Dec. 9, 1969 R. F. HODGSON 3,482,600

HOLLOW SLIDE VALVES

Filed March 4, 1968 2 Sheets-Sheet 1

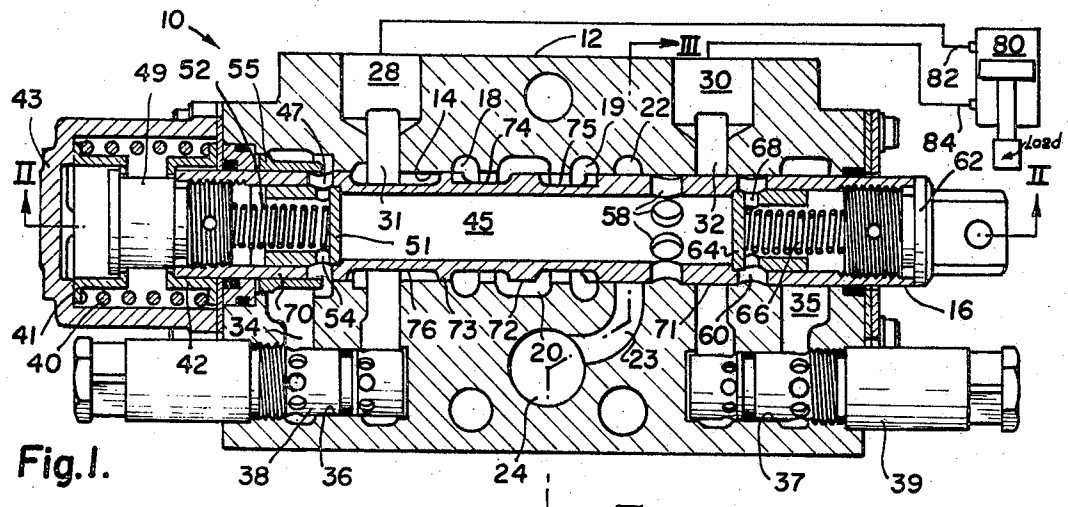


Fig. 1.

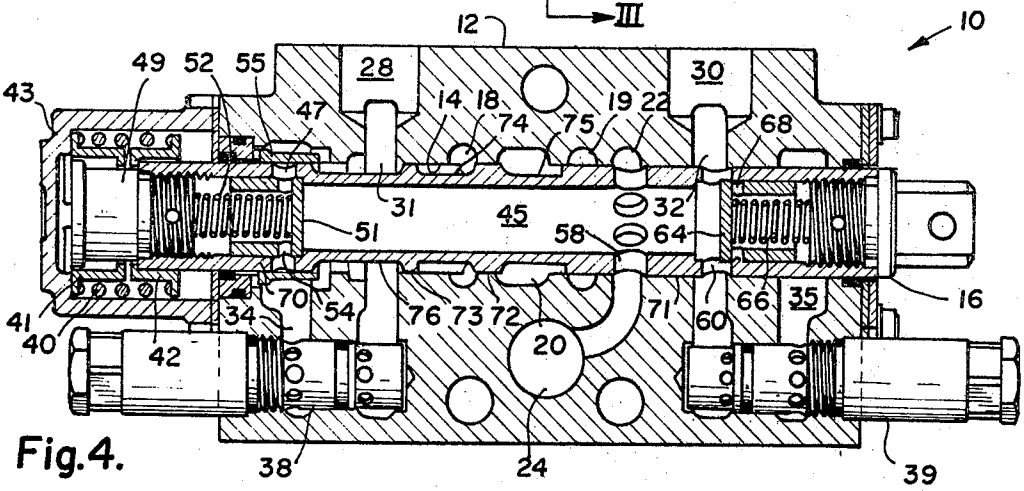


Fig. 4.

