Feb. 7, 1939. M. STERN 2,145,956

DIE CASTING MACHINE

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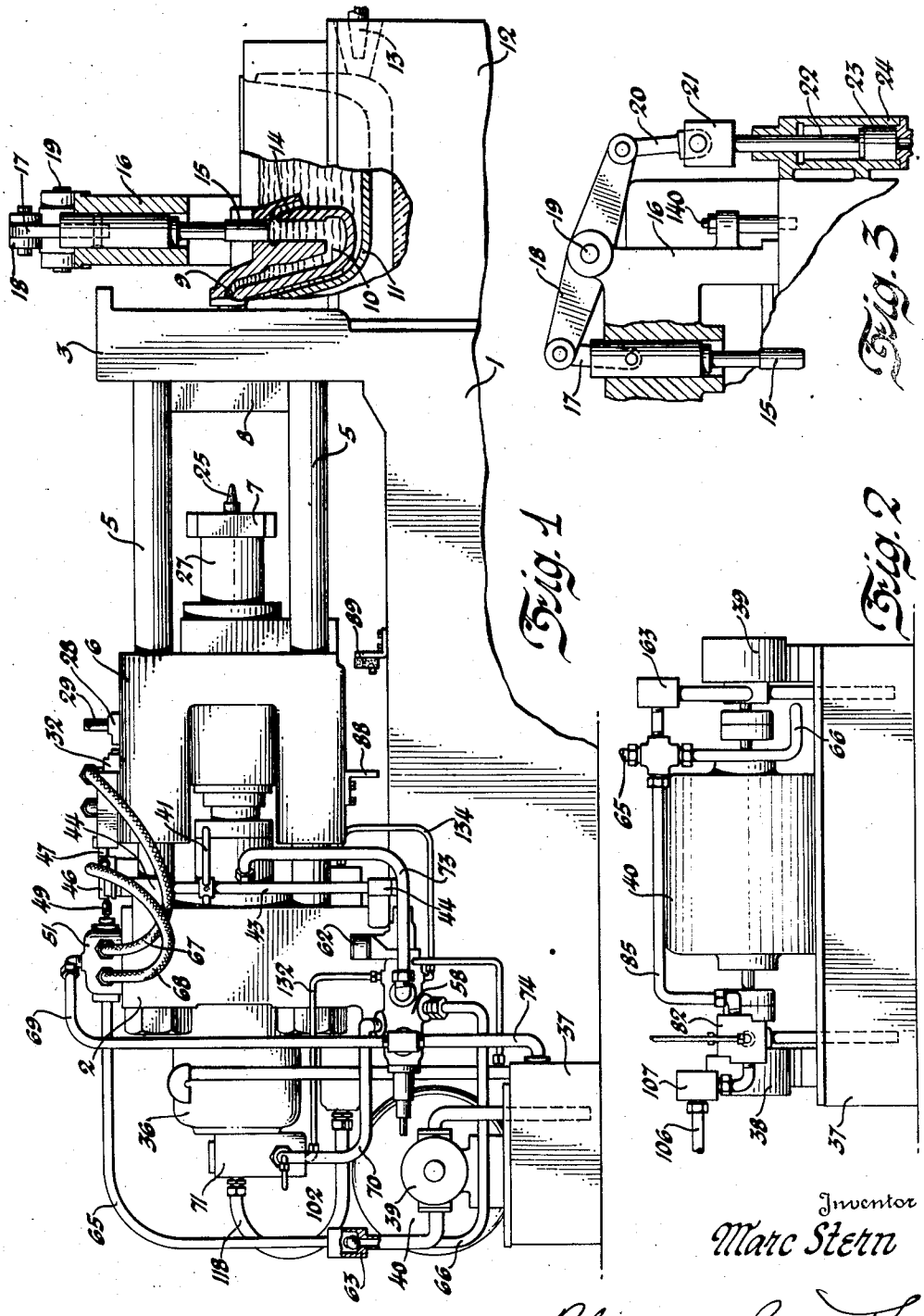

Fig. 1

Fig. 3

Fig. 2

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Feb. 7, 1939. M. STERN 2,145,956

