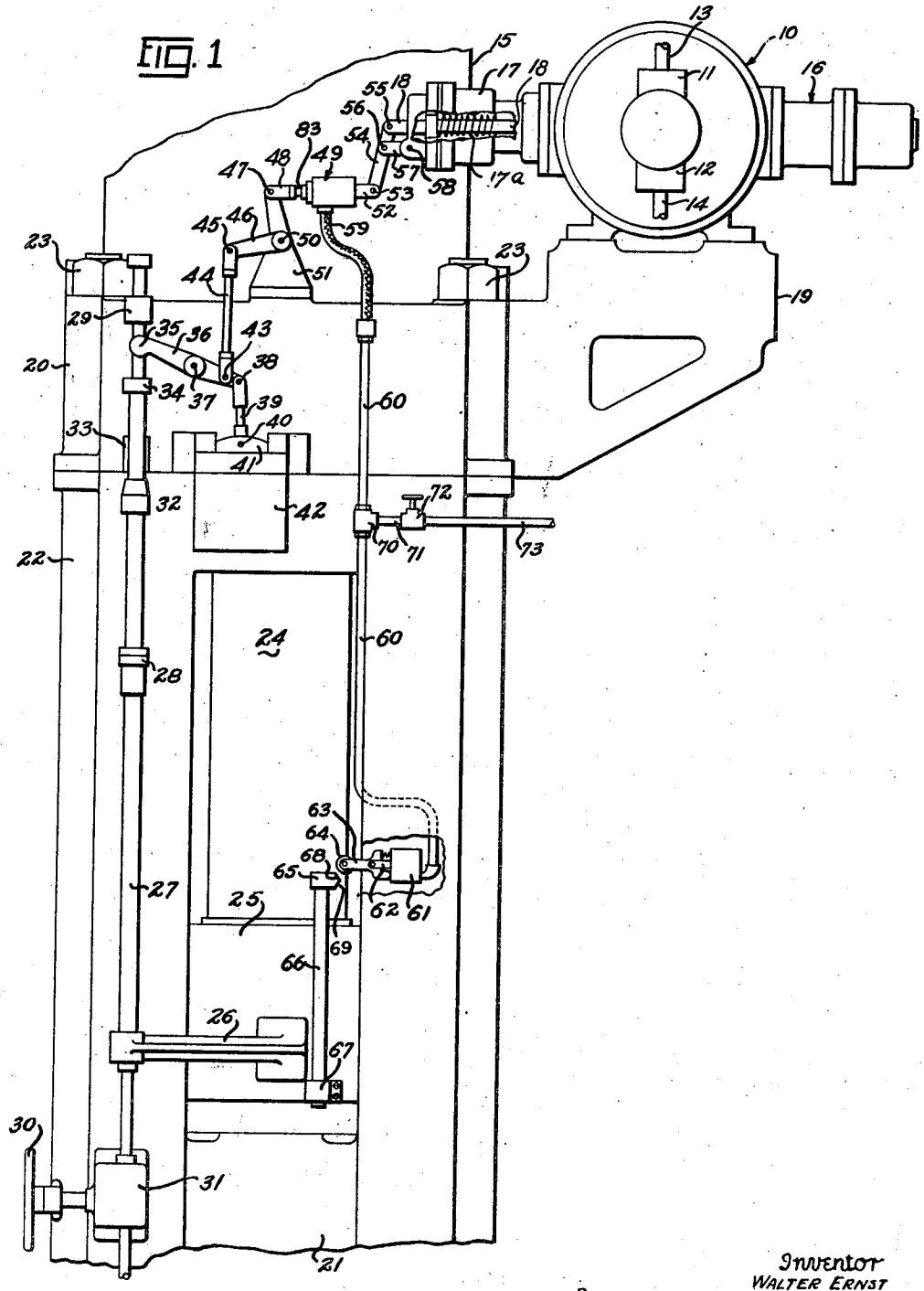
Oct. 14, 1941. W. ERNST 2,258,886

MECHANISM FOR VARYING THE SPEED OF HYDRAULIC PRESS RAMS

Filed July 21, 1938 3 Sheets-Sheet 1

Fig. 1



Inventor
WALTER ERNST

By Toulmin & Toulmin
Attorneys

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Filed July 21, 1938 3 Sheets-Sheet 2