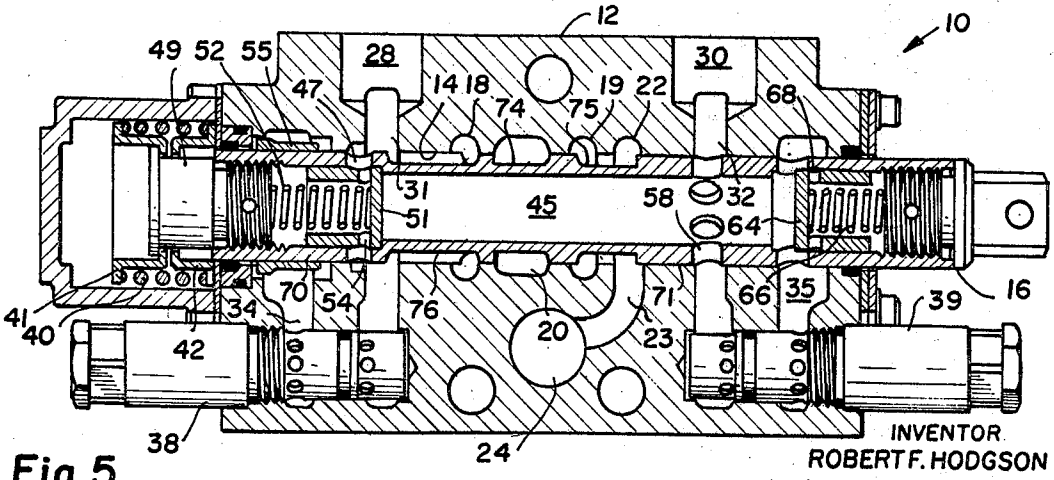


Fig. 5.

INVENTOR
ROBERT F. HODGSON

BY

Buell, Blenko & Ziesenheim

his ATTORNEYS

Dec. 9, 1969 R. F. HODGSON 3,482,600

HOLLOW SLIDE VALVES

Filed March 4, 1968 2 Sheets-Sheet 2

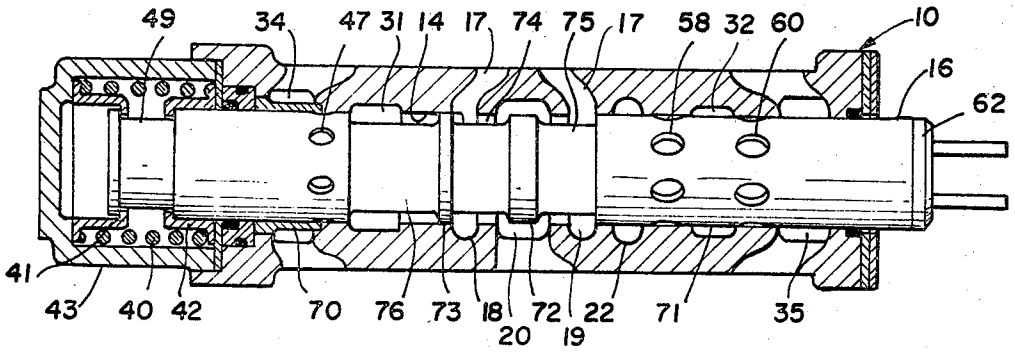


Fig. 2.

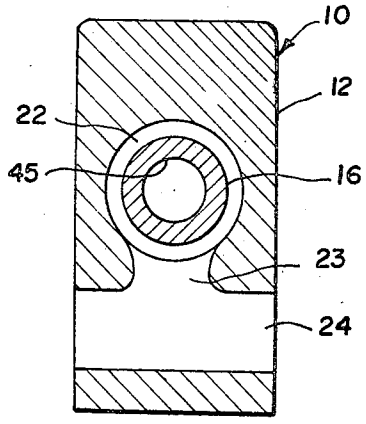


Fig. 3.

INVENTOR
ROBERT F. HODGSON

BY Burell, Blake & Ziesenheim

its ATTORNEYS

United States Patent Office 3,482,600 Patented Dec. 9, 1969

3,482,600

HOLLOW SLIDE VALVES

Robert F. Hodgson, Canfield, Ohio, assignor to Commercial Shearing & Stamping Company

Filed Mar. 4, 1968, Ser. No. 710,091
Int. Cl. F16k 31/44, 3/00
U.S. Cl. 137—596.2 5 Claims

ABSTRACT OF THE DISCLOSURE

A double acting hydraulic control valve having a hollow valve element shiftable from a neutral position to raise and lower work positions. The valve element includes various openings and closure means therefor, with the closure means being pressure responsive such that, with the valve element in the lower position, replenishing fluid will flow from the rod side of a piston motor through the valve element to the piston side thereof during rapid movement of the piston.

