An outlet valve for a metallurgical bottom-pour ladle with a rotary valve part, which is thrust against a stationary valve part by a prestressed resilient ring surrounding the rotary valve part. The reaction thrust of the resilient ring is supported by a ball or roller bearing. The contact surface between the rotary valve part and the stationary valve part has preferably the form of a spherical calot. The rotary valve part is movable about a vertical axis between an open and a closed position.

11 Claims, 2 Drawing Figures
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ROTOR OUTLET VALVE FOR METALLURGICAL LADLES

The invention relates to an outlet valve for the bottom outlets of ladles containing metal melts.

STATE OF THE ART

In conventional casting ladles the outlet opening in the bottom of the ladle, for running out melt, is usually closed by a destructable plug. It is however also known to use for this purpose a rod which penetrates from the upper part downwards through the melt. The rod is operated by means of a system of links. It is also known to use rotary or sliding valves for controlling the flow of melt running out through the bottom of the ladle or the like. Both these arrangements have disadvantages. A destructible plug does not allow the stream of melt to be controlled, once it has started flowing, and does not allow it to be stopped before the ladle has emptied itself. The arrangement in which a rod penetrates downwards through the melt involves the difficulty that the material of the rod must be capable of withstanding the heat in the melt. Furthermore a new rod or a reconstructed rod has to be used for each fresh batch of melt. On the other hand outlet valves with a sliding part are unsatisfactory in practice, mainly due to the effect of thermal expansion. The sliding parts of such outlet valves have to operate with close tolerances if the melt is to be prevented from penetrating into the clearances between the sliding parts. Under the influence of thermal expansion the sliding parts tend to jam. Considerable forces therefore have to be applied in the operation of the valve and this involves the use of massive, powerful and costly actuating devices.

It is an object of the present invention to provide an outlet valve for ladles which will overcome the above-mentioned drawbacks.

It is a further object of the present invention to provide an outlet valve which is largely insensitive to thermal expansions and manufacturing tolerances and which can be operated with reduced force compared with prior art valves so that the driving mechanism can be made simpler and more compact.

SUBJECT MATTER OF THE INVENTION

Briefly, the rotating valve part is thrust resiliently against a stationary valve part by a prestressed spring whose reaction thrust is transmitted through a ball or roller bearing, or through a system of rollers, to a stationary bearing ring fixed by retaining parts to the bottom of the ladle.

Features of this invention together with further objects and advantages thereof may be best understood by reference to the accompanying drawings, wherein:

FIG. 1 is a vertical section through the bottom part of a ladle equipped with an outlet valve according to the invention.

FIG. 2 is a vertical section through the bottom part of a ladle showing a different form of an outlet valve.

The bottom 1 of a bottom-pour ladle for containing molten metal has a depression 2 or cavity containing an outlet opening 3 substantially circular cross section. The expression "ladle" is defined to also include intermediate vessels for hot metal charges. The lower surface of the ladle bottom 1, which is made of firebrick or refractory lining, has a spherical depression into which is firmly bonded a stationary spherical calotte 4,

