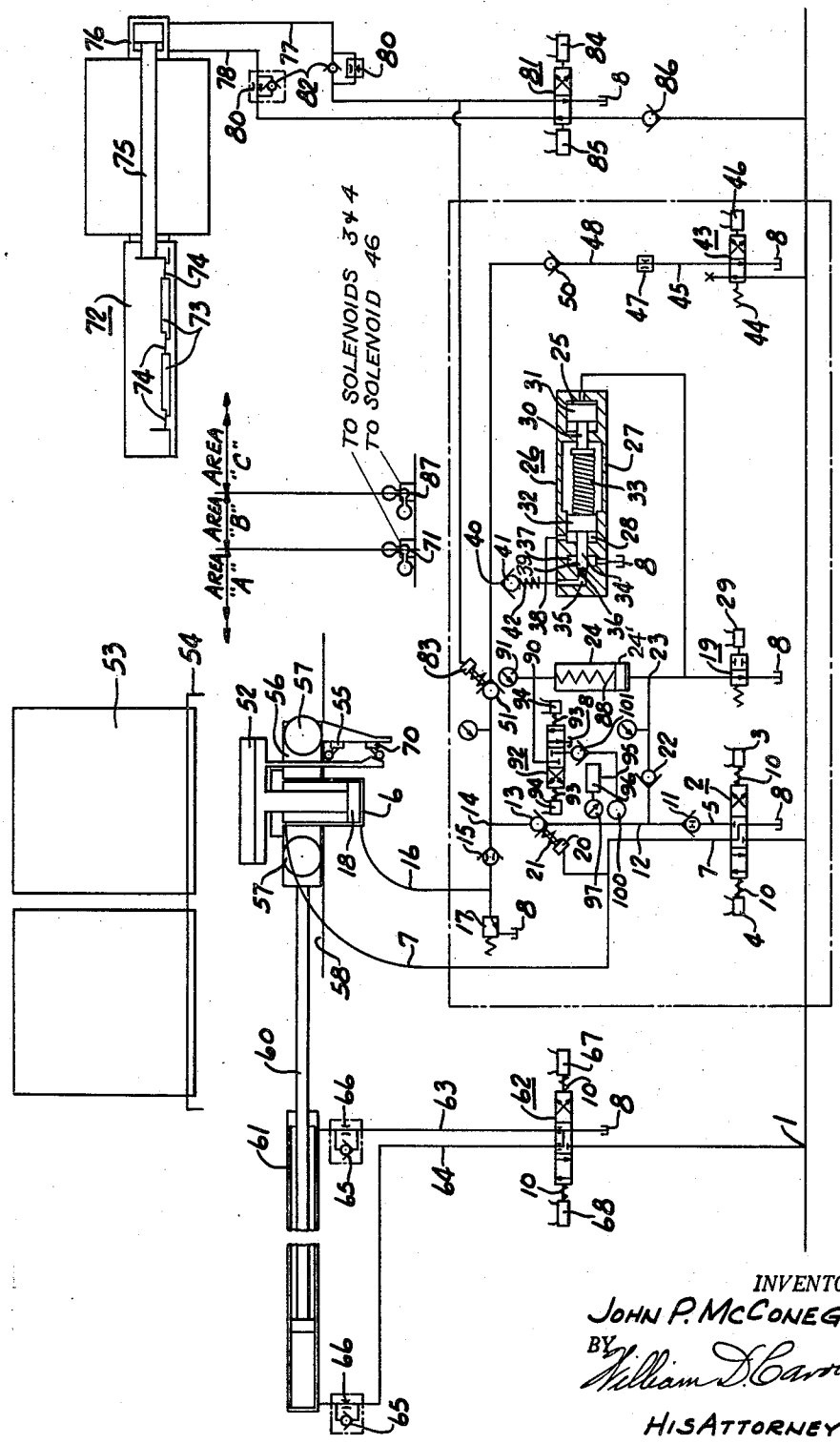
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COIL POSITIONING CONTROL

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COIL POSITIONING CONTROL

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This invention relates generally to a pressure control for a hydraulic cylinder against which a load is applied and more particularly to the pressure control that limits the pressure applied to the cylinder by the present load on the cylinder wherein the cylinder pressure is maintained just a few pounds greater than the load to overcome the same or a few pounds less than the load to be moved.

