Dec. 23, 1941. W. ERNST 2,267,149

HYDRAULIC PRESS CONTROL SYSTEM

Filed March 3, 1937 2 Sheets-Sheet 1

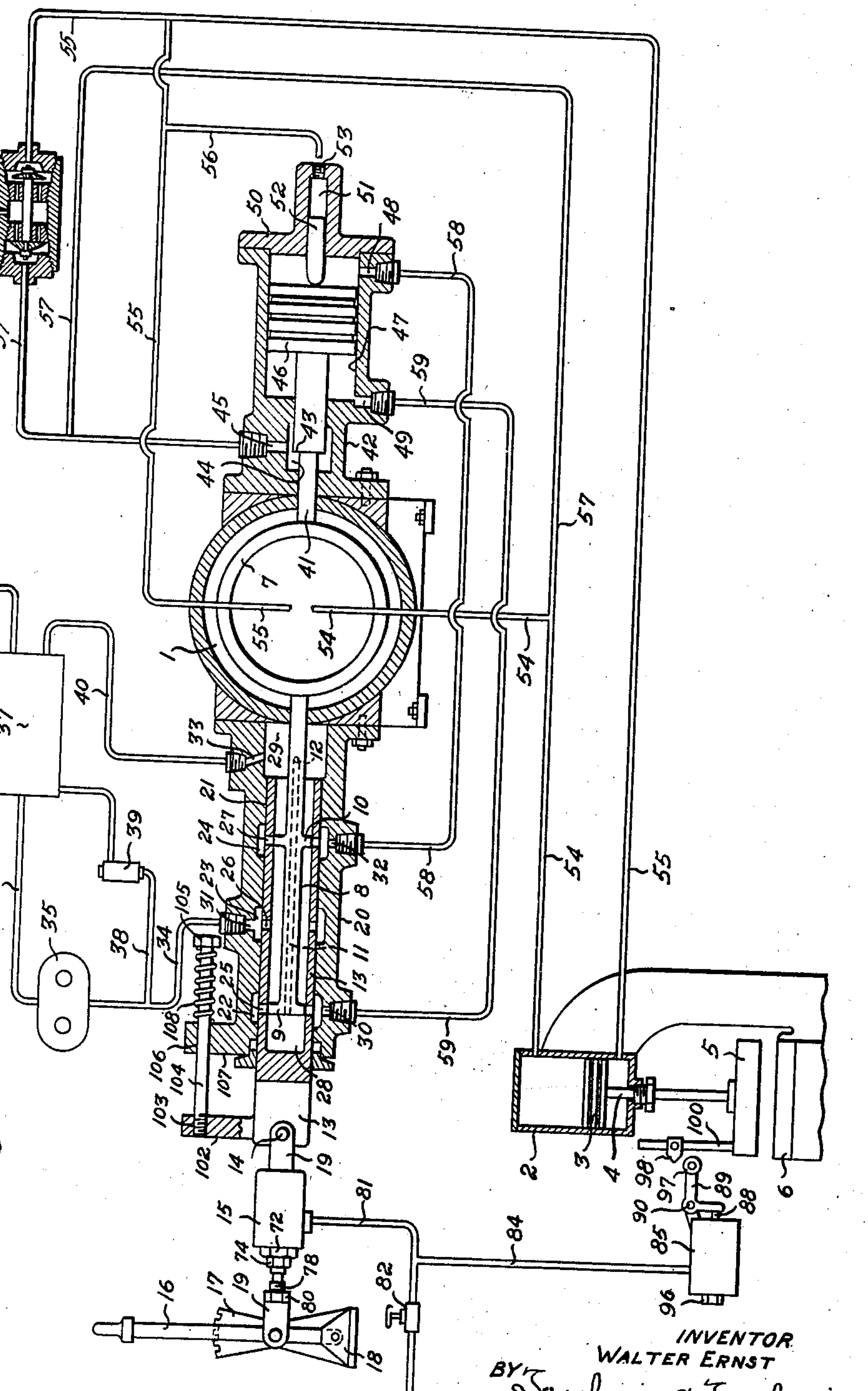

Fig. 1

