

Aug. 6, 1940.

H. O. DAY

2,210,144

HYDRAULIC CONTROL APPARATUS

Filed June 22, 1939

2 Sheets-Sheet 1

FIG. 3.

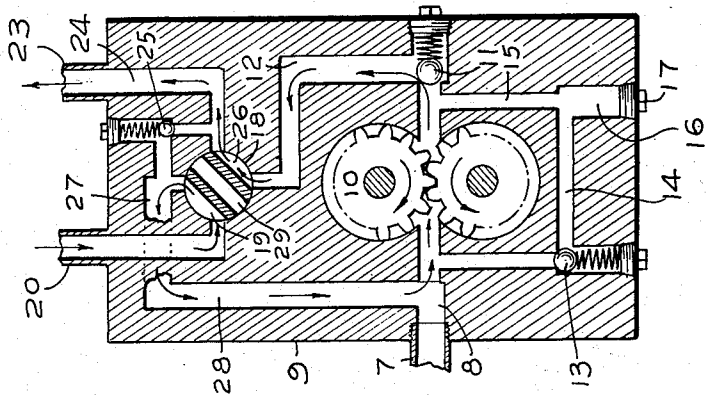


FIG. 2.

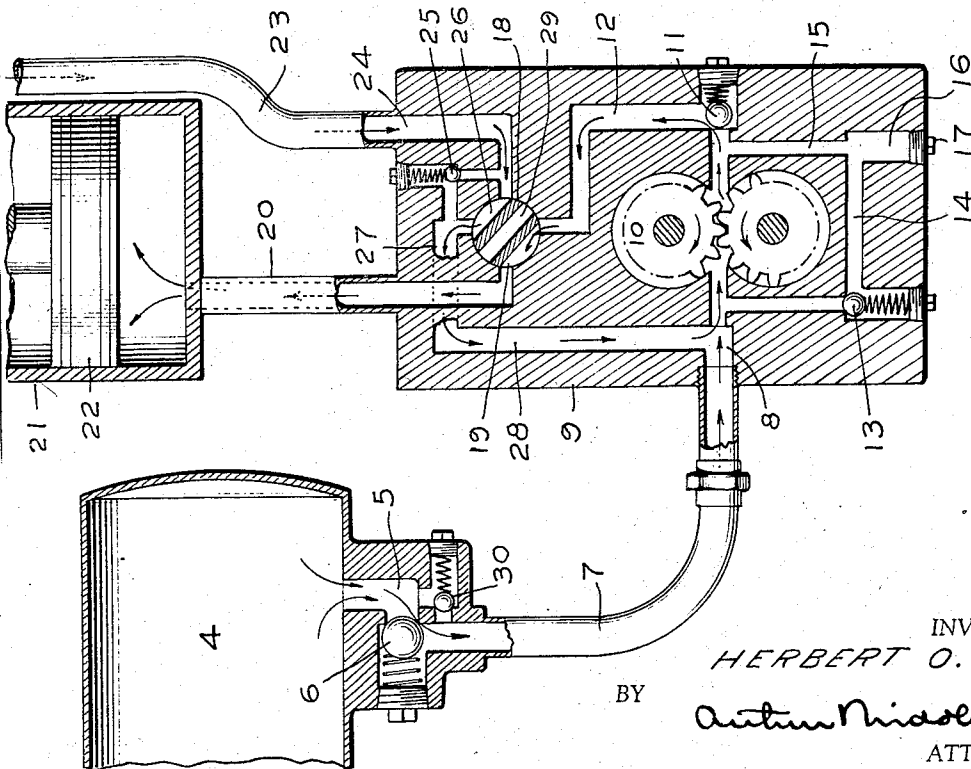
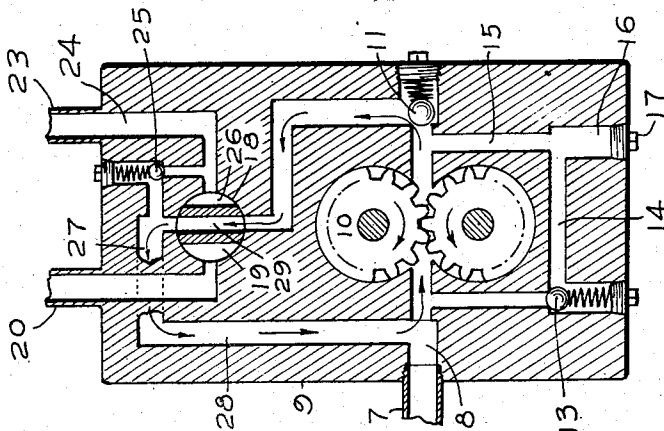