In the application of hydraulics wherein a cylinder is required to overcome a load this cylinder may be supplied with a hydraulic pressure to balance this load and if this pressure is again applied to overbalance the load it may be so great as to destroy the load or anything connected with the load. By the same token if the hydraulic cylinder is in balanced relation with its load and something is applied to the load to upset this balance such thing or the load may be destroyed because the pressure in the cylinder is insufficient to balance the load and is not alleviated unless by a relief valve which requires a setting that might possibly be greater than the pressure required to injure the load or the thing acting on the load.

To solve this problem it is necessary to charge the cylinder with a sufficient pressure to balance the load and if further operation on the load is necessary then a pressure control device is employed to limit the hydraulic pressure in the cylinder to a few pounds over the load balancing pressure and if in manipulating the load it happens to strike something it will only strike it with the force of the few additional pounds which are gauged to prevent injury to the load or to the thing that is struck.

The principle of this pressure control is applicable to hydraulic cylinders and applied loads for many purposes. A practical embodiment illustrating the principles of this invention is the use of a lift cylinder and coil, which lift cylinder lifts the coil and through a carriage carries it and inserts the same on a payoff reel from which the coil is unwound. The cylinder in raising the coil from storage is required to be expanded by a pressure sufficiently great to overcome the mass of the coil. An additional hydraulic fluid is employed to overcome this mass and raise the coil from its storage position. As the coil is transferred to the payoff reel and is required to be raised or lowered so as to insert the open center of the coil on the expansible payoff reel the pressure control of this invention limits the hydraulic pressure or its discharge to or from the cylinder by a pressure control device that employs relatively few pounds pressure differential from that required to balance the coil so that any movement up or down of the coil by the cylinder would not be destructive to the expansible payoff reel. When the coil is in position the hydraulic cylinder may be contracted and thereby deposit the load of the coil on the reel which may then be expanded to hold the coil while it is unwound from the reel.

If the hydraulic cylinder is required to remove a coil from the reel it may be inserted in the coil and expanded to approximate engagement with the coil. Then the pressure control takes over to allow only that much fluid pressure in the hydraulic cylinder which will just overcome the present weight of the coil. If the reel has been retracted as the cylinder supports the coil it will not push the coil into engagement with the contracted reel greater than a few pounds over that required to balance the coil and thus prevent the destruction of the payoff reel.

The balance of the hydraulic pressure in the cylinder which has expanded to raise and lift the coil is also applied

in a memory accumulator which is effective on the pressure control as the present load on the cylinder. The valve means applying this hydraulic pressure to the cylinder is then closed and a second valve means is opened to apply hydraulic pressure to the cylinder at a materially lower rate, which hydraulic pressure is also subjected to another part of the pressure control that opposes the pressure retained within the memory accumulator. By applying these opposing pressures to a piston the small additional pressure applied to the second valve may then be made to overcome the pressure applied by the memory accumulator and operate the piston to open the valve and alleviate this additional pressure if it is in excess of a predetermined amount. This alleviation thus maintains the initial pressure to balance the coil but allows only a relatively few pounds in addition to move or otherwise place the coil, which additional pressure applied to the cylinder is insufficient to damage the coil or the payoff reel if the coil has bumped into the same.

This circuit is improved by the addition of pilot control check valves between the accumulator and the cylinder and between the control valve and the cylinder. The first of these check valves is employed when the opposite end of the cylinder is charged for the purpose of discharging the cylinder, which pilot opens the check valve to permit full speed lowering of the cylinder.

The second pilot check valve is open when the reel is expanded so that the hydraulic pressure in the cylinder is effective directly on the pressure control in case the expansion of the reel engages the coil requiring increased pressure in the cylinder which is balanced out by the pressure control until the reel is fully expanded.

