A stopper arrangement for controlling the flow of molten metal or the like through the bottom opening of a ladle. The stopper arrangement is supported for movement about a longitudinal axis between its opened and its closed positions. The supporting arrangement for the stopper element is such that the element may shift transversely with respect to the longitudinal axis but will always move in a direction parallel to the longitudinal axis as it is opened or closed. The stopper element is also supported for oscillation and is positively rotated when in its closed position for insuring good sealing engagement with the opening.
BOTTOM POUR STOPPER

CROSS-REFERENCE TO RELATED APPLICATION

This application is related to the copending application entitled "Foundry Apparatus," Ser. No. 648,562, filed June 26, 1967, now U.S. Pat. No. 3,537,489, in the name of Robert T. Hall, which application is assigned to the assignee of this application.

BACKGROUND OF THE INVENTION

This invention relates to a stopper arrangement and more particularly to an improved stopper arrangement that is particularly adapted for controlling the flow of molten metals or the like through a bottom pouring ladle opening.

In the aforesaid copending patent application there is disclosed an automated foundry apparatus that includes a bottom pouring ladle. In that apparatus the flow through a bottom positioned pouring opening is controlled by means of a magnetic-type flow control device. While satisfactory it is desirable in some instances to provide a positive flow control embodying a stopper arrangement that coacts with the opening for controlling the flow. With the extremely high temperatures involved with molten metal it is important that the stopper adequately shut off the flow at the end of the pouring cycle and insure against leakage and attendant dripping. Due to the high temperatures and high-temperature variations such sealing with mechanical valves is difficult to obtain. Various devices have been proposed in which the movable valve element is supported by means of a universal-type joint so that it may seek a fully closed position with respect to the opening. Such arrangements, however, fail to provide good sealing in all instances since the direction of opening and closing movement of the valve element is not controlled thus permitting the valve element to skew with respect to its normal direction of movement.

It is, therefore, a principal object of this invention to provide an improved stopper arrangement that insures good sealing.

It is another object of the invention to provide a stopper arrangement in which the stopper element is permitted to move translationally with respect to the longitudinal axis about which it rotates between its opened and closed positions.

It has been further discovered that the seating of the stopper element may be improved by positively rotating the stopper element about its longitudinal axis when the stopper element is in its closed position.

It is, therefore, still a further object of this invention, to provide a stopper arrangement in which the stopper element is oscillated about its longitudinal axis.

SUMMARY OF THE INVENTION

A first feature of this invention is adapted to be embodied in a stopper mechanism for controlling the flow of molten metal or the like through an opening. The stopper mechanism includes a stopper element that is adapted to control the flow through the opening and means for supporting the stopper element for movement along a longitudinal axis relative to the opening between an opened position and a closed position. The supporting means is effective to permit the stopper element to shift transversely relative to the longitudinal axis so that it may located itself relative to the opening. The supporting means, however, restrains the opening and closing movement of the stopper element in directions parallel to the longitudinal axis.

Another feature of the invention is also adapted to be embodied in a stopper mechanism that controls the flow through an opening. In such an embodiment means are provided for reciprocating the stopper element relative to the opening about a longitudinal axis between an opened position and a closed position. Means are additionally provided for oscillating the stopper element about the longitudinal axis.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an automated foundry apparatus embodying this invention.

FIG. 2 is a side-elevational view, with portions broken away, of the foundry apparatus.

FIG. 3 is a top plan view of the structure shown in FIG. 2.

FIG. 4 is an enlarged cross-sectional view taken generally along the line 4--4 of FIG. 2.

FIG. 5 is an enlarged view looking generally in the direction of the line 5--5 of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A foundry apparatus embodying this invention is identified generally by the reference numeral 11. The foundry apparatus 11 is comprised of a ladle 12 that is adapted to be filled with molten metal and that has a pouring opening 13 (FIG. 4) formed in its lower wall 14. A stopper assembly indicated generally by the reference numeral 15 is adapted to control the flow through the opening 13 into molds 16 as they pass beneath the ladle 12. If desired, the foundry apparatus 11 may be constructed in the manner disclosed in the aforesaid copending patent application of Robert T. Hall so as to provide fully automated filling of the molds 16. In such an arrangement, a means is provided for moving the ladle 12 in the direction of movement of the molds 16 as the latter pass along a conveyor assembly 17. The stopper mechanism 15 may be opened and closed automatically as described in the aforesaid patent application.

