March 17, 1936. T. F. STACY 2,034,157

HYDRAULIC PRESS SYSTEM

Filed June 9, 1933

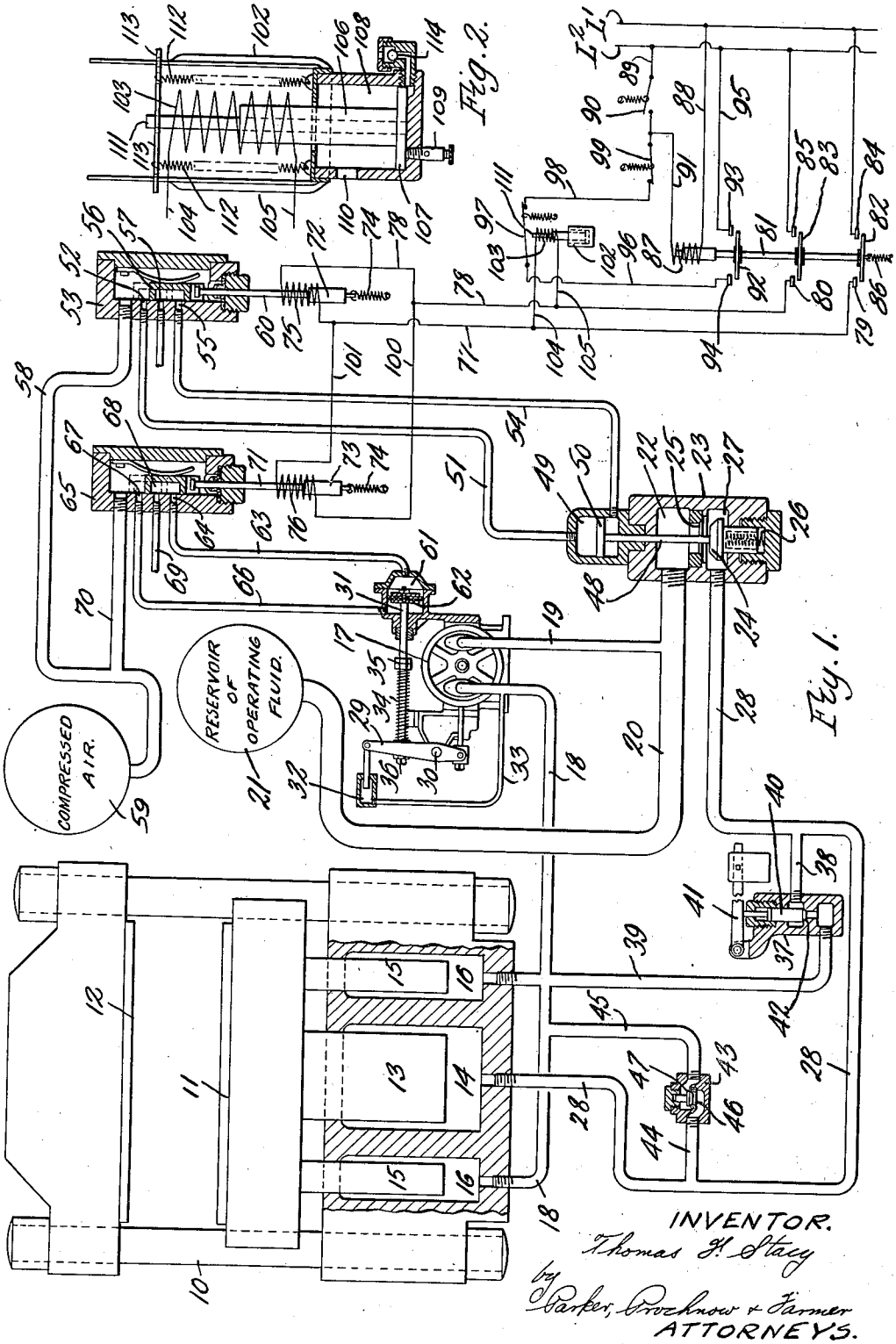


Fig. 1.

Fig. 2.

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Patented Mar. 17, 1936 2,034,157

UNITED STATES PATENT OFFICE

2,034,157

HYDRAULIC PRESS SYSTEM

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Application June 9, 1933, Serial No. 675,069

19 Claims. (Cl. 60—97)

This invention relates to hydraulic press systems, and particularly to the operation of single acting hydraulic presses in which the platen is forcibly moved in one direction by hydraulic means and returned by other means, such as gravity, to starting position.

An object of the invention is to provide improved means for operating a single acting press, which will cause a rapid movement of the platen as it closes against the work and then a smaller movement under substantial pressure; which may be operated by means of a relatively small pump; with which hydraulic valves under pressure are not required; with which the operation of the press, may be controlled solely by the reversal of the pump; which will require a minimum of valve equipment; which will be compact and simple in construction; which will have a low manufacturing and operating cost; and which will require a minimum of attention during use.

Another object of the invention is to provide improved means for operating a single acting press which will be semi-automatic in action; with which the press will be opened automatically a selected interval of time after the pressing stroke has been initiated; and with which the rise of pressure above a selected maximum on said platen will be prevented.

