

[54] **HYDRAULIC ACTUATOR HOLDING SYSTEM**

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[51] Int. Cl. **F15b 11/08, F15b 13/042**

[58] Field of Search ... **91/420, 445, 447; 137/596.2, 137/87, 102, 106**

[56] **References Cited**

UNITED STATES PATENTS

1,222,316	4/1917	Matthewman	137/516.25 X
2,401,258	5/1946	Livers	91/420 X
2,896,663	7/1959	Mena	137/539

FOREIGN PATENTS OR APPLICATIONS

957,851	5/1964	Great Britain	91/420
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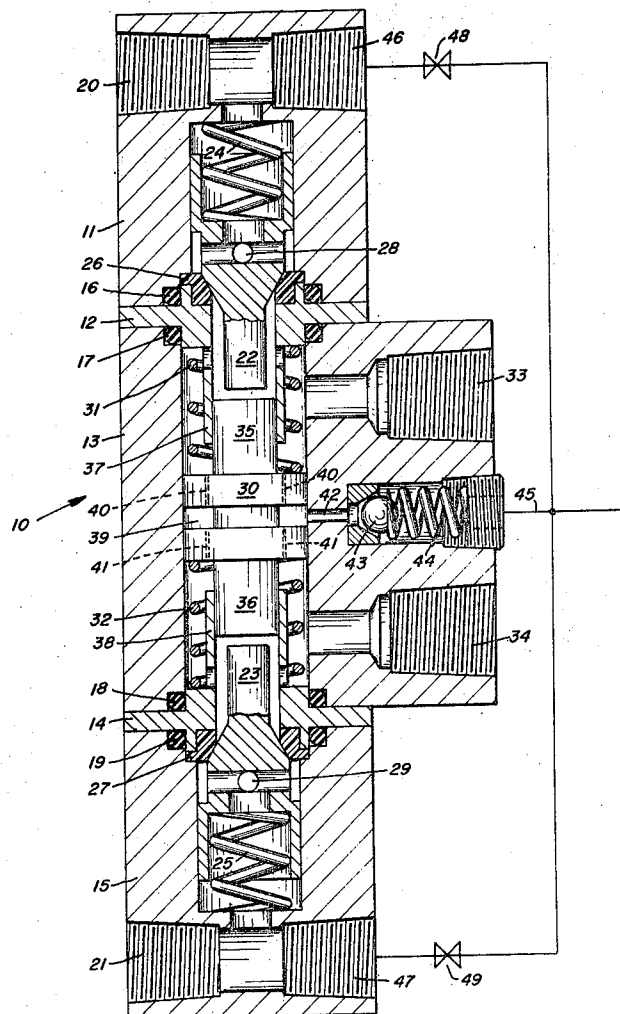
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[57] **ABSTRACT**

The invention improves on a locking valve for holding a hydraulic actuator in place. The locking valve has a pair of check valves and a shuttle piston movable hydraulically between the check valves for opening the check valves in response to an upstream directional valve for moving the actuator, and the improvement is a central opening in the shuttle piston communicating with a return line, bleed holes communicating with both faces of the shuttle piston and the central opening, and centering springs for the shuttle piston. The valve then locks against back pressure from the hydraulic actuator and also allows any positive leakage from upstream to bleed through the shuttle piston and back through the return line without building up a pressure that can eventually open the valve. The system also includes a loading valve arrangement for maintaining pressure on the hydraulic actuator.

