

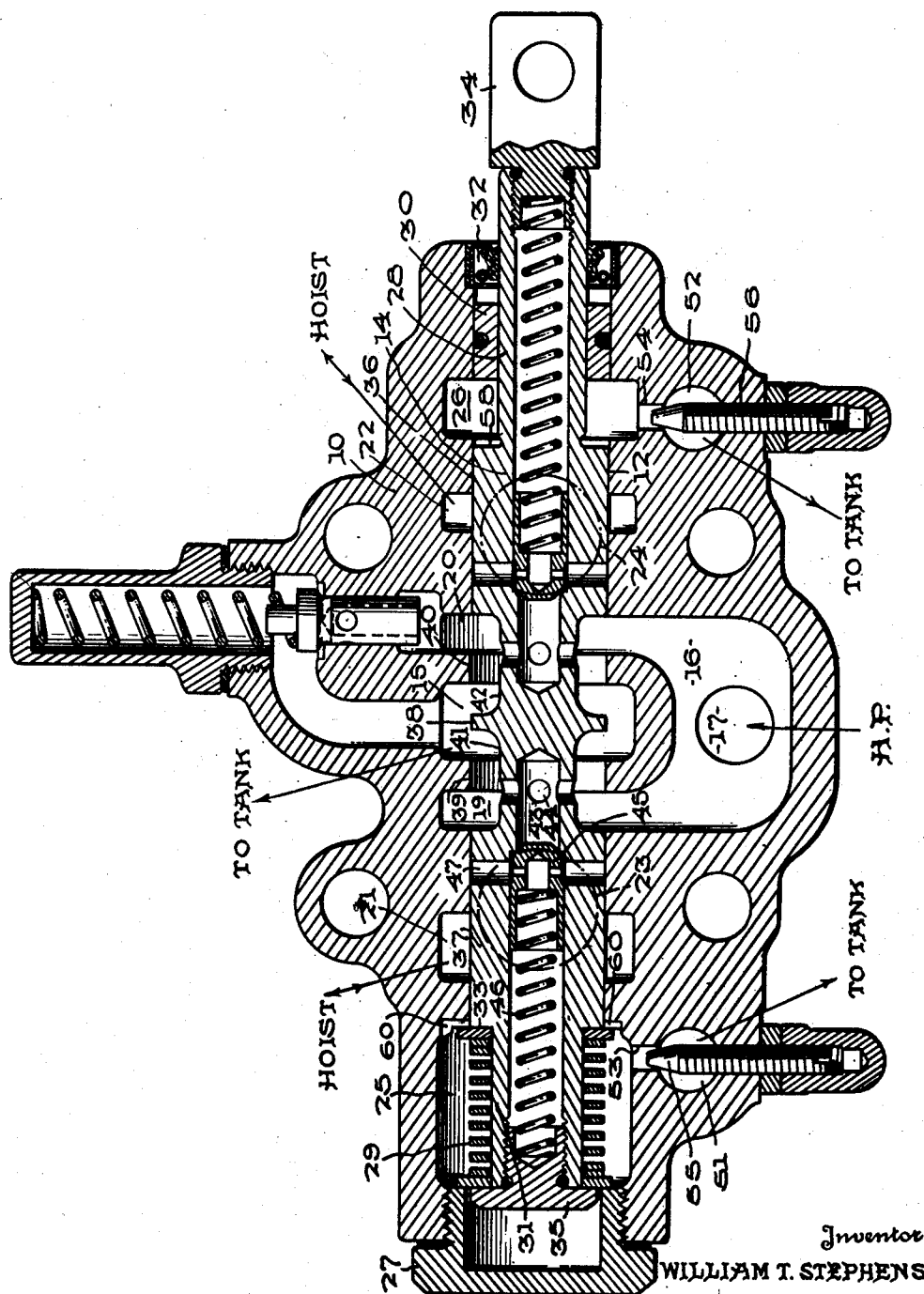
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CONTROL VALVE WITH OPERATING POSITION HOLD

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CONTROL VALVE WITH OPERATING
POSITION HOLD

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This invention relates to manually operated control valves for hydraulic power cylinder systems, and more particularly to such control valves for automatically holding the valve plunger in either of the operating or power positions until the full stroke of the piston in the cylinder is achieved, after which the valve plunger returns to its neutral position where high pressure liquid is by-passed to a tank or reservoir to release the load on the pump.