DIE CASTING MACHINE

Filed June 9, 1937 6 Sheets-Sheet 2

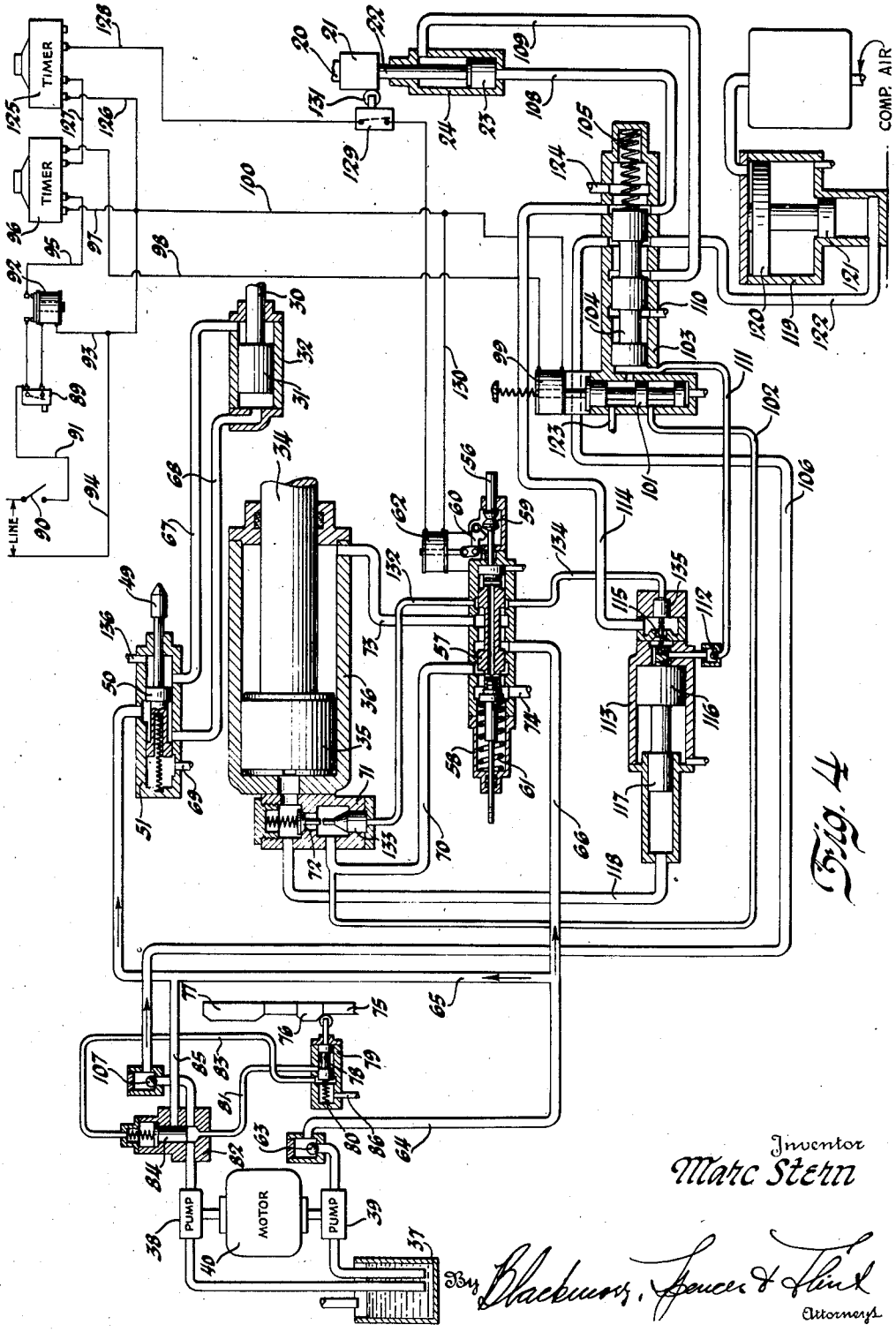

Fig. 4

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Feb. 7, 1939. M. STERN 2,145,956

DIE CASTING MACHINE

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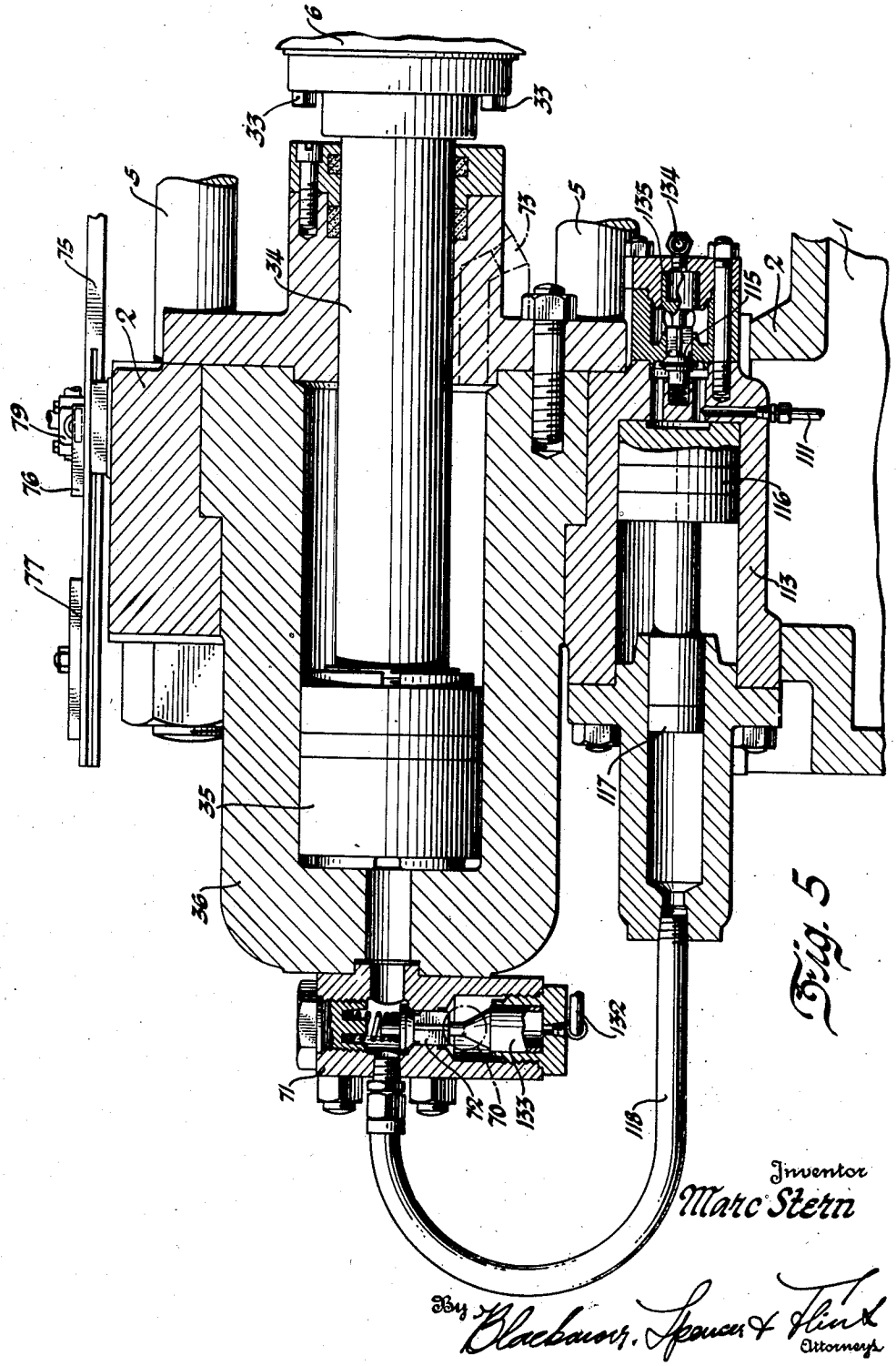

