May 6, 1941. E. WIEDMANN 2,240,898

PUMP CONTROL

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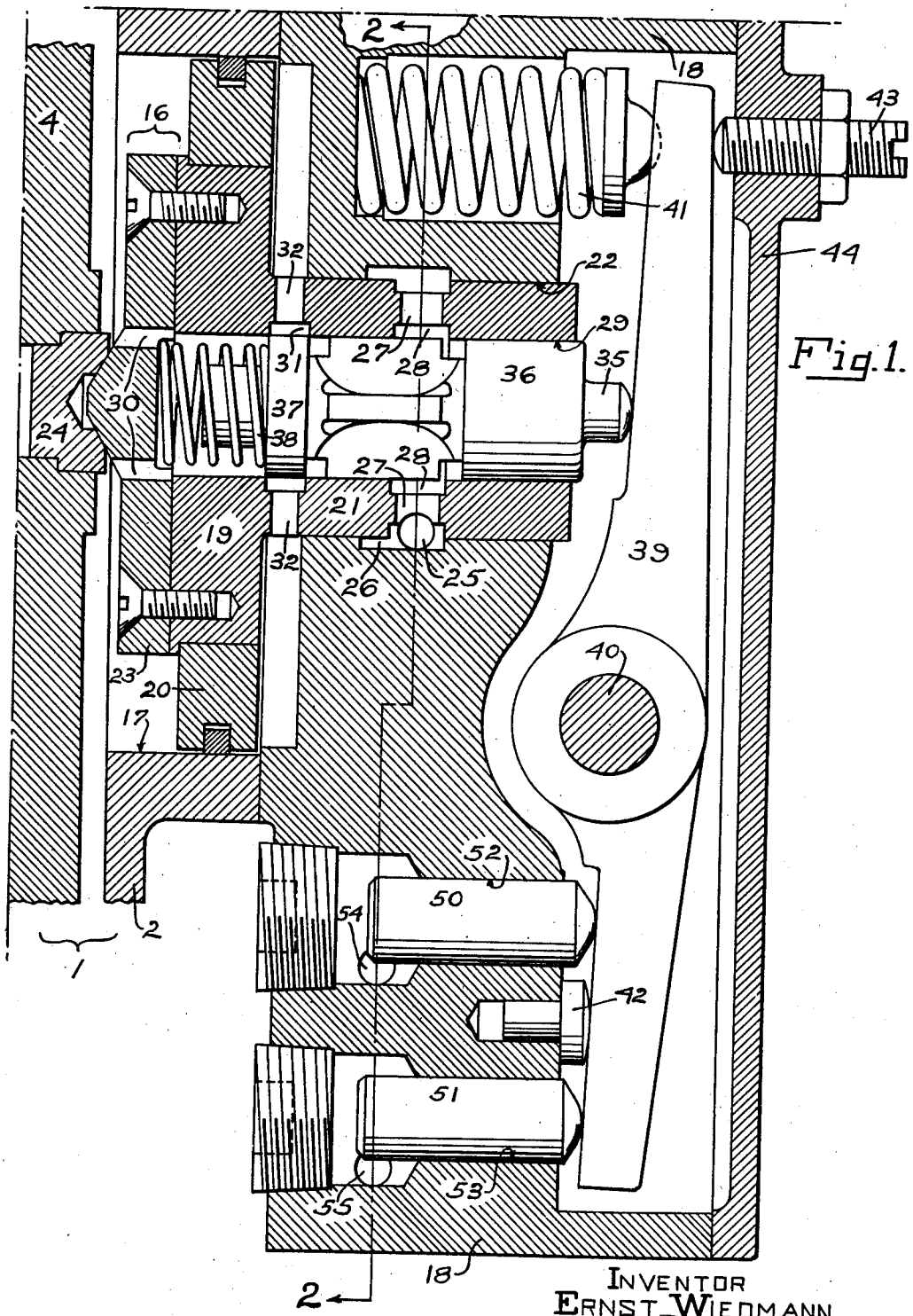


Fig. 1.

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Fig. 2.

