

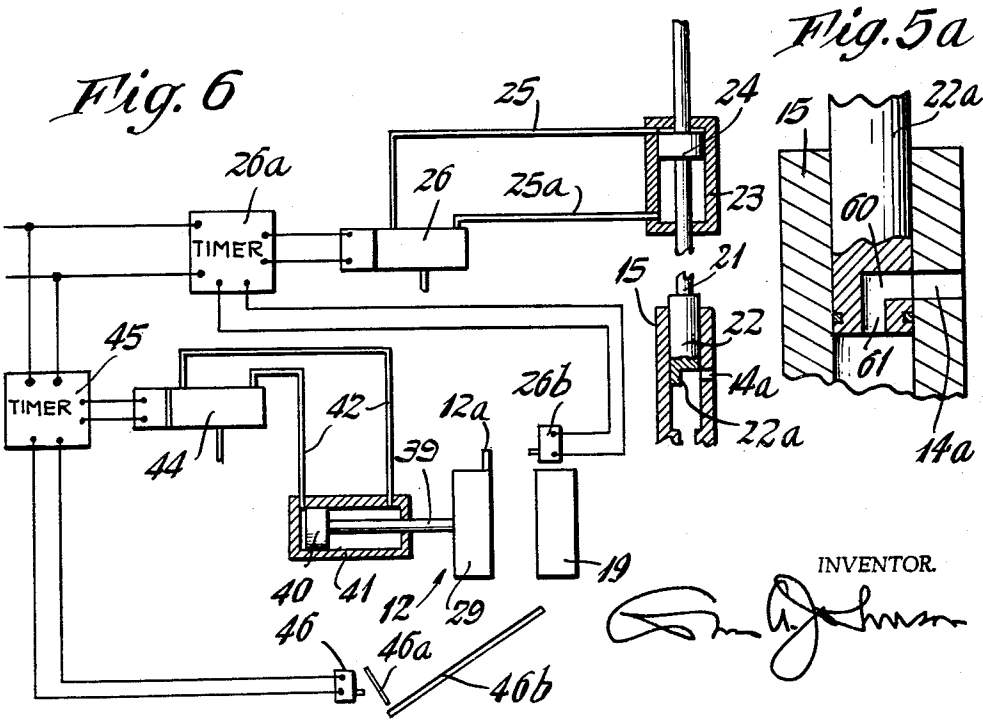
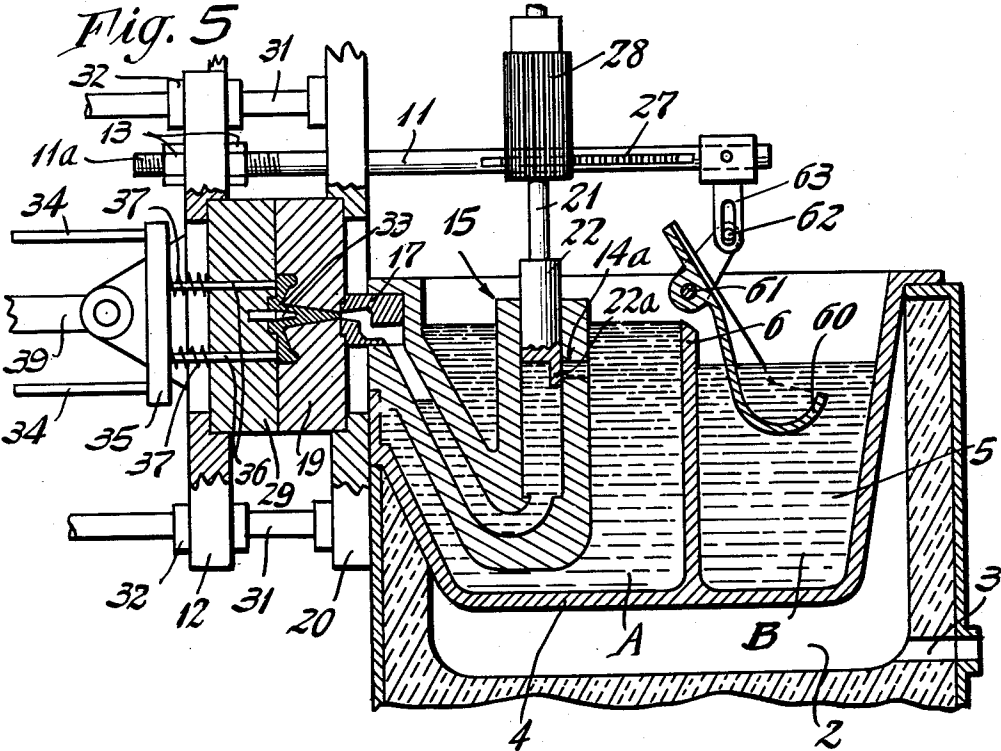
March 9, 1965