This invention relates to a hydraulic control valve, and particularly to the double acting type having improved replenishing flow features.

In order to avoid cavitation in the piston side of a differential area piston motor when the piston is rapidly moved, it is common to replenish the pump flow to the piston side with the exhaust flow from the rod side of the piston motor. This replenishing flow is oftentimes regulated by the control valve. Typical of such a control valve is that illustrated in the Ruhl Patent No. 3,006,372. One drawback of Ruhl's valve is its complexity. Ruhl diverts replenishing fluid through internal coring in his valve body and into his open center pump flow path. I have found that I can avoid the complex coring of Ruhl's valve and provides replenishing flow directly through my valve element to the piston side of the motor.

More specifically, my simplified control valve preferably includes: a valve body having a bore, a parallel flow passage, an open center inlet and outlet chambers, work port chambers adapted to be connected to the piston side and rod side, respectively, of a piston motor; a hollow spool valve slidably received in the bore and shiftable from a neutral position to either a raise or lower work position; the valve element being suitably formed to direct flow to either the rod or piston side of the piston motor when the valve element is in the raise or lower positions, respectively; and the valve element being further adapted to direct return fluid flow from the rod side of the piston motor to the piston side thereof when the valve element is in the lower position and during rapid movement of the piston. It is emphasized that the replenishment flow is directed through the valve element to the work port chamber to which the piston side of the piston motor is connected. In this invention there is no secondary diversion of fluid to the open center chambers and then back into the hollow spool as in the case of the Ruhl valve.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown a present preferred embodiment of the invention in which:

FIGURE 1 is a longitudinal sectional view through a double acting hydraulic control valve embodying my invention with the valve element in a neutral position;

FIGURE 2 is a sectional view taken along the line II—II of FIGURE 1;

FIGURE 3 is a sectional view taken along the line III—III of FIGURE 1;

FIGURE 4 is a longitudinal sectional view of the valve of FIGURE 1 showing the valve element in a raise work position; and

FIGURE 5 is a longitudinal sectional view of the valve of FIGURE 1 showing the valve element in the lower work position.

Referring now to the drawings wherein like reference numerals refer to like parts throughout the various figures, **10** generally designates a double acting hydraulic control valve section, including an elongated body **12** adapted to be attached with other valve body sections by nuts and bolts, for example, to form a desired multivalve arrangement. Such arrangements are well known as typified by the series-parallel-priority valve arrangement disclosed in U.S. Patent No. 3,329,169 granted July 4, 1967. Body **12** has a longitudinal bore **14** extending therethrough with a double acting sliding valve element **16** being suitably received therein. A bifurcated inlet passage **17** having chambers **18** and **19** intersecting bore **14** receives high pressure fluid from a source, not shown, through an inlet section, also not shown but well known in the art. An outlet chamber **20** intersects bore **14** between inlet chambers **18** and **19**. A branch chamber **22** intersects bore **14** adjacent inlet chamber **19** and communicates through passage **23** with parallel flow passage **24** lying in a plane spaced beneath and generally parallel to the plane of the inlet and outlet chambers. Parallel flow passage **24** receives high pressure fluid from the same source as that providing fluid to inlet passage **17**. Work ports **28** and **30** open out of body **12** and communicate with chambers **31** and **32** intersecting bore **14** on opposite sides of inlet chamber **18** and branch chamber **22**, respectively. Exhaust chambers **34** and **35** intersect bore **14** on opposite sides of work chambers **31** and **32**, respectively, and communicate with the respective work chambers through passages **36** and **37**. Identical pressure relief valves **38** and **39** are suitably received in passages **36** and **37**, respectively.