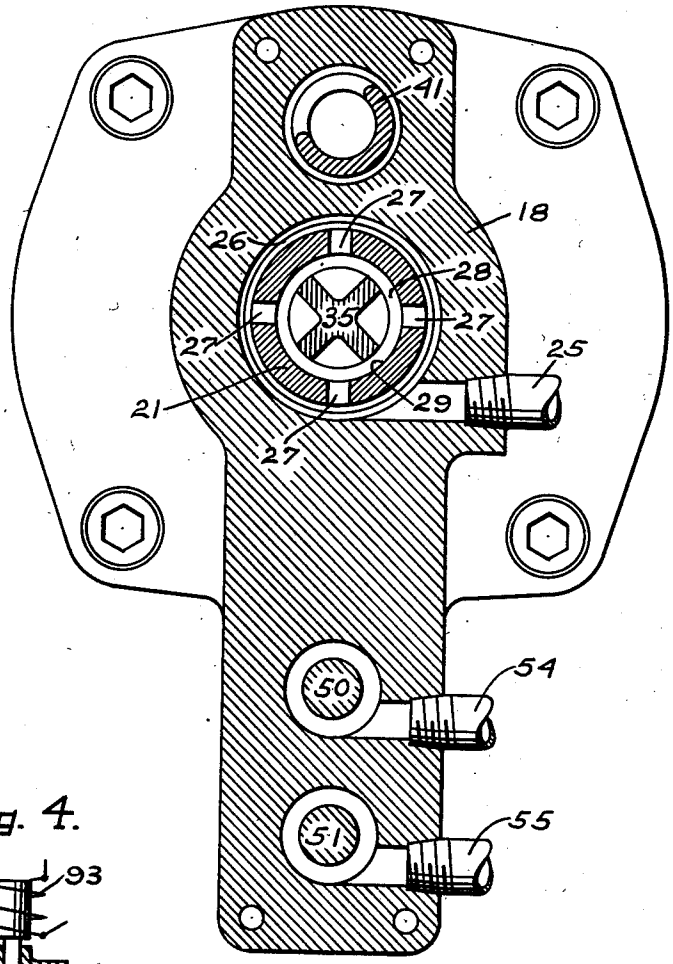


Fig. 4.

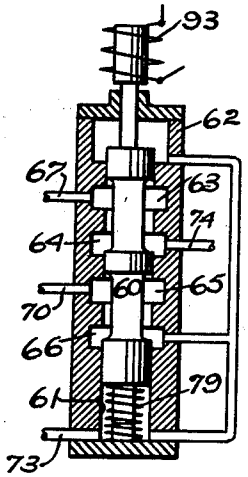
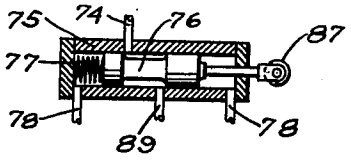


Fig. 5.



