Oct. 28, 1969 B. B. ROY ETAL 3,474,824

DUMP VALVE FOR HYDRAULIC CONTROL SYSTEM

Filed Jan. 17, 1968

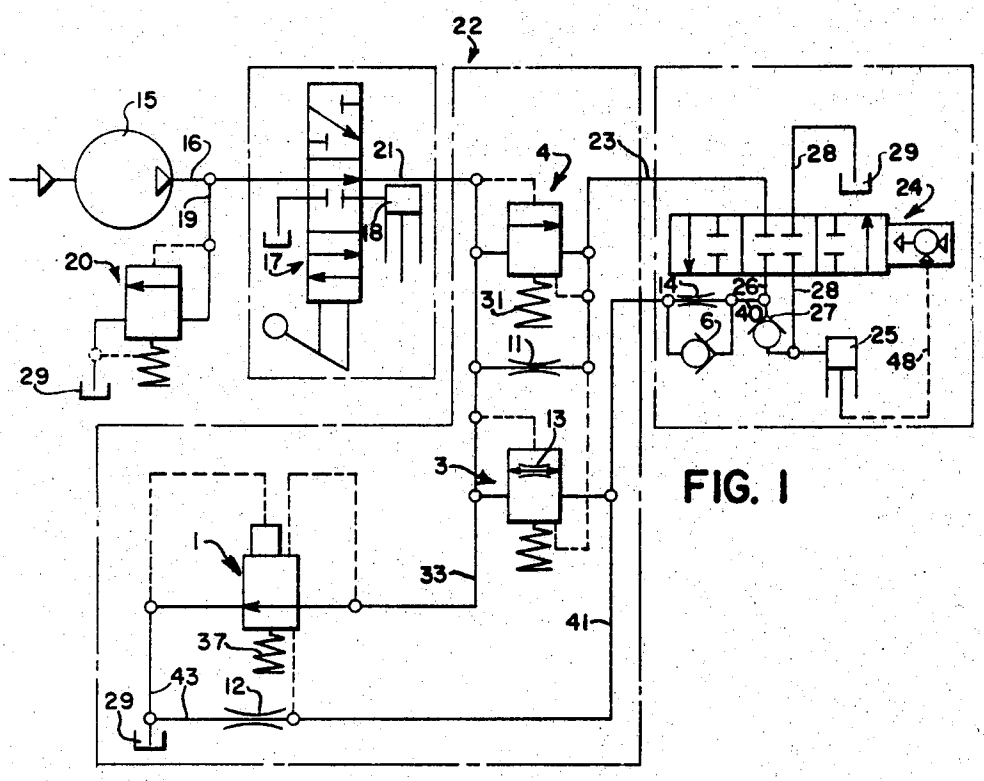
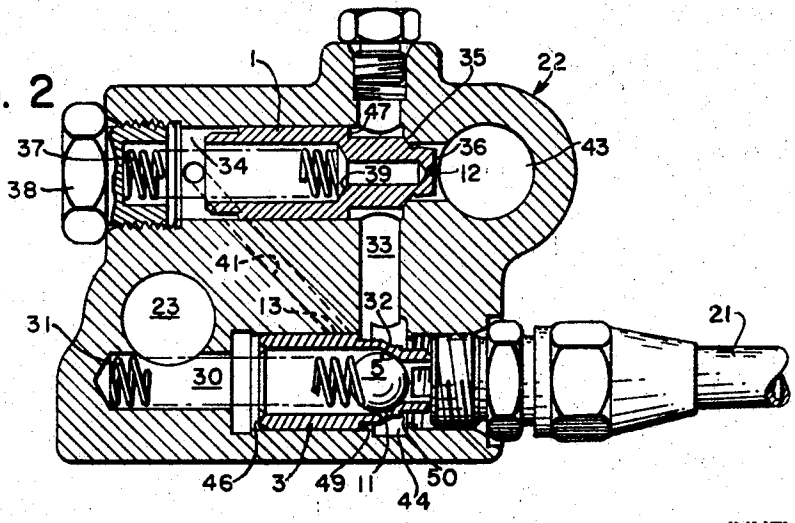