FIG. 1.

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FIG. 6.

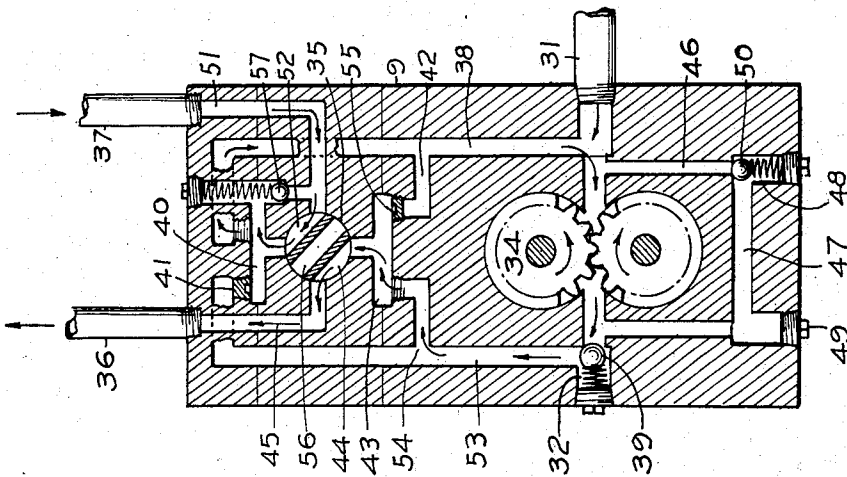


FIG. 5.

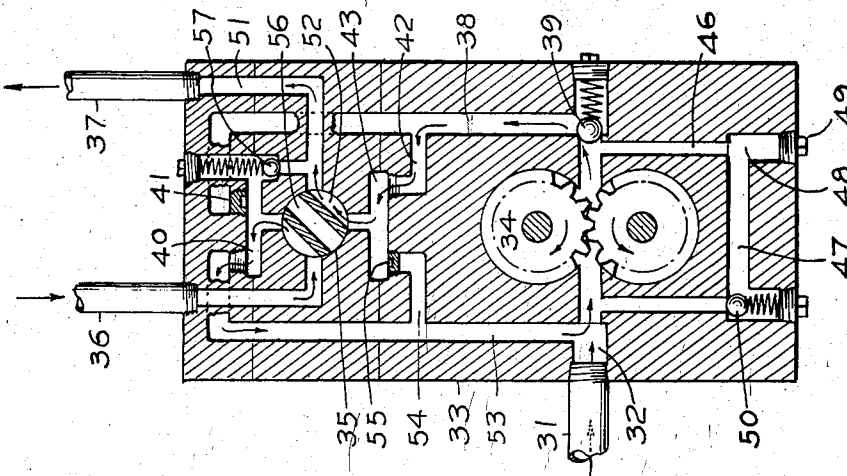
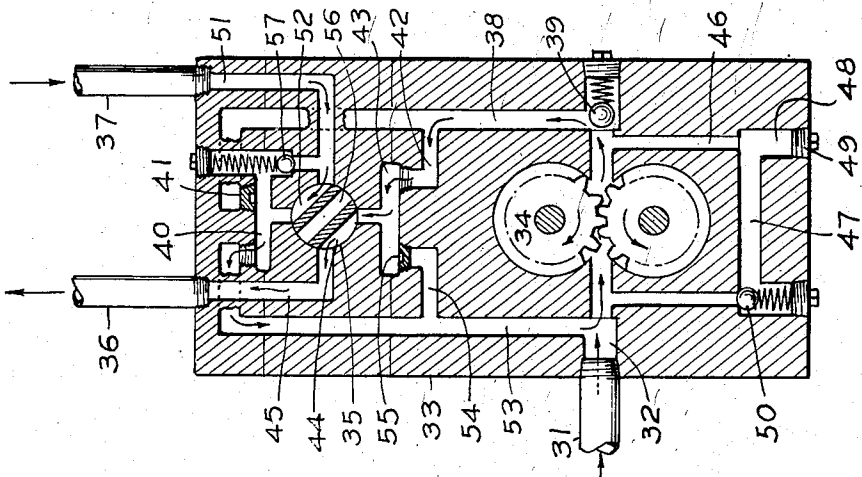