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2 Sheets-Sheet 2

Fig. 2

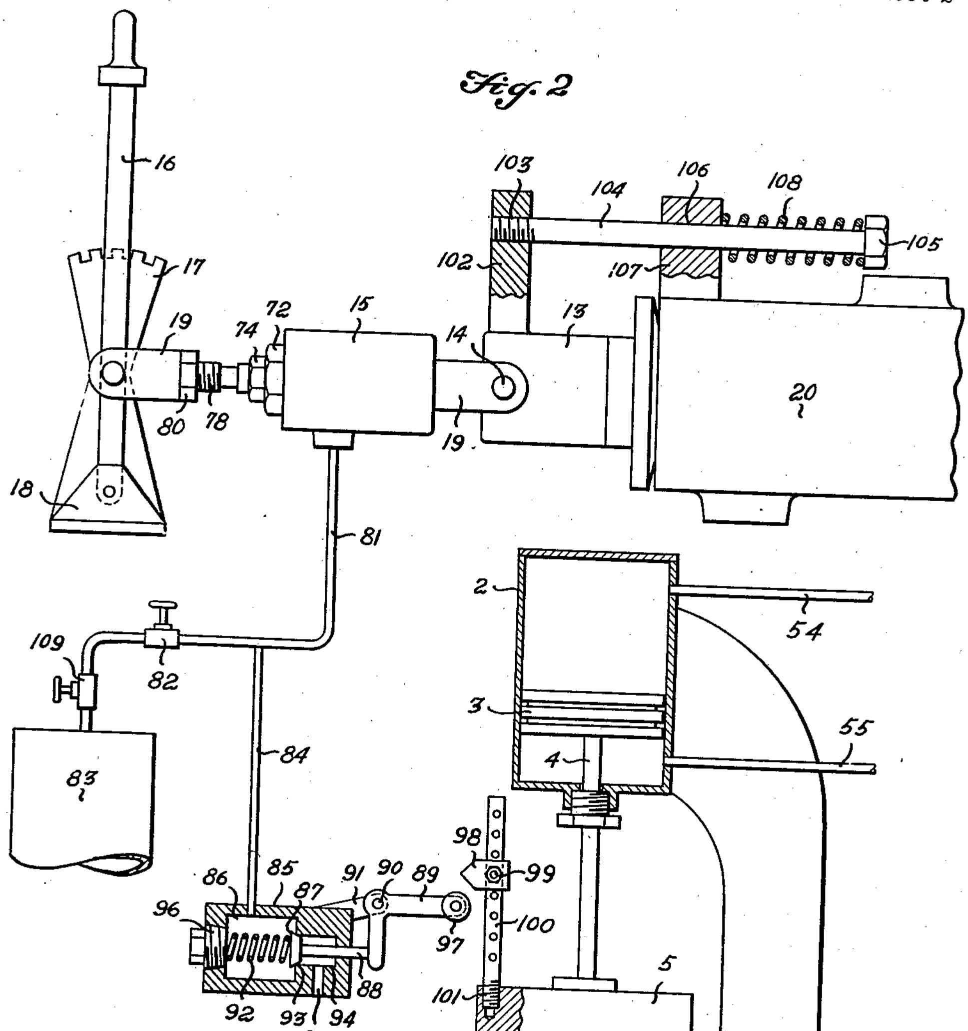
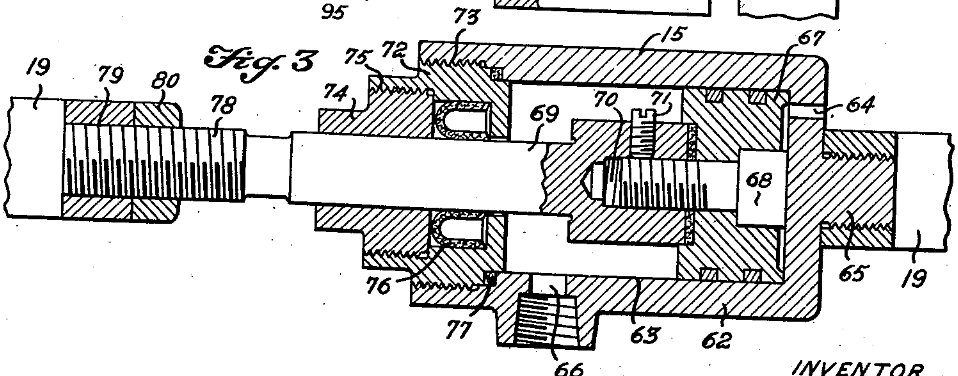