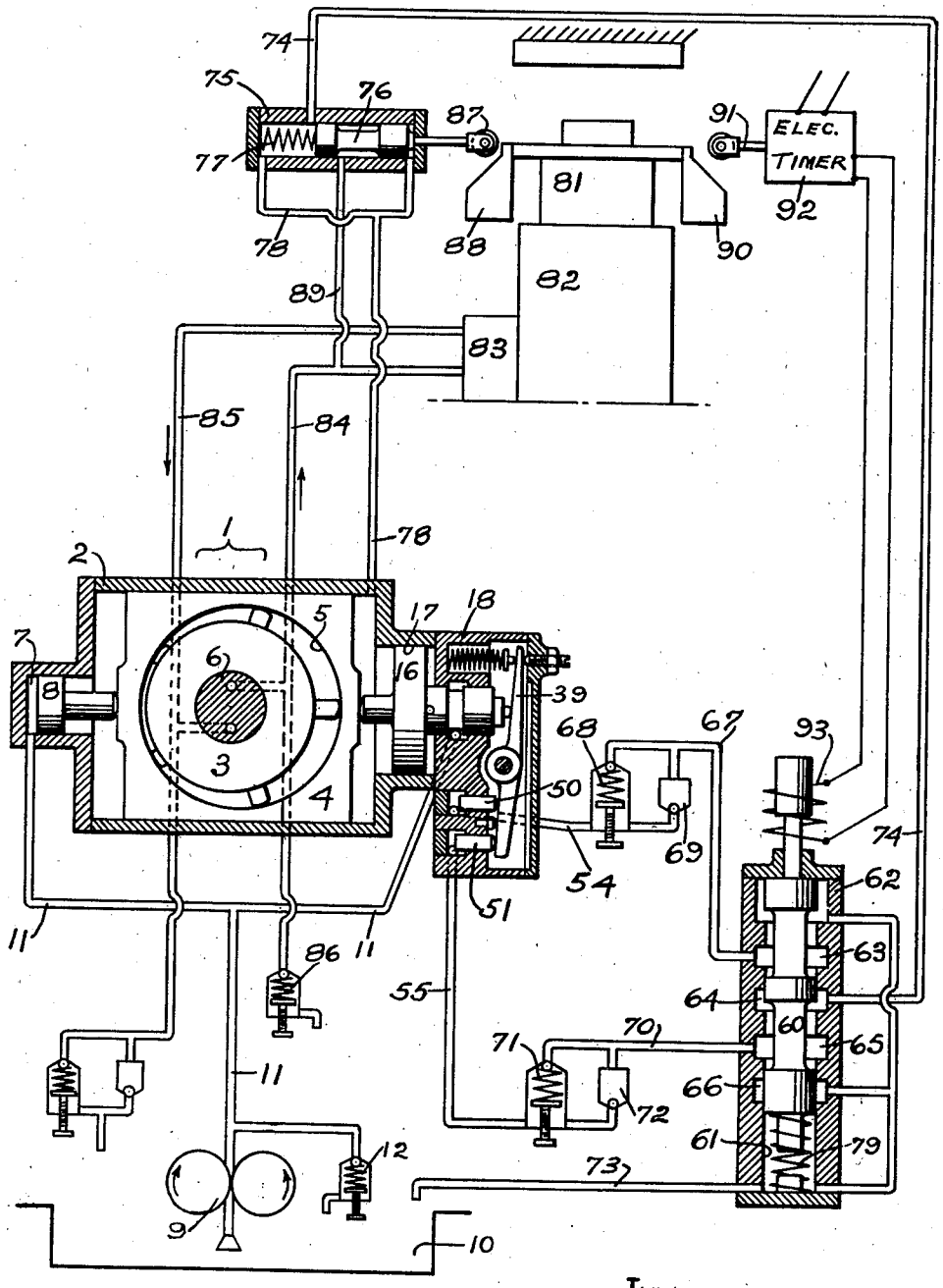
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Fig. 3.



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2,240,898

PUMP CONTROL

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Application November 6, 1937, Serial No. 173,075

18 Claims. (Cl. 103—38)

This invention relates to pump controls of the type which, in response to pump pressure reaching a predetermined value, will reduce the displacement of a pump until the pump is delivering just sufficient liquid to maintain pump pressure at that value.

An object of the invention is to provide a pump control which will automatically limit the pressure created by a pump to any one of a plurality of predetermined values.

Another object is to provide a control which will cause a pump to successively maintain a plurality of predetermined pressures substantially constant.

Another object is to provide a control of this character with means for rendering the control unresponsive to variations in pump pressure.

Other objects and advantages will appear from the description hereinafter given of a pump control in which the invention is embodied.

According to the invention in its general aspect and as ordinarily embodied in practice, the control is provided with a mechanism for varying pump displacement, a plurality of actuators each responsive to a different pump pressure for operating the displacement varying mechanism, and means for selecting any one of the actuators to operate the mechanism.

The invention is exemplified by the controller illustrated in the accompanying drawings in which the views are as follows:

Fig. 1 is a central section through a mechanism for shifting the stroke adjusting member of a pump.

Fig. 2 is a section on the irregular line 2—2 of Fig. 1.

Fig. 3 is a schematic drawing illustrating the operation of the control.

Fig. 4 is a view showing a selector valve in a different position from that shown in Fig. 3.

Fig. 5 is a view showing a cut-out valve in a different position from that shown in Fig. 3.

