June 14, 1955 R. F. HODGSON 2,710,628

CONTROL VALVE WITH INHERENT CIRCUIT PROTECTION

Filed Oct. 11, 1954 2 Sheets-Sheet 1

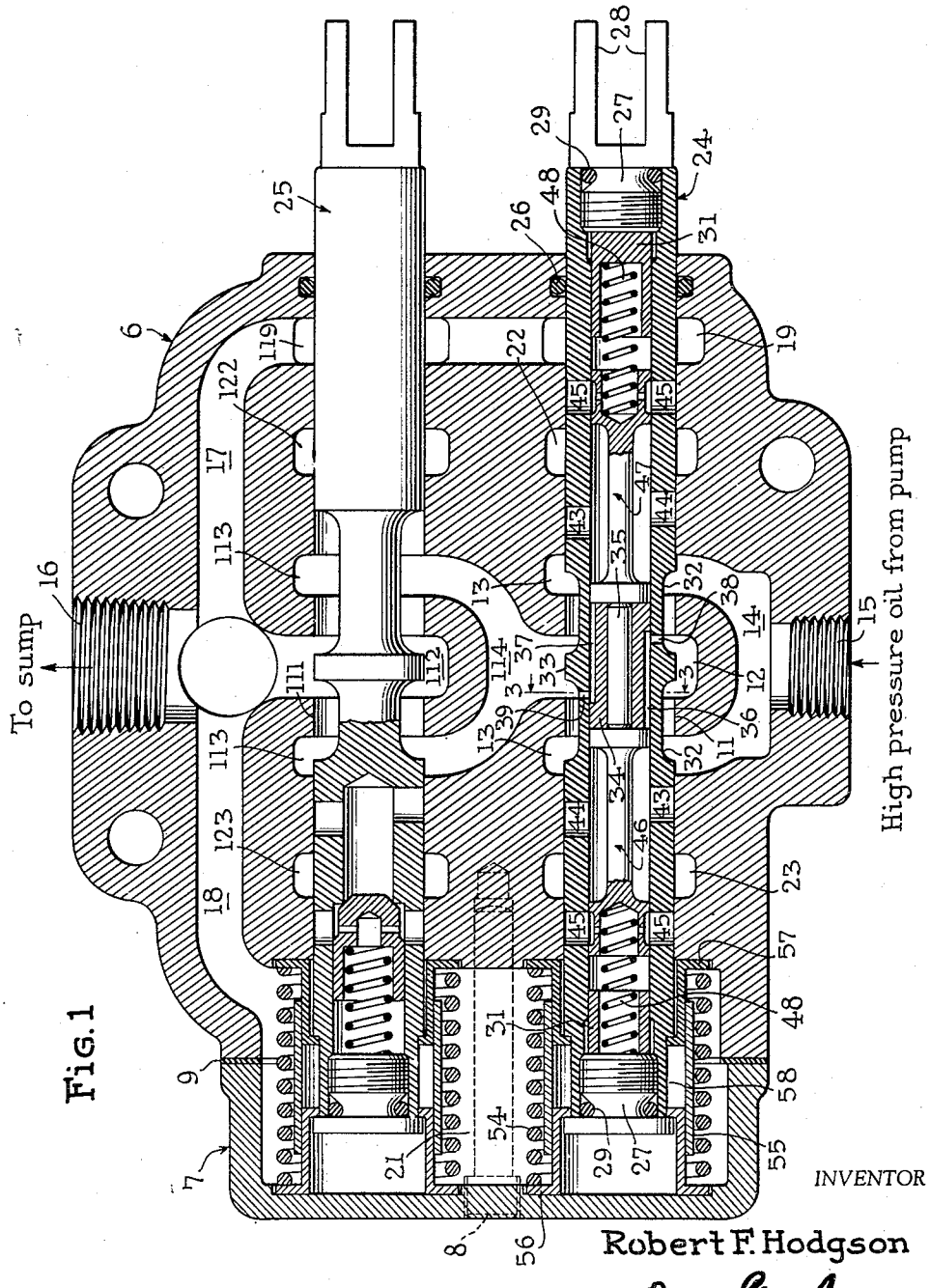


Fig. 1

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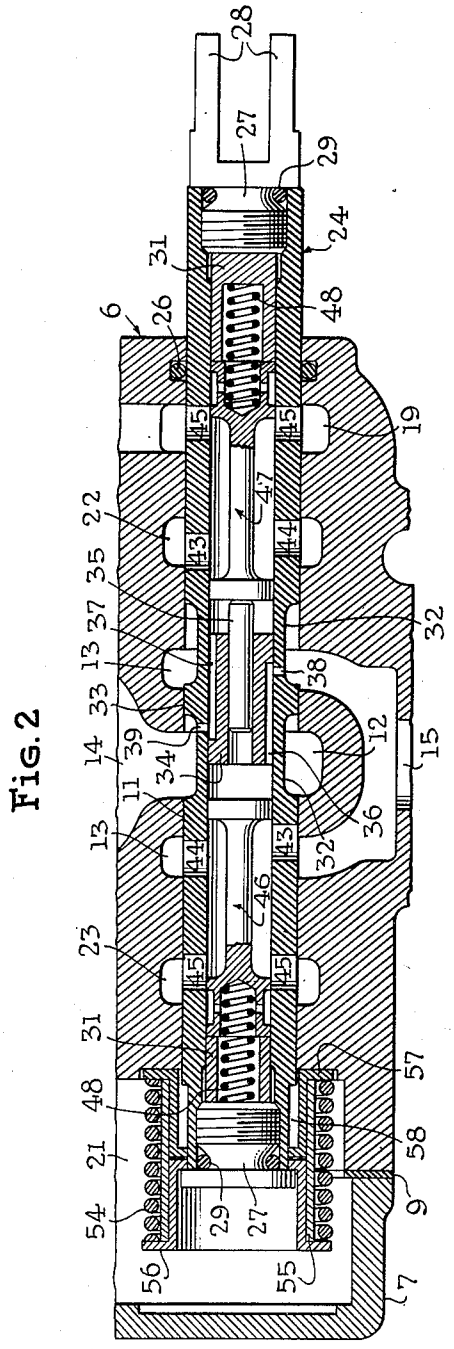


Fig. 2

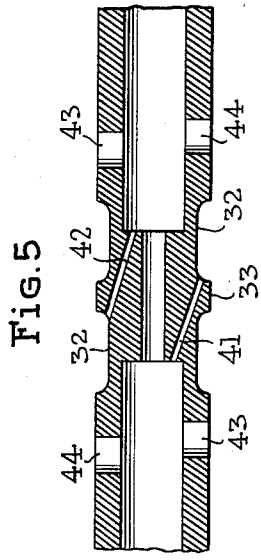


Fig. 5

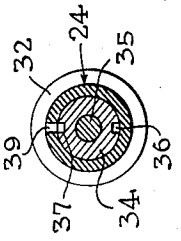


Fig. 3

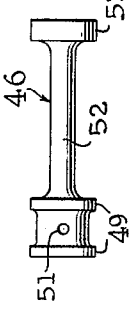


Fig. 4

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CONTROL VALVE WITH INHERENT CIRCUIT PROTECTION

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Application October 11, 1954, Serial No. 461,428

6 Claims. (Cl. 137—622)

This invention relates to control valves for hydraulic and similar pressure motors, particularly double-acting motors.

The patent to Kirkham 2,608,824, September 2, 1952, relates to a flow control valve for double-acting motors which controls the exhaust flows from either end of a double-acting motor in response to the supply flow to the opposite end of that same motor. If the supply pressure to one end of the double-acting cylinder falls or if the load reverses, the Kirkham device closes or throttles appropriately the exhaust path from the other end of the cylinder. This is complementary to the protection offered by schemes which interpose check valves in the supply path, and the Kirkham patent shows such a check valve in the valve plunger.

The patent to Stephens 2,359,802, October 10, 1944, describes a control valve having a hollow plunger with lateral ports and at least one check valve in the bore of the plunger serving to control flows through the bore between certain of the lateral ports. One of these is supply flow. The valve is simple to construct and can be designed to suit the porting of particular seats. Its great advantage however is that it affords flexibility in design, since mere substitution of a hollow valve with one or two check valves, in an existing seat can afford new or improved functions as compared to the same seat with some other more conventional valve. It is economically advantageous to standardize the seat component of a valve (which is permanently connected in the circuit), and vary the over-all characteristics by selection of differently ported plungers. The Stephens invention has gone into extensive commercial use because of this desirable characteristic.

The present invention has the effect of introducing functions similar to those of the Kirkham device into a hollow plunger while retaining the check-valve effect characteristic of the Stephens invention. Thus, without functional sacrifice, and with actual saving in the cost of manufacture, the advantages of two diverse valve mechanisms are combined and are rendered readily available in an interchangeable plunger. Indeed, there is a functional advance over the Kirkham concept, because both inlet and exhaust flows are controlled simultaneously and independently by the two flow control valves which, according to the present invention, are mounted in the bore of a hollow plunger.