Fig. 3



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HYDRAULIC PRESS CONTROL SYSTEM

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9 Claims. (Cl. 60—52)

This invention relates to hydraulic press control systems, and in particular, to such systems for varying the speed of travel of the platen at different points in its stroke.

One object of this invention is to provide means responsive to the motion of the press platen on its working stroke to cause the platen to slow down immediately prior to its engaging the dies, and thereafter to gather speed again for the remainder of its stroke.

Another object is to provide a hydraulic press control system with a press supplied with pressure fluid regulated by a flow-control device, means being provided for altering the flow of fluid to the press in response to the arrival of the platen at a predetermined point in its stroke, and again to alter this flow at another predetermined point.

Another object is to provide a hydraulic press control system, as described immediately above, wherein the arrival of the platen at the predetermined point is caused to initiate the operation of the flow-control device in such a manner as to reduce the flow of fluid to the press, and hence, reduce the traveling speed of the platen so that it engages the dies with a reduced speed, means being provided to bring about an increase in the supply of fluid immediately thereafter.

Another object is to provide a hydraulic press control system for presses operated by pumps, wherein the flow-control member of the pump is provided with a shifting device which is made operative in response to the arrival of the platen at a predetermined point to shift the flow-control member into a reduced flow position so that the platen engages the dies at a reduced speed.

Another object is to provide a hydraulic press control system such as that described immediately above, wherein time delay means is associated with the system in such a manner as to cause an increase of flow of pressure fluid to the pump a predetermined time after the reduction of flow thereto.

Another object is to provide a hydraulic press control system, wherein a press is operated by a pump having a flow-control member with a manual regulating element therefor, and means arranged between the flow-control element and the manual regulating element to shift the flow-control element toward a reduced flow position when the platen arrives at a predetermined point in its stroke, such as immediately before engaging the dies. This shifting means may be pneumatic, hydraulic or electrical, as desired.

Another object is to provide a method of controlling hydraulic pressing systems, including moving the pressing device rapidly until it reaches a predetermined position, thereafter moving it slowly for a predetermined period, and thereafter moving it rapidly again until it reaches the end of its stroke.

In the drawings:

Figure 1 is a diagrammatic view, party in section, of a hydraulic press control circuit according to the present invention, with the control system arranged for pneumatic operation in connection with a reversible variable delivery pump.

Figure 2 is an enlarged view, partly in section, of the left-hand side of Figure 1.

Figure 3 is an enlarged longitudinal section through an expansible link mechanism employed in the circuits of Figures 1 and 2.

General arrangement

In general, the hydraulic press control system of this invention consists of a device for shifting the flow-control element toward a reduced flow position, together with means responsive to the arrival of the platen at a predetermined position for operating this shifting mechanism. Time delay means is optionally provided for delaying the time during which the reduced flow takes place so that the resumption of increased flow occurs at the end of the time interval after its commencement, such as for example, a time interval after the dies have engaged.

Hitherto, it has been found desirable to increase the operating speed of hydraulic presses in order to meet modern production requirements. In the high speed hydraulic presses of the past the traveling speed of the platen has increased to such an extent that a considerable shock is set up when the press platen engages the dies or the work. The purpose of the present invention is to enable a high speed hydraulic press to be employed, yet to provide control means of such a nature that the platen travels at a high speed until it comes within a short distance of the point where it engages the dies, whereupon it slows down so as to engage the dies smoothly and without serious shock, after which the platen again speeds up and finishes its pressing stroke at a relatively rapid speed.