10 Claims, 9 Drawing Figures



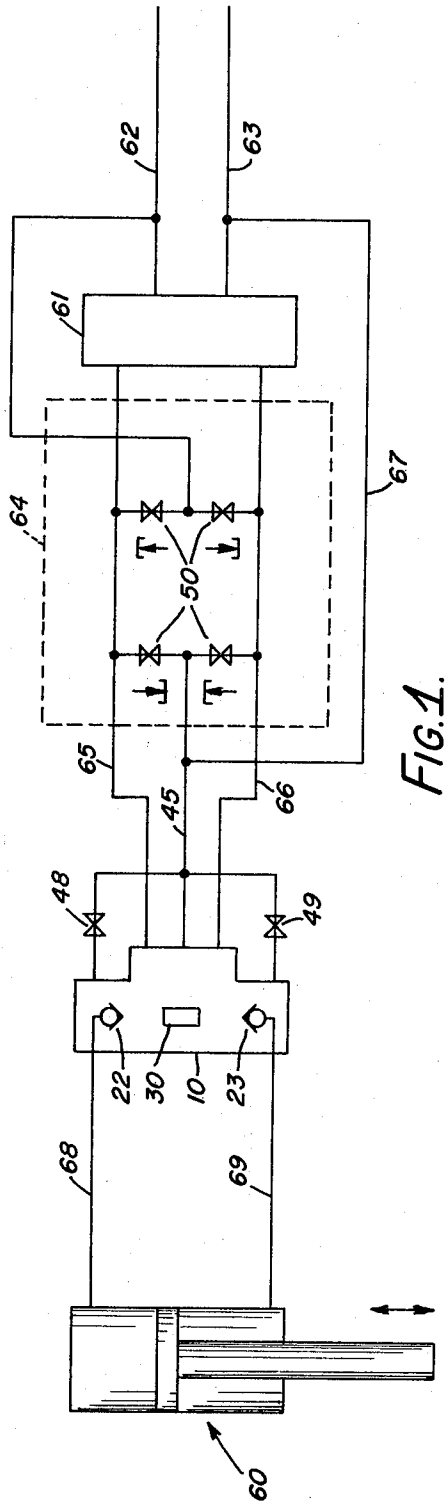


FIG. 1.

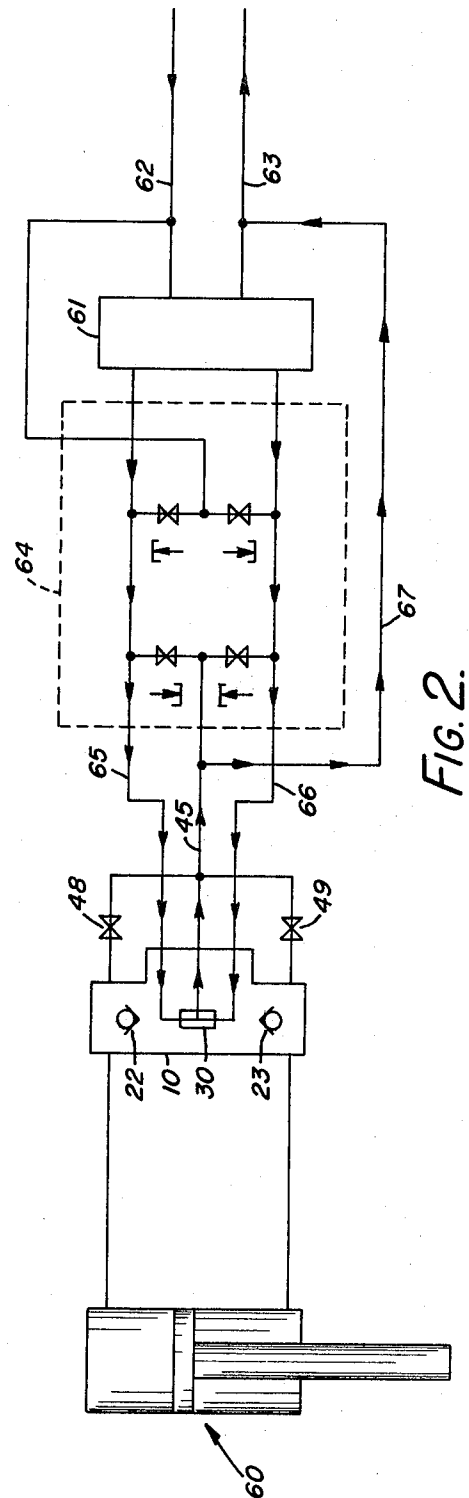


FIG. 2.