Various other objects and advantages will be apparent from the following description of an embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawing:

Fig. 1 is a side elevation, partly in section, of a simplified type of single acting, hydraulic press and a controlling and operating system therefor, constructed in accordance with this invention; and

Fig. 2 is a sectional elevation of one type of timing element which may be employed in such controlling system.

In the illustrated embodiment of the invention, the single acting press includes a frame 10 which guides a platen 11 in a vertical direction toward and from a relatively fixed pressure head 12. The platen 11 is elevated or raised by means of a piston 13 reciprocating in a cylinder 14 and together with the cylinder forming a main ram, and also by one or more smaller pistons 15, two being shown by way of example, reciprocating in cylinders 16, each piston 15 and its cylinder 16 together forming an auxiliary ram for urging the platen 11 upwardly in the same direction as that produced by the main ram. A reversible, variable delivery pump 17 is connected at one side by a pipe 18 to each cylinder 16, and at its other side by pipes 19 and 20 to a reservoir or suitable source 21 of operating fluid. The pipe 20 from the reservoir 21 is connected to a chamber 22 of a free check valve 23. The movable valve element 24 of this free check valve is urged toward a cooperating seat 25 by a spring 26.

The valve seat 25 separates the chamber 22 from another chamber 27 so that communication between the chambers 22 and 27 is prevented when the valve element 24 is engaged with its seat. The valve element 24 opens freely against the action of its spring 26 to pass fluid from the pipe 20 through the valve seat into the chamber 27, and closes automatically to prevent reverse flow. A pipe 28 connects the chamber 27 to the cylinder 14 of the main ram, from which it will be observed that operating fluid from the reservoir 21 may pass freely through the pipe 20 to the chamber 22, thence through the valve seat and into the chamber 27, and thence to the ram cylinder 14, but reverse flow is automatically prevented by the closing of the valve element 24.

The delivery of the pump 17 may be reversed in any suitable manner, but in the illustrated example, it is accomplished by a control element 29 which is pivoted at 30 and operated by a rod 31. A small ram 32 is connected by a pipe 33 to the pipe 18 which delivers fluid from the pumps to the cylinders 16. The ram 32 is connected to the element 29 to force it into neutral delivery position automatically whenever the pressure in the pipe 18 reaches a predetermined maximum, which is the pressure required to overcome the spring 34. The spring 34 is compressed between the element 29 and adjustable abutments 35 on the rod 31, and the rod 31 passes slidingly through the element 29 and carries a head 36 on its free end. The ram 32 can, therefore, shift the element 29 into a neutral delivery position against the action of the spring 34 without movement of the rod 31. Pumps of the reversible, variable delivery type are well known in the art and have been described only briefly by way of example, but it will be understood that other pumps of this general type may also be employed instead of that illustrated and described herein.

A pressure operated check valve 37 is connected by a pipe 38 to the pipe 28, and is connected by a pipe 39 to the pipe 18 which leads directly to the auxiliary cylinders 16. This

valve 37 includes a valve element 40 which is urged into closed position by a weighted arm 41 to prevent flow of fluid from the pipe 38 through the valve to the pipe 39, but opening to pass fluid from the pipe 39 to the pipe 38 whenever pressure of fluid in the pipe 39 is sufficient to lift the valve element 40 from its seat against the pressure exerted on the valve element by the weighted arm 41. The pipes 38 and 39, of course, open into the valve on opposite sides of the valve seat 42 which is engaged by the valve element 40.

A freely operating check valve 43 is connected at one side by a pipe 44 to the pipe 28, and at its other side by a pipe 45 to the pipe 18 which connects the pump to the cylinders 16. The pipes 44 and 45 open into the chamber of the valve 43 on opposite sides of the seat 46 thereof, and the valve element 47 reciprocates toward and from the seat 46 so as to move away from the seat and pass fluid from the pipe 44 to the pipe 45, but closing automatically to prevent reverse flow from the pipe 45 to the pipe 44.

In the operation of the press system by the means just described, let it be assumed that the platen is in its retracted or lower position, and that the pump control rod 31 is in the position shown in the drawing in which the pump is delivering fluid under pressure into the pipe 19 and withdrawing it from the pipe 18. The fluid delivered through the pipe 19 passes into the pipe 20, thence through the valve 23, during which it forces open the valve element 24, thence through the pipes 28 and 44, through the free check valve 43, thence through pipe 45 into pipe 18 and back into the pump. While the pump is so operating, the fluid handled thereby will circulate idly through the path just described, and no material pressure will be exerted on any of the rams attached to the platen. At this time the reservoir 21 is acting mainly as an expansion tank for the operating fluid.

Let it be assumed that an operation of the press is desired. This operation is initiated by a movement of the pump control rod 31, to the left in the drawing, which causes a reversal in the delivery of the pump. The pump will now withdraw fluid from the pipe 19 and deliver it under pressure to the pipe 18. Immediately that fluid is withdrawn from the pipe 19, the valve element 24 may close and the pump will be supplied with operating fluid reaching the pipe 19 through the pipe 20 from the reservoir 21. The fluid delivered by the pump will pass through the pipe 18 into the cylinders 16 of the auxiliary rams, and will exert pressure on the pistons 15 of those rams tending to urge the platen 11 upwardly. At this time, fluid can not pass from pipe 18 through the pipe 45 and the valve 43, because the valve 43 automatically closes to prevent this reverse flow.