Referring to the preferred embodiment of the concept, a hollow plunger has the middle portion of its bore obstructed by an open-ended cylinder in which a closely fitted axially shiftable piston works. At each end of this cylinder the plunger has a larger bore, each such larger bore serving as a cylinder and as a guide for the corresponding one of two piston-actuated piston-type flow control valves. Each of these last named valves controls ports leading through the walls of the plunger, and serves as a flow-control valve. Each also performs the functions of Stephens' check valve, though neither takes the form of a conventional check valve.

The axially shiftable piston closes the bore of the open-ended cylinder, so that this can never short circuit supply to discharge. In each active position the piston serves as a force-transmitter, enabling supply pressure to react simultaneously upon both the flow-control valves. The reaction is direct in the case of a selected one of the valves and is exerted through the piston in the case of the one not so selected. The selection depends on the direction in which the plunger is shifted from its mid-position. The open-ended cylinder is arranged to serve also as stops for the flow-control valves, which engage it in their port-closing positions.

The invention will now be described by reference to the accompanying drawings which illustrate how the improved plunger can be assembled with a conventional valve body.

Figure 1 is an axial section through the body of a two-plunger valve of the series connected type. In this view the two valve seat bores are identically ported. Both valves are in hold position (open center), the upper one being a conventional Stephens valve for a single-acting cylinder and the lower one embodying the invention and adapted to control a double-acting cylinder.

Figure 2 is a fragmentary view similar to a portion of Figure 1, but showing the lower valve of Figure 1 shifted to the right.

Figure 3 is a fragmentary section on the line 3—3 of Figure 1.

Figure 4 is a side elevation of one of the flow-control valve units.

Figure 5 is an axial section of a modified plunger.

All statements of direction refer to Figure 1.

Valves of the type here indicated are commonly used with a constantly running pump which draws oil from a sump and delivers it under pressure to the inlet of the valve, which in turn discharges spent oil to the sump. Hence on Figure 1 the valve inlet is indicated by the legend "High pressure oil from pump" and the valve discharge by the legend "To sump." The connections to the motor cylinders are not elaborated in the drawings, but the communicating seat ports are adequately identified.

Since the valve is of the series-connected open-center type, the pump is unloaded through the valve when both plungers are in "hold" position (shown in Figure 1). A "hold" position in a double-acting motor is one in which both motor ports are closed.

The valve housing conforms generally to known practice and comprises a body 6 and a cap 7 held together by screws 8 (one only of these screws is indicated by broken lines.) The cap is sealed to the body by gasket 9.

The body has two identical parallel bores 11 and 111 in which the ports are bore-encircling grooves.

To save repetition all identified features of bore 111 which are identical with those of bore 11 will be given the same reference numerals increased by 100.

At mid-length, bore 11 has an encircling groove 12, which is the discharge port. At either side of groove 12 are encircling grooves 13 which are supply ports. These are fed through a branching passage 14 which leads from the supply connection 15. Since the valve is of the series connected type discharge port 12 feeds the supply ports 113 of bore 111 through a branching passage 114.

The discharge port groove 112 of bore 111 leads to discharge connection 16 as do two branches 17 and 18. Branch 17 connects with exhaust grooves 19 and 119. Branch 18 connects with space 21 within cap 7 into which space the ends of both plungers project, space 21 functioning as an exhaust port as will be explained.

The groove ports 22 and 23 are motor ports, that is, they are connected to opposite working spaces of a double-acting cylinder or other motor unit. All ports in

bore 11 are controlled by a plunger 24 in which the novel features of the invention are incorporated.

Ports in bore 111 are controlled by a plunger 25 constructed according to the disclosure of Stephens' patent, above identified. Since plunger 25 is designed to control a single-acting motor the connection to port 122 is plugged and port 123 is connected to the working space of the motor. If it be desired to control a double-acting motor ports 122 and 123 are connected to the opposite working spaces thereof and an appropriate plunger is substituted for plunger 25.

Since the bores 11 and 111 are identical as to size and port location, Figure 1 demonstrates the possibility of applying the invention by merely substituting the newly devised plunger.

Plunger 24 is basically a tube which makes a close working fit in bore 11, is sealed by an O-ring 26 where it emerges from the bore, and is closed at its end by plugs 27 threaded into its ends. These plugs are identical except that the right hand one carries a clevis 28 for connection of the valve-actuating linkage (not shown). Each plug is sealed by an O-ring 29 and carries on its inner end a cup-like extension 31 which serves as a valve stop and also as a seat for a valve-loading spring.