by means of an intermediate bonding layer 11 made of refractory mortar or the like. Resting in close contact with the under surface of the spherical calotte 4 there is a second spherical calotte 5 which can be turned relative to the stationary calotte 4. The contact surfaces 34 of the two spherical calottes 4 and 5 are smooth and precisely worked surfaces to ensure that they rest truly in contact with each other everywhere and to ensure that they can slide over each other easily during operation of the valve. The two spherical calottes 4 and 5 are both made of a refractory material, for example a refractory brick. The calottes 4, 5 are preferably moulded to the desired spherical shapes in a press and subsequently sintered. To the under surface of the turnable calotte 5 there is firmly bonded a valve plug 8, by means of an intermediate bonding layer 11 of refractory mortar or the like. Through the valve plug 8 there passes, as shown in FIG. 1, a slightly curved outlet channel 9 for the hot metal melt. The outlet channel 9 is substantially circular in cross section. The valve plug 8 — which consists of heat proof material — is enclosed in a metal jacket 10. The jacket 10, the plug 8 and the lower spherical calotte 5 together form the rotary valve part 28 which can be turned, when the valve is being operated, about a vertical axis of rotation 29. Due to the spherical contacting surfaces 34 of the two calottes 4 and 5 the rotary valve part 28 adapts itself in all directions in accordance with thermal expansions. The two calottes 4 and 5 have openings or passages 6 and 7. When the valve is in its open position, as represented in the drawings, the two passages 6 and 7 coincide with each other so that a continuous outlet passage for the melt is formed. The melt flows therefore through the openings 3, 6 and 7 and thereafter through the outlet channel 9. The slightly curved longitudinal axis 24 of the outlet channel 9 terminates at its lower end offset of the vertical axis of rotation 29 of the rotary valve part 28. The upper end of the outlet channel 9 is displaced to one side of the vertical axis of rotation 29 by a distance which is more than the radius of the outlet channel 9. To close the valve, the rotary valve part 28 is turned about its vertical axis of rotation 29. This brings the opening 7 around into a position in which it no longer coincides with the opening 6, interrupting therefore the stream of melt. The valve can also be so operated that the flow of melt can be controlled by only partly opening or closing the valve.

The lower, rotary spherical calotte 5 is thrust resiliently or springy up against the under surface of the stationary upper calotte 4 by an annular plate spring 12 or cup spring whose inner edge thrusts upwards along the whole circular inner periphery against a ring shoulder 30 of the metal jacket 10 of the valve plug 8. The ring-shaped spring 12 is secured by a plurality of screws 14, distributed around its periphery near the outer surface, to a rotary bearing ring 19. After prestressing the plate spring 12 by the screws 14 a certain amount of clearance remains between the bore of the plate spring 12 and the peripheral surface of the plug jacket 10 as well as between the lower side of the bearing ring 19 and the plate spring 12. The outer periphery of the rotary bearing ring 19 has teeth so that the ring forms a sprocket wheel 20 for co-operating with a chain 46. Instead of a single piece, the rotary bearing ring 19 and the sprocket wheel 20 could be made of two parts secured to each other. Inside and underneath the rotary bearing ring 19 there is a stationary bearing ring 16 which is se-
cured by a plurality of screws 22 to a retainer ring 17, which is in turn fixed firmly by screws 18 to a bottom ring 25, which is welded at its outer edge to a horizontal metallic bottom plate 26 which surrounds the bottom of the ladle.

The rotary bearing ring 19 and the stationary bearing ring 16 both have annular shoulders overlapping each other, forming raceways for closely spaced balls 21 or rollers. This anti-friction bearing 32 is arranged coaxially to the axis of rotation of the rotary valve part 28.

Driving connection is effected between the rotary valve part 28 and the plate spring 12 through at least one driver pin 13 retained in a vertical slot or bore in the wall of the plug jacket 10. The driver pin 13 engages with a certain amount of free play or clearance in a bore in the plate spring 12. The plate spring 12 itself is connected which the rotary bearing ring 19 through at least one driver pin 15 projecting from the lower surface of the rotary bearing ring 19. The driver pin 15 engages, with a certain amount of free play or clearance in a bore in the plate spring 12. The arrangement allows the rotary valve part 28 a certain amount of idle movement relative to the ladle, to ensure that the two spherical calottes 4 and 5 are always thrust into true contact with each other in spite of thermal expansion.

At least one dowel pin 23 ensures rigid engagement of the metallic retainer ring 17 with the button ring 25.

The rotary valve part can be driven in both directions by a motor 44 situated to one side of the valve. Drive motion is transmitted through a pinion 45 and a chain 46 which engages with the sprocket wheel 20. The motor is preferably a compressed air or pneumatic motor driving through a reduction gear which forms a structural unit with the motor. The motor 44 is fixed to the bottom plate 26 by screws or other fastening means. Rotation of the rotary valve part 28 is limited in the fully open and fully closed positions of the valve by mechanical limit stop means 33 and 42, extending from the sprocket wheel 20 and from the retainer ring 17.

