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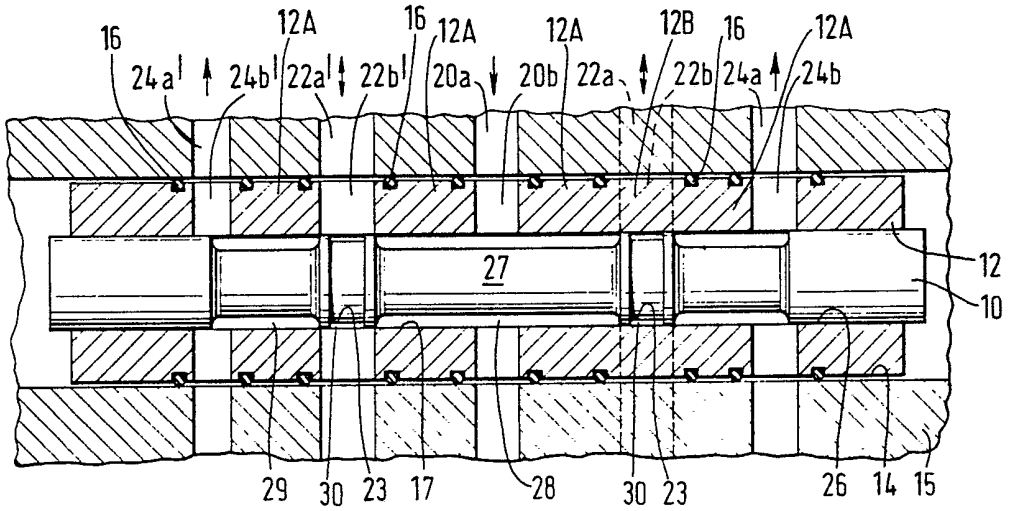
(54) Fluid control valve

(57) A fluid control valve has a spool 10 mounted within a cylindrical sleeve 12, and a plurality of ports distributed along the longitudinal axis of the spool, there being a constituent sleeve portion both between each adjacent pair of ports, and in which each vlave port is formed. There is an adjacent pair of ports, such as a service port 22*b* and a return port 24*b*, arranged such that, when the service port is shut off by a spool land 23 there is a spool chamber 29 extending from the land to the return port, at the same fluid pressure as in the return port, and there is relatively high fluid pressure in the shut-off service port. O-ring seals 16 are provided between the sleeve and the valve body, and different fluid pressure, at different points along the sleeve, compress the seals. In order to reduce the tendency of the sleeve to flex, a passage 30 is provided between the sleeve portion in which the service port 22b is formed and the spool land 23 when closing the service port, so that the sleeve portion is subjected to the fluid pressure at the service port.

FIG. 2



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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FIG. 1

