April 11, 1944. W. ERNST 2,346,254

PUMP STROKE VARYING STRUCTURE

Original Filed Dec. 15, 1939 2 Sheets-Sheet 1

Fig. 3

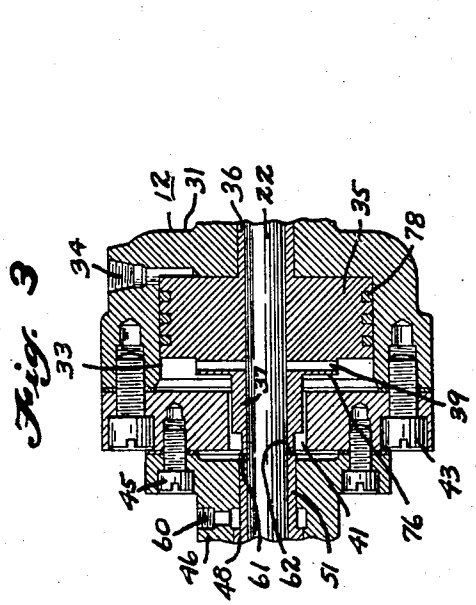


Fig. 1

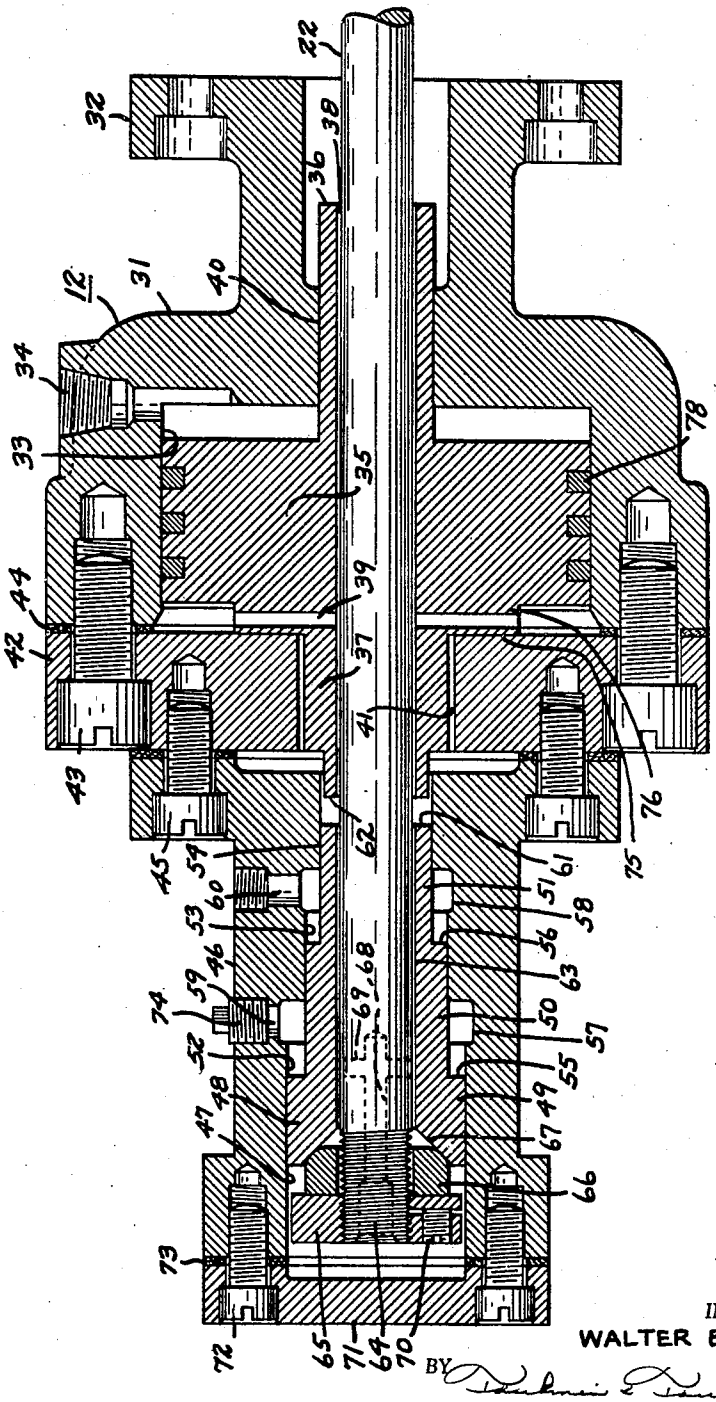
INVENTOR.
WALTER ERNST
BY
ATTORNEYS

April 11, 1944. W. ERNST 2,346,254

PUMP STROKE VARYING STRUCTURE

Original Filed Dec. 15, 1939 2 Sheets-Sheet 2

Fig. 2



INVENTOR.
WALTER ERNST
BY
ATTORNEYS

Patented Apr. 11, 1944 2,346,254

UNITED STATES PATENT OFFICE

2,346,254

PUMP STROKE VARYING STRUCTURE

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

Continuation of application Serial No. 309,435, December 15, 1939. This application December 1, 1941, Serial No. 421,104

10 Claims. (Cl. 121—38)

This invention relates to control mechanisms and, in particular, to mechanisms for controlling the movement of a reciprocable member, such as the flow control member of hydraulic pumps or motors.

Control mechanisms, as heretofore known, for controlling the flow control member of hydraulic pumps or motors required quite a number of packings around the movable members, which packings on one hand, due to friction caused thereby, impaired the efficiency of the device, while, on the other hand, the replacement of said packings causes additional work and cost, aside from the necessary interruption of the operation of said device.

Accordingly, it is an object of the invention to provide an improved control mechanism which will overcome the above mentioned drawbacks.

Another object is to provide a control mechanism for controlling the flow control member of hydraulic pumps or motors, in which the packings heretofore required around reciprocable members are reduced to a minimum or substantially eliminated, thereby eliminating to a great extent the friction arising from the presence of said packings and correspondingly increasing the sensitivity of the control mechanism.

It is a further object of the invention to provide a control mechanism of the above type, which constitutes a material simplification in structure, while simultaneously affording a simplified adjustment thereof.

