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W. ERNST ET AL

2,260,175

PRESS WITH ELECTRICALLY CONTROLLED COLLAPSIBLE AIR LINK

Filed Jan. 23, 1940

3 Sheets-Sheet 1

FIG. 1

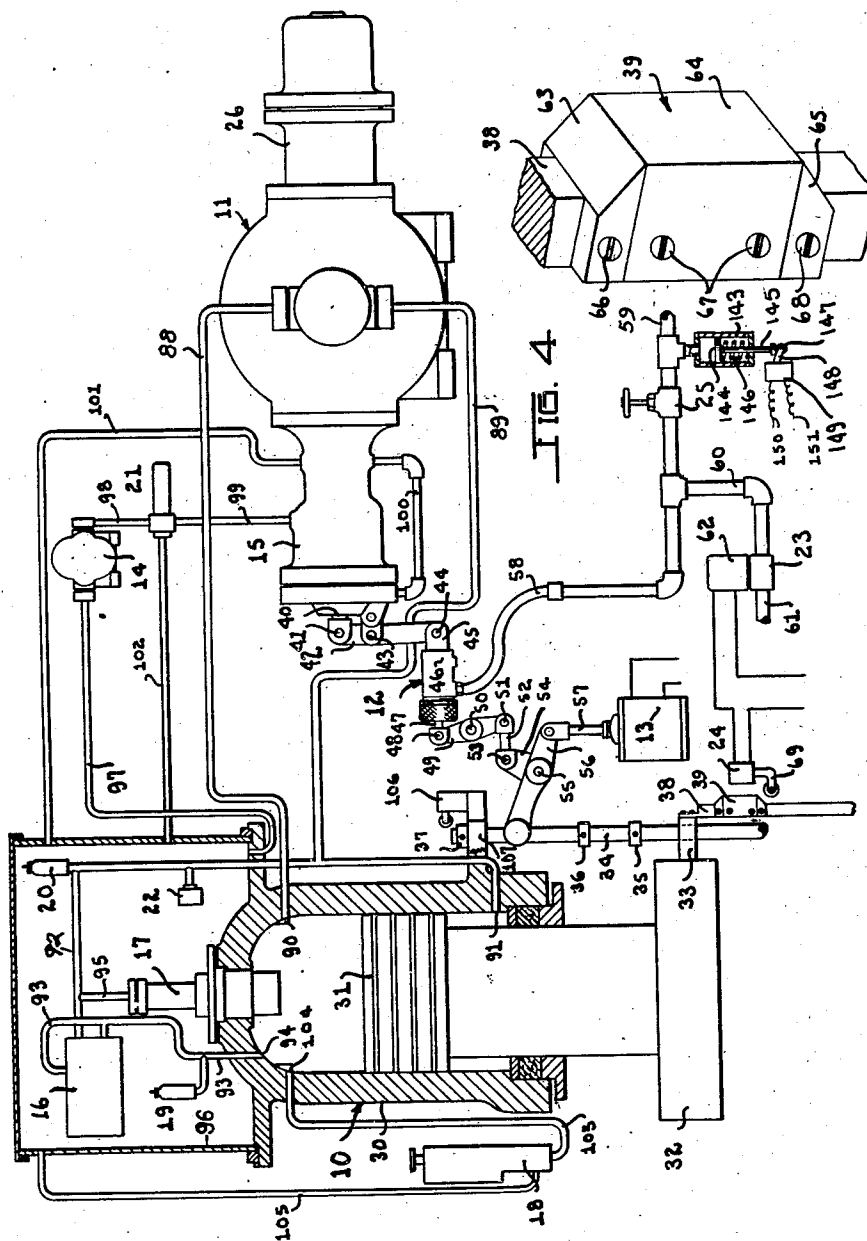


FIG. 4

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3 Sheets-Sheet 2

FIG. 2

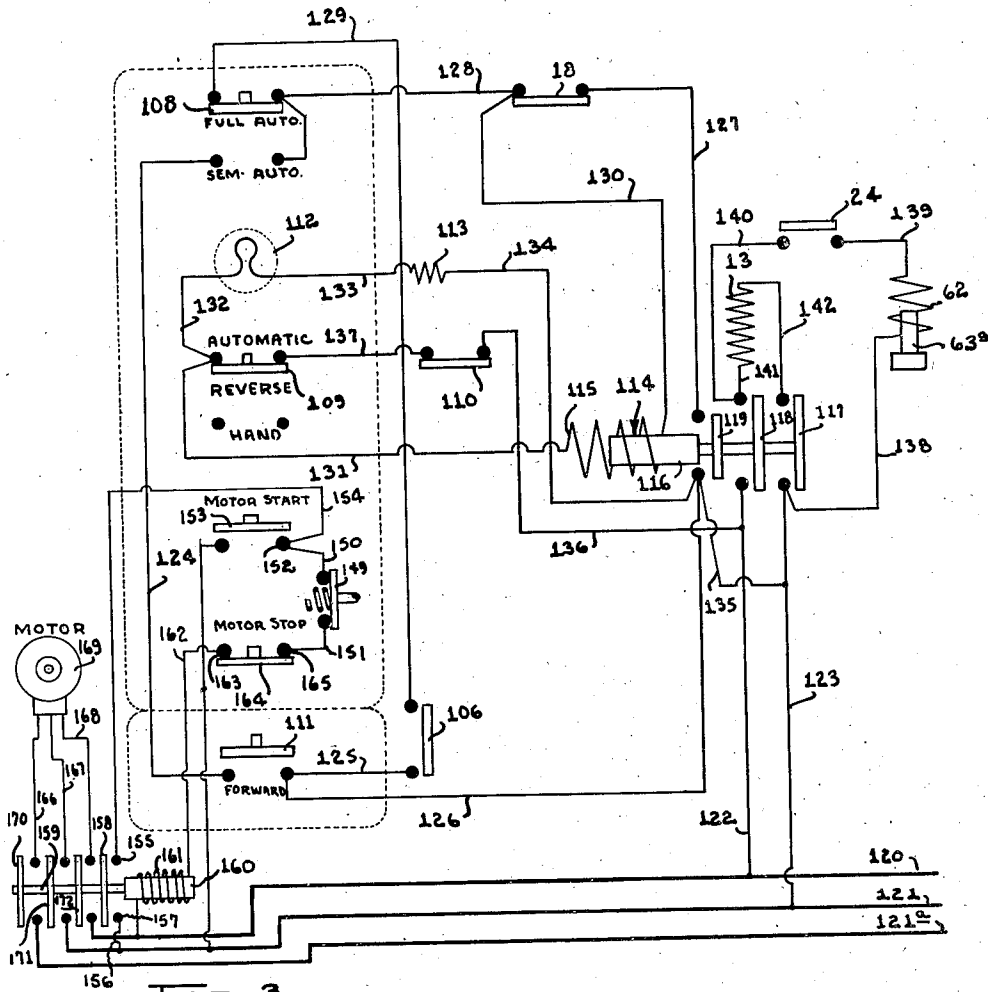
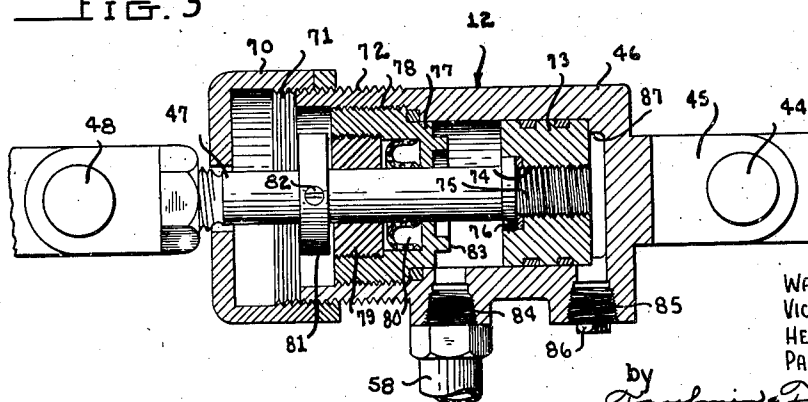


FIG. 3



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UNITED STATES PATENT OFFICE

2,260,175

PRESS WITH ELECTRICALLY CONTROLLED
COLLAPSIBLE AIR LINK

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11 Claims. (Cl. 60—52)

This invention relates to hydraulic press control systems, and in particular, to systems for selectively varying the speed of travel of the ram at different portions of its stroke.

One object of this invention is to provide a hydraulic press control system with a press supplied with pressure fluid from a source regulated by a flow-control member, means being provided for shifting the flow-control member to alter the delivery of the pump at a predetermined location of the ram stroke in one direction, this means being inoperative during the ram stroke in the opposite direction.

Another object is to provide a hydraulic press control system, wherein the ram of the hydraulic press is actuated by pressure fluid supplied from a variable delivery pump, the flow-control member of which is connected to the press control rod through a collapsible link, collapsible at a predetermined point in the stroke of the ram to permit the pump flow-control member to shift to a reduced delivery position so as to slow up the ram for a portion of its stroke in one direction, means being provided for rendering the link inoperative to alter the pump flow during the ram stroke in the opposite direction.

Another object is to provide a hydraulic control system having a press with a ram operated by pressure fluid from a variable delivery pump, a collapsible link being provided between the press control rod and the pump flow-control member, this link being controlled by a solenoidal valve in circuit with the main solenoid which operates the pump control so that the solenoidal valve is incapable of energization while the main solenoid is deenergized, thereby preventing the accidental collapsing of the link during the return stroke of the ram.

Another object is to provide a hydraulic press control system with a ram reciprocable by pressure fluid supplied from a variable delivery pump, the mechanism between the ram and the flow-control member of the pump including a collapsible link under the control of a solenoidally operated valve, the valve solenoid being in circuit with the main solenoid for operating the pump control, and additionally controlled by a limit switch operated by the ram at a predetermined location in its stroke.