At the same time the valve 37 prevents movement of the fluid from the pipe 18 through the pipe 39 and the valve 37 to the pipe 28 until the pressure in the pipe 18 has increased to an extent sufficient to raise the valve element 40 against the pressure exerted thereon by the weighted arm 41. As the pump continues to operate in this direction, the pressure of fluid delivered by the pump is effective solely on the pistons 15 of the auxiliary rams, and forces the platen 11 upwardly at a rapid rate until it engages, or is closed against, the work.

As the platen 11 moves upwardly under the pressure from the auxiliary rams, operating fluid will enter the main cylinder 14 from the reservoir or source 21 by passing through the pipe 20, the valve 23, and pipe 28, the suction created in the cylinder 14 by the elevation of the piston 13 drawing the fluid from the pipe 20 through the free check valve 23, and through the pipe 28. The filling of the cylinder 14 by the operating fluid, directly from the reservoir, requires little power and is effected by the atmospheric air pressure on the fluid in the reservoir 21.

When the pressure on the auxiliary cylinder 16 increases to a selected pressure sufficient to lift the valve element 40 of the pressure operated check valve 37, the fluid then delivered by the pump will not only pass to the cylinder 16 but some will also pass through the pipe 39, the valve 37 and pipe 38, to the pipe 28, and thence to the main cylinder 14 so that the pressure in the main cylinder is then equal to the pressure in the cylinders 16 as the pump continues to increase the pressure. All these rams will then be operating on the platen to force it upwardly and cause it to perform its usual work, but as soon as the fluid began to flow through the pipe 39 and the pressure operated check valve 37, some of it started to flow reversely through the free check valve 23 back into the intake side of the pump, but the valve element 24 closed automatically at the start of this flow through valve 23, and prevented a continuance of flow backwardly through the valve 23 to the pump.

The pressure of fluid delivered by the pump to the three rams continues to increase and when it reaches a predetermined maximum, the small pump ram 32 forces the control element 29 into substantially neutral delivery position in which only sufficient fluid is delivered by the pump into the pipe 18 to provide for leakage and maintain the selected pressure on the three rams. This pressure will be maintained on the rams attached to the platen indefinitely until the pump control rod 31 is operated to reverse the pump.

When the pressing operation has been completed and one desires to cause a return of the platen to its lower or retracted position, the pump control rod 31 is operated to the right, in the drawing, so as to move the control element 29 in a direction to reverse the delivery of the pump. When this occurs, the pump will draw fluid from the pipe 18 and deliver it into the pipe 19. Since the pipe 18 is connected to the cylinders 16, the pressure on those cylinders will rapidly decrease and the fluid under pressure in the main cylinder 14 will pass through the pipes 28 and 44, the free check valve 43, and pipe 45 into the pipe 18 which is now connected to the intake side of the pump. The pump thus draws fluid from all cylinders and rapidly lowers the pressure therein. The fluid delivered by the pump through the pipe 19 passes through the pipe 20 into the reservoir 21 where it is stored for a new operation.

As the operating fluid is withdrawn from the rams, the platen 11 will settle or lower itself by gravity to prepare for a new pressing operation. If the pump 17 is of small capacity, the pumping of all the fluid from the three rams would require considerable time and power, which would retard the opening movement of the platen. In view of this, I provide means for forcibly opening the valve element 24 as soon as possible, and when that occurs, the operating fluid displaced by the main ram, instead of passing through the free check valve 43 to the pump or delivery reservoir, may now pass through the pipe 28 and the valve 23 into the pipe 20 and thence directly

back to the reservoir 21 without being handled by the pump. The platen then may lower as rapidly as the operating fluid is withdrawn from the relatively small cylinders 16 through the action of the pump.

The valve element 24 is forced into open position, against the action of its spring 26, by an operating rod 48 which extends into the valve housing and into a position to engage and operate the valve 24. Since the valve control rod 48 should be operated to force valve element 24 into open position only while the pump is being operated in a direction to lower the platen, it is advantageous to operate the rod 48 concurrently with the operation of the pump control rod 31. Any suitable means for accomplishing this may be employed within the broad concept of this invention, and I will now describe one example of means by which this concurrent operation of the valve element 48 and the pump rod 31 may be obtained.

For this purpose, the valve rod 48 extends into a cylinder 49 and within the cylinder 49 carries a reciprocating piston 50. The cylinder 49, at one side of the piston 50, is connected by a pipe 51 to a port 52 of a valve box 53, and the portion of the cylinder 49 at the other side of the piston 50 is connected by a pipe 54 to a port 55 also opening into the chamber of the valve box 53. A slidable valve element 56 is mounted in the valve box chamber so as to uncover alternately the ports 52 and 55 and has a cavity or recess which connects the covered port automatically to an exhaust port 57.

The chamber of the valve box is supplied with fluid under pressure, such as compressed air received through a pipe 58 from an air storage tank 59. Thus, as the valve element 56 is reciprocated in the valve box, it will automatically admit compressed air alternately to the portions of cylinder 49 on opposite sides of the piston 50, and thus reciprocate the piston 50 and the valve control rod 48. The valve element 56 is reciprocated by an operating rod 60 which extends exteriorly of the valve box through a suitable packing gland and is operated in a manner which will be described presently.