It is still another object of the invention to provide a control mechanism for controlling the movement of a reciprocable member, which comprises a main control piston and an auxiliary control piston operatively connected with said reciprocable member, and in which the main control piston is placed at the end of said control member where it is accessible for adjustment and also serves to transmit the thrust from said auxiliary piston to said reciprocable member.

A still further object of the invention consists in the provision of a control mechanism for a rotary pump or motor, which control mechanism is adapted to shift the flow control element of said pump or motor independently of the shifting accomplished by an additional pressure responsive piston.

This invention is a continuation application of my copending application, Serial No. 309,435, filed December 15, 1939, and which has since become abandoned.

The above and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

Figure 1 shows a control mechanism according to the present invention, in connection with a variable delivery pump serving as pressure fluid source for a hydraulic circuit.

Figure 2 is an enlarged longitudinal section through the control mechanism according to the invention, showing the moving pistons disengaged to render the unit temporarily inoperative.

Figure 3 is a view similar to Figure 2, but with the pistons of the control mechanism engaging each other and shifted into their right hand positions.

Referring now to the drawings in detail, the control mechanism according to the invention is shown in connection with a variable delivery pump 10, merely by way of example, but is by no means limited thereto. The variable delivery pump 10 shown in the drawings is provided with a flow control element or shift ring 20 which is mounted upon the control rods 21 and 22 slidably supported in the pump casing 23 and passing outwardly therethrough. The shift ring 20 ordinarily encircles the secondary rotor of the pump and by varying the eccentricity of the latter relatively to the axis of rotation of the primary rotor or cylinder barrel alters the delivery or output of the pump. When the axis of the secondary rotor coincides with that of the primary rotor or cylinder barrel, and the eccentricity is zero, the shift ring 20 is then said to be in its neutral or zero delivery position. Under these circumstances, as is well known to those skilled in the hydraulic art, the pistons of the pump 10 will not reciprocate and hence the pump delivers substantially no fluid.

