MOLTEN METAL POURING VALVE HAVING VALVE ACTUATOR EXTENDING THROUGH INCLINED CHANNEL

Inventors: Harry Sidney Marr; Arnold Chester, both of Sheffield, England


Filed: Apr. 12, 1973

Foreign Application Priority Data
Apr. 17, 1972 Great Britain 17624/72

U.S. Cl........................................ 222/501, 222/559
Int. Cl........................................... B22d 37/00
Field of Search. 222/501, 559, DIG. 4, DIG. 1, 222/566

References Cited
UNITED STATES PATENTS
1,920,300 8/1933 Gesel et al.................... 222/566 UX
2,005,311 6/1935 Belding....................... 222/559 UX

FOREIGN PATENTS OR APPLICATIONS
3,511,421 5/1970 Smith.................................. 222/559
130,297 7/1919 Great Britain.......................... 222/566

Primary Examiner—Robert B. Reeves
Assistant Examiner—David A. Scherbel
Attorney, Agent, or Firm—Bacon & Thomas

ABSTRACT
Apparatus for pouring molten metal from a receptacle (such as a ladle) comprises a refractory nozzle which is adapted to be mounted within the receptacle and which has a downwardly extending flow channel for removing molten metal from the receptacle, a refractory stopper head operable to close off the flow channel and a stopper rod which extends upwardly through the nozzle and is operable to move the head into and out of contact with a nozzle seat formed about the inlet to the flow channel. The channel is inclined to the vertical along at least a portion of its length so that the outlet orifice of the flow channel which is formed in the lower surface of the nozzle is set to one side of the stopper rod.

6 Claims, 3 Drawing Figures
FIG. 3.
MOLTEN METAL POURING VALVE HAVING VALVE ACTUATOR EXTENDING THROUGH INCLINED CHANNEL

The present invention relates to pouring or casting apparatus for a receptacle containing a molten metal, especially a receptacle containing molten iron or steel, and to a method of operating such apparatus.

In accordance with the present invention in one aspect, there is provided apparatus for pouring molten metal from a receptacle comprising a refractory nozzle adapted to be mounted within the receptacle and having a downwardly extending flow channel for removing molten metal from the receptacle, a refractory stopper head operable to close off the flow channel and a stopper rod extending upwardly through the nozzle and operable to move the head into and out of contact with a nozzle seat formed about the inlet to the flow channel, the channel being inclined to the vertical along at least a portion of its length so that the outlet orifice of the flow channel which is formed in the lower surface of the nozzle is set to one side of the stopper rod.

According to the present invention in a further aspect, there is provided a method of operating apparatus for pouring molten metal from a receptacle comprising causing an upwardly extending stopper rod to be moved upwardly or downwardly through an aperture formed in a surface of the receptacle whereby a stopper head carried by the stopper rod is moved, respectively, out of and into seating contact with the inlet orifice of a downwardly extending flow channel through which molten metal can leave the receptacle, the channel being so shaped that molten metal flowing therethrough leaves the channel through an outlet orifice which is offset with respect to the inlet orifice.

In the accompanying diagrammatic drawings:

FIG. 1 is an elevational view, in section, of pouring apparatus embodying the invention,

FIG. 2 is an elevational view, in section, of alternative pouring apparatus embodying the invention, and

FIG. 3 is an elevational view, in section, of an alternative nozzle assembly.

The apparatus illustrated in FIG. 1 includes a metal pouring assembly which includes a refractory nozzle 1 of, for example, alumino-silicate refractory, secured in the well of a refractory lined ladle 2. A flow channel 3 for the removal of molten metal (for example, iron, steel or non-ferrous metals) from the ladle 2 extends through the nozzle 1 and is closable by a refractory stopper head 4 of, for example, plumbago, which is movable by a metal stopper rod 5 into and out of contact with a nozzle seat 6 formed in the upper surface of the nozzle 1 at the inlet to the channel 3. The stopper rod 5 extends upwardly through an aperture formed in the undersurface of the ladle 2, is slidable vertically within the bore of a refractory sleeve 8 of, for example, plumbago, upstanding from and cemented into the lower portion of the nozzle 1 and is movable by means of a lever 9 coupled by linkage 10 to the stopper rod 5 and pivotally mounted at 11 to an arm 12 secured to the undersurface of the ladle 2. A layer of insulating refractory material may be applied to the inside of the refractory sleeve 8 to reduce heat transfer to the stopper rod 5. A bearing housing 13 is secured to the undersurface of the ladle about the aperture through which the stopper rod extends to prevent sideways movement of the stopper rod. A stop 14 is carried by the stopper rod 5 below the ladle 2 to prevent excessive upward movement of the stopper rod 5 and stopper head 4.

The stopper head 4 is connected to the stopper rod 5 by means of a screw plug 15 constructed of, for example, a refractory material such as plumbago or of steel protected by an overal of refractory material, which is countersunk into the upper portion of the stopper head 4 and which urges a horizontal flange portion 16 of the stopper rod 5 into contact with a seating surface 17 formed in the stopper head 4. The upper end of the refractory sleeve 8 extends into a bore 18 formed in the lower surface of the stopper head 4 and defines therewith sliding joint. The depth of the bore 18 is greater than the permitted lift (for example, 2 inches) of the stopper rod 4 to ensure that a length of the refractory sleeve 8 is always contained within the bore 18 to provide adequate guidance for the stopper head 4 in its open position. The permitted lift of the stopper head 4 is determined by the distance between the stop 13 and the undersurface of the bearing housing 13.

