Jan. 18, 1966 G. W. HOLZ ET AL 3,229,337

FURNACE LADLING APPARATUS

Filed Sept. 24, 1962

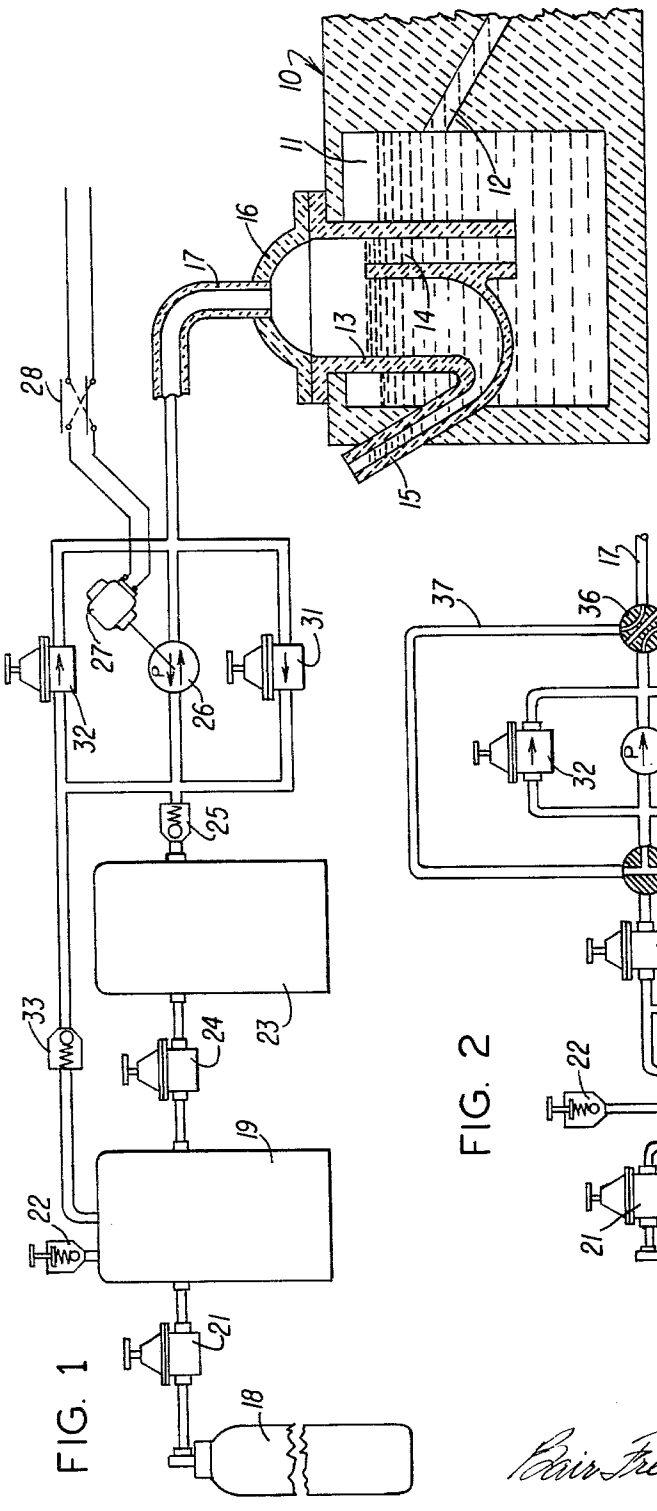


FIG. 1

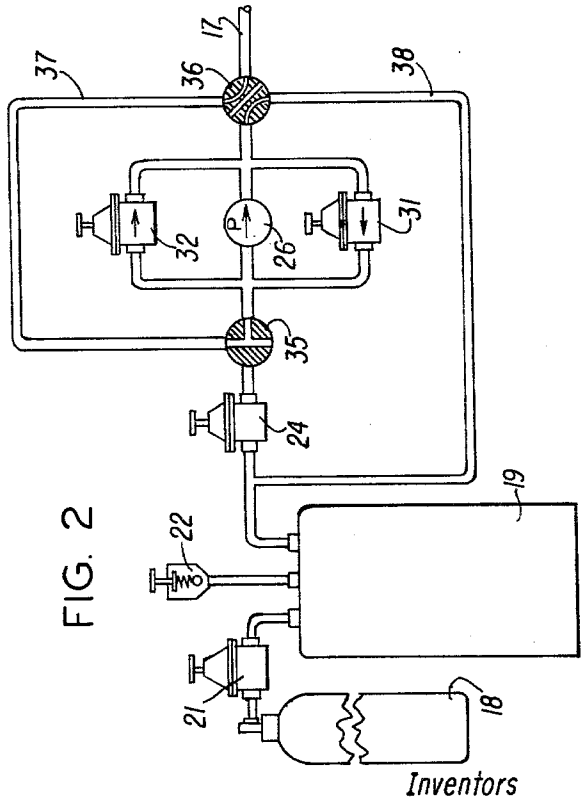


FIG. 2

Inventors
George W. Holz
Hugh E. Pollard

Fair Freeman & McIvaine
Attys.

United States Patent Office 3,229,337 Patented Jan. 18, 1966

3,229,337

FURNACE LADLING APPARATUS

George William Holz, Chicago, and Hugh E. Pollard, Franklin Park, Ill., assignors to Lindberg Engineering Co., a corporation of Illinois

Filed Sept. 24, 1962, Ser. No. 225,706
3 Claims. (Cl. 22—79)

This invention relates to furnace ladling apparatus and more particularly to apparatus for discharging measured shots or charges of molten metal from a furnace chamber.

Apparatus has heretofore been proposed for ladling molten metal from a furnace by applying gas under pressure to the surface of the molten metal in an enclosed chamber in the furnace to force the molten metal from the chamber through a discharge tube to a point outside of the furnace. Such apparatus is typified by that more particularly disclosed and claimed in the patent to Edstrand No. 2,816,334. When the metal is not highly reactive such as aluminum or similar metals or alloys, air may be used as the gas. An oxide film will be formed over the surface of the molten metal under these conditions but since there is a minimum of agitation of the metal the film does not grow excessively and normally is not objectionable.

For use with highly reactive molten metals such as magnesium or in cases where an extremely high degree of purity is required air or other gas which reacts with the molten metal cannot be used. Due to the expense of non-reactive gases and predisposition also to contamination of the atmosphere it is not practical to use a non-reactive gas in apparatus which vents the gas or wastes it to atmosphere.

It is accordingly one of the objects of the present invention to provide furnace ladling apparatus in which a non-reactive gas is employed and is circulated in a closed system so that it may be used indefinitely with a minimum of waste or contamination.

Another object is to provide furnace ladling apparatus in which the gas is pumped from a storage tank into the furnace chamber during a discharging operation and is pumped from the furnace chamber into a storage tank during the filling operation.

