

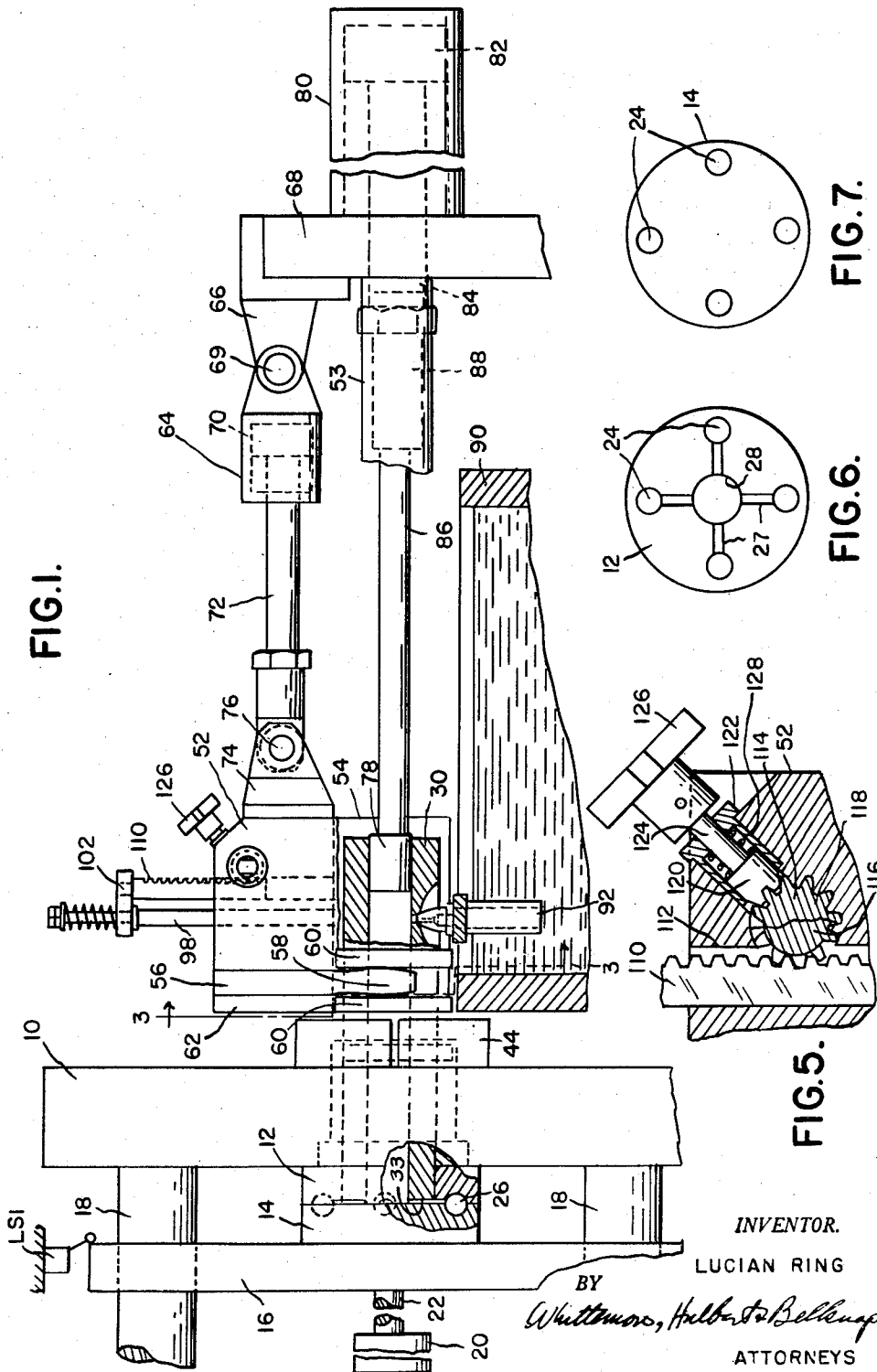
June 10, 1958

L. RING
DIE CASTING MACHINE

2,837,794

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

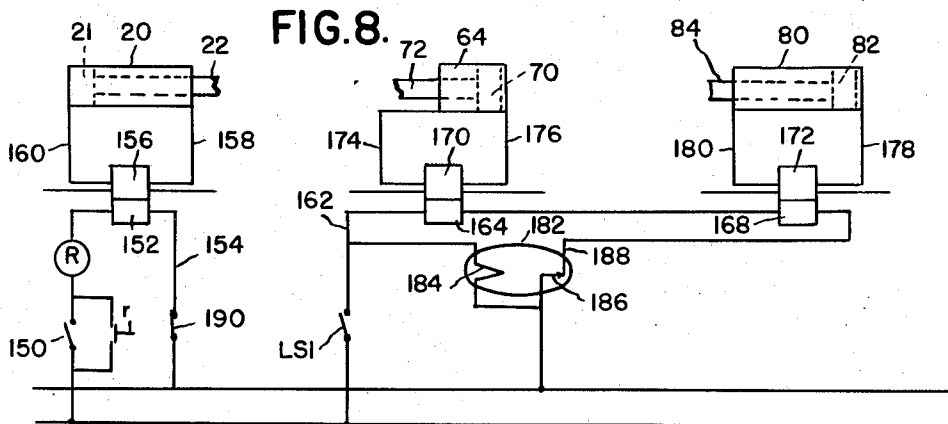