FIG. 1

FIG. 2



INVENTORS
BILLY BERT ROY &
STANLEY MARTIN GREGERSON

United States Patent Office 3,474,824 Patented Oct. 28, 1969

3,474,824

DUMP VALVE FOR HYDRAULIC CONTROL SYSTEM

Billy Bert Roy, Waterloo, and Stanley Martin Gregerson, Cedar Falls, Iowa, assignors to Deere & Company, Moline, Ill., a corporation of Delaware

Filed Jan. 17, 1968, Ser. No. 698,546
Int. Cl. F15b 1/00, 20/00
U.S. Cl. 137—596.13 12 Claims

ABSTRACT OF THE DISCLOSURE

A dump valve to be used in combination with a closed central control valve enabling the control valve to be used in a constant volume circulation hydraulic system. The dump valve is responsive to fluid pressure upstream of the control valve to allow the passage of fluid when the control valve does not allow the passage of fluid, and is responsive to fluid pressure on the downstream side of the control valve to block the passage of fluid when the control valve allows the passage of fluid.

BACKGROUND OF THE INVENTION

This invention relates to a dump valve which is used in combination with a closed center control valve to allow the closed center control valve to be used with a substantially constant volume source of fluid.

When using hydraulic circuits having a substantially constant volume circulation, it has been the general practice to employ an open center control valve to provide a continuous passage through the control valve in all operative positions of the control valve. The closed center control valve has not been employed in hydraulic systems having constant circulation because it does not provide an open circuit for continuous circulation in all of its operative positions, for example, its neutral position. The closed center control valve is generally employed in hydraulic circuits having a variable volume circulation. However, a hydraulic circuit having a variable volume circulation requires a variable volume power supply which is generally more complex and expensive.

SUMMARY OF THE INVENTION

In some constant volume circulation systems it is desirable to employ a closed center control valve because of characteristics present in this valve and not in the open center control valve.

It is therefore an object of this invention to provide a dump valve used in combination with a closed center control valve to provide continual circulation of fluid flow in all positions of the control valve.

Another object of the invention is to provide a dump valve in combination with a closed center control valve in a constant volume circulation hydraulic system in which the dump valve is urged to an open position by fluid pressure in the hydraulic system whenever the control valve is in one of its operative positions that does not allow the passage of fluid.

A further object of the invention is to provide a valve housing which includes a dump valve and is used in combination with a closed center control valve in a constant volume circulation hydraulic system such that the dump valve is held in its open or dump position by the fluid pressure in the hydraulic system leading to the control valve whenever the control valve is in a position which does not allow the passage of fluid and is urged to a closed position by fluid pressure in the hydraulic system on the downstream side of the control valve whenever the control valve is in one of its operative positions which allows the passage of fluid.

Still another object of the present invention is to provide a valve housing which includes a dump valve and is used in combination with a constant volume source of fluid pressure and a closed center servo control valve which is operable manually and/or through a servo linkage from a hydraulic cylinder or other control device which is controlled by the servo control valve.

When a closed center servo control valve approaches its neutral or fluid blocking position as it is being moved from a position in which it allows the passage of fluid from a source to a hydraulic cylinder toward its neutral position by a servo linkage between the cylinder and valve, the pressure drop across the servo control valve becomes so great that there is not sufficient fluid pressure on the downstream side of the servo control valve to cause the flow of fluid into the cylinder and hence the servo linkage will not move the servo control valve its last increment to the neutral position. Therefore, it is still another object of the present invention to provide a bypass around the servo control valve which is operable when the servo control valve is being moved toward its neutral position to supply the hydraulic cylinder with sufficient fluid to move the servo control valve, by way of the servo linkage, to its full neutral position.

The above and other objects and advantages will become apparent from a reading of the following specification taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a control system according to the present invention showing the relationship of the various parts.

FIG. 2 is a cross-sectional view through the dump valve housing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, a constant volume pump **15** supplies fluid under pressure to a conduit **16** leading to an open center control valve **17** for a remote cylinder **18**. A conduit **19** communicates with conduit **16** and leads to a fluid pressure responsive safety valve **20**. Valve **20** limits the pressure within the hydraulic system and as such prevents a pressure buildup in excess of that for which the system was designed. Valve **17**, cylinder **18**, and valve **20** do not form a part of the present invention, but are shown to illustrate a complete circuit in which the present invention may be used.

