United States Patent

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[54] STOPPER PLUG VALVE FOR HOT METAL LADLES

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[58] **Field of Search** ..... 277/DIG. 6, 237 X; 222/488, 222/509, 525, 559, 571; 308/DIG. 8, 238; 164/337; 137/240; 251/155, 339, 353, 354

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[57] **ABSTRACT**

A valve for use in combination with the bottom of a hot metal ladle to enable molten metal to be discharged therefrom into a mold or the like with the valve being in the form of a stopper plug and including a longitudinal passage communicating with the discharge end of the valve and a transverse passage communicating with the longitudinal passage adjacent the upper end of the valve with the valve seat including a seat portion and a recessed portion communicating with the transverse passage to drain molten metal from around the valve when the valve is closed. The valve includes a sleeve of refractory material such as carbon or the like and an insert in the form of an annular band in the guide for the valve is associated with the carbon sleeve to provide for effective guiding of the valve. A supply of inert gas such as argon may be associated with the valve to prevent oxidation of the carbon sleeve and bearing ring and facilitate the sealing of the valve member.

5 Claims, 4 Drawing Figures

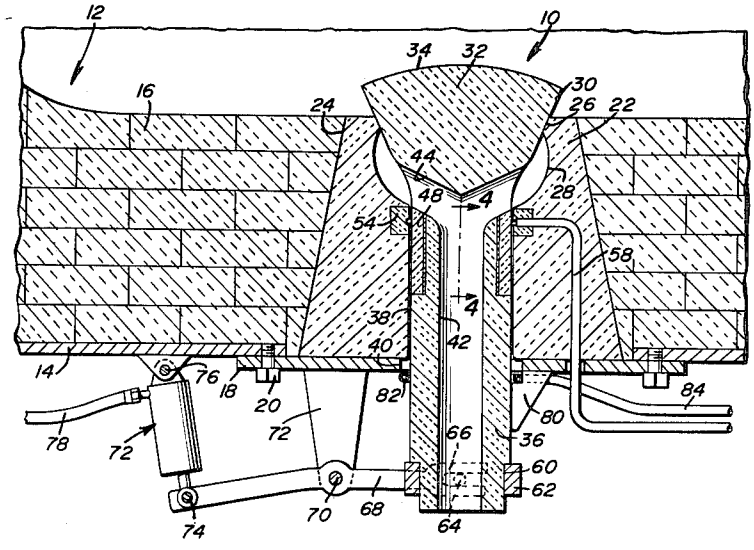

Fig. 1

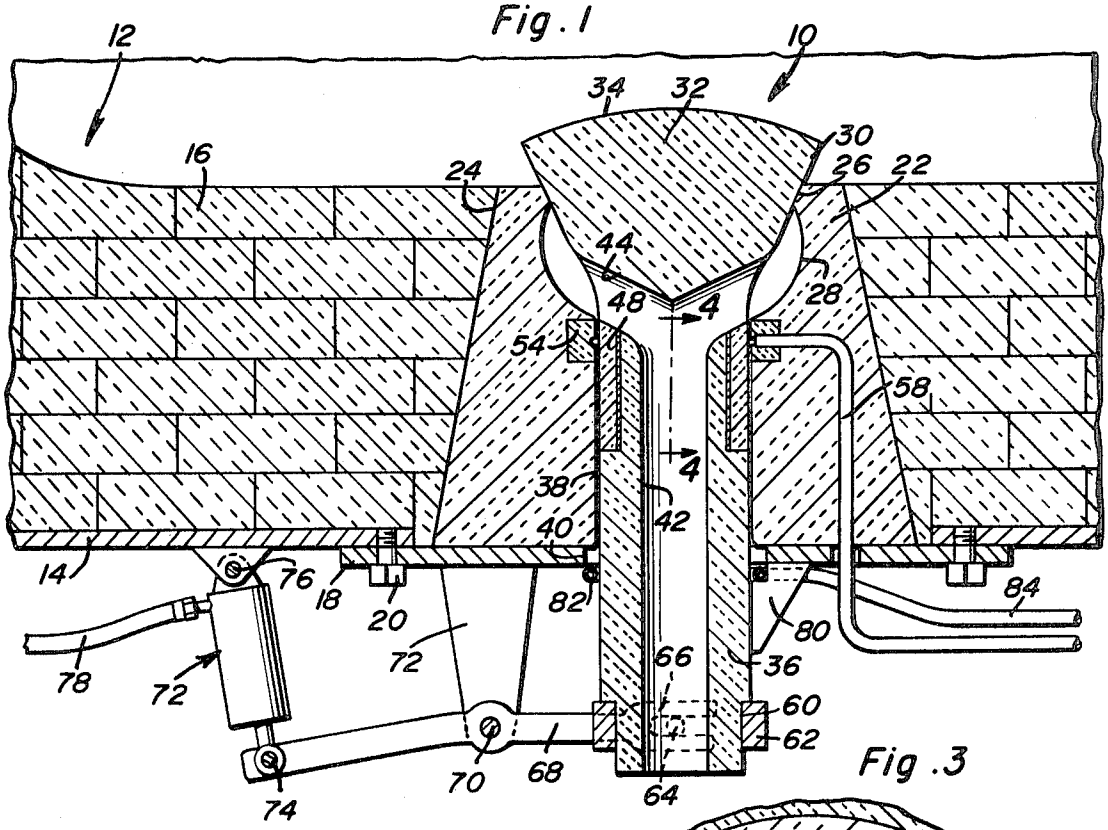

Fig. 2

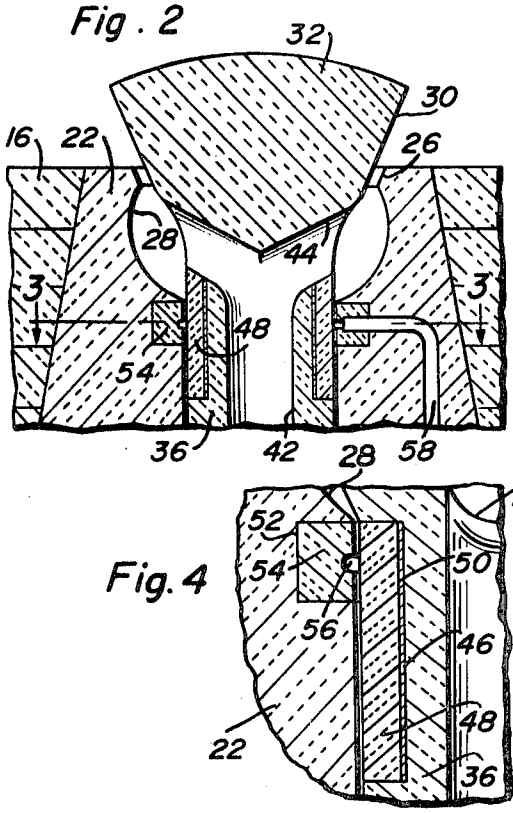

Fig. 3

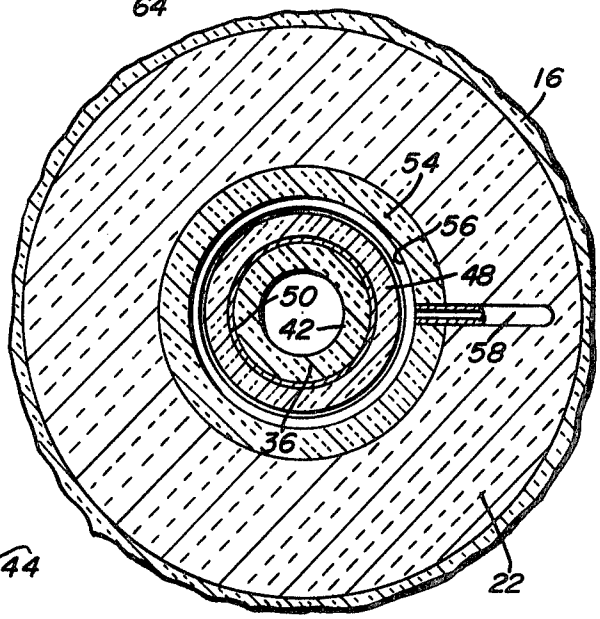

Fig. 4

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STOPPER PLUG VALVE FOR HOT METAL LADLES

The present invention generally relates to a valve for a hot metal ladle and more particularly to a stopper valve which is actuated from the bottom of the ladle by any suitable remotely controlled power means in which the valve is reciprocated from a lowered closed position to a raised open position.

An object of the present invention is to provide a stopper plug valve for hot metal ladles in which the valve is provided with a longitudinal axial passageway communicating with a transversely extending passageway disposed below the upper end of the valve member with the portion of the valve member above the transverse passageway engaging a valve seat and the portion of the valve seat below a predetermined distance from the upper end of the valve seat including a recess communicating with the transverse passageway to enable molten metal to be drained therefrom so that no molten metal will be residually retained in the valve seat which would cause buildup and incomplete seating of the valve.