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DIE CASTING APPARATUS

3,172,174

Filed July 12, 1963

3 Sheets-Sheet 2



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Fig. 7

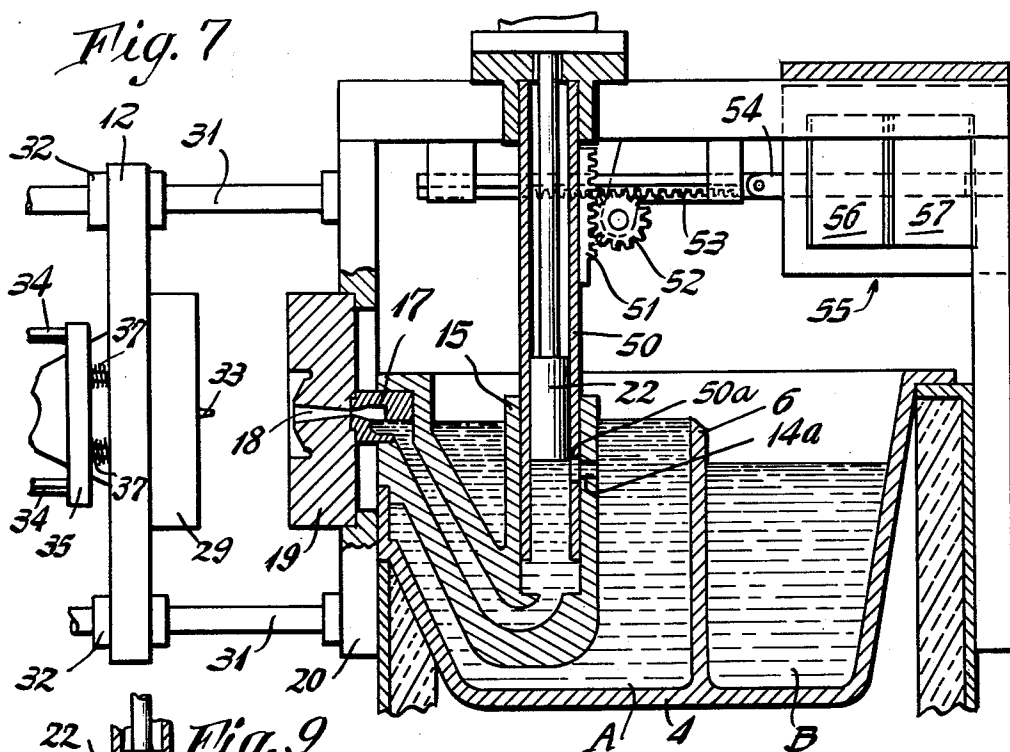


Fig. 9

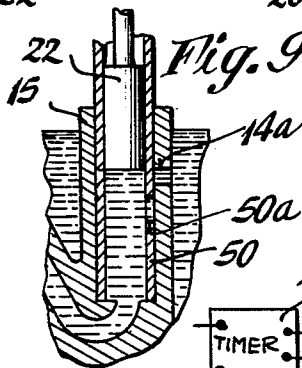
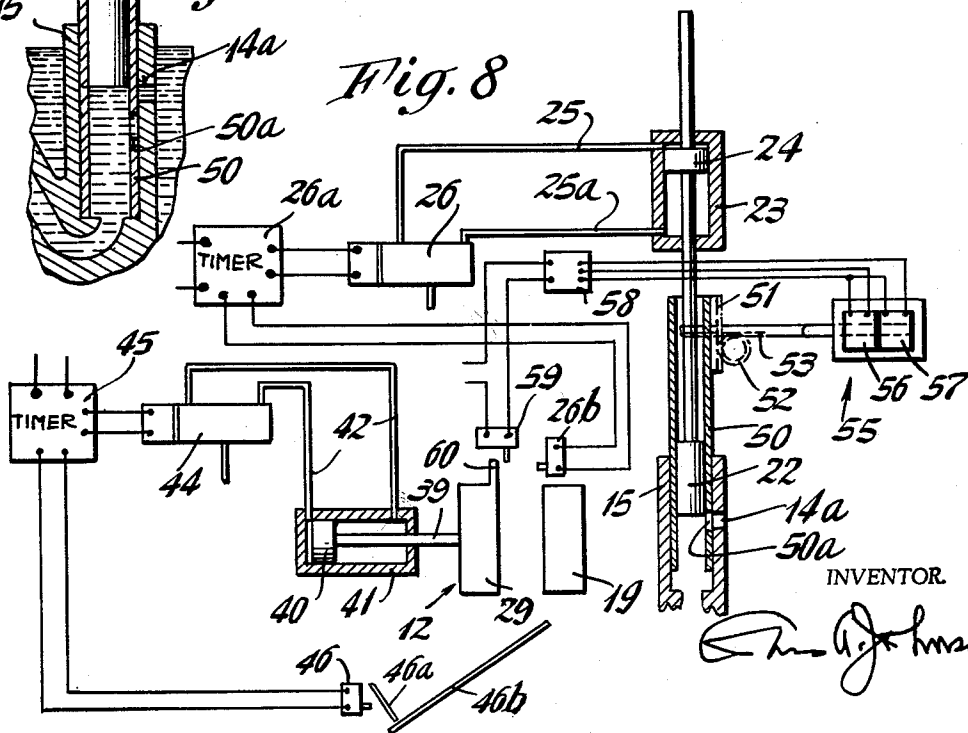


Fig. 8



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DIE CASTING APPARATUS

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Filed July 12, 1963, Ser. No. 294,528

7 Claims. (Cl. 22-70)

The present invention relates to novel automatic die-casting apparatus and more particularly to improvements whereby the problems arising from the freezing of molten metal in the nozzle section of the gooseneck and/or the drippage of molten metal onto the open die faces are substantially completely avoided.

Conventional automatic die-casting machines are in widespread use but such machines encounter a very high shutdown time due to the fact that the molten metal solidifies in the nozzle section of the molten metal-supplying gooseneck. When this occurs, due to the contact of the nozzle section with the dies being cooled, the machine must be stopped and heat must be applied to the nozzle to melt the solidified metal and open the passage within the nozzle. Such down time may equal about 30% or more of the total operating time of the machine.

Another important problem encountered with conventional automatic die-casting machines is the drippage of molten metal from the cast sprue or sprue opening onto the open die faces. The tip of the cast sprue solidifies far less quickly than the remainder of the casting in that it is in contact with the hot injection nozzle. Thus many times the tip of the sprue may not be solidified when the dies are opened and this generally causes drops of molten metal to fall from the tip of the sprue and against one of the open faces of one of the dies where it quickly cools and solidifies. Thus when the die faces come together in the next casting operation, the deposited solidified drops of metal prevent complete closing of the dies and result in faulty castings. Die-casting machines sometimes are provided with wire brushes which sweep the die faces clean after each casting operation but such brushes are not always effective and also add a time-consuming step to each casting operation.

It is an object of this invention to provide a novel apparatus whereby the problem of the freezing or solidification of the molten metal in the nozzle and upper gooseneck section is substantially completely avoided and the shutdown time due to such cause is eliminated.

It is another object of this invention to provide a novel apparatus whereby dripping of molten metal from the sprue tip or sprue hole onto the die faces as the dies open is avoided.