The control rod 21 is urged to the right to shift the shift ring or flow control element 20 into a full delivery position by the spring-urged device 11, consisting of a stationary tubular casing 24 within which is telescopically mounted a movable tubular casing 25. The stationary casing 24 is secured to the pump casing 23 and both casings 24 and 25 enclose a coil spring 26, one end of which rests against the inner left end wall of the stationary casing 24, whereas the other end engages the right-hand end wall of the movable casing 25, which has a ball thrust bearing 27 associated therewith and engaged on its opposite side by the hub of a hand wheel 28 internally threaded upon the threaded portion 29 of the control rod 21. A lock nut 30 beyond the hand wheel 28 enables the locking of the hand

wheel 28 in any desired position of adjustment. The control unit 12, in general, urges the control rod 22 and pump shift ring 20 to the left when it receives pressure fluid, thereby tending to overcome the thrust of the coil spring 26 and move the shift ring 20 back toward its zero delivery or neutral position.

The control unit 12 (Figure 2) consists of a housing 31 attachable by its flanged portion 32 to the pump casing 23. This housing 31 contains a cylinder bore 33 having a threaded entrance port 34, giving access to the end thereof nearest the pump casing 23. Reciprocable within the cylinder bore 33 is an auxiliary piston 35 having sleevelike extensions or hubs 36 and 37 extending in opposite directions along the control rod 22 but separated therefrom by a substantial clearance space 38 therebetween. Fluid leaking past the auxiliary piston 35 to the left-hand end of the cylinder bore 33 escapes by way of the transverse passageway 39 into the clearance space 38, and thence along the control rod 22, back into the pump casing 23, the clearance space 38 forming the annular passageway along the control rod 22. An accurate sliding fit is maintained in the bore 40 between the hub 36 and the casing 31 so that no packing is required at this location. The hub 37, however, is separated by a clearance space 41 from the cylinder head 42, which is bolted to the housing 31 by means of the screws 43 and with the gasket 44 therebetween to prevent leakage.

Bolted to the cylinder head 42, as by the screws 45, is a housing 46 containing a cylinder bore, generally designated 47, and receiving a stepped piston, generally designated 48. The stepped piston 48 consists of three portions 49, 50 and 51, of different diameters, respectively reciprocable in the bore portions 52, 53 and 54 of the cylinder bore 47. This construction provides annular piston areas 55 and 56 opening into bore enlargements 57 and 58, served by the threaded ports 59 and 60; and also provides an annular end wall 61 which is adapted to be engaged by the annular end wall 62 of the piston hub 37 when the piston 48 is moved to the right to close up the space (Figure 2) between the annular end walls 61 and 62, in the manner shown in Figure 3. For this purpose, the stepped piston 48 is separated from the control rod 22 by a clearance space 63, similar to the clearance space 38 between the auxiliary piston 35 and the control rod 22.

The outer end of the control rod 22 is threaded, as at 64 (Figure 2), and provided with a lock nut 65 engaging a collar 66, which, in turn, engages the conical bore 67 in the end of the stepped piston 48. A longitudinal passageway 68, communicating with a transverse passageway 69 in the control rod 22, provides for the drainage of fluid which escapes past the stepped piston 48. Such fluid passes through the passageways 68 and 69, and through the clearance spaces 63 and 38, along the control rod 22 to the pump casing 23.