Another object of the present invention is to provide a stopper plug valve in accordance with the preceding object in which the valve member includes a sleeve of carbon material or the like cushioned around the stem of the valve with the sleeve in engagement with an annular bearing ring of carbon or the like recessed into the pocket brick insert in the bottom of the ladle.

A further important object of the present invention is to provide a stopper plug valve in accordance with the preceding objects in which the annular bearing member is provided with a groove on the inner surface thereof communicated with a source of pressurized argon or other inert gas to prevent oxidation of the carbon sleeve and bearing member at high temperatures.

Yet another important object of this invention is to provide a stopper plug valve in which all of the components thereof are retained in position by a removable plate attached to the bottom of the ladle to enable removal of the valve member and the pocket brick having the valve seat and recess therein for ease of replacement of these components.

Still another important object of the present invention is to provide a stopper plug valve for hot metal ladles which operates without mechanical parts coming into contact with hot molten metal, slag or the like and which, due its particular construction, is capable of reuse rather than being replaced after each heat with the structure of the valve, the valve seat and the actuating mechanism therefor being relatively simple in construction, long lasting and dependable and relatively inexpensive to manufacture.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a sectional view of the stopper plug valve of the present invention illustrating the manner in which it is associated with the bottom of a hot metal ladle.

FIG. 2 is a fragmental sectional view similar to FIG. 1 but illustrating the stopper plug valve in an elevated open position.

FIG. 3 is a transverse, sectional view, on an enlarged scale, taken substantially upon a plane passing along section line 3—3 of FIG. 2 illustrating the specific structural details of the components of the valve structure.

FIG. 4 is a fragmental, sectional view, on an enlarged scale, taken substantially upon a plane passing along section line 4—4 of FIG. 1 illustrating the specific structural details of the sleeve on the valve stem and the annular bearing member associated therewith.

Referring now specifically to the drawings, the stopper plug valve of the present invention is generally designated by the numeral **10** and is associated with the bottom of a hot metal ladle generally designated by the numeral **12** and which includes the usual external shell **14** having a lining of fire brick **16** or the like which is representative of a conventional hot metal ladle.

The shell **14** of the ladle is provided with an opening therein which is closed by a closure plate **18** detachably secured in position thereon by removable fasteners **20** such as conventional bolts or the like. Disposed above the plate **18** is an insert **22** constructed of refractory material and which is cast in one piece and may be generally referred to as a pocket brick. The insert **22** is received in an aperture or recess **24** defined in the fire brick liner **16** in which the insert **22** and the recess **24** receiving the same are upwardly tapering so that the insert **22** may be inserted from the bottom of the ladle when the closure plate **18** has been removed thus enabling ease of replacement of the insert or pocket brick **22** when desired.

The upper end of the insert **22** is provided with a downwardly tapering aperture or valve seat **26** which is generally frustoconical in configuration and which extends downwardly to a predetermined depth where it joins with and merges with an annular groovelike recess **28** which extends peripherally of the insert or pocket brick **22** with the upper edge of the recess **28** defining the lowermost limit of the valve seat **26** which has a relatively short vertical dimension for seating engagement with an inclined or outwardly tapering outer surface **30** on the valve head **32** of the valve **10**. The external surface **30** of the valve head **32** cooperates with the valve seat **26** and forms a seal therebetween. The upper surface of the valve head **32** is convex as indicated by the numeral **34** so that material positioned thereon will flow off of the top surface of the valve **10**.

The valve **10** also includes a longitudinally depending valve stem **36** which is integral with the valve head **32** and of lesser diameter than the upper end of the valve head **32**. The stem **36** is generally cylindrical in configuration and slidably received within a vertical bore or passageway **38** formed in the insert or pocket brick **22**. The lower end of the valve stem **36** terminates below the removable closure plate **18** with the closure plate **18** including an aperture **40** receiving the valve stem **36** for reciprocatory movement.

The valve stem **36** includes a longitudinal passageway **42** therethrough with the upper end of the longitudinal passageway **42** communicating with a transversely extending passageway **44** which communicates with the inclined surface **30** of the valve head **32** at its juncture with the valve stem **36** as illustrated in FIG. **1**. As illustrated in FIG. **1**, when the valve **10** is in closed position, the bottom edge of the transverse passageway **44** is substantially continuous with and flush with the lowermost edge portion of the recess **28** so that any molten metal in the recess below the valve seat **26** will drain from the recess **28** down through the transverse passageway **44** and longitudinal passageway **42** and be discharged out from the lower end of the valve stem **36**.