The stopper head 4 and sleeve 8 are preferably manufactured from refractory materials having similar expansion coefficients so that, in use of the apparatus, a close tolerance is maintained between their surfaces. This close tolerance inhibits ingress of molten metal between the surfaces of the sleeve 8 and the bore 18. Ingress of molten metal is further inhibited by means of an annular refractory fibre gland 20 positioned between these abutting surfaces.

The mid-section of the flow channel 3 is inclined to the vertical so that the lower channel orifice 21 is set to one side of the stopper rod 5. The lower portion of the nozzle 1 defines a teeming nozzle 22 which depends below the undersurface of the ladle 2 a sufficient distance to ensure good stream characteristics.

As is indicated in broken line, the stopper rod 5 may include one or more lengthwise extending passageways 23 for conveying gases therethrough. A cooling medium, for example — air, may be passed through the rod 5 to cool the same. Alternatively, a gas, for example — an inert gas such as argon or nitrogen or a reactive gas such as an oxidising or reducing gas, may be passed up through the or each passageway 23 into the space defined between the upper end of the sleeve 8 and the undersurface of the flange 16 and maintained at a pressure sufficient to inhibit the ingress of molten metal between the opposed surfaces of the sleeve 8 and bore 18.

The refractory material or materials from which the nozzle 1, stopper head 4 and sleeve 8 are constructed depend upon the technique employed for manufacturing the pouring assembly and the particular application for which the assembly is to be used. In general, any suitable pressed, rammed or cast fired material or any chemically clay or resin-bonded cold set material may be employed.

Assembly of the nozzle 1 within the ladle 2 will now be described. Prior to assembly, the refractory sleeve 8 is secured by cementing within a vertical bore 24 formed in the nozzle 1, and the nozzle 1, together with the sleeve, is secured within a steel container 25. The assembly of the nozzle 1 and sleeve 8 mounted within the container 25, together with the head 4 and stopper rod 5, is then introduced upwardly into the ladle 2 through an aperture formed in its base and the container 25 secured to the undersurface of the ladle 2.
Once in position, the lower end of the stopper rod 5 is connected to the lever 9 through the linkage 10. In operation, the stopper head 4 is moved by means of the stopper rod 5 and the lever 9 between a position in which the head 4 contacts the seat 6 to prevent the outflow of molten metal from the ladle 2 and a position in which the head 4 lies above the seat 6 to allow molten metal to flow round the ladle 2 around the exposed end of the refractory sleeve 8 and through the channel 3. The stopper 4 may be held at positions intermediate these extreme positions in order to control the rate of flow of metal leaving the ladle 2. The upper end and inclined mid-portion of channel 3 are of greater cross-sectional area than the lower channel orifice 21 thereby ensuring good stream characteristics.

The apparatus illustrated in FIG. 2 is similar to that illustrated in FIG. 1 and like integers bear the same reference numerals. In this embodiment, the refractory sleeve 8 is slidable within a vertical bore 30 formed in the lower portion of the nozzle 1 and is movable with the stopper rod 5 and the stopper head 4; the sleeve 8 is connected at its upper end to the head 4. A refractory flange 31 is set in an inclined groove formed in the bore 30 and bears against the adjacent surface of the sleeve 8 to prevent or inhibit the flow of molten metal between the abutting surfaces. The sleeve 8 is preferably manufactured from a refractory material having a similar coefficient of expansion as that of the refractory of the nozzle 1.

The flange 16 is urged into contact with the seating surface 17 by a metal screw plug 32 which is covered by an overlay of refractory cement as indicated by reference numeral 33.

The nozzle 1 may be monolithic or may be constructed in one or more vertically split sections for ease of manufacture. When the nozzle is so constructed, the seat 6 may be a monolithic annular member which is positioned within a groove formed at inlet to the channel 3.

When formed separate from the nozzle 1, the seat 6 may be manufactured from a refractory material different from that of which the nozzle 1 is manufactured.

Where different materials are employed, it is important that the material from which the seat is manufactured is chemically compatible with the material of the stopper head and that it will, in operation of the nozzle, form an efficient seal with the refractory of the stopper head. For example, the stopper head may be constructed of plumbago, the nozzle seat of magnesite and the main body of the nozzle of fireclay.

FIG. 3 illustrates an alternative construction of nozzle 1 which is particularly suitable for casting slabs. The nozzle comprises a flow channel 3 having a generally vertical inlet portion and a plurality of inclined portions 33 (only two of which are shown) each terminating in an outlet orifice 21 offset from the stopper rod 5 when in position. A stopper assembly similar to that illustrated in FIG. 1 or FIG. 2 may be employed, the vertical axis of which passes through the centre of the inlet orifice of the flow channel 3. The bore through which the refractory sleeve 8 of the stopper assembly passes is shown at 24. As in FIG. 2, the nozzle seat 6 may be constructed of a different refractory material from that of which the nozzle 1 is constructed.