In Figure 2 the stepped piston 48 is shown as separated by a quarter of an inch from the auxiliary piston 35, yet the latter is at the extreme end of its stroke in the left-hand direction. This separation between the end walls 61 and 62 of the piston portions 51 and 37, respectively, is provided to render the unit 12 temporarily inoperative at the will of the operator. When it is desired to render the unit operative (Figures 1 and 3), the operator rotates the lock nut 65, thereby moving the stepped piston 48 to the right, along the control rod 22, until the end wall 61 engages the end wall 62. Thus, when pressure is admitted through the port 34 to the cylinder bore 33 so as to urge the auxiliary piston 35 to the left, the latter likewise engages the end wall 61 of the stepped piston 48, moving it to the left and with it the control rod 22 by reason of the connection provided by the collar 66 and lock nut 65. The lock nut 65 may be locked at any desired position along the threaded portion 64 by turning the set screw 70. The left-hand end of the cylinder bore 47 is closed by the end plate 71, secured to the housing 46 by the screws 72, leakage being prevented by the gasket 73.

The stepped piston 48 is provided for the purpose of creating a multiplicity of piston areas of different sizes so that the pump flow control element or shift ring 20 may be shifted to its neutral position at one of a plurality of selected pressures. The particular pressure selected is determined by whether the control conduit is connected to the port 60 or to the port 59. In the example shown in Figure 2, the port 59 is illustrated as closed by the threaded plug 74 so that the port 60, cylinder bore 53 and annular piston area 56 are in use. The same arrangement is shown in Figure 1. It will also be obvious that a third piston area will be available if both of the ports 59 and 60 are connected to the pressure circuit, thereby subjecting the combined piston areas 56 and 55 to the action of the pressure fluid. The stepped piston construction shown at the left-hand end of Figure 2 forms no part of the present invention, and is described and claimed in the U. S. Patent No. 2,229,965 to Ernst.

It will be observed that the motion of the auxiliary piston 35 to the left is limited by the shoulder 75 at the end of the portion 76 containing the transverse passageway 39. In Figure 2 the auxiliary piston 35 is shown in its extreme left-hand position, which position it will occupy only when there is sufficient pressure in the cylinder bore 33 to overcome the force of the coil spring 26. By turning the lock nut 65 the amount of movement of the control rod 22, which may be brought about by the auxiliary piston 35, is increased or decreased, depending upon the direction in which the nut 65 is turned.

It will be observed that there is no packing engaging the moving parts excepting the oil seal 77 (Figure 1) surrounding the control rod 21 at the point where it passes out of the spring casing 11 into the pump casing 23. As the oil seal 77 is not under pressure, however, it causes no appreciable friction by its engagement with the control rod 21. The piston rings 78 in the auxiliary piston 35 assist in preventing leakage thereby, but where such leakage occurs it is rapidly taken care of by the leakage system previously described and consisting of the passages 39, 68 and 69 and the clearance spaces 63 and 38 surrounding the control rod 22. The thrust of the spring 26 and, therefore, the force opposing the action of the pistons 35 and 48 is regulated by turning the hand wheel 28.

The variable delivery pump with the control unit described above is capable of a variety of uses, Figure 1 showing the press having an upwardly moving platen and a booster ram. In Figure 1 the press 17 is provided with a head 80, a bed 81 interconnected by the strain rods 82 having the nuts 83 threaded upon the ends thereof. The press 17 is provided with an upwardly moving platen 84, to which is attached the main plunger 85 having a piston head 86

reciprocable in the main cylinder bore 87, the entrance to which is closed by the packing 88 and gland 89. The main plunger 85 is hollow and contains a booster cylinder 90, the walls of which are engaged by the end of the booster ram 91, which consists of a hollow tube mounted in the aperture 92 at the lower end of the main cylinder 93, and having a bore 94 extending longitudinally therethrough. The booster cylinder 90 is provided to move the platen 84 more rapidly toward its closing position than would be possible by using the piston area 95 of the main plunger 85 alone.

