May 29, 1945. W. T. STEPHENS 2,377,278

APPARATUS FOR CONTROLLING FLUID PRESSURE

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Fig. 1.

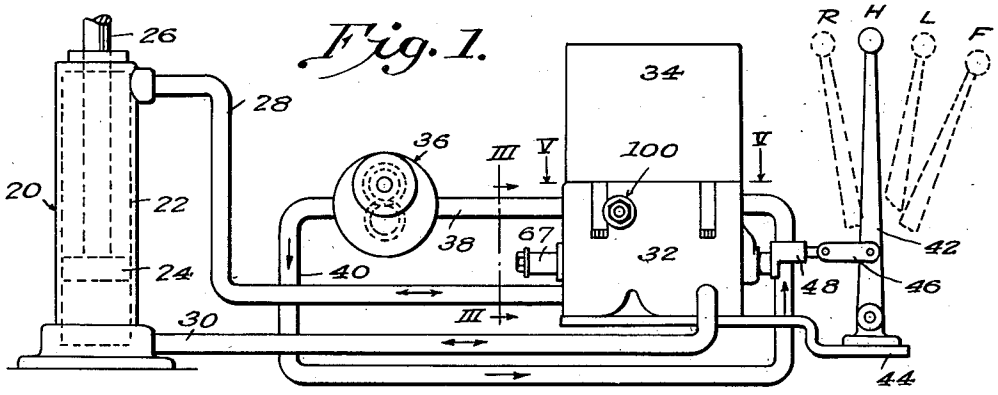


Fig. 2.

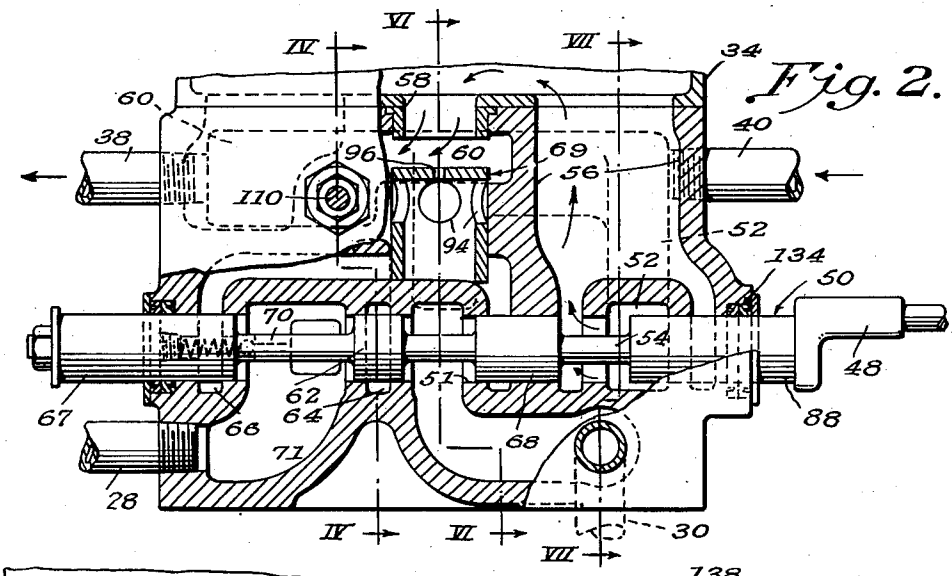


Fig. 3.

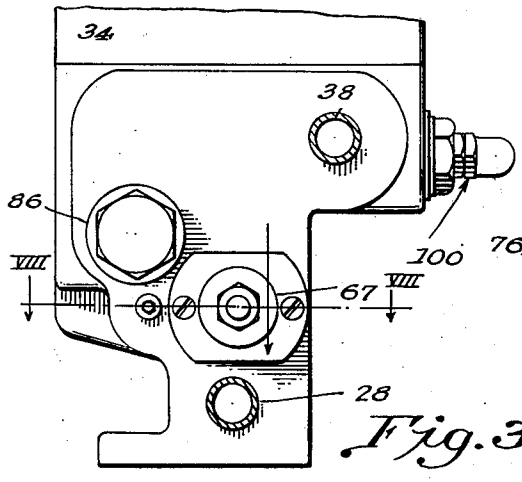
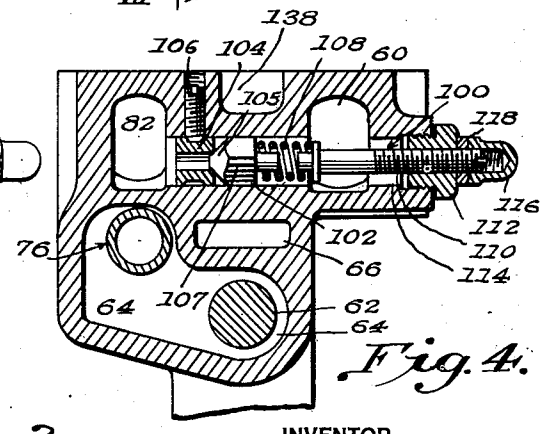


Fig. 4.