Fig. 5

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Feb. 7, 1939. M. STERN 2,145,956

DIE CASTING MACHINE

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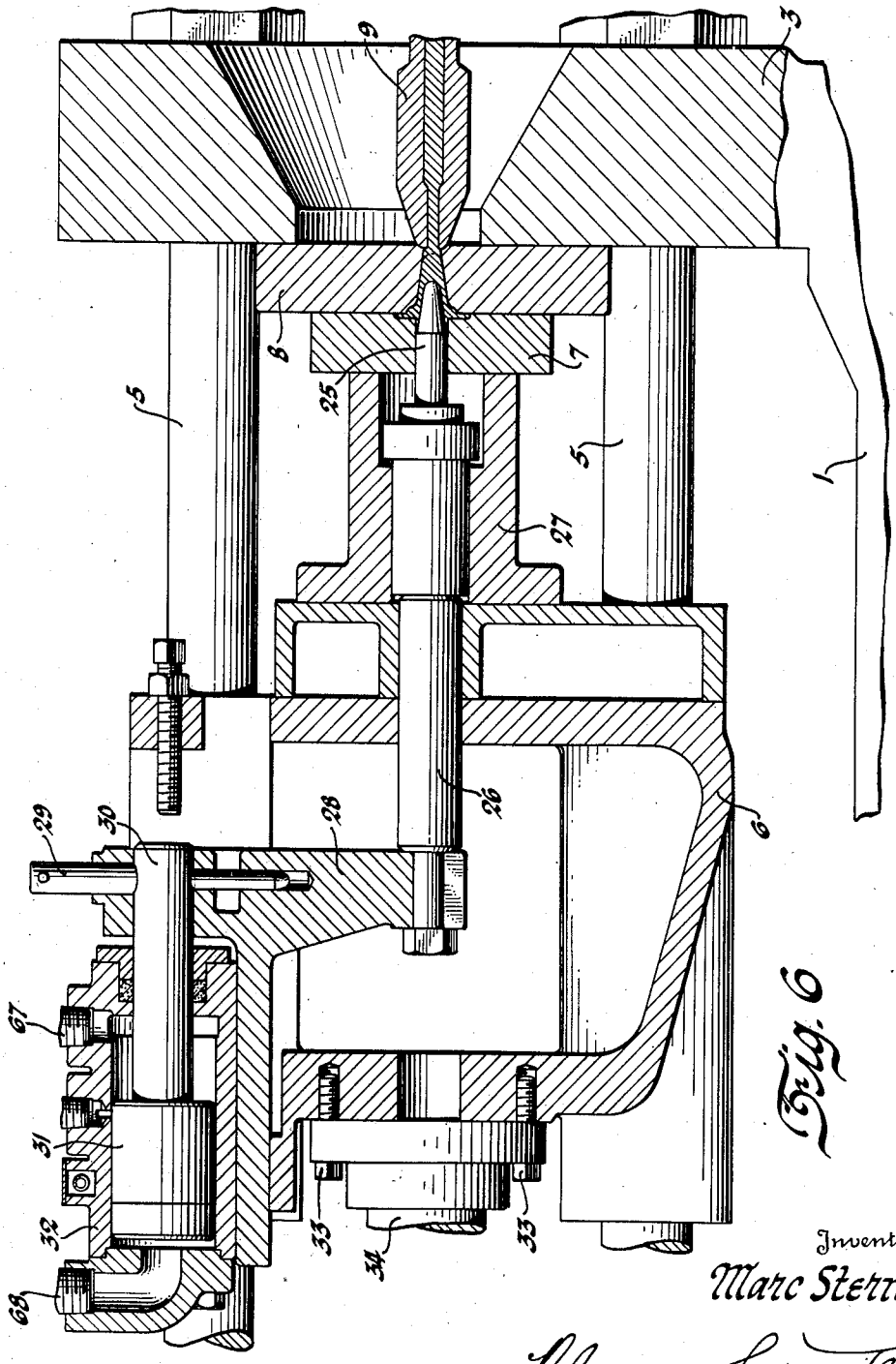

