

United States Patent

Carlson

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[54] VALVE

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137/625.69, 625.68; 91/433

[56]

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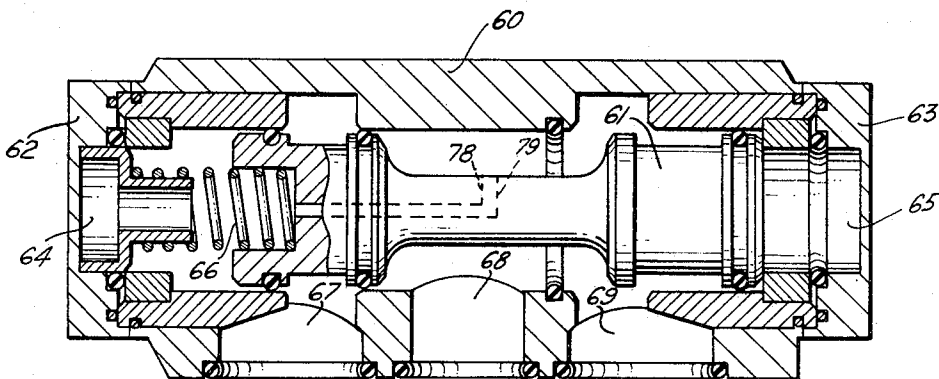
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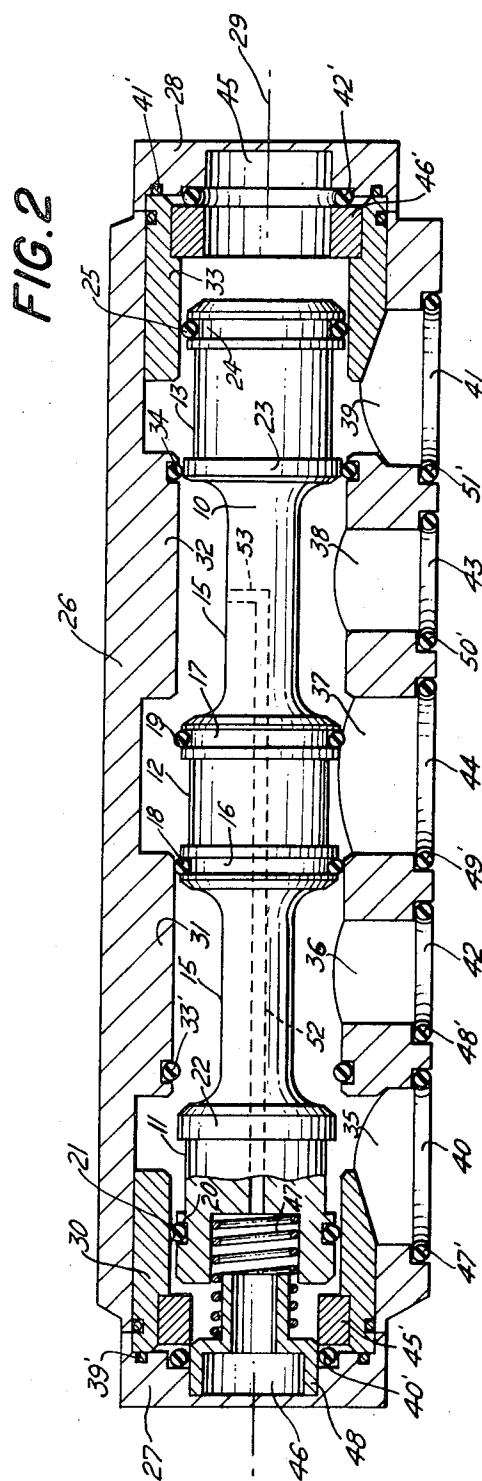
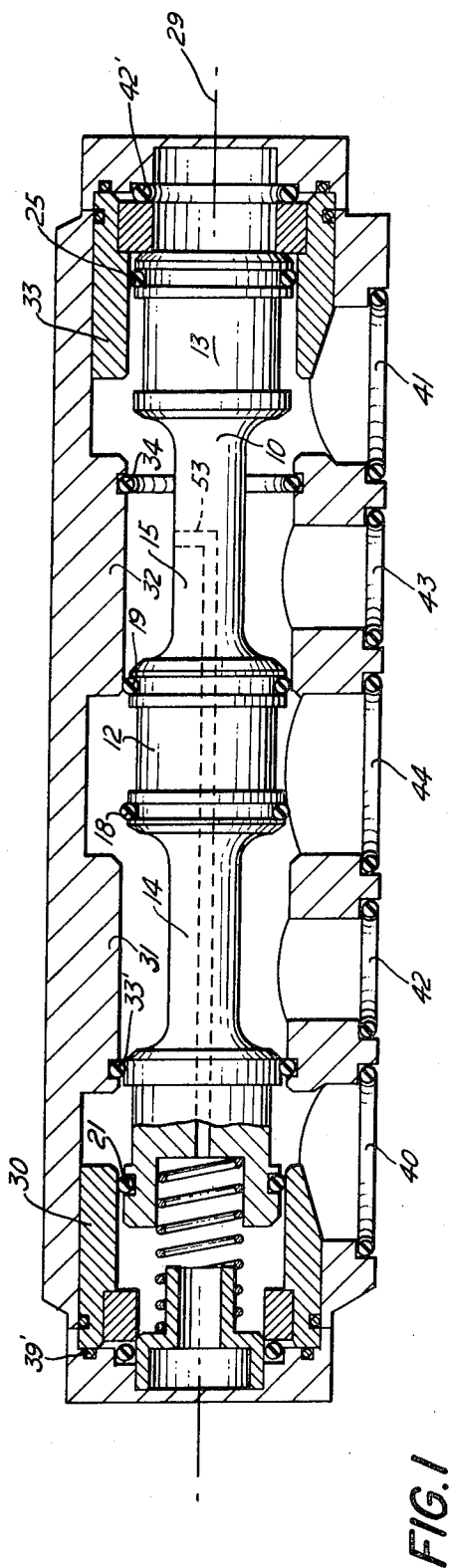
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ABSTRACT