Another object is to provide a hydraulic press control system as set forth in the preceding object, wherein the limit switch is actuated by a cam having a dwell portion for controlling the duration of the slow-down period of the ram.

Another object is to provide a hydraulic press

control system, as set forth in the preceding objects, wherein the collapsible link is operated by pressure fluid, such as compressed air, and is provided with an adjustable stop for regulating the extent of slow-down of the ram by adjusting the distance through which the link can collapse and expand.

In the drawings:

Figure 1 is a diagrammatic view, partly in section, of a hydraulic press control system with a collapsible link circuit arranged according to one embodiment of the invention.

Figure 2 is a wiring diagram of the electrical circuit for controlling the main solenoid and valve-operating solenoid of the collapsible link circuit.

Figure 3 is a longitudinal section through the collapsible link according to this invention, showing the adjustable stop arrangement.

Figure 4 is an enlarged perspective view of the cam for providing a dwell during the press slow-down period.

Figure 5 is a diagrammatic view similar to that of Figure 1 but comprising means for reversing the travel of the press platen in response to a predetermined position thereof.

Figure 6 is a wiring diagram pertaining to the structure of Figure 5.

In general, the hydraulic press control system of the present invention consists of a press having a ram which is reciprocable by pressure fluid supplied by a variable delivery pump, the flow-control member of which is actuated in at least one direction by a main solenoid. Connected between the main solenoid and the flow-control member of the pump is a collapsible link operated by pressure fluid, such as compressed air, and under the control of a solenoidally operated valve, the valve solenoid in turn, being under the control of a limit switch operated by the ram at a predetermined location in its stroke. The valve solenoid is arranged in the same electrical circuit with the main solenoid so that it cannot be energized except when the main solenoid is energized.

This feature prevents the accidental collapsing of the link during the return stroke of the ram which has hitherto occurred as the ram approaches its neutral position and shifts the pump control to neutral. Hitherto, the accidental collapsing of the link as the pump control approached neutral caused a sudden resumption of flow and an undesired continuation of the travel of the ram instead of a halting thereof. This undesired travel of the ram past its halting posi-

tion has previously caused damage to the press, stripping collars and pins from the press control rod and breaking the control linkage, or other mechanism, and causing other damage by reason of the fact that the pump control has not moved to its neutral position as intended.

The present invention prevents this accidental collapsing, and also provides a control over the duration of time the link is collapsed by actuating the limit switch of the solenoidal valve by a cam having a dwell portion thereon. Another feature of the invention is the provision of an adjustable stop within the collapsible link, this adjustable stop being arranged to control the distance through which the link collapses and consequently the distance through which the pump flow-control member moves in reducing its delivery.

Referring to the drawings in detail, Figure 1 shows a press 10, hydraulically connected to a reversible variable delivery pump 11 and having a collapsible air link 12 interposed between the pump control and the main solenoid 13 which operates the pump control and is connected to the press control mechanism. Also provided in the press circuit is a pilot pump 14 connected to supply pressure fluid to the servomotor 15 for shifting the flow-control member of the pump 11. The hydraulic circuit also contains a main cylinder release and by-pass valve 16 of the type disclosed and claimed in the Ernst Patent No. 1,956,758 of May 1, 1934, and forming no part of the present invention. Adjacent the valve 16 is a surge valve 17 of the type disclosed and claimed in the Ernst Patent No. 1,892,568 of December 27, 1932, and likewise forming no part of the present invention.

A tonnage control or pressure-responsive electrical limit switch 18 is likewise provided for regulating the pressure at which the press 10 is reversed and caused to perform a retraction stroke. Pressure relief valves 19, 20 and 21 and a check valve 22 are provided in the remaining portion of the hydraulic circuit. A solenoidally operated valve 23, controlled by a limit switch 24, is provided in the pneumatic circuit controlling the collapsible link 12, the compressed air supplied therefor being additionally regulated by a manually operated needle valve 25. The pump 11 is likewise provided with a safety centering device 26, of known design, on the opposite side of the pump 11 from the servomotor 15, and its details form no part of the present invention.

The press 10 is provided with a main cylinder 30 having a main plunger 31 reciprocable therein, and connected to a main ram or platen 32 having a platen arm 33 projecting laterally therefrom. The press 10 likewise has a reciprocable control rod 34 with a collar 35 engageable by the platen arm 33 at a predetermined position on its return stroke, and a collar 36 for actuating the pump control mechanism as hereinafter explained. A retaining collar 37 at the top of the control 34 regulates the distance through which the latter descends. The platen arm 33 on its outer end is provided with a bracket 38 carrying a cam 39 for operating the limit switch 24.