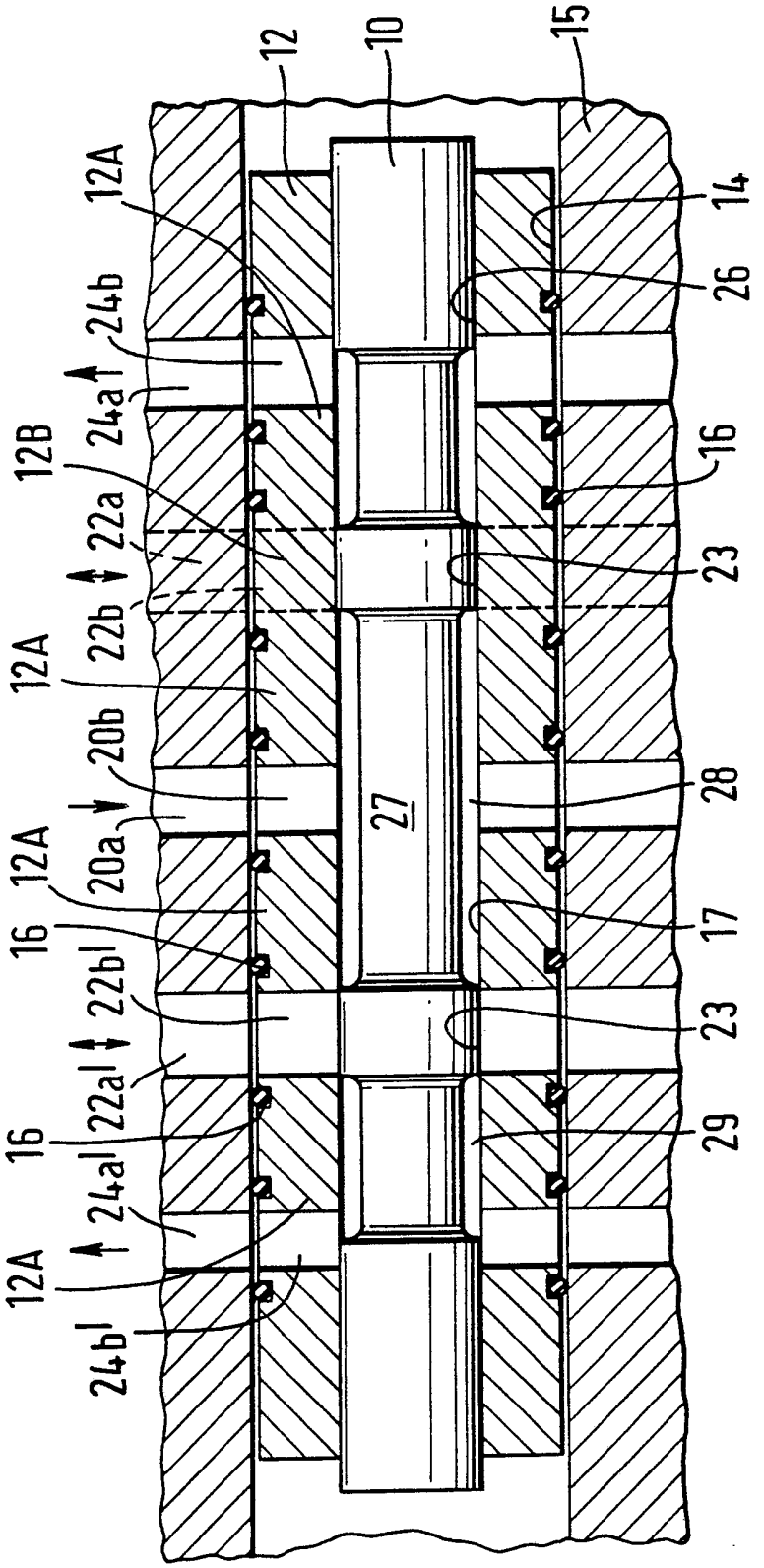
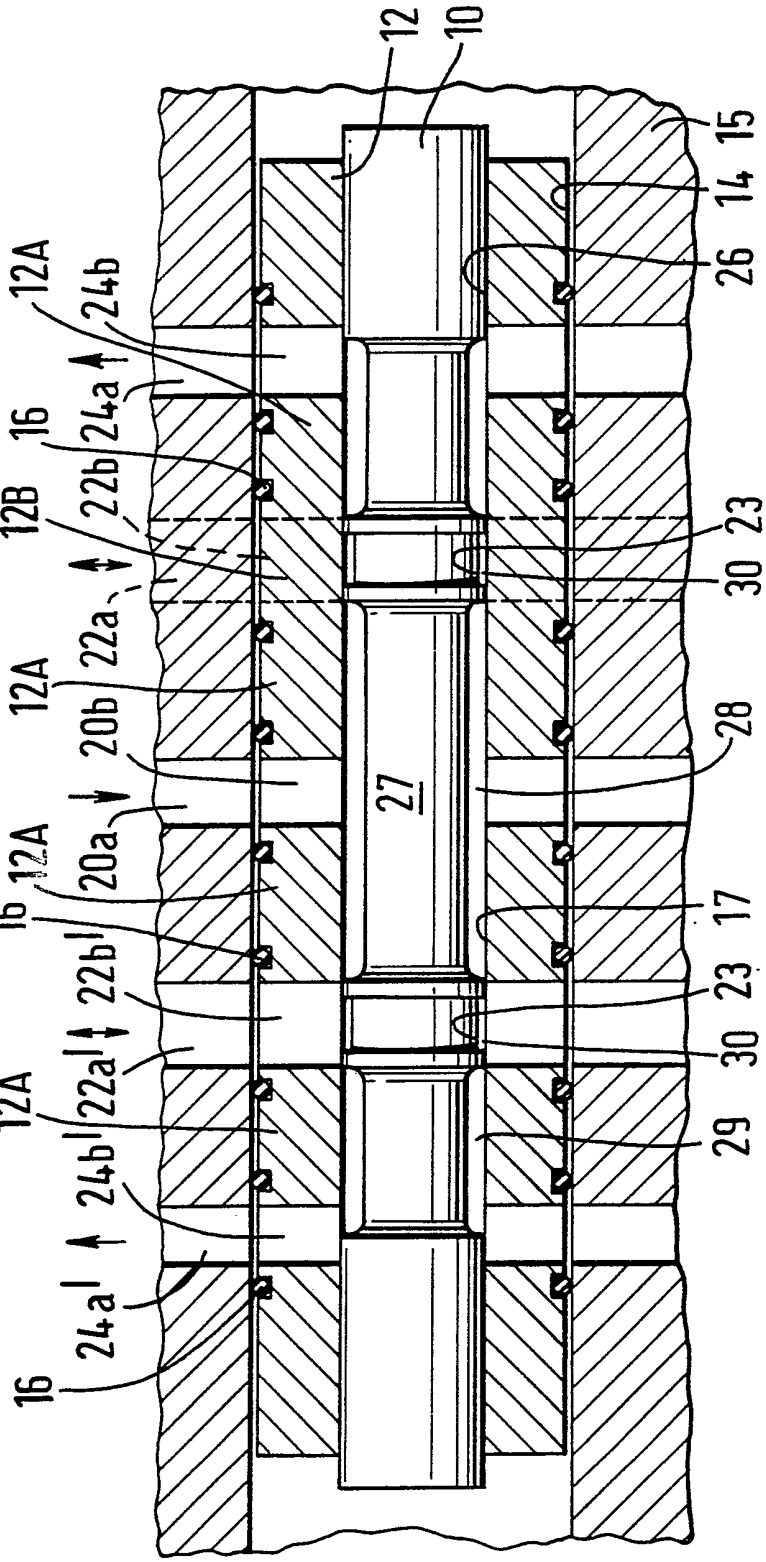