FIG. 4.



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2,210,144

HYDRAULIC CONTROL APPARATUS

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Application June 22, 1939, Serial No. 280,547

2 Claims. (Cl. 60—52)

This invention relates to hydraulic power cylinders or jacks and, more particularly, to fluid circulatory systems and valve and pump arrangements for the operation and control thereof. It is particularly embodied in an improved hydraulically operated apparatus which is advantageous in the raising and lowering of truck dump bodies and is highly efficient in such operations where the truck body is to be raised to a high dumping position, generally one which is beyond the perpendicular, that is, past the center of gravity of the body.

A prime object of the invention is to provide an operating fluid circulatory system and means for control thereof which may be used with practically any hydraulically operated power cylinder and which is rugged, simple and highly efficient.

Another object is to provide an improved system of control for hydraulic power cylinders which is simply and effectively operable to supply fluid under pressure to either end of the cylinder or to maintain the same in inoperative position.

Another object is to provide for automatically relieving pressure within the fluid circulatory system when the same becomes higher than desired.

A further object is to provide a circulatory system having means for positively preventing gravity return of the dump body should the pumping mechanism become inoperative while the control valve is in the raising position.

A still further object of the invention is to provide a pumping and control system wherein the full pump pressure is applied to the piston when the mechanism is in the operation of raising the body.

Yet another object is to provide a pumping and control system which is completely reversible so that it may be connected with the source of fluid supply at either side and so that it may operate effectively in no matter which direction the pump is driven.

With these and other objects in view, the invention consists in the construction and novel combination and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings, and set forth in the claims hereto appended, it being understood that various changes in the form, proportion and minor details of construction, within the scope of the claims, may be resorted to without departing from the spirit of the invention or sacrificing any of the advantages thereof.

Fig. 1 is a plan view more or less diagrammat-

ically performed, of a fluid circulatory system for hydraulic power systems which embodies features of the present invention and showing the pump, valve manifold, control valve and portions of the cylinder and the fluid reservoir or supply tank, the control valve being shown in raising position, that is in position to force the piston outwardly within the cylinder.

Fig. 2 is a diagrammatic plan view of the valve manifold, pump and control valve and showing the valve in locked position whereby the piston is held stationary at any point, though the pump be maintained in operation.

Fig. 3 is a view similar to Fig. 2 but showing the control valve in lowering position, that is in position to allow lowering of the dump body or return of the piston toward the rear end of the cylinder.

Fig. 4 is a diagrammatic plan view of a valve manifold, pump and control valve of a modified form of the invention, showing the control valve in the lifting position.

Fig. 5 is a view similar to Fig. 4 but showing the control valve in lowering position.

Fig. 6 shows the assembly of Figs. 4 and 5, with the valve in the lifting position, but with various parts interchanged in order to operate with the gear pump operating in a direction opposite to that of Figs. 4 and 5.