A limit switch on the contraction of the cylinder may be employed to discharge the memory accumulator in readiness for the next load application on the cylinder.

Two sets of limit switches may be employed to determine when the cylinder is lowered sufficiently to clear the coil on the reel or the skids and another limit switch is employed to determine the extent of the expansion of the cylinder when the coil is raised sufficiently clear of the skids or the reel.

Another limit switch may be employed to transfer the control for applying hydraulic pressure to the cylinder for initially charging the same to that of another valve that subjects a hydraulic pressure differential on the cylinder and on the pressure control which maintains a limited pressure applied to the cylinder when the coil is in the vicinity where it might strike or otherwise injure the reel.

Another object is the provision of an accumulator which retains the pressure and utilizes the same as a memory in controlling the pressure of a device to effect a balance in the control system. This memory accumulator may be pneumatic or mechanical such as those employing a spring for the reaction pressure, or it may be the combination of both the spring and pneumatic pressure controlled by a pre-charge of gas or a supply from a pneumatic pump through a valve. Any type of pressure accumulator could be employed as long as it may be set up and opposed by fluid pressure of the initial charging circuit.

Other objects and advantages appear hereinafter in the following description and claims.

The accompanying drawing shows for the purpose of exemplification without limiting this invention or the claims thereto, certain practical embodiments illustrating the principles of this invention wherein the single FIGURE is a schematic view of the pressure control comprising this invention.

Referring to the drawing, the pressure supply line 1, for example, will contain a hydraulic fluid under pressure of one thousand pounds per square inch. This pressure is applied to a first valve means 2 which is a multiport direc-

tional three-position valve with four connections enclosed in a centered position. This valve is actuated in opposite directions by the solenoids 3 and 4, the solenoid 3 being employed to move to the left and energize the line 5 to expand the cylinder 6 and discharge the opposite side of the cylinder through the line 7 to the tank 8, and the solenoid 4 being employed to move the valve to the right and lower the cylinder 6 through the line 7 by pressure on the line 7 and discharging through the line 5 to the tank 8.

Closed springs 10 are employed to maintain the proper balance on the valve so that when the solenoids are de-energized the valve will remain in its closed position as indicated.

The pressure flowing from the line 1 through the valve 2 and through the line 5 to the orifice check valve 11 is set to provide full speed raising of one hundred inches per minute with the lightest load applied to the cylinder 6. When the line 5 is used to discharge the orifice check valve is of course ineffective.

An extension of the line 5 indicated at 12 passes the fluid for expanding the cylinder 6 through the pilot actuated check valve 13, thence through the line 14 to the orifice check valve 15 which is ineffective in the flow of hydraulic fluid to the cylinder 6 but restricts the flow of fluid from the cylinder 6 when contracting the latter to operate the cylinder at a lowering speed of one hundred inches per minute with the heaviest load applied thereto. The fluid continues the flow through the line 16 to the cylinder 6. A fixed spring pressure relief valve 17 is provided to exhaust the line 16 to the tank 8 when the presure is in excess of the pressure supply.

The cylinder 6 is provided with a piston 18, the opposite side of which is connected by the line 7. The line 7 is also connected to the pressure cylinder 20 of the pilot actuated check valve 13 which when exerted with line pressure will cause the piston 21 to raise the check valve 13 and allow the cylinder 6 to be discharged through the lines 16, 14, 12 and 5 to the tank 8 when the solenoid 4 is energized and the opposite side of the piston 18 is also energized.

The line 12 also passes through the check valve 22 to the line 23 which is directly connected to the memory accumulator 24 and to the pressure chamber 25 of the pressure control means 26. The memory accumulator 24 has a piston 24' biased by the spring 88. The accumulator 24 may be exhausted to the tank 8 through the two-positon single port valve 19 actuated by the solenoid 29 which is spring biased to the position as shown. The pressure control means 26 comprises the housing 27.