These and other objects and advantages will be apparent to those skilled in the art in the light of the present disclosure including the accompanying drawings in which:

FIGURE 1 is a side view of a part of an automatic die-casting machine according to one embodiment of the invention showing the dies in open position.

FIG. 2 is a top view of the pinion and rack arrangement controlling rotation of the injection plunger and taken along the lines 2-2 of FIG. 1.

FIG. 3 is a top view of the injection cylinder and the fill-port-closing extension of the injection plunger taken along the lines 3-3 of FIG. 1 but showing the plunger extension in passage-closing position.

FIG. 4 is a fragmentary sectional view showing the shot plunger in its lowermost position.

FIG. 5 is a sectional view of part of an automatic die-casting machine according to the invention showing the parts of the machine in the positions which they occupy during the solidification of the casting.

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FIG. 5a is a vertical section of the shot cylinder and plunger showing a modification of the plunger shown in FIG. 1.

FIG. 6 is a diagrammatic view of an automatic die-casting machine mechanism according to the embodiment of the present invention illustrated in FIG. 1.

FIG. 7 is a side view of a part of an automatic die-casting machine according to another embodiment of this invention with the parts in their positions while the die parts are separated.

FIG. 8 is a diagrammatic view of an automatic die-casting machine mechanism according to the embodiment of the invention illustrated by FIG. 7.

FIG. 9 is a fragmentary view of the shot cylinder, plunger and sleeve valve shown in FIG. 7.

Referring to the drawings, FIG. 1 illustrates the die-casting machine ready for the start of a new casting cycle. The machine comprises a furnace 1 having a heating chamber 2 and an opening 3 providing access for a gas flame or other heat-supplying means. Into the heating chamber is mounted a pot 4 for maintaining the casting metal 5 in hot molten condition. Though not essential to the operation of the present invention, the pot is preferably separated into two receptacles, A and B, by means of a partition 6, as illustrated, and the level of the molten metal in the injection pot A is maintained constant by means described below.

Within the supply pot A is mounted a metal injection mechanism 14 having a shot cylinder 15, a gooseneck section 16 provided at the upper end with a nozzle 17 communicating with a sprue opening 18 of a stationary die 19 which is mounted in fixed position on the frame 20 of the machine. A plunger rod 21 has an injection plunger 22 which is slidably mounted within the cylinder 15, and a piston 24 which is reciprocated within a cylinder 23 by means of oil pressure alternately exerted and exhausted through lines 25 and 25a which are associated with a reversing valve 26 controlled by a timer 26a and a switch 26b, as shown in FIG. 6 of the drawings.

The movable die system in the form shown comprises a movable die block 12 which is slidably attached to the frame 20 of the machine by means of guide rods 31 and bearings 32. The movable die 29 is attached to the die block and is associated with ejection means for removing the solidified casting from a core 33 to which it may remain attached upon separation of the dies.

The ejection means comprises ejector rods 34 affixed to the rear of the ejector plate 35 and knockout pins 36 affixed to the front of the ejector plate and passing through openings in the die 29. In the closed position, shown by FIG. 5, the ejector plate 35 and the die 29 are forced apart by means of springs 37 mounted on the knockout pins. As the movable die section is brought to the open position, the ejector rods 34 make contact with an ejector block 38, a section of which is shown in FIG. 1, depressing the springs 37 and forcing the tips of the knockout pins past the front surface of the die 29 to eject the casting from the core 33.

The movable die block is activated by means of a rod 39 which is attached to the die carrier 12, as shown in FIG. 1, and which has a piston 40 attached to the opposite end as shown in FIG. 6, said piston being mounted within a cylinder 41 and being adapted for forward and backward motion in response to oil pressure exerted through lines 42. The motion of the piston 40 is controlled by a reversing valve 44, which is associated with a timer 45 and a switch 46 which, in the form shown, is engaged by a switch operating arm 46a adapted to be engaged by a cast piece ejected from the die 29 falling on a chute 46b to cause the die 29 to close on the die 19 and start a new cycle of operations. If desired, the switch 46 or a like switch may be operated

manually. The timer 45 keeps the dies closed for a predetermined time interval at the end of which the dies automatically separate.

