July 3, 1945. G. W. WACKER 2,379,668

HYDRAULIC CIRCUIT FOR PRESSES

Original Filed March 5, 1941 2 Sheets-Sheet 1

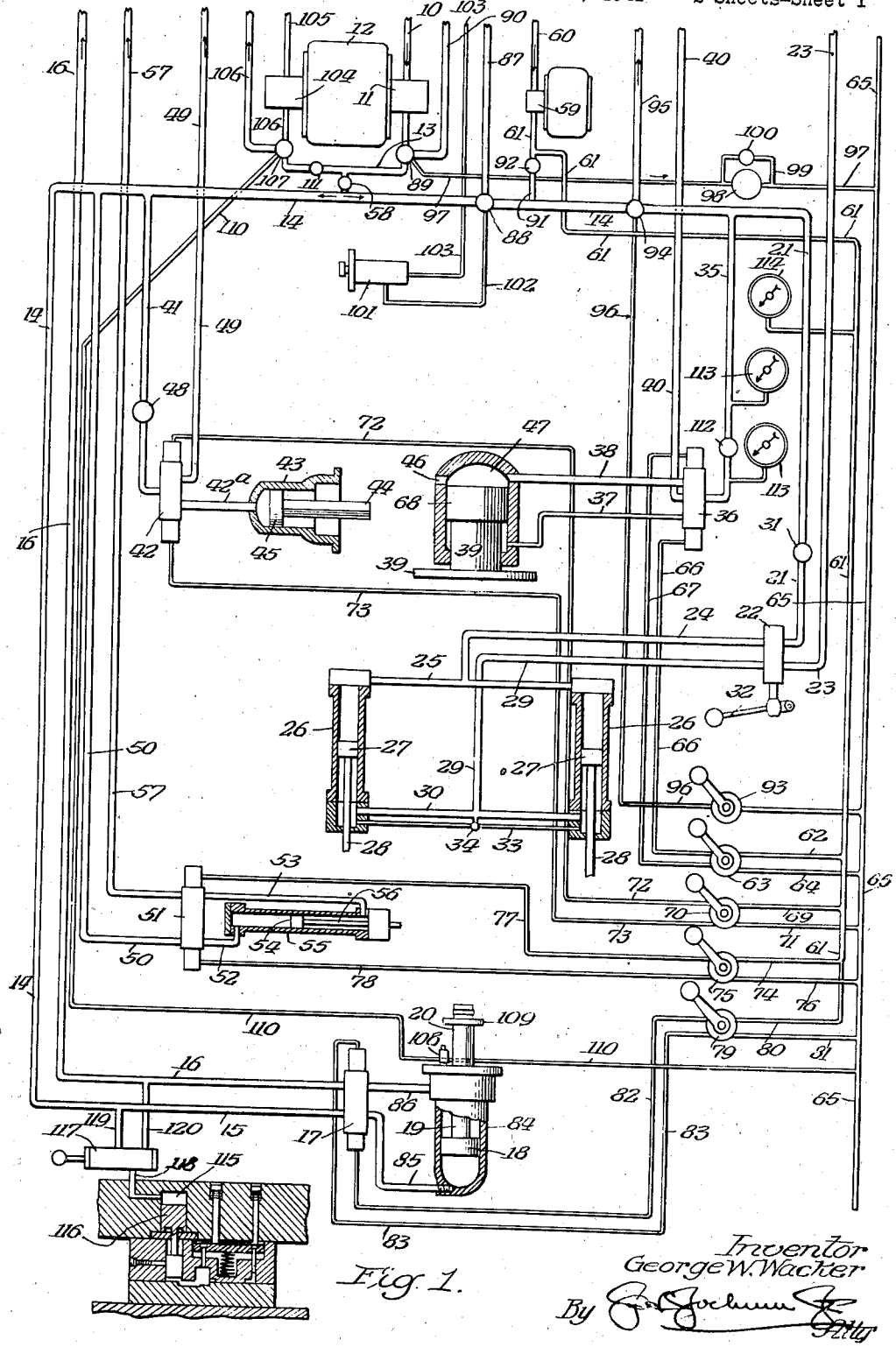


Fig. 1.