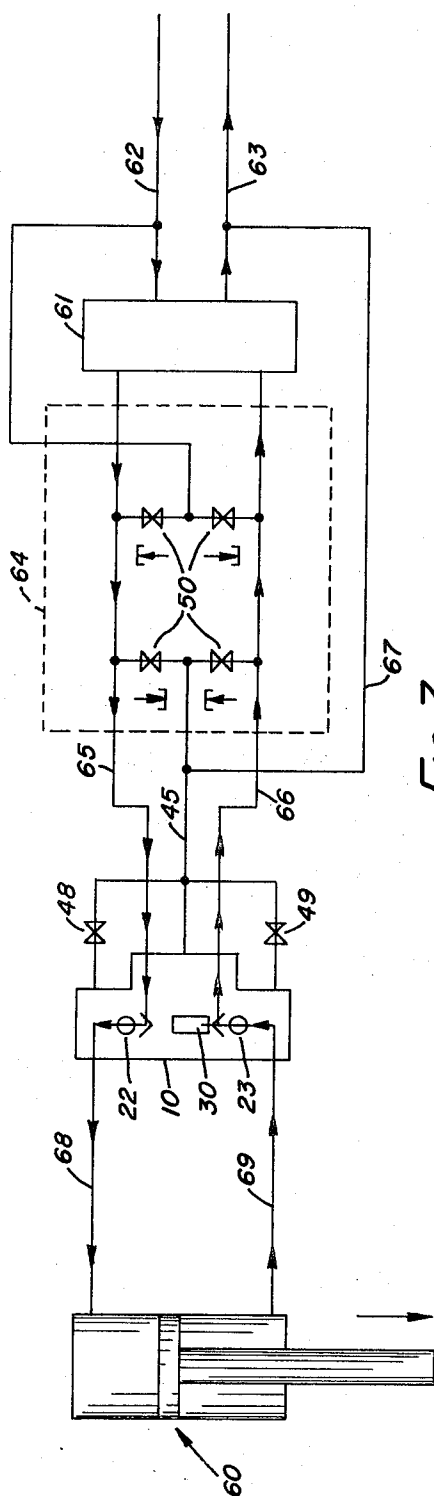


FIG. 3.

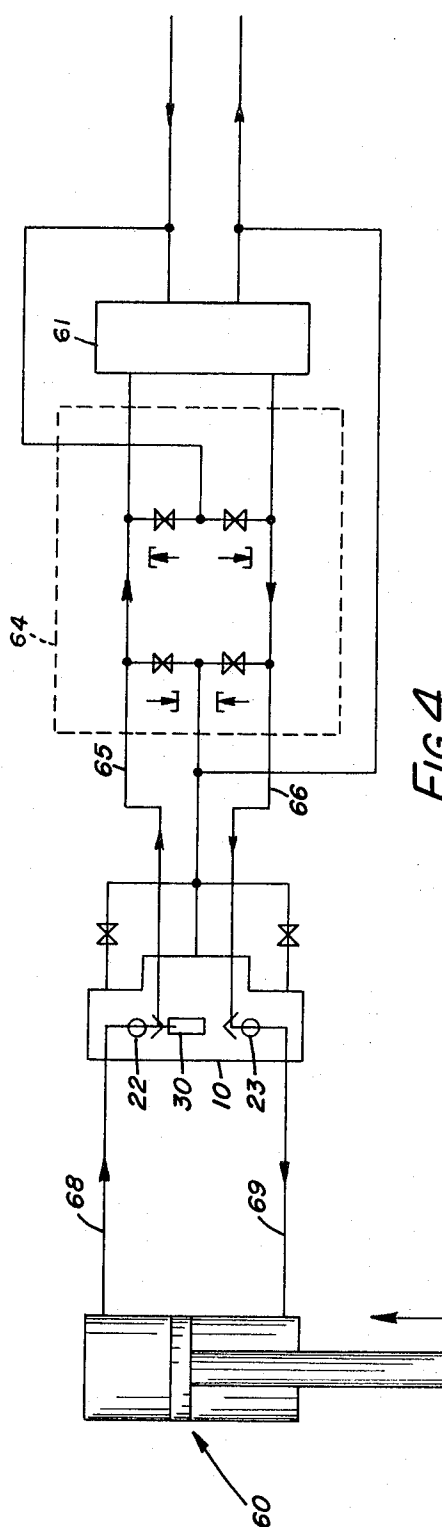


FIG. 4.