The controller has been shown in Fig. 3 as applied to a pump 1 of the rolling piston type. Since this type of pump is fully illustrated and described in Patent No. 2,074,068, it is deemed sufficient to state herein that the pump has its mechanism arranged within a casing 2, that its pistons and cylinders are arranged radially in a rotatable cylinder barrel 3 which is arranged within a thrust member or slide block 4, that the pistons react against an annular reaction surface 5 which in practice is formed in a rotatable thrust member carried by slide block 4 but which has been shown as being formed in slide block 4, that cylinder barrel 3 rotates upon a stationary valve shaft 6 through which liquid flows to and from the cylinders, that reaction surface 5 is eccentric to cylinder barrel 3 when the pump is delivering liquid, and that the displacement of the pump is varied by shifting slide block 4 relative to cylinder barrel 3.

As shown, slide block 4 is urged toward the right to increase pump displacement by a substantially constant force which may be provided, for example, by a spring or, as shown, by liquid supplied at a substantially constant pressure to a cylinder 7 having fitted therein a piston 8 which is provided with a stem to engage slide block 4.

Liquid for operating servo-motor 7—8 may be supplied by a gear pump 9 which may be arranged within casing 2 and driven in unison with pump 1 according to the usual practice. Gear pump 9 draws liquid from a reservoir 10 and delivers it into a channel 11 one branch of which is connected to cylinder 7. Gear pump 9 discharges liquid at a rate in excess of requirements and the excess liquid is discharged through a relief valve 12, thereby enabling gear pump 9 to maintain a constant pressure in channel 11 and in cylinder 7.

Slide block 4 is adapted to be moved toward the left to decrease pump displacement by a piston 16 fitted in a cylinder 17 which is ordinarily formed integral with pump casing 2 and closed at its outer end by a block 18 which is secured to casing 2.

As best shown in Fig. 1, piston 16 consists primarily of a head 19 which is arranged in cylinder 17, a piston ring 20 which is fixed upon head 19 and closely fitted in cylinder 17, a sleeve 21 which is formed integral with head 19 and closely fitted for reciprocation within a bore 22 formed in block 18, and a disk 23 which is attached to the left end of head 19 and is provided with a conical projection to engage a complementary surface formed upon an insert 24 fixed in slide block 4.

Liquid for operating servo-motor 16—17 is supplied by gear pump 9 through channel 11 which has one branch thereof connected to block 18 in communication with a channel 25 leading to an annular port 26 formed in the wall of bore 22 and in the peripheral surface of sleeve 21.

Port 26 communicates, through a plurality of openings 27 formed in the wall of sleeve 21, with an annular port 28 formed in the wall of a cylindrical bore 29 which extends through sleeve 21 and head 19. Bore 29 is partly closed at its inner end by disk 23 which has a plurality of openings

30 formed therein to permit liquid to escape from the closed end of cylinder 17 into the interior of pump casing 2 as will be presently explained. Bore 29 has a second annular port 31 formed in the wall thereof and communicating with the closed end of cylinder 17 through a plurality of openings 32 formed in the wall of sleeve 21.

The flow of liquid to and from cylinder 17 is controlled by a follow-up valve 35 which has two pistons 36 and 37 formed thereon and closely fitted in bore 29 upon opposite sides of port 28.

Piston 36 closes the outer end of bore 29 and prevents leakage of liquid therefrom. Piston 37 is exactly the same width as port 31 and is normally in alinement therewith. The arrangement is such that gear pump 9 is enabled to maintain a constant supply of liquid at a constant pressure in bore 29 between pistons 36 and 37.

When valve 35 is moved toward the left, liquid may flow from bore 29 through port 31 and openings 32 into cylinder 17 and move piston 16 and slide block 4 toward the left to reduce the displacement of pump 1. When valve 35 is moved toward the right, liquid may escape from cylinder 17 through openings 32, port 31, the left end of bore 29 and openings 30 into the pump casing and permit servomotor 7—8 to move piston 16 and slide block 4 toward the right to increase the displacement of pump 1. Since sleeve 21 is a part of piston 16, it will move with it and move port 31 into registry with piston 37 as soon as valve 35 ceases to move, thereby preventing further movement of piston 16 and slide block 4.

Valve 35 is urged toward the right by a spring 38 arranged in bore 29 between piston 37 and disk 23. Movement of valve 35 toward the right is limited by a lever 39 which is arranged in block 18 and pivoted intermediate its ends upon a shaft 40.