The pressure chambers 25 and 28 oppose each other on opposite sides of the piston member 30, the piston 30 having the heads 31 and 32 and biased by the spring 33 to move to the right. The heads 31 and 32 operate in the chambers 25 and 28 respectively. An extension on the head 32 is indicated at 34 which passes into the chamber 35. The chambers 28 and 35 are in effect a single chamber which oppose the chamber 25 and by proportioning the size of the heads 31 and 32 and the pressure of the spring 33 one can effectively control the operation of this pressure control means 26. The extension 34 of the piston has a V-shaped end 36 which cooperates as a valve with port 39 in the chamber 37 which is discharged to the tank 8. The chambers 28 and 35 are connected by the line 38 which is supplied from the line 40 through the check valve 41 having a spring 42 which, for example, may be loaded to require one hundred pounds per square inch. The minimum pressure control means 26 may be said to have a maximum control of three hundred pounds per square inch; otherwise it will be in accordance with the balanced load on the cylinder plus one hundred pounds per square inch. In the structure as shown the exposed areas on the piston heads 31 and 32 are equal.

The line 40 is supplied with hydraulic fluid under pressure from the second valve 43, which is a multiport two-

position valve, of the source of pressure supply 1 which is biased by the spring 44 to move it to the position shown that blocks any supply and allows the line 45 to be exhausted to tank 8. The valve 43 is actuated by the solenoid 46.

When the first valve means 2 is in its off position the second valve means 43 may be energized to supply fluid pressure to the line 45 where it passes through the orifice 47 which has a fixed setting and compensates the pressure for the flow control valve 26 to expand the cylinder 6 at a rate of seventeen hundredths of an inch per second. This corrected flow then travels through the line 48 and the check valve 50 to the line 40 and thence is effective through the check valve 41 of the chambers 28 and 35 and also passes through the pilot control check valve 51 to the line 14 and thence through the orifice check valve 15, line 16, to the cylinder 6. Thus when the first valve means 2 is energized the valve 19 is closed and fluid pressure is admitted to the cylinder 6 to expand the same and also supply the same fluid pressure in the memory accumulator 24. The expansion of the cylinder 6 engages the load which in this instance would be the raising of the piston 18 to lift the platform 52 to engage other loads, such as the coil 53 that is resting on the skids 54. When the platform engages and raises the load off the skids 54 the limit switch 55 is actuated so as to permit the carriage 56 mounted on the wheels 57 to be moved along the track 58 by means of the servomotor such as the piston 60 operating in the cyinder 61 actuated by the multiflow directional three-position valve means 62 which has its intermediate or normal position connected through restrictions to the tank 8 from opposite ends of the cylinder 61 through the lines 63 and 64. Each line 63 and 64 is provided with a check valve 65 to admit fluid to the cylinder at a fast rate but restrict the return flow through the orifice 66 at a slow rate and by energizing the solenoid 67 to move the valve to the right the cylinder 61 is energized to move the carriage 56 to the left. If the solenoid 68 is energized the valves move to the right for the purpose of moving the carriage 56 to the right as shown on the drawings.

The control limit switch 70 on the carriage is to permit the carriage to be operated as it indicates that the platform 52 is lowered sufficiently to avoid contact with the reel or skids 54. The limit switch 55 which represents the upper or expanded position of the cylinder 6 permits the carriage to travel because at this position the load or coil 53 is supported on the reel or the platform 52 and not on the skids 54.

As the carriage 56 is moved to the right it can travel through the distance indicated at area A which permits the coil to be raised or lowered through the operation of the first valve means 2. However when the carriage strikes the limit switch 71 and flops the same to open a circuit to both solenoids 3 and 4 to shut off, the first valve means 2 maintains the fourth valve means 19 closed and maintains energization of solenoid 46 which permits the operation of the second valve means 43 to further expand the cylinder 6 to move the load but at a reduced rate. This allows the pressure to flow to the line 40 where by means of the pressure control means 26 pressure is supplied to expand the cylinder 6 under load at a predetermined limited pressure over that required to balance the load due to the memory accumulator 24 and this additional pressure which ranges from one to three hundred pounds per square inch is supplied at a very low rate of speed so as to permit one to raise the coil to the pressure height so that it may be slid over the expansion reel 72.