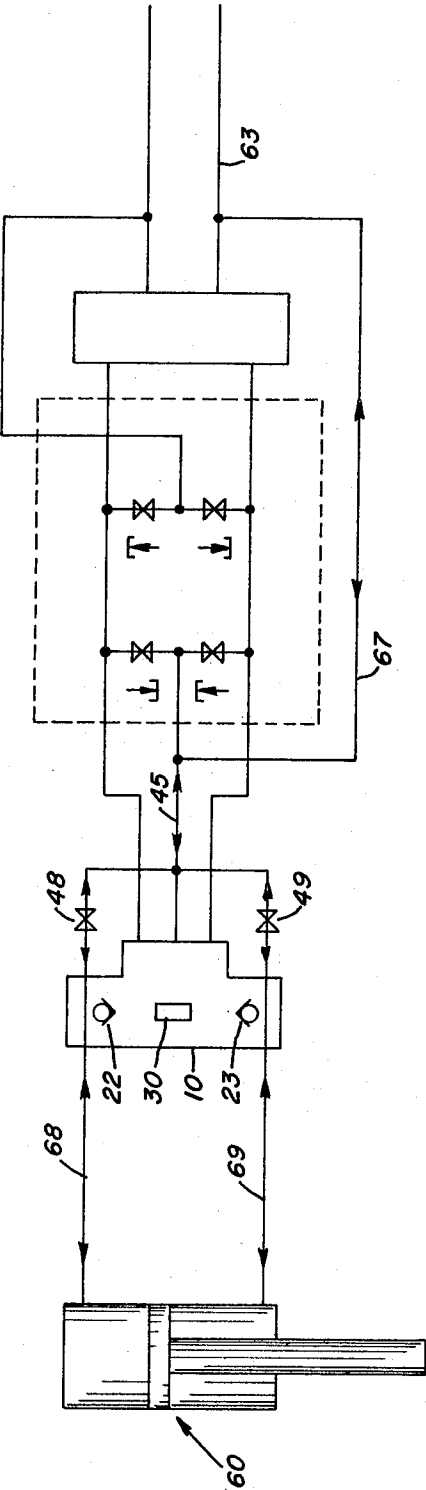


FIG. 5.

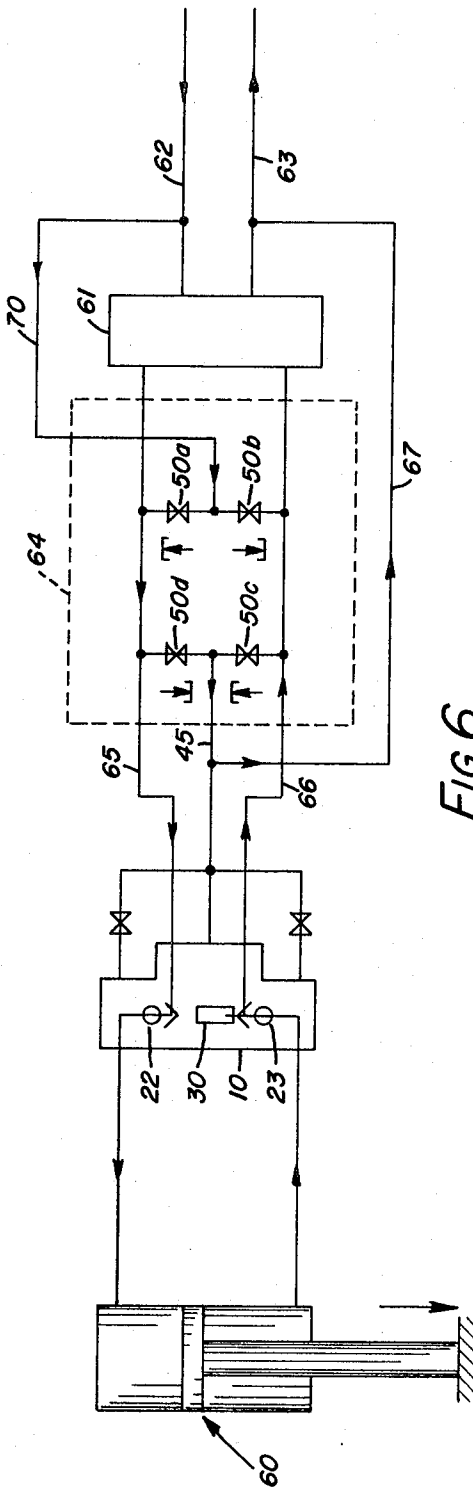


FIG. 6.