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

Pump and press construction

Referring to the drawings in detail, Figure 1 shows a reversible variable delivery pump, generally designated 1, in circuit with a press having a cylinder 2 so as to supply fluid thereto. The press cylinder 2 is provided with a piston 3, reciprocable therein. Connected to the piston 3 is a piston rod 4, having at its opposite end a platen 5 cooperating with the press frame 6. The pump 1 is provided with a shifting ring or flow-control element 7, the shifting of which varies the amount and direction of the flow from the pump, according to its distance from its neutral position.

Connected to the shifting ring 7 is a valve member 8 having spaced heads 9 and 10 and a longitudinal bore 11 running from an open end beyond the head 9 to a port 12 beyond the ring head 10. Cooperating with the valve member 8 and its heads 9 and 10 is a reciprocable sleeve 13 pivotally connected, as at 14, to a collapsible link device, generally designated 15. The detail construction of this collapsible link device will be described subsequently. The collapsible link device 15 is connected to a hand lever 16, cooperating with a quadrant 17 and pivotally mounted upon a base 18, the clevises 19 being utilized to connect the collapsible link device 15 on its opposite sides to the reciprocable sleeve 13 and hand lever 16, respectively.

The sleeve 13 is mounted for reciprocation within the control valve casing 20. The latter is provided with a central bore 21 having three spaced annular chambers 22, 23 and 24. The sleeve 13 serves as a control valve member in cooperation with the valve member 8 having the heads 9 and 10. For this purpose the sleeve 13 is provided with ports 25, 26 and 27 adapted to register with the annular chambers 22, 23 and 24 in the control valve casing 20. The ports 25 and 27 are so spaced as to be registrable with and closed by the valve heads 9 and 10, respectively, on the valve member 8. At the extreme lefthand end of the interior of the sleeve 13 is a chamber 28, whereas at the extreme right-hand end of the bore 21 is a chamber 29. The bore 11 within the valve member 8 is of such length that its port 12 communicates at all times with the chamber 29, thereby establishing communication with the chamber 28. Communicating with the annular chambers 22, 23, and 24 are ports 30, 31 and 32. A similar port 33 communicates with the chamber 29.

It will subsequently be seen that the movement of the sleeve 13 by the hand lever 16 controls the supply of fluid to a servomotor which moves the shifting ring 7 of the pump 1. For this purpose the port 31 of the annular chamber 23 is connected by the line 34 to a servomotor pump 35. The latter may be a gear pump, and is connected by the line 36 to the fluid tank 37. A by-pass line 38, having a pressure relief valve 39 opening in the direction of the tank 37, provides for the by-passing of the discharge of the pump 35 when the line 34 is closed by the cooperation of the valve member 8 and the valve sleeve 13. Connected to the port 33 leading to the chamber 29 is an exhaust line 40, leading to the tank 37. The servomotor for moving the shifting ring 7 of the pump 1 is mounted on the opposite side of the pump from the control valve member 8.

The servomotor consists of a piston rod 41 connected to the shifting ring 7 and passing through a casing 42, wherein it contains an enlargement forming an annular shoulder 43. This annular shoulder 43 is located in a chamber 44 having an outlet port 45. Mounted on the end of the piston rod 41 is a piston head 46 reciprocable in a cylinder bore 47 within the casing 42. The cylinder 47 is provided with ports 48 and 49 for supplying and discharging pressure fluid. The cylinder head 50 is provided with a pilot cylinder bore 51 containing a pilot cylinder 52, and having a port 53 for supplying pressure fluid to the pilot piston 52.