According to a feature of the invention the gas under an intermediate pressure is supplied directly from a storage tank to the furnace through the pump when the pump is stopped.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawing in which:

FIGURE 1 is a diagrammatic view with parts of the furnace shown in section of a furnace ladling apparatus embodying the invention; and

FIGURE 2 is a partial diagram showing an alternative system.

The apparatus as shown is adapted to ladle molten metal from a furnace indicated generally at **10** which is provided with a discharge chamber **11** normally open to atmosphere at its top. In the case of highly reactive metals the space above the molten metal in the chamber **11** may be kept filled with an inert atmosphere at a predetermined low pressure approximating atmospheric pressure through connection to a suitable source of such atmosphere not shown. In the furnace illustrated the chamber **11** forms one chamber of a two chamber furnace and may be connected to the other chamber through channels **12**. An alternating current coil may thread the channels **12** to induce a flow of current through the metal therein, thereby to heat the metal as is well understood in the art. It will further be understood that the exact type of furnace employed forms no part of the present

invention and that the invention may be used in connection with any conventional type of furnace.

For discharging the molten metal from the chamber **11** a crucible **13** is mounted in the chamber and receives metal therefrom through a vertically elongated inlet passage **14** opening at its lower end in the chamber below the level of molten metal therein and opening at its upper end into the upper part of the crucible. A discharge tube **15** communicates at its lower end with the lower part of the crucible and extends upwardly to discharge at a point outside of the furnace body above the normal maximum level of molten metal in the furnace chamber. The top of the crucible is closed by a cover **16** through which a conduit **17** communicates with the interior of the crucible to supply gas under pressure thereto.