In conventional die-casting methods and apparatus, when the dies are closed the switch 26b causes the reversing valve 26 to apply fluid pressure to the top of the piston 24 causing the plunger 22 to descend in the shot cylinder 15 and forcing the molten metal up through the gooseneck 16 and the nozzle 17, into the sprue hole and the cavity formed between the dies 19 and 29 to fill the cavity. As soon as sufficient time passes to allow the metal in the dies to partially solidify, the timer 26a causes the valve 26 to apply fluid pressure to the lower side of the piston 24 and move the plunger rod 21 to the upper limit of its movement. During this operation the molten metal in the nozzle and adjacent part of the gooseneck is withdrawn by suction, but as soon as the lower end of the piston passes the fill-port 14a the molten metal surges into the shot cylinder 15 and causes the gooseneck and nozzle to be filled. The dies being still closed and the metal in the cavity and sprue continuing to solidify, frequently the molten metal returned to the nozzle also solidifies with the result that to successfully complete a subsequent operation the nozzle must be freed of the frozen metal which requires shutting down the machine and loss of time. This happens more frequently when the stationary die 19 has become too cold. On the other hand, if the stationary die and nozzle become too hot, the metal in the sprue does not solidify and, as a result, when the dies are opened molten metal may drip off the end of the sprue or out of the sprue hole onto the face of the die 19 and/or onto the face of the movable die 29. The metal so deposited on the die members freezes and thus prevents the dies from reclosing completely, with the result that the next articles to be cast will be malformed and/or have excessive flash, the molten metal running in the space caused by the separation of the dies by the metal freezing on the face thereof.

According to the apparatus herein disclosed, these difficulties are avoided by providing improved means for preventing the molten metal from filling the gooseneck or reaching the nozzle until the dies have been separated and yet permitting the plunger to be quickly returned its full stroke to the upper limit of its movement.

To accomplish this, the fill-port 14a is controlled independently of the vertical movements of the plunger and is controlled by the opening movement of the dies. For this purpose, in the form of the invention shown in FIGS. 1 to 6, the plunger 22 is made to perform a dual function—(1) to act in pumping, and (2) to act as a valve closing the fill-port 14a.

In the specific form of the invention shown in FIGS. 1 to 6, the valving function of the plunger 22 is performed by an arcuate depending flange 22a on the bottom end of the plunger and the plunger is rotated between positions in which the flange-valve 22a closes or opens the fill-port 14a.

In FIG. 3, the flange 22a is shown as closing the fill-port 14a in full lines, and in dotted lines in the position which it occupies when the fill-port 14a is open.

In the form of the invention shown in FIGS. 1 to 6, the plunger 22 is rotated by means of a pinion 28 mounted on the plunger rod 21 and adapted to be engaged by a rack 27 mounted on a rod 11 adjustably secured by nuts 13 on the threaded end 11a of the rod to the die block 12 so as to reciprocate therewith so that as the die block 12 moves between die-opening and closing positions, the plunger 22 will be rotated.

As shown in FIG. 1, the dies are separated and the plunger 22 is in the position exposing the fill-port 14a. As the movable die 29 approaches the fixed die 19, the rack 27 will cause the pinion 28, rod 21 and plunger 22 to rotate from the dotted-line position shown in FIG. 3 in a clockwise direction to the full-line position shown in which

the fill-port 14a is closed and at which time the dies are also closed.

When the dies close, the arm 12a on the die block 12 engages the switch 26b and causes, in the manner previously explained, the plunger 22 to descend and force the molten metal trapped in the shot cylinder 15 up through the gooseneck and nozzle into the die cavity. After a period determined by the timer 26a, the plunger 22 is raised to the limit of its movement sucking back the metal from the nozzle and upper portion of the gooseneck. Since, during this return movement of the plunger 22 to its upper limit the flange 22a is in position to keep the fill-port 14a closed, the level of the molten metal in the gooseneck is maintained to that shown in FIG. 4, and therefore does not lie in the nozzle or the adjacent part of the gooseneck, thereby isolating the molten metal from the sprue which may therefore solidify without being prevented from doing so by molten metal and avoiding the freezing of the molten metal in the nozzle.