Generally speaking, the arrangement of the present invention includes a cylinder having a piston therein with a piston rod projecting through the outer end of the cylinder, the free end of the piston rod being connected with a truck dump body or other body to be actuated by movement of the piston and piston rod. A fluid reservoir is provided for containing oil or other suitable actuating fluid and the said reservoir is connected by means of a conduit with a manifold containing a pump for supplying fluid from the reservoir to the cylinder at one side or the other of the piston, and a control valve for directing the fluid to either side of the piston or for circulating the fluid through the pump and a neutral sector of the valve and thus maintaining the piston in inoperative position even though the pump be functioning. A system of check valves is provided in the fluid circulatory system for properly controlling the application of pressure and certain of these valves are arranged so as to relieve pressure within the system should the same be built up to an undesirable extent.

Referring first to Fig. 1, wherein the control valve is positioned to supply liquid under pressure to the rear end of the cylinder and thus

force the piston outwardly, the numeral 4 represents a supply tank or reservoir for the actuating fluid, preferably oil. The reservoir 4 connects through a channel 5, check valve 6 (lightly spring-pressed as hereinafter more fully described) and conduit 7 with inlet passageway 8 of a pump chamber and valve manifold 9, the conduit preferably being detachably screw-threaded into the passageway 8. From the inlet passage 8 oil is drawn by the gear pump 10 and forced past the check valve 11 and through the passageway 12, the check valve 13 remaining closed due to back pressure of the oil which will be filling passages 14 and 15 and compartment 15 16 which is normally closed by a plug 17.

With the three-way control valve 18 in the position shown, oil will be forced through the passage 12 and through the port 19 of the control valve and thence through the conduit 20 into the rear end of the cylinder 21 in the rear of the piston 22, thus forcing the same outwardly and raising the truck dump body. At the same time oil in the cylinder 21 in front of the piston 22 will be forced by the same out of the outer end of the cylinder through appropriate check and relief valves and through return conduit 23 into passageway 24 in the manifold 9. Relief valve 25, being set to operate only under relatively high pressures, the returning oil will flow through port 26 of the control valve 18 and through passageways 27 and 28 back into the manifold supply passageway 8 where it will proceed through the pump 10 and on into the rear end of the cylinder. All of the oil returned from the head end of the cylinder through return conduit 23 and valve passageway 26 will be transferred by the pump directly to the rear end of the cylinder by the piston 22. However, due to displacement of the piston rod it will manifestly require more oil to fill the space behind the piston than will be forced out from the cylinder ahead of the piston. To this end the check valve 6 is under only a relatively slight tension, sufficient merely to prevent leakage of oil by gravity from the reservoir 4. Therefore, only a slight amount of pull or suction from the pump 10 is sufficient to unseat the valve 6 enough to permit make-up fluid to be drawn into the pump and manifold so as to fill the rear end of the cylinder. In Fig. 2 of the drawings the control valve 18 is shown in locked position whereby the piston 22 is maintained stationary at any point in its travel even though the pump 10 be still functioning. Under this condition oil pumped past the check valve 11 into passageway 12 will flow therefrom through the middle port or sector 29 of the control valve 18 and thence through the passageways 27 and 28 back to the manifold supply passageway 8 and thence again through the pump. The valve ports 19 and 26, being completely out of communication with any of the flow passageways, oil in the cylinder and in the passageways 20, 23 and 24 will remain in static condition and the piston will be held stationary at any desired point.

In Fig. 3, in lowering the dump body or forcing the piston inwardly by pressure, oil is forced by the pump 10 past the check valve 11 through the passageway 12 and through port 26 of the control valve 18, through passage 24 and conduit 23 to the head end of the cylinder in front of the piston to thus force the same rearwardly, it being remembered that relief valve 25 is set to respond only to very high pressures. Oil returning from the rear end of the cylinder through conduit 20 passes

through port 19 of the control valve and through passageways 27 and 28 back to the manifold supply passageway 8 where it is carried through the pump and on into the outer end of the cylinder. Now, due to displacement of the piston rod, more oil must return from the rear end of the cylinder in back of the piston than can be pumped into the front end of the cylinder ahead of the piston. Therefore, a quantity of the oil returned through conduit 20 must return to the reservoir 4. This is accomplished through the relief valve 30, the check valve 6 being positively seated by back pressure in the conduit 7 and relief valve 30 opening when the back pressure has become sufficient to overcome the tension of said relief valve.

