

[54] **APPARATUS FOR SUPPORTING AND OPERATING A SLIDABLE GATE AND EXTENDED TUBE NOZZLE ON A BOTTOM-POUR VESSEL**

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[51] Int. Cl.**B22d 37/00**

[58] Field of Search.....**164/281, 337; 222/561, DIG. 7, DIG. 1, 512**

[56] **References Cited**

UNITED STATES PATENTS

3,459,346 8/1969 Tiunes.....222/DIG. 7

3,501,068 3/1970 Shapland.....222/DIG. 7
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[57] **ABSTRACT**

A bottom-pour teeming vessel for pouring molten metal into a mold is provided with a slidable gate for controlling the flow of metal and a nozzle extension tube fixed below the gate. A nozzle plate is secured to the vessel bottom and the gate is urged thereagainst by spaced rails mounted on spring-loaded rocker arms on opposite sides of the nozzle. The tube is urged against the underside of the gate by a separate set of spaced rails mounted on spring-loaded rocker arms. The gate and tube are free to slide relative to each other. Means are provided for changing the gate and tube simultaneously or either one separately without disturbing the other.

12 Claims, 10 Drawing Figures

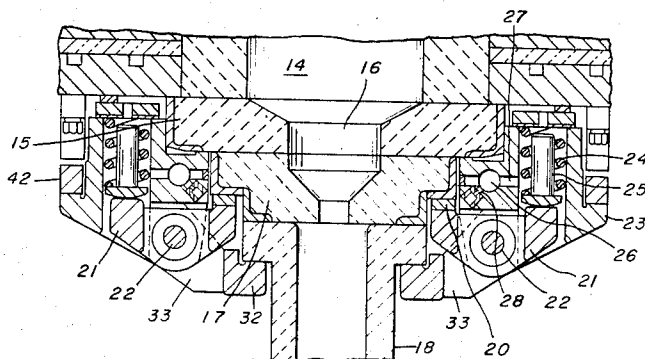


FIG. 3.

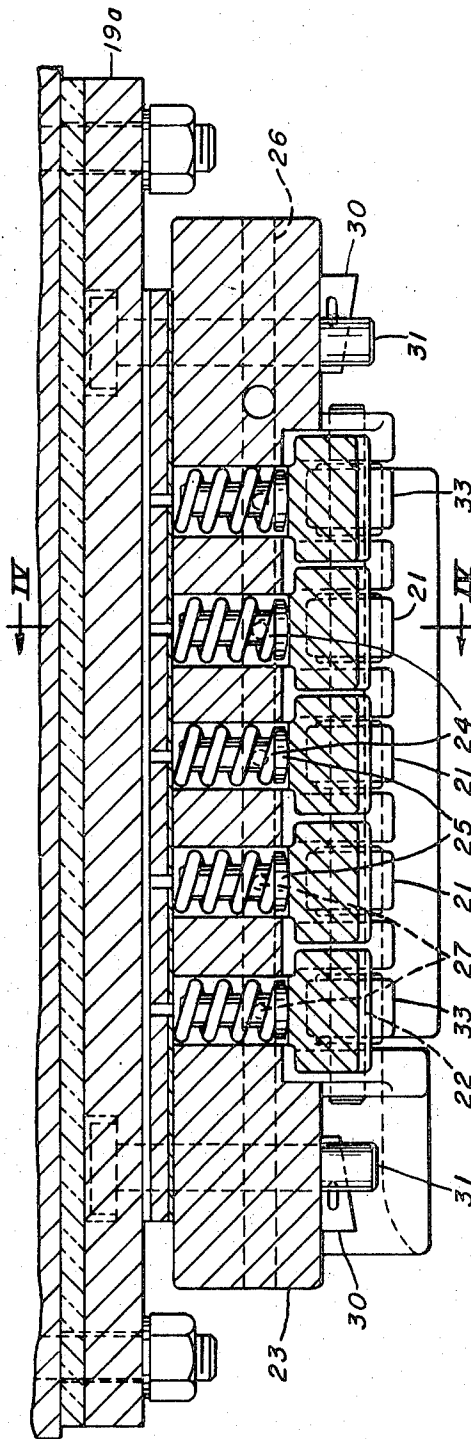


FIG. 4.