FIG. 3.

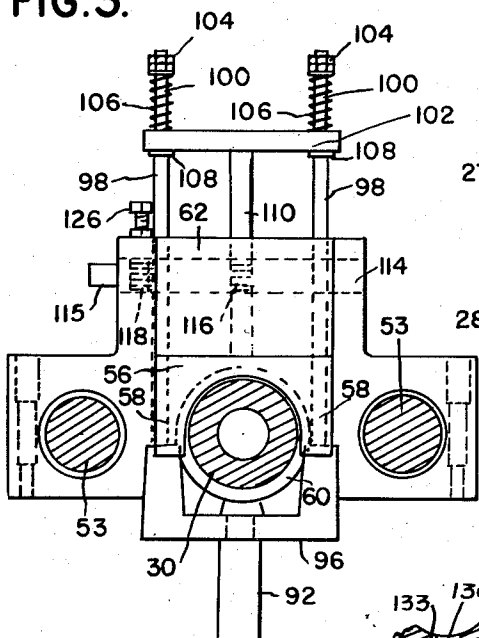


FIG. 2.

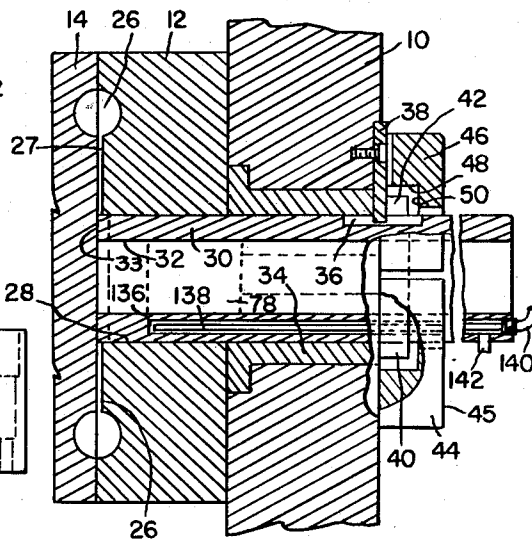
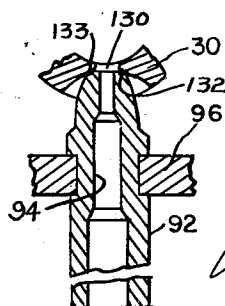


FIG. 4.