Referring now to the construction of the stopper assembly 15, the assembly includes a stopper element 18 that has a lower end 19 formed in the shape of a segment of a sphere. The end 19 is adapted to coat with a conically shaped seat 21 formed at the upper end of the opening 13 for controlling the flow through this opening.

The stopper element 18 is connected to a supporting arm assembly, indicated generally by the reference numeral 22, in a manner which will become more apparent as this description proceeds. The supporting assembly 22 is connected by means of a bracket 23 to the upper end of a piston rod 24. The piston rod 24 carries a piston 25 at its lower end which piston is received in a cylinder 26. The cylinder 26 is affixed in any known manner to one of the outer faces of the ladle 12. The cylinder 26 is adapted to be hydraulically or pneumatically operated for effecting reciprocation of the piston 25, piston rod 24, arm assembly 22 and stopper element 18. The stopper element 18 is, thereby, reciprocated along a longitudinal axis between an opened position and a closed position. The arm assembly includes a fail-safe or structural l-beam 27 that extends outwardly from the bracket 23 across the opened upper end of the ladle 12. At the outer end of the l-beam 27 a pair of vertically extending plates 28 and 29 are affixed to the upper side of a horizontally extending plate 31. The plates 28, 29 and 31 are connected to a rear plate 32 that is, in turn, affixed to the outer extremity of the l-beam 27. The lower plate 31 is formed with a recess 33 that extends inwardly from its outer edge to pass a rod 34 that has a threaded connection with the stopper element 18.

A guide element, indicated generally by the reference numeral 35 is supported upon the threaded rod 34. The guide element 35 has a large diameter cylindrical center segment 36 and smaller diameter cylindrical segments 37 and 38 formed on its opposite sides. Adjacent the segments 37 and 38 still smaller diameter segments 39 and 41 are integrally formed. A pair of washerlike retainers 42 and 43 engage opposite sides of the guide segments 39 and 41 and are axially held in place by nuts 44 and 45. The guide 35 is, thereby, axially positioned upon the threaded rod 34.

Upper and lower ball bearing assemblies 46 and 47 engage opposite faces of the cylindrical segment 36 and are radially located by the segments 37 and 38, respectively. The ball
bearings 46 and 47 are engaged at their opposite sides by annular members 48 and 49 that are spaced apart by means of a cylindrical spacer 51. The annular member 49 is supported upon the plate 50 of the arm assembly 22.

The cylinder 52 has a bifurcated outer end 53 that encircles the washer 42. At its opposite end, the retainer top 52 is supported upon a bearing pin 54 that is received in a notch 55 formed in the I-beam 27. A bolt 56 holds the retainer top 52 in position and captures the above described support for the rod 34 within the fabricated assembly at the outer end of the arm 22. The arrangement is such that support for the rod 34 is permitted to shift translationally with respect to the normal longitudinal axis of reciprocation of the rod 34. The rod 34 is always maintained, however, in a vertical position. Thus, the rod 34 may move in directions that are perpendicular to the direction of the normal longitudinal axis but the reciprocation of the rod 34 always takes place along an axis that is parallel to the normal longitudinal axis. Thus, the end 19 of the stopper element 18 may move translationally relative to the seat 21 but may not skew relative to this seat.

In addition to being supported for translational movement, the bearings 46 and 47 permit rotation of the stopper element 17 relative to the arm 22. Although permitting such free rotation may, in some instances, be sufficient to provide for good seating, a device, indicated generally by the numeral 61, is provided for positively rotating the stopper element 18 in a manner which will become more apparent and in a predetermined sequence.

The stopper rotating mechanism 61 includes a lever arm 62 that has a socket opening 63 which receives the nut 44. The opposite end of the lever 62 is cradled in an opening 64 formed in a member 65. The member 65 is connected to a piston rod 66 of a piston (not shown). The piston is received in a cylinder 67 that is affixed to the I-beam 27 by means of an upstanding bracket 68. Reciprocation of the piston and piston rod 66 will cause the member 65 to move and exert a rotational force upon the lever 62. This rotational force is transmitted through the nut 44 to the rod 34 and stopper element 18. The slotted opening 64 is sufficiently large so as to permit movement of the lever 62 with the stopper rod 34 when the latter experiences translational movement. Hence, the lever 62 will not interfere with this translational movement.