To operate the pump reversing rod 31, the latter extends into a cylinder 61 and carries a piston 62. The cylinder 61 is connected, at one side of the piston 62 by a pipe 63 to a port 64 opening into the chamber of another valve box 65. A pipe 66 connects the cylinder 61 at the opposite side of the piston 62, to a port 67 which also opens into the chamber of the valve box 65. A sliding valve element 68 is provided in the chamber of the valve box 65 to reciprocate back and forth therein and uncover the ports 64 and 67 alternately. The valve element 68 has a recess or cavity which automatically connects the covered port 64 or 67 with an exhaust outlet 69 and, thus, by the reciprocation of the valve element 68 the pipes 63 and 66 are alternately connected to the exhaust outlet 69 and when either of the pipes 63 and 66 is connected to the exhaust outlet 69, the other pipe is uncovered in the chamber of the valve box 65.

A pipe 70 connects the pipe 58, supplying compressed air to the valve box 53, to the chamber of the valve box 65, and thus compressed air will be admitted alternately to the pipes 63 and 66 in the same manner as explained for the valve box 53 which passed compressed air alternately into opposite ends of the cylinder 49. The valve element 68 is reciprocated back and forth by a valve rod 71 which extends exteriorly of the valve box through a packing gland and may be operated in any desired manner.

I have found it advantageous to use electrical means for operating the valve rods 60 and 71 and this electrical system will now be described. The valve rod 60 is provided at its outer end with an armature 72 of soft iron or other magnetically attracted material, and the rod 71 is similarly provided with an armature or core 73 of similar material. Springs 74 are connected to the cores or armatures 72 and 73 and tend to urge them in directions to pull the valve elements 56 and 68 into the positions shown in full lines in the drawing. A solenoid 75 is provided for the armature or core 72 and, when energized, tends to draw the core or armature 72 upwardly and shift the valve element 56 into the position shown in dash lines in the drawing.

Similarly, a solenoid 76 is provided for the core or armature 73, so that when the solenoid 76 is energized, it will magnetically attract the armature or core 73, shift it against the action of its spring 74, and move the valve element 68 into the position shown by dash lines in the drawing. The solenoid 75 is connected by wires 77 and 78 to contacts 79 and 80 respectively of a relay. A member or arm 81 of the relay carries bridges 82 and 83 that electrically connect the contacts 79 and 80 to additional contacts 84 and 85, respectively, automatically whenever the relay is energized to shift the arm 81 in one direction against the action of a retracting spring 86. This relay arm is operated, against the action of the spring 86, to carry the bridges 82 and 83 into engagement with the contacts 79 and 80 by means of a solenoid or winding 87 which is connected at one side by wire 88 to a power line wire L^1. The other line wire L^2 is connected by a wire 89, a normally open starting switch 90, and a wire 91 to the other side of the relay winding 87. Electric current is supplied to this system through the line wires L^1 and L^2 and, thus, when the switch 90 is closed, current will flow from the line wires through the relay winding 87 to energize it and shift the relay member 81 into circuit closing position. The relay member 81 also carries a bridge 92 which engages and electrically connects contacts 93 and 94 whenever the relay winding 87 is energized. The contact 93 is connected by wire 95 to one of the line wires, such as L^2, and the contact 94 is connected by wire 96, a normally closed switch 97, a wire 98, and a second normally closed switch 99, to the wire 91 which is connected to the normally open switch 90. It will be observed that when the relay winding 87 is energized and the bridge 92 connects the contacts or terminals 93 and 94, a circuit will be established as follows:—from line wire L^2, through the wire 95, contact 93, bridge 92, contact 94, wire 96, switch 97, wire 98, switch 99, wire 91, relay winding 87, and wire 88 to the other line wire L^1. This circuit last described is what is known as a stick circuit and, when closed, will keep the relay winding 87 energized and thus maintain the relay member 81 in closed position.

To deenergize the relay winding 87, it is merely necessary to open either of the switches 97 or 99 of the stick circuit whereupon the relay member 81 will be moved to retracted position by spring 86 and the stick circuit opened at the bridge 92. It will be observed that when one closes the switch 90, the winding 87 is energized, following which the stick circuit is closed by movement of relay

member 81, and when this occurs, the bridges 82 and 83 will connect the lines wires L^1 and L^2 to the wires 77 and 78 which supply current to the winding or solenoid 75. This winding when energized then operates the valve element 56 from the full line position to the dash line position shown on the drawing. Wires 100 and 101 connect the wires 77 and 78 to the solenoid or winding 76 of the other valve box, so that the two valve rods 60 and 71 will be operated concomitantly under the control of the bridge elements 82 and 83 of the relay. When the stick circuit is opened to deenergize the relay winding 87, the windings 75 and 76 will be deenergized by the retraction of relay member 81, and the valve elements 56 and 68 will be returned to the full line positions shown in the drawing through the action of the spring 74.