INVENTOR.
LUCIAN RING

BY

Whittemore, Herbert & Bellows

ATTORNEYS

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DIE CASTING MACHINE

Lucian Ring, Birmingham, Mich., assignor to Ring Aluminum Development Company, Clawson, Mich., a corporation of Michigan

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10 Claims. (Cl. 22—68)

This invention relates to die casting equipment and refers more particularly to apparatus of the type employed in die casting lightweight non-ferrous metals such, for example, as aluminum, magnesium and zinc.

One object of this invention is to simplify, as well as greatly expedite the manufacture of die castings on a high volume production basis by substantially reducing the time required to transfer molten metal from the source of supply to the interior of the injection cylinder.

Another object of the invention is to provide die casting apparatus of the above type wherein provision is made for sealing the cylinder from the atmosphere during the retraction of the plunger in the cylinder in order to produce a sub-atmospheric pressure in the cylinder in advance of the plunger sufficient to draw the required quantity of molten metal through an intake port formed in the cylinder in a position to be uncovered by the plunger before the plunger reaches its limit of retracting movement.

The foregoing, as well as other objects of the invention, will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is a side elevational view, partly in section, of die casting apparatus embodying the invention.

Figure 2 is an enlarged fragmentary sectional view of a portion of the apparatus shown in Figure 1.

Figure 3 is a sectional view taken along the line 3—3 on Figure 1.

Figure 4 is an enlarged fragmentary sectional view of a portion of Figure 1.

Figure 5 is a sectional view of a portion of the apparatus shown in Figure 1.

Figure 6 is an elevational view of the stationary die part.

Figure 7 is an elevational view of the movable die part.

Figure 8 is a combined hydraulic and wiring diagram.

Referring now more particularly to the drawings, the apparatus includes a stationary support or platen 10 having a stationary die part 12 secured thereto. A die part 14 is carried by a member 16 which is slidable on the rods 18 which project in an outward direction from the platen 10 and extend through openings in member 16. A cylinder 20 is provided for reciprocating the member 16 and has a piston 21 therein connected to the member by a connecting rod 22. Inward and outward movement of the member 16 causes the movable die part to be moved toward and away from the fixed die part.

The adjacent surfaces of the die parts 12 and 14 are formed with recesses 24 which respectively register with each other in the closed position of the die parts to provide die cavities 26. The fixed die part 12 is formed with grooves 27 which extend from the central opening 28 to the respective recesses 24 to enable charging the die cavities with molten casting material in the closed position of the die parts, that is, when the adjacent sur-

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faces of the die parts are in surface-to-surface contacting relation.

Molten casting material is injected into the die cavities by an injection cylinder 30. The injection cylinder 30 is in the form of an elongated tube having a through passage 32, the cylinder having its outer end slidably extending through the central opening 28 in the fixed die part 12 and also slidably supported in a bushing 34 secured in an opening through the fixed platen 10. The injection cylinder is closely received in the opening 28 and the bushing 34 to permit axial sliding movement thereof. As seen in Figure 2, the injection cylinder has a groove 36 in its external surface which is elongated in the direction of length of the cylinder and into which extends a key 38 secured to the platen 10. The key 38 is slidably received in the groove 36 and is provided to prevent rotation of the cylinder relative to the fixed support 10.

The injection cylinder has a ring 40 secured thereto and extending about the latter which is formed with a notch 42 for clearing the key 38. An annular cap 44 loosely embraces the cold chamber and is secured to the support 10. The cap 44 may be formed of two half sections 45 and 46 if desired for convenience of assembly. The cap has an annular groove 48 in the side adjacent the support 10 and the base 50 of the groove is provided to engage the ring 40 and thereby limit the inward movement of the injection cylinder.

Normally the outward movement of the injection cylinder is limited by engagement of the outer end thereof with the movable die part 14. The discharge or outer end 33 of the injection cylinder is in the form of a plane annular surface at right angles to the axis of the injection cylinder and the adjacent surface of the movable die part is in a plane parallel to said annular surface 33 so that in the outer position of the injection cylinder, shown in full lines in Figure 2, the injection cylinder engages the movable die part and provides a seal throughout the full 360° of engagement to seal the interior of the injection cylinder from the atmosphere. In the open position of the die, that is when the movable die is shifted outwardly from the position shown, the injection cylinder may move outwardly a small amount farther until the ring 40 thereon engages the bushing 34 to limit further outward movement.