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Fig. 5.

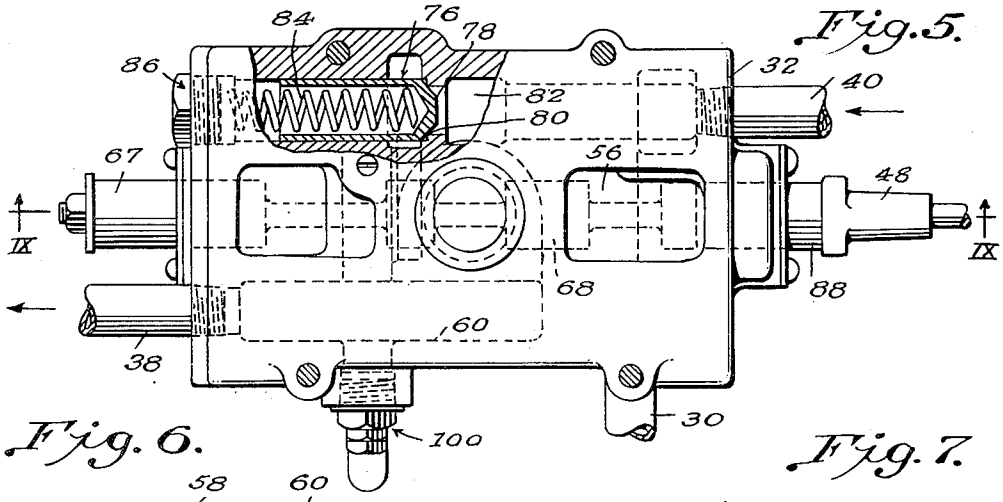


Fig. 6.

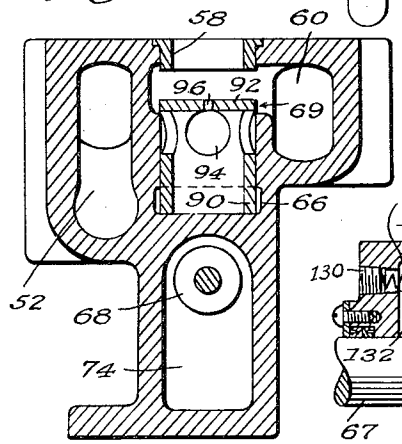


Fig. 8.

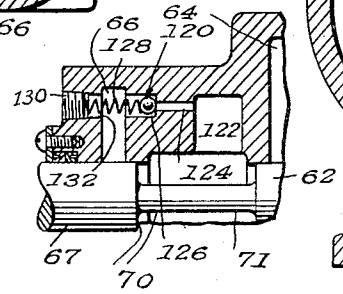


Fig. 7.

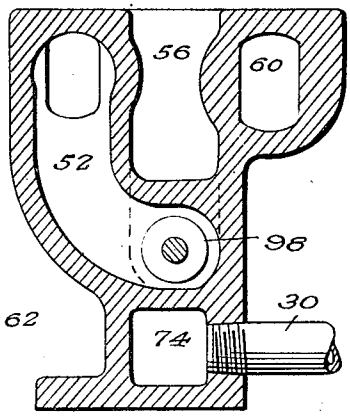
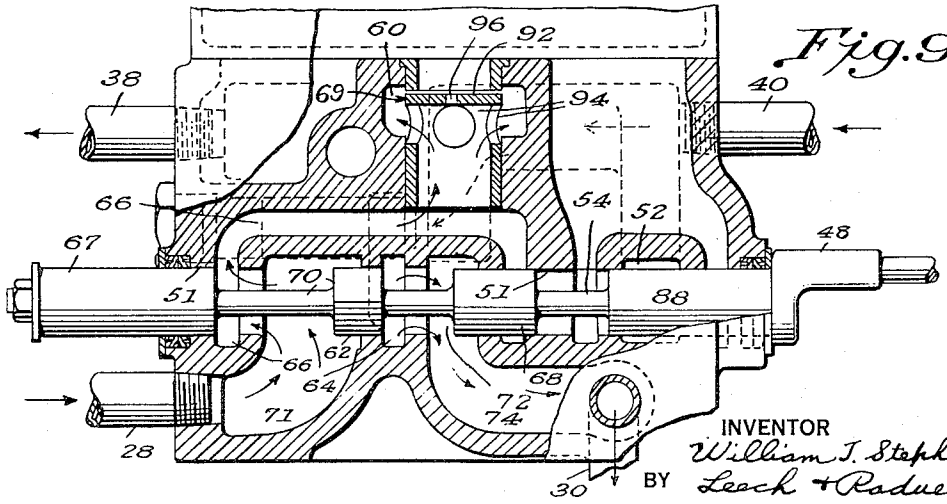


Fig. 9.



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Fig. 10.