It is a general object of the present invention to provide a novel and improved control valve for hydraulic cylinder systems.

More particularly it is an object of the invention to provide a control valve for hydraulic cylinder systems in which means is incorporated for hydraulically maintaining the valve plunger in operated position until the piston in the cylinder achieves full stroke or is otherwise mechanically stopped, whereupon the valve plunger is returned to the neutral position.

A still further object of the invention resides in the use of pressure achieved through restriction of the flow of liquid returning from the power cylinder for providing the "hold."

An important feature of the invention comprises the arrangement of restricted discharge passages for the low pressure liquid chambers in the valve housing and the provision of areas on the valve plunger within said chambers for effecting the holding operations.

Other and further objects and features of the invention will be more apparent to those skilled in the art upon consideration of the accompanying drawings and following specification, wherein is disclosed a single exemplary embodiment of the invention, with the understanding that it may be applied in a similar manner to various other valve embodiments without departing from the spirit of the invention.

In said drawing the single figure is a longitudinal central section through the valve housing and valve plunger, the latter being illustrated in central or neutral position.

In the operation of simple hydraulic power cylinder systems the need has often been felt for a control valve which does not require the operator to maintain it in the power positions manually after once having placed it there. This problem would not be difficult of solution if it were not required that the valve be returned to the neutral position when the power cylinder piston reaches its full stroke.

To visualize the improvement of the present invention it is necessary to first consider the hy-

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draulic system used for actuating a small hydraulic power cylinder of the double acting variety, such as are used in large numbers for manipulating earth moving and agricultural machinery from tractors and the like and for an infinite variety of other industrial purposes. A constant volume pump driven by some prime mover takes liquid from a tank or reservoir and delivers it to the manual control valve. When this valve has its plunger in the neutral or hold position, both ends of the cylinder are cut off from the pump and the reservoir. It is always desirable that the valve in this position provide an open by-pass so that the pump delivers liquid back to the tank, which relieves it from load when not needed and circulates the oil through the tank to keep it cool. When the valve plunger is moved to either of its "power" positions for moving the piston in the cylinder, the high pressure from the pump is connected to the appropriate end of the cylinder and the other end of the cylinder is connected through the valve to the reservoir. Valves for performing this operation are well known and for a full detailed description of one not substantially different from the one to which the present improvement is applied reference should be had to my Patent No. 2,362,944, granted Nov. 14, 1944, for Control valve for hydraulic systems.

The drawing in the present case shows a valve adapted for cooperation directly with the tank or reservoir by being mounted on the side thereof. As a consequence fluid from the several low pressure compartments, chambers or ports passes directly to the tank. The construction can readily be modified to provide a piping or integral manifold to lead to a port for connection to a pipe carrying this liquid to a separate tank if desired. The details of these several features are unimportant and have not been illustrated.

Referring now to the drawing, there is shown at 10 a suitable cast metal housing having a continuous longitudinal bore 12 of uniform diameter extending from end to end and adapted to receive a cylindrical, reciprocable valve plunger 14 with a close working fit therein. The bore 12 traverses a plurality of chambers within the housing arranged in symmetrical form in pairs about a single central chamber 15, which may be considered a discharge chamber, leading by means of a port (not shown) directly to the tank or reservoir. A high pressure chamber 16 supplied by fluid from the pump through port 17 has tributaries 19 and 20 straddling the discharge chamber 15. Spaced outwardly from

these tributary chambers are the power chambers 21 and 22, each adapted to be connected by suitable piping attached to power ports 23, 24 respectively to the opposite ends of the power cylinder. These power ports may be distinguished as "advance" and "retract." Next beyond these power chambers are the low pressure chambers 25 and 26 substantially at the ends of the plunger and housing. Chamber 25 is closed by threaded cap 27, the inner annular edge of which forms one abutment for the centering spring 29 fitted about the reduced diameter end portion 31 of the plunger. A washer slidable on this reduced portion abuts the inner edge of the hollow cap 27 while a similar washer at the opposite end of the spring abuts either the shoulder 33 at the junction of the two diameters of the plunger or the right end wall of the chamber 25. A plug 35 closes a bore in the left end of the plunger and has a flange forming an abutment to engage the left face of the outer washer. It will be seen that this construction permits the valve plunger to be manually manipulated in either direction from the central position shown, and in each case the spring is loaded so that the plunger is returned to the central position when released.