A pressure actuated spool-type fluid valve in which the spool is shifted by the pressurized fluid with or without the assistance of mechanical spring means.

6 Claims, 4 Drawing Figures





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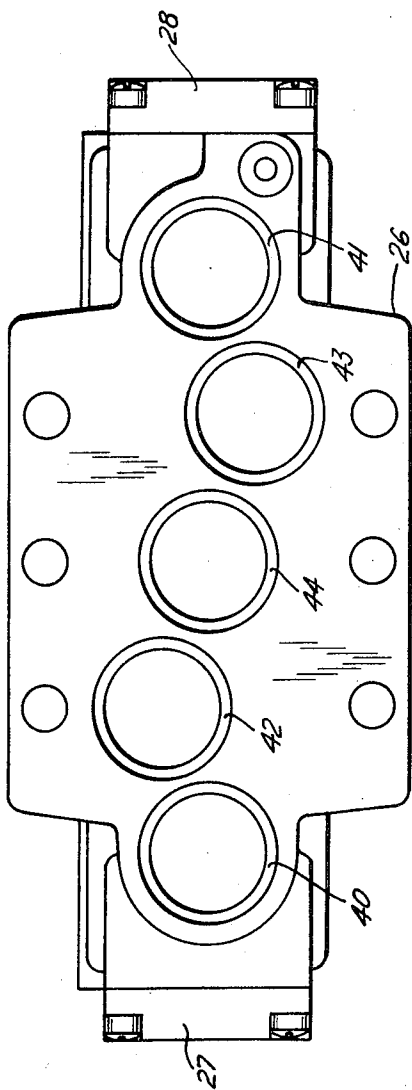
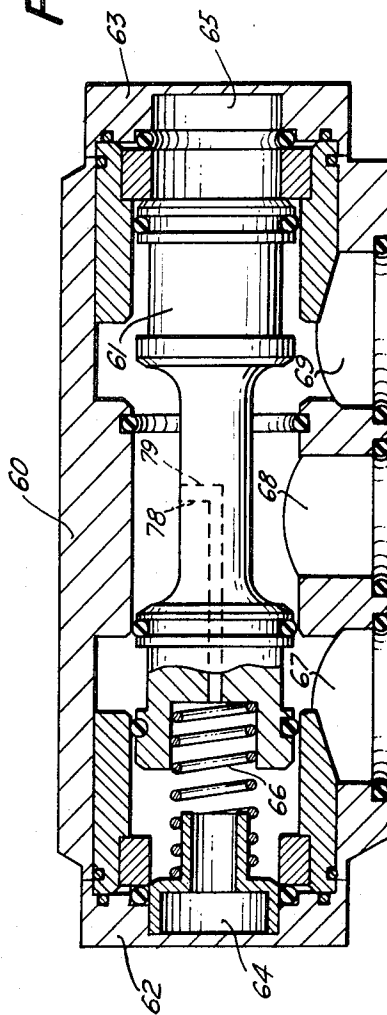