To clearly understand the actual operation of the system of this invention, and the important part played by the several check valves, Fig. 1 is again referred to. In this figure, as before indicated, the check valve 6 is held under only a very slight tension, just sufficient to prevent gravity leakage of oil from the reservoir but will be positively seated by any back pressure in the conduit 7. Assume the relief valve 30 to be set at twenty pounds, the by-pass valve 13 at one pound, the check valve 11 at one pound and the relief valve 25 at 250 pounds. Oil pumped by the pump 10 will readily unseat valve 11 set at one pound and valve 13 will be held positively closed by oil in the passageways 14 and 15 and chamber 16, on the high pressure side of the pump. Oil returning through the conduit 23 and passageway 24 will normally flow through the valve port 26 and back to the pump, since the relief valve 25 is set at 250 pounds. In this position of the control valve it will be noted that there is no relief valve operable on the high pressure side of the pump so that the full pump pressure may always be applied to the piston in its outward stroke. Ultimate relief for the fluid under pressure will normally be provided when the piston 22 reaches the outer limit of its stroke through valve arrangements near the outer end of the cylinder preferably similar to those shown in my co-pending application Serial No. 201,733, April 13, 1938. The provision of the check valve 11 in the high pressure line prevents gravity return of the piston 22 should the drive connection for the pump 10 be broken or the pump otherwise become inoperative. Without the check valve 11, in the event the pump drive were broken, the dump body and piston 22 would return by gravity, the returning fluid forcing the pump gears to rotate in a direction opposite to normal, thus allowing the body to drop with tremendous velocity on the truck chassis. In the present arrangement, upon failure of the pump 10, back pressure of the oil in the passageway 12 will immediately seat the valve 11 and prevent any return whatever of the piston 22.

In returning the piston 22 by power with the valve in the position of Fig. 3, the pressure in the passageway 12, port 26, passageway 24 and conduit 23 and in the cylinder ahead of the piston will obviously be built up to a tremendous degree if the piston 22 reaches the rear limit of its travel and the pump 10 continues to operate. Upon the establishing of this condition the relief valve 25 comes into play. This valve is set at, say 250 pounds, which, in the specific illustration herein, is sufficient to return the piston 22. When the piston reaches the rear limit of its travel the pressure in the high pressure side of the circuit will immediately begin to build up. How-

ever, upon reaching 250 pounds, which is insufficient to cause any damage or breakage in the system, the valve 25 will be unseated, permitting fluid to exhaust or by-pass into passage 27 and through passage 28 and back through the pump 10 and thus prevent any damage to the system or breakage of the pump or its driving mechanism.