Fig. 6

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DIE CASTING MACHINE

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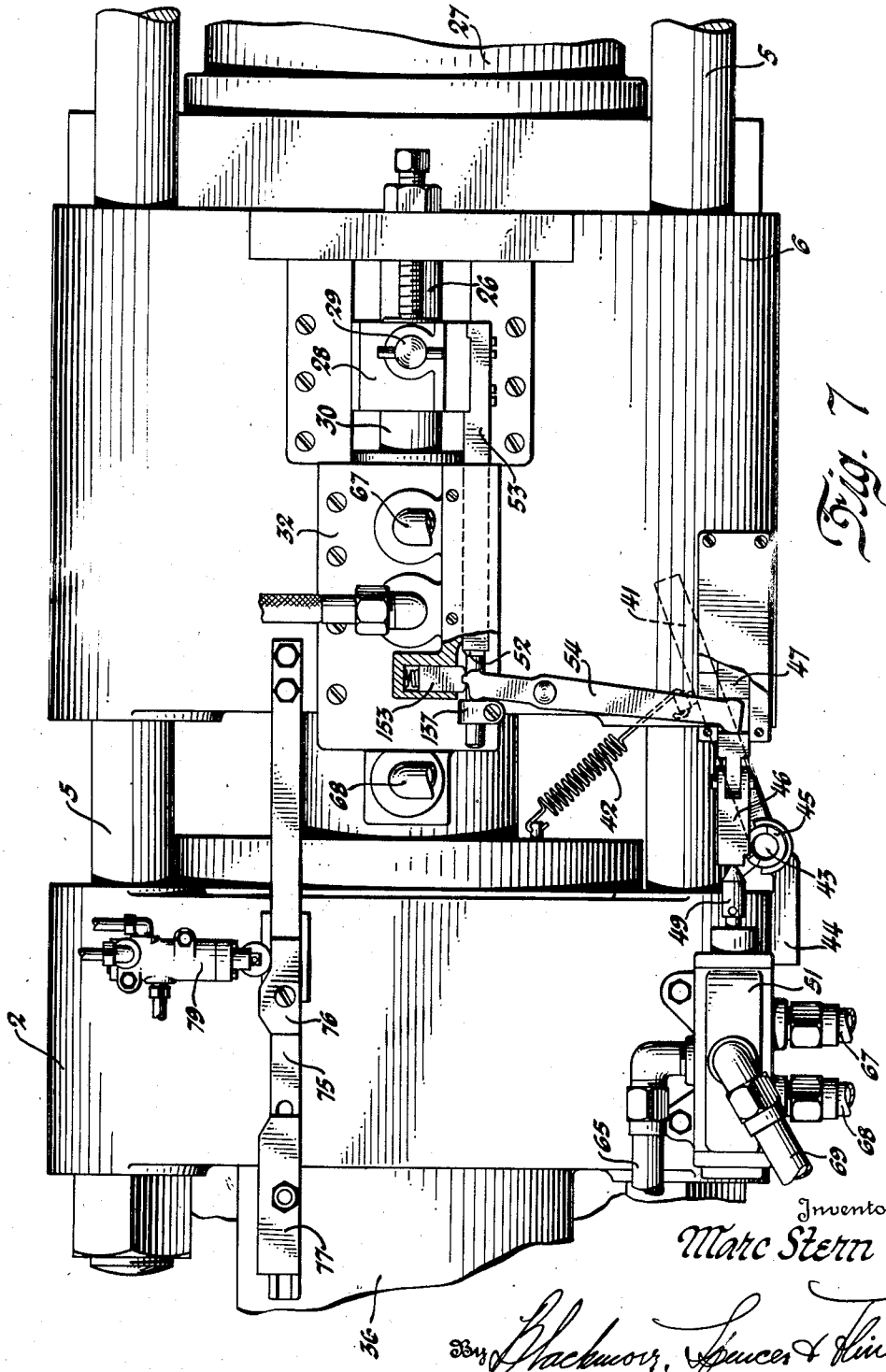

Fig. 7

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Feb. 7, 1939. M. STERN 2,145,956

DIE CASTING MACHINE

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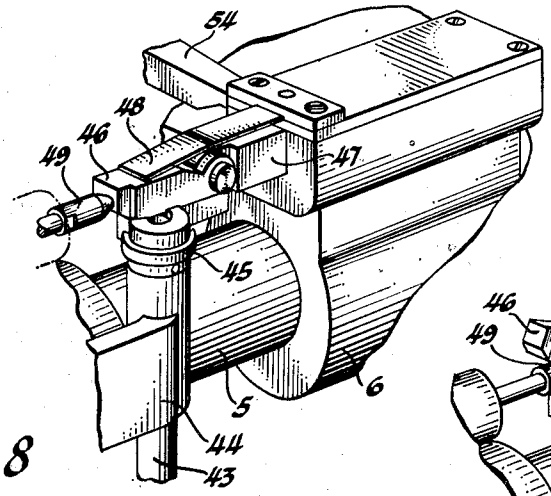