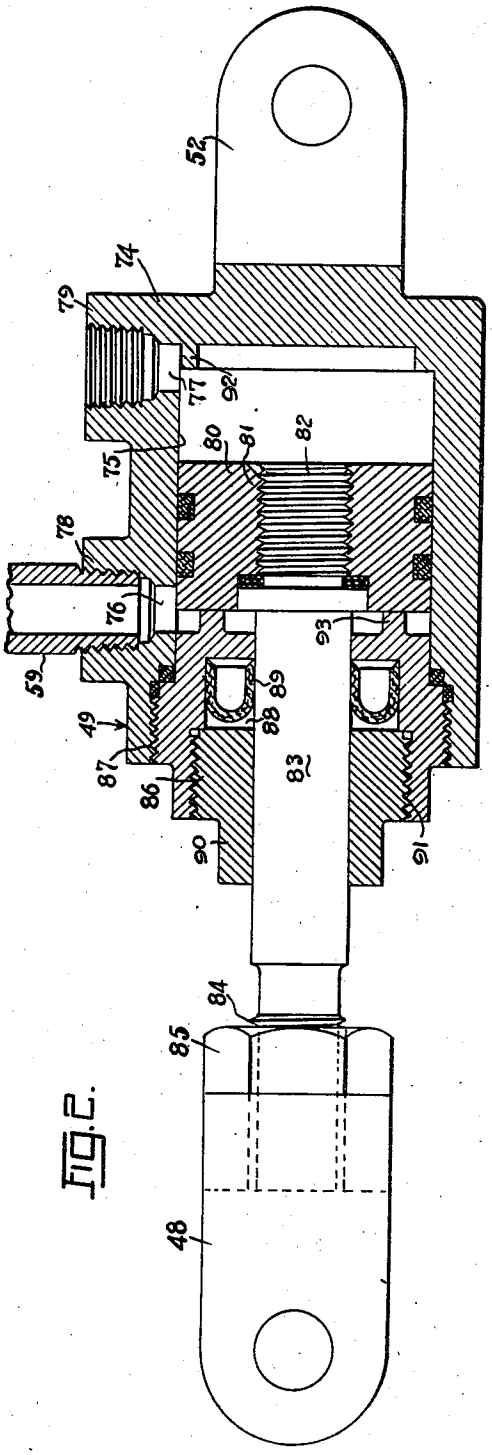

Fig. 2.

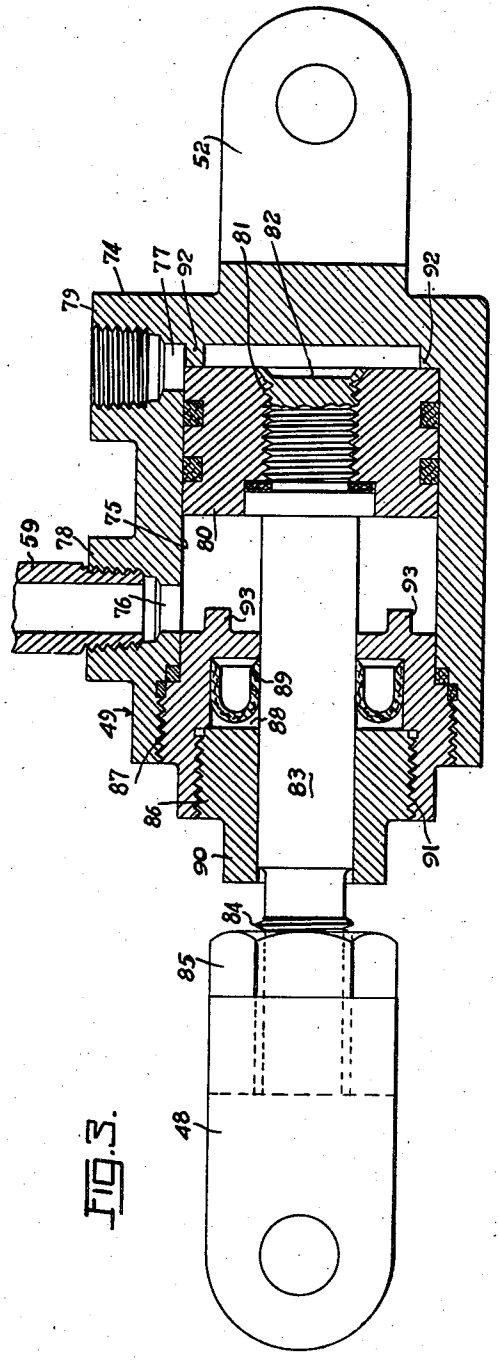

Fig. 3.