The resilient supporting of the rotary valve part 28 with a certain prestressing force and a limited amount of free play ensure that the parts of the valve can adapt themselves extensively both to thermal expansions and to manufacturing tolerances. Consequently the rotary valve part 28 rotating easily relative to the stationary valve part. The use of ball or roller bearing ensures that the rotary valve part operates with much less friction, compared to what is encountered in valves with plain sliding bearing. Therefore, comparatively little force need be applied for operating the valve, compared to hitherto known devices. This is a considerable advantage because the entire driving mechanism can be made simpler and more compact.

Instead of a combined axial-radial thrust bearing — as shown in FIGS. 1 — which takes also the pull of the chain drive a separate bearing for supporting the radial and axial forces could be used.

In regard to the passages 6 and 7 through the two spherical calottes 4 and 5, the axes of these two passages at least approximately intersect the centres of the spherical calottes or, in other words, the axes of the passages 6 and 7 are directed at least approximately radially with reference to the spherical calottes 4, 5. The radius of the spherical contact surface 34 is preferably three to five times the diameter of the outlet channel 9.

The radius of the curvature of the outlet channel 9 should be as great as practicable, to reduce abrasion of the wall of the outlet channel by the stream of metal melt. The smallest radius of curvature of the outlet channel 9 is therefore more than eight times the diameter of the channel. Furthermore the curvature of the outlet channel 9 should be as little as possible to allow the channel 9 to be cleaned out from underneath as far up as the bottom of the ladle. The channel 9 should be straight enough to allow a straight foundry lance of the like, of diameter one quarter of the channel diameter, to be pushed upwards through the channel as far as the interior of the ladle.

The longitudinal middle axis 24 of the channel 9, at the outlet end of the channel, is slightly off centre with respect to the axis of rotation 29 of the rotary valve part 28, these two axes forming an angle of 1° to 5° between them at the lower end of the rotary valve part.

If desired the two axes can coincide at the outlet end of the channel 9.

In the valve shown in FIG. 2 only the bearing for the rotational movement is somewhat differently. Identical or similar parts have the same reference numbers as in FIG. 1 and are functioning in a manner already described in connection with FIG. 1. Instead of a ball bearing 32 with bearing rings 16 and 19 for balls 21 there is in this execution form of a valve a stationary bearing ring 35 which has a sloping annular shoulder forming a roll track 36 for a plurality of truncated conical rollers 37. The rollers 37 are distributed around the inner wall of an outer rotary ring 38. The outer edge of this rotary ring 38 has teeth and forms a sprocket wheel 20 to take a chain. Alternatively however the sprocket wheel and the rotary ring 38 could form two separate parts fixed together. The rotary ring 38 is in driving connection via the plate spring 12 through several driver pins 15 projecting from the lower face of the rotary ring 38 and engaging, with a certain amount of free play or clearance, in bores in the spring plate 12. The free play allows the rotary valve part 28 a limited freedom, relative to the rotary ring 38 in all directions, for compensation of thermal expansions. The rollers 37 rotate on needle roller bearings on bearing pins 39, fixed to the rotary ring 38, to minimize friction. Otherwise this valve according to FIG. 2 functions as already described in FIG. 1.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practised within the scope of the following claims.

What is claimed is:

1. Outlet valve for bottom-pour ladles comprising a stationary valve part (4) and a rotary, moveable valve part (28) each containing an outlet channel (6, 7, 9), said moveable valve part (28) being rotatable by moving means (44, 45, 46) between an open and closed position, prestressed resilient supporting means (12) for thrusting said rotary valve part (28) against said stationary valve part (4) in upward direction, said prestressed resilient means comprising a plate spring ring (12), the inner edge of said plate spring ring engaging a shoulder (30) of said rotary valve part (28) and being movable together with it, bearing means (32) comprising roller means (21, 37) and a stationary bearing ring
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5 (16, 35) surrounding said movable valve part (28), means (22, 40) for fixing said stationary bearing ring (16, 35) to a stationary bottom part (17) of the ladle, said roller means (21, 37) transmitting the reaction thrust of said prestressed resilient means (12) to said stationary bearing ring (16, 35).