Fig. 8

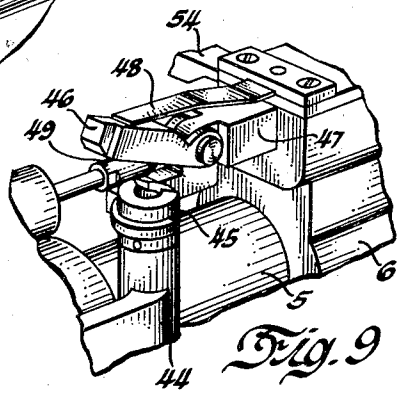

Fig. 9

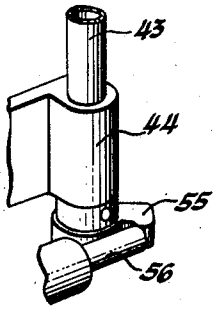

Fig. 10

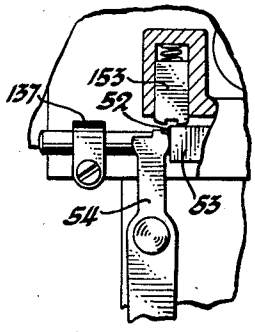

Fig. 11

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UNITED STATES PATENT OFFICE

2,145,956

DIE CASTING MACHINE

Marc Stern, Flint, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application June 9, 1937, Serial No. 147,229

15 Claims. (Cl. 22—70)

This invention relates to die casting machines and more particularly to improved operating mechanism for automatically actuating the parts in timed sequence through a cycle which includes closing the die, injecting molten metal, opening the die and ejecting the completed casting.

An object of the invention is to provide a machine having a series of independent pressure responsive devices for performing the several operations in the casting cycle and a control system for the delivery of fluid pressure, wherein a number of interrelated parts upon manual initiation are active according to predetermined timing to supply fluid under pressure to the pressure responsive devices.

A further object is to provide a system designed for operation generally on relatively low fluid pressures and wherein the effective pressures are automatically varied in certain steps of the operating cycle. Such variation as affecting relative motion of the dies, for example, results in an initial slow movement, an accelerated movement in the intermediate range of travel, and a final slow movement so that the dies open and close quickly and without inertia shock. Additionally, when the die is closed and is being filled with molten metal an increased pressure is built up to hold the die closed and resist separation under influence of metal injecting pressures.

Additional objects and advantages of the construction will become apparent during the course of the following specification having reference to the accompanying drawings wherein Figure 1 is a side elevation of the complete machine; Figure 2 shows the pair of pressure pumps driven by the same motor; Figure 3 is a fragmentary view, partly in section, of the metal injecting device; Figure 4 is a diagram of the control system; Figure 5 is a sectional view of the die operating cylinder; Figure 6 is a sectional view of the ejector assembly showing the die in closed position; Figure 7 is a plan view of a portion of the machine; Figures 8, 9 and 10 are perspective views showing the parts which serve to initiate and cut off the operation, and Figure 11 shows a detail of construction.

Figure 1 shows the bed or main frame 1 of the machine as having two spaced uprights 2 and 3 between which extend a series of four spaced slide rods 5—5 for supporting the movable carriage 6. On the slidable carriage is mounted a suitable die block 7 adapted to mate with a stationary die block 8 fastened to the upright 3. The sprue opening in the die block 8, as seen in Figure 6, communicates through the nozzle 9 with the pressure chamber 10 suspended within the melting pot 11. The melting pot to contain fluid metal forms a part of the furnace 12 which may be fired by a gas burner 13 or the like. Molten metal from the pot 11 enters the pressure chamber through a passage 14 and is forced by a slidable plunger 15 into the die cavity. At its upper end the plunger 15 is guided in a frame 16 and, as shown in Figure 3, is connected by a link 17 to one end of a rocker 18 pivoted at 19 on the frame 16 and connected at its opposite end by a link 20 to a connecting head 21 on the rod 22. The rod 22 is joined to the piston 23 slidable within the cylinder 24 under influence of fluid pressure applied on opposite sides of the piston.

Upon separation of the die blocks the finished casting is pushed out of the cavity of the movable die 7 by an ejector pin 25 which is shown in Figure 6 as on the end of a rod 26 reciprocable within spacer and die supporting members 27 on the movable carriage 6. The opposite end of the rod 26 is fastened to a slider 28 fixed by a removable pin 29 to the stem 30 of a piston 31 slidable within a cylinder 32 upon the application of fluid pressure to one side or the other of the piston. The cylinder is supported upon the movable carriage 6 and the carriage is fastened by the studs 33 to the piston rod 34 which, as seen in Figure 5, is joined to a piston 35 slidable within a cylinder 36 which is mounted on the upright 2 and into the opposite ends thereof pressure fluid is introduced for effecting carriage reciprocation.

Fluid, preferably oil, for operating the several work performing cylinders is supplied from a reservoir 37 by a pair of pumps 38 and 39 continuously driven by an electric motor 40. The oil under pressure flows through a system of pipes and under control of certain valves puts the machine through a complete operating cycle. To initiate operation there is provided a hand lever 41 firmly held in inoperative position by a spring 42 and which lever is mounted at the side of the machine within convenient reach of the operator on a rockshaft 43 supported in suitable bearings 44. At its upper end the shaft 43 carries a cam 45 which upon manual actuation of the shaft 43 lifts a pawl 46 about its pivotal mounting on the slide 47 and against the flat spring 48 out of alignment with the tip 49 on a spring pressed slide valve 50 contained within the valve housing 51 on the upright 2. This allows oil under pressure to reach the ejector cylinder 32 and retract the ejector pin 25. Upon movement of the slider 28 the camming abutment 52 on the rod 53 carried by the slider 28 engages under the spring pressed poppet 153 and retracts the same from its engagement with a lug on the end of a swinging lever 54 and thereafter the shouldered abutment on the rod 53 swings the lever 54 about its pivot to the position shown in Figure 11. The opposite end of the lever engages with the bar 47 and slides it to a predetermined set position for a purpose to be hereinafter referred to.