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Fig. 2

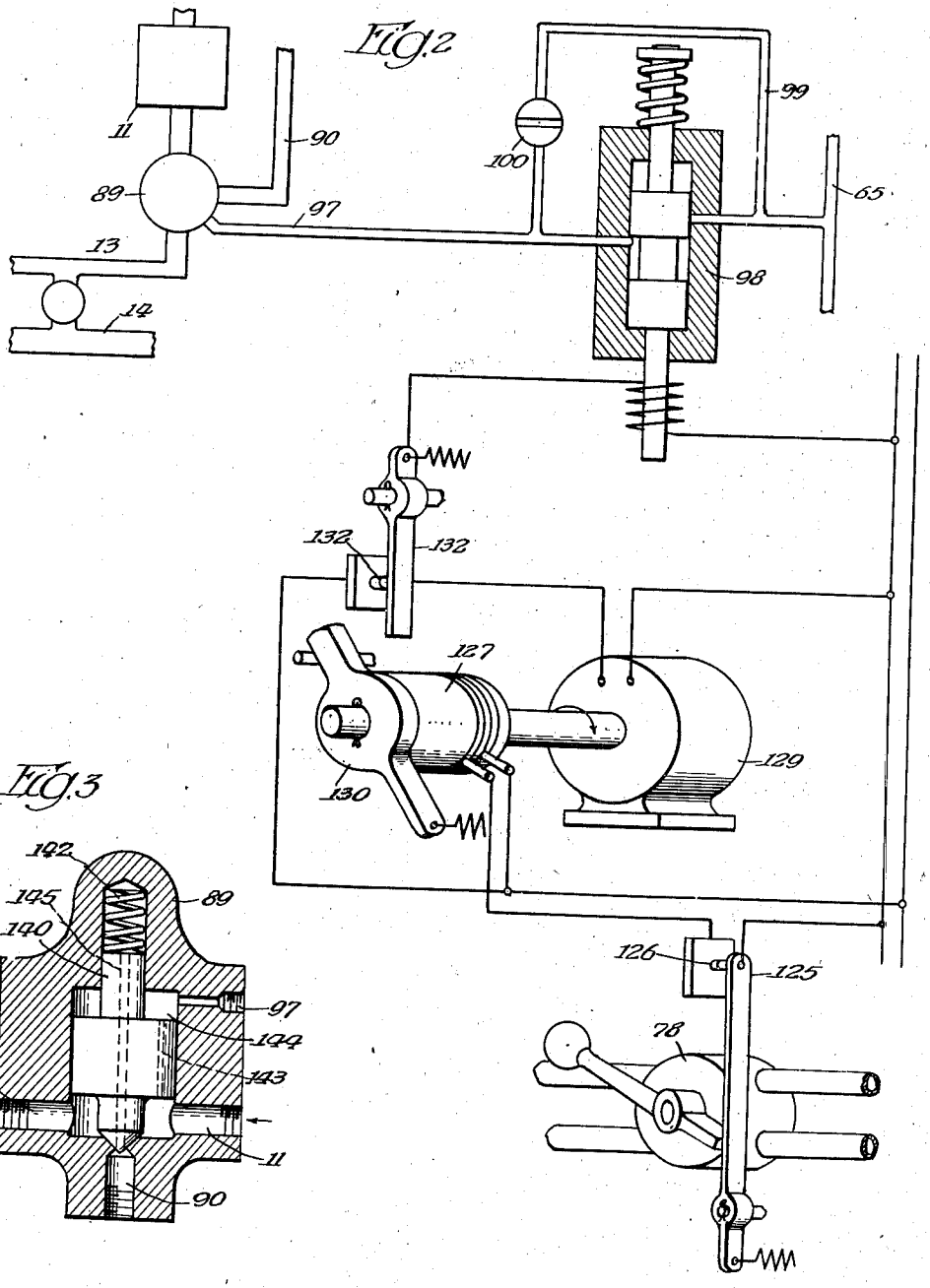


Fig. 3

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HYDRAULIC CIRCUIT FOR PRESSES

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Original application March 5, 1941, Serial No. 381,841. Divided and this application October 10, 1941, Serial No. 414,497

14 Claims. (Cl. 60—97)

This application is a division of original application, Serial No. 381,841, filed March 5, 1941.

The present invention relates more specifically to an improved hydraulic circuit for operating the parts of a press, and one of the objects of the same is to provide an improved, safe, and economical hydraulic circuit whereby a fluid pressure line common to a plurality of driven elements and supplied by a plurality of constant delivery pumps may be operated:

(a) With the normally used volume of fluid at operating pressure.

(b) With the maximum available volume of fluid at operating pressure.

(c) With a greatly reduced volume of fluid at operating pressure.

(d) With either maximum volume, normal volume, or reduced volume of fluid at negligible pressure.

Another object is to maintain, in a supplemental or pilot circuit supplied by a pump which is also adapted to supply the main circuit, sufficient pressure, at all times, to assure the positive operation of control devices supplied by the pilot circuit, regardless of the pressure existing in the main circuit.

Another object is to provide a fluid pressure circuit supplied by a large and a small constant delivery pump, the larger of which is by-passed at negligible pressure after it has supplied the circuit for a predetermined period of time, the smaller pump continuously supplying pressure fluid to the circuit.

Another object is to direct the normally by-passed flow from the larger of two pumps to a fluid pressure circuit, to supplement the continuous flow of the smaller pump, automatically and simultaneously with the operation of controls, the functioning of which latter brings about the necessity for a greatly increased fluid supply from said circuit.

Another object is to provide a circuit supplied by constant delivery pumps, whereby a fluid driven clamping mechanism will be economically operated to obtain three successive stages of mold closing and clamping pressure, the last stage requiring an intensifier.

To the attainment of these ends and the accomplishment of other new and useful objects as will appear, the invention consists of the features of novelty in substantially the construction, combination and arrangement of the several parts hereinafter more fully described and claimed and shown in the accompanying drawings, illustrative of this invention.

In the drawings,

Figure 1 is a diagrammatic illustration of the system with parts of the mechanisms operated thereby, such mechanisms being shown partly in elevation and partly in section.

Figure 2 is a diagrammatic view, with parts in section, of an electrical timing mechanism, by means of the use of which the circuit is controlled.

Figure 3 is a detail sectional view, on an enlarged scale, of the unloading valve for the circuit.