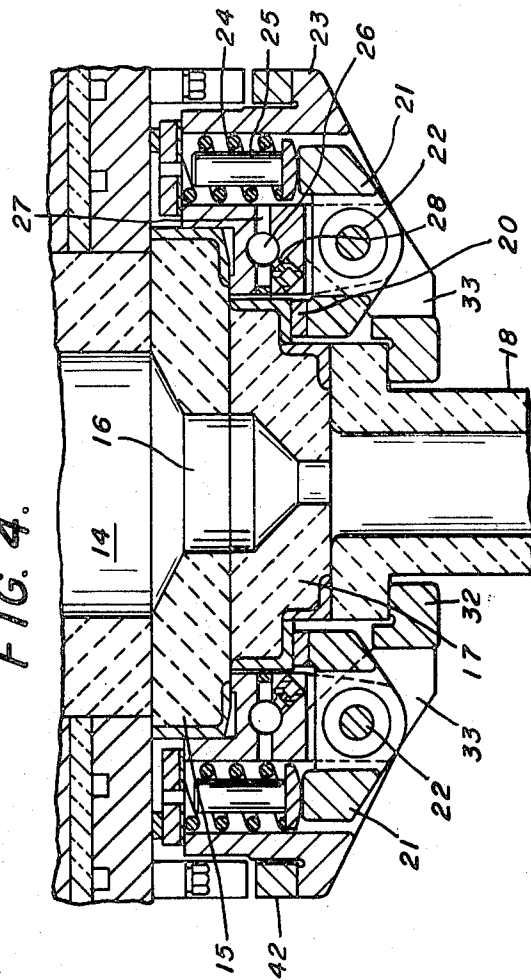


FIG. 5.

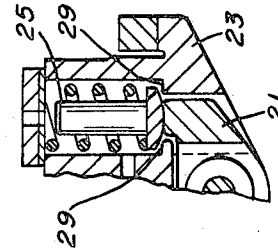


FIG. 6.

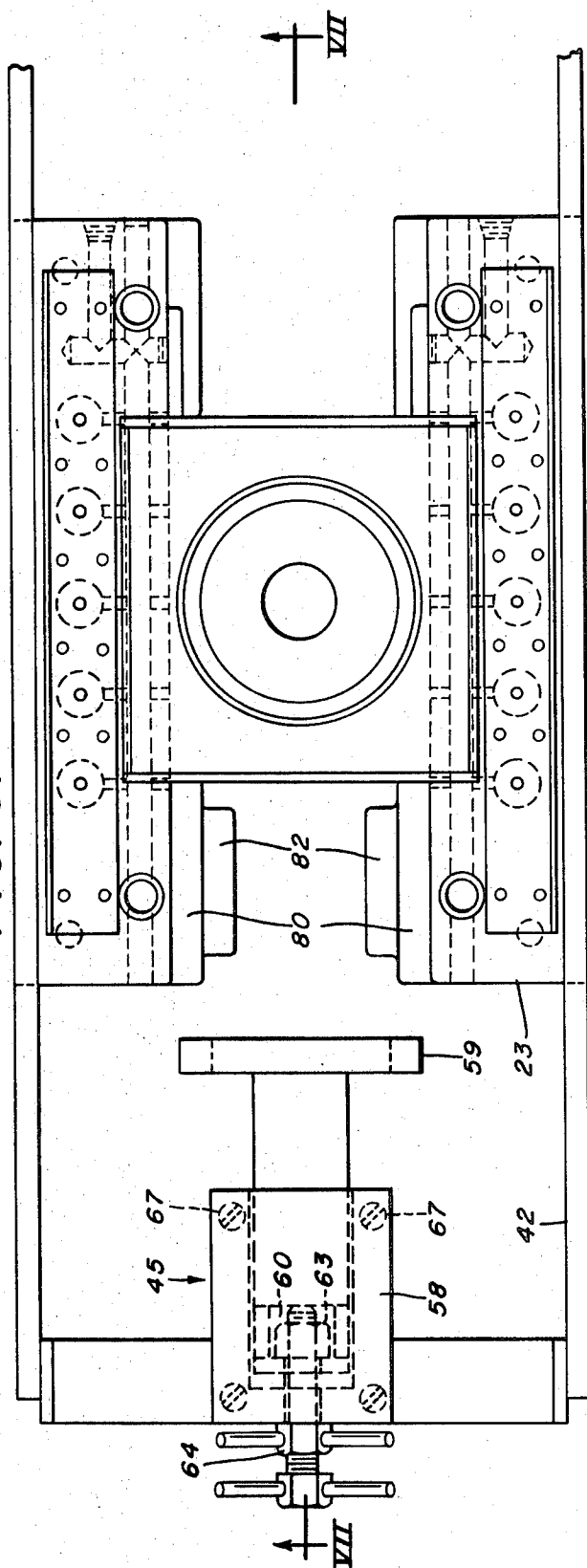


FIG. 7.