The right hand end of the plunger is provided with a reduced diameter stem 28 which passes through the low pressure chamber 26, and through the bushing 30 pressed into the bore 12 outwardly thereof. It also extends through the packing unit 32 secured in the outer end of the bore 12. The external end of this stem portion receives an eye 34 screwed into the hollow end thereof for the attachment of an operating link or the like for manipulating the valve.

Adjacent the reduced ends the plunger is provided with full diameter lands 36 and 37, which in the neutral position shown isolate the power chambers 21 and 22. A central land 38 of small longitudinal extent is ineffective in the neutral position, but when the valve is pressed to the left or right engages respectively with the bore portions 39 or 40 and cooperates with the appropriate land 36 or 37 to isolate the discharge chamber 15 from the tributaries to the high pressure chamber 16. In the position shown it will be seen that high pressure fluid flows from the tributaries through the grooves 41 and 42, in the plunger, to be discharged in the chamber 15 and thence to the tank, but this operation is prevented when the plunger is moved in either direction as just described.

Assuming the plunger to be moved to the left, it will be seen that high pressure fluid will flow into the chamber 43 in the left end of the plunger through radial bores 44 in the bottom of the groove 41 and will lift the check valve 45 against its spring 46. This permits high pressure fluid to be discharged through radial passages 47 emerging from the surface of the land 37 and now registering with power chamber 21. This will deliver high pressure fluid to the desired end of the power cylinder while fluid returning from the other end thereof by operation of its piston will enter power chamber 22, which is now in communication with low pressure chamber 26, via the space surrounding the reduced diameter portion 28 at the right hand end of the plunger. The check valves insure against return flow from the cylinder in event of damage to the pump or its delivery pipe and under certain other conditions.

A pair of discharge chambers 51 and 52 are in direct communication with the tank and in restricted communication respectively with the low pressure chambers 25 and 26 through passages 53

and 54. These passages are adjustable in size by means of the threaded metering pins 55 and 56 respectively. The pins extend to the outside of the housing and are fitted with kerfs for adjustment with a screw driver. They are covered by acorn nuts and proper sealing gaskets to prevent leakage.

With the valve plunger positioned to the left as just described the returning fluid from the inactive side of the power cylinder in endeavoring to escape from low pressure chamber 26 via restricted passage 54 for return to the tank through discharge chamber 52 builds up a pressure in 26 which acts on the annular or differential area 58 between the two diameters of the plunger at the right end and holds the plunger in its displaced position until movement of the piston in the power cylinder ceases. Such movement stops either because the piston reaches the end of its stroke or some mechanical means prevents its further movement at the pressure of the liquid delivered to it. Liquid then drains from chamber 26 and the pressure therein drops to that of the tank, which is substantially atmospheric, and the centering spring 29 takes over and returns the valve plunger to the neutral position shown. The pressure in chamber 26 is never permitted to become so great as to prevent the operator from manually returning the valve plunger to the neutral position if he desires to stop the operation of the power cylinder intermediate the length of its piston stroke.

For operation in the opposite direction the conditions are just reversed from those described and the pressure in the chamber 25 and the hollow in cap 27 acts on the whole area of the plunger for holding the same in the hoist position. In order that the fluid may readily pass the washer abutting the shoulder 33 several by-pass ducts 60 are provided as shown.

The amount of restriction effected by the metering pins may be varied to favor any flow conditions up to the capacity of the valve and may also, by proper adjustment, equalize to "holding" effort on the two ends of the plunger even though the "holding" pressure is effective on different areas of plunger.