The expansion reel 72 is provided with expanding grip members 73 actuated by the wedge type slides 74 operated by the piston rod 75 from the expansion piston motor 76 which is supplied on opposite sides of the piston by the lines 77 and 78, both of which require a limiting orifice 80 to limit the supply of the liquid from the third valve 81. However the check valves 82 do not limit the return flow

from the opposite ends of the piston in the expansion reel. The line 77 is connected to the pilot chamber 83 of the pilot control check valve 51 so that when the line 77 is energized the pilot check valve 51 is open to permit the fluid pressure in the cylinder 6 to be effective in the chambers 28 and 35 of the pressure control means 26.

The third valve means 81 is a multiport two-position valve which either expands or retracts the expansion reel 72 depending upon the energization of the solenoids 84 and 85. When one of the other sides of the piston of the expansion piston motor 76 is energized, the other side is connected by the valve 81 to tank 8. The third valve 81 is supplied with pressure from the supply line through the check valve 86.

When the carriage reaches the position where it actuates the bell crank of the limit switch 87 both the first valve means 2 and the second valve means 43 are deenergized. However the fourth valve means 19 is maintained energized to hold the memory accumulator 24 charged and the coil is then moved on to the expansion reel and when the third valve 81 is energized to expand the reel the pilot check valve is open so as to balance the pressure with the load between the expansion of the reel and the coil. If the reel parts strike the coil in such a way as to add pressure on the cylinder 6 the same will be relieved by the pressure control means 26.

When the carriage is retracted lifting the coil on the expanded reel the limit switches 87 and 71 are returned to the positions shown and the fourth valve means 19 is then deenergized to discharge the memory accumulator 24 and the system connected thereto to the tank 8.

With this pressure control one may be enabled to pick up a coil from the reel without having the memory accumulator by expanding the cylinder 6 to place the platform 52 against the coil, then retracting the reel to allow the coil to rest on the cylinder 6 and partially lower the same, which opens the pilot actuated check valve 13 to charge the memory accumulator 24, and thereafter the control may be transferred to the second valve 43 which will function as before with a memory accumulation pressure on the pressure control means 26.

As previously stated, this type of pressure control device may be used on other cylinders which are required to provide a load regardless of whether it is in the direction of the load application. Each of the solenoids is actuated by a pushbutton and is termined by a release pushbutton except the solenoid 29 which is automatically operated by the limit switch 71.

Either limit switches 55 or 70 must be closed to traverse the carriage in either areas A or B. In this way one cannot change the elevation of the coil or the load during the traverse of the carriage. Limit switch 87 must be actuated before the electric circuit can be changed.

The memory accumulator 24 may be of any suitable design such as a single chamber for the free piston or as shown it may be provided with the spring 88 which pre-loads the piston 24' and which is adjustable for preloading this piston 24' at different selected pressures.

In addition to the spring or in place of the spring the accumulator 24 is provided with the air line 90 which has connected thereto the pressure gauge 91 and is connected to the multidirectional three-position valve 92 which is biased by the springs 93 to maintain the chamber of the memory accumulator 24 under pre-charged conditions. The valve 92 is operated by the solenoids 94 which when selectively energized connects the line 90 with the line 95 which in turn is connected to the pressure chamber 96 having a gauge 97 connected therewith and is supplied by the air compressor 100. A check valve 101 is placed in the line 95 to prevent the return of any fluid from the valve to the compressor and tank 96. Thus the compressor may be employed to supply any suitable air pressure or other gas if required, to the chamber in the memory accumulator 24 and when this chamber reaches the proper gas pressure the valve 92 may be shut off by moving the same to the mid or normal position wherein both the lines 90 and 95 are blocked. In this manner the chamber in the memory accumulator may be charged and held at any predetermined pressure which will be reacted upon by the actual pressure applied in order to supply the proper memory function in the operation of the device. By selectively operating the valve 92 in the opposite direction the chamber of the memory device is connected to tank 8 to discharge the same.

As previously mentioned the memory accumulator may be of any desired form so long as it provides a proper reaction standard against which the fluid pressure in line 23 is effected.