Provision is also made, with the valve in the position of Fig. 3 for allowing the dump body to return to its lower position by gravity, that is, with the pump 10 not functioning and with the dump body, of course, back of the center of gravity. This operation is efficiently permitted through the agency of the check valve 13. Assume the control valve 18 to be in the position of Fig. 3, the pump 10 not functioning and the piston 22 returning toward the rear of the cylinder under the influence of gravity, the fluid returning through conduit 20 and through the valve port 19 and passageways 27 and 28. Obviously, pressure will be built up in the manifold supply passage 8 and conduit 7. This pressure will maintain the check valve 6 closed and the relief valve 30 will not operate until the pressure is twenty pounds or more. Since the check valve 13 is set at only one pound the same will open and permit this liquid to flow into passageways 14 and 15 and thence past check valve 11 also set at one pound and through passage 12, valve port 26, passage 24 and conduit 23 to the head end of the cylinder. As the surplus oil coming from the rear end of the cylinder and not accommodated at the head end thereof due to displacement of the piston rod, raises the pressure above twenty pounds the relief valve 30 will unseat and permit the surplus liquid to return to the reservoir 4. A further feature of the present arrangement is that the pump and valve manifold assembly is completely reversible, so that it may be conveniently mounted on either side of the truck chassis and may be easily connected with the reservoir regardless of the location of the same. As shown in the drawings, the reservoir 4 is connected with the manifold at the left side thereof. Should it be desired to reverse this arrangement, all that is necessary is that the check valve 11 be removed and the conduit 7 connected with the opening wherein the screw-threaded base of the said check valve is located in the present illustrations. The said check valve 11 will then be inserted in the opening indicated at 8 in the present example. The plug 17 will be removed and the check valve 13 inserted in its place, whereupon the plug 17 will be utilized to stop up the opening vacated by the valve 13 in reversing its position. Now the flow of the actuating liquid will be exactly the reverse of that shown in the illustrated examples. In other words, the raising position of the control valve 18 will be that of the present Fig. 3 and the lowering position of the same will be as now seen in Fig. 1. In other words, in raising the dump body oil will be forced by the pump 10 through the passageways 28 and 27 (Fig. 3), through the valve port 19 and conduit 20 into the rear of the cylinder. Oil returning through the conduit 23 will flow through valve port 26 and back to the suction side of the pump. In lowering (Fig. 1) oil will be forced through passages 28 and 27, valve port 26, passageway 24 and conduit 23 to the head end of the cylinder, while returning oil will flow through valve port 19 and back through the pump, the surplus by-passing back into the reservoir 4 as previously

described. In lowering by gravity the check valve 13 will operate just as previously described to allow oil to pass through passageway 14 into passageways 28 and 27 and thence back to the head end of the cylinder, with surplus oil from the rear of the cylinder being relieved through relief valve 30 as previously fully discussed. The locked position of Fig. 2 would allow the circulation to function in the same manner as previously described except that the direction will be exactly reversed.

Thus it will be seen that there is provided a compact manifold containing pump and control valve with by-pass and relief valve arrangements to insure circulation of the fluid in the exact manner desired and which are effective at all times to prevent any damage to the system through abnormally high fluid pressures. Further, the manifold, complete in itself, can be located at practically any point, no matter how remote from the hydraulic cylinder and from the supply reservoir. It is furthermore completely reversible so as to be positioned at either side of a truck chassis or so that it can be made to function in identical manner, no matter in which direction the gear pump is rotated. This is sometimes an important feature because the apparatus can be located at either side of the drive shaft of the truck, from which power for the pump is commonly derived, and made to function perfectly, by a simple interchange of check valves, no matter in which direction it is desired to rotate the gear pump.

From the foregoing description of the form of the invention shown in Figs. 1, 2 and 3, it will be apparent that, in order to reverse the supply connection 7 and also drive the pump in the opposite direction this will also necessitate a reversal of the direction of flow of the operating fluid throughout the various manifold passages, as well as necessitating reversed valve positions for the several functions of the apparatus. Where these features are not objectionable, this form of the invention will find advantage in its relative simplicity and minimum number of parts required to be interchanged for reversal of the operation. However, in Figs. 4, 5 and 6 there is shown a modification of the invention which, while somewhat more complicated than the form just described, provides for reversing the rotation of the pump gears and thus forcing the liquid through the manifold in reverse direction, while at the same time the control valve always assumes the same positions for the several functions of the apparatus regardless of the direction of rotation of the pump gears or the flow of liquid.

Fig. 4 shows, substantially as in Figs. 1, 2 and 3, the fluid supply conduit 31 communicating with the inlet passageway 32 of the valve manifold 33 which is provided with a gear pump 34 and control valve 35 for a hydraulic cylinder which is connected with the manifold through the conduits 36 and 37. The inlet passageway 32 communicates with the gear pump 34 which communicates at its opposite side with the passageway 38, the same being normally closed off by the check valve 39. The passageway 38 extends upwardly and communicates with a transverse intercepting passageway 40 but is closed off, in the case of Figs. 4 and 5, by the plug 41. The passage 38 has a branch passageway 42 which communicates freely with another transverse passageway 43, fluid being free to flow into

the passageway 43 with the elements in the position of Figs. 4 and 5.