Valve 35 engages the upper arm of lever 39 between shaft 40 and a spring 41 which is arranged in block 18 and urges the upper end of lever 39 toward the right. Spring 41 tends to move the lower end of lever 39 against a stop 42 which is fixed in block 18 and is ordinarily so adjusted at the factory that, when lever 39 is in contact therewith, valve 35 will be in the correct position to cause the displacement of the pump to be maximum.

It is sometimes desirable to limit the volumetric delivery of a pump to a rate somewhat lower than the maximum rate of delivery. In order to obtain this result without altering the adjustment of stop 42, a stop bolt 43 is threaded through the upper part of a cover plate 44 which is attached to the right face of block 18. By turning bolt 43 inward, movement of the upper arm of lever 39 may be limited with a resultant limitation of the movement of slide block 4 toward its maximum displacement position.

Valve 35 is adapted to be moved toward the left to cause a reduction in pump displacement by a plurality of hydraulic actuators each of which is responsive to a different pump pressure to effect operation of valve 35. Any number of actuators may be employed. As shown, the lower arm of lever 39 is engaged by two plungers 50 and 51 which are fitted, respectively, in cylinders 52 and 53 formed in block 18.

Liquid for operating plungers 50 and 51 is supplied to cylinders 52 and 53, respectively, through two channels 54 and 55. If the actuators are arranged different distances from shaft 40, one actuator will require a higher pressure than another actuator to overcome the resistances of springs 38 and 41 due to the mechanical advantage of one actuator over another actuator. For example, if one actuator is arranged midway between the other actuator and shaft 40 as shown, the pressure required to operate it will be twice as great as the pressure required to operate the other actuator.

Referring now to Fig. 3, delivery of liquid to cylinders 52 and 53 is controlled by a selector valve 60 which is fitted in the bore 61 of a valve casing 62. Bore 61 has four annular ports 63, 64, 65 and 66 formed in the wall thereof. Port 63 is connected to channel 54 through a channel 67 and a resistance valve 68 having a check valve 69 connected in parallel therewith. Port 65 is connected to channel 55 through a channel 70 and a resistance valve 71 having a check valve 72 connected in parallel therewith. Port 66 and both ends of bore 61 are connected to a drain channel 73 which discharges into reservoir 10. Port 64 is connected by a channel 74 to a valve casing 75 in which a cut-off valve 76 is fitted.

Valve 76 is urged toward the right by a spring 77 so that channel 74 is normally open to a drain channel 78 which is connected to both ends of valve casing 75. Valve 60 is urged to its uppermost position by a spring 79 in which position ports 64 and 65 are in communication with each other and port 63 is open to drain channel 73. With valves 60 and 76 in the positions shown, liquid may escape freely from cylinders 52 and 53.

For the purpose of illustration, pump 1 has been shown as being employed to supply liquid to a press to effect operation thereof. Since the press forms no part of the present invention, it has been represented diagrammatically by a fragment of a ram 81, a ram cylinder 82 and a valve block 83 which controls operation of the press.

As shown, pump 1 delivers liquid to valve block 83 through a channel 84 and has liquid returned to it therefrom through a channel 85. A high pressure relief valve 86 is connected to channel 84 to limit the pressure which can be created by pump 1.

Valve 76 has a roller 87 arranged upon the end of its stem and in the path of a cam 88 carried by ram 81 so that, when ram 81 is advanced a predetermined distance, cam 88 will engage roller 87 and move valve 76 toward the left to the position shown in Fig. 5 in which position of valve 76 channel 74 communicates with a channel 89 which connects pressure channel 84 to valve casing 75 intermediate the ends thereof.

Ram 81 also carries a cam 90 to engage the operating rod 91 of an electric timer 92 which controls the energization of a solenoid 93 the core of which is connected to valve 60 to operate it. Timer 92 has not been illustrated in detail as it is a standard commercial article. It is deemed sufficient to state herein that timer 92 will connect solenoid 93 into an electric circuit at the expiration of a predetermined period of time after operating rod 91 has been actuated.

In order that pump 1 may deliver liquid at its maximum rate to move ram 1 at a rapid traverse speed until it approximately meets the work, and in order that pump 1 may be capable of developing its maximum pressure to accelerate the ram when the press is of the upward pressure type, cams 88 and 90 are ordinarily so positioned relative to valve 76 and timer 92 that cam 88 will engage roller 87 and cam 90 will actuate operating rod 91 just as or just before ram 81 meets the work.