Inventor
WALTER ERNST

By Goudmin & Goudmin
Attorneys

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Filed July 21, 1938 3 Sheets-Sheet 3

Fig. 4

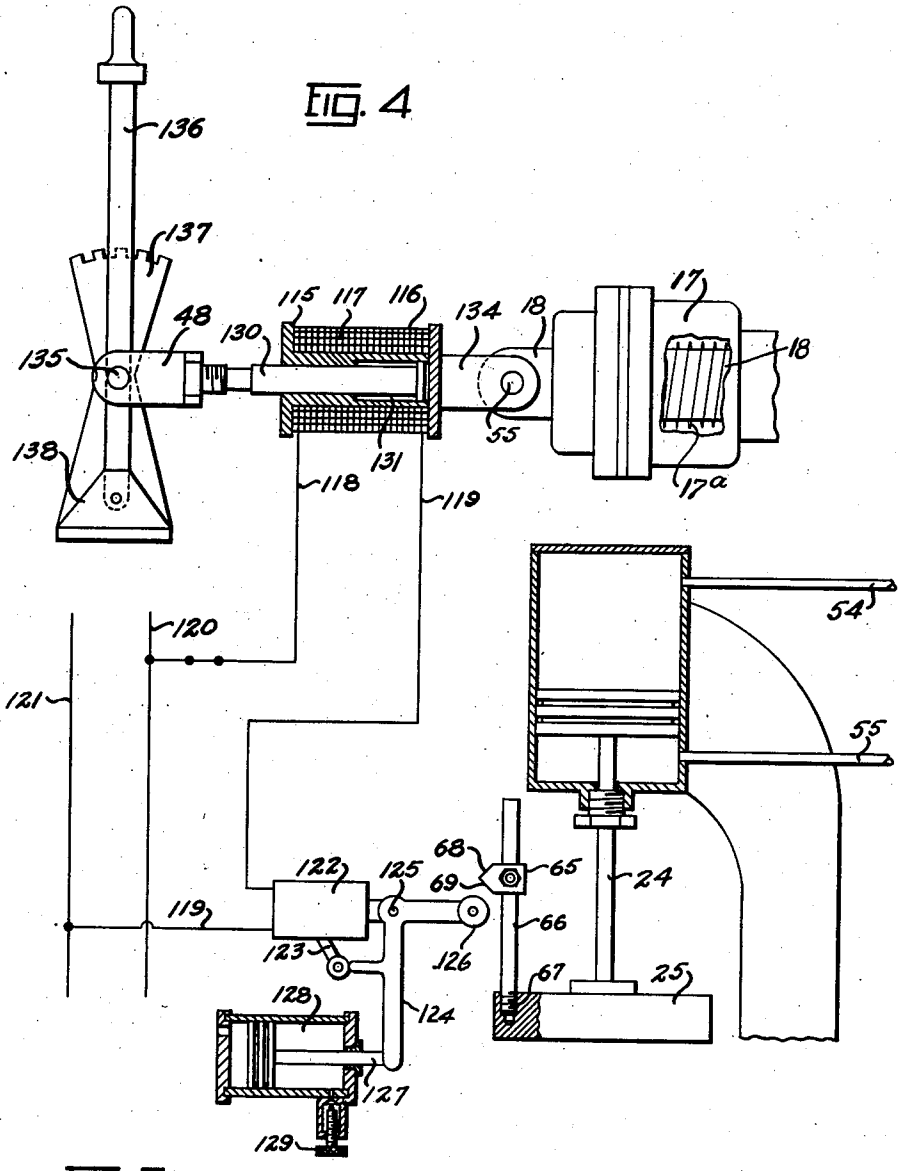
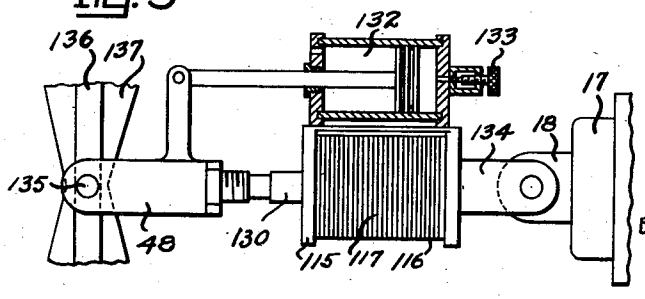


Fig. 5



INVENTOR
WALTER ERNST

By Faulkner & Faulkner
Attorneys

Patented Oct. 14, 1941 2,258,886

UNITED STATES PATENT OFFICE

2,258,886

MECHANISM FOR VARYING THE SPEED OF HYDRAULIC PRESS RAMS

Walter Ernst, Mount Gilead, Ohio, assignor to The Hydraulic Development Corp. Inc., Wilmington, Del., a corporation of Delaware

Application July 21, 1938, Serial No. 220,554

9 Claims. (Cl. 60—52)

This invention relates to hydraulic machine control systems, and in particular, to systems including a hydraulic pump and having provision for altering the delivery of the pump to vary the speed of the machine at different points in its operation.