12
10
15
12A
14
24b
26
24a
12B
16
22a
23
22b
12A
20b
28
27
20a
12A
17
16
22b'
23
22a'
16
29
24a'
12A
24b'

FIG. 2


12
10
15
14
26
12A
24b
24a
16
22b
12B
23
30
22a
12A
20b
28
27
20a
12A
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17
22b
23
30
22a
12A
24b
29
24a
16

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FLUID CONTROL VALVE

THIS INVENTION relates to a fluid control valve, and, in particular, to such a valve having spool mounted within a cylindrical sleeve, the sleeve being clamped in a cylindrically shaped aperture in a body, and the sleeve providing ports for the valve, O-ring seals being provided between the sleeve and the body, and the O-ring seals being distributed along the longitudinal axis of the spool.

Usually there is a plurality of ports distributed, in the sleeve, along the longitudinal axis of the spool, there being constituent cylindrical portions of the sleeve having the valve ports therein, and other such sleeve portions between each adjacent pair of valve ports.

Further, references in this specification, and the accompanying claims, to a port, include references to a sole port, or an arrangement of a plurality of identical, separate, constituent, ports, distributed about the circumference of the cylindrical chamber in which the valve spool is displaceable, and comprising, in effect, a single port. Thus, any single port, along the longitudinal axis of the spool, may comprise either a sole port, or a plurality of constituent ports distributed about the circumference of the cylindrical chamber in which the valve spool is displaceable, irrespective of whether each co-operating single port is a sole port, or a plurality of constituent ports. However, the sole, or any constituent port, of, say, a return port, may not be in the same plane, including the longitudinal axis of the spool of the valve, as the sole, or any constituent, port, of, say, a co-operating inlet port.

Because of the provision of the ports in the sleeve, and especially when, at least some of, the inlet, return and service ports each comprise a plurality of constituent ports distributed about the circumference of the cylindrical chamber in which the valve spool is displaceable, the sleeve has a tendency to flex.

In the operation of the valve, different fluid pressures are present at different positions along the longitudinal axis of the spool, causing different O-ring seals to be compressed between the sleeve and the body by different amounts. Usually the arrangement is such that each constituent portion of the sleeve between each adjacent pair of valve ports, along the longitudinal axis of the spool, is provided with at least one O-ring seal, to enable the sleeve portion to be clamped to the valve body. Thus, different fluid pressures act on different O-ring seals, possibly, causing the sleeve to flex.