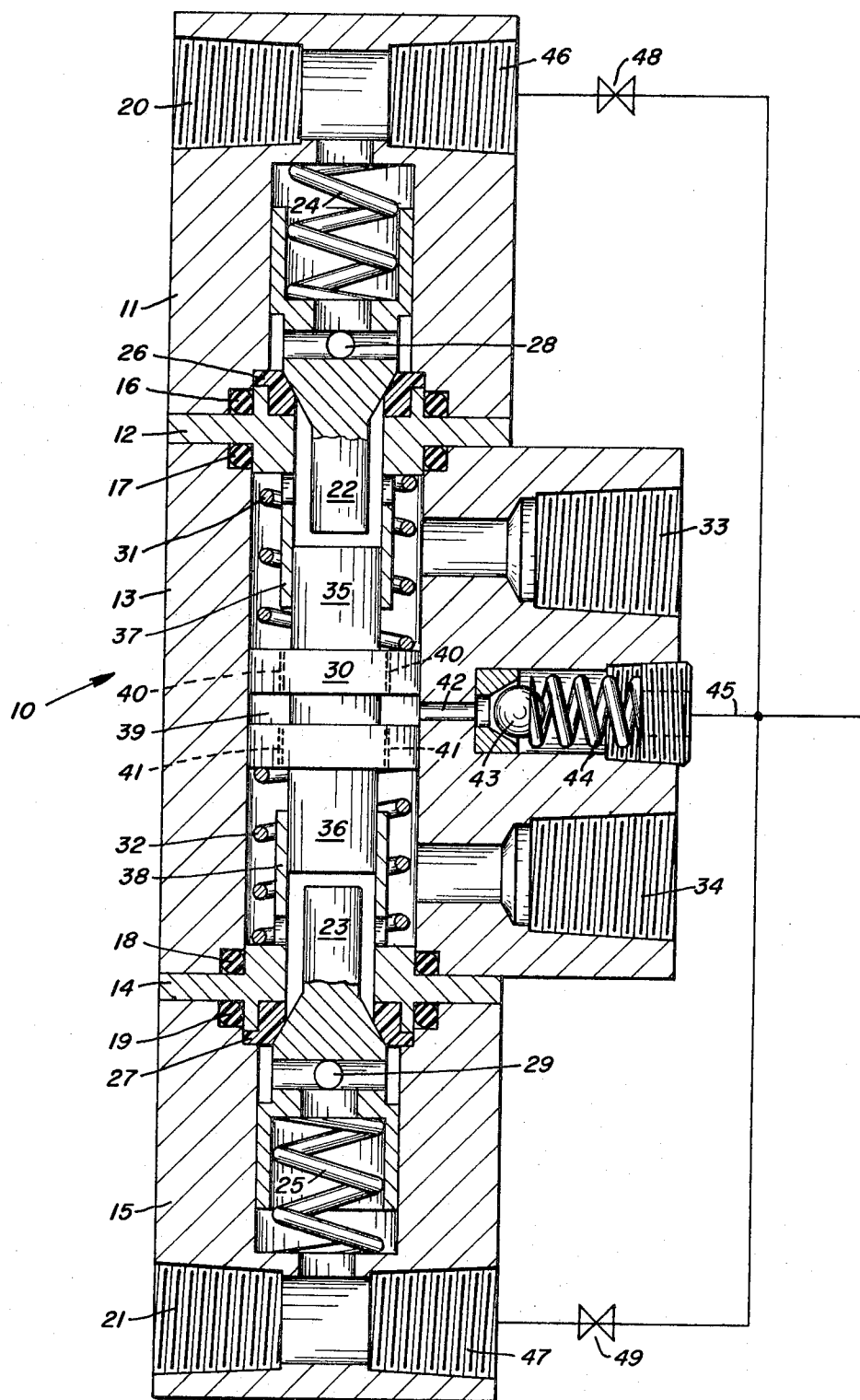


FIG. 8.

HYDRAULIC ACTUATOR HOLDING SYSTEM

THE INVENTIVE IMPROVEMENT

Locking valves are commonly used for holding hydraulic actuators in place, and such valves use a pair of check valves in lines leading from both sides of the actuator, and a shuttle piston arranged between the check valves for opening the valves hydraulically to move the actuator. Such valves work reasonably well in locking against back pressure from the actuator.

The invention involves recognition that positive upstream leakage can also move the actuator, and the invention suggests an improvement for overcoming the effect of this. The invention also proposes a loading circuit cooperating with the locking valve for automatically maintaining pressure on the actuator at a limit of motion, and the invention aims at simplicity, economy, effectiveness, reliability, and serviceability in an improved holding system for a hydraulic actuator.

SUMMARY OF THE INVENTION

The inventive system for holding a hydraulic actuator in place includes a locking valve having pair of check valves, a shuttle piston between the check valves, lines leading from both sides of the actuator to the check valves, and input lines leading to the shuttle piston for opening the check valves for moving the actuator. The improvement is a central opening in the shuttle piston, a return line communicating with the central opening when the shuttle piston is centered between the check valves, bleed holes communicating with both faces of the shuttle piston and its central opening, and centering springs for biasing the shuttle piston toward its central position. The effect of this is that positive upstream leakage into the input lines is bled through the holes in the shuttle piston and returned through the return line without building up a pressure sufficient to open the check valves and move the actuator.

DRAWINGS

FIGS. 1 - 7 are schematic views of a preferred embodiment of the inventive system showing all the operational modes;

FIG. 8 is a partially schematic, cross-sectional view of a preferred embodiment of locking valve for use in the inventive system;

FIG. 9 is a cross-sectional view of a preferred embodiment of loading valve for use in the inventive system.