I claim:

1. A pressure control for a hydraulic cylinder limited by the present load on the cylinder compirsing, valve means to charge said cylinder with a hydraulic pressure at a predetermined rate sufficiently to move said load, a memory accumulator connected to receive a hydraulic pressure correlated with the hydraulic pressure applied to the cylinder to move the load, a second valve means to charge said cylinder when said first valve means is shut off and said memory accumulator is isclated from said cylinder, said second valve means adding a charge to said cylinder at a reduced rate and at an additional hydraulic pressure while said memory accumulator remains isolated, a pressure control means having piston means operating in opposed pressure chambers and a cylinder discharge port controlled by said piston means, the first of said pressure chambers subjected to the pressure of said memory accumulator and the second of said pressure chambers subjected to said additional hydraulic pressure to actuate said piston means and alleviate the latter hydraulic pressure through said discharge port when this hydraulic pressure on the cylinder exceeds a predetermined pressure above the original pressure applied to said cylinder by said first valve means to balance the load.

2. The pressure control of claim 1 characterized in that the pressure faces of said piston means in said pressure chambers of said pressure control means are proportionsd to receive directly the hydraulic charge from said memory accumulator.

3. The pressure control of claim 1 characterized in that said piston means is spring-biased.

4. The pressure control of claim 1 characterized by a third valve means to discharge said memory accumulator after having served its purpose.

5. The pressure control of claim 1 characterized by a check valve between said first valve means and said memory accumulator to prevent flow from said first pressure chamber and said memory accumulator and a check valve to prevent flow from said second pressure chamber to said cylinder.

6. The pressure control of claim 1 characterized by a pilot controlled check valve between said memory accumulator and cylinder to prevent fluid flow from said cylinder, said first valve means controlling the exhaust from said cylinder by energizing said pilot control check valve.

7. The pressure control of claim 6 characterized by a second pilot controlled check valve between said cylinder and said second pressure chamber.

8. The pressure control of claim 1 characterized by a pilot controlled check valve between said cylinder and said second pressure chamber.

9. The pressure control of claim 8 which also includes an expansible reel when the load on said cylinder is a coil, the pilot opening said check valve when said reel is expanded to pass the hydraulic fluid from said cylinder to said second pressure chamber and balance the load on said cylinder.

10. The pressure control of claim 1 characterized by an expansible and contractible reel for receiving coils to be unwound thereon, a carriage shiftable to present coils

to said reel, said cylinder mounted on said carriage to hoist said coils for insertion on said reel, a third valve connected to expand and contract said reel, any pressure on the coil created by the expansion of said reel being effective in said second pressure chamber to balance the pressure load and prevent destruction.

11. The pressure control of claim 10 characterized by a limit switch actuated by the movement of said carriage to a predetermined zone approaching said reel to close said first valve means and open said second valve means.

12. The pressure control of claim 10 characterized by a limit switch actuated by the movement of said carriage beyond a predetermined zone adjacent said reel to prevent the operation of both of said first and second valve means.

13. The pressure control of claim 1 characterized by a movable carriage supporting said cylinder, means for moving said carriage, and a limit switch actuated by the extent of expansion of said cylinder with its load to permit movement of said carriage with the load.

14. The pressure control of claim 1 characterized by a movable carriage supporting said cylinder, means for moving said carriage, and a limit switch actuated by the extent of contraction of said cylinder from the load to permit movement of said carriage without the load.

15. The pressure control of claim 1 characterized by orifice limiting means to control the flow of hydraulic fluid in expanding and contracting said cylinder.

16. The pressure control of claim 1 characterized by orifice check valve means in the line from said first valve means to said cylinder to control full speed expansion of said cylinder, an orifice means in the line from said second valve means to said cylinder to control the expansion of said cylinder at a fixed setting, pressure compensated to expand said cylinder at a slow rate, and an orifice check in said cylinder line for full speed contracting said cylinder.

17. The pressure control of claim 1 which also includes a check valve to prevent flow from said second pressure chamber to said cylinder.

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