FIG. 3

FIG. 4



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VALVE

BACKGROUND OF THE INVENTION

The invention is described herein in the first embodiment in terms of a four-way valve. The invention however can be embodied in valves other than the four-way valves and the embodiments shown herein are selected for purposes of description only and the invention is not limited solely thereto. Parallel advantages of the valve described and claimed herein as opposed to conventional valves can be shown for any model spool or plunger type valve which is pressure actuated and has a normal unactuated spool position.

The terms "porting areas" and "valving elements" are used herein as generally understood in that branch of technology which is devoted to fluid power applications. The precise definitions of these terms as used herein will become apparent below.

A four-way valve basically serves to control the reciprocation of a double acting cylinder. When the valve spool or plunger is in one of said positions, for example, one end of the cylinder might be pressurized through the valve, at which time the remaining end would be open to the tank or exhaust through the valve. When the spool is in the opposite offset position, the former end would be open to tank and the latter would be pressurized. In short, four pairs of valving elements in the valve are involved to control the pressure urged reciprocation of the piston of a double acting cylinder. Two of the pairs of valving elements communicate, one to pressure, one to tank, with one of the two cylinder porting areas, while the other two pairs communicate in like manner, one to pressure, one to tank, with the other cylinder porting areas of the valve. These pairs of valving elements, the bore in the body and the lands of the spool form the opening and closing pairs in a spool-type valve and are further integrated by design to open and close so that when pressure is on, either cylinder ports, its communication with the tank is closed and so that the other cylinder port is open to tank and its communication with pressure is closed.

In certain pressure actuated spool-type valves having a normal unactuated spool position it has been necessary to provide a mechanical means, such as a spring, to return the spool to its normal offset position after deactuation. In view of this, the design of the valve has limited the range of pressure which can be provided in the valve pilot chamber while still having a properly functioning valve. This is because the force developed by pressure in the pilot chamber must be related to the mechanical means provided for returning the spool to its normal offset position after deactuation.

SUMMARY OF THE INVENTION

A pressure actuated spool-type fluid valve having a normal unactuated spool position in which a closed chamber is provided at the end of the spool opposite the pilot chamber into which pressurized fluid is introduced which upon exhaust returns the spool to its normal position so that the force developed by the fluid pressure in the pilot chamber can vary over a wide range. Or, such a chamber in tandem with the spool, (i.e. the pilot and return pressures may be introduced to separate chambers having pistons [of appropriate areas] which pistons are in tandem with the spool and urge the spool, one way each, in opposite directions. It

is even conceivable that both these "tandem" chambers could be on one end of the spool.)

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 2 is a longitudinal cross sectional view of a four-way valve which has been constructed in accordance with the teachings of this invention with the spool in its normal offset position when the pilot chamber is not pressurized;

FIG. 2 is a longitudinal cross sectional view of the valve shown in FIG. 1 with the spool in the left hand offset position as viewed in the Fig. which is the position when the pilot chamber is pressurized and the valve is actuated;

FIG. 3 is a plan view of the valve shown in FIG. 1; and

FIG. 4 is a longitudinal cross sectional view of a three-way valve constructed in accordance with the teachings of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1 and 2 the numeral 10 indicates the spool or plunger of a typical spool in a spool type four-way valve in which longitudinally displaced cylindrical portions 11, 12 and 13 provide greater diameter cylindrical zones and the lesser diameter cylindrical zones are indicated by the numerals 14 and 15. Zone 12 is terminated at its ends by annular grooves 16 and 17 which respectively support resilient O rings 18 and 19 which are captured therein. Zone 11 has an annular groove 20 which supports resilient O ring 21 and a large diameter cylindrical portions 22 which is annular and has an outside diameter substantially equal to the outside diameter of O ring 21 which is substantially equal to the outside diameter of O rings 18 and 19. Likewise zone 13 has a large diameter annular portion 23 which has an outside diameter substantially equal to the outside diameter of portion 22 and zone 13 has an annular groove 24 formed at one end which supports resilient O ring 25, the outside diameter of which is substantially equal to the outside diameter of O rings, 18, 19 and 21.