The flow to and from the pump 1 is conveyed by the lines 54 and 55. In the forward stroke position of the press, the line 54 serves as the pressure line and the line 55 as the suction line. When the pump 1 is reversed, however, as in the return stroke of the press, the line 55 serves as a pressure line and the line 54 as a suction line. A branch line 56 runs from the line 55 to the port 53 leading to the pilot cylinder bore 51. A branch line 57 similarly leads from the line 54 to the port 45 opening into the chamber 44 surrounding the annular shoulder 43 on the servo-piston rod 41. The ports 32 and 30 in the control valve casing 20 are connected, respectively, to the ports 48 and 49 opening into the servomotor cylinder bore 47 by the lines 58 and 59. A different valve 60 interconnects the pump power lines 55 and 57 in order to supply any deficiency in fluid, and for this purpose the differential valve 60 is connected, by the line 61, to the fluid tank 37.

Collapsible link circuit

The collapsible link device 15 shown in Figures 1 and 2 consists of a casing 62 (Figure 3) having a cylinder bore 63 with a port 64 in the head thereof. The casing 62 is provided with a threaded projection 65, to which the right-hand clevis 19 is attached. Opening into the opposite end of the cylinder bore 63 is a port 66. Reciprocably mounted within the cylinder bore 63 is a piston head 67, secured as by the screw 68 to the piston rod 69, the screw 68 being threaded into the threaded socket 70 thereof and secured therein by the set screw 71. The piston rod 69 passes through a cylinder closure 72, threaded into the threaded aperture 73 and having a threaded plug 74 secured within a threaded bore 75. Beyond the threaded bore 75 is arranged an oil seal member 76, surrounding the piston rod 69 and preventing leakage therefrom. A gasket 77 similarly prevents leakage between the cylinder closure 72 and the casing 62 at the threaded aperture 73. At its extreme left-hand end the piston rod 69 is provided with a threaded portion 78, secured within the threaded bore 79 in the left-hand clevis 19 and held in position by the locknut 80.

Connected to the port 66 in the casing 62 is a line 81, leading, by way of a needle valve 82, to a compressed air source 83, indicated diagrammatically by a tank. The compressed air source 83, however, may consist of a tank or air compressor, or a combination of both. From the line 81 a branch pipe 84 leads to a tappet valve casing 85 having a chamber 86 in which is mounted on a valve head 87 on a valve rod 88 operated by the bellcrank 89, pivotally mounted, as at 90, to the arm 91 mounted on the tappet valve casing 85. A coil spring 92 urges the valve head 87 into a closed position with its seat 93, beyond which a chamber 94 is provided with a leakage port 95. A threaded plug 96 serves to support the end of the spring 92 and at the same time to provide access to the tappet valve chamber 86. The outer end of the bellcrank 89 is provided with a roller 97 arranged to be operated by a cam member 98, secured by the bolt 99 to the arm 100, mounted as at 101 upon the press platen 5.

In the pump shown in Figure 1, the shifting of the shifting ring 7 to the right places the pump in a position for delivering pressure fluid through the line 55 so as to cause the press to execute a return stroke. To execute a forward stroke the shifting ring 7 is moved to the left of the position shown in Figure 1. These movements may be brought about by corresponding movements of the control valve sleeve 13 as manually operated by the hand lever 16. Mounted upon the outer end of the control valve sleeve 13 is an upwardly projecting lug 102 having a threaded seat 103 for receiving the threaded end of a rod 104, in the form of an elongated cap screw and having a head 105 at the opposite end thereof. The rod 104 passes through a bore 106 in a lug 107 projecting upwardly from the control valve casing 20, and carries a compression spring 108 engaging the head 105 to force the rod 104 and the control valve sleeve 13 to the right. Normally, therefore, the control valve sleeve 13 is under the tension of the spring 108, urging it in the direction of reducing the flow of the pump 1 upon its forward stroke. This motion, however, is opposed by the force of compressed air within the bore 63 of the collapsible link device 15.

Operation

In Figure 1 the pump 1 is shown with its shifting ring 7 in its neutral position. In this neutral position the pump delivers no discharge of fluid either from its line 54 or from its line 55. Under these circumstances, therefore, the piston head 3 and platen 5 remain substantially motionless.