At the same time that the pawl 46 releases the tip 49, the lever 55 at the bottom of the

rockshaft 43 engages the rod 56 and moves the same inwardly to shift the slide valve 57 in the casing 58 for delivering liquid under pressure to the carriage operating plunger. As seen in Figure 4 the rod 56 carries a locking collar 59 which moves into engagement with a pivoted latch 60 which holds the slide valve in set position against its spring 61 until the latch 60 is released by the action of a solenoid 62.

Referring more particularly to the diagrammatic illustration of the control system and assuming the parts have been moved by the operation of the hand lever 41 to the positions mentioned, oil under pressure will be supplied by the pump 39 through the check valve 63 and the conduit 64 to the branches 65 and 66. The oil flowing through the branch 65 will pass through the valve casing 51 and through the conduit 67 to the ram end of the ejector cylinder 32. At this time the opposite side of the piston, by means of the conduit 68, is vented through the valve 51 to the drain pipe 69 which leads back to the supply reservoir 37.

In the mentioned setting of the valve 57 oil under pressure supplied by the branch 66 will flow through the conduit 70 to a valve casing 71 and after lifting the spring seated poppet valve 72 will pass into the head end of the cylinder 36 for moving the carriage toward die closing position. At this time the opposite end of the cylinder 36 is being vented by means of the conduit 73 through the valve casing 58 and the drain pipe 74. For this purpose the slide valve 57 has an axial passage therethrough communicating with the casing beyond the two piston formations thereon.

Means is provided to superimpose pressure from the pump 38 upon that supplied by the pump 39 during the intermediate range of carriage travel in order that the travel in this zone may be speeded up. For this purpose the carriage has secured thereto a strap 75 on which are located spaced cam abutments 76 and 77, respectively, the latter of which may be adjustable. In the first portion of carriage movement the cam 76 engages a roller on a slide valve 78 and moves this valve inwardly in its casing 79 against a spring 80 into position wherein the pipe 81 leading from the valve casing 82 connected with the pump 38 communicates through a pipe 83 with a chamber in the valve body 82 on the upper side of a piston valve 84 to close off communication of the pump 38 through the conduit 85 leading to the branch conduit 65. As the movement of the carriage proceeds the cam 76 moves away from the roller on the slide valve 78 and allows the valve to be projected under influence of its spring 80 to a position wherein the pipes 81 and 83 are out of communication and the pipe 83 is drained through the pipe 86. Thereupon the pressure from the pump 38 will lift the piston valve 84 and oil from the pump will flow through the conduit 85 and into the conduits 65 and 66 through the valve 58 and conduit 70 for action on the piston 35. As the carriage approaches die closing position the cam 77 engages with the roller on the slide valve 78 and again operates the valve to communicate the pipes 81 and 83 and thereby close the piston valve 84 whereupon the final movement is decelerated to cut down the momentum of the sliding carriage.

As soon as the die is closed an angle bracket 88 or other suitable part (see Figure 1) mounted on the carriage 6 engages a button on the switch 89 to close an electrical circuit which controls the application of pressure for operating the metal injecting apparatus. The circuit includes a main line switch 90 and when both switches 89 and 90 are closed electric current flows through the wire 91 to a relay 92 connected by the wire 93 to the return line 94. Actuation of the relay 92 allows current flow through the line 95 to a timer 96 of a well known adjustable type. The return line from the timer is indicated at 97. Thereafter for a predetermined interval electric current flows through the line 98 to a solenoid 99 and back through the return line 100. Actuation of the solenoid 99 moves a slide valve 101 to communicate a pressure line 102 constituting a branch of the conduit 70 with a valve cylinder 103. This causes the slide valve 104 to move toward the right in Figure 4 against the spring 105 and thereafter the pressure line 106 leading from the gear pump 38 through the check valve 107, communicates with a conduit 108 leading to the head end of the cylinder 24, whereupon the piston 23 is lifted and the plunger 15 is depressed for injecting metal into the die. At the same time the ram end of the cylinder 24 is vented through the conduit 109 by the slide valve 104 to the drain 110. As soon as oil is supplied by the line 102 to the valve chamber 103 it also flows through the pipe 111 through a check valve 112 to a booster cylinder 113 for priming the same. Concurrently with the flow of oil to the line 108 oil under pressure is also supplied through the conduit 114 and past a check valve 115 to the booster or intensifier cylinder 113. Within the booster cylinder are interconnected large and small pistons 116 and 117, respectively, and the oil supplied through the line 114 acting on the large piston 116 forces oil at a relatively high pressure through the conduit 118 leading to the valve casing 71. This oil flowing across the valve 72 closes this valve and acts on the piston 35 to insure the dies being held firmly together during the pressure injection of molten metal to the die cavity.

In order that the pressure in the system may be uniform from time to time there is provided an accumulator in the form of a cylinder 119 containing a large piston 120 and a small piston 121 and beneath the small piston the cylinder communicates through a conduit 122 with the valve casing 103 in alignment with the pressure supply line 106. The oil containing portion of the cylinder, therefore, provides a reserve supply of oil which is under a predetermined pressure through the action on the large piston 120 from a suitable source of air under pressure.