Assuming that pumps 1 and 9 are running, that the parts are in the positions shown in Fig. 3, and that a valve in valve block 83 has been operated to cause ram 81 to advance, the apparatus will function as follows:

Pump 1 will deliver liquid at its maximum rate to cylinder 82 to advance ram 81 at high speed. The pressure created by pump 1 will not cause a reduction in pump displacement at this time due to the fact that valve 76 blocks communication between channels 89 and 74.

As ram 81 approaches the work, cam 88 will engage roller 87 and cam 90 will engage rod 91 so that, just as or just before ram 81 meets the work, valve 76 will be shifted to the position shown in Fig. 5 and timer 92 will be started in operation.

Shifting valve 76 to the position shown in Fig. 5 permits pump pressure to extend from channel 84 through channel 89, valve casing 75, channel 74, valve casing 62, channel 70, resistance valve 71 and channel 55 to cylinder 53. If the pump pressure required to rapid traverse the ram is greater than the desired holding pressure, the liquid delivered to cylinder 53 will immediately advance plunger 51. If the pump pressure required to rapid traverse the ram is less than the desired holding pressure, pump pressure will rise as soon as the ram meets the work and the liquid delivered to cylinder 53 will advance plunger 51.

In either case, plunger 51 will swing lever 39 upon shaft 40 and cause the upper arm thereof to move valve 35 toward the left to effect a reduction in the displacement of pump 1 as previously explained. Plunger 51 will continue to move outward and thereby continue to effect a reduction in the pump displacement until pump 1 is delivering just sufficient liquid to maintain in cylinder 82 the pressure determined by the pressure required to open resistance valve 71 and the pressure required to advance plunger 51.

At the expiration of a predetermined interval of time after the ram meets the work, timer 92 will effect energization of solenoid 93 which will then shift selector valve 60 to the position shown in Fig. 4, thereby disconnecting channel 70 from channel 74 and connecting it to drain channel 73 and simultaneously disconnecting channel 67 from drain channel 73 and connecting it to channel 74.

Connecting channel 70 to drain channel 73 permits pump displacement to increase until the pump develops the pressure required to open resistance valve 68 and operate plunger 50. Then plunger 50 will move outward and effect a reduction in pump displacement until the pump is delivering just sufficient liquid to maintain that pressure constant.

After the second holding pressure has been maintained for the desired length of time, ram 81 may be retracted by either automatic or manual operation of a valve in valve block 83. Shortly after ram 81 disengages the work, cams 88 and 90 will disengage roller 87 and rod 91, thereby permitting spring 77 to shift valve 76 to the position shown in Fig. 3 and stopping operation of timer 92 so that solenoid 93 is deenergized and spring 79 permitted to shift valve 60 to the position shown in Fig. 3.

With the valves 60 and 76 in the positions shown in Fig. 3, cylinders 52 and 53 are open to drain so that spring 41 can swing lever 39 against stop 42 or stop 43, thereby permitting spring 38 to move valve 35 toward the right so that liquid can escape from cylinder 17 and servo-motor 7—8 can move slide block 4 toward the right to increase pump displacement to maximum. Pump 1 will then deliver liquid at its full volumetric rate to cause ram 81 to be retracted at high speed, but the pressure developed by the pump cannot cause operation of plunger 51 due to valve 76 blocking communication between channels 74 and 89.

In the foregoing example, the pump first maintains a lower holding pressure and then a higher holding pressure but it is obvious that the order in which the pressures are maintained can be reversed by simply reversing the connections of channels 67 and 70 to selector valve case 62. It is also obvious that each of the holding pressures may be varied through a wide range by simply varying the adjustment of the resistance valve.

When a pump was provided with one of the prior controls which enabled it to maintain a predetermined maximum pressure substantially constant, considerable difficulty was encountered in preventing the displacement varying mechanism of the pump from hunting.

