover for the crucible, and means to supply gas under pressure to the upper part of the crucible to force molten metal therein out the discharge tube.

5. The construction of claim 4 in which the passage includes a portion of restricted cross sectional area below the inlet opening.

6. Furnace ladling apparatus comprising a furnace body defining a chamber to hold molten metal, a crucible extending down into the chamber to be partially immersed in the molten metal therein, the crucible having an inlet opening above its bottom and a discharge opening below the inlet opening, a discharge tube communicating with the discharge opening and extending upward therefrom to a level above the level of molten metal in the chamber and discharging outside of the chamber, means defining a passage communicating with the inlet opening and extending downward therefrom into the molten metal in the chamber, connections from the upper part of the crucible to sources of two different fluid pressures, one pressure being sufficient to reduce the level of molten metal in the crucible to substantially the level of the inlet opening and the other being sufficient to force molten metal out the discharge tube without being sufficient to force the metal level below the bottom of

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said passage, and control means to vent the crucible or to connect it selectively to said sources.

7. Furnace ladling apparatus comprising a furnace body defining a chamber to hold molten metal, a crucible extending down into the chamber to be partially immersed in the molten metal therein, the crucible having an opening in its bottom and a discharge opening near its bottom, a discharge tube communicating with the discharge opening and extending upward therefrom to a level above the level of molten metal in the chamber and discharging outside of the chamber, a tube communicating with the inlet opening and extending upward therefrom in the crucible and terminating in an inlet opening at a level below the normal level of molten metal in the chamber, a second tube communicating with the inlet opening and projecting downward therefrom into the chamber, connections from the upper part of the crucible to sources of two different fluid pressures, one pressure being sufficient to reduce the level of molten metal in the crucible to substantially the level of the inlet opening and the other being sufficient to force molten metal out the discharge tube without being sufficient to force the metal level below the bottom of the last named tube, valves for venting the crucible and for connecting it selectively to said sources, and a cyclic controller for the valves operating through a cycle in which the valves first vent the crucible, second connect the crucible to the source of said one pressure, and third connect the crucible to the source of said other pressure.

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