After a predetermined interval the timer 96 acts to open the circuit containing the solenoid 99 whereupon the valve 101 will be restored and vent the piston cylinder 103 through the drain pipe 123. Thereupon the spring 105 moves the slide valve 104 toward the left in Figure 4 and opens the conduit 108 to the drain pipe 124. At the same time oil under pressure from the line 106 flows through the conduit 109 and acts on the piston 23 to restore the same. Thereafter the timer 125 having the return line 126 closes a switch between the line 127 and the line 128 and through a switch 129 supplies current to the solenoid 62, having a return line 130 for releasing the latch 60 and allowing the slide valve 57 to be restored. As a safety measure the switch 129 precludes closing of this circuit until the metal injecting plunger is fully restored and accordingly the switch blade has a roller 131 which projects into the path of and is adapted to be operated

by the coupling head 21. As soon as the valve 57 is restored oil under pressure flows through the line 73 to the ram end of the cylinder 36 for returning the carriage. At the same time the line 70 is vented through the drain 74 and oil under pressure flows through the pipe 132 and lifts a piston 133 in the casing 71 which has a stem to engage and open the poppet valve 72 for communicating the head end of the cylinder 36 with the conduit 70. Oil under pressure also flows through the pipe 134 and acts on a piston 135 within the cylinder 113 to engage and hold open the valve 115 so that the cylinder may be vented through the conduit 114 and the drain pipe 124. The initial return movement of the carriage is slow and then fast and finally slow by reason of the engagement and disengagement successively of the cams 77 and 76 with the valve 78 as before referred to.

As the carriage approaches the final open position the pawl 46 contacts with the tip 49 and moves the valve 50 to an intermediate position in which the ram end of the cylinder 32 communicates through the conduit 67 with the drain pipe 136 and oil under pressure is supplied through the branch 65 and conduit 68 to the head end of the cylinder 32 for projecting the ejector pin 25. As the piston 31 moves to its limit the rod 53 carried thereby through an adjustable collar 137 strikes the adjacent end of the lever 54 and carries this back into latched engagement with the poppet 153. The swinging of the lever 54 projects the pawl 46 an additional amount sufficient to move the valve 50 further inward to a position whereby the pressure supply line 65 communicates with the drain 136. Thus in the inoperative position of the parts a continuous circulation of the pressure fluid is afforded and the reduction in resistance to pump operation avoids unnecessary heating of the oil.

It will be noted among other things, that the operating cylinder 24 for the metal injector plunger 15 is not mounted directly above the melting pot as is ordinarily the practice in die casting machines, but rather is mounted at one side of the furnace and operates the plunger through the rocker 18. This eliminates a fire hazard due to oil leaks and furthermore enables access to the melting pot for replacement without disturbing the operating cylinder and its connections with the fluid pressure lines. When the melting pot is to be replaced a disconnection is made in the link 20 and the plunger guide frame 16 is moved out of interference. For this purpose one of the vertical supporting legs of the guide may be swivelly mounted on the furnace assembly as by means of the screw stud 140 and the other leg is detachably fastened by a similar stud so that the frame can be swung about a vertical axis and to one side.

I claim:

1. Operating mechanism for a die casting machine, including a pair of fluid pressure actuated operating units operable, respectively, to close the die and to inject molten metal into the closed die, a source of pressure fluid adapted for communication with the unit which operates to inject metal into the die, a second source of pressure fluid adapted for communication with the die closing unit, and means active after a predetermined response of the last mentioned unit from fluid pressure supplied by said second source to communicate the first mentioned source of pressure with said last mentioned unit.

2. In a die casting machine, a pair of relatively movable die members, a fluid pressure operated device associated with said members for effecting their relative movement, means to supply pressure fluid to said device including a pair of pumps, means to connect one of said pumps with said device throughout the range of movement and means active in a predetermined intermediate portion of the range of movement to connect the other pump with the device.

3. In a die casting machine, a pressure operated device to operate the dies between opened and closed positions, a pressure operated device to inject metal into the closed dies, a source of fluid pressure to operate the last mentioned device, a second source of pressure fluid independent of said first mentioned source to operate the first mentioned device and means active within a predetermined intermediate portion of the stroke of the first mentioned device to superimpose pressure fluid from the first source on that supplied by the second source for accelerating the operation of said device.

4. In a die casting machine, a die operating piston, a cylinder containing said piston, a pair of conduits leading to opposite ends of the cylinder, a two-way valve adapted to communicate either of said conduits with a source of low pressure fluid and concurrently vent the other conduit, a check valve in one of said conduits adapted to be opened by fluid flow through the conduit to the cylinder, a high pressure line leading to the end of the cylinder beyond said check valve so that fluid flow therethrough closes said check valve, a fluid pressure actuated valve operating device to open said check valve and means to supply pressure fluid to said device when said two-way valve vents the conduit containing the check valve and communicates the other conduit with said source of pressure fluid.

5. In a die casting machine, a die operating device movable in opposite directions within a chamber in response to pressure differential on opposite sides thereof, a pair of conduits communicating with the chamber on opposite sides of said device, a two-way valve to connect either conduit with a source of fluid pressure and concurrently drain the other conduit, a check valve in one of said conduits, a fluid pressure actuated booster connected beyond said check valve, means to supply actuating fluid pressure to the booster, a check valve associated with said means, pressure actuated devices associated with both check valves to open the same, and means active through said two-way valve when the conduit containing the check valve is being drained to supply actuating fluid to both of said pressure actuated devices.