The dies are maintained closed by operation of the timer 45 for a predetermined time interval after which, by operation of the piston 40, the movable die 29 is moved away from the fixed die 19. In moving away from the fixed die 19, the movable die block 12 moves the rod 11 to the left as shown in FIG. 1 and this causes the plunger 22 to rotate from the full-line position shown in FIG. 3 to the dotted-line position.

The arcuate length of the flange 22a is such that the fill-port 14a opens sometime after the dies are parted and before they are in the full open position, allowing the level of the molten metal in the gooseneck to equalize hydrostatically with the level of the metal in the pot A and exclude the air from the gooseneck. The nozzle 17 is so situated with regard to the level of the molten metal in the pot A that it will not overflow through the nozzle, there being no vacuum in the gooseneck and nozzle when the fill-port 14a opens to cause the metal to be sucked up into the nozzle and against the sprue as in conventional methods and apparatus.

The rack 27 is horizontally and adjustably attached to the rod 11 within a slot 27a and is locked in the desired position by means of bolts 27b. The location of the valve element 22a relative to the fill-port 14a may be adjusted by changing the position of the rack 27 or by adjusting the position of the rod 11 on the die block 12 by means of the nuts 13. In this way the opening and closing of the fill-port may be closely controlled and the machine may be set at the point at which the best results are obtained.

Thus, while the segmented circumferential valve element 22a preferably has a surface area of about 120° as illustrated by FIG. 3 so that the fill-port is not uncovered immediately upon separation of the dies and while the valve element is generally positioned so that it completely uncovers the fill-port when the dies are in the open position, as shown by broken lines in FIG. 3, it may be found preferable to adjust the position of the rack 27 and/or the rod 11 so that the fill-port 14a begins to be uncovered as soon as rotation is imparted to the piston 22 or so that the fill-port 14a is never completely uncovered by the valve element, whichever effect may be found most preferable.

It is an advantageous feature of this invention that the fill-port is closed and opened by the movement of the movable die holder mechanically thereby obviating the need for auxiliary means for accomplishing the result.

The level of the molten metal in the gooseneck section is preferably kept high and as close to the opening in the nozzle as practical in order to reduce the amount of air present in the gooseneck section and nozzle since excess amounts of air forced into the die cavity during the casting cycle result in defective castings containing air pockets and surface blemishes. This is preferably accomplished as shown in FIG. 1 by means of an automatic ladling device 60 which is adjustably mounted on

the rod 11 and which serves to transfer from the pot B to the pot A an amount of molten metal equal to the amount of molten metal used in each casting operation.

The ladle 60 is pivotally mounted on a shaft 61 and which is slidably secured by a pin 62 in a slotted member 63 which is adjustably mounted on the arm 11. Thus, as each new casting is formed and the dies are opened, the horizontal movement of the rod 11 causes the ladle 60, which had been submerged in the molten metal of the pot B, to rise to the position shown in FIG. 1 whereby molten metal spills from the ladle into the pot A. Any excess metal spills back into the pot B over the partition 6 so that the level of molten metal in the pot A is maintained constant for the start of each casting cycle.

Since the opening of the fill-port 14a prior to the start of each casting cycle causes the molten metal to flow into the gooseneck until it reaches a hydrostatic level equal to the level of molten metal in the pot A, it is preferred that the height of the partition 6 be just below the height of the nozzle opening, as shown by FIG. 1, so that as little air as possible must be injected into the casting.

While the form of the invention illustrated by FIGS. 1 to 6 of the drawings relates to the embodiment in which the opening and closing of the fill-port 14a is controlled by a rotatable plunger provided with a flange-valve and rotation of the plunger is controlled by its mechanical association with the movable die block, it should be understood that the present invention is not limited to such embodiment but includes on a broader scope any automatic die-casting machine in which the plunger is allowed to return quickly to the full extent of its upward motion while the fill-port is maintained closed by means of a valve until after the casting has solidified and the dies have separated.

