April 14, 1953 A. E. HOLDER 2,634,468

APPARATUS FOR PRESSURE CASTING

Filed Oct. 16, 1948 2 SHEETS—SHEET 1

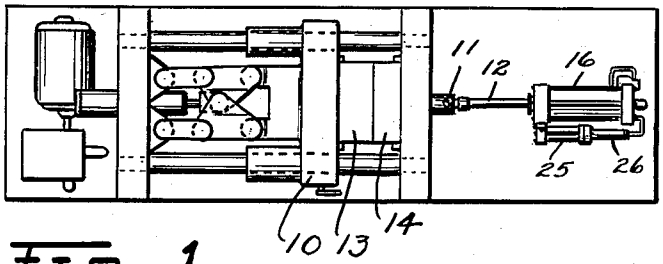
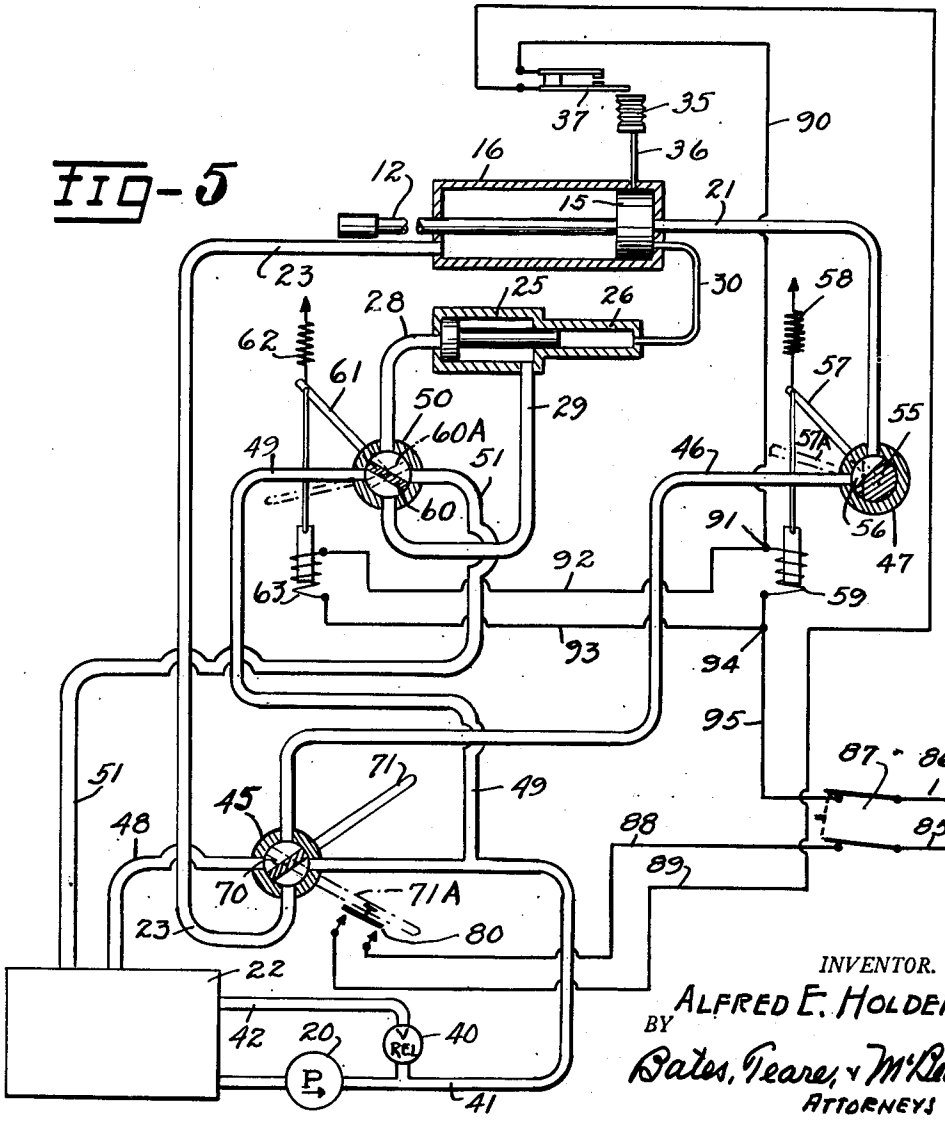