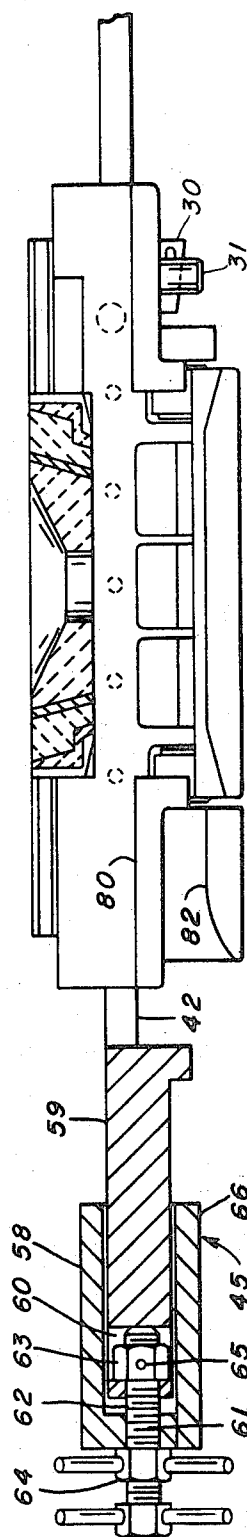


FIG. 8.

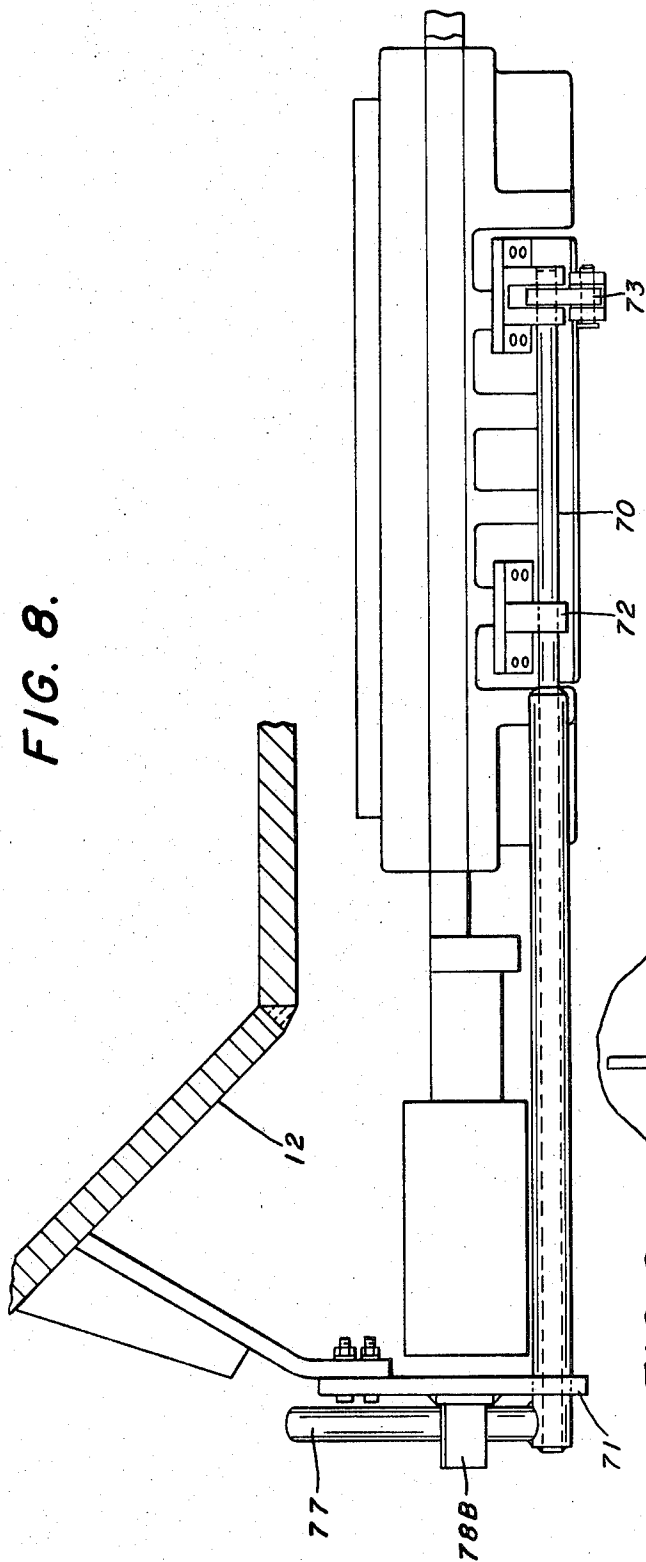


FIG. 9.

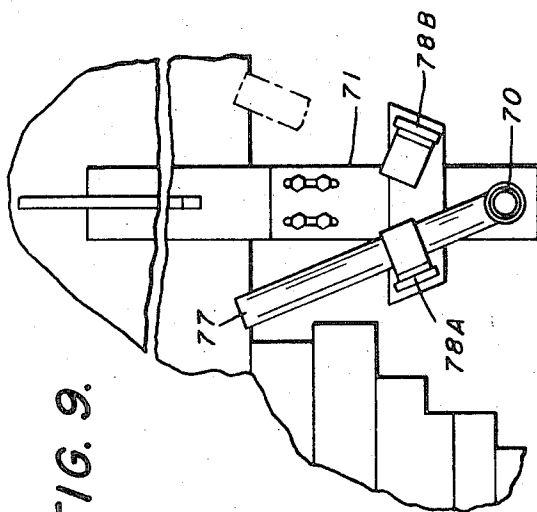
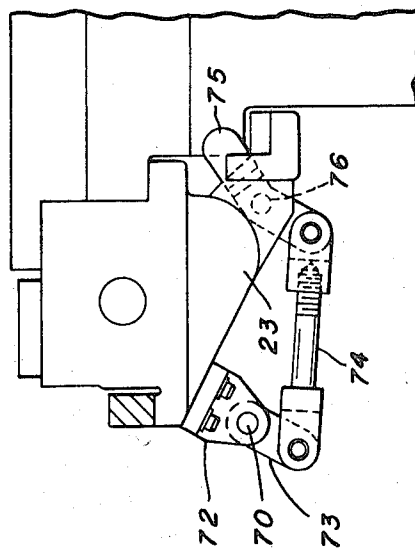


FIG. 10.



APPARATUS FOR SUPPORTING AND OPERATING A SLIDABLE GATE AND EXTENDED TUBE NOZZLE ON A BOTTOM-POUR VESSEL

This invention relates to the teeming of metals, and more particularly to an improved apparatus for supporting slidable gates and extension tubes mounted therebelow.

Although my invention is not thus limited, the apparatus is particularly advantageous as applied to a continuous-casting operation for steel. Oxides of iron form as molten steel is teemed through air into a receiving vessel, such as a continuous-casting mold. Iron oxides and other oxides formed by de-oxidizers, such as aluminum and silicon, are insoluble in molten steel and form a slag-like layer which floats on the surface of the molten steel in the mold. The oxides tend to collect near the mold walls and on the surface of the casting as it solidifies. The oxides impair the quality of the surface and must be removed by suitable treatment, such as scarfing.

Exposure of the molten steel stream to air during teeming also results in surface cracks, pits, scabs and ripples because entrainment of air causes turbulence of the steel stream.

In order to minimize oxidation of steel as it is teemed, to minimize surface irregularities due to a turbulent steel stream and to minimize entrainment of slag due to the stream passing through a slag cover, it is known to protect the stream from exposure to air and slag. This is commonly accomplished by conducting the stream through a tube or sleeve which extends downwardly from the teeming vessel into the mold, as shown in Seidel U.S. Pat. No. 1,923,119 or in Shapland U.S. Pat. No. 3,501,068. Such tubes when used in combination with a slidable gate have been affixed to the gate as shown in Andrzejak et al. Application, Ser. No. 4,965, filed Jan. 22, 1970, now abandoned, or have been fixed to the pouring vessel or some part thereof as shown in the aforementioned Shapland patent. When the tube extends into the mold beneath the surface of the metal, it is subject to attack by slag at the liquid level line. It is therefore desirable to be able to change the extended tube, as well as the slidable gate, especially if the lower end of the extended tube is beneath the surface of the metal in the mold.