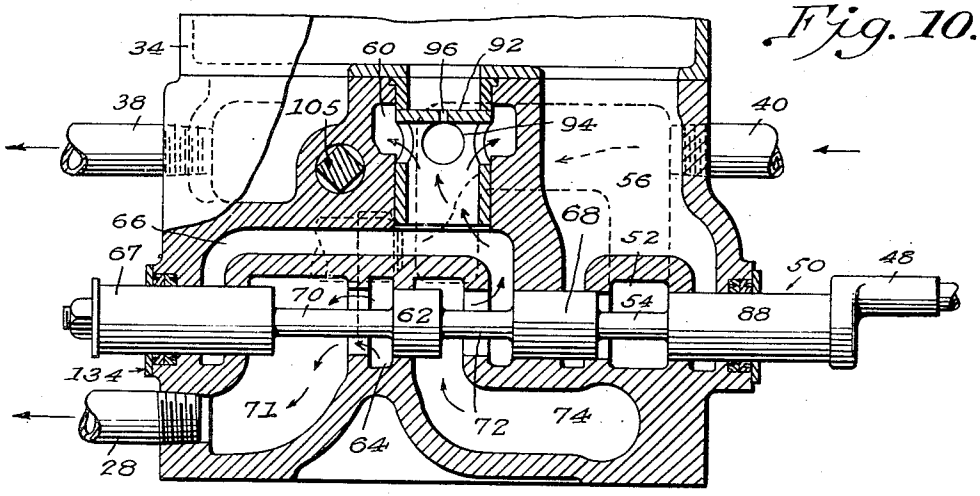
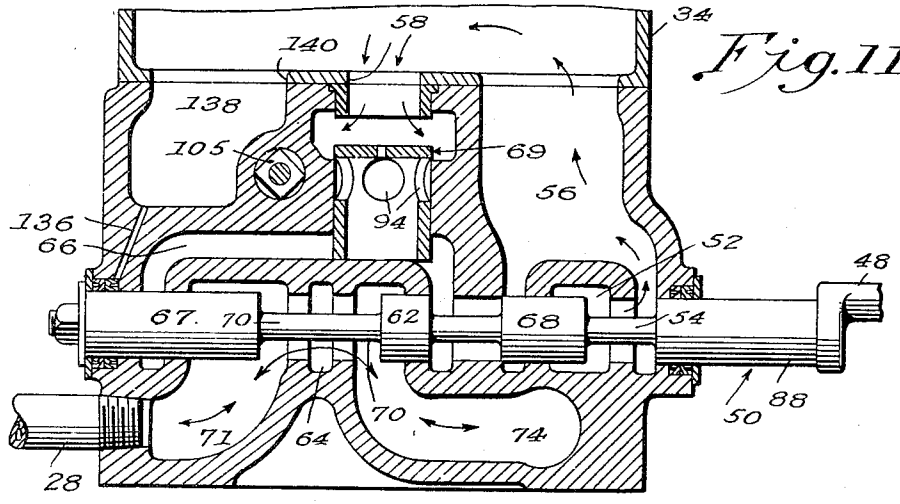


Fig. 11.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR CONTROLLING FLUID PRESSURE

William T. Stephens, Cleveland, Ohio, assignor to Hydraulic Control Engineering Company, Cleveland, Ohio, a corporation of Ohio

Application October 31, 1941, Serial No. 417,401

12 Claims. (Cl. 60—52)

The present invention relates to apparatus for controlling fluid pressure such as may be employed in hydraulic systems, comprising a hydraulic piston, a fluid pressure pump, and a fluid reservoir.

In the operation of certain types of road machinery and other equipment where double-acting hydraulic cylinders are used, it is necessary to control the lowering as well as the raising. That is to say, it is desirable to have the blade or other implement lower at the same speed at which it is raised. In order to accomplish this, the problem to overcome is that of keeping the piston from falling away from the pump and sucking a void on the pressure side of the hydraulic cylinder. This faulty operation is especially objectionable with a bulldozer when the control valve is put in the lowering position. Sometimes the blade at first will fall almost to the ground, and then it will hesitate in that position for a few seconds until the pump fills up the void in the hydraulic cylinder. Obviously, this causes jerky operation and prevents the attainment of a smooth fine grade which can be had with equipment of this type.

There are numerous ways of acquiring this desired positive control. The best previously known way was by use of the familiar type of closed system wherein the oil or other pressure fluid was pumped from one side of the hydraulic cylinder to the other, and a check valve was used in the line from the suction side of the pump to the reservoir tank so that it was impossible for any fluid to get back to the reservoir, with the result that the blade would not lower any faster than the speed with which the pump was operating. The inherent characteristics of the closed system are such that in the neutral position, oil was by-passed practically from one side of the pump to the other. Because of this, and in view of the fact that a bulldozer is operated a good many minutes at a time in the neutral position, an enormous amount of heat was generated because of the relatively small quantity of oil being circulated. Another known way of controlling the lowering of the blade or implement is by throttling the lowering orifices to build up a back pressure that would hold the blade back. The objection to this procedure is that it requires some two hundred pounds per square inch pressure, thus requiring that the whole hydraulic unit do work by forcing oil through an orifice. Again, the great amount of heat generated in this manner is highly objectionable.