FIG- 1

FIG- 5



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APPARATUS FOR PRESSURE CASTING

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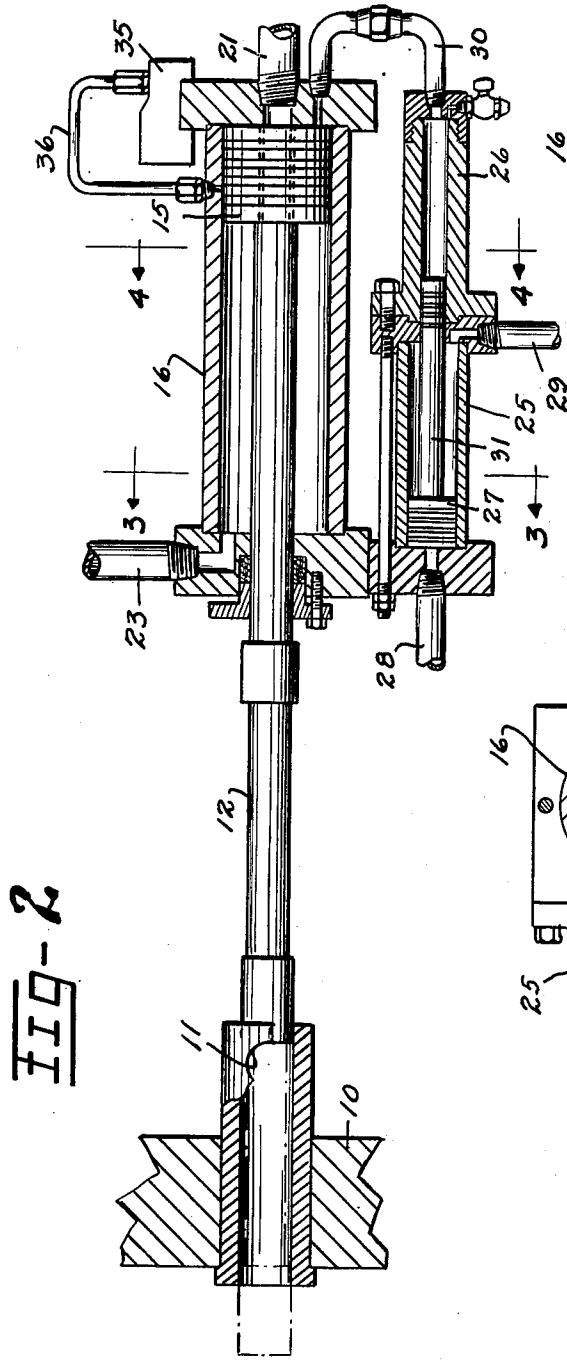

FIG-2

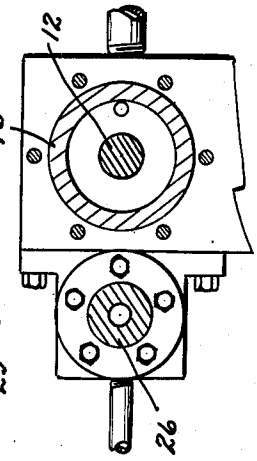

FIG-4

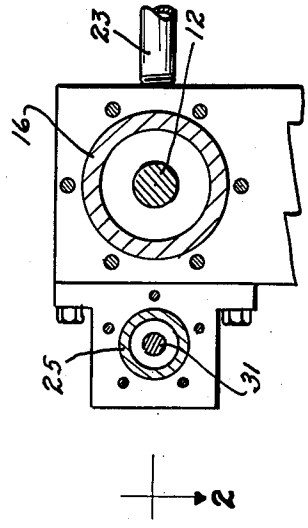

FIG-3

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APPARATUS FOR PRESSURE CASTING

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3 Claims. (Cl. 22—68)

1

This invention relates to die casting and more particularly to die casting machinery of the hydraulic pressure type.