The servomotor 15 which shifts the shift ring or flow-control member of the reversible variable delivery pump 11 is under the control of a servomotor control valve rod 40, in the manner set forth in the Ernst application Ser. No. 170,250, filed October 21, 1937, now Patent No. 75

2,184,665, of December 26, 1939. Pivotaly connected at 41 to the servomotor control valve rod 40 is a rocking lever 42, having its fulcrum at 43 and pivotally connected at its opposite end to the pin 44 engaging the arm 45 on the cylinder 46 of the collapsible air link 12. The plunger 47 of the latter is pivotally connected, as at 48, to the rocking lever 49 having its fulcrum at 50 and pivotally connected at 51 to the link 52. The latter is pivotally connected at 53 to the arm 54, mounted upon the shaft 55 upon which the rocking lever 56 is also mounted. One end of the rocking lever 56 is provided with a rounded yoke engageable by the collar 36 as the press control rod 34 is lifted by the platen arm 33 through the engagement of the latter with the collar 35. The other end is pivotally connected to the armature 57 of the main solenoid 13. The collapsible air link 12 is connected by a conduit 58 to one side of the needle valve 25, the opposite side being connected to the compressed air supply conduit 59. Also connected to the conduit 58 is the branch conduit 60 running to one side of the solenoidal valve 23, the opposite side thereof being connected to the air exhaust conduit 61. The solenoidal valve 23 is operated by a solenoid 62 in circuit with the limit switch 24, as hereinafter explained.

The cam 39 on the bracket 38 (Figure 4) may be made in a single piece, or it may consist of three pieces 63, 64 and 65 clamped to the bracket 38. The portions 63 and 65 are beveled and provide the entering and leaving portions of the cam 39, whereas the portion 64 is a dwell portion, the length of which regulates the duration of the slow-down period. These three portions are clamped to the bracket 38 by the screws 66, 67 and 68, respectively. By loosening the screws 66, 67 and 68 the dwell portion 64 may be removed and a longer or shorter dwell portion substituted. The limit switch 24 is provided with a contact arm 69 for engagement with the cam 39.

The collapsible air link 12, as previously stated, consists of a cylinder 46 having a projecting arm 45 pivotally connected at 44 to the rocking lever 42. The plunger 47, pivotally connected at 48 to the rocking lever 49, enters the cylinder 46 through an adjustable cap 70 having a threaded portion 71 (Figure 3) engageable with a threaded portion 72 upon the outside of the cylinder 46. The plunger 47 is provided with a piston head 73, having a threaded bore 74, mounted upon the threaded end 75 of the plunger 47 and seated against an annular enlargement 76. The plunger 47 passes through a hollow plug 77, threaded as at 78 into the cylinder 46 and provided internally with a bored plug 79 for retaining an annular oil seal element 80 in position. On the plunger 47 there is also mounted a stop collar 81, secured thereto by the set screw 82. This stop collar engages the inner end wall of the cap 70 when the piston 73 moves to its extreme left-hand position. If, however, the cap 70 is unscrewed a sufficient distance the piston 73 will be halted by the annular stop portion 83 on the inner end of the plug 77. The cylinder 46 is provided with threaded end ports 84 and 85. The port 84 serves to receive the end of the conduit 58, whereas the port 85 receives a threaded plug 86, preferably with a drilled passageway therethrough (not shown) as a breather passageway. The right-hand end of the cylinder 46 is provided with an annular ridge 87 serving as a stop for the forward end of the piston 73.

In the hydraulic circuit, in addition to the elements previously mentioned, the pump 11 is connected by the conduits 88 and 89 to the upper and lower ports 90 and 91 of the main cylinder 10. A branch conduit 92 runs from the conduit 89 to the main cylinder release and by-pass valve 16, from which the conduit 93 runs to the port 94 in the upper end of the main cylinder 10. A branch conduit 95 also runs to the surge valve 17 to open the latter upon the return stroke of the press. The pilot pump 14 receives fluid from the surge tank 96 through the conduit 97, and discharges pressure fluid through the conduits 98 and 99 into the servomotor 15. The branch conduits 100 and 101 run from the ends of the servomotor 15 to the surge tank 96, and the exhaust conduit 102 runs to the surge tank from the pressure relief valve 21. The pressure-responsive tonnage control limit switch 18 is connected by the conduit 103 to the port 104 in the upper end of the main cylinder 10, and is also provided with an exhaust conduit 105 running to the surge tank 96.

The electrical circuit, in addition to the main solenoid 13, the valve solenoid 62, the limit switch 24 and the tonnage control limit switch 18, also contains a normally open automatic restarting switch 106 (Figure 2) operated by the platen as it nears the end of its return stroke and before the control rod 34 has been raised a sufficient amount to shift the pump control to its neutral delivery position. The restarting switch 106 is ordinarily actuated by the control rod 34 and may be shifted by its engagement with the collar 37, or any other suitably located stop. As shown in Figure 1, the restarting switch 106 is mounted upon the bracket 107 which serves as a guide for the upper end of the control rod 34, but it may likewise be mounted in any other suitable position. The automatic restarting switch 106 serves to automatically reenergize the main solenoid 13 and place the pump 11 automatically upon its forward delivery stroke as the plunger 31 nears the end of its return stroke. This feature enables the press to be operated in so-called "full automatic" operation, wherein the plunger 31 and ram or platen 32 perform a repeated number of working and return strokes without halting more than momentarily at the end of each stroke.