It has also been proposed to obtain the desired control with various types of flow control valves which, for the most part, are complicated and have been found unsuccessful.

In the present invention the advantages of two systems have been combined. The closed system is used in which in either of the power positions the fluid is taken from one side of the hydraulic piston to the other through the pump, but in the neutral position, fluid is withdrawn from the reservoir tank and carried back to that tank, as with the familiar open system, so that hydraulic fluid is supplied to the pump throughout the operation. The combining of the features of the two systems has resulted in more positive control with much less heat than had been previously attainable.

One of the objects of this invention is to provide efficient control mechanism for producing the novel functions which have been described.

Another feature of the invention resides in the positioning of a check valve on the delivery side of the pump through which valve pressure fluid is supplied to either end of the hydraulic cylinder.

Further novel features of improvement contributing to ease and accuracy in operation will be perceived and understood from reading the following detailed description of an illustrative embodiment of the invention in connection with the accompanying drawings, in which

Fig. 1 is a side elevation showing in somewhat diagrammatic form the entire hydraulic system;

Fig. 2 is a vertical, longitudinal section of the control mechanism in hold position;

Fig. 3 is a transverse vertical section taken on the line III—III of Fig. 1;

Fig. 4 is a further transverse vertical section taken on the line IV—IV of Fig. 2;

Fig. 5 is a plan view of the control mechanism as seen on the line V—V of Fig. 1;

Fig. 6 is an additional transverse vertical section taken on the line VI—VI of Fig. 2;

Fig. 7 likewise is a transverse vertical section at line VII—VII of Fig. 2;

Fig. 8 is a partial horizontal section showing a check valve as viewed on line VIII—VIII of Fig. 3;

Fig. 9 is a vertical, longitudinal section of the control mechanism in the raise position;

Fig. 10 is a vertical, longitudinal section of the control mechanism in lower position; and

Fig. 11 is a similar vertical, longitudinal section of the control mechanism in float position.

Referring to Fig. 1, the system is shown to comprise a double-acting hydraulic ram 20 having a vertical cylinder 22 enclosing a piston 24 carrying a piston rod 26 on its upper or inner side.

The cylinder 22 has upper and lower connections 28 and 30 which extend to a chambered valve housing 32 surmounted by a fluid reservoir tank 34. A conventional gear pump 36 has an inlet or return connection 38 with housing 32 and an outlet or supply connection 40 thereto. An operating lever 42 pivoted upon an extension 44 of valve housing 32 is provided with a link 46 pivotally connected to a valve stem 48.

Hold position

In the neutral or hold position corresponding to the vertical, H location of operating lever 42, the valve parts will have the relative arrangement of Fig. 2. The valve stem 48 has moved its integral piston valve 50 through cylinder bore 51 so that the delivery end of pump 36, which has supply connection 40 to the upper right end portion of housing 32 and discharges to passageway 52, feeds through annular piston groove 54 to a passageway 56 opening directly into the oil reservoir tank 34. At the same time, oil from tank 34 is flowing through a housing port 58 into one end of an upper passageway 60 whence it is carried to return connection 38 leading to the inlet side of pump 36. The sequence of this circuitous flow is: pump 36 to chambered valve housing 32, through reservoir tank 34, back to housing 32, and finally again to pump 36. In the meantime, interconnection between the upper and lower end connections, 28 and 30 respectively, of cylinder 22 is blocked by a piston or land portion 62 of the valve 50; the intermediate passageway port 64 for supplying pressure fluid from the pump 36 to the lower connection 30 of ram cylinder 22 is closed by the same piston portion 62; and the passageway port 66 which returns fluid to the pump 36 from the upper or rear end cylinder connection 28 is closed by an extreme left end piston portion 67 of valve plunger 50. The right end of passageway port 66 is likewise closed by a piston portion 68.

The absence of upward acting pressure from port 66 permits a vertical control plunger 69, seated across the distant upper end of passageway port 66, to remain closed; and the downward pressure of fluid going from housing port 58 back to the pump 36 aids in maintaining the closed position.

It will be understood that the system is functioning as an open system in the hold position which has been described.

Raise position

Fig. 9 illustrates the valve condition when operating lever 42 is in its raise or dotted R position (Fig. 1). A reduced connection section forming annular piston groove 70 adjacent piston portion 67 of valve plunger 50 affords passage between upper or rear cylinder connection 28, passageway 71, and passageway port 66 for returning fluid to pump 36 through control plunger 69. A still further annular piston groove 72, to the right of piston portion 62 admits pressure fluid from passageway port 64 for movement lengthwise of the valve cylinder bore 51 into passageway port 74 and delivery direct to the lower or front end connection 30 of hydraulic cylinder 22, to raise the bulldozer blade, or other implement.