In the manufacture of die casting, it is desirable to increase the density of the casting so as to eliminate the porous nature of the metal of which the casting is composed.

An object of the present invention, therefore, is to obtain a dense casting by applying pressure against the molten metal until the resistance reaches a predetermined pressure, whereupon, a secondary application or a booster pressure is automatically and immediately applied before the metal has an opportunity to harden in any portion thereof. The invention consists of an apparatus by means of which this procedure may be carried out, either on a new machine or on existing machines without necessitating extensive changes in the construction thereof.

Referring now to the drawings, Fig. 1 is a top plan view of a pressure die casting machine embodying the present invention; Fig. 2 is a horizontal section taken adjacent the right hand end of the machine shown in Fig. 1 but on a scale larger than that of Fig. 1, the plane of the section being indicated on the line 2—2 of Fig. 3; Figs. 3 and 4 are sections taken on planes indicated by the correspondingly numbered lines in Fig. 2, and Fig. 5 is a combined wiring and hydraulic system diagram for illustrating the operation of the invention.

The die casting machine is shown in general at 10 in Fig. 1 as having an entrance port 11 for receiving molten metal, and as having a ram 12 which is used for forcing the metal into the mold members which are indicated in general at 13 and 14, respectively. The ram is shown as terminating in a piston 15 which is mounted for reciprocation within a cylinder 16. An intake conduit 21 is adapted to deliver a liquid, such as oil, to the cylinder from a source of supply indicated as a pump 20 in Fig. 5. The construction of the cylinder 16 is such that as the piston is moving forwardly on the delivery stroke, the liquid in advance of the piston is returning to the reservoir 22 (Fig. 5) through conduit 23.

The foregoing construction is illustrative of a type of pressure die casting machine which has heretofore been in general commercial use. The present invention contemplates the provision of a system and apparatus by means of which the ram forces molten metal into the mold members until the mold is filled, whereupon the resistance of the metal to compression causes a pressure to be built up within the cylinder 16. When the

2

pressure reaches a predetermined amount, a booster device is automatically brought into operation to increase the pressure upon the ram before the metal has a chance to cool in any portion thereof.

The booster apparatus embodying the present invention is shown in Fig. 2 as two cylinders 25 and 26 which are disposed in tandem relationship. The cylinder 25 has a larger bore than that of the cylinder 26 and the bore of the cylinder 26 is a continuation of the bore in the cylinder 25. A piston 27 is mounted for reciprocation within the cylinder 25 and has a rod or ram 31 projecting from one side thereof and extending into the bore of the cylinder 26. Suitable rings on the ram prevent the passage of liquid between the two cylinders.

The cylinder 25 is a double acting cylinder with a conduit 28 connected to one end thereof and a conduit 29 connected to the other end for effecting reciprocation of the piston 27. The cylinder 26 is in communication with the interior of the cylinder 16 through a conduit 30, so that the ram 31 may force liquid into the cylinder 16 during a portion of the forward stroke of the ram 12, and may draw liquid out of the cylinder 16 upon the retractile stroke of the ram 12.

Under the normal operation of the apparatus, liquid under pressure is forced into the cylinder 16 until the resistance to the forward movement of the ram 12 causes the liquid pressure on the pressure side of the piston 15 to reach a predetermined amount. That portion of the cylinder on the pressure side of the piston is in communication with a pressure responsive device 35 through a conduit 36. The device 35 is shown diagrammatically in Fig. 5 as an expansible element which when expanded is adapted to close a switch 37 and thereby to control an electric circuit by means of which suitable valves will be operated in the hydraulic system. The valves function (*a*) to cut off the flow of liquid through the conduit 21 to the cylinder 15 and (*b*) to apply liquid under pressure through the conduit 28 to the piston 27 so as to force the liquid within the cylinder 26 into the cylinder 16 and thereby impart a booster pressure to the ram 12. The booster pressure will be in accordance with the ratio of the cross-sectional area of the bores in the cylinders 25 and 26, respectively, and for practical purposes I have found that a ratio of 4 to 1 will produce satisfactory results in the finished casting.

