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PRESSURE POURING CONTROL ARRANGEMENT

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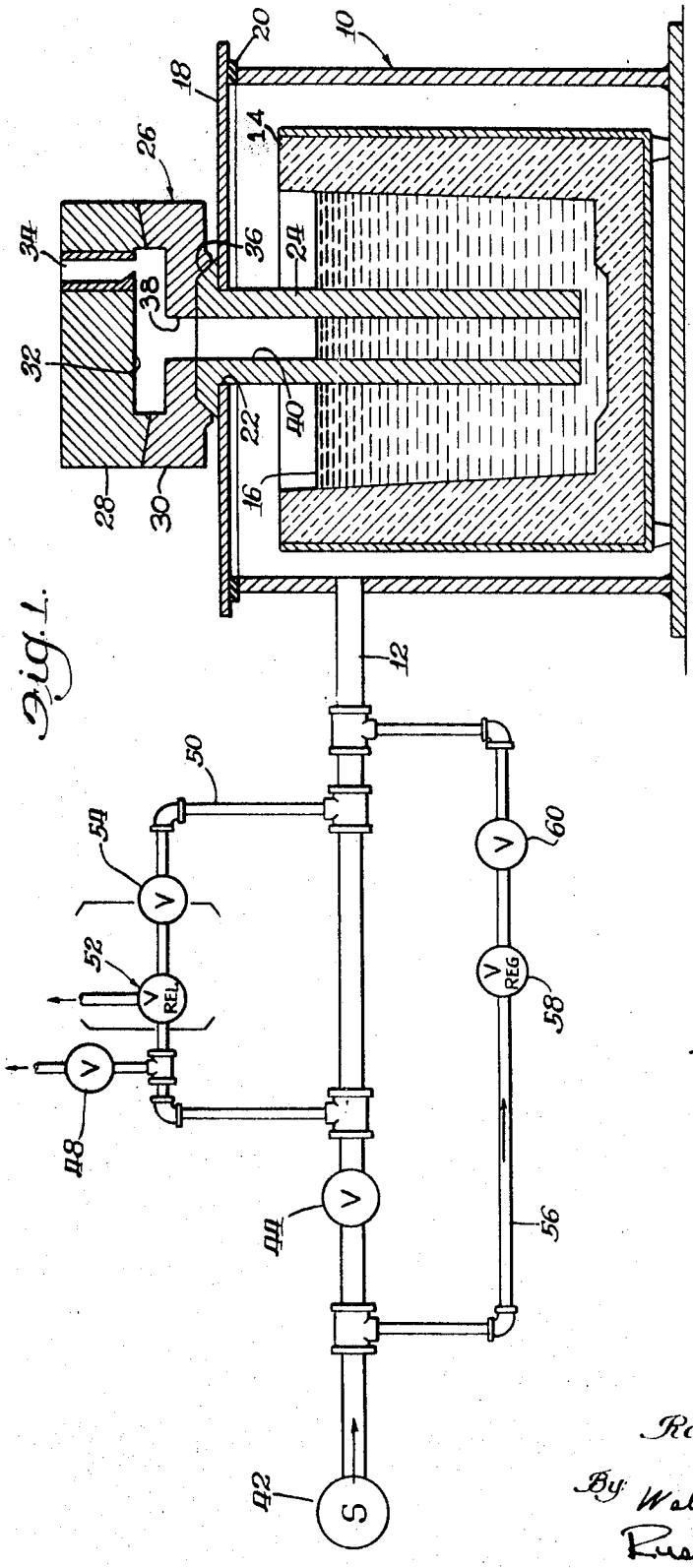


Fig. 1.

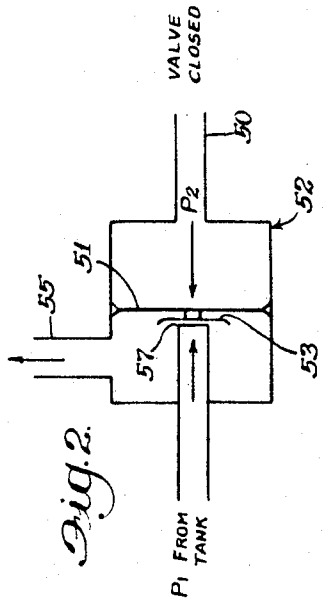


Fig. 2.

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PRESSURE POURING CONTROL ARRANGEMENT

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ABSTRACT OF THE DISCLOSURE

A valve system is used in conjunction with a pressure casting operation to maintain a constant pressure and hold the molten metal in the mold. Additional pressure is added to compensate for leaks and a pressure relief valve is provided to bleed off pressure in excess of that required to fill the mold.

This invention relates to pressure casting, and more particularly to methods and apparatus for maintaining a substantially constant pressure in a pressure pouring operation.