To perform a pressing stroke of the press the operator now shifts the hand lever 16 and consequently the control valve sleeve 13 to the left of the position shown in Figure 1. With compressed air in the bore 63 of the collapsible link device 15, the device 15 acts as a rigid link and moves the control valve sleeve 13 to the left in response to the motion of the hand lever 16, thereby compressing the spring 108. The motion of the control valve sleeve 13 uncovers the ports 27 and 25 from being blocked by the piston heads 10 and 9. The servomotor pressure fluid then passes from the servomotor pump 35, through the line 34 and annular chamber 23, through the sleeve port 26, along the interior thereof, and out the sleeve port 27 into the annular chamber 24, whence it passes into the servomotor line 58. Entering the servomotor cylinder bore 47 to the right of the servomotor piston head 46 through port 48, this fluid operates the latter and forces it to the left.

The fluid displaced from the opposite side of the piston head 46 is discharged through the port 49; line 59, port 30, annular chamber 22, sleeve ports 25, sleeve chamber 28, valve member bore 11, port 12, chamber 29, port 33 and line 40 to the tank 37. The corresponding movement of the piston rod 41 moves the pump shifting ring 7 from its neutral position (Figure 1) to the left into a forward discharge position so that the pump 1 will force pressure fluid through the line 54 to the press cylinder 2. Under the influence of this pressure fluid the press piston head 3 and piston rod 4 are moved downward, causing the platen 5 to descend. The fluid displaced from beneath the piston head 3 returns to the pump 1 by way of the line 55, which is now the suction line.

Meanwhile, the travel of the pump shifting ring 7 to the left, under the influence of the motion of the servomotor piston 46, causes the shifting of the valve member 8 to the left, together with its valve heads 9 and 10. These will then move into position, again shutting off the sleeve ports 25 and 27 from communication with the annular chambers 22 and 24, thereby shutting off the circulation of fluid through the servomotor lines 58 and 59. The servomotor pump 35 will then discharge its output through the by-pass line 38 and pressure relief valve 39, into the tank 37. In this manner the extent of movement of the control valve sleeve 13 regulates the extent to which the servomotor piston 46 will shift the pump shifting ring 7.

If, during the pressing stroke, an excessive pressure develops in the pressing or working line 54, this pressure will be transmitted through the branch line 57 to the chamber 44, where it acts against the annular shoulder 43 on the piston rod 41 to move the latter to the right. This action moves the pump shifting ring 7 to the right toward its neutral position, thereby reducing the discharge of the pump and lowering the pressure in the pressing line 54.

As the press platen 5 moves downward on its forward stroke, the cam member 98 engages the roller 97 on the bellcrank 89 just before the platen 5 engages the dies. The bellcrank 89 shifts the tappet valve rod 88 to the left, thereby moving the valve head 87 from its seat 93 and allowing the compressed air to leak through the port 95 into the open air. As the compressed air passing through the needle valve 82 is insufficient to maintain a sufficient pressure in the line 81 while this leakage is taking place, the air is released at a much more rapid rate than it is supplied to the casing 62 of the collapsible link device 15. Accordingly, the casing 62 is moved to the right, under the influence of the coil spring 108 because insufficient pressure is exerted by the air in the bore 63 to maintain the casing 62 in contact with the end of the piston head 67 (Figure 3).

The consequent collapse of the link device 15 permits the coil spring 108 to shift the control valve sleeve 13 to the right, thereby causing the servomotor piston 46 to shift the shifting ring 7 of the pump 1 to the right, and reduce the flow of the pump. The press platen 5, therefore, slows down by an amount predetermined by the stroke within the bore 63 of the collapsible link device 15 as it affects the action of the control valve sleeve 13 when shifted through the same distance. The platen 5 continues to move downward at this reduced speed until the cam member 98, upon its arm 100, releases the roller 97 and the bellcrank 89. The tappet valve 85 then closes, permitting compressed air to accumulate within the lines 84 and 81 and within the bore 63 of the collapsible link device 15.