The hydraulic system for carrying out the present invention includes a pump 20, as aforesaid,

which may be driven by an electric motor (not shown) and which may have a pressure relief valve 40 connected to the conduit 41 on the discharge side of the pump so as to enable the pump to be kept in constant operation. The pressure relief valve may be connected to the reservoir 22 through a conduit 42. The conduit 41 is connected to a four-way valve 45 which in turn is connected through a conduit 23 to one end of the cylinder 16, and to the other end of the cylinder 16 through conduit 46, valve 47 and conduit 21 respectively. The valve 45 may also be connected to the reservoir 22 through conduit 48.

The pump 20 also serves to deliver liquid to the cylinder 25, such connections being diagrammatically shown in Fig. 5 as including conduits 41 and 49, the latter of which is connected to a valve 50. The valve in turn is connected to one end of the cylinder 25 through conduit 28 and to the other end of the cylinder through conduit 29. The valve also has a conduit 51 extending therefrom and connecting it to the reservoir 22.

In Fig. 5, the valve 47 is shown as having a member 55 oscillatably mounted therein and provided with a passageway 56 which is intended to establish communication between conduits 46 and 21 whenever the valve operating arm 57 is in the position shown by the full line position. The valve is normally biased to the full line position by a spring 58 but is adapted to be shifted to the dotted line position 57A whenever the solenoid coil 59 is energized. Similarly, the valve 50 has a valve member 60 which is attached to a valve arm 61 that is biased to the full line position of Fig. 5 by means of a spring 62. The valve member 60 is adapted to be moved to the broken line position 60A whenever the solenoid coil 63 is energized.

The valve 45 is utilized for initiating the advancing movement of the ram 12 and for initiating the retractile movement at the completion of the formation of the casting in the mold. Accordingly, the valve 45 is shown as having a valve member 70 which is adapted to be actuated by a manually operable arm 71 for movement from the full line position to the position shown by the broken lines 71A. In the full line position the connections are such that liquid flows from the pump 20 through conduits 41 and 23 to effect a retractile movement of the ram, but in the dotted line position 71A, the connections are such that liquid flows from the pump through the conduit 41, valve 45, conduit 46, valve 47, and conduit 21, into the cylinder 16 so as to advance the ram and to deliver a charge of molten metal into the mold members. The movement of the arm 71 from the full to the dotted line position also closes a switch, indicated in general at 80, which is in circuit with the switch 37. Normally, the switch 37 is open until the pressure within the cylinder 16 reaches a predetermined amount, at which time the pressure responsive device 35 closes the switch and thereby energizes the coils 59 and 63 so as to swing the arms 57 and 61 respectively from the full to the dotted line positions of Fig. 5. At such time, the valve 47 is closed and liquid under pressure is delivered to the cylinder 25 so as to force the ram 31 along the cylinder 26 and thereby to impart a booster pressure to the cylinder 16. The pressure remains on the booster device until such time as the operator opens the switch 80 by moving the arm from the dotted line position 71A to the full-line position 71. This automatically disconnects the circuit through the solenoid coils and allows the valve members 55 and 60 to be returned to the full line positions, whereupon the ram 12 and the booster ram 31 are automatically returned to the starting position.

The electrical circuit illustrated in Fig. 5 includes a source of supply, indicated by the leads 85 and 86, and a master switch indicated in general at 87. When the switch 80 is closed, assuming that the switch 87 is also closed, current flows through conductor 88, switch 80, conductor 89, switch 37, conductor 90 to junction 91, where the current divides, part flowing through the coil 59, and part flowing through conductor 92 to the coil 63 and thence back through conductor 93 to junction 94, from whence current flows through conductor 95 back to the source lead 86.