This supply of pressure fluid to port 74 is by way of a large non-return check valve yieldable to pump pressure, and designated generally as 76 in Fig. 5. The check valve 76 comprises a tapered hollow head 78 resiliently urged against a seat 80 formed in the valve housing 32 near the left end of a rearward passageway 82 leading from fluid pressure supply connection 40. A compression spring 84 is received in the valve head 78 and may be adjusted by means of a threaded retaining plug 86 projecting externally of the chambered valve housing 32.

It is to be further observed that a valve piston portion 88 on the right end of piston valve 50 has moved inwardly from its hold position to close the supply passageway 52 from communication with passageway 56 leading to fluid reservoir tank 34.

As previously mentioned, the fluid returning to valve housing 32 from connection 28 leading to the upper end of ram cylinder 22 will flow through piston groove 70 and into passageway port 66 as piston 24 rises. As illustrated best in Figs. 2 and 6, an upper distant part of port 66 is arranged to surround the lower end or skirt 90 of the control plunger 69 in a way which permits fluid to lift it from the closed position of Fig. 2 to the open position of Fig. 9 or Fig. 10. In the upward or open position, the head 92 of control plunger 69 will seat against and close housing port 58 communicating with reservoir 34, but through a plurality of large lateral openings 94 just below the head, the returning fluid will enter the passageway 60 for discharge through connection 38 to the inlet side of pump 36. Since the volume of oil being displaced above piston 24 is less than that being added below the piston, valve member 69 will not be raised far enough to completely close off port 58 and hence the additional oil needed by the pump will be supplied to passage 60 from the tank through the passage so left.

The system is functioning at this time as a closed system with the plunger or valve member 69 limiting the flow of hydraulic fluid from the reservoir tank 34 to the control valve means.

Lower position

Referring to Fig. 10, the piston valve 50 is placed as shown for its lower position by moving operating lever 42 to the dotted L position of Fig. 1.

Valve piston portion 62 is now to the right of the point of entry of passageway port 64 into cylinder bore 51, but still blocking communication with passageway port 74. Consequently, pressure fluid from pump delivery connection 40 into passageway 82 passes through the check valve 76 (as for raise position) and enters passageway 71 through piston groove 70; thence it is discharged through upper ram cylinder connection 28 to lower the blade (not shown) joined to piston rod 26.

Oil forced from the front or lower end of ram cylinder 22 enters connection 30 and then passageway port 74. From port 74 the oil or other fluid passes piston valve groove 72 and flows into the right end of passageway port 66 where it can raise and upwardly seat control plunger 69, as previously explained. In so doing the oil escapes through plunger openings 94 into pump return passageway 60.

By means of a small bore 96 through the control plunger head 92, the excess volume of returned fluid from the lower end of cylinder 22, due to the lesser fluid displacement at the upper piston rod (26) end, will be forced back into the tank 34. With piston rods on both ends of the ram piston, no such compensation would be required.

Float position

In the float or by-pass position the piston valve

50 will have the relation to the bore 51 of chambered housing 32 which is illustrated by Fig. 11. This position is characterized by the direct communication of upper and lower ram connections 28 and 30 through passageway 71, valve plunger notch or groove 70, and passageway port 74, thus permitting oil to flow freely from one side of hydraulic piston 24 to the other.

As in the neutral or hold position, oil enters passageway 60 from housing port 58 communicating with oil reservoir 34 and flows to pump inlet connection 38. The flow control plunger 69 also is maintained in its downward closed position, and oil from the delivery or pressure side of pump 36 is returned by connection 40 to housing passageway port 52, whence it discharges past piston valve groove 54 to a right branch of passageway 56 and upwardly into the oil reservoir 34. The right branch of passageway 56 is opened by withdrawal of the extreme right piston portion 88 of piston valve 50.

Both ends of passageway port 66 are closed to the entrance of fluid by the piston portions 67, 62, and 68, but by means of the relief valve 120, later described, excess pressure in passage 71 due to the difference in volume of the two ends of the motor cylinder will be relieved to passage 66.

Relief valves

Referring to Figs. 4 and 5, it will be seen that the pressure side of the control apparatus is provided with a relief valve 100 arranged transversely to unload predetermined and excessive pump pressure from passageway 82 through a by-passageway 102 into passageway 60, and back to the suction side of pump 36.

The relief valve 100 comprises a centrally bored seat member 104 of the same outside diameter as relief passageway 102. A screw 106 threaded vertically through housing 32, and accessible from its exterior, engages a cooperating lateral portion of seat member 104 and secures it in position within passageway 102 and adjacent passageway 82. A tapered valve head 105 having bore engaging guides 107 seats upon and closes the bored seat member 104 under the urging of a compression spring 108 carried on the inner end of a valve adjusting rod 110 threaded through a plug 112 threadedly secured in an outwardly opening counter bore 114 continuation of relief passageway 102. As shown in Fig. 4, a lock cap 116 and washer 118 maintain the rod 110 in the desired position. This relief valve assembly is such as to require a minimum of working of the housing 32 and avoids concentric boring by use of the insertable valve seat member 104.