When semi-automatic operation is desired so that the press performs a single working stroke followed by a single return stroke and then halts, the automatic restarting switch 106 is switched out of the circuit by the combined push-button and selector switch 108. An additional switch 109 of this combined type is provided for selecting whether automatic operation or hand operation is to be employed, and is also used in its push-button function for manually reversing the press at any point in its cycle. Hand operation is employed when the electrical control circuit of Figure 2 is deenergized and the press control rod 34 is raised manually by a hand lever (not shown).

The electrical circuit likewise contains an oil temperature limit switch 110 (Figure 2) which is shifted from its normally closed position to a circuit-breaking position by a thermostat when the temperature of the oil, or other working fluid, exceeds a predetermined maximum. The opening of the oil temperature limit switch 110 terminates the automatic operation of the press. An additional forward push-button switch 111 is likewise provided as a safety feature, so that the operator must use both hands in starting the press. In order to indicate when the electrical circuit is en-

energized there is provided a signal light 112 in series with a resistance 113.

The electrical control circuit finally contains a magnetic contactor 114 having an operating coil 115 and an armature 116 carrying switch blades 117 and 118, and an interlock switch blade 119 forming a holding circuit for the operating coil 115 when the push-button switch 111 is released after being momentarily depressed. The valve solenoid 62 contains an armature 63^a for operating the solenoidal valve 23.

The electrical control circuit (Figure 2) is energized from the main power lines 120 and 121 through the branch lines 122 and 123. One of the semi-automatic contacts of the combined push-button and selector switch 108 is connected to one contact of the push-button switch 111 by the line 124, from the other contact of which the lines 125 and 126 run to the automatic restarting switch 106 and interlock contact of the magnetic contactor 114, from the other contact of which the line 127 runs to the tonnage limit switch 18. From the latter the line 128 runs to the combined push-button and selector switch 108, as does the line 129 from the automatic restarting switch 106. The tonnage limit switch 18 is connected by the line 130 to the operating coil 115 of the magnetic contactor 114, from the other end of which the line 131 runs to the combined push-button and selector switch 109. Beyond this the line 132 runs to the signal light 112, from which the lines 133, 134 and 135 run to the branch power line 123 by way of the resistance 113. From the branch power line 122 the line 136 runs to the oil temperature limit switch 110, beyond which the line 137 runs to the combined push-button and selector switch 109. The valve solenoid 62 is connected by the line 138 to the branch power line 123, and by the line 139 to the platen-operated limit switch 24, beyond which the line 140 runs to one of the contacts of the contactor switch blade 118. The line 141 runs from the same contact to the main solenoid 13, from which the line 142 runs to one contact of the contactor switch blade 117.

It will be noted that on the return stroke of the press ram the servo-motor on the pump is actuated by spring pressure, holding the pump on full stroke. As the ram approaches the end of its upward travel the arm 33 on the platen 32 contacts the collar 35 on the control rod 34. This in turn acting through the linkage which includes the air link 46 moves the servo-motor control rod 40 to place the pump on neutral. Without air pressure in the air link 46 no movement can be transmitted through the linkage and, therefore, the pump remains at full stroke tending to force the ram beyond its upper limit, with the corresponding damage to control linkage.

In Figure 1 it will be noted that an air cylinder 143 is in connection with the pipe 59. In this cylinder is a piston 144 and a piston rod 145. The piston is spring pressed upwardly by spring 146, the lower end of piston rod 145 engages the roller 147 of the switch arm 148 of the switch 149 which controls the circuit included within the wires 150 and 151. The wire 150 is connected to a terminal 152 which is adapted to be engaged by the motor starting switch 153. The other side of the terminal 152 is connected to a wire 154 to the terminal 155. This is a part of a holding circuit which consists of the wire 121, wire 156, terminal 157, blade 158 to the wire

155. The switch arm 159 is solenoid operated by the solenoid core 160 and coil 161, one side of which is connected to the main line wire 120 and the other side of which is connected by the wire 162 to the terminal 163 engaged by the motor stop switch 164, the other side of which is connected to the terminal 165 and wire 151, which is in turn controlled by the switch 159.

Returning to the switch arm 159, the lines 120, 121 and 121a are connected to the motor lines 166, 167 and 168 of the motor 169 by the switch blades 170, 171 and 172.

In operation the switch 149 is normally closed by the air pressure in the line 59. In the event of failure of that air pressure, the spring 146 will move up the piston rod 145 permitting the switch 149 to open under the influence of a spring 149a. The air pressure acts against the spring pressure or spring 146 to hold the plunger at full stroke position. With the plunger air operated as above, the limit switch 149 in series with the stop button 164 for the main motor circuit will be held closed. On the failure of the air or loss of air pressure, the spring 146 will return the plunger 145 to its opposite position allowing the closed limit switch 149 to open to press the control circuit to the motor 169 in the same manner as when the stop button 164 is pushed.