As soon as the pressure within the bore 63 of the link device 15 becomes sufficient to overcome the thrust of the coil spring 108, the cylinder casing 62 moves to the left, similarly shifting the control valve sleeve 13 and thereby increasing the flow from the pump 1 by causing the shifting ring 7 to be shifted to the left into the position which it occupied as originally set by the hand lever 16. The platen 5 then continues on its downward stroke at its original high speed, after it has gathered speed as a result of the increased pressure.

By adjusting the needle valve 82 it is possible to introduce a time lag or delay of any desired length between the time that the platen 5 slows down to engage the dies and the time that it picks up speed and resumes its original high speed. The greater the choking effect of the needle valve 82 the longer is the time delay period.

It will be obvious that while a pneumatic circuit is shown in Figure 2 for operating the collapsible link device 15, hydraulic pressure could similarly be used and is understood to be included within the scope of the invention.

To perform a return stroke of the press, the operator shifts the hand lever 16 and valve sleeve 13 to the right of the position shown in Figure 1, whereupon the flow through the servomotor lines 58 and 59 is reversed and the servomotor piston 46 moves the pump shifting ring to the right, past its neutral position. The pipe 55 now becomes the pressure line and the pipe 54 the suction line, causing the press plunger 3 and platen 5 to rise and execute a return stroke.

If an excessive pressure develops in the pullback or return line 55 of the press, it will back up in the branch line 56 and will enter the pilot cylinder bore 51. There it acts against the pilot piston 52, forcing the latter and the servomotor piston 46 to the left, thereby moving the shifting ring of the pump to the left, toward its neutral position.

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 adapted to be operated by fluid from said pump, a fluid flow-controlling member for controlling the fluid from said pump, a manual regulating device for regulating the setting of said flow-controlling member, expanding and collapsing link means interposed between said controlling member and said regulating device for moving said flow-controlling member independently of the setting of said manual regulating device, means responsive to a predetermined travel of said ram for operating said interposed link means to decrease the speed of said ram beyond said predetermined travel, and responsive to a further predetermined travel of said ram for increasing the speed thereof.

2. In a hydraulic machine control circuit, a pump, a hydraulic ram adapted to be operated by fluid from said pump, a fluid flow-controlling member for controlling the fluid from said pump, a manual regulating device for regulating the setting of said flow-controlling member, expanding and collapsing link means interposed between said controlling member and said regulating device for moving said flow-controlling member independently of the setting of said manual regulating device, means responsive to a predetermined travel of said ram for operating said interposed link means to decrease the speed of said ram beyond said predetermined travel, and responsive to the expiration of a predetermined period of time beyond the point of decreasing said ram speed for increasing said ram speed.

3. In a hydraulic machine control circuit, a hydraulic ram, a pump adapted to feed said ram, a fluid flow-controlling member for controlling the fluid flow from said pump, a manual regulating device for regulating the setting of said flow-controlling member, independent operating means having expanding and collapsing link mechanism including relatively movable elements operatively interconnecting said flow-controlling member and said regulating device, means responsive to a predetermined travel of said ram for actuating said independent operating means to move the elements of said expanding and collapsing link mechanism relatively to each other and shift said flow-controlling member in a direction adapted to decrease the fluid flow from said pump to said ram whereby to decrease the speed of travel of said ram, and responsive to a further predetermined travel of said ram for actuating said independent operating means to move the elements thereof to shift said flow-controlling member in a direction adapted to increase the fluid flow from said pump whereby to increase the speed of travel of said ram.

4. In a hydraulic machine control circuit, a hydraulic ram, a pump adapted to feed said ram, a fluid flow-controlling member for controlling the fluid flow from said pump, a manual regulating device for regulating the setting of said flow-controlling member, a fluid pressure motor having a cylinder element and a piston element with one element connected to said manual regulating device and the other element connected to said flow-controlling member, means for supplying fluid to said motor, yielding means for urging the elements of said motor in a direction opposite to the motion produced by the fluid and stressed to move said flow-controlling member in response to the release of fluid from said motor, valve means for releasing fluid from said motor, means responsive to a predetermined travel of said ram for shifting said valve means into its fluid-releasing position to cause said yielding means to shift said motor elements and move said flow-controlling member to reduce the flow of said pump whereby to reduce the speed of travel of said ram, and means responsive to a further predetermined travel of said ram for shifting said valve means into its fluid-retaining position to cause said fluid to operate said motor to restore the original setting of said fluid flow-controlling member.