In operation, the stopper element 18 is normally in engagement with the seat 21 to preclude flow during the opening 13. At this time, the piston rod 66 of the stopper rotating mechanism 61 is in a first position as viewed in the figures. In this first position the lever 62 is also in a first angular position as shown in the solid-line view of FIG. 3. At the same time, the piston 25 and piston rod 24 are retracted to a first position.

When it is desired to commence the flow the piston 25 is actuated to move it and the piston rod 24 upwardly. This upward movement is transmitted through the arm 22 to the stopper element 18. Its end 19 thereby moves away from the seat 21 and permits flow through the opening 13.

When the stopper element 18 has moved to its opened position, the cylinder 67 is operated in any known manner so as to cause the piston rod 66 and element 65 to move outwardly. The element 65 moves outwardly to a second position, represented by the dotted-line view in FIG. 3, to rotate the lever 62 and stopper element 18 about the longitudinal axis of the latter. Again, the width of a slot or opening 64 is sufficient to permit this movement without binding.

After sufficient flow through the opening has occurred, the cylinder 67 is operated and moves the arm 22 downwardly carrying the stopper element 18 with it. As the stopper element end 19 approaches the seat 21 some misalignment may have occurred. Because of the complementary curved shapes, however, the stopper element 18 will be shifted transversely so that the surfaces 19 and 21 may come into full seating engagement. After the cylinder 26 has cycled to its closed position, the cylinder 67 is actuated to rotate the lever 62 and stopper element 18 back to its first rotational position. During this rotation, some additional translational movement of the stopper element 18 may occur to insure complete shutoff of flow through the opening 13.

It should be readily apparent from the foregoing description that the permission of the translational movement of the stopper element 18 and the oscillation of this element about its longitudinal axis, particularly once it has reciprocated to its closed position insures good shutoff of the flow of liquid through the opening 13. Any known type of arrangement may be provided for controlling the sequential operation of the cylinder 26 and 67 as described.

It is to be understood that the foregoing description is that of a preferred embodiment of the invention. Various changes and modifications may be made without departing from the spirit and scope of the invention as defined by the appended claims.

We claim:

1. A stopper mechanism for controlling the flow of molten metal or the like through an opening comprising a stopper element adapted to control the flow through the opening and means for supporting said stopper element for movement along a longitudinal axis relative to the opening between an opened position and a closed position, said last named means being effective to permit said stopper element to shift transversely relative to said longitudinal axis to locate itself relative to said opening and means restraining the opening and closing movement of said stopper element in directions parallel to said longitudinal axis.

2. A stopper mechanism as set forth in claim 1 wherein the last-named means is effective to permit the stopper element to shift in a plane containing the longitudinal axis.

3. A stopper mechanism as set forth in claim 2 wherein the last-named means permits the stopper element to shift in a plurality of planes containing the longitudinal axis.

4. A stopper mechanism as set forth in claim 1 wherein the last-named means further supports the stopper element for rotation about its axis of reciprocation.

5. A stopper mechanism as set forth in claim 4 further including means for oscillating the stopper element about its axis of reciprocation.

6. A stopper mechanism as set forth in claim 5 further including means for moving the stopper element between its opened position and its closed position and for oscillating the stopper element between first and second positions, and means for interrelating the reciprocating and the oscillating means for effecting rotation of the stopper element in at least one direction when the stopper element is in its closed position.

7. A stopper mechanism as set forth in claim 5 wherein the means for supporting the stopper element comprises a pair of spaced bearings rotatably journaling said stopper element and means for supporting said bearings for translational movement.

8. A stopper mechanism as set forth in claim 4 wherein the means for supporting the stopper element comprises a pair of spaced bearings rotatably journaling said stopper element and means for supporting said bearings for translational movement.

9. A stopper mechanism as set forth in claim 4 wherein the stopper element has an end surface adapted to engage the seat formed at one end of the opening, said stopper element end portion taking the shape of a segment of a sphere, said seat having a conical shape.

10. A stopper mechanism for controlling the flow of molten metal or the like through an opening comprising a stopper element, means for reciprocating said stopper element relative to said opening about a longitudinal axis between an opened position and a closed position, and means for oscillating said stopper element about said longitudinal axis.

11. A stopper mechanism as set forth in claim 10 wherein the means for oscillating the stopper element is effective to move a stopper element from a first position to a second position when the stopper element is in its opened position and for moving said stopper element from its second position back to
its first position when said stopper element is in its closed position.