Differences of fluid pressure occur, along the longitudinal axis of the spool, when at least one port is shut off, because of different fluid pressures established at different ports, for example, a service port and a return port. Inevitably, there is leakage of the fluid to the return port. Thus, in the operation of the valve, with a service port closed, typically, the fluid pressure at the service port is half the fluid pressure at the inlet port of the valve, it being considered that the fluid pressure at the return port is zero. Such a difference in fluid pressure along the longitudinal axis of the spool increases to a maximum value a few seconds after the valve has closed. The portion of the sleeve between the service port and the return port extends longitudinally along a chamber formed between a reduced diameter portion of the spool, and the sleeve. The spool chamber extends between two lands provided by the spool. When one land shuts off the service port, and the return port is not shut off, the fluid pressure established at the spool chamber is the same fluid pressure as the substantially zero pressure established at the return port. Thus, for a known valve construction, and in the operation of the valve, the portion of the sleeve between the return port and the service port is subjected to substantially zero pressure.

If the sleeve flexes, then the spool-to-sleeve clearance at, at least, one position along the longitudinal axis of the spool, may be other than is desired. For example, the clearance may be less than is desired, causing the frictional

forces acting on the spool to be greater than is desired, and in an extreme case, the spool may be rendered immovable.

It is an object of the present invention to provide a novel and advantageous construction for a fluid control valve having a spool mounted within a cylindrical sleeve, the sleeve being clamped in a body with O-ring seals provided therebetween, the O-ring seals being distributed along the longitudinal axis of the spool, in operation, there being differences of fluid pressure along the longitudinal axis of the spool, the novel construction of the valve being such that the tendency of the sleeve to flex, because of such differences of fluid pressure, is reduced.

According to the present invention a fluid control valve having a spool mounted within a cylindrical sleeve, and a plurality of ports distributed along the longitudinal axis of the spool, the sleeve being clamped in a cylindrically shaped aperture in a body, with O-ring seals provided therebetween, the O-ring seals being distributed along the longitudinal axis of the spool, there being constituent cylindrical portions of the sleeve having the valve ports formed therein, and other such sleeve portions between each adjacent pair of valve ports, and each such constitutent portion of the sleeve between an adjacent pair of valve ports being provided with at least one O-ring seal, in the operation of the valve, fluid pressure within the valve acting to compress the O-ring seals, and there being at least one pair of adjacent ports arranged such that, with one of the ports shut off by a spool land, there is a difference between the fluid pressures established within the pair of adjacent ports, one sleeve portion extends, between said one pair of adjacent ports, along a spool chamber, and a first fluid pressure is established both in the spool chamber, and in said other port, said one port being formed in an adjacent sleeve portion, a second fluid pressure is established in said one port, the second fluid pressure being greater than the first fluid pressure, and possibly said first fluid pressure being substantially zero, and a passage for the fluid is provided between the cylindrical portion of the sleeve in which said one

port is formed, and the spool land when closing said one port, the passage being in communicaton with said one port, and extending both, at least substantially, wholly around the circumference of the spool land, and along the longitudinal axis of the spool, at least substantially, across the width of said one port.

The provision of the passage ensures that the sleeve portion, in which said one port is formed, is subjected to the fluid pressure established at said one port, reducing the tendency of the sleeve to flex adjacent to said one port.

The passage may be provided by a groove formed in either the surface of the sleeve portion in which said one port is formed, or in the spool land.

The present invention will now be described by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional side elevation of a known form of a hydraulic control valve, with a spool mounted within a cylindrical sleeve, the sleeve being clamped in a cylindrically shaped aperture in a body, with O-ring seals provided therebetween, and

Figure 2 corresponds to Figure 1, but shows a modification in accordance with the present invention, there being a groove formed in the spool land, so that the sleeve portion in which the service port is formed is subjected to the fluid pressure established at the service port, the modification ensuring that the sleeve has a reduced tendency to flex, in relation to the known valve construction of Figure 1, because of different fluid pressures along the longitudinal axis of the spool, and established at the service port and a co-operating return port.

Figure 1 shows a hydraulic control spool valve, having a spool 10, displaceable along its longitudinal axis, and a co-operating sleeve 12. The sleeve 12 is mounted within a cylindrical aperture 14 of a body 15, annular O-ring seals 16 being provided at spaced locations along the longitudinal axis of the valve. The sleeve 12 defines a cylindrical chamber 17 in which the spool 10 is displaceable.