One object of this invention is to provide means responsive to the motion of a hydraulic machine for varying the delivery of a hydraulic pump so as to cause the machine to slow down at a predetermined point in its operation.

Another object is to provide means, as described above, wherein the machine is thereafter caused to gain speed again following the slowing down thereof.

Another object is to provide a hydraulic press control system operated by a hydraulic pump, and including means responsive to the arrival of the press platen at a predetermined point to cause the platen to slow down immediately prior to its engaging the workpiece, and thereafter to gain speed so as to apply an increased pressing force to the workpiece.

Another object is to provide a hydraulic press control system, as described in the preceding paragraph, wherein the press is operated by a variable delivery pump having a flow-control member with a collapsible or expansible link therein, this collapsible link being operated pneumatically or electrically, and responsive to the arrival of the press platen at a predetermined point on its stroke to change the relative working positions of the link so as to vary the delivery of the pump, and preferably also to cause the link to resume its original position after the platen has passed the above-mentioned predetermined point.

Another object is to provide a hydraulic press control system, as above described, wherein a time delay device in the system operates to cause an increase of flow of pressure fluid from the pump to the press a predetermined time after the reduction of flow from the pump to the press.

This application is a continuation in part of my copending application, Ser. No. 128,827, filed March 3, 1937.

In the drawings:

Figure 1 is a diagrammatic view, partly broken away, of the essential portions of a hydraulic press circuit with a pneumatic collapsible link interposed between the press control rod and the servomotor control of the pump.

Figure 2 is an enlarged central longitudinal section through the pneumatic collapsible link of Figure 1, with the link parts in one position.

Figure 3 is a view similar to Figure 2, but with the link parts in a reversed position relatively to Figure 2.

Figure 4 is a diagrammatic view of a hydraulic press control system having an electrically operated collapsible link for actuating the flow-control element of the pump.

Figure 5 is a fragmentary view, similar to a portion of Figure 4, but showing the electrical shifting element or solenoid closely associated with a time delay device or dash-pot.

General arrangement

In general, the hydraulic press control system of this invention consists of a hydraulic press to which pressure fluid is supplied by a variable delivery pump having a flow-control element for varying its delivery. Interposed between the manually controlled lever or control rod of the press and the servomotor valve rod for controlling the delivery of the pump, is a collapsible or expansible link operated either pneumatically or electrically when the press platen reaches a predetermined position upon its stroke. When this position is reached the link is operated to permit the shifting of the servomotor valve rod so as to shift the pump flow-control member and reduce the delivery of the pump. A time delay device, such as a dash-pot, is optionally provided for establishing a time delay period for the operation under reduced flow so that the pump resumes its normal or increased flow at the end of a predetermined time interval following its reduction of flow. The link device may be either pneumatically or electrically operated, and both such systems are illustrated herein. The link may also be expansible or collapsible, according to the mechanical requirements of its particular position in the pump operating mechanism, as hereinafter explained in detail.

Modern production requirements have made it advisable to increase the speeds of hydraulic presses far beyond the speeds previously thought necessary. When such presses are used in connection with dies, however, it has been found that the life of the dies is greatly shortened and damage frequently caused thereto because of the considerable shock which is set up when the press platen engages the dies while moving at this high speed. The purpose of the present invention, therefore, is to enable the press platen to close the dies at a high speed so as to shorten the working cycle, yet to slow down the platen just before the dies are engaged, whereupon the dies are engaged smoothly and without serious shock,

after which the platen again speeds up and finishes its pressing stroke at a relatively rapid speed and high pressure.

The invention is shown in connection with a press operated by a reversible variable delivery hydraulic pump in a closed circuit, wherein the press platen is reversed by reversing the pump. It will be understood, however, that the invention may be applied to an open circuit, wherein the fluid flow from the pump and the press is valved in order to control the speed and direction of the platen movement.

Pneumatic collapsible link system

Referring to the drawings in detail, Figure 1 shows a reversible variable delivery pump 10 having fluid connections 11 and 12, connected to conduits 13 and 14, respectively. Depending upon whether the pump is in a forward or reverse position, one of the conduits 13 or 14 serves as a pressure conduit while the other serves as a suction conduit. The conduit 13 serves as a pressure conduit for supplying pressure fluid to the main cylinder of the press during the pressing stroke, while the conduit 14 serves as a suction conduit to withdraw fluid from the return side of the press-operating circuit, in a manner well known to those skilled in the art.