6. In a die casting machine, a frame, a reciprocatory carriage on the frame for opening and closing a die, a pressure fluid actuated device mounted on the carriage for performing a service operation, a valve mounted on the frame for supplying fluid pressure to said device, a pawl slidable on the carriage to engage a valve operating member to set the same in either of two positions, one of which completes a circuit for the pressure fluid, and the other of which supplies fluid pressure to one side of said device, means for tripping the pawl to set the valve in a third position for supplying fluid pressure to the other side of the device and means connected with the pawl and movable with the pressure responsive device after tripping the pawl to slide the pawl to a setting for engagement, upon the return stroke of the carriage, with the valve operating member and thereby move the valve to the second mentioned

position, and upon response of said device to such valve setting to slide the valve in the opposite direction and thereby set said valve in the first mentioned position.

7. In a die casting machine, control mechanism for a fluid pressure device which moves the die between opened and closed positions, including, a two-way valve to supply fluid pressure to said device, means biasing the valve toward die opening position, means for shifting the valve manually to die closing position, latch means to hold the valve in its manually set position, an electrically actuated device to release the latch, timing mechanism controlling the actuation of said latch releasing device, and a switch to set the timing mechanism into action automatically when the die is closed.

8. In a die casting machine, a reciprocable die actuating device movable in response to pressure differential on opposite sides thereof, a two-way valve adapted when in one position to supply fluid pressure on one side of the device to close the die and when in the other position to supply pressure fluid to the other side of the device to open the die, means responsive to pressure differential on opposite sides thereof to depress and retract a metal feeding plunger, a two-way valve to supply operating fluid pressure on either side of said means, manual means to set the first valve in die closing position, a releasable latch to retain the valve in its manually set position, means dependent upon die closing position of the first device automatically to set the second valve in plunger depressing position, timing mechanism to render said setting means ineffective so as to set the valve in plunger retracting position, additional timing mechanism to release said latch so as to set the first valve in die opening position, and plunger operated means to render the last mentioned mechanism ineffective until the plunger is fully retracted.

9. In a die casting machine, a source of actuating pressure fluid, a die closing fluid pressure responsive device, a fluid pressure actuated booster to increase fluid pressure on said device, a metal injecting fluid pressure responsive device, a fluid pressure actuated valve operable to connect said pressure fluid source with both the last mentioned device and the booster, secondary valve means operable to connect said pressure fluid source with both the booster and said pressure actuated valve and means acting automatically when the die is closed to operate the secondary valve means.

10. Control mechanism for a die casting machine, having a movable die carriage and a fluid pressure actuated ejector mechanism mounted on said carriage, a valve operating plunger adapted when in one position to communicate said ejector mechanism with a source of operating fluid and when in another position to by-pass said mechanism, a projectible abutment on said carriage adapted to engage said plunger coincident with carriage movement to move the same to the first mentioned position and means operating in response to said ejector mechanism to project said abutment for moving the plunger to the second mentioned position.

11. Control mechanism for the sequential operation of the fluid pressure actuated devices of a die casting machine, including a fluid pressure actuated valve adapted upon pressure fluid application thereon to supply operating pressure fluid to metal injecting means and to a booster associated with die closing means, a control valve adapted when open to flow operating pressure fluid to the booster and the first mentioned valve, a master valve adapted when manually set to supply operating pressure fluid to the die closing means and through said control valve to the first mentioned valve and the booster, a latch device for locking the master valve in manually set position, electrically actuated means to release the latch after a predetermined time interval, electrically actuated means to hold the control valve open for a predetermined time interval and a switch device automatically operated in the die closing position of the parts to supply electric current to both of said electrically actuated means.

12. Control mechanism for a die casting machine including a fluid pressure actuated valve adapted upon actuation to supply operating pressure fluid to metal injecting means and to a pressure fluid booster associated with die closing means, a valve controlling pressure fluid flow to the fluid pressure actuated valve for its actuation and to the booster in advance of the supply from the pressure actuated valve, means operated automatically to open said control valve when the die is closed, and a manually set valve adapted to supply pressure fluid to a die closing means and through said control valve to the pressure actuated valve and the booster.

13. In a die casting machine, a source of fluid pressure, die closing means and metal injecting means, both operated by pressure fluid from said source, a fluid pressure actuated booster associated with the die closing means to increase fluid pressure thereon, a fluid pressure actuated valve adapted to communicate the pressure fluid source simultaneously with both the metal injecting means and the booster upon the application thereon of pressure fluid, a manually set valve adapted when in manually set position to communicate the pressure fluid source simultaneously with the die closing means and said fluid pressure actuated valve, an electrically actuated valve interposed between said valves and adapted when actuated to pass pressure fluid simultaneously to the fluid pressure actuated valve and to the booster and means actuated by the die closing means when in die closing position to supply current to said electrically actuated valve.

14. In a die casting machine, a movable die carriage, a fluid motor therefor, a pair of pumps for supplying pressure fluid to said motor, a valve controlling fluid flow from one of the pumps, and a valve operating cam bar supported by the carriage and having valve closing camming abutments spaced apart and active on the valve near opposite limits of carriage travel.

15. Control mechanism for a die casting machine including a valve casing mounted on a stationary part of the machine, a valve operating plunger movable to any one of three positions to control flow of pressure fluid in one position to project an ejector mechanism carried by a movable die carriage, in another position to retract said mechanism and in the third position to by-pass said mechanism, a projectible abutment on the carriage to engage said plunger and move the same coincident to carriage movement to its ejector projecting position, means movable with the ejector mechanism to project said abutment for moving the plunger to its by-passing position and a manually operated trip device to disengage the abutment and plunger for plunger movement to ejector retracting position.

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