On the downstream side of control valve **17**, a conduit **21** leads to the dump valve housing indicated generally at **22**, and a conduit **23** communicates the dump valve housing **22** with the intake side of a closed center servo control valve **24** which controls cylinder **25**. The cylinder **25** is used for any desired function such as operating a rockshaft on which the lift arms of a tractor are mounted. Conduit **26** provides for the passage of fluid from the control valve to the rockshaft cylinder **25**. A check valve **27** is placed within conduit **26** to prevent any backup of fluid when the fluid pressure in cylinder **25** is greater than the pressure in conduit **23** when the servo control valve is moved to its raise position. Circuit **28** which communicates with conduit **26** between the check valve **27** and cylinder **25** functions to drain fluid from the cylinder **25**, through the control valve **24**, and to the sump **29**.

As fluid from conduit **21** enters the dump valve housing **22**, it enters a bore **30**. Slidably received within bore **30** is a pilot valve **3** normally closing off an orifice **13** which communicates the bore **30** with a pilot circuit **41** which will be fully explained hereinafter. Pilot valve **3** is a hollow cylindrical member with a reduced forward or upstream end. A ball **5** is located with the pilot valve and

is normally seated on a reduced portion 32 of the inner wall of pilot valve 3 to form a check valve 4. A compression spring 31 acting between the end of bore 30 and the ball 5 keeps the ball seated and also keeps the pilot valve 3 in a forward position where it closes off orifice 13. An orifice 11 extends through the wall of pilot valve 3 at a location in the reduced end portion of the pilot valve and behind the check valve 4. Rearwardly of the pilot valve 3, the bore 30 communicates with conduit 23 which leads to the servo control valve 24.

A dump valve 1 is slidably positioned within a bore 34 provided in housing 22. Dump valve 1 takes the form of a hollow cylindrical member which is closed at its forward end 36 and open at the back end. The forward end of bore 34 is of a reduced diameter and the forward end of the hollow cylindrical member is tapered as shown at 35 so that as it starts to enter the reduced portion of bore 34, it seats upon the shoulders provided by the reduced portion of bore 34. The dump valve 1 is normally held in its forward or seated position by a compression spring 37 which acts between a closure member 38 for the bore 34 and an annular shoulder 39 provided within the cylindrical valve. The normal position of the valve is that position which it assumes in the absence of fluid pressure. The forward or reduced end of bore 34 communicates with passageway 43 which leads directly to sump 29. The closed forward end of the dump valve is provided with an orifice 12 for a purpose to be explained hereinafter.

Bore 30 is provided with an annular groove 44 adjacent its forward end and around the reduced portion of the pilot valve 3 when the pilot valve 3 is in its forward or closed position and communication is established between the annular groove 44 and bore 34 by passageway 33.

An auxiliary conduit 40 communicates with the conduit 26 between the control valve 24 and the check valve 27 and leads to the pilot circuit 41. The pilot circuit 41 communicates with the bore 34 rearwardly of the dump valve 1, and, as previously mentioned, also communicates with the bore 30 via the orifice 13.

A restricted orifice 14 is placed with the conduit 40 and a check valve 6 is placed in parallel to the orifice 14 to provide for unrestricted flow through the conduit 40 in one direction while restricting the fluid flow in the other direction.

The above-described system operates in the following manner. With the closed center servo control valve 24 in its neutral position, fluid flow from the constant volume pump 15 will pass freely through the open center control valve 17 to housing 22. Upon entering the housing 22, the fluid is free to flow through annular groove 44 to passage 33. Since the closed center control valve 24 is in its neutral position, there will be no fluid flow through the orifice 11 and across the control valve 24 and therefore no pressure differential across the orifice 11. In the absence of a pressure drop across the orifice 11, the pilot valve 3 and check valve 4 are in hydraulic balance and the spring 31 will hold the pilot valve 3 and check valve 4 in their normal closed positions.