Fluid for operating the circuit is contained in the surge tank 15. The pump 10 is provided on one side with a safety centering device 16 and on the other side with a servomotor, generally designated 17, for operating the flow-control member of the pump to vary its delivery. The servomotor 17 is, in turn, controlled by the servomotor valve rod 18. The details of the pump 10 and its associated elements form no part of the present invention, and a disclosure thereof is found in my copending application, Ser. No. 170,250, filed October 21, 1937.

The pump 10 is mounted upon a bracket 19 secured to the press head 20, which in turn, is connected to the press bed 21 by the strain rods 22 having the nuts 23 threaded upon the ends thereof. The press head 20 contains a main cylinder (not shown) within which a main plunger 24 reciprocates. Secured to the main plunger 24 is a platen 25 having an arm 26 extending laterally therefrom to encircle the press control rod 27, and to engage an adjustable collar 28 thereon when the platen 25 reaches a predetermined position upon its return stroke. The control rod 27 is guided in lugs 29 in the press head and bed 20 and 21, and may be raised and lowered manually by means of the hand wheel 30 mechanically connected thereto through the gear box 31.

The control rod 27 is provided with a cam collar 32 arranged to operate a limit switch 33 in the electrical circuit for controlling the reversal of the press circuit in full automatic operation. The control rod 27 also is provided with a collar 34 engagable by the yoked end 35 of a rocker arm 36, pivotally mounted upon the rocker shaft 37 which, in turn, is mounted upon the press head 20. Pivotally connected, as at 38, to the opposite end of the rocker arm 36 is a connecting rod 39 having its lower end pivotally connected, as at 40, to the armature 41 of the operating solenoid 42. Also pivotally connected to the rocker arm 36, as at 43, is a link 44 pivotally connected at 45 to a bellcrank 46, the other end of which is pivotally connected at 47 to the clevis 48 of a link device, generally designated 49, hereinafter described in more detail. The bellcrank 46 is pivotally mounted, as at 50, upon the bracket 51 mounted upon the press head 20. Mounted upon the opposite end of the link device 49 is a yoke 52 pivotally connected, as at 53, to the lever 54. The latter is pivotally connected, as at 55, to the servomotor valve rod 18 of the pump 10 and is pivotally mounted, as at 56, upon the floating link 57, which in turn, is pivotally mounted, as at 58, upon the casing of the servomotor 17.

Connected to the link device 49 is a flexible compressed air conduit 59, connected in turn, to a conduit 60 which leads to a two-way air release valve 61 having a valve rod 62 operated by an arm 63 carrying a roller 64. The valve rod 62 is urged by an internal spring into a normally closed position. The valve rod 62 is adapted to be moved to the left into an open position to release air from the valve 61 by the engagement of the roller 64 with the cam 65 upon the cam arm 66, secured as at 67 to the platen 25. The cam 65 is provided with oppositely beveled portions 68 and 69 for engaging the valve-operating roller 64. Mounted at an intermediate point along the conduit 60 is a T-connection 70 having a conduit 71 leading thereto, and containing a choke valve 72. On the opposite side of the choke valve 72 the conduit 73 leads to a source of compressed air, such as a tank served by a compressed air pump.

The link device 49, shown in Figures 2 and 3, consists of a cylinder 74 terminating at one end in the yoke 52, as previously explained. Within the cylinder 74 is a cylinder bore 75, having ports 76 and 77 communicating therewith at opposite ends thereof. Only one of the ports 76 or 77 is utilized at a given time, the other being opened to the atmosphere, depending upon whether the link device 49 is to be used for a collapsible or expansible link. The cylinder 74 is provided with pipe connections 78 and 79 leading to the ports 76 and 77, and serving as connections for the flexible conduit 59.

Reciprocably mounted within the cylinder bore 75 is a piston head 80, mounted as at 81 upon the threaded end 82 of the piston rod 83. The latter is connected, as at 84, to the clevis 48 and locked in position by the locknut 85. The piston rod 83 passes through the cylinder head 86, secured as at 87, to the cylinder 74. The cylinder head 86 contains a bore 88 with a packing 89, which is held in place by a gland 90 threaded therein as at 91. The cylinder 74 and cylinder head 86 are provided, respectively, with annular abutments 92 and 93, adapted to engage and limit the stroke of the piston head 80 at the opposite ends of its stroke.

If the compressed air line 59 is connected to the pipe connection 78, the link device 49 will be held contracted in the position shown in Figure 3, and as soon as pressure is removed from the pipe connection 78 by the opening of the valve 61, the device will expand into the position shown in Figure 2, the expansion being accomplished by a spring 17*a* engaging the servomotor valve rod 18 within the servomotor 17. On the other hand, if the compressed air conduit 59 is connected to the pipe connection 79, the link device 49 will be held in the expanded condition shown in Figure 2, and will be collapsed as soon as pressure is removed from the pipe connection 79 and conduit 59 by the opening of the valve 61.