The fluid for the system is supplied from any suitable source through a pipe 10, which pipe is connected with a pump 11 that, in turn, is operated by a motor 12. Leading from the pump 11 is a pipe 13 which has communication with a pipe 14, the latter in turn being connected by means of branches through the medium of pipes 15 and 16, with a four-way valve 17, which latter controls the direction of flow of the fluid with respect to the piston 18 connected, by means of a piston rod 19, to a movably operated part 20 of the press and embodying the injection mechanism.

This pipe 14 is connected, by means of a pipe 21, with one side of a manually controlled valve 22, and connected also to the valve 22 is an exhaust or outlet pipe 23. A pipe 24 leads from the casing of the valve 22, and communicates with a pipe 25 having communication with the cylinders 26 in which pistons 27 operate, and constitute a platen-operating mechanism, and these pistons 27 are connected, by means of piston rods 28, to the long stroke platen of the press, for raising and lowering such platen.

The valve 22 also has communication with a pipe 29, which in turn has communication with a pipe 30 leading to the cylinders 26 on the other side of the pistons 27, and in the pipe 21 may be arranged a globe or suitable valve 31.

The valve 22 is manually operated in any suitable manner, such as by means of an operating lever or handle 32.

Both of the pipes 24 and 29 serve as fluid inlet and fluid outlet pipes for the cylinders 26; that is, when the valve 22 is set so as to direct the fluid into the cylinders 26 on one side of the pistons 27, the fluid on the other side of the pistons will flow through the pipe 30, pipe 29, through the valve 22, into the exhaust pipe 23. When the valve 22 is reversed, the direction of the flow of the material will also be reversed.

As a means for preventing a sudden blow to the part which is moved by the pistons 27 against a mold, or abutment when the piston is lowered, cushioning means are provided in the cylinders

26, and comprise a pipe 33 of a very small diameter, which leads from the ends of the cylinders below the pistons 27, and has communication with the pipe 29, by means of a valve 34.

This valve 34 may be of any desired or suitable construction, such as an ordinary open and shut valve, and is adapted to be opened to any degree or extent so as to control the size of the passage through which the fluid, being forced out of the cylinders 26, will flow back into the pipe 29. It will therefore be manifest that, inasmuch as the pipe 33 is of a smaller diameter, the fluid, when trapped between the piston and the end of the cylinder, will flow slowly through the pipe 33, and thereby form a cushion.

The pipe 30 has communication with the cylinders 26 at a higher elevation than the point at which the pipe 33 has communication with the cylinder, and it will be seen that during the first part of the descent of the piston 27 in the cylinder 26, fluid will be forced out through the pipe 30, but when the piston assumes a position to close the pipe 30 and the corresponding opening in the cylinder 26, the only escape for the fluid will be through the pipe 33.

The pipe 14 also has communication with another pipe 35 that leads to a valve 36, which latter may be of any desired or suitable construction, but is preferably of the four-way type, and is the valve which controls the flow of fluid through the pipes 37 and 38 that control the operation of the short stroke or supplemental ram 39, which ram embodies the mold clamping mechanism of the press. To the casing of the valve 36 is also connected an exhaust pipe 40.

Similarly, the pipe 14 is connected, by means of a branch 41, with a valve casing 42, and the casing in turn is connected, by means of a pipe 42a, to a cylinder 43. This valve controls the admission of the fluid pressure to the cylinder 43 to actuate a plunger or intensifier mechanism 44, through the medium of a piston 45, to move the plunger into an opening 46 of a cylinder 47, in which the ram 39 operates, to intensify the pressure of the fluid in the cylinder 47, and within the pipe 41 may be arranged a check valve 48. Leading from the casing of the valve 42 is an exhaust pipe 49.

Leading from the pipe 14 is another pipe 50 which has communication with a valve mechanism 51, the latter operating to control the direction of flow of the fluid through the pipes 52 and 53 for moving the piston 54 in a cylinder 55, and which piston 54 is connected, by means of a plunger rod 56, to a thrust transmission mechanism that is positioned between the platen and a supplemental or short stroke ram 39 of the press, and leading from the casing of the valve 51 is a discharge outlet pipe 57.

Thus it will be seen that the pump 11, receiving its supply of fluid from the pipe 10, will direct the same through the pipe 13, to be distributed to the various mechanisms, a check valve 58 being provided between the pipes 13 and 14.

The pump 11 is a continuously operating pump, and will establish and maintain a pressure in the line through the pipe 14, and by means of controlling the respective valves 36, 51, 42, and 17, the direction of the flow of the fluid will be controlled to move the respective parts accordingly. The raising and lowering movement of the part to which the pistons 27 are connected is controlled by the valve 22.

The valves 36, 51, 42, and 17 are fluid actuated valves, and pressure is supplied to actuate them by means of a pump 59, which receives its supply through a pipe 60. This pump discharges into a pipe 61, and this pipe with the branches which are attached thereto is of a smaller diameter than the diameter of the pipe 14 with the various pipes attached to the latter.

In the description of the pipe 61 and its communicating pipes which convey the fluid pressure to the valves to operate them, they will hereinafter be designated as the pilot pipes or pilot system.