DETAILED DESCRIPTION

Hydraulic actuators often must be held accurately in place for long periods of time extending to weeks or months. Present arrangements for this use a locking valve between the actuator and an upstream directional valve for checking any back pressure flow from either side of the actuator. However, these systems overlook an important circumstance. The directional valves used to direct hydraulic pressure to the desired side of the actuator for moving the actuator all leak somewhat, and they leak more with age and wear. Positive leakage from a directional valve builds up a pressure in the locking valve that can eventually open its check valves and allow the actuator to slip out of position. In some situations, such as shipboard hydraulic systems, this can be very troublesome or dangerous.

The invention recognizes the problem of positive leakage from an upstream directional valve and provides a better holding system that keeps the actuator steadily in place in spite of any such leakage.

It is sometimes desirable to maintain a positive pressure on the actuator at a limit of motion position, and the inventive system accomplishes this with a simple loading valve circuit that is integrated into the improved holding system. The invention also provides for manual bypass of the locking valve so that the actuator can be deliberately moved by other means during hydraulic failure.

The locking valve of FIG. 8 and the loading valve of FIG. 9 will be described first to facilitate understanding of the overall working of the system as best shown in FIGS. 1 - 7.

Locking valve 10 of FIG. 8 is formed of body parts 11-15 secured tightly together and sealed with O-rings 16 - 19. Any leakage between body parts around O-rings 16 - 19 runs externally out of valve 10 along the interfaces with body parts 12 and 14 so that such leakage is visible externally of valve 10. The source of such leakage can then be readily identified, and the defective part can be replaced without dismantling or replacing the entire valve 10.

End body parts 11 and 15 have respective ports 20 and 21 for lines leading to opposite sides of a hydraulic actuator, and passages from ports 20 and 21 lead through ports 28 and 29 machined in check valves 22 and 23 that are biased by springs 24 and 25 to seat against valve seats 26 and 27 that are preferably formed of a resilient plastic material such as nylon so as to be leakproof.

A shuttle piston 30 is arranged between check valves 22 and 23 and is normally centered in locking valve 10 by a pair of centering springs 31 and 32. Input ports 33 and 34 lead into central valve body part 13 in the region of shuttle piston 30 to direct pressurized fluid into valve 10 from an upstream directional valve. Shuttle piston 30 has end stubs 35 and 36 that glide in sleeves 37 and 38 extending away from check valve seats 26 and 27. Stubs 35 and 36 engage the stems of check valves 22 and 23 as shuttle piston 30 moves from its central position.

Shuttle piston 30 has a central opening 39 preferably formed as an annular groove around the central part of shuttle piston 30, and bleed hole passageways 40 and 41 extend from each face of shuttle piston 30 into central opening 39. A return port 42 communicates with central opening 39 when shuttle piston is centered in valve 10, a ball check valve 43 biased by a spring 44 guards return port 42 against back pressure, and a return line 45 connects to return port 42 and leads to the low pressure side of the hydraulic system. Ports 46 and 47 of valve 10 are also connected to return line 45 through normally closed and manually operable bypass valves 48 and 49.

Until a pressure differential appears between ports 33 and 34, locking valve 10 rests in its illustrated position with check valves 22 and 23 closed and valves 48 and 49 closed to lock and maintain a hydraulic actuator in a fixed position. Any leakage entering either port 33 or 34 runs through bleed holes 40 or 41 and returns through line 45 to the low pressure side of the system. When a substantial pressure differential appears between ports 33 and 34 for moving the actuator, bleed holes 40 and 41 are too small to accommodate the

flow, and shuttle piston 30 is driven against one of the check valves 22 or 23. This opens the engaged check valve, and the same pressure opens the opposite check valve to establish input and return flow for moving the actuator. Also, such movement of shuttle piston 30 closes return port 42 to eliminate any by-pass flow, and bleed holes 40 or 41 engage sleeves 37 or 38 at the limit of travel to block any bleed flow through piston 30. When the pressure at ports 33 and 34 equalizes, shuttle piston 30 returns to its illustrated position to hold the actuator in its new position. Locking valve 10 thus acts as a relay during actuator movement and as a locking device when the actuator is stopped.

FIG. 9 shows a preferred double check valve 50 for use with the inventive system in a loading circuit. Sliding piston 51 is biased by a spring 52 to close against seat 53. An orifice 54 extends through piston 51 in such a way as to allow a small bleed through in the flow direction indicated by the arrow when piston 51 is off of seat 53. A substantial pressure differential in the direction of the arrow compresses spring 52 enough to drive piston 51 against forward seat 55 to check the flow. Hence, valve 50 allows a trickle flow in the direction of the arrow and check stops any large flow in that direction and also acts as a complete check against any flow in the reverse direction. Such valves are used to bleed air from hydraulic lines, but they are employed in the inventive system in a different manner and for a different purpose described below.