In the normal operation of the furnace the crucible may first be subjected to a vacuum to draw molten metal from the furnace chamber through the inlet passage into the crucible to a level above the upper end of the inlet passage. The chamber is then subjected to an intermediate pressure which may be atmospheric or slightly above atmospheric to depress the level in the inlet passage to a point slightly below its upper end as shown in FIGURE 1, leaving the crucible filled to the top of the inlet passage. Thereafter a higher discharge pressure may be applied to force the metal in the crucible through the discharge conduit **15** without, however, being high enough to blow past the molten metal in the inlet passage **14**.

According to the present invention an inert gas is circulated in a closed system to produce the various pressure conditions in the crucible which are desired therein so that the gas may be reused. The exact gas employed will depend upon the metal to be discharged but is selected to be non-reactive with respect to the metal. In the case of magnesium, argon gas is the most satisfactory gas known at the present time although other gases could perhaps be used. In the case of aluminum, any non-oxidizing gas can be used such, for example, as argon, nitrogen or various combustion gases. In the case of other metals a gas may be selected which will not react with the molten metal.

As shown in FIGURE 1 the gas is initially supplied from a storage tank **18** containing gas under relatively high pressure. Gas from the tank **18** flows therefrom to a high pressure reservoir or tank **19** through a reducing valve **21** which is adjusted to maintain the gas in the tank **19** under the desired pressure. A relief valve **22** may be connected to the tank **19** to prevent accumulation of excessive pressure therein. The high pressure tank **19** is connected to a low pressure storage tank **23** through a reducing valve **24**. The reducing valve **24** may be adjusted to maintain the desired intermediate pressure in the tank **23** which may be atmospheric pressure or a pressure slightly above atmospheric as explained above. The low pressure tank **23** is connected through an outwardly open check valve **25** to one side of a reversible pump **26** which is driven by a reversible electric motor **27**. The motor **27** may be supplied with power through a reversing switch **28** by means of which its direction of operation is determined. The other side of the pump is connected to the conduit **17** as shown.

The maximum pressure discharged by the pump **26** is determined by a regulator **31** which bypasses the pump to permit flow from the conduit **17** to the side of the pump adjacent to the check valve **25** but which will block flow in the opposite direction. The regulator **31** is adjusted to limit the pressure developed by the pump to the maximum discharge pressure desired in operation of the ladling apparatus so that excessive pressure cannot be developed. The pump is also bypassed by a similar regulator **32** which will pass gas in the direction opposite

to the regulator **31** and which functions to limit the maximum degree of vacuum which can be developed in the crucible by the pump. The conduit between the check valve **25** and the pump is also connected through an outwardly open check valve **33** to the high pressure storage tank **19**.

In operation of the apparatus with the system filled with inert gas from the tank **18**, the pump will first be operated in a direction to create a flow from right to left therethrough to create a vacuum in the crucible. High pressure gas discharged from the pump will flow through the check valve **33** into the high pressure storage tank **19** and the regulator **32** will limit the pressure differential created by the pump so that an excessive vacuum cannot be produced in the crucible. At this time the crucible will be filled with molten metal from the furnace chamber.

With the crucible filled to the desired level above the top of the inlet passage the pump will be stopped through control mechanism not shown. When stopped the pump, while preferably of the positive displacement type, has enough leakage so that the pressure in the crucible will equalize with the pressure in the low pressure storage tank to create within the crucible the desired intermediate pressure. This pressure which may be atmospheric or very slightly above atmospheric will depress the level in the inlet passage **14** to a point below the upper end thereof as shown in the drawing so that the apparatus is ready for a discharge operation.

For discharge the pump is reversed to create a flow from left to right. At this time the pump receives gas from the low presure storage tank and forces the gas into the crucible at the relatively high discharge pressure to force molten metal in the crucible out through the discharge tube.