Hydraulic fluid enters the valve through a centrally located port 20a in the body 15, and through a co-operating port 20b in the sleeve 12. When the valve is open the fluid flows to one of two service ports 22a, and 22a', in the body 15, over the appropriate land 23 in the spool 10, and via a co-operating service port 22b, or 22b', in the sleeve 12. The fluid flows from the other service port 22b', or 22b, respectively, to the associated one 24a', or 24a, of two return ports, in the body, via a co-operating return port 24b', or 24b, in the sleeve.

Each of the valve ports comprises a plurality of separate, identical, constituent, ports, distributed about the circumference of the cylindrical chamber 17 in which the spool 10 is displaceable, and comprising, in effect, a single port.

Usually, any constituent port of the service port 22b, or 22b', is not in the same plane, including the longitudinal axis of the spool 10, as any constituent port of the co-operating return port, respectively, 24b, or 24b'. Figure 1 is of an imaginary plane, including the longitudinal axis of the spool 10, for convenience, constituent ports of all the return and service ports, except the service port 22a, 22b, being shown in this plane. The service port 22a, 22b is indicated in Figure 1 only in dotted form.

The spool 10 is shown in a position in which the spool lands 23 close the service ports 22b, and 22b', in the sleeve 12. The ends of the spool comprise lands 26, but the lands 26 do not close the return ports 24b, and 24b', when the service ports 22b and 22b' are closed. Between the two intermediate spool lands 23 is a reduced diameter portion 27 of the spool, the chamber 28 provided by this reduced-diameter portion 27 of the spool being normally in communication with the inlet port 20b in the sleeve 12.

Between adjacent pairs of ports, for example, between each return port 24b, or 24b', and the adjacent service port 22b, or 22b', is a cylindrical sleeve portion 12A; and each port is formed in a cylindrical sleeve portion 12B, shown only in relation to the service port 22b, the service port being

indicated in dotted form. One, or two, O-ring seals 16 are provided for each of the sleeve portions 12A.

Thus, there are two arrangements each of an adjacent, co-operating pair of ports, comprising a service port 22b, or 22b', and a return port 24b, or 24b', and an associated pair of sleeve portions 12A, and 12B, along the longitudinal axis of the spool. For either such arrangement, when the service port 22b, or 22b', is shut off by a spool land 23, there is substantially zero fluid pressure established both at the return port 24b, or 24b', and at a spool chamber 29, corresponding to the spool chamber 28, and extending between the co-operating pair of ports. With the service port closed, the spool chamber 29 is in communication with the return port, the return port being only partially shut off by the spool land 26. Further, there is a relatively high fluid pressure established at the shut off service port 22b, or 22b'. Inevitably, there is leakage of the fluid from the service port to the return port, and, typically, the fluid pressure at the closed service port is half the fluid pressure at the inlet port 20b. Thus, the sleeve portion 12A is subjected to zero fluid pressure, and the sleeve portion 12B is subjected to a higher fluid pressure. The O-ring seals 16 are compressed by the fluid pressure to which the associated sleeve portion 12A is subjected.

Because of such pressure differences along the longitudinal axis of the spool, the thin sleeve 12, having the plurality of ports, each comprising a plurality of constituent ports, formed therein, has a tendency to flex, causing the spool-to-sleeve clearance to vary along the longitudinal axis of the spool. Thus, at certain positions along the spool the clearance may be, for example, less than is desired, causing the frictional forces acting on the spool to be greater than is desired, and in an extreme case, the spool may be rendered immovable.

The modification of the hydraulic control spool valve of Figure 1, shown in Figure 2, is such that the tendency for the sleeve to flex is reduced.

Parts of the control valve of Figure 2 identical to, or closely resembling, parts of the valve of Figure 1 are identified by the same reference numerals in both Figures.

The modification, in accordance with the present invention comprises, as is shown in Figure 2, the provision of a passage 30 between each sleeve portion 12B in which a service port 22b, or 22b', is formed, and the spool land 23 when closing the service port. The passage 30 is in communication with the service port, and extends both, at least substantially, wholly around the circumference of the spool land, and along the longitudinal axis of the spool, at least substantially, across the width of the service port. Thus, the fluid pressure established at the service port is also established at the passage 30, and the sleeve portion 12B is subjected to this fluid pressure. Hence, there is reduced tendency for the sleeve to flex adjacent to the service port. As shown in Figure 2, the passage 30 is provided by a groove formed in the spool land 23. Alternatively, the passage may be provided by a groove formed in the sleeve portion 12B.