Figs. 2, 3, and 8 show a small check valve 120 which has an important function contributing to the efficiency of operation of the present controlling apparatus in the hold and float positions Figures 2 and 11 respectively.

It has been previously noted that the fluid displacements on opposite ends of the ram piston 24 are unequal by reason of the piston rod 26 on the upper or inner end of that piston. As a consequence, when the piston 24 and its connected tool or implement are lowered positively, less oil will be pumped into the top of cylinder 22 than is removed from the bottom by piston displacement. It will be recalled that this greater volume of withdrawn oil flows to port passageway 74 of housing 32, and freely past valve piston groove 72 into the right end of passageway 66, having free access at this time to passageway 60 connected to the inlet side of pump 36. The excess supply of pressure fluid to the piston rod side of the system is relieved through the passage 96 in the head of the flow control valve which is now in the raised position.

In the hold or float positions the passageways 71, 74, communicating at all times with the opposite ends of cylinder 22 are either completely isolated or connected together. A short transverse, spur passageway 122 is in constant communication with passageway 71 and emergency communication with pump return passageway 66 through a rather small connection passage 124 forming the seat for a valve ball 126 of the check valve 120. The valve ball 126 is on the end of passage 124 adjacent passageway 66 and is normally held seated by a spring 128, retained in position by a threaded plug member 130 closing the outside end of a counterbored continuation 132 of connecting passage 124. Therefore, as is apparent from Fig. 8, check valve 120 will open in one direction to return an excess of pressure fluid in passageway 71 to the pump return passageway 66, whereby it has access to either the pump inlet or the tank through passage 96. Valve 120 is set to open at a pressure greater than that required to open valve 100 so that the smaller valve will never be opened during the lowering operation.

Conventional, fluid seal, packing assemblies 134 are disposed around the piston portions 67 and 68 at opposite ends of housing 32 (Fig. 2) to provide suitable sealing for the reciprocable piston valve 50. The right assembly 134 constantly receives a supply of oil from passageway 56, and the left assembly 134 is connected by a small passageway 136 (Fig. 11) to the bottom of an isolated well space 138 opening into reservoir 34 through a large port 140.

It is to be understood that the above described embodiment of the invention is for the purpose of illustration only and that various changes may be made therein without departing from the scope and spirit of the invention.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A fluid pressure system comprising, a fluid pressure motor having a cylinder and piston; a hydraulic control mechanism connected to opposite ends of the cylinder of said fluid-pressure motor; a fluid-pressure pump having its inlet and outlet connected to said hydraulic control mechanism; a fluid reservoir for said hydraulic control mechanism; and selectively operable means for actuating said hydraulic control mechanism, said hydraulic control mechanism including a valve housing, ported passageways within said housing connecting the opposite ends of the cylinder of said fluid-pressure motor, passageway means formed and arranged to supply fluid from the outlet of the fluid-pressure pump alternatively to the said ported passageways for the said opposite cylinder ends, a check valve in said passageway means constructed and arranged to prevent return flow of the outlet of the fluid-pressure pump, a passageway for connecting the outlet of the fluid-pressure pump to said fluid reservoir, a conduit for connecting said fluid reservoir to the inlet of the fluid-pressure pump, a passageway formed and arranged to withdraw fluid alternatively from the said ported passageways for the said opposite cylinder ends, a conduit connecting the pump inlet to said reservoir, said withdrawing passageway having a connection to said last mentioned conduit, a valve responsive to pressure

in said withdrawing passageway to open the connection to the said conduit and to simultaneously restrict flow from the reservoir to the pump inlet when in one position; and to connect said reservoir through said conduit to the pump inlet while blocking the withdrawing conduit in another valve position, and a piston valve controlled by the selectively operable means and formed and arranged to close and open selectively the aforesaid passageways to move the piston of said fluid-pressure motor in either direction.

2. The combination of claim 1 in which the pressure responsive valve has a relatively small opening therein for connecting the fluid reservoir to the passageway for withdrawing fluid from the ported passageways for the said opposite cylinder ends.

3. The combination of claim 1 in which a compensating check valve is arranged to provide restricted discharge of an excess of fluid into said withdrawing passageway from one of said ported passageways having connection with a cylinder end.

4. The combination of claim 1 in which a packing assembly surrounds one end of the piston valve, and a fluid connection extends between the reservoir below the level of the liquid therein and said packing assembly to insure a fluid seal.