The injection cylinder is moved inwardly and outwardly by apparatus including the block 52. The block 52 has a longitudinally extending groove 54 on the under side to loosely overlie and surround the upper and side portions of the injection cylinder. Block 52 is slidably supported on rods 53 which extend between supports 10 and 68 through holes in the block.

Secured to the outer end of the block 52 is a yoke 56, the legs 58 of the yoke extending downwardly along opposite sides of the injection cylinder between the longitudinally spaced rings 60 which are secured to and surround the injection cylinder. The yoke 56 is secured to the block 52 by a plate 62.

The injection cylinder may be moved inwardly and outwardly by a corresponding movement of the block 52 and this is accomplished by a cylinder 64. The cylinder 64 has one end pivotally connected to a bracket 66 by a pin 69, the bracket being mounted on a fixed support 68. The piston 70 within cylinder 64 is connected to one end of a connecting rod 72 extending through the outer end of cylinder 64, the other end of the connecting rod being pivoted to a bracket 74 by a pin 76. Bracket 74 is secured to the block 52. Hence, reciprocation of the piston 70 will effect a corresponding reciprocation of the block 52.

A plunger 78 is reciprocable within the passage 32 in the injection cylinder and is provided for forcing a

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charge of molten casting material into the die cavities upon outward movement of the plunger. The plunger is reciprocated in the injection cylinder by a cylinder 80. More specifically, the piston 82 within cylinder 80 is connected to a rod 84 which projects through the outer end of cylinder 80 and through an opening in support 68. Rod 84 is connected to the inner end of rod 86 by a coupling 88, the outer end of rod 86 being secured to plunger 78. The plunger 78 is shown in its retracted or inner position in Figure 1 and is capable of moving in an outward direction toward the outer end of the cylinder to force a charge of casting material into the die cavities.

The molten casting material is contained in a reservoir 90 located beneath the injection cylinder. A supply tube 92 is provided for the transfer of casting material from the reservoir to the injection cylinder. The casting material in the reservoir may be heated to a molten condition by any suitable means. The supply tube has a passage 94 which extends from one end to the other of the tube, the lower end of the tube being at all times immersed in the casting material. The central portion of the supply tube is secured to a yoke 96, the legs of which are carried by the vertically extending rods 98 which extend through vertical openings in the block 52 for sliding movement therein. The upper end portions 100 of the rods are of reduced cross-section and a plate 102 has a pair of openings thereto in which the reduced portions of the rod are slidably received. The upper ends of the reduced portions are provided with abutments 104, and compression coil springs 106 are supported on and surround the reduced portions, being compressed between the abutments and the plate 102. The springs urge the plate 102 downwardly against the fixed abutments 108 on the rods.

A vertically extending rack 110 has the upper end secured to plate 102 and the lower end extends into a vertical passage 112 in block 52. A shaft 114 is rotatably supported in a transverse opening in block 52 and has a polygonally shaped external end 115 for cooperation with a suitable wrench to rotate the same. A pinion 116 secured to the shaft and engageable with the rack is provided for raising and lowering the rack upon rotation of shaft 114. Raising and lowering of the rack of course imparts a corresponding movement to the supply tube thereby moving it up and down into and out of operative relation with the injection cylinder. The springs 106 provide a means for cushioning the engagement between the supply tube and the injection cylinder.