Valve element **16** is shown in FIGURE 1 in a neutral position and can be shifted to the raise position shown in FIGURE 4 and the lower position shown in FIGURE 5 by any well-known means, as by suitable linkages, for example connected to the right side of valve element **16**, as viewed in FIGURE 1. Valve element **16** is urged into its neutral position by a helical coil spring **40** urging a force on either colar **41** or **42** suitably arranged on valve element **16**, with the direction of the force depending on the longitudinal position of the valve element. A hollow housing **43** suitably fixed to body **12** encloses spring **40**, collar members **41** and **42**, and the left side of valve element **16**. Valve element **16** has a hollow chamber **45** extending longitudinally therethrough. Circumferentially spaced first openings **47** extend radially into communication with a left portion of hollow chamber **45**. A plug **49** is threadedly received in the left end of valve element **16**. A pressure responsive closure means in the form of a cup-shaped check valve **51** closes first openings **47** from the central portion of hollow chamber **45**. A helical coil spring **52** in compression is suitably disposed between the inner end of plug **49** and check valve **51** to urge same into its closed position. Check valve **51** has a plurality of circumferentially spaced openings **54** extending radially through the inner end portion thereof and communicating with openings **47** when check valve **51** is in its closed position. A generally cylindrically shaped sleeve member **55** is suitably carried by body **12** and extends inwardly into exhaust chamber **34** and terminates in a generally vertical plane extending through an intermediate point of openings **47** when valve element **16** is in its neutral position.

Circumferentially spaced second openings **58** extend radially through valve element **16** into communication with hollow chamber **45**, which second openings are dis-

posed rightwardly of the transverse center of valve element **16**. Circumferentially spaced third openings **60** are disposed rightwardly of second openings **58** and extend radially through valve element **16** into communication with hollow portion **45**. A clevis spool **62** is threadedly received in the right end of valve element **16**. A pressure responsive closure means in the form of a cup-shaped check valve **64** closes third openings **60** from the central portion of hollow chamber **45**. A helical coil spring **66** in compression is suitably disposed between the inner end of clevis spool **62** and check valve **64** to urge same into its closed position. The compressive force of spring **66** is greater than that of spring **52**, for reasons to be specified hereinafter. Check valve **64** has a plurality of circumferentially spaced openings **68** extending radially through the inner end portion thereof and communicating with third openings **60** when check valve **64** is in its closed position.

Valve element **16** has a left land **70**, right land **71**, central land **72**, and intermediate land **73** disposed between the central and left lands. Grooves **74** and **75** are disposed on the opposite sides of central land **72** with groove **74** being disposed rightwardly of intermediate land **73**. Another groove **76** is disposed between intermediate land **73** and left land **70**. With valve element **16** in its neutral position groove **76** extends leftwardly from a point adjacent inlet chamber **18** across work chamber **31** to adjacent exhaust chamber **34**.

In use, the work ports **28** and **30** of valve **10** are connected with the opposite ends of a double-acting differential area piston motor **80** by lines **82** and **84**, respectively, as shown in FIGURE 1. The rod end of motor **80** is illustrated as being connected to a load, typical of which can be the bucket of an earth moving vehicle. With the valve element **16** in the neutral position shown in FIGURE 1 the open-center chambers are clear to bypass pump flow downstream. That is, fluid entering body **12** is free to pass through inlet chambers **18** and **19** to outlet chamber **20**. Fluid will also pass freely downstream through parallel flow passage **24**. Work chambers **31** and **32** are blocked by valve element **16**. To raise the piston of piston motor **80** the valve element **16** is placed in the position shown in FIGURE 4. Open center is thus blocked. That is, communication between inlet chambers **18** and **19**, and outlet chamber **20** is blocked. The second openings **58** are aligned with branch chamber **22** and fluid flowing through parallel flow passage **24** will flow through second openings **58** into hollow chamber **45** of valve element **16**. Sleeve member **55** prevents the fluid from entering exhaust chamber **24** through first openings **47** so the fluid will urge check valve **64** rightwardly and will flow through third openings **60** into work chamber **32** and out work port **30** into the rod side of piston motor **80**. Return fluid from the piston side of piston motor **80** will enter work port **28** by way of line **82** and into work chamber **31**, around groove **76**, into exhaust chamber **34** and back to reservoir. Check valve **64** also serves to prevent any back flow of fluid between the rod side of piston motor **80** and parallel passage **24**.