The stick circuit is utilized as a part of a time control for the press, and any suitable means may be employed for opening the stick circuit, such as by an opening of the switch 97, a predetermined and selected length of time after the relay 87 has been energized which will be after the platen has been started on its upward movement. As an example, I provide a time limit relay 102 whose winding 103 is supplied with current to start it into operation by wires 104 and 105 connecting it to the wires 77 and 78 which receive current automatically whenever the relay winding 87 is energized. Thus, the winding 103 of the time limit relay will be energized automatically whenever the relay winding 87 is energized. This time limit relay may be of any suitable construction, but one form of such a relay is shown in Fig. 2.

This relay shown in Fig. 2 includes the winding 103 which, when energized, elevates, by magnetic attraction, a soft iron core 106 carrying a piston 107 which reciprocates in a cylinder 108. Air enters below the piston 107 through a controlled, adjustable valve 109 until the piston 107 uncovers a port 110 in a side wall of the cylinder, whereupon the core 106 may move upwardly freely, and through an extension 111 of the core will engage and open the switch 97 with a rapid movement. The opening of the stick circuit, through switch 97, deenergizes the relay winding 87 and through it the winding 103 of the time limit relay and, thereupon, the core 106 falls, or is pulled downwardly by the springs 112 which are connected to arms 113 of the extension 111 of the core. A ball check valve 114 connected to the bottom end of the cylinder 108 allows free escape of air displaced by the downward movement of the piston 107, but automatically closes to prevent entrance of air to the cylinder 108 when the piston 107 starts upwardly.

In the operation of this system, whenever a pressing movement of the platen is desired, the attendant closes the switch 90 which completes the electric circuit through the relay winding 87. Immediately following the energization of this winding 87, the member 81 is lifted or moved to carry the bridge members 82, 83 and 92 into bridging relation with their coordinated contacts. The bridge member 92 closes the stick circuit which keeps the winding 87 energized, and the bridge members 82 and 83 complete the circuit to the time limit relay 102 and to the windings of solenoids 75 and 76. The solenoids 75 and 76 shift the valve elements 56 and 68 from the full to the dotted line positions shown in the drawing and, in doing so, reverse the delivery of the pump and shift the valve control rod 46 outwardly into ineffective position.

When the pump is reversed in this manner, it delivers operating fluid into the pipe 18 and thence to the auxiliary rams to start the upward movement of the platen, and the suction created by the upward movement of the piston 13 of the main ram draws operating fluid from the reservoir 21 through the check valve 23 into the cylinder 14. At the same time that the pump is reversed and the valve element 24 released, current begins to flow through the time limit relay winding 103. This winding then causes a magnetic attraction and elevation of its core 106 and piston 107, and the upward movement of the piston 107 of this relay is retarded by the air valve 109. By adjusting the valve 109, the time required for the piston 107 to reach the port 110 may be varied, and when the piston reaches and uncovers the port 110, it is no longer retarded and moves upwardly at a rapid rate to engage and open the switch 97 which breaks the stick circuit.

Since the starting switch 90 was only operated momentarily in order to temporarily energize the relay winding 87, the opening of the stick circuit by the time limit relay 102 causes a deenergization of the relay winding 87, whereupon the circuits which were established by the relay 87 will be broken. Thereupon the springs 74 will retract the cores 72 and 73 and move the valve elements 56 and 68 from the dash line to full line positions shown in the drawing. Upon this movement of the valve elements 56 and 68, the pump is again reversed so as to draw liquid from the auxiliary rams and deliver it to the pipe 20. At the same time pressure is applied to the piston 50 tending to force the valve rod 48 inwardly. This pressure is at first insufficient to open the valve 24 until the pressure in the main ram and pipe 28 has fallen sufficiently so that the pressure on the piston 50 can overcome the fluid pressure transmitted to the valve element 24 from the main ram and the pressure of spring 26. When this occurs the valve element 24 will be forcibly opened so that further operating liquid displaced in the main ram cylinder 14 may pass through the valve 23 directly to the reservoir 21 without being handled by the pump.

It will be noted that the pump was reversed and a return movement of the platen started, a selected but adjustable interval of time after the pressing movement of the platen was started, but if the pressure on the platen reached a selected pressure before this time interval was up, then the pump was automatically set approximately to neutral delivery so as to maintain that pressure until the time interval expired.

It will be noted that through the connections which have been illustrated, the pump operates to transfer the operating liquid or fluid between the auxiliary rams and the reservoir alternately, and after a selected resistance has been encountered by the platen, the pump also transfers the operating fluid under pressure from the source to the main ram. Through this arrangement, the pump 17 may be of relatively small capacity, but nevertheless, a very rapid travel of the platen in both directions is possible. The auxiliary rams can be made very small so as to operate rapidly with a small capacity pump. The pressure, in response to which the pump automatically sets itself to approximately neutral delivery, may be varied in any suitable manner, such as by adjusting the nuts 35 which determine the pressure on the spring 34 that must be overcome before the pump will change to neutral delivery.

If desired, the valve boxes 53 and 65 and sole-

noids 75 and 76 may be replaced by a single box and solenoid in which case, the pipes 70 and 58, 63 and 54, 66 and 51 will be connected together and to one of the valve boxes, and the solenoid of the unused valve box may be eliminated.