This pilot pipe 61 has communication with a pipe 62 controlled by a manually operated valve 63, and leading from the casing of this valve is a pipe 64, which connects with an exhaust pipe 65. Leading also from the casing of the valve 63 is a pilot pipe 66, which has communication with the casing of the valve 36, and a second pilot pipe 67 also has communication with the casing of the valve 36 and the valve 63, so that by manipulating the valve 63, the direction of flow of the fluid through the pilot line to the valve 36 will be controlled, as will also the raising and lowering movement of the piston 68 in the cylinder 47 that is connected to the ram 39.

Similarly, leading from the pipe 61 is another pipe 69, which has communication with the casing of a valve 70, and leading from the casing of the valve 70 is another pipe 71 which communicates with the exhaust pipe 65. The valve 70 is manually controllable, and leading from the casing of this valve is a pipe 72 which has communication with the valve 42, and another pipe 73 also has communication with the valve casing 70 and the valve casing 42, so that by positioning the valve 70 in one position, fluid from the pipe 41 will enter the cylinder 43 to advance the piston 45 and the plunger 44 to force the latter into the cylinder 47, and thereby intensify or increase the fluid pressure in the cylinder 47 against the piston 68.

When the valve 70 is set to exhaust the fluid pressure from the cylinder 43, the pressure in the cylinder 47 will operate upon the end of the plunger 44 to force the piston 45 backwardly in the cylinder 43, so that the fluid in the cylinder 43 behind the piston 45 will flow through the valve 42, thence through the pipe 49 back to the exhaust or tank.

Still another pipe 74 forms communication between the pipe 61 and a valve casing 75, the latter having a valve therein which is preferably manually operated, and a pipe 76 forms communication between the casing of the valve 75 and the exhaust pipe 65.

Leading also from the valve casing 75 is a pipe 77, which has communication with the casing of the valve 51, and another pipe 78 forms communication between the casing of the valve 51 and the casing of the valve 75, with the result that when the valve 75 is set to direct the fluid pressure from the pilot system through the pipe 77, and the valve 51 is moved in one direction, the piston 54 will be correspondingly moved by the advance of fluid pressure from the pipe 50, 52, and at the same time the fluid on the other side of the piston 54 will flow out of the cylinder through the pipe 53 to the exhaust through the pipe 57. The exhaust from the pilot system will flow from the valve casing 51, pipe 78, through the valve 75, pipe 76, to the exhaust pipe 65.

The action of the movable part or plunger 20 is controlled by a valve 79, which is also preferably a manually operated valve, the casing of which has communication, by means of a pipe 80,

with the pilot pipe 61, and has communication, by means of a pipe 81, with the exhaust pipe 65.

Leading from the valve casing 79 is a pipe 82, which has communication with the casing of the valve 17, and a pipe 83 also has communication with the valve casing 17 and the valve casing 79, so that when the valve 79 is set to direct the fluid pressure beneath the piston 18 to raise the movable part 20, the fluid pressure to operate the valve 17 will be from the pilot pipe 61, through the pipe 80, pipe 82, to valve 17. The fluid pressure to the cylinder 84 will then be through the pipe 85 leading from the valve casing 17, beneath the piston 18. At the same time, fluid on the other side of the piston 18 will be exhausted from the cylinder 84, through the pipe 86, to the exhaust pipe 16.

Thus it will be seen that by manipulating the various valves 63, 70, and 75, as well as the valve 32, the operation of the various parts of the press will be controlled.

The pipe 14 also has communication with a discharge or outlet pipe 87, and in the operation of the pump 11 to build up the necessary pressure in the system, such pressure is controlled by means of the necessary pressure-regulating valve 88 in the pipe 14, and this pressure-regulating valve 88 will also operate as a relief valve.

When the part of the mechanism to which the pressure is applied (such as the slide) reaches the limit of its movement or meets with sufficient resistance, then no more fluid in volume can be supplied to the operating parts, but the pump 11 will still be operating, and by attempting to force more fluid into the system, the adjustable relief valve 88 will open to handle the surplus fluid, and the pump 11 will then operate to discharge the fluid, at full pressure, back to the tank or source of supply through the pipe 13, past the valve 58, out through the pipe 87, back to the tank or source of supply. However, such a condition would result in the loss of power, and in order to obviate such loss, an unloading valve 89 is provided in the pipe 13, and connected also to the casing of this valve is an exhaust pipe 90. This valve 89 is operated at a predetermined time in the operation of the mechanism, and the means for controlling the operation of this valve itself operates to automatically open the valve, with the result that the fluid, at low pressure, will be discharged from the pump 11, through the pipe 13, past the valve 89, into the pipe 90, back to the tank or source of supply. However, at this time, and although the fluid is being discharged back to the tank or source of supply by the pump 11, it is necessary to maintain the operating fluid pressure within the system and against the actuated parts, that is, such as against the slides, etc. This may be accomplished by the use of the pump 59, which is preferably of a smaller capacity and connected with the system so as to supply the necessary fluid to maintain such pressure, such connection being made by means of a pipe 91, which has communication with the pipe 61, and in which pipe 91 is arranged a sequence valve 92. The output of the pump 59 is prevented from discharging through the valve 89 when open, by means of the check valve 58. This pump 59 directs fluid through the pilot system 61, and the direction of flow in this pilot system is controlled by the manually operated valves 70, 63, 75, and 79, so as to direct the fluid to one side or the other of the respective four-way valves 36, 51, 42, and 17 to cause a change in the direction of flow of fluid to one side or the other of the respective operating pistons.