Valves of the type just described are particularly helpful in the operation of tractors and small vehicles equipped with hydraulically actuated accessories, for in such cases the operator is very often in need of more hands and feet than the normal person possesses in order to successfully manipulate both the vehicle and accessories. This is especially true of a farm tractor reaching the end of a row, for when this occurs the operator must steer, declutch and shift gears on the vehicle and at the same time must operate one or more control valves to pull to plow or other implement out of the ground to prevent it from being damaged by the lateral movement on the turn. In the case of the conventional form of hydraulic valve one hand must be kept on the control lever until the implement is entirely free of the ground. The operation is not a rapid one because of the economic necessity of a small pump. Hence it becomes quite a problem to steer and shift gears with the remaining hand. The automatic hold feature incorporated in the present valve eliminates the need for the operator having to hold the valve actuating lever in position more than long enough to start movement of the power cylinder piston, for then the returning liquid immediately takes over and substitutes for his hand until the full stroke of the piston has

been achieved. Then the operating valve returns to neutral, permits the pump to be relieved to the tank and holds the lifted implement immobile until the reverse operation lowers it.

I claim:

1. In a control valve of the type described, in combination, a housing, a chamber therein for high pressure liquid, a pair of power chambers, a pair of low pressure chambers, a bore intersecting all of said chambers, a valve plunger operatively positioned in said bore and so constructed and arranged that in the "neutral" or central position the power chambers are isolated, and in either "power" or end position one power chamber is connected to the high pressure chamber and the other to one of the low pressure chambers, a restricted vent for each low pressure chamber whereby pressure may be built up therein when connected to a power chamber, an area on each portion of said plunger extending into said low pressure chambers adapted to be subjected to the built-up pressure therein to hold the plunger in the power position to which it has been manually moved and a centering means for said plunger of insufficient strength to overcome said holding pressure.

2. In a hydraulic control valve, in combination, a housing having a high pressure inlet chamber, a liquid return chamber and two power chambers, a valve plunger, resilient means to centralize said plunger in the housing, said plunger being selectively movable manually to either side of center position to connect one power chamber to the inlet chamber and the other to the liquid return chamber, and means dependent on liquid flow between said last mentioned chambers to hold said plunger in the position manually set in spite of said centralizing means.

3. In a hydraulic control valve, in combination, a housing having a high pressure inlet chamber, a liquid return chamber and two power chambers, a valve plunger, resilient means to centralize said plunger in said housing, said plunger being selectively movable manually to either side of center position to connect one hoist chamber to the inlet chamber and the other to the liquid return chamber, means restricting the flow of liquid between said last mentioned chambers to build up a holding pressure, and a surface at each end of said plunger arranged to be selectively subjected to said pressure when the valve plunger is moved from its central position to maintain it against the centralizing means.

4. In a valve for use between a pump, a double acting power cylinder and a tank, in combination, a housing having pump or inlet chamber, a tank or outlet chamber and two power chambers, a plunger reciprocable in said housing from a neutral "central" to either of two power positions and being constructed and arranged for cooperation with the housing in the neutral position to directly connect the pump and tank chambers and to isolate the power chambers and in either power position to connect one power chamber to the pump chamber and the other to the tank chamber, resilient means to centralize the plunger in the housing, means to meter the flow from either power chamber to the then connected tank chamber to create a liquid pressure and means cooperating with the plunger to use said pressure to hold the plunger in the power position in which it has been placed.

5. In a control valve for use between a pump, tank and double acting power cylinder, in com-

bination, a housing having two power chambers and two low pressure chambers, a plunger reciprocable in said housing, resilient centralizing means for said plunger, each end of the plunger having an effective area exposed in one of said chambers whereby pressure therein exerts longitudinal effort on the plunger, means to connect one of said low pressure chambers to one of said power chambers when the plunger is manually moved in one direction from the centralized position and vice versa, and a metered outlet for each low pressure chamber.