A modification in accordance with the present invention, and as described above, can be made in relation to any appropriate pair of ports of a control valve, different fluid pressures being likely to be established at the two ports. Possibly the appropriate pair of ports comprise an inlet port, and either a service, or a return, port.

Claims

1. A fluid control valve having a spool mounted within a cylindrical sleeve, and a plurality of ports distributed along the longitudinal axis of the spool, the sleeve being clamped in a cylindrically shaped aperture in a body, with O-ring seals provided therebetween, the O-ring seals being distributed along the longitudinal axis of the spool, there being constituent cylindrical portions of the sleeve having the valve ports formed therein, and other such sleeve portions between each adjacent pair of valve ports, and each such constituent portion of the sleeve between an adjacent pair of valve ports being provided with at least one O-ring seal, in the operation of the valve, fluid pressure within the valve acting to compress the O-ring seals, and there being at least one pair of adjacent ports arranged such that, with one of the ports shut off by a spool land, there is a difference between the fluid pressures established within the pair of adjacent ports, one sleeve portion extends, between said one pair of adjacent ports, along a spool chamber, and a first fluid pressure is established both in the spool chamber, and in said other port, said one port being formed in an adjacent sleeve portion, a second fluid pressure is established in said one port, the second fluid pressure being greater than the first fluid pressure, and a passage for the fluid is provided between the cylindrical portion of the sleeve in which said one port is formed, and the spool land when closing said one port, the passage being in communication with said one port, and extending both, at least substantially, wholly around the circumference of the spool land, and along the longitudinal axis of the spool, at least substantially, across the width of said one port.

2. A valve as claimed in claim 1 having the passage provided by a groove formed in the surface of the sleeve portion in which said one port is formed.

3. A valve as claimed in claim 2 having the passage provided by a groove formed in the spool land.

4. A fluid control valve substantially as described herein, with reference to Figure 2 of the accompanying drawings.

Amendments to the claims have been filed as follows

Claims

1. A fluid control valve has a spool mounted within a cylindrical sleeve, and a plurality of ports distributed along the longitudinal axis of the spool, the sleeve is clamped in a cylindrically shaped aperture in a body, at least one spool chamber is provided within the spool, and each spool chamber is between an adjacent pair of lands provided by the spool, there are constituent first cylindrical portions of the sleeve with the valve ports formed therein, and second cylindrical sleeve portions between each adjacent pair of valve ports, a plurality of O-ring seals are provided between the sleeve and the body, and the O-ring seals also are distributed along the longitudinal axis of the spool, each of the second cylindrical portions of the sleeve, between an adjacent pair of valve ports, is associated with at least one O-ring seal, in the operation of the valve, fluid pressures within the valve act to compress the O-ring seals, and the arrangement in relation to at least one pair of adjacent ports is such that, with a spool land closing one of the pair of adjacent ports, a spool chamber extends from the spool land to communicate with the other of the pair of adjacent ports, a second cylindrical sleeve portion extends between the pair of adjacent ports, and said one port is formed in a first cylindrical sleeve portion adjacent to said second cylindrical sleeve portion, a first fluid pressure is established within both said other of the pair of adjacent ports, and the spool chamber, and acts on said second cylindrical sleeve portion, a second fluid pressure, greater than the first fluid pressure, is established in said one port, and a fluid passage is provided at the interface between said first cylindrical portion of the sleeve in which said one port is formed, and the spool land, in the operation of the valve, and with the spool land closing said one port, the passage is in communication with said one port, and extends both, at least substantially, wholly around the circumference of the interface between said first cylindrical sleeve portion and the spool land, and along the longitudinal axis of the spool, at least substantially across the width of said one port, and said second fluid pressure acts on said first cylindrical sleeve portion.

2. A valve as claimed in claim 1 having the passage provided by a groove formed in the surface of said first cylindrical sleeve portion in which said one port is formed.

3. A valve as claimed in claim 1 having the passage provided by a groove formed in the spool land.

4. A fluid control valve substantially as described herein, with reference to Figure 2 of the accompanying drawings.

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