2. Outlet valve according to claim 1, wherein said roller means are combined axial-radial thrust anti-friction bearing means (32) arranged coaxially to the axis of rotation of the rotary valve part (28).

3. Outlet valve according to claim 1, wherein the contact surfaces (34) between said rotary valve part (28) and said stationary valve part (4) are spherical calotte surfaces, the rotating axis (29) of said rotary valve part (28) being at least approximately vertical.

4. Outlet valve according to claim 3, wherein the spherical calotte surfaces (34) are upwardly convex so that the center of the calotte will be below said contact surfaces (34).

5. Outlet valve according to claim 3, wherein the outlet channel (9) in the rotary valve part (28) is slightly curved, the tangent to the longitudinal middle axis (24) of said outlet channel (9) near the contact surface (34) being directed approximately radially with respect to said calotte, and the lower end of said outlet channel (9) being off centre with respect to the axis (29) of said rotary valve part (28) and the axis (24) forming an angle of 1° to 5° between them.

6. Outlet valve according to claim 3, wherein the radius of the spherical calotte (5) at the sliding surface (34) is three to five times greater than the diameter of the outlet channel (9) in said rotary valve part (28) and the smallest radius of curvature of said outlet channel (9) is more than eight times greater than the diameter of the outlet channel (9) in said rotary valve part (28).

7. Outlet valve according to claim 1, wherein said roller means are a plurality of conical rollers (37), said stationary bearing ring (35) having a sloping annular shoulder forming a track (36) for said conical rollers, said conical rollers (37) being rotatably supported by the rotary ring (38), said ring (38) being in driving connection with a plate spring (12) forming said resilient supporting means and said driving means (44, 45, 46) cooperating with said ring (38).

8. Outlet valve according to claim 1, wherein said prestressed resilient means is at least one cup spring (12), said bearing means (32) comprising further a rotary bearing ring (19), said cup spring (12) being axially spaced from said rotary bearing ring (19) and secured by a plurality of screws (14) distributed around its periphery to said rotary bearing ring (19), the securing means (15) allowing limited play in all directions between the rotary bearing ring (19) and the cup spring (12).

9. Outlet valve according to claim 1, wherein said moving means comprises a chain sprocket wheel (20), said metallic ring (12) being secured to said chain sprocket (19, 20) wheel by a plurality of screws (14) distributed around its periphery.

10. Outlet valve for bottom-pour ladles comprising a stationary part (4) and a rotary valve part (28), each formed with an outlet channel (6; 7, 9), the contact surfaces (34) between said stationary valve part (4) and said rotary valve part (28) being spherical calotte surfaces, with the axis of rotation (29) of the rotary valve part being approximately vertical;

resilient supporting means (12) in engagement with said rotary valve part (28) and thrusting said rotary valve part against said stationary valve part (4) in upward direction;

a chain sprocket wheel (20) drivingly connected to said movable part at the circumference of the calotte forming the movable part (28);

axial-radial thrust anti-friction bearing means (32) arranged co-axially to the axis of rotation of the rotary valve part (28) to form roller bearing means therefore;

a stationary bearing ring (16, 35) surrounding said movable valve part (28);

a bottom part (17) of the ladle being stationary, and means (22, 40) for securing said stationary bearing ring (16, 35) to said stationary bottom part (17), the roller means (21, 37) of the bearing means transmitting the reaction thrust of said resilient supporting means (12) to said stationary bearing ring (16, 35).

11. Outlet valve according to claim 10, wherein the resilient supporting means comprises an annular-shaped spring means secured to the rotary valve part (28), and said sprocket chain wheel (20) is secured to the annular spring means (12) around the periphery thereof.

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