As the fluid pressure builds up within the passageway 33, it acts against a forwardly facing shoulder 47 on the pilot valve 1 until it provides a force on the shoulder 47 which is equal to the force provided by spring 37. At this time the dump valve is moved rearwardly and the fluid from passageway 33 is free to flow by the tapered portion 35 of the valve member 11, into the reduced portion of bore 34 to passageway 43, and to sump 29. The system will remain in this condition until acted upon by some force external of the hydraulic system.

When the servo control valve is moved to the raise position, either manually or by servo control linkage 48, the fluid in conduit 23 is free to flow through control valve 24, conduits 26 and 40, pilot circuit 41, into bore 34, and through orifice 12 to sump 29. Since the orifice 12 is of restricted size, there will be a pressure drop across this orifice. This pressure drop creates a force on the back side of dump valve 1 which is accumulative to the force created by the compression spring 37 and causes the dump valve 1 to produce a higher pump pressure. Fluid flow through orifice 11 will increase until a predetermined pressure drop across the orifice is reached. When this predetermined pressure drop is reached, the fluid pressure acting on forwardly facing annular shoulders 49 and 50 on the pilot valve 3 will compress the spring 31 and move the pilot valve rearwardly, thereby permitting flow through the now uncovered orifice 13 into the pilot circuit 41. The increased flow into the pilot circuit 41 will create a larger pressure drop across the orifice 12 which will in turn cause the dump valve 1 to produce a higher pump pressure.

The flow through orifice 11 will continue to increase until a second predetermined pressure drop across the orifice 11 is reached. At this time the check valve ball 5 will be moved off its seat to provide a large volume flow through the bore 30, conduit 23, control valve 24, and into conduit 26. The pressure in the system continues to build up until it reaches the pressure in the cylinder 25 at which time the check valve 27 moves off its seat and fluid flows from the conduit 26 to the cylinder 25.

The hydraulic system will again remain in this condition until acted upon by some external force. The external force may come as a result of manual manipulation of the control lever for the servo control valve 24 or through the servo control linkage 48. In either event, as the servo control valve is moved to its neutral position, the opposite sequence of events, as described above, will occur to cause the dump valve 1 to return to its bypass position. As the servo control valve is moved to its neutral position, the pressure drop across the control valve will increase and cause decreased flow through conduit 23 and bore 30. The decreased flow through bore 30 will decrease the pressure drop across orifice 11 and check valve 4 to below the second predetermined pressure across the orifice 11 so that the check valve ball 5 will again seat. As the flow through conduit 23 continues to decrease, the flow through orifice 11 will decrease and as a result the pressure drop across orifice 11 will decrease past the first predetermined pressure drop, thus permitting the pilot valve to move to its forward position and close off the orifice 13. With the control valve 24 now in its closed position, there will be no pressure drop across the orifice 12 and the fluid pressure within passageway 33 acting on shoulder 47 will compress the spring 37 and move the dump valve rearwardly to its bypass position.

When the servo control valve is moved to its neutral position by the servo control linkage 48, it will be moved back gradually depending upon the amount of fluid which flows into the cylinder 25. However, as the control valve nears its neutral position, the pressure drop across the same will be so great that there will not be sufficient pressure on the downstream side of the control valve to flow into the cylinder 25 and hence the control valve will not move its last increment to the neutral position. At this point, as the pressure in conduit 26 decreases upstream of the check valve 27, the fluid passing through orifice 13 into pilot circuit 41 will backflow through the orifice 14 into the conduit 26 and supply the cylinder 25 with sufficient fluid to move the control valve, through linkage 48, its last increment to the neutral position.

We claim:

1. A control system for a hydraulic control device comprising: means providing a constant volume flow of fluid pressure to a closed center control valve means and a dump valve means, said closed center control valve means being movable from a first position in which fluid passes through said closed center control valve means to a second position in which fluid is prevented from passing through said closed center control valve means, said dump valve means being movable from a first position in which fluid from said first mentioned

means passes freely through said dump valve means to a second position in which fluid from said first mentioned means is prevented from passing through said dump valve means, said dump valve means being responsive to the fluid pressure passing directly from said first mentioned means to move to its first position when said closed center control valve is in its second position, and said dump valve means being further responsive to fluid pressure passing through said closed center control valve means when said closed center control valve means is in its first position to move to its second position whereby fluid from said first mentioned means is free to flow through either said control valve means or said dump valve means at all times.