This difficulty is avoided in the present invention for the reason that, since the resistance of a compression spring increases as the spring is compressed, spring 41 permits plunger 50 or 51 to start to swing lever 39 and thereby effect a reduction in pump displacement before pump pressure reaches the predetermined maximum. As the pump pressure continues to rise, spring 41 will continue to yield and permit pump displacement to be gradually reduced until pump pressure reaches the predetermined maximum at which time the pump is delivering just sufficient liquid to make up for leakage losses and thereby maintain the predetermined maximum pressure constant. Consequently, there is no tendency for plunger 50 or 51 to swing lever 39 so far that pump displacement is reduced too much.

Also, if spring 41 is quite stiff so that reduction in pump displacement begins at a pressure considerably lower than maximum, the pump is at short stroke when pump pressure approaches maximum, thereby permitting the pump to be driven by a smaller electric motor than would otherwise be required.

The controller described herein is susceptible of various modifications and adaptations without departing from the scope of the invention as hereafter claimed.

The invention is hereby claimed as follows:

1. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of means for moving said member in the opposite direction, a plurality of means each responsive to a different fluid pressure for effecting operation of the aforesaid means, and means for selectively connecting said plurality of means to the outlet of said pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement.

2. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of a motor for moving said member in the opposite direction, means for supplying energy to said motor, a controller for controlling the operation of said motor, a plurality of means each responsive to a different fluid pressure for effecting operation of said controller, and means for selectively connecting said plurality of means to the outlet of said

pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement.

3. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of means for moving said member in the opposite direction, a plurality of means each responsive to a different fluid pressure for effecting operation of the aforesaid means, means for selectively connecting said plurality of means to the outlet of said pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement, and means for rendering said plurality of means effective or ineffective.

4. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of a motor for moving said member in the opposite direction, means for supplying energy to said motor, a controller for controlling the operation of said motor, a plurality of means each responsive to a different fluid pressure for effecting operation of said controller, means for selectively connecting said plurality of means to the outlet of said pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement, and means for rendering said plurality of means effective or ineffective.

5. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a mechanism for moving said member in a direction to decrease pump displacement, a plurality of means for effecting operation of said mechanism, said plurality of means being operable at different predetermined pressures, and means for connecting any one of said plurality of means to the outlet of said pump to thereby cause said mechanism to reduce pump displacement in response to pump pressure exceeding the value determined by that one of said plurality of means.

6. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a motor for moving said member in a direction to decrease pump displacement, means for supplying energy to said motor, a controller for controlling the operation of said motor, a plurality of means for effecting operation of said controller, said plurality of means being operable at different predetermined pressures, and means for connecting any one of said plurality of means to the outlet of said pump to thereby cause said motor to reduce pump displacement in response to pump pressure exceeding the value determined by that one of said plurality of means.

7. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a mechanism for moving said member in a direction to decrease pump displacement, a plurality of means for effecting operation of said mechanism, said plurality of means being operable at different predetermined pressures, means for connecting any one of said plurality of means to the outlet of said pump to thereby cause said mechanism to reduce pump displacement in response to pump pressure exceeding the value determined by that one of said plurality of means, and means for rendering said plurality of means effective or ineffective.

8. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a motor for moving said member in a direction to decrease pump displacement, means for supplying energy to said motor, a controller for controlling the operation of said motor, a plurality of means for effecting operation of said controller, said plurality of means being operable at different predetermined pressures, means for connecting any one of said plurality of means to the outlet of said pump to thereby cause said motor to reduce pump displacement in response to pump pressure exceeding the value determined by that one of said plurality of means, and means for rendering said plurality of means effective or ineffective.

9. The combination, with a pump having a displacement varying member, of servo-motor means for moving said member in opposite directions to thereby vary pump displacement, means for supplying motive liquid to said servo-motor means, a control valve for controlling the operation of said servo-motor means, means including a plurality of hydraulic actuators each responsive to a different fluid pressure for effecting operation of said valve, means including a selector valve for selectively connecting said actuators to the outlet of said pump, and means for operating said selector valve.

10. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of a hydraulic servo-motor for moving said member in the opposite direction, means for supplying motive liquid to said servo-motor, a control valve for controlling the operation of said servo-motor, means including a plurality of hydraulic actuators each responsive to a different fluid pressure for effecting operation of said valve, means including a selector valve for selectively connecting said actuators to the outlet of said pump, and means for operating said selector valve.

11. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of a hydraulic servo-motor for moving said member in the opposite direction, means for supplying motive liquid to said servo-motor, a control valve for controlling the operation of said servo-motor, means including a plurality of hydraulic actuators each responsive to a different fluid pressure for effecting operation of said valve, means including a selector valve for selectively connecting said actuators to the outlet of said pump, means for operating said selector valve, and means for rendering said actuators effective or ineffective.

12. The combination, with a pump having a displacement varying member, of servo-motor means for moving said member in opposite directions to thereby vary pump displacement, means for supplying motive liquid to said servo-motor means, a follow-up valve for controlling the operation of said servo-motor means, valve operating means normally urging said valve in a direction to effect movement of said member in a direction to increase pump displacement, a plurality of hydraulically actuated means each responsive to a different fluid pressure for causing said valve operating means to shift said valve in a direction to effect a reduction in pump displacement, means including a selector valve for connecting said hydraulically actuated means

to the outlet of said pump, and means for operating said selector valve.

13. The combination, with a pump having a displacement varying member, of servo-motor means for moving said member in opposite directions to thereby vary pump displacement, means for supplying motive liquid to said servo-motor means, a follow-up valve for controlling the operation of said servo-motor means, valve operating means normally urging said valve in a direction to effect movement of said member in a direction to increase pump displacement, a plurality of hydraulically actuated means each responsive to a different fluid pressure for causing said valve operating means to shift said valve in a direction to effect a reduction in pump displacement, means including a selector valve for connecting said hydraulically actuated means to the outlet of said pump, means for operating said selector valve, and means for rendering said hydraulically actuated means effective or ineffective.

14. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a hydraulic servo-motor for moving said member in the opposite direction, means for supplying motive liquid to said servo-motor, a follow-up valve for controlling the operation of said servo-motor, valve operating means normally urging said valve in a direction to effect movement of said member in a direction to increase pump displacement, a plurality of hydraulic actuators for causing said valve operating means to move said valve in the opposite direction to thereby effect a reduction in pump displacement, each of said actuators being responsive to a different fluid pressure to effect operation of said valve operating means, and means for selectively connecting said actuators to the outlet of said pump.

15. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a hydraulic servo-motor for moving said member in the opposite direction, means for supplying motive liquid to said servo-motor, a follow-up valve for controlling the operation of said servo-motor, valve operating means normally urging said valve in a direction to effect movement of said member in a direction to increase pump displacement, a plurality of hydraulic actuators for causing said valve operating means to move said valve in the opposite direction to thereby effect a reduction in pump displacement, means for selectively connecting said actuators to the outlet of said pump, and a resistance valve connected in series with each actuator to thereby determine the pump pressure required to cause each actuator to operate said valve operating means.

16. The combination, with a pump having a displacement varying member urged in a direction to increase pump displacement, of a hydraulic servo-motor for moving said member in the opposite direction, means for supplying motive liquid to said servo-motor, a follow-up valve for controlling the operation of said servo-motor, valve operating means normally urging said valve in a direction to effect movement of said member in a direction to increase pump displacement, a plurality of hydraulic actuators for causing said valve operating means to move said valve in the opposite direction to thereby effect a reduction in pump displacement, each of said actuators having a different mechanical advantage in the operation of said valve operating means, means including a selector valve for selectively connecting said actuators to the outlet of said pump, and a resistance valve connected in series with each actuator to thereby determine the pump pressure required to cause each actuator to operate said valve operating means.

17. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of means for moving said member in the opposite direction, a plurality of means each responsive to a different fluid pressure for effecting operation of the aforesaid means, and means responsive to motion created by liquid discharged by said pump for selectively connecting said plurality of means to the outlet of said pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement.

18. The combination, with a pump having a member movable in opposite directions to increase or decrease pump displacement and urged in one of said directions, of a motor for moving said member in the opposite direction, means for supplying energy to said motor, a controller for controlling the operation of said motor, a plurality of means each responsive to a different fluid pressure for effecting operation of said controller, and means responsive to motion created by liquid discharged by said pump for selectively connecting said plurality of means to the outlet of said pump to thereby cause any one of a plurality of predetermined pump pressures to effect adjustment of pump displacement.

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