In Figure 1 the link device 49 is in tension when the solenoid 42 is energized because the latter, through the linkage, tends to pull the piston rod 83 and clevis 48 to the left while the spring 17*a* that is within the servomotor 17 tends to shift the

servomotor valve rod 18 to the left, thereby urging the opposite end of the lever 54 and the yoke 52 to the right. This arrangement provides a contracted link which is permitted to expand by the release of the compressed air from the port 76 and conduit 59. If, however, the link device 49 were connected directly to the servomotor valve rod 18, the conduit 59 would be connected to the pipe connection 79 in order to accomplish the same result. The link device 49, under these conditions, would be in compression rather than in tension under the same circumstances. It is, therefore, an advantage to have the link device 49 adapted to be arranged either as a collapsible or expansible link so as to operate either in tension or in compression, as desired, depending upon the manner in which it is installed.

Operation

In the operation of the system shown in Figure 1, let it be assumed that the press platen 25 and main plunger 24 are in their retracted positions so that the platen is up instead of being down, as shown in Figure 1. The compressed air reaching the link device 49, through the conduits 73, 71, 60 and 59, contracts the device into the position shown in Figure 3. The solenoid 42 is energized by the closing of an electrical circuit, and pulls down its armature 41 and the link 44, connected to the rocker arm 36. This motion is transmitted, through the various links and levers and through the now contracted link device 49, to the servomotor valve rod 18, shifting the servomotor 17 into a position to cause the pump 10 to deliver pressure fluid through the line 13, into the upper end of the main cylinder. This causes the main plunger 24 and platen 25 to descend rapidly, aided by gravity and a surge valve (not shown), which for a time permits fluid to enter the main cylinder directly from the surge tank 15, in a manner well known to those skilled in the art.

Just before the platen 25 engages the work or dies, the beveled surface 69 of the cam 65 strikes the roller 64 and shifts the arm 63 to move the valve rod 61. The air then escapes from the conduits 59 and 60 and from the port 76 in the cylinder 74 of the link device 49, so that the device is now free to expand. The spring 17*a* that is within the servomotor 17 is then free to shift the servomotor valve rod 18, thereby causing the shiftring or flow-control member of the pump to be shifted nearly to its neutral position. The stroke of the piston 80 is such that the servomotor valve rod 18 cannot cause the shiftring or pump flow-control member to be pulled quite to its neutral position. However, because the pump flow-control member has been pulled nearly to its neutral position, the pump 10 is capable only of removing oil slowly from the retraction chamber of the press. This causes the platen 25 to slow down materially for a time.

As soon as the cam 65 passes the roller 64, however, the lever 63 is returned by springs to its normal position, thereby permitting the valve rod 62 of the air release valve 61 to return to its normally closed position. The valve 61 then closes, but the choke 72 prevents the rapid refilling of the cylinder 74 of the link device 49 with compressed air. The duration of this time delay can be adjusted by adjusting the choke 72. As the slowing up of the platen 25 is timed to occur just before the platen 25 engages the workpiece or dies, by the time the link device 49 is restored to its original position and the servomotor valve rod 18 is shifted to cause the pump 10 to resume its full stroke position for full delivery, the workpiece or dies have been engaged. The operation of the platen 25 then progresses under normal speed. It is, of course, understood that under such a system, where a surge valve is employed to permit the gravitational descent of the platen, as disclosed in the Ernst Patent No. 1,892,568, of December 27, 1932, the platen 25 descends only just as rapidly as fluid is removed by the pump 10 from the retraction area of the press, which is relatively small in comparison with the advancing area upon the main plunger 24.

After the workpiece or dies are engaged, the platen 25 will no longer descend by gravity, but is urged in a forward direction to continue its working stroke by pressure fluid delivered by the pump 10 through the conduit 13 to the main cylinder against the platen-advancing side of the main plunger 24. As this area is considerably greater than the retraction area, the platen 25 moves more slowly than it did during the idle advance stroke, even though the pump capacity is the same as it was before the brief period during which its delivery was reduced by the action of the link device 49, as explained above.

Electrically operated link device and circuit

In the modified arrangement shown in Figures 4 and 5, the pneumatic link device 49 is replaced by an electrically operated device 115. The latter consists of a solenoid 116 having a winding 117 connected to the lines 118 and 119, running to the power lines 120 and 121, respectively. Inserted in the line 119 is a normally closed switch 122 having a switch arm 123, adapted to be operated by a bellcrank 124 pivoted, as at 125, and having an operating roller 126 adapted to be engaged by the cam 65 operated by the platen 25. The switch 122 contains a spring constantly urging the lever 123 into the position shown in Figure 4. The bellcrank 124 also engages the operating rod 127 of a time delay device 128, having an adjustment screw 129. The time delay device 128 may consist of a dash-pot and the adjustment screw 129 a needle valve. Reciprocable within the solenoid bore 131 is a solenoid plunger 130.