FIGURE 5 shows the valve element **16** shifted rightwardly into the lower position. In the lower position, open center is blocked. That is, communication between outlet chamber **20** and inlet chambers **18** and **19** is blocked. With the piston motor loaded, fluid will flow from parallel flow passage **24** into branch chamber **22** around groove **75** to be combined with the fluid flow in inlet chamber **19**. The combined flow in inlet chamber **19** passes across groove **76** to work chamber **31**, out of work port **28**, and through line **82** into the piston end of piston motor **80**. Pressurized fluid in work chamber **31** enters behind check valve **51** through first openings **47** and openings **54**, and holds check valve **51** in the closed position. Return fluid from the rod side of piston motor **80** enters work port **30** through line **84**, and then through second openings **58** into the hollow portion **45** of valve element **16**. Check valve **51** is held closed by the pressurized fluid behind it, and, thus, the fluid in hollow portion **45** will urge check valve **64** rightwardly and thereby flow into exhaust chamber **35** and back to reservoir.

When the piston motor **80** is subjected to a weight which would cause the cylinder to move at such a rate that the fluid cannot fill the piston side of the piston motor, then the following sequence occurs. The pump fluid flow will continue to flow into work chamber **31** from inlet chamber **18** around groove **76**. The pressure in work chamber **31** will, however, drop off, as will the pressure behind check vave **51**. The return flow from the rod side of piston motor **80** will enter hollow portion **45** of valve element **16**. This return fluid will now urge check valve **51** leftwardly to open first openings **47** to work chamber **31**. This movement of check valve **51** will result since, as noted earlier, the compression force of spring **66** acting on check valve **64** is greater than that of spring **52** acting on check valve **51**. Thus, the return flow from the rod side of piston motor **80** will be diverted to work chamber **31** and then to the piston side of the piston motor **80**. Accordingly, cavitation in the piston side of piston motor **80** will be avoided during the rapid movement of the piston.

The compression force of the spring **66** acting on check valve **64** can be suitably selected to determine the amount of fluid to be diverted around check valve **51** during the rapid movement of the piston of piston motor **80**. Alternatively, the compression force of spring **52** acting on check valve **51** could be suitably selected for the same reason.

As indicated earlier, it should be noted that replenishing fluid for supplementing fluid flow to the piston side of piston motor **80** flows directly through the hollow chamber **45** of valve element **16** to work chamber **31**. There is no secondary diversion of fluid to the open center inlet chambers **18** and **19** and then back into the hollow chamber **45** of the valve element **16** as was done in the control valves heretofore used. Accordingly, the valve of the present invention is considerably simpler in construction than the previously known flow replenishing type control valves.

I claim:

1. A hydraulic control valve comprising: an elongated body having inlet and outlet means, a longitudinally extending bore therethrough, an inlet chamber intersecting said bore and communicating with said inlet means, an outlet chamber intersecting the bore spaced from the inlet chamber and communicating with the outlet chamber, a parallel flow passage extending through said body transverse to the bore and spaced therefrom, a branch chamber intersecting said bore and communicating with said parallel flow passage, a first work port chamber intersecting said bore and having means adapted to be connected to the piston side of a piston motor, a second work port chamber intersecting said bore and having means adapted to be connected with the rod side of a piston motor, exhaust chamber means intersecting said bore adjacent each of said work port chambers and communicating therewith, an elongated hollow, closed ended valve element slidably received in said bore, said valve element shiftable longitudinally in said bore from a neutral position in which fluid entering said inlet chamber enters said outlet chamber around a first reduced portion of said valve element and fluid entering said parallel flow passage flow passage flows entirely downstream, said valve element being shiftable from asid neutral position to raise and lower work positions, said valve element having first, second and third openings extending radially therethrough and a second reduced portion adjacent said first openings; first pressure responsive closure means received in said valve element for closing said first openings; second pressure responsive closure means received in said valve element for closing said third openings; said valve element having means adapted when in said raise position to block communication between said inlet and outlet chambers while connecting said branch chamber to said second openings, and said third openings with said second work port chamber