2. A control system for a hydraulic control device comprising: means providing fluid pressure at a substantially constant volume of fluid flow to first and second chambers provided within a valve housing, said first chamber being in fluid communication with the inlet side of a closed center control valve, said second chamber having an exhaust port adapted to return fluid to said means providing fluid pressure, said second chamber having an inlet port in fluid communication with a pilot circuit which is in fluid communication with the outlet side of said closed center control valve, dump valve means within said second chamber normally closing off said exhaust port, said dump valve means being responsive to fluid pressure from said first mentioned means to open said exhaust port when said control valve is in a position preventing passage of fluid therethrough, and said dump valve means being further responsive to fluid pressure passing through said control valve when said control valve is in a fluid passing position to return to its normal exhaust port closing position.

3. A control system according to claim 2 further including check valve means within said first chamber normally preventing fluid supplied by said first mentioned means from passing into said first chamber, bypass orifice means within said first chamber providing a fluid circuit around said check valve means for a limited amount of fluid flow, and said check valve means being responsive to a predetermined pressure drop across said bypass orifice means to move to an open position in which there is unlimited fluid flow into said first chamber.

4. A control system according to claim 3 in which said first chamber has an outlet port in fluid communication with said pilot circuit, pilot valve means normally covering said outlet port, said pilot valve means being responsive to a predetermined pressure drop across said bypass orifice means to move to a position in which it does not cover said outlet port.

5. A control system according to claim 4 in which said pilot valve means is responsive to a predetermined pressure drop across said bypass orifice means which is substantially less than the predetermined pressure drop across said bypass orifice means to which said check valve means is responsive.

6. A control system according to claim 5 which further includes restricted orifice means through said dump valve means allowing limited fluid flow from said pilot circuit to said exhaust port.

7. A control system according to claim 6 in which said dump valve means, said check valve means, and said pilot valve means are all spring biased to their normal positions,

8. A control system according to claim 2 in which said first chamber is provided with an outlet port which is in fluid communication with said pilot circuit, pilot valve means normally covering said outlet port, said pilot valve means being responsive to a predetermined difference in pressure between the fluid entering said chamber from said first mentioned means and the fluid leaving said chamber to the inlet side of said control valve to move to a position in which it does not cover said outlet port.

9. A control system according to claim 8 in which said dump valve means is provided with a restricted orifice means to release a limited amount of fluid from said pilot circuit to said exhaust port.

10. A control system according to claim 9 in which said dump valve means and said pilot valve means are spring biased to their normal positions.

11. A control system according to claim 8 in which said closed center control valve is a servo control valve, said system further including servo linkage means operably connected between said control device and said servo control valve to move said servo control valve to its fluid blocking position after said control device is supplied with a predetermined amount of fluid, said outlet port and pilot circuit constituting means to bypass fluid around said servo control valve as the pressure across said servo control valve increases when it is moved toward its fluid blocking position to insure that the control device is supplied with a sufficient amount of fluid to move the servo control valve to its full fluid blocking position.

12. In a control system including a hydraulic control device, means providing a substantially constant volume flow of fluid pressure to said control device, a closed center servo control valve having a fluid passing position and a fluid blocking position controlling the flow of fluid from said means to said control device, servo linkage means operably connected between said control device and said servo control valve to move said servo control valve to a fluid blocking position after said control device is supplied with a predetermined amount of fluid, the improvement comprising: bypass circuit means which will direct a portion of the fluid flow from said first mentioned means around said servo control valve to said control device, valve means for said circuit means, said valve means having a fluid passing position and a fluid blocking position, said valve means being operative to move to its fluid passing position when said servo control valve is moved to its fluid passing position and to move to its fluid blocking position after said servo control valve is moved to its fluid blocking position, thereby insuring that the control device is supplied with a sufficient amount of fluid to move the servo control valve to its full fluid blocking position.

References Cited

UNITED STATES PATENTS

3,234,957	2/1966	Allen	137—117
3,237,636	3/1966	Strader	137—115
3,411,416	11/1968	Herd et al.	137—117 XR

HENRY T. KLINKSIEK, Primary Examiner

U.S. Cl. X.R.

91—451; 137—115