The modification shown in Figure 5 is similiar to the arrangement shown in Figure 4, with the exception that a time delay device, such as a dash-pot 132, is interposed between the solenoid plunger 130 and the solenoid winding 117. This dash-pot is provided with an adjusting screw 133 so that the relative motion between the parts is delayed when the solenoid is energized. An ordinary switch 122 is employed without the time delay device or dash-pot 128 in this arrangement. The solenoid winding 117 is connected at one end to the yoke 134, which in turn, is connected to the servomotor valve lever 54, in the manner shown in Figure 1. The solenoid plunger 130 is connected to the clevis 48, in the manner shown in Figure 1. The clevis 48 may be connected either to the bellcrank 46 and control rod mechanism of Figure 1, or else it may be connected (Figure 4) at 135 to a hand lever 136, adjustable relatively to a sector plate 137, and pivotally mounted at its lower end upon a bracket 138, as at 139.

The operation of the electrical circuit shown in Figures 4 and 5 is similar to that already described for the pneumatic link device 49, shown in Figure 1. The solenoid 116 is normally energized, and its energization causes its winding 117

to be attracted by the solenoid plunger 130, so that the solenoid bore 131 is drawn over the plunger 130. In this normally energized position, therefore, the solenoid winding 117 and the plunger 130 are drawn together in a manner analogous to the position of the pneumatically operated parts in Figure 3. Under these conditions, the solenoid 116 when energized acts as a rigid contracted link between the hand lever 136 or bellcrank 46 and the servomotor valve rod 18. When, therefore, the hand lever 136 or the bellcrank 46 is moved to the left to place the pump 10 upon its full delivery forward stroke, the servomotor valve rod 18 is shifted so that the pump 10 withdraws fluid from the retraction side of the press circuit at a rapid rate, so that the platen 25 moves downward at full speed.

When the cam 65 engages the roller 126, however, the bellcrank 124 is moved, shifting the switch arm 123 so as to open the normally closed switch 122. The solenoid winding 117 is thereby deenergized, whereupon the spring 17a within the servomotor 17 shifts the servomotor valve rod 18 so as to correspondingly shift the flow-control element of the variable delivery pump 10 almost to its neutral delivery position. The flow is thereby so greatly reduced, in a manner similar to that already described for the pneumatic control system of Figure 1, as to cause the platen 25 to move downwardly at a reduced speed.

Meanwhile, the dash-pot 128 has come into action, and after the cam 65 has passed the roller 126 the bellcrank 124 is prevented from releasing the switch arm 123 by this dash-pot 128. The latter delays closing of the switch 122 for a sufficient period to maintain the solenoid 116 deenergized, and the pump 10 is kept on reduced stroke for a predetermined period. At the end of this period, and when the dash-pot 128 has operated to a sufficient extent, the bellcrank 124 releases the switch arm 123, and the consequent closing of the switch 122 reenergizes the solenoid 116. Accordingly, the parts thereof again come together, shifting the servomotor valve rod 18 and the shiftring or flow-control member of the pump 10 again to their full delivery positions. This places the pump 10 again upon its full forward stroke position. The press platen 25 then picks up its speed and resumes its normal speed for the completion of the stroke.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, said means comprising a fluid flow-controlling member for controlling the fluid flow from said pump and an operated device for initiating a movement of said flow-controlling member to a predetermined position and for holding said member in that position, electric means associated with said device and adapted when energized to cause movement of said flow-controlling member in one direction in response to the operation of said device, means responsive to a predetermined travel of said ram for effecting de-energization of said electric means, and means responsive to the de-energization of said electric means to cause movement of said flow-controlling member in another direction to temporarily slow down the speed of travel of said ram beyond said predetermined travel without changing the direction of travel.

2. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, said means comprising a fluid flow-controlling member for controlling the fluid flow from said pump and a regulating device for regulating the setting of said flow-controlling member, electrically operable means associated with said regulating device and said flow-controlling member and adapted to cause movement of said flow-controlling member in one direction, spring means associated with said regulating device and urging said flow-controlling member in the opposite direction, means responsive to a predetermined travel of said ram for causing a shifting of said flow-controlling member to alter the speed of travel of said ram beyond said predetermined travel, and means responsive to a further predetermined travel of said ram in the same direction for causing said electrically operable means to move in a direction adapted to restore said fluid flow-controlling member to its original position.

3. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram comprising a fluid flow-controlling device for controlling the fluid flow from said pump and a regulating device for shifting said flow-controlling device, electrically operable means interposed between said regulating device and said flow-controlling device and adapted when energized to move said flow-controlling device so as to increase the fluid flow from said pump, means urging said flow controlling member into the opposite direction to decrease said fluid flow, means responsive to the motion of said ram to a predetermined position for altering the energization of said electrically actuated means so that said flow-controlling device is moved relatively to said regulating device, and time delay means responsive to the expiration of a predetermined period of time after said alteration of the energization of said electrically actuated means for restoring the original condition of energization to said electrically operable means.

4. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram comprising a fluid flow-controlling device for controlling the fluid flow from said pump and a regulating device for shifting said flow-controlling device, an electrical solenoid interposed between said regulating device and said flow-controlling device and adapted to effect movement of said flow-controlling device in one direction, the armature of said solenoid being connected to one of said devices and the coil thereof to the other device, spring means associated with said fluid flow-controlling device and adapted to cause movement of said flow-controlling device in another direction and means responsive to the motion of said ram to a predetermined position for altering the energization of said solenoid so that movement of said flow-controlling device relatively to said regulating device occurs.

5. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram comprising a fluid flow-controlling device for controlling the fluid flow from said pump and a regulating device for shifting said flow-controlling device, an electrical solenoid interposed between said regulating device and said flow-controlling device and adapted

to effect movement of said flow-controlling device in one direction, the armature of said solenoid being connected to one of said devices and the coil thereof to the other device, spring means associated with said fluid flow-controlling device and adapted to cause movement of said flow-controlling device in another direction, means responsive to the motion of said ram to a predetermined position for altering the energization of said solenoid so that movement of said flow-controlling device relatively to said regulating device occurs, and time delay means responsive to the expiration of a predetermined period of time after said alteration of the energization of said solenoid for restoring the original condition of energization to said solenoid.

6. In a hydraulic machine control circuit, a variable delivery pump having a delivery-varying device associated therewith for varying the delivery thereof, a hydraulic ram, means for causing said pump to move said ram, said means comprising a regulating device for shifting said delivery-varying device, an expansible and collapsible link interposed between said device, electric means operatively connected with said link and adapted when energized to effect collapse of said link for moving said delivery-varying device into one direction, spring means continuously urging said delivery-varying device into the opposite direction, and means responsive to a predetermined position of said ram for temporarily de-energizing said electric means to allow said spring means to effect movement of said delivery-varying device while the ram is continuing its movement in the same direction.

7. In a hydraulic machine control circuit, a variable delivery pump having a delivery-varying device associated therewith for varying the delivery thereof, a hydraulic ram, means for causing said pump to move said ram comprising a regulating device for shifting said delivery-varying device, an electrically actuated expansible and collapsible link interposed between said devices, electric means associated with said link and adapted when energized to effect collapse thereof, spring means adapted to bring about an expansion of said link when said electric means is de-energized, means responsive to the motion of said ram to a predetermined position for de-energizing said electric means, and time delay means responsive to the expiration of a predetermined period of time after said de-energization of said electric means for restoring the original condition of energization thereto.

8. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, said means comprising a flow-controlling member for controlling the fluid flow from said pump and a regulating device for regulating the setting of said flow controlling member, electric means, said electric means including two relatively movable parts, one connected to said flow-controlling member and the other connected to said regulating device, said electric means adapted when energized to cause movement of said flow-controlling member in one direction, biasing means responsive to the deenergization of said electric means to cause movement of said flow-controlling member in the opposite direction, and means responsive to the movement of said ram to a predetermined position on its working stroke to de-energize said electric means whereby the biasing means moves the flow control member to temporarily slow down the speed of travel of said ram beyond said predetermined travel without changing the direction of travel.

9. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, said means comprising a flow-controlling member for controlling the fluid flow from said pump and a regulating device for regulating the setting of said flow controlling member, electric means, said electric means including two relatively movable parts, one connected to said flow-controlling member and the other connected to said regulating device, said electric means adapted when energized to cause movement of said flow-controlling member in one direction, and biasing means responsive to the de-energization of said electric means to cause movement of said flow-controlling member in the opposite direction, and means responsive to the movement of said ram to a predetermined position on its working stroke to de-energize said electric means whereby the biasing means moves the flow control member to temporarily slow down the speed of travel of said ram beyond said predetermined travel without changing the direction of travel, and time delay means responsive to the expiration of a predetermined period of time after the operation of said biasing means, for restoring the original condition of energization of said electric means.

WALTER ERNST.