The shaft 114 also carries a pinion 118 which is secured thereto. A detent 120 cooperates with the pinion 118 to hold it against rotation. The detent 120 is slidable in a cup-shaped retainer 122 secured in a passage in block 52 and the detent has a reduced shank 124 which extends outwardly through the base of the retainer. The shank is slidable in the base of the retainer and has a head 126 by means of which it may be grasped and withdrawn from pinion 118. A compression coil spring 128 is disposed in the retainer 122 encircling the shank 124 and having its opposite ends compressed between the detent and the base of the retainer normally urging the detent into engagement with the pinion as illustrated in Figure 5.

The injection cylinder has an intake port 130 in its underside and a frusto-conical seat 132 surrounds the intake port. The upper end of the supply tube is formed with an annular surface 133 adapted to engage the frusto-conical seat in the upper position of the supply tube whereby molten casting material may be drawn into the injection cylinder. The annular surface 133 forms a complete seal with the seat 132 throughout the full 360° thereof to seal the injection cylinder.

The injection cylinder has longitudinally extending passages 136 extending from the inner end to a point adjacent the outer end. Tubes 138 extend into these passages and terminate short of the outer ends thereof.

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The tubes are of substantially less diameter than the passages to provide a return for cooling medium introduced into the tubes by pipes 140. Discharge pipes 142 communicate with the passages to withdraw the coolant.

In order to start the machine, the supply tube 92 is raised to the operative position illustrated in which its annular surface 133 sealingly engages the conical seat 132.

The operation is as follows: momentary closing of the start button 150 is operative to energize the solenoid 152 through circuit 154. The solenoid 152 controls the 4-way 2-position valve 156. When the solenoid 152 is de-energized it is spring loaded to a position wherein the valve 156 admits fluid under pressure to the inner end of the cylinder 20 via hydraulic line 158 and exhausts fluid from the outer end of the cylinder via line 160 to open the die. However, upon energization of the solenoid 152, it shifts the valve 156 so as to admit fluid under pressure through line 160 and to exhaust fluid through line 158 to move the movable die part 14 inwardly, or to the right, to close the die. As the movable die part approaches closed position, the limit switch LS-1 is closed by engagement with the movable member 16 to close the circuit 162 to solenoids 164 and 168. Solenoids 164 and 168 respectively control the 4-way 2-position valves 170 and 172. Relay R in circuit 154 has a contact (r) in the holding circuit 153 which holds the circuit 154 energized after the start button is released.

When solenoid 164 is de-energized, it is spring loaded to a position wherein the valve 170 admits fluid under pressure to the outer end of cylinder 64 by hydraulic line 174 and exhausts fluid from the inner end of the cylinder via line 176 to retract the injection cylinder to its inner limiting position, as determined by the engagement of ring 40 with the cap 44. The location of the discharge end of the injection cylinder when thus retracted is shown in dotted lines in Figure 2. When solenoid 168 is de-energized, it is spring loaded to a position wherein the valve 172 admits fluid under pressure to the inner end of cylinder 80 via hydraulic line 178 and exhausts fluid from the outer end of the cylinder via line 180 to advance the plunger 78 to its outer limiting position axially beyond the intake port to the injection cylinder.

However, when solenoid 164 is energized, the valve 170 is shifted to admit fluid under pressure to the inner end of the cylinder 64 and to exhaust the outer end, thereby advancing the injection cylinder outwardly until its discharge end 33 moves into sealing engagement with the adjacent surface of the movable die part 14. This position of the injection cylinder is shown in solid lines in Figure 2. The annular surface 33 at the discharge end of the injection cylinder sealingly engages with the adjacent surface of the die part 14 throughout the full 360° thereof to seal the interior of the cylinder from the atmosphere. Simultaneously, with the energization of the solenoid 164, solenoid 168 is also energized to shift valve 172 to a position admitting fluid to the outer end of cylinder 80 and exhausting the inner end to retract the plunger 78 from its outer limiting position shown in dotted lines in Figure 2 inwardly beyond the intake port to the position shown in Figure 1. Since the movement of the injection cylinder is very short as compared with the movement of the plunger, the injection cylinder is sealed at the discharge end almost immediately so that the further and continued retraction or inward movement of the plunger creates a vacuum or sub-atmospheric pressure within the cylinder which increases with the inward movement of the plunger. When the plunger uncovers the intake port during its inward movement, the vacuum within the cylinder is sufficient to draw molten casting material from the reservoir into the cylinder through the supply tube. It will be understood, of course, that the plunger has a close sliding engagement with the inner surface of the cylinder to maintain the vacuum created at the outer end of the plunger during its inward movement.