6. A control valve for use with a double acting power cylinder, a pump and a tank and including, in combination, a housing having pump and tank ports and advance and retract ports for connection to opposite ends of said power cylinder, a plunger manually reciprocable in said housing from a "central" to advance and retract positions, resilient means biasing said plunger toward central position, a separate low pressure chamber in the housing cooperating with each end of the plunger, means on said plunger and housing to connect said tank and pump ports when in central position and to connect the "pump" and advance or retract ports when in one of the latter positions, and to connect the other of the advance or retract ports to the corresponding low pressure chamber and means effective during liquid flow from the power cylinder into said connected chamber to apply a longitudinal pressure on said valve plunger to hold it in its off "central" position against said biasing means.

7. A control valve for use with a double acting power cylinder, a pump and a tank and including, in combination, a housing having pump and tank ports and advance and retract ports for connection to opposite ends of said power cylinder, a plunger manually reciprocable in said housing from a "central" to advance and retract positions, resilient means biasing said plunger toward central position, a separate low pressure chamber in the housing cooperating with each end of the plunger, means on said plunger and housing to connect said tank and pump ports when in central position and to connect the "pump" and advance or retract ports when in one of the latter positions, and to connect the other of the advance or retract ports to the corresponding low pressure chamber, each of said chambers having an outlet, and a metering device for each outlet to maintain a pressure in the chamber as long as there is adequate flow into the same returning from the cylinder, each of said plunger ends having an effective area available to the pressure in its chamber to hold the valve in selected off center position.

8. In a valve for controlling the flow of pressure and return liquid for a double acting power cylinder, in combination, a housing having a reciprocable plunger therein, resilient means centering said plunger in said housing, a pair of low pressure chambers in said housing, each chamber surrounding an effective end area on the plunger which area is capable of reacting to pressure in the chamber to hold the shifted plunger against centralizing after it is initially moved from center, and means to build up the pressure of returning liquid in the desired one of said chambers when the plunger is shifted.

9. In a valve of the type described, in combination, a housing having a bore, a plunger having lands and grooves reciprocable in said bore between "central" and power positions,

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resilient centralizing means for said plunger, a high pressure inlet and an outlet in said housing connected together by plunger grooves when in central position and separated by lands when in power positions, spaced power cylinder ports and adjacent chambers in said housing, each end of said plunger having an effective transverse area facing from the center and arranged in one of said chambers, means including said grooves and lands to connect one power cylinder port to said high pressure inlet and the other to its adjacent chamber when the plunger is moved to either power position, and a restricted outlet for each chamber.

10. The valve as defined in claim 9 in which said outlet is restricted by means of an adjustable metering device.

11. In a control valve of the type described, in combination, a housing having an inlet port, an outlet means and two cylinder ports, a chamber for high pressure liquid in communication with said inlet port, a pair of cylinder chambers, each in communication with one of said cylinder ports, a pair of low pressure chambers, a bore connecting all of said chambers, a valve plunger operatively positionable in anyone of three positions in said bore and so constructed and arranged that when positioned in its central or "neutral" position the cylinder chambers are fully isolated, and when positioned in either of its non-central or "power" positions one cylinder chamber is connected to the high pressure chamber and the other to one of the low pressure chambers, a restricted vent for each low pres-

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sure chamber forming the only communication between said chambers and said outlet means whereby pressure may be built up within a low pressure chamber when said chamber is connected to a cylinder chamber, an effective pressure area on each portion of said valve plunger extending into said low pressure chambers and adapted to respond to the built-up pressure within the chamber to hold the valve plunger in the power position to which it has been moved and a centering means for said plunger of insufficient strength to overcome said holding pressure.

12. In a valve of the type described, in combination, a housing having a high pressure fluid inlet port, a valve plunger movable in the housing, resilient means to longitudinally centralize said plunger in the housing, chambers in said housing spaced on opposite sides of the center thereof, each end of the plunger having an effective lateral area exposed in one of said chambers and facing away from the center whereby fluid pressure in either chamber tends to move the plunger in the direction of the other, a continuously open restricted discharge orifice for each chamber, means controlled by movement of the plunger in either direction from the central position to open an orifice to admit fluid under the influence of that entering the inlet port to the chamber in the other direction from the central position to act on the exposed plunger area therein and hold the plunger against action of the centralizing means.

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