The schematic diagrams of FIGS. 1 - 7 show the arrangement and operation of valves 10 and 50 in the inventive system for holding hydraulic actuator 60 in place. Valves 10, 48, 49 and 50 are arranged between actuator 60 and a directional valve 61 as illustrated, and are connected with a high-pressure supply line 62 and a low pressure return line 63. Valves 50 are arranged in a loading circuit 64 that can be omitted if not desired. Lines 65 and 66 lead from directional valve 61 to the input ports of locking valve 10, and return line 45 leads to a line 67 communicating with return line 63. Hydraulic flow for the various operations illustrated in FIGS. 1 - 7 is indicated by arrowheads along the lines of flow.

FIG. 1. shows the inventive system in static condition with check valves 22 and 23 both closed and shuttle piston 30 centered in valve 10. No flow occurs, and lines 68 and 69 between valve 10 and actuator 60 are checked against back pressure flow by check valves 22 and 23.

FIG. 2 shows the flow path for positive leakage from directional valve 61 through either of lines 65 or 66. Any such leakage flow passes through the bleed passageways in shuttle piston 30 as previously described and returns through lines 45, 67, and 63, to the low pressure side of the system. This prevents the pressure buildup of any such leakage from moving shuttle piston 30 to open check valve 22 or 23 and allow actuator 60 to move.

In the conditions shown in FIG. 3, hydraulic actuator 60 is being driven downward by the illustrated flow through lines 65, 68, 69, and 66. The high-pressure in line 65 moves the shuttle piston 30 downward in valve 10 to open check valve 23, and the pressure opens check valve 22 to allow the illustrated flow. Valve 10 then acts as a relay for the flow directed from valve 61.

FIG. 4 shows the flow for the opposite motion of hydraulic actuator 60 upward. The flow follows a reverse

path through lines 65, 68, 69 and 66 and passes through locking valve 10 where shuttle piston 30 is at its upper limit of motion to open check valve 22.

FIG. 5 shows the manual bypassing of locking valve 10 for hydraulic failure or other reasons. Regulations for shipboard hydraulic systems require that actuator 60 be movable if the hydraulic system fails, and this may also be desirable in other systems. Generally, it is accomplished by manually opening valves 48 and 49 to bypass locking valve 10 by allowing a free flow path in either direction in lines 68 and 69 by connecting these lines directly to return line 45, line 67 and line 63 leading to the low pressure side of the system. Once valves 48 and 49 are opened, actuator 60 can be moved manually or by a jack, tackle or other means with displaced oil running out and in through return line 45.

FIGS. 6 and 7 show the operation of loading circuit 64 with its loading valves 50 A-D. The high pressure supply line 62 is connected to loading valves 50 A & B through a line 70 that bypasses directional valve 61. Line 70 then puts the inlets of valves 50 A & B at the supply pressure, and valves 50A & B are oriented for a trickle flow in the forward or high pressure direction as illustrated by the arrows and for a check stop preventing any reverse flow. Valves 50 B & D check any reverse flow.

When actuator 60 is moving downward in response to directional valve 61, the outlet sides of valves 50A & B see a much lower pressure than their inlet sides, because of friction losses through directional valve 61. This pressure differential is enough to drive the pistons of valves 50A & B against their forward seats and prevent any flow through these valves.

Actuator 60 moves as previously described until it reaches a stop or a limit of mechanical travel, and at that instant, flow in the system substantially stops and the friction losses through directional valve 61 disappear because the system is static. Valve 50A then sees substantially the same pressure at its outlet as its inlet, and its piston travels back toward its inlet seat under the bias of its relatively light spring. Directional valve 61 then returns to an inoperative position as is common with such valves, and the supply pressure is maintained in line 65 by loading valve 50A, because any slight pressure drop from leakage, flow past piston rings, etc. nudges the piston of loading valve 50A off its inlet seat and allows sufficient bleed through its forward flow orifice to maintain the pressure in line 65. This pressure also holds open check valves 22 and 23 of locking valve 10 to maintain a high pressure path to actuator 60. Any through flow toward the return side of the system trickles through loading valve 50C which is oriented to admit such flow in its forward direction through return lines 45, 67 and 63.

FIG. 7 shows a circuit for holding actuator 60 upward against an upper limit of mechanical motion with loading valve 50B maintaining the pressure in line 66. Any return flow trickles through loading valve 50D and through return lines 45, 67, and 63. Valves 50 A & C are operating as check valves against reverse flow.