Slidable gates are normally moved into operating position by a hydraulic cylinder or a ram. The nozzle in the gate should be co-axial with the vessel nozzle. Any error in alignment can be corrected only by adjusting the cylinder rod or by changing the shims between the cylinder base and the support frame and inserting a new gate in place of the misaligned gate.

It is an object of my invention to provide a means for removably suspending an extended pouring tube beneath a slidable gate independently of the gate.

It is a further object to provide a means for changing the slidable gate without disturbing the extended tube and for changing the extended tube without disturbing the slidable gate and for changing both the gate and the tube simultaneously.

It is another object to provide a means for adjusting the central axis of the gate with respect to the axis of the vessel nozzle without adjusting the cylinder rod or changing shims.

It is a further object to provide simple, rugged and reliable mounting and actuating means for the gate and extended tube.

It is also an object to provide an apparatus that can be quickly changed from straight exposed stream casting to submerged pouring.

It is also an object to provide a hydraulically actuated apparatus for operating a slidable gate in which the hydraulic cylinder is readily removable.

It is also an object to provide an improved means for cooling the mounting means for the gate and extended tube.

These and other objects will be more readily understood by reference to the following detailed specification and the appended drawings, in which:

FIG. 1 is a vertical sectional view of a portion of a bottom-pour vessel having the invention incorporated therein.

FIG. 2 is a top plan view of the gate-operating mechanism of FIG. 1 detached from the vessel.

FIG. 3 is a vertical sectional view of the spring housing mechanism taken along line III—III of FIG. 2.

FIG. 4 is a transverse sectional view of the mechanism of FIG. 3 taken along line IV—IV of FIG. 3.

FIG. 5 is a partial sectional view similar to FIG. 4, but showing a modification of the spring housing mechanism.

FIG. 6 is a horizontal section similar to FIG. 2 but showing a modification of the invention.

FIG. 7 is a vertical sectional view of the embodiment of FIG. 6 taken along line VII—VII of FIG. 6.

FIG. 8 is a front elevational view of the apparatus.

FIG. 9 is an end view taken from the left side of FIG. 8.

FIG. 10 is an end view taken from the right side of FIG. 8.

The drawings show a conventional bottom-pour vessel 10 and a mold 11 positioned beneath the vessel to receive molten metal therefrom. The vessel has a metal shell 12 and a refractory lining 13. The bottom wall of the vessel has an outlet opening 14 and carries a nozzle plate 15 fixed to its underside and having an orifice 16 therein aligned with the opening. A slidable gate closure member 17 is mounted beneath the orifice plate. An extended tube pouring nozzle 18 is mounted beneath the slidable gate. The bottom wall of vessel 10 carries a pair of mounting plates 19a and 19b. The slidable gate is supported by slide rails 20 (FIG. 4) fixed to rocker arms 21. The rocker arms pivot about a shaft 22 mounted on spring housing 23 which is fixed to mounting plate 19a. Enclosed housing 23 contains compression springs 24 which carry spring guides 25 which bear downwardly against the outboard ends of rocker arms 21. The housing has longitudinal holes 26 through which cooling air is introduced, sized ports 27 leading to the spring chambers, and ports 28 aimed at the rocker arms, through which holes and ports air is forced around the springs and over the rocker arms and slide rails. FIG. 5 shows an alternative housing configuration in which the spring guide can be bottomed against ledges 29 in housing 23 when gates are not in the mechanism or when the mechanism is removed from the tundish. Thus the rocker arms are free from spring pressure and can easily be replaced or repaired. Housing 23 is itself fastened to the vessel bottom by suitable means such as tapered keys 30 (FIG. 7) in slotted pins 31. The extended tube pouring nozzle is supported by rails 32 fixed to rocker arms 33. These rocker arms 33 also are pivoted about shaft 22 outboard of arms 21.

The actuating or gate-changing mechanism as shown in FIGS. 1 and 2 comprises a double-acting fluid-pressure cylinder 40 with trunnions 41, an open rectangular frame 42, an adjustable clevis mechanism 43 and an adjustable pusher mechanism 45.