The plunger valve is of the open center type, i. e., it connects ports 12 and 13 in mid-position and disconnects them when displaced in either direction therefrom. There are various known portings to afford these functions, but the simplest, and the one best adapted to the present invention, comprises two encircling grooves 32 with a narrow intervening land 33.

Within land 33 and grooves 32 the bore of plunger 24 receives a tightly fitted plug 34 with an open ended axial bore. Within this bore a floating piston 35 is reciprocable. The ends of the plug serve as stops opposed to corresponding stops 31, so that the range of motion of the flow-control valves (later to be described) is defined. The function of floating piston 35 is to open selectively the flow control valve on the exhaust side and at the same time afford no short circuit path between ports 12 and 13.

To afford the desired result the left-hand groove 32 is connected to the space at the right end of floating piston 35 and the right-hand groove 32 is connected to the space at the left-hand end of the piston. In the construction shown in Figures 1–3 this is done by cutting grooves 36, 37 from opposite end of plug 34 long enough to reach radial ports 38, 39.

A somewhat more expensive construction is shown in Figure 5. It requires that the plunger be bored from each end so as to leave an integral central portion replacing plug 34. It is then possible to drill simple cross-connecting ports 41, 42. No functional difference is involved.

Reverting to Figures 1–3, beyond each end of plug 34 ports 43, 44 are drilled through the plunger. They are slightly offset in the direction of the axis for graduation purposes. Nearer each end of the plunger are drilled ports 45. The ports above named are terminal portions of flow-paths through portions of the bore of the plunger. For example, in Figure 2 supply flow is controlled by the left portion of plunger 24 from 13, through 43, 44, through the plunger bore, through 45 to motor port 23. In the same figure exhaust flow from the other motor port is controlled by the right portion of plunger 24 and is from 22 through 43, 44, through the plunger bore through 45 to 19 and so via 17 to sump.

These flows are controlled according to the invention by identical pressure-actuated balanced piston valves generally indicated by the numerals 46 and 47. A description of the left-hand one in Figure 1 will suffice for both, it being understood that they are reversely arranged and biased toward each other by the springs 48.

As best shown in Figure 4, the valve proper is a cup shaped piston head having two narrow lands 49 between

which are vent holes 51. These permit the valves to reach the positions shown in Figure 2 without becoming oil-bound. At that point the stop flanges 31 arrest them. A slender stem 52 connects the valve head with an actuating piston 53. These heads engage the opposite ends of plug 34 and piston 35 and define the closed positions of the valves.

As is illustrated in Figure 2, when the plunger 24 is shifted to charge one motor working space and vent the other, supply pressure acts directly on the pistonhead 53 of that valve which controls supply flow (valve 46 in Figure 2), but acts through piston 35 on that valve which controls exhaust flow (valve 47 in Figure 2).

These valves 46 and 47 are not check valves in the true sense, but they accomplish all the functions of Stephens' check valve and additional functions. If supply pressure in passage 14 falls from any cause while the plunger is away from its mid-position ("hold" position) both valves 46 and 47 moves in closing directions and either throttle both supply and exhaust flows or close them off altogether. If they close they establish a "hold" position irrespective of the position of plunger 24.

The plunger 24 is held yieldingly in mid-position by a centering spring 54 (see Figure 2) which encloses a sleeve 55 slidable between the flanged rings 56 and 57. One flange on each ring engages a groove 58 surrounding plunger 24 near its left-hand end. Such centering springs are well known in the art and an identical one is shown on the conventional plunger 25.

Plunger 25 being conventional requires no description. It merely illustrates the prior art and emphasizes the point that a plunger such as 24 can be substituted in bore 111 and can then afford additional functions and safeguards. This presupposes that the connection to port 122 is unplugged and a double-acting motor is connected to the two ports 122, 123.

The construction of the best embodiment presently known has been described in detail to comply with the statute. Structural changes within the scope of the claims are contemplated and are not excluded by implication.

What is claimed is:

1. For use in a valve housing having a bore with spaced supply and discharge and motor ports; a plunger valve comprising a tubular element shiftable in said bore and having spaced lateral ports so located that in three different positions the plunger alternatively closes a motor port, or connects that port selectively with supply or with exhaust by paths leading through the bore of the tubular element between spaced lateral ports at least one of which ports is common in both paths; a piston valve controlling the lateral port just specified and thus controlling both flow paths said valve being balanced so as to be indifferent to the pressure of fluid flowing through said paths; means biasing said balanced valve in its closing direction; pressure motor means for opening said valve; and port means effective in both connecting positions of the plunger to subject said motor means to supply pressure, and effective in the other position to vent said motor means.