The valve 92, hereafter designated as a "sequence valve," is provided to insure that the pump 59 first supplies fluid to the pilot system 61 up to a predetermined minimum pressure, after which the valve 92 is open to the pipe 91, permitting fluid flow from the pilot system to the main circuit. In this way, a positive supply of pressure fluid is always available to operate the controls, regardless of the pressure existing elsewhere in the circuit.

Another valve 93 controls the operation of a dump valve 94 in the pipe 14, and which valve 94 controls the discharge of fluid pressure into an exhaust pipe 95, and which valve 94 is opened to permit a sudden discharge of the fluid pressure from the system back into the tank or source of supply through the pipe 95. This is sometimes necessary or desirable to temporarily render the machine inoperative.

The valve 94, which is designated as a "dump valve," is normally closed, and is operated to permit such discharge of pressure fluid by the manually worked valve 93, which vents the dump valve through the pipe 96, thereby unbalancing the controlling pressure in the valve and causing it to open to the exhaust pipe 95. Reversing the valve 93 to block the vent line 96, will cause the valve 94 to close the opening to pipe 95, thereby resuming pressure in the circuit.

A vent line 97 normally maintains the valve 89 in a position that the pump 11 will cause the fluid to flow therethrough into the exhaust line 90, and is operated so as to be positioned to direct the supply of fluid from the pump 11 to the fluid system, through the pipes 13 and 14.

The unloading or by-pass valve 89 is normally open to the exhaust pipe 90, and is provided to prevent the loss of power and the heating of fluid due to the unnecessary flow of pressure fluid from the pump 11 during non-flow periods of pressure operation, during which times the flow must discharge at high pressure through the pressure relief valve 88. This purpose is accomplished by limiting the duration of pressure operation of the pump 11 to the time necessary for the completion of any operative function of the press requiring pressure fluid, and then by-passing the fluid supply from the pump to the source through the pipe 90 at substantially zero pressure.

Fluid flow from the pump 11 into the operative circuit of the press is established simultaneously with the necessity for such flow, by causing the valve 89 to direct the fluid flow into the pipe 13 each time any one of the four-way valves is reversed, thereby creating a fluid demand. By providing an automatically operated apparatus, such as described, or any other suitable electrically operated mechanism, the same control which operates the valve 89 to by-pass the pump 11 may be employed to resume the flow from the pump into the operative circuit when required, and for a timed duration.

There may be times when it is desired to maintain the valve 89 open for a prolonged period, and to that end there is provided a by-pass 99, preferably manually controlled by a valve mechanism 100, by-passing the fluid around the valve mechanism 98, and the valve 100 may be any ordinary valve to open and close the by-pass.

A manually adjustable pressure regulator 101 is provided for remote control of the circuit pressure through the valve 88, one side of the latter being connected with the valve 101 by a pipe 102, and the other side of the valve 101 is con-

nected with an exhaust pipe 103, so that by opening the valve 101, the pressure in the system which it is necessary to maintain may be increased or decreased; that is, the circuit pressure necessary to open the valve 88 may be varied at will.

An auxiliary pump 104 is provided to meet operating conditions which require exceptionally high injection plunger speeds, and operates to supplement the flow from pump 11. Pump 104 is substantially a duplicate of pump 11, and is normally by-passed through the valve 107 to the exhaust pipe 106 at substantially zero pressure. When the injection plunger 20 starts its working stroke, it carries collar 109 out of contact with a spring returned valve 108, thus closing the normally open vent line 110. This action causes the valve 107 to close the passage to pipe 106, thus directing the flow from pump 104 into the operating line under pressure, and where it is added to the flow from pump 11 to increase the speed of the injection plunger.

As the injection plunger resumes its retracted position, the vent line 110 is again blocked by the valve 108, and this causes the valve 107 to open the passage to the exhaust pipe 106. Escape of pressure fluid from the other pumps through the valve 107 into the pipe 106 is prevented by check valve 111.

The check valve 111 is provided in the pipe 13 between the pump 104 and the line 14, and a check valve 112 may also be provided in the line 35. Pressure gauges 113 may also be provided in the line 35 on both sides of the line 112, so as to indicate different pressures, while a pressure gauge 114 may also be provided in the pilot line 61.

Obviously, check and relief valves may be provided at any desired or necessary points in either the main line or the pilot line.

When this system is employed with the injection method and apparatus as described in my aforesaid application, a chamber 115, in which a piston 116 operates, is connected to the supply line 14—15 and the exhaust line 16, through the medium of a valve mechanism 117, one side of the valve casing 117 being connected to the chamber 115 by means of a pipe 118, and to the supply line 14—15 by means of a pipe 119, and is also connected to the exhaust line 16 by means of a pipe 120. This valve 117 is of any ordinary and suitable type, and is adapted to be positioned so as to form communication between the pipe 119 and the chamber 115, to permit the fluid pressure from the line 14—15 to enter the chamber 115 to actuate the piston 116.

The valve 117 is also adapted to be positioned so as to close the pipe 119 with respect to the pipe 118, and open communication between the pipe 118 and a pipe 120, to permit the fluid pressure to escape.

Electrical control of the valve 89 is preferred, and may be accomplished in any of a number of different ways, one of which is illustrated in Fig. 2.