The cylinder trunnions 41 are supported in brackets 46 which are attached to mounting plate 19b. Locking pins 47 retain the trunnions in the brackets. These locking pins include ear 48 and twisting handle 49. When the locking pins are in the locked position, ear 48 engages recess 50 in the brackets 46. Hydraulic cylinder 40 has a threaded piston rod 52 which is received by threaded hole 53 in the clevis. Proper spacing between the cylinder and the clevis is maintained by locking nut 54 on the piston rod. The clevis is attached to frame 42 by a locking pin 56 which is substantially the same as pin 47. Frame 42 extends from the clevis to pusher mechanism 45. The pusher mechanism includes a housing 58 and an L-shaped pusher block 59. The long arm of the block, which has a recess 60 near its end as shown in FIG. 1, is positioned in the housing. Adjusting bolt 61 is engaged in threaded hole 62 in the end of the housing and extends through a hole in the block 59 into recess 60, where it is engaged by retaining nut 63. Jam nut 64 on bolt 62, exterior to housing 58, provides a means of locking the block. A cotter pin 65 holds nut 63 on bolt 61. A top plate 66 is removably attached to housing 58 by screws 67.

A stop mechanism for holding the pouring tube when the gate is changed is shown in FIGS. 7, 9 and 10. Rod 70 is journaled in arm 71, which is fixed to the vessel, and in bearing 72 which is fixed to the housing. One end of links 73 is fixed to rod 70, the other end of link 73 is pivotally connected to adjustable link 74 which is in turn pivotally connected to stop 75. The stop is pivotal about pin 76 which is housed in housing 23. Rod 70 has a handle 77 at the end opposite the stop. The handle is movable between handle stops 78A and 78B which are fixed to arm 71.

In the modified embodiment shown in FIGS. 6 and 7, a pair of gate supports 80 and a pair of tube supports 82 are provided on spring housing 23 for initial support of gate 17 and tube 18 respectively. A deflector shield 85, shown in FIG. 1, is attached to the vessel to deflect expended gates or tubes downward and prevent damage to the gate changing mechanism.

In operation, the spring-housing assembly 23 is installed on the bottom of the vessel by driving tapered keys 30 into slotted pins 31. An extended tube is positioned on supports 82. A blank gate (not shown) is positioned above the tube on supports 80. Hydraulic cylinder 40 is operated and forces the piston rod out of the cylinder moving the clevis, which moves frame 42 to the right, as seen in the drawings, and with it the pusher mechanism 45. The face of pusher block 59 abuts both the blank gate and tube simultaneously and moves them into position beneath the nozzle plate 15. Springs 24, through rocker arms 21 and 33 and rails 20 and 32, furnish the compressive force necessary to hold both the gate and tube in place against the nozzle plate 15. Hydraulic cylinder 40 is operated in the opposite direction, returning the frame 42 and pusher mechanism 45 to their original positions. A pouring gate having a nozzle orifice therein is then placed on supports 80 in position to be pushed into alignment with the nozzle plate when pouring is to begin. The ves-

sel is lowered over the mold 11 until the outlet end of tube 18 is beneath the level the meniscus will assume in the mold. Cylinder 40 is operated and again it moves frame 42 to the right carrying the pouring gate into position beneath the nozzle plate and expelling the blank gate. Metal then flows through the pouring gate and through the pouring tube into the mold. Cylinder 40 is operated in the other direction and a closure member is placed on supports 80. During the gate changing step, the tube remains in pouring position because the stop 75 holds it in position, preventing it from moving.

When a new extended tube is to be inserted, stop 75 must first be repositioned so it will not prevent movement of the expended tube. This is accomplished by moving handle 77 against stop 78B which rotates rod 70 moving links 73 and 74, and rotating stop 75 about pin 76.

If it is desired to change the extended tube, the vessel must be raised so that the extended tube will not strike against the mold. A replacement tube is then positioned on supports 82 and the pusher mechanism is actuated, bringing the replacement tube into position beneath the pouring gate and expelling the previous tube.