An important advantage of the present invention is the fact that the application of the secondary or booster pressure occurs automatically, whenever the pressure in the primary cylinder 16 reaches a predetermined amount. I have found, for example, when the source of fluid pressure supply is about one thousand pounds per square inch, and when the pressure responsive device 35 is set to operate at about 900 lbs. per square inch, and when the ratio of the areas of the bores in the cylinders 25 and 26 respectively is 4 to 1, that castings are produced which have a high, smooth finish and are substantially free from objections incident to the presence of voids, porous places, strictures or cracks.

I claim:

1. In a die casting machine of the type described having a die mold, a plunger adapted to inject a charge of molten metal into said mold, a hydraulically operated shot piston adapted to actuate said plunger, a hydraulic cylinder rigidly associated with said mold and in which said shot piston operates, a booster piston, a hydraulic cylinder connected in communication with the shot cylinder and in which said booster piston operates, the booster piston including a rod having a cross-sectional area smaller than the cross-sectional area of the booster piston, a pair of conduits interconnected respectively with said shot and booster cylinders, a valve in each conduit, a hydraulic pump interconnected with such conduits and operable to deliver fluid under pressure to said cylinders through said conduits, and means for simultaneously closing the valve in the conduit leading to the shot cylinder and opening the valve in the conduit leading to the booster cylinder whereby after said shot piston is advanced to cause the plunger to inject molten metal into said mold, and after movement of the shot piston has been momentarily arrested by the filling of the mold, said booster piston is advanced to increase the pressure in the shot cylinder.

2. In a die casting machine of the class described having a die mold, a plunger adapted to inject a charge of molten metal into said mold, a hydraulically operated shot piston adapted to actuate said plunger, a hydraulic cylinder rigidly associated with said mold and in which said shot piston operates, a booster piston, a hydraulic cylinder connected in communication with said shot cylinder and in which said booster piston operates, a rod fixed to the booster piston and having a cross-sectional area smaller than that of the booster piston, a pair of conduits interconnected respectively with said shot and booster cylinders, a valve in each of said conduits, a hydraulic pump interconnected with said conduits and operable to deliver fluid under pressure to said

cylinders through said conduits, whereby when the valve in the conduit leading to the shot cylinder is open, said shot piston is advanced to cause said plunger to inject molten metal into said mold, and a pressure responsive device in communication with the shot cylinder and operable upon the attainment of a predetermined pressure of fluid in the shot cylinder to close the valve in the conduit leading to the shot cylinder and to open the valve in the conduit leading to the booster cylinder, to direct the flow of fluid from said pump into the booster cylinder whereby the booster piston is advanced to increase the pressure in the shot cylinder after the shot piston has been momentarily arrested by the filling of the mold.

3. In a die casting machine of the class described having a die mold, a plunger adapted to inject a charge of molten metal into said mold, a hydraulically operated shot piston adapted to actuate said plunger, a hydraulic cylinder rigidly associated with said mold and in which said shot piston operates, a booster piston, a hydraulic cylinder connected in communication with said shot cylinder and in which said booster piston operates, a rod fixed to the booster piston and having a cross-sectional area smaller than that of the booster piston, a pair of conduits interconnected respectively with said shot and booster cylinders, a valve in each of said conduits, a hydraulic pump interconnected with said conduits and operable to deliver fluid under pressure to said cylinders through said conduits, whereby when the valve in the conduit leading to the shot cylinder is open, said shot piston is advanced to cause said plunger to inject molten metal into said mold, pressure responsive means communicating with the shot cylinder, an electric switch actuated by the pressure responsive means, a circuit for said switch, and electromagnetic means in said circuit for closing the valve in the conduit leading to the shot cylinder and opening the valve in the conduit leading to the booster cylinder to direct the flow of fluid from said pump into the booster cylinder, whereby the booster piston is advanced to increase the pressure in the shot cylinder after the shot piston has been momentarily arrested by the filling of the mold.

ALFRED EMIL HOLDER.

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