Likewise it is not necessary that the valve for closing the fill-port be a flange depending from the injection plunger, or that the injection plunger be rotatable. Thus, in the embodiment of the invention illustrated by FIG. 7 of the drawing, the die-casting apparatus may be similar to conventional apparatus of this type except that a vertically slidable sleeve 50 is provided which is inserted between the circumference of the plunger 22 and the interior wall of the injection cylinder 15. The lower section of the sleeve 50 extends close to the bottom of the injection cylinder and closes the fill-port 14a to seal the same when the sleeve is in the lowered position, as illustrated in FIG. 9.

The sleeve 50 has a hole 50a so placed that when the sleeve is in its uppermost position the fill-port 14a is uncovered (as shown in FIG. 7), thereby allowing casting metal to fill the cylinder and the gooseneck ready for the next casting operation. The sleeve 50 may be reciprocated vertically by any suitable means in coordination with opening and closing movements of the movable die.

In the embodiment of the invention illustrated in FIGS. 7, 8 and 9, this is accomplished by providing the upper end portion of the sleeve 50 with a rack 51 meshing with a pinion 52 which also engages a horizontally movable rack 53 connected to the armature 54 of an electromagnet 55. Thus, when the rack 53 moves in one direction to the right as shown in FIG. 7, the sleeve is moved upwardly to align the hole 50a with the fill-port 14a and when it is moved to the left the sleeve is moved to the position shown in FIG. 9 where the fill-port is closed.

As shown in FIG. 8, the solenoid 55 has two coils 56 and 57 and these are connected to a reversing switch 58 which in turn is connected to a switch 59 which is engaged by a lug 60 on the movable die holder 12. When the movable die moves from its wide open position toward the fixed die, the switch 59 is engaged and this operates the reversing switch 58 to energize the coil 56 which causes the rack 53 to move to the left and the sleeve 50 to close the fill-port 14a. This condition remains until the dies have been closed, the plunger 22 op-

erated to inject the casting metal into the die and to return to suck back the molten metal from the nozzle and upper end of the gooseneck and during the time that the casting is solidifying. It is also maintained until the die carrier 12 approaches its wide open position at which time the switch 59 is again operated, but this time the reversing switch 58 deenergizes the coil 56 and energizes the coil 57 so that the rack 53 moves to the right and causes the sleeve 50 to move to its upper position where the hole 50a aligns with the fill-port 14a so that the gooseneck may refill.

Instead of the segmental circumferential valve element 22, the shot plunger 22a shown in FIG. 5a may be provided with a radial hole 60 which intersects a vertical central hole 61 which form a passage for the molten metal from the fill-port 14a to the interior of the cylinder when the shot plunger 22a is in the position shown in FIG. 5a. Rotation of the shot plunger 22a will move the radial hole 60 away from the fill-port 14a and thus close it off.

The advantage of this construction is that any possible leakage that might be present with the segmental valve element shown in FIG. 5a would be prevented by the use of a piston ring which is at the lower end of the plunger and always in contact with the wall of the cylinder 15.

It should be understood that the present invention is not limited to each of the features specifically discussed and illustrated, and alternative embodiments where desired will be obvious to those skilled in the art in the light of the foregoing description. The important features of the invention comprise an injection plunger capable of rapid movement between the upper and lower limits of its movement to inject molten metal into the die cavity and create a vacuum in the injection cylinder on the reverse stroke, and a valve in operative association with the opening and closing of the dies for closing the molten metal in the injection cylinder to the atmosphere whereby the vacuum is maintained during solidification of the casting and until the dies are separated.

In this manner, the residual molten metal is drawn down the gooseneck away from the nozzle and upper section of the gooseneck so that freezing in these areas is prevented. In fact, a side advantage has been discovered in that portions of the sprue of the casting comprising the sprue tip and adjacent areas are also sucked back through the nozzle into the gooseneck thereby reducing the amount of metal in the sprue which must be remelted for future re-use.