With the control valve 35 in the raising position of Fig. 4, oil is drawn by the pump 34 from the inlet 32 and forced past the check valve 39 and through the passageway 38. Since the upper end of this passageway is closed by the plug 41, the oil flows through the branch 42 and into the transverse passageway 43, thence flowing through the port 44 of the control valve and through the passage 45 and conduit 36 into the cylinder to force the piston outwardly.

Pressure of the oil on the high pressure side of the pump within the passageways 46 and 47 and chamber 48, closed by plug 49 will maintain the valve 50 closed. Oil returning from the head end of the cylinder through the conduit 37 enters the passageway 51 and flows through the port 52 of the control valve and into the transverse passageway 40 whence, the plug 41 being in the position shown, it flows into the passageway 53 with which it is now in open communication, to be returned to the inlet passageway 32 and carried through the pump and forced on into the rear end of the cylinder. Make-up fluid required by the piston displacement will be drawn from the reservoir in a manner heretofore explained. While the passageway 53 has a branch 54 which communicates with the transverse passageway 43, oil cannot flow from one to the other, in Figs. 4 and 5, due to the presence of the plug 55 being in the position shown. If the piston reaches the end of its outward travel and the pump is still kept in operation, pressure will be relieved by the customary relief valves at the head end of the cylinder as previously indicated.

With the valve 35 in the lowering position of Fig. 5, lowering or return of the piston is accomplished by oil being drawn from the inlet 32 and forced by the pump 34 past the check valve 39 through the passageway 38, its upper terminus closed by the plug 41, through the branch 42 and transverse passageway 43, through the valve port 52, passageway 51 and conduit 37 to the head end of the cylinder, the valve 50 being maintained closed by the high pressure as stated above. Oil returning through the conduit 36 enters the passageway 45 and passes through the valve port 44 into the transverse passageway 40 from which it must escape into the passageway 53, due to the position of plug 41. Since the plug 55 is in the position shown the oil returning through passage 53 is carried back to the inlet 32 for further circulation through the pump. Surplus oil returning from the cylinder will by-pass back to the reservoir substantially in the manner heretofore described.

In returning by gravity, with the pump not being operated, the oil returning through the passage 53 will unseat the valve 50, there now being no high pressure behind it, and flow through the passageways 47 and 46, past the check valve 39 and on to the head end of the cylinder, surplus oil returning to the reservoir when the pressure becomes sufficient to unseat the reservoir relief valve as shown in Fig. 1.

It will be manifest from the drawings that, with the control valve 35 in a neutral position, not shown, the oil will be merely circulated through the passageways 38, 42, 43, valve port 56, and passages 40 and 53 back to the low pressure side of the pump.

When it is desired to reverse the rotation of the pump for any reason, a simple reversal of parts serves to enable the device to operate in

the same manner as just described with the control valve 35 assuming the same positions for its several functions. Such reversed position of parts is illustrated in Fig. 6 where the supply conduit 31 has been connected with the manifold at the opposite side of the pump and the relief valve 39 inserted in the previous inlet passageway 32 as is readily apparent. The positions of the valve 50 and plug 49 are reversed, the valve being inserted in the chamber 48 and the plug 49 taking the position vacated by the valve. The plugs 41 and 55 are also reversed so that the transverse passageway 40 is sealed from the passageway 53 but in communication with the passageway 38, while the transverse passageway 43 is in communication with the passageway 53 but sealed from the passageway 38. Now, with the pump operating in an opposite direction from that of Figs. 4 and 5 fluid supplied by the conduit 31 is forced past the check valve 39 through the passageway 53 and via the branch 54 into the transverse passageway 43, the upper terminus of the passageway 53 being closed by the plug 41. From the transverse passageway 43 the liquid now flows through the valve port 44, passageway 45 and conduit 36 into the rear end of the cylinder to force the piston outwardly. Oil returning through the conduit 37 enters the passageway 51 and flows through valve port 52 into transverse passageway 40 whence it passes into passageway 38 and back to the low pressure side of the pump, the branch 42 being closed by the plug 55. It is obvious that when the valve is reversed to the lowering position, oil forced through the passage 53 will enter the passage 43 and flow through the valve port 52 and thence through the passageway 51 and conduit 37 to the head end of the cylinder, while returning oil will flow through the valve port 44 into the transverse passageway 40 and back to the low pressure side of the pump. With the valve in the neutral position it is obvious that oil will be merely circulated by the communicating passageways without entering either end of the cylinder. In returning by gravity the valve 50 will function in the manner previously described to by-pass the fluid around the pump.