Loading circuit 64 cooperates with the inventive holding system and is useful wherever a positive pressure should be maintained on actuator 60. Directional valve 61 is normally not made with a capacity for maintaining pressure on actuator 60, and loading valves 50 A - D are a simple, convenient, and economical way of

accomplishing this in cooperation with the rest of the system.

Locking valve 10 operates only when actuator 60 comes to rest in a desired position and otherwise serves as a relay passing along the hydraulic power from directional valve 61 to actuator 60. The entire system is relatively simple, easy to install, compatible with existing equipment, reliable, easy to service, and meets standards for shipboard operation. It is also useful in other hydraulic systems, however, and can be applied for holding many actuators in place.

Persons wishing to practice the invention should remember that other embodiments and variations can be adapted to particular circumstances. Even though one point of view is necessarily chosen in describing and defining the invention, this should not inhibit broader or related embodiments going beyond the semantic orientation of this application but falling within the spirit of the invention. For example, those skilled in the art will appreciate the adaptation of the inventive system to various specific circumstances, and will understand the connection and operation of the system with different components.

I claim:

1. A system having an hydraulic actuator, a pair of actuator lines having alternate flow for moving said actuator, a control valve, a pair of control lines having alternate flow under control of said control valve, and a locking valve for relaying said alternate flow from said control lines to said actuator lines for moving said actuator and for blocking said actuator lines to hold said actuator in place in the absence of flow from said control valve, said system comprising:

- a. said locking valve having a shuttle piston with a central opening, and a pair of check valves axially aligned with said shuttle piston on opposite sides of said shuttle piston;
- b. said control lines communicating with opposite faces of said shuttle piston and respective ones of said check valves for alternatively opening one of said check valves by hydraulic pressure and moving said shuttle piston to engage and open the other one of said check valves;
- c. a return line having a check valve and communicating with said central opening when said shuttle piston is in a central position between said check valves, said return line bypassing said control valve;
- d. centering spring means for biasing said shuttle piston toward said central position; and
- e. said shuttle piston having bleed holes communicating with both faces of said shuttle piston and said central opening for bleeding any positive leakage from said control valve through said control lines into said central opening and through said return line without opening said check valves and without moving said shuttle position from said central position, said return line being blocked by said shuttle piston when said shuttle piston opens either of said check valves.

2. The system of claim 1 wherein abutment means limits the travel of said shuttle piston, and said bleed holes are blocked by said abutment means at the limits of travel of said shuttle piston to prevent any bleed during said flow from said control valve.

3. The system of claim 1 including a pair of normally closed and manually openable shut-off valves connected between said return line and said actuator lines for manually bypassing said locking valve and said check valve in said return line.

4. The system of claim 1 wherein said locking valve has a plurality of housing parts joined together along generally transverse planes, and O-ring seals are arranged between said parts along said transverse planes so any leakage between said parts is external to said valve and visible from outside said valve to facilitate repair.

5. The system of claim 1 wherein said check valves of said locking valve have seats formed of resilient plastic.

6. The system of claim 1 including a high-pressure line bypassing said control valve, one pair of double-check valves having bleed through passages for limited flow in one direction being supplied by said high pressure line and outputting into respective ones of said control lines, and another pair of double-check valves having bleed through passages for limited flow in one direction being supplied by respective ones of said control lines and outputting into said return line, said pairs of double-check valves cooperating for maintaining pressure in one of said control lines to hold said check valves of said locking valve open to maintain pressure on said actuator at a limit of motion position of said actuator.

7. The system of claim 1 wherein said check valves of said locking valve have seats formed of resilient plastic, abutment means limits the travel of said shuttle piston, and said bleed holes are blocked by said abutment means at the limits of travel of said shuttle piston to prevent any bleed during said flow from said control valve.

8. The system of claim 7 including a pair of normally closed and manually openable shut-off valves connected between said return line and said actuator lines for manually bypassing said locking valve and said check valve in said return line.

9. The system of claim 8 including a high-pressure line bypassing said control valve, one pair of double-check valves having bleed through passages for limited flow in one direction being supplied by said high pressure line and outputting into respective ones of said control lines, and another pair of double-check valves having bleed through passages for limited flow in one direction being supplied by respective ones of said control lines and outputting into said return line, said pairs of double-check valves cooperating for maintaining pressure in one of said control lines to hold said check valves of said locking valve open to maintain pressure on said actuator at a limit of motion position of said actuator.

10. The system of claim 9 wherein said locking valve has a plurality of housing parts joined together along generally transverse planes, and O-ring seals are arranged between said parts along said transverse planes so any leakage between said parts is external to said valve and visible from outside said valve to facilitate repair.

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