While portions of the sprue are sucked back into the gooseneck as evidenced by the appearance of the final casting on which the sprue has a hollow recess where the tip would ordinarily be, it should be understood that none of the molten metal is sucked back from the body of the casting. This is so because the cavity formed by the closing of the dies comprises the cavity proper, the sprue opening and narrow runners and thin gates communicating therebetween. Since the dies are relatively cool, the molten metal freezes or solidifies much more rapidly in the gates than it does in either the cavity proper or the sprue so that the gates are quickly sealed and prevent the effect of the vacuum from disturbing the metal in the die cavity proper.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. In die-casting apparatus in which molten metal is injected from a cylinder through a nozzle and a sprue hole into a cavity formed by fixed and movable die parts when closed to cast articles by operation of a plunger movable between upper and lower limits in a cylinder submerged in a pot of molten casting metal, and receiving molten metal from the pot through a fill-port in its wall, the improvement comprising: means

for causing closing and opening movements to be imparted to the movable die part; time-controlled means to cause the plunger, after the dies are closed, to inject molten metal through the gooseneck, nozzle and sprue hole into the die cavity and subsequently at a predetermined time before the opening movement of the movable die part cause the rapid return of the plunger to the upper limit of its movement to withdraw molten metal from the sprue, nozzle and adjacent part of the gooseneck; and means responsive solely to the closing and opening movements of the movable die part for respectively closing and opening said fill-port while the plunger is at the upper limit of its movement.

2. In die-casting apparatus in which molten metal is injected from a cylinder through a nozzle and a sprue hole into a cavity formed by fixed and movable die parts when closed to cast articles by operation of a plunger movable between upper and lower limits in a cylinder submerged in a pot of molten casting metal, and receiving molten metal from the pot through a fill-port in its wall, the improvement comprising: means for causing closing and opening movements to be imparted to the movable die part; means to cause the plunger, after the dies are closed, to inject molten metal through the gooseneck, nozzle and sprue hole into the die cavity and subsequently while the dies remain closed cause the continuous return of the plunger to the upper limit of its movement to withdraw molten metal from the sprue, nozzle and adjacent part of the gooseneck; and means responsive solely to the closing and opening movements of the movable die part for respectively closing and opening said fill-port while the plunger is at the upper limit of its movement.

3. Die-casting apparatus according to claim 2 in which there is a valve element adapted to open and close the fill-port, and the means responsive to the opening and closing movements of the movable die part causes the valve element to open said fill-port after the movable die is separated from the fixed die part.

4. Die-casting apparatus according to claim 2 in which the means responsive to the closing and opening movements of the movable die part for closing and opening the fill-port comprises a valve element associated with the fill-port, and mechanical means connecting the valve

element with the movable die part for simultaneous and coordinate movements.

5. Die-casting apparatus according to claim 4 in which the plunger is mounted for rotation and the valve element comprises a segmental flange depending from the plunger, and the mechanical means connecting the valve element to the movable die part comprises a rack and pinion drive whereby the plunger is rotated to cause the valve flange to close and open the fill-port as the movable die part is being moved respectively to closed and open positions.

6. Die-casting apparatus according to claim 2 in which the means responsive to the closing and opening movements of the movable die part for closing and opening the fill-port comprises a valve element associated with the fill-port, and in which there are electromagnetic means for operating the valve element, and switch means connected to said electromagnetic means and actuated by said movable die part whereby the valve is operated to close and open the fill-port as the movable die part is being moved respectively to closed and open positions.

7. Die-casting apparatus according to claim 2 in which the means responsive to the closing and opening movements of the movable die part for closing and opening the fill-port comprises a sleeve valve fitted between the interior surface of the cylinder and the exterior surface of the plunger having a fluid passage aligning with the fill-port when the valve is in open position, and the means responsive to the closing and opening movements of the movable die part comprises means operated independently of the operation of the plunger for reciprocating said sleeve valve axially to align and disalign the passage therein with the fill-port.

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