and said first work port chamber to the exhaust chamber means adjacent thereto around said second reduced portion of said valve element, whereby fluid flows from said parallel flow passage to open said second closure means to flow to the rod side of the piston motor and fluid exhausted from the piston side of the piston motor flows through said first work port chamber around said second reduced portion of said valve element; said valve having means further adapted when in said lower position to block communication between said inlet and outlet chambers while connecting said branch chamber with said inlet chamber around said first reduced portion, connecting said inlet chamber to said first work port chamber around said second reduced portion, connecting said second work port chamber with the exhaust means adjacent thereto through said second and third openings, and connecting said first work port chamber to said first openings, whereby fluid will flow from said inlet chamber to the piston side of the piston motor and fluid from the rod side of the piston motor opens said second closure means to flow to exhaust; and said first closure means being pressure responsive to open, when said valve element is in said lower position at a pressure in said first work port chamber below a predetermined pressure such that at least a portion of the fluid flow from the rod side of the piston motor will flow to the piston side of the piston motor through said valve element and said second and first openings.

2. A hydraulic valve as set forth in claim 1 wherein said first closure means is a slidable first check valve; said second closure means is a slidable second check valve; and said first check valve has a portion thereof in communication with the fluid presure in the piston side of the piston motor when said valve element is in said lower position, such that said fluid pressure acts on said first check valve to hold same closed until said fluid pressure drops below a predetermined value.

3. A hydraulic valve as set forth in claim 2 wherein said first check valve includes a first biasing means; said second check valve includes a second biasing means; said biasing means having relative compressive forces acting on their respective check valves for regulating the amount of fluid flow from the rod side of the piston motor to the piston side thereof when said valve element is in said lower position and the pressure in said first work port chamber drops below said predetermined pressure.

4. A hydraulic control valve comprising: an elongated body having inlet and outlet means, a longitudinally extending bore therethrough, an inlet chamber intersecting said bore and communicating with said inlet means, an outlet chamber intersecting the bore spaced from the inlet chamber and communicating with the outlet chamber, a parallel flow passage extending through said body transverse to the bore and spaced therefrom, a branch chamber intersecting said bore and communicating with said parallel flow passage, a first work port chamber intersecting said bore and having means adapted to be connected to the piston side of a piston motor, a second work port chamber intersecting said bore and having means adapted to be connected with the rod side of a piston motor, exhaust chamber means intersecting said bore adjacent each of said work port chambers and communicating therewith; an elongated hollow, closed ended valve element slidably received in said bore, said valve element shiftable longitudinally in said bore from a neutral position in which fluid entering said inlet chamber enters said outlet chamber around a first reduced portion of said valve element and fluid entering said parallel flow passage flows entirely downstream, said valve element being shiftable from said neutral position to raise and lower work positions, said valve element having means adapted when in said raise position to block communication between said inlet and outlet chambers while connecting said branch chamber to said second work port chamber and connecting said first work port chamber to the exhaust chamber means adjacent thereto around a second reduced portion of said valve element, said valve having means further adapted when in said lower position to block communication between said inlet and outlet chambers while connecting said branch chamber with said inlet chamber around said first reduced portion, connecting said inlet chamber to said first work port chamber around said second reduced portion, connecting said second work port chamber with the exhaust means adjacent thereto; and connecting said first work port chamber to said first openings; and said valve element having means yet adapted when in said lower position to divert at least a portion of the fluid flow from the rod side of the piston motor to the piston side of the piston motor directly through said valve element when the pressure in said first work port chamber drop below a predetermined value.

5. A hydraulic valve as set forth in claim 4 wherein said valve element has first, second and third openings extending radially therethrough; first and second pressure responsive closure means for closing said first and third openings, respectively; said second closure means being responsive when said valve element is in said raise position to open under the fluid pressure in said valve element such that fluid flows to said second work port chamber from said parallel flow passage through said second and third openings; said first closure means being responsive when said valve element is in said lower position to open under the fluid pressure in said valve element, and when the pressure in said first work port chamber drops below said predetermined value such that fluid will flow from said second work port chamber through said valve element and said first openings into said first work port chamber.

References Cited

UNITED STATES PATENTS

2,965,133	12/1960	Rice et al.	137—612.1
3,006,372	10/1961	Ruhl	91—436 XR
3,390,700	7/1968	Hodgson et al.	137—596.2

HENRY T. KLINKSIEK, Primary Examiner

U.S. Cl. X.R.

91—436, 438; 137—625.68