In describing the control, it is assumed that the four-way valves 32, 63, 70, 75 and 78 are equipped with normally closed contacts, and that as the lever is shifted to reverse the fluid flow of the pilot controls governed by the valve, the lever 125 is tripped, thus momentarily opening the contact 126. Opening this contact de-energizes the coil in the magnet clutch 127, which latter is mounted to revolve with the slow-turning spindle of the self-starting synchronous motor 129.

Adjoining the clutch 127 and rotatably mounted on the spindle 128, is a tripping member 130, normally held against a stop by a spring and adapted to be rotated in a clockwise direction when the clutch is energized. When the hand lever of the valve 78 momentarily opens the contact 126, the tripping mechanism is snapped into the position shown.

This permits the contact 131, mounted on the arm 132, to engage, closing the motor circuit and also closing the circuit through the coil of the spring returned solenoid valve 98. As a result, the motor 129 starts rotating the clutch 127, which now carries the member 130 with it. Closing the solenoid circuit of the valve 98, moves the spool to stop fluid flow from the unloading valve through the pipe 97 to the exhaust pipe 65 and, as a result, the pressure in the valve 89 becomes equalized, closing the valve to the exhaust line 90, and causing the pump 11 to discharge its flow into pipe 13, thence to the common line 14.

In the meantime, the member 130 has rotated through an arc determined by the setting of the control, so that at the end of a predetermined interval, the member 130 will engage the contact arm 132 and open the contact 131. This stops the motor 129 and de-energizes the spring returned solenoid valve 98, permitting the fluid flow from the valve 89 to be resumed to the exhaust pipe 65 through the pipe 97. The valve 89 will now open, because the internal pressure becomes unbalanced, and the fluid flow from the pump 11 will be by-passed at practically zero pressure to the exhaust pipe 90.

The pump 11 will continue to run under no load until another control valve lever is turned to initiate movement of another press element, when the aforesaid cycle of operation will be repeated.

The electrical control, therefore, provides automatic means to operate the main supply pump under pressure for a definite and limited period only, and to initiate such periods as called for by the fluid requirements of the press.

The by-pass or unloading valve 89 is preferably of a construction as shown in Fig. 3, wherein 140 is a spring returned piston valve adapted to open and close the passage 90.

A relatively restricted passage 143 is provided, connecting the chamber 144 with the main passage through the valve. Another passage 145 is provided entirely through the piston valve, to connect the spring chamber 142 with the passage 90, to prevent the accumulation of any pressure in the chamber.

It will be seen that if the passage 97 is closed, pressure will be built up in chamber 144, equal to the pressure in the through passage 145, and the piston valve will be in approximately hydraulic balance. Therefore, the pressure of the spring predominates, and will keep the valve on its seat, closing the passage to 90, but when passage 97 is opened by the control valve 98, it will discharge fluid faster than the passage 143, which latter, being restricted, can supply it, thereby dissipating the pressure in the chamber 144, and creating an unbalanced hydraulic condition with reference to the piston valve.

The pressure from the pump 11 will now be able to move the valve against the pressure of the spring, opening the passage to 90, and reducing the pressure of the fluid flow from the pump 11 to the negligible amount needed to overcome the pressure of the spring. Blocking or closing of the passage 97 will resume the hydraulic balance in the valve, and the spring will again return the valve to its seat.

It is thought that the operation of this circuit will be clearly understood from the foregoing

description; but, briefly stated, it will be seen that the main pressure for operating the parts of the press is supplied through the pipe 14 from the main supply and by the pump 11. By the hand-operated valve mechanisms, the pressure from the pilot system may be controlled to operate the various valves which, in turn, control the direction of flow of the fluid to the operating parts. Furthermore, by the operation of these valves any order or sequence of the movement of parts may be obtained.

With this improved system it will also be manifest that there is provided a pump of relatively large capacity operating to feed the liquid into the pressure circuit, and a pump of a smaller capacity which also feeds into the same circuit. The valve mechanism operates to divert the output of the larger pump away from the circuit at a negligible pressure, and the pump of smaller capacity operates, during such diversion by the pump of larger capacity, to supply the circuit and maintain full pressure therein.

There is also provided a supplemental fluid or pilot circuit which is supplied by the pump of smaller capacity for controlling the valve mechanism, and the pressure in the pilot circuit will be always maintained at a predetermined minimum pressure, regardless of the pressure of the main circuit.

With this improved circuit, the maximum power input to the pressure sources is maintained at a predetermined and limited duration, and the power input is substantially reduced while the full pressure on the hydraulic circuit will be maintained.

While the preferred form and manner of operating the various parts of this system have been herein diagrammatically shown and described, it is to be understood that various changes may be made in the system, within the scope of the claims, without departing from the spirit of this invention.

What is claimed as new is:

1. An hydraulic circuit providing variable volume of fluid at constant pressure for operating the fluid driven elements of a press, comprising a constant delivery high pressure large volume pump adapted to intermittently supply said circuit through an unloading valve and a check valve, a small volume pump continuously supplying said circuit, and electrically operated control means responsive to the expiration of a predetermined period of circuit supply by said large pump, to by-pass the supply from the large pump through said unloading valve, said check valve operating to maintain the small pump from discharging through said unloading valve, said electrically operated control means being also responsive to the initiation of fluid flow to said driven elements, and also operating to resume the supply from the large pump to the circuit simultaneously with the initiation of said fluid flow.