The platen 84 may operate in any manner upon the work piece or upon the other mechanism to be operated. In Figure 1 the platen 84, for purposes of example, is shown as carrying a die half 96 cooperating with the stationary die half 97 mounted upon the press head 98. The platen 84 is also provided with a platen arm 98 adapted to engage a collar 99 upon the valve rod 100 of the two-way auxiliary valve 16, previously described. An additional collar 101 is provided beneath the platen arm 98 so that the latter will shift the valve rod 100, and change the setting of the two-way valve 16 at the opposite ends of its stroke.

The variable delivery pump is connected to the tank 13 by the suction conduit 102 from the suction connection 103. The fluid received along the suction conduit 102 is pumped through the pressure head 104, along the conduit 105 to the four-way main control valve 15 having the valve rod 106. From the valve 15 the discharge conduit 107 leads back to the tank 13, and the conduits 108 and 109 lead respectively to the upper end of the main cylinder bore 87 and to the two-way auxiliary valve 16. A branch conduit 110 leads from the conduit 109 to the bore 94 within the stationary booster ram 91. A conduit 111 leads from the two-way valve 16 to the port 112 in the lower end of the main cylinder bore 87, and in this conduit a choke 18 is optionally inserted. A branch conduit 113 runs from the conduit 111 to the check valve 14 within the tank 13. A control conduit 114 also runs from the conduit 111 to the port 34 of the cylinder bore 33, whereas the control conduit 115 runs from the pressure conduit 105 to either or both of the ports 59 and 60, adapted to admit pressure fluid to the stepped piston 48.

In the operation of the circuit shown in Figure 1, the variable delivery pump 10 is started in operation, it being assumed that the main plunger 85 is in its lower position opposite to that shown in Figure 1. It is also assumed that the two-way auxiliary valve 16 is in the opposite position from that shown in Figure 1, namely, with its valve heads in their lowered positions. Fluid is then pumped by the variable delivery pump from the tank 13, through the suction conduit 102, along the pressure conduit 105, through the four-way main control valve 15, thence through the conduits 109 and 110 and the bore 94 of the booster plunger 91, into the booster cylinder 90, the auxiliary valve 16 being in its lowered or closed position. Pressure fluid within the booster cylinder 90 acts against the limited area thereof and causes the main plunger 85 and platen 84 to be moved upwardly at a rapid rate. The void thus produced in the main cylinder bore 87 is filled with fluid through the port 112, the conduit 113 and the check valve 14 from the tank 13.

When the lower mold half 96 has almost reached the upper mold half 97, or at any desired point in the operation of the press 17, the platen arm 98 engages the collar 99 and lifts the valve rod 100 of the auxiliary valve 16, opening the latter by shifting its heads to the positions shown in Figure 1. Since the pressure fluid can now pass from the conduit 109 through the auxiliary valve 16, and the conduit 111 and port 112, into the main cylinder bore 87, it encounters less resistance therein than in the booster cylinder 90. Most of the discharge from the variable delivery pump 10, on this account, will now be diverted to the main cylinder bore 87, where it acts against the large piston area 95 thereof, with the result that a sufficient pressure will be produced to continue the lifting of the main plunger 85 but at a reduced speed and with a much greater potential pressing force. Pressure fluid now backs up in the conduit 114 and passes through the port 34 (Figure 2), into the cylinder bore 33, where it acts against the piston head 35 and moves it to the left.

Assuming that the stepped piston 48 has been brought into operative engagement by rotating the nut 65 in a clockwise direction (Figure 3) and the gap between the end walls 61 and 62 is closed up from the position shown in Figure 2 to that shown in Figure 3, the motion of the piston 35 will be transmitted to the control rod 22, shifting the latter to the left by overcoming the thrust of the coil spring 26. This movement shifts the flow control element or shift ring 20 of the pump 10 toward its neutral or zero delivery position, thereby reducing the delivery of the pump 10 and placing the latter upon part stroke. The amount of reduction in pressure depends upon the adjustment of the nut 65. This reduction in the discharge of the pump 10 thus slows up the movement of the main plunger 85, the speed of which can be adjusted by adjusting the nut 65. The area of the piston head 35 is preferably made sufficiently large so that the pressure, due to the weight of the moving parts 84 and 85, will be sufficient to cause the shifting of the piston head 35 to the left as soon as the two-way valve 16 is opened by the engagement of the platen arm 98 with the collar 99 on the control rod 100.