The function of the relief valve 57 is to relieve the pressure if, in lowering by pressure, the piston reaches its rear limit of travel and the pump is continued in operation. This valve is set at a relatively high pressure, as mentioned in connection with Figs. 1, 2 and 3, so that it will be unseated only when an abnormal pressure is built up. The valve is under sufficient tension so that there will always be sufficient pressure in the passageway 51 to lower the dump body or to retard the piston. However, when the piston reaches its rearmost position and the pump continues to operate, a tremendous pressure will be built up in the conduit 51 and conduit 37. The valve 57 will become unseated when this pressure passes a predetermined point and will thus prevent damage likely to be caused by excessive pressure. Looking at Fig. 5, when the pressure in the passageway 51 rises in excess of a predetermined amount, the valve 57 will become unseated allowing fluid to by-pass into the transverse passageway 40 and thence back to the low pressure side of the pump, thereby relieving the excess pressure. With the mechanism reversed as in Fig. 6, and the valve 35 in the position of Fig. 5, the same effect is realized, the excessive pressure in passageway 51 serving to open the valve 57 and allow fluid to by-pass into the transverse passage 75

40 and thence through the passageway 38 back to the low pressure side.

Thus it will be seen that the present modification provides a completely and readily reversible control system but yet permits the control valve to always assume the same positions for its various functions regardless of the positions of the interchangeable elements. Furthermore there is provided means for readily relieving excess pressures regardless of whether the device is arranged for operation of the pump in one direction or the other. The present modification, while not quite as simple as that of Figs. 1, 2 and 3, is of obvious advantage where it is desired that the respective positions of the control valve remain constant regardless of the direction of the pump drive.

The device of the present invention has been described in a particular environment, namely, that of the application to a dumping truck for the purpose of raising and lowering the dump body of the same. It will be manifest, however, that the application and use of the invention are not at all restricted to this environment and that power cylinders embodying features of the invention will find use in many instances where the application of power is necessary or desirable for the moving or actuation of any object.

What is claimed is:

1. A device for supplying and directing the application of actuating fluid to hydraulic power cylinders, comprising a pump, one pump connection at one side thereof, another pump connection at the other side thereof, a control valve construction interposed between the pump and the power cylinder, and operatively connected

with the pump and the power cylinder, said construction comprising a casing, a positionable valve body therein, an in-leading passageway to said valve body, an out-leading passageway from said valve body, a flow connection between the valve body and one side of the power cylinder, another flow connection between said valve body and the other side of the power cylinder, said valve body being positionable and adapted to establish connection therethrough between said in-leading passageway and said one cylinder connection as well as between said out-leading passageway and said other cylinder connection, and also positionable and adapted to establish connection between said in-leading passageway and said other cylinder connection, as well as between said out-leading passageway and said one cylinder connection, conduit means between said one pump connection and said in-leading and said out-leading passageways of the valve, other conduit means between the other pump connection and said in-leading and said out-leading passageways of the valve, and means for optionally preventing communication on the one hand between the first mentioned conduit means and said in-leading passageway as well as between said other conduit means and said out-leading passageway, and on the other hand between said other conduit means and said in-leading passageway as well as between said first mentioned conduit means and said out-leading passageway.

2. A device according to claim 1, in which the pump and the valve construction have a unitary casing construction.

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