Disposed in the valve stem **36** adjacent the end thereof having the transverse passageway **44**, there is provided an annular recess **46** which receives an annular sleeve **48** of refractory material such as carbon or the like of one piece construction. Disposed between the carbon sleeve **48** and the bottom surface of the recess **46** in the valve stem **36** is a resilient filler **50** to enable relative expansion between the sleeve **48** and the valve stem **36**. The filler **50** is of a resilient material capable of being compressed slightly without exerting radial forces on the carbon ring **48** thereby enabling the valve stem **36** to expand due to the heat produced therein by the passage of hot molten metal whereas the carbon sleeve **48** has a very low coefficient of expansion, the resilient filler **50** will enable relative movement between the stem **36** and the carbon sleeve **48** without rupturing or damaging the carbon sleeve **48**.

The insert **22** is provided with an annular groove **52** adjacent the upper end thereof in alignment with the carbon sleeve **48**. An annular bearing member **54** is disposed in the sleeve **22** and is also constructed of carbon or similar material. A resilient filler may also be provided behind the annular ring **54** that is, between the inner wall of the groove **52** and the annular ring **54** if desired. The carbon ring **54** cooperates with the carbon sleeve **48** to provide an effective seal for preventing passage of molten metal downwardly therebetween.

The inner surface of the bearing ring **54** where it engages the carbon sleeve **48** is provided with an annular groove **56** communicated with a supply pipe or passage **58** extending through the bottom plate **18** and communicated with a source of pressurized inert gas such as argon or the like so that pressurized argon may be discharged from the groove **56** to prevent oxidation of the carbon sleeve **48** and the carbon bearing ring **54** due to the high temperatures thereof. The argon gas will thus effectively lengthen the life of the carbon sleeve and carbon ring and at the same time more effectively seal the space between the valve stem and the vertical bore **38** in the insert or pocket brick **22**.

The lower end of the valve stem **36** is provided with a recess **60** having a split clamp **62** received therein. The annular ring **62** which may be of one piece construction or a split clamp is provided with diametrically opposed projecting pins **64** which receive the bifurcated ends **66** of a lifting yoke or fork **68** that is pivotally supported intermediate its ends at a pivot point or bolt **70** supported on a depending bracket **72** carried by the supporting plate **18** or the like. The opposite end of the lifting fork or lever **68** is attached to a power cylinder generally designated by the numeral **72** by the use of a pivot pin or bolt **74**. The power piston and cylinder assembly **72** is pivotally attached to the bottom shell **14** of the ladle by a pivot pin or bolt **76** or the like and may be either single or double acting with a suitable hose or hoses **78** connected thereto so that the piston and cylinder assembly may be used to actuate the valve to power it open and permit gravity and the weight of the molten metal on top of it to close it or to power it open and closed as determined appropriate by requirements for each individual installation. If the valve is to be powered in both a closed and opened condition, then the recess **60** in the valve stem should be in the form of a groove so that the annular member or split clamp **62** will be retained in position thereon. Other operating mechanisms may be employed for opening and closing the valve including manually operated mechanical linkages and the like.

For stabilizing the valve during reciprocation thereof, generally triangular gusset type guides **80** may be provided at circumferentially spaced points on the bottom plate **18** with the inner edge of the gussets **80** being disposed adjacent the peripheral surface of the valve stem **36** which will retain the valve stem for longitudinal movement in a substantially straight direction. Also, a tub or pipe **82** having a plurality of orifices in the top surface thereof may be oriented around the valve stem **36** immediately below the closure plate **18** and in alignment with the aperture **40** therein for discharging argon gas upwardly around the valve stem to further serve to prevent oxidation of the valve stem and carbon sleeve and to also further effectively seal the valve stem. The tube **82** is communicated to a source of pressurized argon or other inert gas through a tube or hose **84** with the hose or tube **58** as well as the hose or tube **84** being controlled by a suitable control valve or the like.