5. In a hydraulic machine controlled circuit, a hydraulic ram, a pump connected to feed said ram, a fluid controlling member for controlling the fluid flow from said pump, a regulating device for regulating the setting of said flow controlling member, expanding and collapsing link means interconnecting said regulating device and said flow controlling member, means responsive to a predetermined travel of said ram to effect the operation of said expanding and collapsible link means for shifting said flow controlling member to decrease the speed of travel of said ram beyond said predetermined travel, and responsive to a further predetermined travel of said ram to effect the operation of said expanding and collapsing link means for further shifting said flow controlling member to increase the speed of said ram.

6. In a hydraulic machine control circuit, a

pump, a hydraulic ram, means for causing said pump to drive said ram, a fluid flow-controlling device for controlling the fluid flow from said pump, means for operating said fluid flow-controlling device, a fluid pressure motor having its piston and cylinder interposed between and connected respectively to said last mentioned means and said flow-controlling device, means for supplying fluid to said motor, yielding means for urging the elements of said motor in an opposite direction to the motion thereof by said fluid and stressed to move said flow-controlling device in response to the release of fluid from said motor, valve means for releasing fluid from said motor, means responsive to a predetermined travel of said ram for actuating said valve means whereby to cause said yielding means to shift said motor elements so as to move said flow-controlling device to reduce the flow of said pump and reduce the speed of travel of said ram, and means responsive to a further predetermined travel of said ram for shifting said valve means into its fluid-retaining position to cause said fluid to operate as a motor to restore the original setting of said fluid flow-controlling device.

7. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, including a fluid flow-controlling device for controlling the fluid flow from said pump, means for operating said fluid flow-controlling device, a fluid pressure motor including two relatively movable members interposed between and connected respectively to said flow-controlling device and said operating means, means for supplying fluid to said motor at a restricted rate, a ram actuated valve for exhausting fluid from said motor when actuated by said ram, and biasing means, said biasing means being operative to actuate said fluid flow-controlling device upon the exhaustion of fluid in said motor by the operation of said ram actuated valve.

8. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, including a fluid flow-controlling device for controlling the fluid flow from said pump, means for operating said fluid flow-controlling device, a fluid pressure motor including two relatively movable members interposed between and connected respectively to said flow-controlling device and said operating means, means for supplying fluid to said motor, a ram actuated valve for exhausting fluid from said motor when actuated by said ram, and biasing means, said biasing means being operative to actuate said fluid flow-controlling device upon the exhaustion of fluid in said motor by the operation of said ram actuated valve, said ram and said ram-actuated valve having cooperating means for releasing said valve upon the further movement of said ram, whereby to permit said motor-supplying means to resume the supplying of fluid to said motor to restore the original setting of said fluid-flow-controlling device.

9. In a hydraulic machine control circuit, a pump, a hydraulic ram, means for causing said pump to move said ram, including a fluid flow-controlling device for, controlling the fluid flow from said pump, means for operating said fluid flow-controlling device, a fluid pressure motor including two relatively movable members interposed between and connected respectively to said flow-controlling device and said operating means, means for supplying fluid to said motor, a ram-actuated valve for exhausting fluid from said motor when actuated by said ram, and biasing means, said biasing means being operative to actuate said fluid flow-controlling device upon the exhaustion of fluid in said motor by the operation of said ram-actuated valve, said ram and said ram-actuated valve having cooperating means for releasing said valve upon the further movement of said ram whereby to permit said motor supplying means to resume the supplying of fluid to said motor to restore the original setting of said fluid flow-controlling device, and time delay means for preventing the return of said flow-controlling device to its setting until the elapse of a predetermined interval.

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