2. The combination of a valve body having a seat comprising a bore with supply and discharge ports near mid-length of the bore, discharge ports adjacent the end of the bore and two motor ports, each located between a supply port and a corresponding end discharge port; a valve plunger axially shiftable in said bore and having ports which in the mid-position of the valve plunger connect the first named supply and discharge ports, opposite end portions of said valve plunger being tubular and each having lateral through-ports which are blanked in the mid-position of the valve plunger, and which according as the valve plunger is displaced in one or the other direction from mid-position afford simultaneous flow paths through respective tubular portions from supply to a selected one of said two motor ports and from the other

one of said motor ports to an end discharge port; flow control valves, one shiftable in each tubular portion and each controlling inter-port flow therethrough; means biasing said flow control valves to close; pressure motor means mounted in said valve plunger and at least partly in said tubular portions, and operable by fluid pressure to move said flow control valves in their opening directions; and means rendered effective by shift of said valve plunger from its mid-position to subject said pressure motor means to supply pressure.

3. The combination of a valve body having a seat comprising a bore with supply and discharge ports near mid-length of the bore, discharge ports one adjacent each end of the bore and two motor ports, each located between a supply port and a corresponding end discharge port; a valve plunger axially shiftable in said bore and having ports which in the mid-position of the valve plunger connect the first named supply and discharge ports, opposite end portions of said valve plunger being tubular and each having lateral through-ports which are blanked in the mid-position of the valve plunger, and which according as the valve plunger is displaced in one or the other direction from midposition afford simultaneous flow paths through respective tubular portions from supply to a selected one of said two motor ports and from the other one of said motor ports to an end discharge port; flow control valves, one shiftable in each tubular portion and each controlling inter-port flow therethrough, each of said flow control valves being of the balanced piston type and indifferent to the pressure of fluid flowing through the corresponding tubular portion; means biasing said flow-control valves to close; pressure motor means mounted in said valve plunger and at least partly in said tubular portions, and operable by fluid pressure to move said flow control valves in their opening directions; and means rendered effective by shift of said valve plunger from its mid-position to subject said pressure motor means to supply pressure.

4. The combination of a valve body having a seat comprising a bore with supply and discharge ports near mid-length of the bore, discharge ports one adjacent each end of the bore and two motor ports, each located between a supply port and a corresponding end discharge port; a valve plunger axially shiftable in said bore and having ports which in the mid-position of the valve plunger connect the first named supply and discharge ports, opposite end portions of said valve plunger being tubular

and each having lateral through-ports which are blanked in the mid-position of the valve plunger, and which according as the valve plunger is displaced in one or the other direction from mid-position afford simultaneous flow paths through respective tubular portions from supply to a selected one of said two motor ports and from the other one of said motor ports to an end discharge port; flow control valves, one shiftable in each tubular portion and each controlling inter-port flow therethrough; means biasing said flow control valves to close; means affording within the valve plunger an open ended cylinder with its axis substantially parallel with the valve plunger axis, and its ends communicating with respective tubular end portions of the valve plunger; a floating piston in the bore of said cylinder; actuating pistons in said tubular end portions in position to be engaged by said floating piston and each connected with a corresponding flow control valve; and port means rendered effective selectively by motion of the valve plunger in respective directions from its mid-position to admit supply pressure fluid between a selected actuating piston and the adjacent end of the floating piston.

5. A plunger valve comprising a tubular element; a floating piston axially shiftable in the bore of said tubular element substantially at mid-length thereof, and dividing said bore into two non-communicating portions, each portion having spaced lateral ports which afford distinct flow-paths, one through the bore of each portion; two piston valves each valve controlling flow through a corresponding one of said flow paths; yielding means biasing each of said piston valves toward said floating piston; two piston heads each for actuating a corresponding piston valve in opposition to its biasing means and each interposed in said bore between its piston valve and the proximate end of said floating piston; motion limiting means for said valves and piston heads; and means affording two distinct ports each leading to the space between a corresponding end of the floating piston and the adjacent piston head.

6. The combination defined in claim 5 in which each piston head and its corresponding piston valve are connected together to form a unit balanced so as to be indifferent to the pressure of fluid whose flow the piston valve controls.

No references cited.