A time delay relay 182 is provided to determine the period of energization of solenoids 164 and 168. When limit switch LS-1 is closed, the coil 184 of the time delay relay is energized and after the time interval set into the time delay relay has elapsed, the normally closed contact 186 moves out of engagement with the lead 188 to break the circuit to the solenoids 164 and 168. Thereupon, the solenoids are shifted to their normal positions by springs (not shown) to return the valves 170 and 172 to their normal positions in which the injection cylinder is retracted inwardly out of sealing engagement with the movable die part and the plunger is advanced outwardly to force molten casting material in the cylinder outwardly beyond the discharge end of the cylinder and into the die cavities 26 through the grooves 27 in the fixed die parts which are in open communication with the discharge end of the injection cylinder when it is in its retracted or inward position.

The injection cylinder remains in its retracted position shown in dotted lines in Figure 2 and the plunger in its advance or outer position a period of time determined to permit the solidification of the casting material in the die cavities. During this time, the plunger 78 is pushing against the casting material at the outer end of the cylinder with a considerable pressure to insure that the die cavities are completely filled. After the time allowed for solidification, the normally closed stop button 190 is pressed to open the circuit 154 thereby de-energizing solenoid 152 and shifting valve 156 to open the die. Plunger 78 is enabled to move outwardly until the piston 82 bottoms in the cylinder 80 determining its limit of outward movement. This additional outward movement of the plunger is effective to eject the waste material remaining in the outer end portion of the cylinder. When the die opens, that is, when the movable die part moves outwardly, limit switch LS-1 is opened to de-energize the time delay relay 182.

Another cycle of operation may be started by merely again closing the manual start button 150.

The drawings and the foregoing specification constitute a description of the improved die casting machine in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. Die casting apparatus comprising a die having a cavity, means for introducing molten casting material into said cavity including an axially shiftable cylinder having a discharge opening at the outer end in communication with said cavity and having an intake port for molten casting material spaced inwardly from the discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between the discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a source of molten casting material, said die having an abutment surface adjacent said discharge opening axially outwardly thereof, and means operative in timed relation to said plunger and upon initial movement of said plunger axially inwardly of said cylinder to shift said cylinder axially outwardly to sealingly engage the outer end of said cylinder with said abutment surface to close said discharge opening and produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the axially inner side of said intake port.

2. The apparatus defined in claim 1 including means operative in timed relation to said plunger and upon initial movement of said plunger axially outwardly of said cylinder to shift said cylinder axially inwardly to disengage said outer end and abutment surface and open

communication between said discharge opening and cavity.

3. Die casting apparatus comprising a die having a cavity, means for introducing molten casting material into said cavity including an axially shiftable cylinder having a discharge opening at the outer end in communication with said cavity and having an intake port for molten casting material spaced inwardly from the discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between the discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a source of molten casting material, said die having an abutment surface adjacent said discharge opening axially outwardly thereof, power means alternately operative to move said cylinder axially outwardly to sealingly engage said outer end of said cylinder with said abutment surface to close said discharge opening and to move said cylinder axially inwardly to disengage said outer end and abutment surface to open communication between said discharge opening and cavity, means operative in timed relation to said plunger and upon initial movement of said plunger axially inwardly of said cylinder to actuate said power means to move said cylinder axially outwardly to sealingly engage said outer end with said abutment surface to produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the axially inner side of said intake port, and means operative in timed relation to said plunger and upon initial movement of said plunger axially outwardly of said cylinder to actuate said power means to move said cylinder axially inwardly to disengage said outer end and abutment surface and open communication between said discharge opening and cavity.