2. In an hydraulic circuit for operating the fluid driven elements of a press, comprising a plurality of pilot operated four-way valves, and including a main supply line, a pilot supply line, a constant delivery high pressure large volume pump adapted to intermittently supply said main line through an unloading valve and a check valve, a small volume pump continuously supplying said pilot line, a sequence valve connecting said pilot line and said main line, and open only while a predetermined minimum pressure is maintained in said pilot supply line, and electrically operated control means responsive to the expiration of a predetermined period of main line supply by said large pump, to by-pass the supply from the large pump through the said unloading valve, said check valve operating to maintain the small pump from discharging through the said unloading valve, said electrically operated control means being also responsive to the initiation of reversal of the pilot operated four-way valves, and operating to resume the flow from the large pump to the main line automatically and simultaneously with the initiation of said reversal.

3. An hydraulic circuit for operating the fluid driven elements of a press, said circuit comprising a main supply line, and including a plurality of pilot operated four-way valves, a pilot supply line, a dump valve in said main supply line, a constant delivery high pressure large volume pump adapted to supply the main supply line through an unloading valve and a check valve, a small volume pump continuously supplying said pilot line, a sequence valve connecting said pilot line and said main line, and open only while a predetermined minimum pressure is maintained in the pilot line, electrically operated control means responsive to the expiration of a predetermined period of main line supply by said large pump, to by-pass said large pump through said unloading valve, said check valve operating to maintain the small pump from discharging through said unloading valve, said electrically operated control means being also responsive to the initiation of reversal of the pilot operated four-way valves, said control means operating to resume the flow from the large pump to the main line automatically and simultaneously with the initiation of said reversal, and means to cause the discharge of fluid from the main line through the said dump valve in emergencies, thereby reducing the pressure in said main line to a degree sufficient to arrest movement of the driven elements.

4. An hydraulic circuit for operating the elements of a press, embodying a main supply line, a constant delivery pump of relatively large capacity adapted to supply pressure fluid intermittently to said line, a constant delivery pump of small capacity continuously delivering pressure fluid to said line, and electrically operated control means for controlling the flow from said large pump, to by-pass the large pump at negligible pressure after a predetermined period of supply from said large pump to said line, and to resume the pressure supply from said large pump to said line upon the initiation of fluid demand to operate the press elements at maximum speed.

5. Means for controlling the hydraulic system of a molding press, embodying a small and a relatively large pressure supply pump, and a plurality of elements driven by the pressure fluid from said pump, a main supply line, and a pilot supply line, automatic electrically operated selective control means responsive to both the continuity of operation of said large pump and the fluid requirements of the press, the said control means operating to obtain either a full or reduced high pressure fluid supply in said main line, means to reduce the fluid pressure in said main line to substantially zero, and means to maintain a constant fluid supply of a predetermined minimum pressure in said pilot line.

6. In an hydraulic circuit, a plurality of relatively movable cylinder and piston mechanisms, a plurality of constant delivery high pressure pumps for supplying fluid to said circuit for operating said mechanisms, one of which operates as a main, and the other as an auxiliary, pump,

both of which are of relatively large capacity, and adapted to supply the circuit intermittently, and a pilot pump of small capacity which supplies the circuit continuously, a source of fluid supply, and a plurality of means for controlling the supply of fluid from said main and auxiliary pumps to said circuit, one of said control means operating automatically, under predetermined working conditions with respect to the complete cycle of said mechanisms, to direct the fluid flow from the auxiliary pump into the circuit for a portion of said cycle, and by-passing said auxiliary pump to the fluid source at negligible pressure for the remainder of the cycle, the other control means being electrically operated and responsive to the expiration of a predetermined time period, during which the main pump delivers its fluid to the circuit, upon which expiration said electrically operated means functions to by-pass the main pump to the source at negligible pressure, said electrically operated means being also responsive to the initiation of fluid flow to any of the cylinder and piston mechanisms, and functioning to direct the fluid flow from the main pump to the circuit simultaneously with the initiation of such flow.

7. In an hydraulic circuit for operating presses and the like, which embodies an injection plunger adapted to move throughout its stroke at substantially constant speed, said circuit embodying a source of supply of fluid, a main constant delivery high pressure pump for advancing and retracting said plunger, an auxiliary and substantially similar pump for augmenting the supply of fluid from said main pump, means to by-pass the flow from said auxiliary pump to the source of supply at negligible pressure while the injection plunger is in its retracted position, said means also operating to direct the flow from said auxiliary pump to supplement the flow from the main pump while the plunger is not in its retracted position, means to prevent the flow from the main pump being by-passed with the flow from the auxiliary pump, and an electrically operated control means responsive to a predetermined period of pressure operation of said main pump to by-pass said main pump to said source of fluid at negligible pressure, said electrically operated means being also responsive to the initiation of movement of said injection plunger, and operating to resume the flow from the said main pump to operate said plunger simultaneously with the initiation of plunger movement.

8. In an hydraulic circuit for operating the fluid driven elements of a press, comprising a source of fluid, a constant delivery high pressure large volume pump normally by-passed to the source of fluid supply at substantially zero pressure, a small volume pump continuously supplying pressure fluid to said pressure circuit, an electrically operated control means to direct the fluid flow from the large pump into the circuit upon the initiation of fluid flow to any of the driven elements, the duration of said diversion of flow to the circuit being timed and terminated by the said electrical control, and valve means to maintain fluid pressure in said circuit while the large pump is by-passed.