Operation

In the operation of the press control circuit of this invention the pumps 11 and 14 are first started in operation. To cause the ram 32 to execute a working stroke, the operator momentarily depresses the switches 108 and 111. If semi-automatic operation is desired the switch 108 is locked in engagement with the lower or semi-automatic contacts. Under these circumstances the contactor coil 115 is energized from the branch power line 123 by way of the lines 135 and 126, the push-button switch 111, the line 124, the switch 108, the lines 128 and 130, the contactor winding 115, the line 131, the switch 109 (assuming, of course, that it is set for automatic operation), the line 137, the oil temperature limit switch 110 and the line 136 to the branch power line 122.

The normally open magnetic contactor 114 then closes so that its switch blades 117 and 118 energize the main solenoid 13. The interlock switch blade 119, in closing, operates a holding circuit which maintains the energization of the magnetic contactor winding 115 even when the forward push-button switch 111 is released. The energization of this holding circuit is maintained from the branch power line 123, through the line 135, the now closed switch blade 119, the line 127, the tonnage control limit switch 18, the line 130, the contactor winding 115, the line 131, the switch 109, the line 137, the oil temperature limit switch 110 and the line 136 to the branch power line 122. The valve solenoid 62, however, as yet remains unenergized since the normally open limit switch 24 has not yet closed by reason of the descent of the platen or main ram 32. Meanwhile compressed air has been furnished to the compressed air supply line 59 and flows through the needle valve 25 and the conduit 58, into the left-hand end of the collapsible air link 12. This compressed air pushes the piston head 73 to the right, shortening the distance between the pivot pins 44 and 48. The solenoidal valve 23, however, remains in its normally closed position since its solenoid 62 has not yet been energized.

The energization of the main solenoid 13, as described above, pulls down its armature 57 and rocks the rock shafts 56 and 49 (Figure 1), shifting the collapsible link 12 to the left and rocking the lever 42 to cause the servomotor control valve rod 40 to move to the right towards the servomotor 15. This action shifts the shift ring or flow-control member of the variable delivery pump 11 and places the latter on stroke so that it delivers pressure fluid by the conduit 88 to the upper end of the main cylinder 10, and withdraws fluid from the lower end thereof through the conduit 89. The consequent descent of the main plunger 31 and ram 32 causes the cam 39 to engage the contact member 69 of the limit switch 24 so that the latter is closed and energizes the valve solenoid 62 since the latter is electrically connected through the lines 139 and 140 to the already energized main solenoid 13. The solenoidal valve 23 then opens, permitting compressed air to escape through the conduits 58 and 60 from the left-hand end of the collapsible link cylinder 46. The piston head 73 and the cylinder 46 then move relatively to one another so as to increase the distance between the pivot pins 48 and 44. This permits the servomotor control valve rod 40 to shift toward its reduced delivery position, moving the shift ring of the pump 11 toward its reduced delivery position and consequently slowing down the speed of the main plunger 31 and main ram or platen 32.

Meanwhile, the main ram 32 continues to descend, and the contact member 69 of the limit switch 24 rides along the dwell portion 64 until it arrives at the beveled portion 63, when it is permitted to swing back to its normally open position. The opening of the switch 24 deenergizes the valve solenoid 62 and closes the solenoidal valve 23. Air from the air supply conduit 59 then passes through the needle valve 25 and replenishes the air in the left-hand end of the cylinder 46, causing the pistons 73 and cylinder 46 to move again into their contracted position with the pivot pins 44 and 48 at their minimum separations.

The consequent shifting of the servomotor control valve rod 40 immediately shifts the pump shift ring or flow-control member toward an increased delivery position, increasing the discharge of pressure fluid to the main cylinder 10 and speeding up the descent of the main ram 32. The latter then completes its working stroke, whereupon the building up of pressure in the main cylinder 10 by engagement of the main ram 32 with the workpiece, causes the normally closed tonnage control limit switch 18 to open, breaking the holding circuit of the magnetic contactor coil 115 by opening the circuit between the lines 127 and 130 (Figure 2).

The opening of the magnetic contactor 114 immediately deenergizes the main solenoid 13, whereupon a spring (not shown) within the servomotor 15 shifts the servomotor control valve rod 40 to its reversed delivery position. The variable delivery pump 11 then delivers pressure fluid through the conduit 88 to the lower end of the main cylinder 10, and exhausts fluid from the upper end through the conduit 89. The main cylinder release and by-pass valve 16 operates to momentarily by-pass the flow of the pump while releasing pressure fluid from the upper end of the main cylinder 10 at the instant of reversal, as described in the previously mentioned patent disclosing and claiming this device. At

the same time the surge valve 17 is forcibly opened, as described in the previously mentioned patent disclosing and claiming it.

The rise of the main plunger 31 and platen or ram 32 causes the cam 39 to close the normally open limit switch 24, but nothing happens since the main solenoid 13 is deenergized by the opening of the magnetic contactor 114. Consequently, there is no danger of the operation of the collapsible link 12 on the return stroke of the main plunger 31. The main ram 32 continues to rise until its arm 33 engages the collar 35 and lifts the control rod 34, causing the collar 36 to engage and rock the lever 56 and shift the servomotor control valve rod 40 to its neutral position through the motion of the intermediate linkage. The pump 11 then operates at zero delivery, but immediately goes upon stroke at any tendency of the main plunger 31 to descend. In this manner the main plunger 31 is held at the top of its retraction stroke.