4. The apparatus defined in claim 3 in which said abutment surface is a plane surface at right angles to the axis of said cylinder, and said outer end of said cylinder is a plane annular surface also at right angles to the axis of said cylinder and surrounding said discharge opening.

5. The apparatus as defined in claim 4 in which said cavity is located radially outwardly of said cylinder and communicates with the latter through a passage in said die axially inwardly of said abutment surface.

6. Die casting apparatus comprising a die having a cavity, means for introducing a molten casting material into said cavity including a movable cylinder having a discharge opening in communication with said cavity and having an intake port for molten casting material spaced inwardly from said discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between said discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a source of supply of molten casting material, sealing means adjacent said discharge opening, means for moving said cylinder to sealingly engage said discharge opening with said sealing means to close said discharge opening, and means operative in timed relation to said plunger for actuating said moving means during axially inward movement of said plunger to close said discharge opening and produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the inner side of said intake port.

7. Die casting apparatus comprising a die having a cavity, means for introducing molten casting material into said cavity including an axially shiftable cylinder having a discharge opening at the outer end in communication

with said cavity and having an intake port for molten casting material spaced inwardly from said discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between said discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a source of molten casting material, an abutment surface adjacent said discharge opening axially outwardly thereof, means for shifting said cylinder axially outwardly to sealingly engage said outer end of said cylinder with said abutment surface to close said discharge opening, and means operative in timed relation to said plunger for actuating said shifting means during axially inward movement of said plunger to close said discharge opening and produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the inner side of said intake port.

8. Die casting apparatus comprising a die having a cavity, means for introducing molten casting material into said cavity including an axially shiftable cylinder having a discharge opening at the outer end in communication with said cavity and having an intake port for molten casting material spaced inwardly from said discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between said discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a source of molten casting material, an abutment surface adjacent said discharge opening axially outwardly thereof, means for shifting said cylinder axially outwardly to an outer position in which said outer end of said cylinder sealingly engages said abutment surface to close said discharge opening and axially inwardly to an inner position disengaging said outer end and said abutment surface to open communication between said discharge opening and said cavity, means operative in timed relation to said plunger for actuating said shifting means during axially inward movement of said plunger to shift said cylinder axially outwardly to its outer position to close said discharge opening and produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the inner side of said intake port, and means operative in timed relation to said plunger for actuating said shifting means during axially outward movement of said plunger to shift said cylinder axially inwardly to its inner position opening communication between said discharge opening and cavity.

9. In die casting apparatus including a die having a cavity, means for moving molten casting material to be introduced into said cavity including a cylinder having a discharge opening and having an intake port spaced inwardly from said discharge opening axially of said cylinder, a plunger supported in said cylinder for axial sliding movement between said discharge opening and a position at the axially inner side of said intake port, means providing a supply passage communicating with said intake port and with a supply of molten casting material, and means operative in timed relation to said plunger for closing said discharge opening during movement of said plunger axially inwardly of said cylinder to produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the inner side of said intake port.

10. Die casting apparatus comprising a die having a cavity, means for introducing molten casting material into said cavity including a movable cylinder having a discharge opening adapted to communicate with said cavity and having an intake port for molten casting material spaced inwardly from said discharge opening axially of said cylinder, a plunger supported in said cylinder for axially inward sliding movement to a position at the inner side of said intake port and axially outward sliding movement outwardly beyond said intake port to expel molten casting material in said cylinder from said discharge opening, means providing a supply passage communicating with said intake port and with a source of supply of molten casting material, sealing means adjacent said discharge opening, and means for moving said cylinder to sealingly engage said discharge opening with said sealing means to close said discharge opening during axially inward movement of said plunger to produce a sub-atmospheric pressure in said cylinder at the outer side of said plunger sufficient to draw molten casting material through said supply passage into said cylinder through said intake port when the latter is uncovered by movement of said plunger to the inner side of said intake port.

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