9. In an hydraulic circuit arrangement for operating the fluid driven elements of a press, comprising a source of fluid supply, a main fluid circuit, a pilot fluid circuit, a constant delivery high pressure large volume pump normally by-passed to the source of supply at substantially zero pressure, a small volume pump continuously supplying pressure fluid to the pilot circuit, automatic electrically operated means responsive to the fluid requirements of said elements to direct the fluid flow from the large pump into the main circuit intermittently and for a timed and limited duration, means to render the aforesaid electrical means inoperative and to keep the large pump by-passed to the source of supply, valve means to provide free fluid flow from the pilot circuit to the main circuit while pressure equaling or exceeding a predetermined minimum exists in said pilot circuit, and valve means to maintain fluid pressure in the main line delivered by the small pump, while the large pump is being by-passed, to render possible the operation of the driven elements at greatly reduced speed.

10. In an hydraulic circuit arrangement for operating the fluid driven elements of a press, comprising a source of fluid, a main fluid circuit, a pilot fluid circuit, a constant delivery high pressure large volume main pump normally by-passed to the source of supply at negligible pressure, a small volume pilot pump continuously supplying pressure fluid to the pilot circuit, an electrically operated control means for directing the fluid supply from the main pump into the main circuit upon the initiation of fluid flow to any of the driven elements, the duration of said diversion of flow into the main circuit being timed and terminated by said electrical means, valve means to provide free fluid flow from the pilot circuit into the main circuit while pressure equaling or exceeding a predetermined minimum exists in said pilot circuit, and valve means to maintain fluid pressure in the main circuit while the main pump is by-passed.

11. In an hydraulic circuit for supplying fluid pressure to a plurality of fluid driven elements, including an injection cylinder and plunger, and embodying a source of fluid supply, a main constant delivery large volume pump normally by-passed to the source of fluid at substantially zero pressure, an auxiliary constant delivery large volume pump also normally by-passed to said source of fluid at substantially zero pressure, a small volume pump continuously supplying fluid pressure to said circuit, control means for directing the fluid flow from said auxiliary pump to the circuit only during such time as the injection plunger is not in its retracted position, electrically operated control means to direct the fluid flow from the main pump to the circuit upon the initiation of fluid flow therefrom to any of the driven elements, the duration of said diversion of flow to the circuit being timed and terminated by said electrical control, and valve means to maintain pressure in said circuit during the by-passing of either or both of the large pumps.

12. An hydraulic circuit for operating the parts of a press and normally maintained at operative pressure, said circuit comprising a constant delivery pump of relatively large capacity adapted to supply fluid under operating pressure to a main circuit and normally by-passed at non-operative pressure regardless of the circuit pressure, a constant delivery pump of relatively small capacity continuously supplying pressure fluid to the same circuit and selectively adapted to operate parts of the press at slow speed, a plurality of pilot operated valves in the said circuit, a plurality of controls manually operated at will for controlling the pilot operated valves and thus the functioning of the parts of the press and simultaneously momentarily

initiating the flow of fluid from said large pump into the main circuit, said controls also operating to automatically first maintain said fluid flow for a predetermined time and then divert said flow from the main circuit at non-operative pressure, means independent of other control means, operable at will and adapted to reduce the pressure in the main circuit to a non-operative condition and to resume the normal operating pressure at will while maintaining the press parts against operation, and a pilot fluid circuit for operating said pilot operated valves, and which pilot fluid circuit is continually maintained at a predetermined minimum pressure regardless of pressure fluctuations in the main circuit.

13. An hydraulic circuit for operating the elements of a press, said circuit being continually maintained at operative pressure and embodying a main hydraulic line, a secondary hydraulic line, a constant delivery pump of relatively large capacity adapted to supply fluid intermittently to said main line, a prime mover for said pump, a constant delivery pump of relatively small capacity continuously supplying fluid to said secondary line and adapted to operate certain of said elements independently of the large pump, means embodying control mechanism operable at will during the cycle of operation of the press for directing the fluid flow of the large pump into the main line, said means being also operable to normally divert the fluid flow from the large pump away from the line at non-operative pressure regardless of said circuit pressure, the said means being further and automatically operable to divert said flow away from the main line to prevent a continuous overload upon the prime mover, means whereby the secondary line will continually supply the main line and maintain operating pressure therein, and means to automatically maintain a minimum pressure in the secondary line regardless of the pressure fluctuations in the main line.

14. An hydraulic main circuit for operating a press, said press embodying a plurality of movable members, a source of fluid supply, a pump of relatively large capacity adapted to supply fluid under pressure to said circuit to impart motion to said members, and normally by-passed to said source at negligible pressure regardless of said circuit pressure, a pump of relatively small capacity, a pilot circuit in which the last said pump is included, said pilot circuit continuously supplying fluid under pressure to the main circuit to impart steady pressure upon said members and to selectively operate said members, means embodying mechanism manually controlled and operable at will to direct the fluid supplied by the large pump into the main circuit, and timing mechanism automatically controlled and operable in conjunction with said means to again divert said fluid flow from the main circuit to the source, the said means being also operable to simultaneously control the supply of fluid to said movable members.

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