As described and illustrated, the stopper 4 is operated mechanically. Alternatively, the stopper 4 may be operated hydraulically, pneumatically or electrically.

The inclined mid-portion of the channel permits simple operation of the stopper head 4 from below whilst interfering minimally with the flow of metal from the ladle 2. Furthermore, the use of a stopper rod which extends upwardly through the undersurface of the ladle leaves the upper surface of the ladle accessible for purposes such as ladle steelmaking and ladle degassing.

A further advantage of apparatus in accordance with the invention over conventional casting apparatus in which a stopper rod extends downwardly from the upper open end of a ladle through the slag and metal contained in the ladle to seat in a nozzle orifice formed in the bottom of the ladle is that a more positive control is provided over stopper head movement; disadvantages which are overcome are the high refractory wear experienced with conventional assemblies due to attack by the slag layer on the refractory sleeve which encases the stopper rod and elimination of possible misalignment of the stopper rod during ladle preheating.

In the drawings, the flow channel 3 has been illustrated as having an inclined mid-portion with substantially vertical inlet and outlet portions. Alternatively, the flow channel 3 may be inclined to the vertical over its whole length or be inclined at its inlet and mid-portions. The cross-section of the teeming nozzle may be circular, rectangular or of any other desired cross-section.

The following is an example of a trial carried out utilising a nozzle assembly as illustrated in FIG. 1.

EXAMPLE

A nozzle in accordance with the invention was set in the well of a ladle of 7-ton capacity. The nozzle was constructed of magnesite and the stopper head and refractory sleeve of plumbago. The diameter of the teeming nozzle was 1¾ inches, that of the inlet to the flow channel 3 inches and that of the refractory sleeve 1¼ inches.

Molten metal containing 0.2 percent carbon, 0.6 percent manganese, remainder iron was poured at a temperature of 1,580°C through the nozzle at a rate of 11 tons per hour. The metal was cast into 8 moulds which required throttling, closing and re-opening the nozzle on eight occasions. The nozzle was closed finally when slag appeared.

On inspection, the stopper head was intact and the flow channel clean.

The pouring apparatus may be incorporated in various metallurgical vessels and its use is not restricted to the ladle described herein. For example, it may be employed for pouring metal from tundishes, cupolas, steelmaking vessels or molten metal holding vessels.

We claim:

1. Apparatus for pouring molten metal from a receptacle comprising a refractory nozzle adapted to be mounted within the receptacle and having a downwardly extending flow channel for removing molten metal from the receptacle, an upstanding refractory sleeve member secured at its lower end within a bore formed in the refractory nozzle, a refractory stopper head operable to close off the flow channel, a stopper rod mounted within said upstanding refractory sleeve member and extending upwardly through the nozzle and operable to move the head into and out of contact with a nozzle seat formed about the inlet to the flow channel, and means to impart vertical movement to the stopper head relative to the refractory sleeve member,
the channel being inclined to the vertical along at least a portion of its length so that the outlet orifice of the flow channel which is formed in the lower surface of the nozzle is set to one side of the stopper rod.

2. Apparatus according to claim 1 wherein the stopper head has formed in its under surface a bore into which extends the upper end of the refractory sleeve member, the respective dimensions of the bore and the sleeve member being such that their opposed surfaces co-operate to form a sliding joint, the length of which is greater than the permitted lift of the head from the nozzle seat.

3. Apparatus according to claim 2 wherein an annular gland is set in a groove formed in the bore of the refractory head and bears against the adjacent surface of the refractory sleeve member to provide a seal between the head and the sleeve member.

4. Apparatus according to claim 1 wherein the refractory nozzle is mounted within a metal container which is removably secured to the receptacle, the upper portion of the nozzle extending upwardly through an aperture formed in the receptacle, and wherein the refractory sleeve member is secured within the bore formed in the refractory nozzle prior to the container being secured to the undersurface of the receptacle.

5. Apparatus for pouring molten metal from a receptacle comprising a refractory nozzle adapted to be mounted within the receptacle and having a downwardly extending flow channel for removing molten metal from the receptacle, a refractory sleeve member slidably mounted within an upwardly extending bore formed in the lower part of the refractory nozzle, a refractory stopper head operable to close off the flow channel, a stopper rod mounted within said refractory sleeve member and movable with the sleeve member and the stopper head relative to the nozzle to move the head into and out of contact with a nozzle seat formed about the inlet to the flow channel, and means to impart vertical movement to the stopper head relative to the refractory sleeve member, the channel being inclined to the vertical along at least a portion of its length so that the outlet orifice of the flow channel which is formed in the lower surface of the nozzle is set to one side of the stopper rod.

6. Apparatus according to claim 5 wherein the refractory nozzle is mounted within a metal container which is removably secured to the receptacle, the upper portion of the nozzle extending upwardly through an aperture formed in the receptacle, and wherein the refractory sleeve is mounted within the upwardly extending bore formed in the refractory nozzle prior to the container being secured to the undersurface of the receptacle.

* * * * *