It will be obvious that various changes in the details, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim:

1. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operable on said platen to force it in a pressing direction, a source of operating liquid, a pump, connections from said pump to said source and to said auxiliary ram by which said pump may transfer operating fluid under pump pressure selectively in either direction between said source and said auxiliary ram, a connection from said source to said main ram, a free check valve in said last named connection and opening freely to pass liquid from said source toward said main ram, and automatically closing to prevent return flow, means including a free check valve connected between the connections from the pump to the auxiliary ram and to the connection from the first free check valve to the main ram and opening freely to pass operating liquid from the first free check valve to the connection between the auxiliary ram and the pump but closing automatically to prevent reverse flow, a pressure opened check valve connected in parallel to said second free check valve for preventing flow in the same direction as the second check valve and automatically opening to pass operating liquid in the reverse direction when the pressure exerted thereon is in excess of a selected value, and means operable to forcibly open said first free check valve while the pump is withdrawing liquid from said rams, to pass liquid directly from said rams to said source.

2. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operable on said platen to force it in a pressing direction, a source of operating liquid, a pump, connections from said pump to said source and to said auxiliary ram by which said pump may transfer operating fluid in either direction between said source and said auxiliary ram, a connection from said source to said main ram, a free check valve in said last named connection and opening freely to pass liquid from said source toward said main ram, and automatically closing to prevent return flow, means including a free check valve connected between the connections from the pump to the auxiliary ram and to the connection from the first free check valve to the main ram and opening freely to pass operating liquid from the first free check valve to the connection between the auxiliary ram and the pump but closing automatically to prevent reverse flow, a pressure opened check valve connected at one end to the auxiliary ram and at the other end to the connection receiving fluid from said first free check valve, when the latter operates as a free check valve, in parallel to said second free check valve for preventing flow in the same direction as the second check valve and automatically opening to pass operating liquid in the reverse direction when the pressure exerted thereon is in excess of a selected minimum, and means for operating the first mentioned free check valve into open position automatically when the pump and connections are set to withdraw operating liquid from said auxiliary ram, whereby operating liquid displaced by the main ram may flow directly to said source through said first check valve.

3. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram for operating said platen forcibly in one direction, a reversible pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, a pipe connecting said source to said main ram, a free check valve connected in series in said pipe and freely passing fluid from said source to said main ram and automatically closing to prevent reverse flow, and a pair of check valves connected in parallel at one side between the portion of the pipe connecting said first check valve and the main ram, and at the other side to the connection from the pump to the auxiliary ram one of said pair of check valves opening freely to pass operating fluid leaving the first free check valve in the direction in which it opens freely as a check valve and passing through said pipe to said pump and automatically closing to prevent reverse flow, and the other valve of said pair closing automatically to prevent flow in the direction in which it is free to pass in the other valve of the pair, but opening to pass said fluid in the reverse direction automatically and solely when the pressure at the side thereof which is connected to the pump and the auxiliary ram exceeds a predetermined pressure.

4. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram for operating said platen forcibly in one direction, a reversible pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, a pipe connecting said source to said main ram, a free check valve connected in series in said pipe and freely passing fluid from said source to said main ram and automatically closing to prevent reverse flow, a pair of check valves connected in parallel at one side between the portion of the pipe connecting said first check valve and the main ram, and at the other side to the connection from the pump to the auxiliary ram, one of said pair of check valves opening freely to pass operating fluid from the first free check valve and said pipe to said pump and automatically closing to prevent reverse flow, and the other valve of said pair closing automatically to prevent flow in the direction in which it is free to pass in the other valve of the pair, but opening to pass said fluid in the reverse direction automatically and solely when the pressure at the side thereof which is connected to the pump and the auxiliary ram exceeds a predetermined pressure, means for reversing the direction of delivery of said pump, and means external to said hydraulic circuit but associated with said reversing means for urging the first mentioned check valve into open position automatically whenever the pump is set to withdraw operating fluid from said auxiliary ram.

5. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operating on said platen to force it in one direction, a reversible variable delivery pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, said pump having means to set itself substantially to neutral automatically while delivering

fluid to said auxiliary ram whenever the pressure on said auxiliary ram reaches a predetermined pressure, a pipe connecting said source directly to said main ram, a free check valve in series in said pipe and operating automatically to pass fluid freely from said source to said main ram and closing automatically to prevent reverse flow, and a pair of check valves connected, in parallel to one another, to the portion of said pipe connecting the first check valve to said main ram and to the auxiliary ram, one of the valves of said pair opening to pass fluid freely in a direction from said source through said first check valve to said auxiliary ram and pump, and closing automatically to prevent reverse flow, and the other check valve of the pair operating to pass and restrict flow in a manner opposite to the first mentioned valve of the pair, but opening to pass fluid in a direction from said auxiliary ram toward said first check valve solely when the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, whereby when said pump is delivering fluid to said auxiliary ram, said fluid from said pump will force the platen upwardly at a rapid rate and the space vacated by the piston of the main ram will be filled by fluid passing from said source through the first check valve directly to said main ram, and when the pressure on said auxiliary ram reaches said predetermined pressure, said pressure-operated check valve will open and pass operating fluid from said pump directly to said main ram and cause said first check valve to close.

6. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operating on said platen to force it in one direction, a reversible variable delivery pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, said pump having means to set itself substantially to neutral automatically while delivering fluid to said auxiliary ram whenever the pressure on said auxiliary ram reaches a predetermined pressure, a pipe connecting said source directly to said main ram, a free check valve in series in said pipe and operating automatically to pass fluid freely from said source to said main ram and closing automatically to prevent reverse flow, a pair of check valves connected, in parallel to one another, to the portion of said pipe connecting the first check valve to said main ram and to the auxiliary ram, one of the valves of said pair opening to pass fluid freely in a direction from said source through said first check valve to said auxiliary ram and pump, and closing automatically to prevent reverse flow, and the other check valve of the pair operating to pass and restrict flow in a manner opposite to the first mentioned valve of the pair, but opening to pass fluid in a direction from said auxiliary ram toward said first check valve solely when the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, whereby when said pump is delivering fluid to said auxiliary ram, said fluid from said pump will force the platen upwardly at a rapid rate and the space vacated by the piston of the main ram will be filled by fluid passing from said source through the first check valve directly to said main ram, and when the pressure on said auxiliary ram reaches said predetermined pressure, said pressure-operated check valve will open and pass operating fluid from said pump directly to said main ram and cause said first check valve to close, a control device for reversing the direction of delivery of said pump, and means for operating said first check valve into open position whereby when said pump is withdrawing operating fluid from said auxiliary ram and returning it to said source, said first check valve may be opened to permit direct return of fluid displaced by the main ram to said source and continuance of the operation of said pump in the same direction will then draw operating liquid from said source through the first check valve and through the first mentioned check valve of said pair, and return it directly to said source.

7. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operating on said platen to force it in one direction, a reversible variable delivery pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, said pump having means to set itself substantially to neutral automatically while delivering fluid to said auxiliary ram whenever the pressure on said auxiliary ram reaches a predetermined pressure, a pipe connecting said source directly to said main ram, a free check valve in series in said pipe and operating automatically to pass fluid freely from said source to said main ram and closing automatically to prevent reverse flow, a pair of check valves connected, in parallel to one another, to the portion of said pipe connecting the first check valve to said main ram and to the auxiliary ram, one of the valves of said pair opening to pass fluid freely in a direction from said source through said first check valve to said auxiliary ram and pump, and closing automatically to prevent reverse flow, and the other check valve of the pair operating to pass and restrict flow in a manner opposite to the first mentioned valve of the pair, but opening to pass fluid in a direction from said auxiliary ram toward said first check valve solely when the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, whereby when said pump is delivering fluid to said auxiliary ram, said fluid from said pump will force the platen upwardly at a rapid rate and the space vacated by the piston of the main ram will be filled by fluid passing from said source through the first check valve directly to said main ram, and when the pressure on said auxiliary ram reaches said predetermined pressure, said pressure-operated check valve will open and pass operating fluid from said pump directly to said main ram and cause said first check valve to close, means for forcibly opening said first check valve, means for reversing the direction of delivery of said pump, and common control means for said reversing means and said valve opening means, for operating the latter to open the first check valve automatically when the delivery of the pump is reversed to withdraw operating fluid from said auxiliary ram.

8. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram operating on said platen to force it in one direction, a reversible variable delivery pump connected at one side to said auxiliary ram, a source of operating fluid connected to the other side of said pump, said pump having means to set itself substantially to neutral automatically while delivering fluid to said auxiliary ram whenever the pressure on said auxiliary ram reaches a predetermined pressure, a pipe connecting said source directly to said main ram, a free check valve in series in said pipe and operating automatically to pass fluid

freely from said source to said main ram and closing automatically to prevent reverse flow, a pair of check valves connected, in parallel to one another, to the portion of said pipe connecting the first check valve to said main ram and to the auxiliary ram, one of the valves of said pair opening to pass fluid freely in a direction from said source through said first check valve to said auxiliary ram and pump, and closing automatically to prevent reverse flow, and the other check valve of the pair operating to pass and restrict flow in a manner opposite to the first mentioned valve of the pair, but opening to pass fluid in a direction from said auxiliary ram toward said first check valve solely when the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, whereby when said pump is delivering fluid to said auxiliary ram, said fluid from said pump will force the platen upwardly at a rapid rate and the space vacated by the piston of the main ram will be filled by fluid passing from said source through the first check valve directly to said main ram, and when the pressure on said auxiliary ram reaches said predetermined pressure, said pressure-operated check valve will open and pass operating fluid from said pump directly to said main ram and cause said first check valve to close, means for forcibly opening said first check valve, means for reversing the direction of delivery of said pump, controlling means for regulating the direction of delivery of said pump and the activity of the means for forcibly opening the first check valve, means for operating said control means to initiate a pressing movement of said platen, and time controlled means set in motion automatically at each pressing movement of the platen and operable a predetermined interval of time thereafter for reversing the direction of delivery of said pump and opening said first check valve, whereby the platen may automatically return to starting position.

9. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them and forming a hydraulic circuit, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, and means operating against the fluid pressure in said hydraulic circuit for forcibly opening said first free check valve while said pumping means is withdrawing operating fluid from the main ram and delivering it to said source.

10. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, and means for operating said transferring means to change its direction of delivery selectively, and automatically opening said check valve while said transferring means is withdrawing fluid from said auxiliary ram.

11. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, means for operating said transferring means to change its direction of delivery selectively, and automatically opening said check valve while said transferring means is withdrawing fluid from said auxiliary ram, and timing means for operating said last preceding means automatically a selected interval of time after said transferring means has been set to deliver operating fluid to said auxiliary ram.

12. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, and valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, said transferring means being formed to cease delivery to said auxiliary ram automatically whenever the pressure on said auxiliary ram reaches a selected maximum.

13. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting

said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, and means for operating said transferring means to change its direction of delivery selectively, and automatically opening said check valve while said transferring means is withdrawing fluid from said auxiliary ram, said transferring means being formed to cease delivery of said operating fluid to said auxiliary ram automatically whenever the pressure on the auxiliary ram reaches a selected maximum pressure.

14. In a hydraulic press system, a platen, a main ram, and a smaller auxiliary ram connected to said platen for raising it in a pressing direction, a reservoir for operating fluid, a pipe connecting said reservoir to said main ram, a free check valve in series in said pipe, normally preventing flow from said main ram to said source and opening for free flow in the reverse direction, a reversible, variable delivery pump connected at one side to said auxiliary ram and at its other side to said source, and operating to set itself approximately to neutral delivery automatically whenever the pressure on said auxiliary ram reaches a selected maximum, a pressure opened connection from the side of the pump connected to said auxiliary ram, to said main ram for passing operating fluid from the pump to the main ram whenever the pressure on the auxiliary ram reaches or exceeds a selected pressure, and means including a valve connecting said rams and operable automatically to pass fluid from said main ram to said auxiliary ram when said pump is withdrawing operating fluid from said auxiliary ram.

15. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for elevating it in a pressing direction, a source of operating fluid, a reversible pump connected at one side to said auxiliary ram and at its other side to said source, a pipe connecting said source to said main ram, valve means connecting said rams to pass fluid at any pressure from said main ram to said auxiliary ram when said pump is withdrawing fluid from said auxiliary ram, and to pass fluid from said auxiliary ram to said main ram solely when the pressure equals or exceeds a selected maximum pressure, whereby when said pump is delivering fluid to said auxiliary ram, said valve in said pipe may open to pass fluid from said source directly to said main ram until the pressure in said auxiliary ram passes a selected minimum pressure, and whereby said valve in said pipe may be opened to pass fluid from said main ram to said source while said pump is withdrawing fluid from said auxiliary ram.

16. In a hydraulic press system, a single acting press having a platen, and a main ram and a small auxiliary ram for forcing said platen in one direction, means including a reversible pump connected to said rams for supplying an operating fluid under major pressure to said auxiliary ram, and an operating fluid under minimum pressure to said main ram while said press is closing against the work, then delivering operating fluid under major pressure to both of said rams during the remaining pressure movement of said platen, and then upon reversal of the pump withdrawing said fluid from both of said rams, and controlling means for said pump for initiating a pressing movement of said platen and automatically reversing said pump to initiate a return of said platen, a selected and predetermined interval of time after a pressure movement of said platen has been initiated.

17. In a hydraulic press system, a single acting press having a platen, and a main ram and a small auxiliary ram for forcing said platen in one direction, means including a reversible pump connected to said rams for supplying an operating fluid under major pressure to said auxiliary ram, and an operating fluid under pressure to said main ram while said press is closing against the work, then delivering operating fluid under major pressure to both of said rams during the remaining pressure movement of said platen, and then upon reversal of the pump withdrawing said fluid from both of said rams, fluid actuated means for reversing the pump, a valve device controlling the operativeness of said reversing means, means including an electric circuit for controlling the operation of said valve device, and a timing device rendered operative by said circuit when said circuit is rendered effective to cause delivery of the pump in one direction, for automatically causing the reversal of the pump a predetermined interval of time thereafter.

18. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, fluid operated means for actuating said transferring means to change its direction of delivery selectively, fluid operated means for automatically opening said check valve, valve devices for controlling both of said fluid operated means, and means including an electric circuit for controlling the activity of said valve devices so as to cause said check valve to open automatically when the delivery of said transferring means is changed so as to withdraw the operating fluid from said rams.

19. In a hydraulic press system, a platen, a main ram and a smaller auxiliary ram connected to said platen for raising said platen in a pressing direction, a source of operating fluid connected to said main ram, a free check valve in series in the connection from said source to said main ram, opening to pass fluid from said source to said main ram, and closing automatically to prevent reverse flow, means including a pump connected to said auxiliary ram and said source for transferring operating fluid in either direction between them, valve means for connecting said auxiliary ram to said main ram automatically whenever the pressure in the auxiliary ram reaches or exceeds a predetermined pressure, valve means shunting said preceding valve means automatically when said pumping means is withdrawing operating fluid from said auxiliary ram, fluid operated means for actuating said trans-

ferring means to change its direction of delivery selectively, fluid operated means for automatically opening said check valve, valve devices for controlling both of said fluid operated means, means including an electric circuit for controlling the activity of said valve devices so as to cause said check valve to open automatically when the delivery of said transferring means is changed so as to withdraw the operating fluid from said rams, and timing means automatically set in operation by an operation of said circuit to initiate a forced movement of said rams, and causing an actuation of said valve devices to initiate a withdrawal of fluid from said rams, a predetermined interval of time after said transferring means has been actuated to initiate said forced movement of said rams.

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