Pressure casting primarily involves the application of superatmospheric pressure to a sealed tank to force molten metal from a container disposed within the tank through a pouring tube and into the casting cavity of a mold. Various systems have been proposed to accurately control the pressure applied to molten metal in a pressure pouring operation, in order to insure a constant and uniform rate of flow of metal into the mold. One such system may be found in Patent No. 2,990,592 to Hursen, incorporated herein by reference, which describes an apparatus for providing a constant rate of increase in pressure applied to the molten metal. The present invention may be used in conjunction with, and as an additional improvement to, such systems, to the extent that it provides a means for maintaining a substantially constant pressure on the molten metal after the casting cavity has been filled.

For example, in the production of hollow castings, the molten metal is forced into the mold by a certain amount of pneumatic fluid pressure and is allowed to remain in the mold for a certain period of time. During this period, the portion of the molten metal in contact with the mold first begins to freeze, leaving an inner liquid portion. The pneumatic pressure is then released from the molten metal, and any molten metal remaining in the mold is allowed to flow back into the container within the tank, thereby achieving a hollow casting.

In the production of such hollow castings in coreless molds, it is important that a constant pressure be maintained against the molten metal after the casting cavity has been filled. A pressure increase in the tank, caused by factors which include temperature gradients between the external source of pneumatic pressure and the pressure in the tank, would cause the metal to be forced out of the mold. Loss of pressure in the tank, caused by factors including leaks in the system, would allow the molten metal to empty from the casting cavity of the mold before the required period of time had elapsed.

Accordingly, an object of this invention is to provide methods and apparatus for maintaining a constant pressure against the molten metal after the mold has been filled.

Another object of this invention is to provide a constant pressure system in a pressure pouring operation which will compensate for pressure fluctuations caused by temperature gradients, leaks, and other factors.

A further object of this invention is to provide such methods and apparatus in a pressure pouring operation

which will maintain any pressure necessary to retain the molten metal in the mold.

The above and other objects, which will become apparent to those skilled in the art will appear in the following specification and in connection with the accompanying drawing wherein:

FIGURE 1 is a schematic illustration of the invention herein described with accompanying pressure pouring apparatus shown schematically in vertical cross section.

FIGURE 2 is a schematic cross sectional view of the bracketed portion of FIGURE 1.

Describing the invention in detail and referring to FIGURE 1, a substantially sealed tank **10** is connected to a main pneumatic fluid pressure line **12**, adapted to deliver pressurized pneumatic fluid such as compressed air to the tank. The tank houses a ladle **14** which has previously been filled with molten metal **16** such as steel to be used in a casting operation.

The top of the tank **10** is preferably closed by a removable cover **18** seated on a resilient seal ring **20** and secured to the tank by releasable clamps or other suitable means (not shown) to afford a substantially sealed enclosure. Cover **18** has an opening **22** adapted to receive a pouring tube **24** which extends through the cover into a lower portion of the ladle **14**. A mold **26** is provided above the cover **18** of the tank **10** and is mounted on the upper extremity of pouring tube **24**. Molten metal **16** may be forced upwardly through pouring tube **24** into mold **26** by the application of superatmospheric pressure on the molten metal in ladle **14**.

The mold **26** comprises cope and drag sections **28** and **30**, respectively, which define therebetween a coreless casting cavity **32**. The cope section **28** contains a riser opening **34** between the atmosphere and casting cavity **32**. The drag section **30** is sealed on the upper surface of a flange **36** formed on the upper end of pouring tube **24**. A gate **38** in the drag section **30** extends downwardly from cavity **32** and is substantially aligned to communicate with the bore **40** of pouring tube **24**.

A source of pressurized pneumatic fluid, indicated at **42** is connected to main line **12** for raising the molten metal **16** upwardly through the pouring tube **24**. Preferably, such source comprises a system which provides variable pressures, such as that system described in the aforementioned Patent No. 2,990,592. The supply of fluid pressure from source **42** is controlled by main intake shut-off valve **44** on line **12**. An exhaust valve **48** is provided on a branch **50** that bypasses line **12** between main shut-off valve **44** and tank **10**. Preferably, valves **44** and **48** are pneumatically operated by a common source (not shown).

A pressure relief valve **52** is provided on bypass branch **50** between exhaust valve **48** and tank **10**. A shut-off valve **54**, preferably activated by a solenoid, is provided on bypass branch **50** between pressure relief valve **52** and tank **10**. Pressure relief valve **52** is adapted to relieve any tank pressure which is in excess of the pressure between said valve and the branch shut-off valve **54**, as will be hereinafter explained.

A second branch **56** is provided that bypasses main shut-off valve **44** and the first bypass branch **50** hereinbefore described. A regulator valve **58** is located on bypass branch **56** and a shut-off valve **60**, preferably operated by a solenoid, is located on said branch between said regulator valve and the tank **10**.

During the pouring operation, valves **44** and **54** are opened and valve **60** is closed. Pressure from source **42** is transmitted through line **12** to tank **10**, and the molten metal **16** is thus raised upwardly through the pouring tube **24** to fill the casting cavity **32** of the mold **26**. The amount of pressure required to fill a particular mold will, of course, vary according to the size of the casting cavity.