At this point in full automatic operation, however, since the operator has previously moved the switch 108 to its full automatic position, the limit switch 106 is closed by the rise of the control rod 34 and reenergizes the coil 115 of the magnetic contactor 114 by way of the branch power line 123, the lines 135, 126 and 125, the limit switch 106, the line 129, the switch 108, the lines 128 and 130, the coil 115, the line 13, the switch 109, the line 137, the oil temperature limit switch 110 and the line 136 to the branch power line 122.

The main solenoid 13 is thus reenergized and shifts the servomotor control rod 40 to place the pump 11 upon its forward delivery stroke, causing the main plunger 31 to commence another working stroke with but a momentary halt at the top of its return stroke. The repeated operation of the valve-operating solenoid 62 and the collapsible link 12 takes place in the manner previously described upon each working stroke, but is prevented from taking place upon the return stroke by the fact that the main solenoid 13, with which the valve solenoid 62 is in circuit, is deenergized. The press is halted by the operator when the operator depresses the switch 109 or automatically by the oil temperature limit switch 110 if the oil temperature rises to an undesired height.

The invention is, of course, not limited to presses in which the travel of the press platen is reversed in response to a predetermined pressure acting thereupon, but may as well be used in connection with presses in which the reversal of the travel of the press platen is effected in response to a predetermined point of travel of the platen. To this end, with reference to Figures 5 and 6, the platen 32 may, at a predetermined point of its pressing stroke and by means of a cam 175, open the switch 18a, which takes the place of switch 18 in the circuit of Figure 2.

Opening of the switch 18a breaks the holding circuit for solenoid 115 (Figure 6), thereby enabling the spring in the pump 11 to move the latter to full delivery retraction stroke position. Since otherwise Figures 5 and 6 fully correspond to Figures 1 and 2, the cycle will then continue in the manner described in connection with Figures 1 and 2.

It will be understood that it is desired to comprehend within the invention such modifications as come within the scope of the claims and the invention.

Having thus fully described the invention

what is claimed as new and desired to be secured by Letters Patent is:

1. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a source of pressure fluid therefor with a flow-control member for reversibly controlling the distribution of pressure fluid to said hydraulic motor means, of means including an electrical device for reversibly moving said flow-control member between its forward delivery and its reverse delivery positions through its neutral delivery position, said flow-control-member-moving means including an expanding and collapsing link device, electrical means for effecting the operation of said link device, means responsive to the travel of said ram to a predetermined location for energizing said electrical means to effect the operation of said link device to shift said flow-control member in a delivery-reducing direction, and means for deenergizing said electrical means near the end of the travel of said ram in one direction and for maintaining said electrical means deenergized during the opposite direction of travel of said ram.

2. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a source of pressure fluid therefor with a flow-control member for reversibly controlling the distribution of pressure fluid to said hydraulic motor means, of means including an electrical device for reversibly moving said flow-control member between its forward delivery and its reverse delivery positions through its neutral delivery position, said flow-control-member-moving means including an expanding and collapsing link device, electrical means for effecting the operation of said link device connected in circuit with said electrical device for moving said flow-control member, means responsive to the travel of said ram to a predetermined location for energizing said electrical means to effect the operation of said link device to shift said flow-control member to a delivery-reducing direction, and means for deenergizing said electrical device near the end of the ram travel in one direction whereby to concomitantly deenergize said electrical means, and for maintaining said electrical means deenergized during the opposite direction of travel of said ram.

3. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a source of pressure fluid therefor with a flow-control member for reversibly controlling the distribution of pressure fluid to said hydraulic motor means, of means including an electrical device for reversibly moving said flow-control member between its forward delivery and its reverse delivery positions through its neutral delivery position, said flow-control-member-moving means including an expanding and collapsing link device, electrical means for effecting the operation of said link device connected in circuit with said electrical device for moving said flow-control member, means responsive to the travel of said ram to a predetermined location for energizing said electrical means to effect the operation of said link device to shift said flow-control member in a delivery-reducing direction, and means responsive to the attainment of a predetermined pressure in said motor means near the end of the ram travel in one direction for deenergizing said electrical device and concomitantly deen-

energizing said electrical means and for maintaining said electrical means deenergized during the opposite direction of travel of said ram.

4. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a source of pressure fluid therefor with a flow-control member for reversibly controlling the distribution of pressure fluid to said hydraulic motor means, of means including an electrical device for reversibly moving said flow-control member between its forward delivery and its reverse delivery positions through its neutral delivery position, said flow-control-member-moving means including an expanding and collapsing link device, means for supplying pressure fluid to said link device to operate the same, a solenoidal valve connected to control the supply of pressure fluid in said link device, the solenoid of said valve being connected in circuit with said electrical device, means responsive to the arrival of said ram at a predetermined position for energizing said solenoidal valve to actuate said link device, and means responsive to the attainment of a predetermined pressure in said hydraulic motor means for concomitantly deenergizing said electrical device and said solenoidal valve.

5. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a source of pressure fluid therefor with a flow-control member for reversibly controlling the distribution of pressure fluid to said hydraulic motor means, of means including an electrical device for reversibly moving said flow-control member between its forward delivery and its reverse delivery positions through its neutral delivery position, said flow-control-member-moving means including an expanding and collapsing link device, means for supplying pressure fluid to said link device to operate the same, means responsive to the arrival of said ram at a predetermined position for by-passing the supply of pressure fluid to said link device to actuate the same, and means responsive to the attainment of a predetermined pressure in said motor means for altering the energization of said electrical device to shift said flow-control member into its reverse delivery position, and means responsive to the alteration of energization of said electrical device for rendering said by-passing means inoperative.

6. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a reversible variable delivery pump with a flow-control member for reversibly varying the pump delivery from a forward delivery position through a neutral position to a reverse delivery position, of yielding means for urging said flow-control member in one direction, an electrical device for moving said flow-control member in the opposite direction, an expanding and collapsing link device connected between said flow-control member and said electrical device, means responsive to the arrival of said ram at a predetermined location on its forward stroke for actuating said link device to effect the moving of said flow-control member to a reduced-delivery position, means for supplying pressure fluid to actuate said link device, a valve for controlling said supplying means, a second electrical device for operating said valve, and means adapted to be actuated near the end of the forward stroke of said ram for deenergizing both of said electrical

cal devices and for maintaining the same deenergized during the retraction stroke of the ram.

7. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a reversible variable delivery pump with a flow-control member for reversibly varying the pump delivery from a forward delivery position through a neutral position to a reverse delivery position, of a press control element connected to said flow-control member and engageable by said ram, a solenoid operatively connected to shift said flow-control member, an expanding and collapsing link device connected between said solenoid and said flow-control member, fluid pressure-operated means including a solenoidal control valve for actuating said link device, means responsive to the arrival of said ram at a predetermined location on its stroke in one direction for operating said solenoidal valve to actuate said link device and shift said flow-control member in a delivery-reducing direction, means for deenergizing said solenoid to shift said flow-control member to its reverse delivery position, and means responsive to the deenergization of said solenoid for deenergizing said solenoidal valve.

8. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a reversible variable delivery pump with a flow-control member for reversibly varying the pump delivery from a forward delivery position through a neutral position to a reverse delivery position, of yielding means for urging said flow-control member into a reverse delivery position, a solenoid adapted when energized to urge said flow-control member into a forward delivery position, an expanding and collapsing link device connected between said solenoid and said flow-control member and operable when actuated to effect the shifting of said flow-control member to a reduced delivery position, electrical means for controlling the actuation of said link device, means responsive to the arrival of said ram at a predetermined location for operating said electrical means to actuate said link device, means responsive to the travel of said ram upon its forward stroke for deenergizing said solenoid to reverse the delivery of said pump, and means responsive to the deenergization of said solenoid for concomitantly deenergizing said electrical means.

9. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a reversible variable delivery pump with a flow-control member for reversibly varying the pump delivery from a forward delivery position through a neutral position to a reverse delivery position, of yielding means for urging said flow-control member in one direction, an electrical device for moving said flow-control member in the opposite direction, an expanding and collapsing link device connected between said flow-control member and said electrical device, means responsive to the arrival of said ram at a predetermined location on its forward stroke for actuating said link device to effect the moving of said flow-control member to a reduced-delivery position, means for supplying pressure fluid to actuate said link device, an electric motor for driving said pump, and means controlled by the fluid pressure actuating said link whereby, upon a

failure of said fluid pressure, said motor will be rendered inoperative.

10. In a hydraulic press control system, the combination with reversible hydraulic motor means having a reciprocable ram and a reversible variable delivery pump with a flow-control member for reversibly varying the pump delivery from a forward delivery position through a neutral position to a reverse delivery position, of yielding means for urging said flow-control member in one direction, an electrical device for moving said flow-control member in the opposite direction, an expanding and collapsing link device connected between said flow-control member and said electrical device, means responsive to the arrival of said ram at a predetermined location on its forward stroke for actuating said link device to effect the moving of said flow-control member to a reduced-delivery position, means for supplying pressure fluid to actuate said link device, a valve for controlling said supplying means, a second electrical device for operating said valve, means adapted to be

actuated near the end of the forward stroke of said ram for deenergizing both of said electrical devices, and for maintaining the same deenergized during the retraction stroke of the ram; a motor for operating said pump, and means controlled by the fluid pressure actuating said link to control the operation of said motor whereby, upon a failure of said pressure, said motor will be rendered inoperative.

11. A hydraulic press comprising in combination a press ram, means for supplying pressure fluid to said ram for actuating the same, electric means for driving said fluid supply means, link means including a fluid pressure chamber operable to vary the delivery of said pressure fluid supply means, and means adapted in response to a predetermined pressure condition in said chamber to prevent said driving means from further driving said pressure fluid supply means.

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