In the event of gas leakage from the system, as for example by seeping through the crucible or the joints therein, the loss of gas will be made up from the supply tank **18** so that the system will be maintained full at all times to the desired pressure values. If there should be seepage into the system which would tend to create an excessive pressure therein the relief valve **22** will open and reduce the pressure to the desired value. It will be seen, therefore, that under normal operating conditions the gas may be reused indefinitely and will be subject to contamination due only to the slight seepage into the system which may occur. If the gas does become contaminated over a period of time due to such seepage, the system may be purged and refilled with fresh gas although this should be necessary only at extremely long intervals.

FIGURE 2 illustrates a simplified system which may be used under certain conditions for the same purposes as the system of FIGURE 1. For the purposes of brevity of description parts in FIGURE 2 corresponding to like parts in FIGURE 1 have been indicated by the same reference numerals. In the construction shown in FIGURE 2 only one storage tank **19** is employed which is connected to the supply tank **18** through a reducing valve **21** and to a relief valve **22** so that the desired high pressure will be maintained in the tank. The tank is connected through a reducing valve **24** and a three-way valve **35** to the left side of the pump **26** and the right side of the pump **26** communicates with a four-way valve **36**. A conduit **37** connects the valves **35** and **36** and a second conduit **38** connects the valve **36** to the tank **19** with the conduit **17** also communicating with the valve **36**. In this case the pump **26** is not reversible and functions at all times to create a flow from left to right therethrough as indicated.

To produce a vacuum in the crucible the valves **35** and **36** are adjusted to the position shown in which the

conduit **17** communicates through the valves with the inlet side of the pump and the outlet side of the pump is connected through the valve **36** and conduit **38** to the storage tank **19**. Under these conditions the pump will produce a vacuum in the crucible to fill it with molten metal.

At the completion of the filling operation the valve **35** is turned through 90° clockwise to connect the inlet side of the pump through the regulator **24** to the storage tank **19**. At the same time the valve **36** is turned through 45° counterclockwise to connect the outlet of the pump to the conduit **17**, and the pump is stopped. At this time the crucible will be subjected to an intermediate pressure determined by the setting of the regulator **24** due to leakage through the stopped pump to create a condition in the crucible such as that illustrated in FIGURE 1. The crucible is now ready for a discharge operation. Without re-adjusting the valves the pump is now started up to draw gas from the storage tank **19** through the reducing valve **24** and to discharge the gas through the valve **36** and the conduit **17** into the crucible to produce the desired relatively high discharge pressure. At this time the molten metal in the crucible will be forced therefrom through the discharge tube **15** and at the completion of the discharging operation the apparatus is ready for a further cycle.

While two embodiments of the invention have been shown and described in detail, it will be understood that these are illustrative only and are 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 means defining a chamber adapted to hold molten metal and closed at its top, the chamber having an inlet for molten metal, a discharge tube communicating with the lower part of the chamber and discharging outside of the chamber above the maximum level of molten metal therein, a first storage tank to hold a gas under relatively high pressure which is non-reactive with the molten metal, a second storage tank connected to the first storage tank to receive gas therefrom, and including regulating means to maintain a lower pressure in the second storage tank than in the first storage tank, pump means connected to the storage tanks and the chamber, and control means to establish one condition in which the inlet of the pump means communicates with the chamber and the outlet with the first storage tank and a second condition in which the inlet of the pump means communicates with the second storage tank and the outlet with the chamber.

2. The apparatus of claim **1** in which the pump means is a reversible pump having one side thereof connected to the storage tanks respectively through oppositely opening check valves.

3. The apparatus of claim **1** in which the second storage tank communicates with the chamber through the pump means when it is stopped to supply an intermediate pressure to the chamber.

References Cited by the Examiner

UNITED STATES PATENTS

2,149,633	3/1939	Schnoor	222—399
2,816,334	12/1957	Edstrand	22—79
2,819,059	1/1958	Breymeier	266—38
2,846,740	8/1958	Edstrand	22—79
3,050,794	8/1962	Holz	22—79
3,058,180	10/1962	Port et al.	22—79

J. SPENCER OVERHOLSER, *Primary Examiner.*

MARCUS U. LYONS, WILLIAM J. STEPHENSON, *Examiners.*