Normally, continuous increments in pressure applied will continue until the operator sees molten metal in the riser opening **34**. At this time, no pressure is released from relief valve **52**, since the pressure on both sides of said valve is substantially the same.

After the casting cavity **32** has been filled to the desired level, intake shut-off valve **44** is closed, branch shut-off valve **54** is closed, and branch shut-off valve **60** is opened. The same pressure required to fill the mold **26** with molten metal is trapped between branch shut-off valve **54** and pressure relief valve **52**. At the same time, bypass branch **56** acts to supply sufficient pneumatic fluid pressure through regulator valve **58** to maintain the tank pressure at or over the desired level.

Bypass branch **50** now serves as a pressure relief branch. As shown in FIGURE 2, relief valve **52** may comprise an enclosure with a port **55** open to the atmosphere on the tank side of the valve. A flexible diaphragm **51** is sealed within the enclosure. A sealing disk **53** is attached on the tank side of a diaphragm **51** and is engageable with the end **57** of the branch communicating with the tank **10**. The valve is designed to close when the pressure on the tank side (P_1) is the same or less than the pressure (P_2) between closed valve **54** and the other side of diaphragm **51**. It will be recalled that the pressure (P_2) is the same as that pressure required to fill the casting cavity of the mold with molten metal. If the pressure (P_1) from the tank becomes greater than the required pressure (P_2), the diaphragm **51** will flex and allow the excess pneumatic fluid pressure to bleed off through port **55** into the atmosphere.

The pressure admitted through regulator valve **58** is adjusted to be somewhat over the pressure (P_2) required to fill the casting cavity **32** of the mold **26**. This will compensate for any leaks in the tank. Any excess pressure through regulator valve **58** and other excess pressure caused by temperature gradients will be bled off by relief valve **52**, thereby achieving a substantially constant pressure in the tank.

After the pressure in the tank has been maintained for the required period of time, exhaust valve **48** is opened, allowing any molten metal in the casting cavity **32** to return to the ladle **14**.

It may thus be seen that the present invention provides a method and apparatus for maintaining a constant pressure while accommodating fluctuations of pressure in the tank due to temperature gradients, leaks and the like. The present invention also has the advantage of maintaining any pressure required to retain the molten metal in the mold.

Having thus described the invention, what is claimed is:

1. In conjunction with a pressure pouring operation wherein the casting cavity of a mold has been filled by the application of superatmospheric pressure against the molten metal to force the metal generally upwardly into the cavity, the process of maintaining a substantially constant molten metal level in the mold which comprises pressurizing the molten metal with pneumatic fluid at a pressure above that pressure required to fill the cavity and relieving that pressure from the molten metal which is in excess of the pressure required to fill the cavity.

2. The process according to claim **1** wherein relieving the pressure which is in excess of the pressure required to fill the mold comprises the steps of trapping that pressure required to fill the cavity during the pouring operation and thereafter maintaining a constant molten metal level

in the cavity by relieving that pressure from the molten metal in excess of said trapped pressure.

3. In conjunction with pressure pouring apparatus wherein molten metal within a pressure tank is forced generally upwardly to a mold through a pouring tube by the pressurization of the molten metal with superatmospheric pneumatic pressure fluid, an arrangement for maintaining a constant molten metal level in the mold which comprises a source of pressurized pneumatic fluid, means to deliver said fluid to said tank, said means including relief valve means for releasing excess pressure in the tank over that pressure required to fill the mold and a pressure supply branch for supplying additional pressure to said tank to compensate for pressure losses therein.

4. In conjunction with a pressure pouring operation wherein the casting cavity of a mold is filled by the application of superatmospheric pneumatic fluid pressure against the molten metal within a pressure tank to force the metal generally upwardly into the cavity, the process of maintaining a substantially constant molten metal level in the mold which comprises the steps of providing an amount of superatmospheric pressure necessary to fill the mold to the desired level through an external main line to the tank, trapping said amount in said main line between a main shut-off valve in said line and the tank and trapping said amount in a branch shut-off valve and a relief valve on a bypass branch between said main line shut-off valve and said tank, and thereafter maintaining a constant molten metal level in the mold by providing additional pressure over said amount through a second branch on said main line bypassing said main line valve and relieving any pressure in excess of said amount through said relief valve.

5. In conjunction with pressure pouring apparatus wherein molten metal in a pressure tank is forced generally upwardly to a mold through a pouring tube by the pressurization of the molten metal with superatmospheric pneumatic pressure fluid, an arrangement for maintaining a substantially constant molten metal level in the mold which comprises a source of pneumatic pressure fluid, a main supply line connecting said source to said tank, shut-off valve means on said main line, a first bypass branch, the ends of said branch connected to said main line between said main line valve and said tank, said first bypass branch including a first branch shut-off valve means and a pressure relief valve means, said pressure relief valve including means for relieving pressure in said first branch in excess of the pressure between said first branch shut-off valve means and said pressure relief valve means, and a second bypass branch connected to said main line around said main line shut-off valve means, said second bypass branch including a second branch shut-off valve means and pressure regulator means.

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