Although the drawings show a stop for the tube only, a second stop mechanism could be provided to hold the gate in position while changing the tube. This gate stop mechanism would be a mirror image to the tube stop, installed in the opposite half of housing 23, but having a longer stop which will contact the side of the gate when in the stop position. Alternatively, a second stop position can be provided on the depicted stop to selectively hold either the gate or the tube in position while the other is being changed. If it is desired to change both the sliding gate and the extended tube, replacement members for each are positioned on the respective supports 80 and 82 and the pusher mechanism is actuated, bringing both replacement members into position beneath the nozzle orifice.

The pusher block may be adjusted to ensure proper positioning of the sliding gate and immersion tube merely by loosening jam nut 64 and screwing adjusting bolt 61 into or out of housing 58. If pusher mechanism 45 becomes damaged, it can be removed simply by removing screws 67 and removing the cotter key 65 from retaining nut 63.

It can readily be seen from the foregoing that my invented apparatus provides means for supporting both a slidable gate and an extended pouring tube nozzle therebeneath as well as means for changing the gate and tube simultaneously or either one separately without disturbing the other. Further, its adjustable features assure the proper positioning of both a gate and a tube beneath the nozzle of a bottom-pour vessel.

I claim:

1. In combination, a bottom-pour vessel having a nozzle in its bottom wall, a slidable gate for selectively closing said nozzle, an extended pouring tube, and an apparatus for supporting and operating said gate and said tube, said apparatus comprising:

a base affixed to the bottom of said vessel;

a plurality of compression springs housed in said base;

sets of rocker arms pivotally attached to said base, said sets being equally and oppositely disposed, the outboard ends of said rocker arms being urged downwardly, a number of said arms being relatively long, the remainder of said arms being relatively short;

a first pair of spaced rails fixed to said long arms, whereby said first rails support said tube;

a second pair of spaced rails fixed to said short arms, whereby said second rails support said gate; and means supported by said vessel for moving said gate and said tube into and out of vertical alignment with said vessel nozzle.

2. A combination as defined in claim 1 in which said means comprises:

a hydraulic cylinder connected to said vessel, a clevis against which the piston rod of said hydraulic cylinder bears,

an adjustable pusher assembly, and

an open frame connecting said clevis to said assembly.

3. A combination as defined in claim 2 in which said pusher assembly comprises:

a housing open at its top and end, and having a threaded hole in its closed end,

a removable cover fixed to the top of said housing,

a pusher block positioned in said housing having an arm extending downwardly exterior to said housing, said pusher block having a recess therein and a hold through the end of the block opposite to the downwardly extending arm,

an adjusting bolt passing through the threaded hole in said housing and the hole in said pusher block,

a retaining nut in said recess of said pusher block engaging said bolt, and

a jam nut locking said bolt exterior to said housing.

4. A combination as defined in claim 2 in which said piston rod carries a threaded projection, a jam nut threadedly engages said projection, and said clevis is internally threaded and receives said projection.

5. A combination as defined in claim 2 in which said clevis and said frame each have a vertical hole substantially in alignment and a pin inserted in said hole connects said clevis to said frame.

6. A combination as defined in claim 5 in which said pin has an ear at one end substantially at a right angle to the body of said pin and a handle at its opposite end, and said clevis has a recess to accommodate said ear, whereby said pin can be quickly and easily removed from said holes by rotating the pin until the ear is aligned with the hole, then pulling the pin axially, removing it from the hole, disengaging the clevis from the stirrup.

7. A combination as defined in claim 1 further comprising means connected to said vessel for supporting said gate in a position adjacent the position of alignment with said vessel nozzle.

8. A combination as defined in claim 1 further comprising means connected to said vessel for supporting said tube in a position adjacent the position of alignment with said vessel nozzle.

9. A combination as defined in claim 1 further comprising a deflector shield connected to said vessel in the horizontal path of ejection of a slidable gate.

10. A combination as defined in claim 1 further comprising means for air cooling said rocker arms.

11. A combination as defined in claim 1 in which a base plate is fixed to said vessel and has a plurality of slotted pins depending therefrom, said base has a hole to receive each pin which protrudes through said hole, and said base is connected to said base plate by a tapered wedge inserted in the slot of each of said pins.

12. A combination as defined in claim 1 in which each spring chamber is provided with a shoulder at one end, and a spring guide is positioned in each spring which is adapted to contact said shoulder when said rocker arm is not supporting a gate, whereby the spring pressure is relieved from each of said rocker arms to facilitate removal and replacement of said rocker arms.

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