The body or cylinder of the valve is indicated by the numeral 26. The valve body has end caps 27 and 28 which seal the bore thereof and the numeral 29 indicates the longitudinal axis of the spool and body which are concentric.

The body 26 is provided with four reduced diameter zones 30, 31, 32 and 33 with zones 31 and 32 supporting respectively resilient O rings 33' and 34 in annular grooves provided for that purpose. The decreased diameter zones 30, 31, 32 and 33 provide lands which define five porting areas which are respectively indicated by the numerals 35, 36, 37, 38 and 39. Lands 30 and 31 define porting area 35, lands 31 and 32 define porting area 37, lands 32 and 33 define porting area 39 and porting areas 36 and 38 are substantially within lands 31 and 32 respectively, as appears in the Figs. The tank ports are indicated by the numerals 40 and 41, the cylinder ports by the numerals 42 and 43, and the inlet or pressure port by the numeral 44. There are four valving pairs. One valving pair includes the portion 22 of spool 10 and the O ring 33' in land 31. The second valving pair is formed by the right hand

edge of land 31 and the O ring 18. The third valving pair is formed by the O ring 19 and the left hand edge of land 32. The fourth valving pair is formed by the portion 23 of spool 10 and the O ring 34 in land 32.

The chamber formed in the right hand end of the valve in the zone between the end cap 28, right hand end of spool 10 and land 33 is indicated in the Figs. by the numeral 45 and referred to herein as the pilot chamber. The chamber between the left hand end of spool 10 and cap 27 is indicated by the numeral 46 and referred to herein as the return chamber. A spring 47 is provided in the return chamber yieldingly urging piston 10 to the right or into its normal position in FIG. 1. As will become apparent below, the strength of spring 47 need not be high and must be sufficient only to assure that the spool will remain in its normal (unactuated) position when the valve is not pressurized. Spring 47 is supported in the return chamber by spring guide 48. O rings 39', 40', 41' and 42' are provided as static seals, as are resilient spacers 45' and 46'. O rings 47', 48', 49', 50' and 51' are respectively provided at the ports.

The return chamber 46 is made to communicate with porting area 38 by means of bore 52 and orifice 53 in spool 10.

The communication of the porting area and the return chamber can be either through the spool as shown, through a passage in the body of the valve, or can be external.

In the normal position of the valve spool 10 shown in FIG. 1 where the cylinder port 43 is open to the tank port or exhaust 41 and porting area 38 is in communication with porting area 39, the return chamber 46 through bore 52, orifice 53, porting area 38 and porting area 39 is open to exhaust. Cylinder port 42 is communicating through porting areas 36 and 37, with inlet or pressure port 44.

Upon introduction of pressure into pilot chamber 45 a force is developed and the force need be sufficient only to overcome the static friction between the points of contact of the spool 10 and body 26 and the force in spring 47 which is quite low, for the plunger to be moved to the left in the Figs. from the position in FIG. 1 to the position in FIG. 2. As the spool 10 so moves, the valving pair 33' and 22 separate and porting area 36 is communicated with porting area 35 and the cylinder port 42 is exhausted through port 40. The valving pair 19 and 32 become separated and the valving pair 18 and 31 engage. Likewise, the valving pair 23 and 34 engage causing cylinder porting area 38 to become pressurized. The pressure in porting area 38 is transmitted to the return chamber 46, causing a build-up of pressure in the return chamber preventing further movement of the spool to the left when a balanced condition (of pressure, inertia and friction forces on the spool) is reached.

A balanced condition will not be reached if a stop is provided in the valve so that spool 10 will stop positively in its left hand offset position even though the forces developed by the pressure in pilot chamber 45 are higher than the forces developed by the pressure in return chamber 46. Hence the pressure area in the return chamber 46 can be equal to or less than the pilot chamber area in an application where the pressure introduced into the pilot chamber results from the pressurized fluid medium.

The spool 10 can be easily returned to the right hand offset position by the removal of the pressure from the pilot chamber or simply by the decrease of pressure in the pilot chamber so that the force being developed in the return chamber by the fluid therein can overcome the force developed in the pilot chamber. Thus with the reduction of pressure in the pilot chamber the spool 10 is moved to the right, by the forces developed in return chamber 46, and as it moves to the right with the opening and closing of valving pairs the porting area 38 becomes open to exhaust and the normal position of the spool is achieved.