5. A fluid pressure system comprising, a fluid pressure motor having a cylinder and piston; a hydraulic control mechanism connected to opposite ends of the cylinder of said fluid-pressure motor; a fluid-pressure pump having its inlet and outlet connected to said hydraulic control mechanism; and a fluid reservoir for said hydraulic control mechanism, said hydraulic control mechanism including a valve housing, ported passageways within said housing connecting the opposite ends of the cylinder of said fluid-pressure motor, passageway means formed and arranged to supply fluid from the outlet of the fluid-pressure pump alternatively to the said ported passageways for the said opposite cylinder ends, a check valve in said passageway means constructed and arranged to prevent return flow to the outlet of the fluid-pressure pump, a passageway for connecting the outlet of the fluid-pressure pump to said fluid reservoir, a passageway formed and arranged to withdraw fluid alternatively from the said ported passageways for the said opposite cylinder ends, a conduit connecting the pump inlet to said reservoir, said withdrawing passageway having a connection to said last mentioned conduit, a valve responsive to pressure in said withdrawing passageway to open the connection to the said conduit and to simultaneously restrict flow from the reservoir to the pump inlet when in one position; and to connect said reservoir through said conduit to the pump inlet while blocking the withdrawing conduit in another valve position, a piston valve formed and arranged to close and open selectively the aforesaid passageways to move the piston of said fluid-pressure motor in either direction, said piston valve having alternate lands and passages spaced thereon to cooperate with the passageways to cause reservoir to pump to reservoir circulation when the ported passageways are separated from each other and from the outlet of the pump, or when they are freely connected together, and to cause cylinder to pump to cylinder circulation when either end of the cylinder is connected to the pump outlet.

6. A hydraulic control mechanism, comprising in combination a valve housing; a fluid reservoir for supplying fluid to the valve housing; multi-ported valve means operable within said valve housing, a fluid-pressure pump, the valve housing being formed to provide connections to the pump inlet and outlet, connections within the housing for said pump inlet and outlet to opposite ends of a fluid-pressure motor, and open communication at several spaced points with said fluid reservoir, and said multi-ported valve means being constructed and arranged to control fluid flow between said connections to pass pressure fluid from the pump outlet connection alternatively to either fluid-pressure motor connection and to pass fluid alternatively from the remaining fluid-pressure motor connection to the pump inlet connection when in one position; to connect the pump inlet connection to the pump outlet connection through said fluid reservoir and to connect the fluid-pressure motor connections with each other when in another position; a check valve in the connection between the pump outlet and the fluid-pressure motor connections; and a control plunger in the connection from the pump inlet to the motor and responsive to pressure therein, one of said reservoir communications leading to the pump inlet and said plunger being arranged to close the last mentioned communication under the action of said pressure and simultaneously to open communication between the pump inlet and motor exhaust.

7. A hydraulic control mechanism, comprising in combination a valve housing; a fluid reservoir mounted above the valve housing; a multi-ported piston valve operable within said valve housing, a fluid-pressure pump, the valve housing being formed to provide connections to the pump inlet and outlet, connections within the housing for said pump inlet and outlet to opposite ends of a fluid-pressure motor, and open communication at several spaced points with said fluid reservoir, and said multi-ported piston valve being constructed and arranged to control fluid flow between said connections to pass pressure fluid from the pump outlet alternatively to either fluid-pressure motor connection and to pass fluid alternatively from the remaining fluid-pressure motor connection to the pump inlet when in one position; to connect the pump inlet connection to the pump outlet connection through said fluid reservoir and to connect the fluid-pressure motor connections with each other when in another position; a check valve in the connection between the pump outlet and the fluid-pressure motor connections; and a control plunger in the connection from the pump inlet to the motor and responsive to pressure therein, one of said reservoir communications leading to the pump inlet, said plunger being positioned to close the pump inlet to reservoir communication under the action of said pressure and simultaneously to open communication between the pump inlet and the motor.

8. A hydraulic control mechanism, comprising in combination a valve housing; a fluid reservoir mounted above the valve housing; a multi-ported piston valve operable within said valve housing, a fluid-pressure pump, the valve housing being formed to provide connections to the pump inlet and outlet, connections within the housing for said pump inlet and outlet to opposite ends of a fluid-pressure motor, and open communication at several spaced points with said fluid reservoir, and said multi-ported piston valve

being constructed and arranged to control fluid flow between said connections to pass pressure fluid from the pump outlet connection alternatively to either fluid-pressure motor connection and to pass fluid alternatively from the remaining fluid-pressure motor connection to the pump inlet when in one position, to connect the pump inlet connection to the pump outlet connection through said fluid reservoir and to connect the fluid-pressure motor connections with each other when in another position; a check valve in the connection between the pump outlet and the fluid-pressure motor connections; a control plunger in the connection from the pump inlet to the motor and responsive to pressure therein, one of said reservoir communications leading to the pump inlet and said plunger being arranged to close the last mentioned communication under the action of said pressure and simultaneously to open communication between the pump inlet and motor exhaust, and a relief valve for discharging fluid from the fluid-pressure motor side of the check valve to the connection to the inlet of the fluid-pressure pump.