However, the weight of these moving parts may not be sufficiently large to provide enough pressure to shift the piston head 35, as may occur in the case of a downwardly acting press plunger with a booster cylinder in which no pressure would build up because the ram travels downwardly under the influence of gravity. In that event, the choke 18 may be inserted in the conduit 111, as shown by the dotted lines in Figure 1. This choke 18 artificially increases the pressure in the conduit 114 and therefore causes the piston head 35 to move.

The piston head 35 is intended to reduce the stroke of the pump but not to reduce it to zero. Thus, after the two-way valve 16 is opened at a predetermined point in the motion of the platen 84, the pump 10 is on part stroke and is still delivering pressure fluid. When the main plunger 85 meets a sufficient positive resistance so that the pressure fluid backing up in the conduit 115 is of sufficient force to shift the stepped piston 48 to the left and overcome the thrust of the coil spring 26, the control rod 22 and shift ring 20 of the pump are shifted to substantially neutral position. The pump in this position is arranged to deliver just enough fluid to take care of leakage in the circuit, if such leakage is present. To reverse the motion of the platen 84, the valve rod

106 of the main control valve 15 is shifted to its opposite position, whereby pressure fluid is delivered to the conduit 108, into the space at the upper end of the main cylinder bore 87.

Since the two-way valve 16 remains open until the platen arm 98 encounters the lower collar 101 on the valve rod 100, fluid escapes from the lower end of the main cylinder bore 87, through the port 112, the conduit 111, the two-way valve 16, the conduit 109, the main control valve 15 and the conduit 107, into the tank 13. At the same time, fluid escapes from the booster cylinder 90, through the bore 94, the conduit 110, the conduit 109, the main control valve 15 and the conduit 107, into the tank 13. The platen 84, therefore, descends until the platen arm 98 engages the collar 101 and closes the two-way valve 16. Pressure then builds up in the circuit and backs up in the conduit 115 to shift the stepped piston 48, the control rod 22 and shift ring 20 to the left to reduce the discharge of the pump 10 substantially to zero.

While the control system according to the invention has been illustrated and described in connection with a variable delivery pump for an upwardly acting press, it will be evident that the arrangement may be used with any hydraulic pump, regardless of whether the press plunger is downwardly acting, upwardly acting, or moving horizontally.

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 combination in a control mechanism for controlling the movement of a reciprocable element, yielding means urging said element in one direction, a pair of cylinders, a fluid operable control piston reciprocable in one of said cylinders, a fluid operable auxiliary piston reciprocable in the other one of said cylinders, said auxiliary piston being provided with means adapted to be engaged by said control piston, a reciprocable control member operatively connected to said reciprocable element and passing through bores in both of said pistons, said control member forming with said bores a passageway connected with a chamber for returning leakage thereto, and means for transmitting fluid pressure acting upon said pistons to said control member against the thrust of said yielding means.

2. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston in one cylinder, a fluid operable auxiliary piston reciprocally mounted in the other cylinder and provided with a portion adapted to be engaged by said control piston, a control member connected to said reciprocable element, said control member passing and being movable relative to both of said pistons, said control member also being provided with a threaded portion, a threaded element for engagement with said control piston, said threaded element being adjustably mounted on said threaded portion for selectively changing the effectiveness of said auxiliary piston, and means operable to admit fluid pressure to said pistons for moving the same against the thrust of said yielding means.

3. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston in one cylinder, a fluid operable auxiliary piston reciprocable in the other cylinder and provided with a portion for engagement with said control piston to selectively actuate the latter or to be actuated thereby, a control member connected to said reciprocable element and passing through and movable relative to both of said pistons, said control member having a threaded portion thereon and being operable against the thrust of said yielding means, and a threaded element on said threaded portion for engagement with said control piston, said threaded element being movable to vary the space between said pistons from the other piston, to thereby vary the actuation of said control piston by said auxiliary piston.

4. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston in one cylinder, a fluid operable auxiliary piston reciprocably mounted in the other cylinder, a control member connected to said reciprocable element and passing through said pistons, and means for transmitting the thrust of said pistons to said control member against the thrust of said yielding means, said pistons having enlarged bores therethrough surrounding said control member and providing an annular passageway therebetween for the escape of leakage fluid.

5. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston in one cylinder, a fluid operable auxiliary piston reciprocable in the other cylinder, a control member connected to said reciprocable element and passing through said pistons, and means for transmitting the thrust of said pistons to said control member against the thrust of said yielding means, said control piston having an enlarged bore larger than said control member and surrounding said control member, while providing an annular passageway therebetween for the escape of leakage fluid, said auxiliary piston having a passageway leading from one side thereof to said enlarged bore.

6. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston reciprocable in one cylinder, a fluid operable auxiliary piston reciprocable in the other cylinder, a control member connected to said reciprocable element and passing through said pistons, means for admitting pressure fluid to said pistons for actuating said control member against the thrust of said yielding means, said control piston having a plurality of portions of different diameters thereon for providing piston portions of different areas, and means for selectively making one or more of said areas effective.

7. In combination in a control mechanism, a reciprocable element, yielding means for urging said reciprocable element in one direction, a pair of cylinders, a fluid operable control piston having a bore therethrough and being reciprocable in one cylinder, a fluid operable auxiliary piston having a bore therethrough in alignment with said first mentioned bore and being reciprocable in the other cylinder, a control member connected to said reciprocable element and passing through the bores in said pistons, said control member having an outer diameter less than the

diameter of said bores so as to form an annular passageway between said bores and said control member for the escape of leakage fluid from said cylinders, means for hydraulically connecting one side of said pistons with said annular chamber, and means for transmitting fluid pressure acting upon said pistons to said control member to move the same against the thrust of said yielding means.

8. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a pair of cylinders, a fluid operable control piston reciprocably mounted in one cylinder, a fluid operable auxiliary piston reciprocably mounted in the other cylinder, a control member connected to said reciprocable element and passing through said pistons, means for transmitting fluid pressure acting upon said pistons to said control member, said auxiliary piston having an axial extension passing into the other cylinder for engagement with said control piston, and means for selectively effecting relative movement between said control member and said control piston to thereby prevent engagement of said control piston by said extension during the actuation of said auxiliary piston.

9. In combination in a control mechanism, a reciprocable element, yielding means for urging said element in one direction, a control cylinder and an auxiliary cylinder, a fluid operable control piston in said control cylinder, a fluid operable auxiliary piston in said auxiliary cylinder, a control member connected to said reciprocable element and passing through said pistons, and means for transmitting fluid pressure acting upon said pistons to said control member against the thrust of said yielding means, said auxiliary cylinder having axial extensions in opposite directions, of which one extension passes into the control cylinder for engagement with said control piston, while the other extension snugly engages said auxiliary cylinder.

10. In a control device, a pressure fluid casing, a control casing connected to said pressure fluid casing and having a pair of cylinders therein, a movable flow control element, yielding means for urging said flow control element in one direction, a first fluid operable piston movably mounted in one of said cylinders, a second fluid operable piston movably mounted in the other cylinder and adapted to be engaged by said first piston, a control member connected to said flow control element and passing through both of said pistons, and means for transmitting fluid pressure acting upon said pistons to said control member to move the same against the thrust of said yielding means, said first piston having an axial extension snugly engaging said control casing for minimizing leakage between said control casing and said pressure fluid casing.

WALTER ERNST.