Spring 47 in the return chamber is not functionally necessary but rather is incorporated to provide and to insure that the spool 10 is in its normal position at all times when the pilot chamber 45 is not pressurized. In fact, it is apparent that the spring must be lighter than the frictional force holding the spool in its actuated position of the areas of the return chamber and the pilot chamber are equal and the pressure on both chambers are also equal. If these pressures are equal and there is no substantial frictional resistance to spool movement and a spring is used, it would be necessary that the return chamber area be less than the pilot area in order to provide a force balance that would keep the spool in the actuated position.

The invention can be incorporated in valves other than four-way valves as mentioned above, and an example of the invention incorporated in a three-way valve is shown in FIG. 4 wherein the body is indicated by the numeral 60, spool by the numeral 61, the end caps by the numerals 62 and 63, the return chamber by the numeral 64, the pilot chamber by the numeral 65 and the return spring by the numeral 66. There are three porting areas--pressure porting area 67, cylinder porting area 68 and exhaust porting area 69. The return chamber 64 communicates with porting area 68 through bore 78 and orifice 79.

The return chamber and cylinder porting area 68 are normally open to exhaust through exhaust porting area 69 as is shown in FIG. 4. Upon introduction of pressure into pilot chamber 65 the spool is moved to the left and porting area 68 is pressurized through porting area 67. As this occurs, return chamber 64 becomes pressurized preventing further movement of the spool to the left when a balanced condition is reached. Upon the reduction of pressure in chamber 65 the spool is moved to the right and the return chamber 64 is again open to exhaust.

As mentioned above, the invention can be utilized with valves other than 4-way and 3-way valves and paths communicating the return chamber to a normally exhausted porting area can be provided through the spool, the valve body, or otherwise.

I claim:

1. A pressure actuated fluid valve including in combination a valve body, a longitudinal bore formed in said body, a spool disposed within said bore and movable therein, a plurality of porting areas formed by facing surfaces of said spool and said body, a plurality of ports formed in said body and communicating with respective porting areas, valving pairs formed on said spool and said body cooperating in predetermined relative positions of said spool and said body to communicate respective porting areas, pilot and return cham-

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bers formed in said body, a normal position of said spool relative to said body in the unpressurized condition of said pilot chamber and a pressure position of said spool in the pressurized condition of said pilot chamber, said pilot and return chambers communicating with said spool in such manner that pressure in said pilot chamber from an external source urges said spool toward the pressure position and pressure developed in said return chamber urges said spool toward the normal position, a communication porting area, and a return chamber conduit communicating said return chamber and said communication porting area.

2. A pressure actuated fluid valve in accordance with claim 1 in which the return chamber conduit is formed in said spool.

3. A pressure actuated fluid valve in accordance with claim 1 in which said pilot chamber and said return chamber are formed in said body at opposite ends of said spool on the axis thereof.

4. A pressure actuated fluid valve in accordance with claim 1 in which upon pressurization of said pilot chamber and the movement of said spool towards said pressure position the communication porting area pressure condition is changed.

5. A pressure actuated fluid valve in accordance with claim 1 in which said communication porting area is exhausted in said normal position and pressurized in said pressure position.

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6. A pressure actuated fluid valve including in combination a valve body, a longitudinal bore formed in said body, a spool disposed within said bore and movable therein, a plurality of porting areas formed by facing surfaces of said spool and said body, a plurality of ports formed in said body and communicating with respective porting areas, valving pairs formed on said spool and said body cooperating in predetermined relative positions of said spool and said body to communicate respective porting areas, pilot and return chambers formed in said body, a normal position of said spool relative to said body in the unpressurized condition of said pilot chamber and a pressure position of said spool in the pressurized condition of said pilot chamber, said pilot and return chambers communicating with said spool in such manner that pressure in said pilot chamber urges said spool toward the pressure position and pressure in said return chamber urges said spool toward the normal position, a communication porting area, said communication porting area being exhausted in said normal position and pressurized in said pressure position, and a return chamber conduit communicating said return chamber and said communication porting area whereby the pressurization of said pilot chamber causes a build-up of pressure in said return chamber preventing further movement of said spool when a balanced condition exists.

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