The valve **10** will normally be in closed position with a relatively large quantity of molten metal disposed in the ladle. When it is desired to discharge molten metal into a mold or for whatever purpose desired, the valve is actuated so that it is moved vertically upwardly to a position generally illustrated in FIG. **2** at which time molten metal will flow down between the valve seat **26** and the inclined valve surface **30** into the recess **28** and down through the passageway **44** and passageway **42** to discharge from the lower end thereof. Even if slag or other material has accumulated in the bottom of the ladle, hot molten metal will still flow downwardly inasmuch as upward movement of the valve head **32** will assure communication of the hot molten metal with the passageway between the valve seat **26** and the valve surface **30**. When the desired quantity of molten metal has been obtained, the valve is moved to a closed position or permitted to move by gravity with the weight of the metal on top of the valve head moving the valve to a closed position as illustrated in FIG. **1**. After the valve surface **30** has seated against the valve seat **26**, the molten metal in the recess **28** as well as any molten metal in the transverse passageway and the longitudinal passageway **42** will drain through the discharge end of the passageway **42** thus retaining the passageway clear of residual molten metal which would tend to harden and solidify and build up after which the valve would not seat properly. By providing the recess **28** and the drainage therefor, there will be substantially less buildup of hardened metal on the valve seat which would tend to preclude complete closing of the valve **10**. The carbon sleeve and carbon ring form an effective seal for the molten metal to prevent it from running downwardly around the valve stem and the argon gas effectively prevents oxidation of the carbon sleeve and carbon ring and also oxidation of the valve stem as well as effectively seal the valve stem. The valve member will be constructed of any suitable refractory material as is the insert **22** and various mechanisms may be employed for opening and closing the valve member which is capable of repeated use in a ladle so that the stopper valve does not have to be replaced after each heat. Also, the passage **44** may be provided with any suitable number of bores communicating with the periphery of the valve head **32**. Further, the shape of the valve seat **26** and valve **30** may be varied such as by making the cooperating surfaces curved or partially spherical in configuration.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A valve assembly for installation in the bottom of a hot metal ladle comprising an insert member having a vertical bore therethrough, valve seat means at the upper end of the bore, a valve member reciprocally mounted in the bore and including a head operatively associated with the valve seat means for closing the bore when resting against the valve seat means, said valve member including a stem depending below the bore for enabling vertical reciprocation of the valve member between a lowered closed position and a raised open position, said valve member including a passageway therethrough having a lower end communicating with the lower end of the valve member and an upper end communicating with the space between the valve member and the valve seat for conveying molten metal when the valve member is in the open position and draining molten metal from around the valve member when the valve member is in the closed position, said valve stem including an external sleeve of carbon material at the upper end thereof adjacent the juncture of the valve head with the stem, said insert member including an annular bearing ring of carbon for sealing relation with the carbon sleeve while permitting reciprocation thereof.

2. The structure as defined in claim **1** wherein said bearing ring includes a peripheral groove on the surface thereof facing the sleeve on the stem, a source of pressurized inert gas communicating with said groove in the bearing ring for introducing such gas between the carbon sleeve and carbon ring to reduce oxidation of the carbon at high temperature and provide an effective seal therebetween.

3. The structure as defined in claim **1** together with an annular tube encircling the valve stem at the lower end of the insert member with the tube having a plurality of openings therein facing upwardly around the periphery of the stem, said tube communicating with a source of pressurized inert gas for discharging such gas upwardly around the periphery of the valve stem.

4. For use in combination with a receptacle adapted to receive flowable material, a valve assembly comprising an insert having a bore therethrough and adapted to be disposed in the wall of the receptacle, a valve member reciprocally supported by said insert and including a stem guidingly disposed in said bore with one end of the stem extending outwardly of

the bore to enable reciprocation of the valve member, the inner end of said bore including a valve seat, said valve member including a valve seat engaging surface to close the bore when engaged with the valve seat, said valve member including passage means communicating with the outer end portion of the valve stem and the inner end portion thereof inwardly of the valve seat engaging surface for discharge of material when the valve member is open and drainage of any material disposed outwardly of the valve seat when the valve member is in closed position, said insert and valve member being constructed of refractory material for use in a molten metal ladle, said valve stem and bore having a peripheral recess therein with the recesses being in registry, and an annular insert of high density carbon in each peripheral recess for guiding and sealing relation.

5. For use in combination with a receptacle adapted to receive flowable material, a valve assembly comprising a carbon bearing insert having a bore therethrough and adapted to be disposed in the wall of the receptacle, a valve member reciprocally supported in said bore by said insert and controlling flow therethrough, said insert and said valve member defining s space therebetween, inert gas means communicating with said space for introducing inert gas between said insert and said valve member to reduce oxidation thereof due to high temperatures encountered when the flowable material passes through said bore, said space including a peripheral groove on a surface portion of said insert and surrounding said valve member to permit intoduction of the inert gas around said valve member, the surface portion of said insert being in sliding relation with said valve member.

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