9. A hydraulic control mechanism, comprising in combination a valve housing; a fluid reservoir for supplying fluid to the valve housing; multi-ported valve means operable within said valve housing, a fluid-pressure pump, the valve housing being formed to provide connections to the pump inlet and outlet, connections within said housing for said pump inlet and outlet to opposite ends of a fluid-pressure motor having a double-acting piston with a piston rod on only one end, and open communication at several spaced points with said fluid reservoir, and said multi-ported valve means being constructed and arranged to control fluid flow between said connections to pass pressure fluid from the pump outlet alternatively to either fluid-pressure motor connection and to pass fluid alternatively from the remaining fluid-pressure motor connection to the inlet to the fluid-pressure pump when in one position; to connect the pump inlet connection to the pump outlet connection through said fluid reservoir and to connect the fluid-pressure motor connections with each other when in another position; a check valve in the connection between the pump outlet and the fluid-pressure motor connections; a control plunger in the connection from the pump inlet to the motor and responsive to pressure therein, one of said reservoir communications leading to the pump inlet and said plunger being arranged to close the last mentioned communication under the action of said pressure and simultaneously to open communication between the pump inlet and motor exhaust, and means for compensating under any of the above connections for the unequal fluid displacements of the fluid-pressure motor due to its piston rod.

10. An open and closed hydraulic system comprising in combination a double-acting hydraulic motor; a continuously operable hydraulic pump; a reservoir tank for hydraulic fluid; a control valve for the hydraulic motor; a conduit connecting the tank to the control valve; a conduit connecting the inlet side of the pump to the control valve; a conduit connecting the outlet side of the pump to the control valve; and conduits connecting the opposite ends of the hydraulic motor respectively to the control valve, said control valve including a housing, a valve member formed to provide fluid passage therepast at a plurality of points and movable within the housing, said housing being formed with passages and ports arranged for selective cooperation with said valve member to place either end of the hydraulic motor in fluid communication with the outlet side of the pump while the other end thereof is placed in fluid communication with the inlet side of the pump, and to provide for flow from one end of the hydraulic motor directly to the other, a check valve arranged to control the entrance of high pressure fluid from the outlet side of the pump to the control valve, a fluid pressure actuated flow control valve member disposed within the housing of the control valve and constructed and arranged to automatically restrict flow of hydraulic fluid from the reservoir tank to the control valve when the hydraulic motor is being operated in either direction and to place the inlet side of the pump in communication with the reservoir tank when the control valve is in either a float position connecting the opposite ends of the hydraulic motor to each other or a hold position in which return flow from both ends of the hydraulic motor is prevented.

11. An open and closed hydraulic system comprising in combination a double-acting hydraulic motor; a continuously operable hydraulic pump; a reservoir tank for hydraulic fluid; control valve means for the hydraulic motor; a conduit connecting the tank to the control valve; a conduit connecting the inlet side of the pump to the control valve means; a conduit connecting the outlet side of the pump to the control valve means; conduits connecting the opposite ends of the hydraulic motor respectively to the control valve means, said control valve means being constructed and arranged selectively to place either end of the hydraulic motor in fluid communication with the outlet side of the pump while the other end thereof is placed in fluid communication with the inlet side of the pump, and to provide for flow from one end of the hydraulic motor directly to the other; a check valve arranged to control the entrance of high pressure fluid from the outlet side of the pump to the control valve means; and a flow control valve connected with the control valve means and constructed and arranged to operate independently of the control valve to restrict flow of hydraulic fluid from the reservoir tank to the control valve means when the hydraulic motor is being operated in either direction and to place the inlet side of the pump in communication with the reservoir tank when the control valve means is in either a float position connecting the opposite ends of the hydraulic motor to each other or a hold position in which return flow from both ends of the hydraulic motor is prevented, the control valve means being arranged to place the outlet side of the pump in communication with the reservoir tank when the same is in float or hold positions.

12. An open and closed hydraulic system comprising in combination a double-acting hydraulic motor; a continuously operable hydraulic pump; a reservoir tank for hydraulic fluid; control valve means for the hydraulic motor; a conduit connecting the tank to the control valve; a conduit connecting the inlet side of the pump to the control valve means; a conduit connecting the outlet side of the pump to the control valve means; conduits connecting the opposite ends of the hydraulic motor respectively to the control valve means, said control valve means being constructed and arranged selectively to place either end of the hydraulic motor in fluid communication with the outlet side of the pump while the other end thereof is placed in fluid communication with the

inlet side of the pump; and a flow control valve hydraulically connected with the control valve means and constructed and arranged to limit flow of hydraulic fluid from the reservoir tank to the control valve means when the hydraulic motor is being operated in either direction and to place the inlet side of the pump in communication with the reservoir tank when the control valve means is in a hold position in which return flow from both ends of the hydraulic motor is prevented, the control valve means being arranged to place the outlet side of the pump in communication with the reservoir tank when the same is in hold position.

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