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(56) Documents cited
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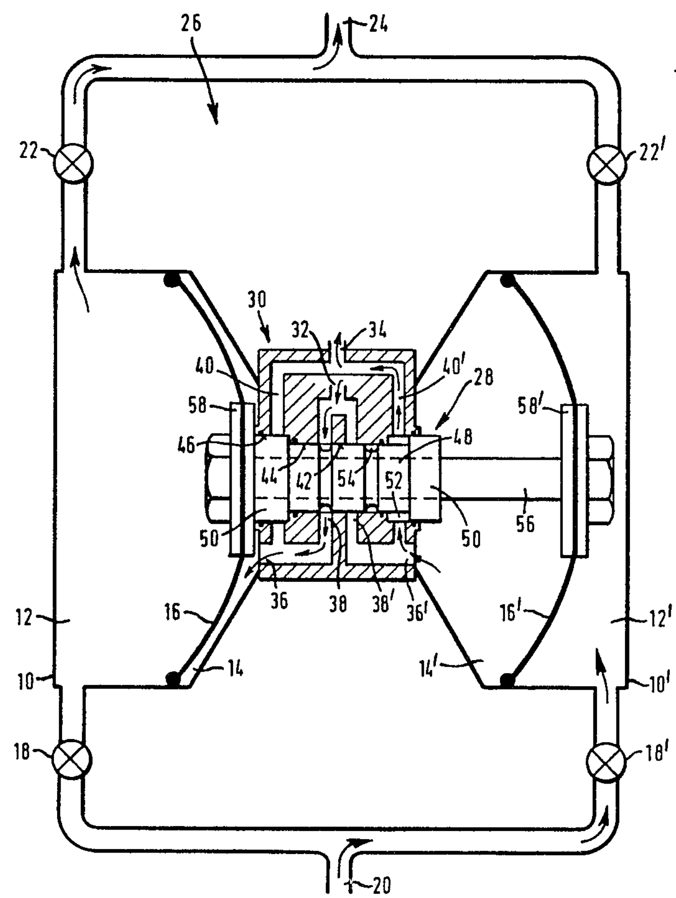
(58) Field of search
F1W

(54) Valve system

(57) A valve system, e.g. for a fluid pressure-autuated double diaphragm pump, comprises inlet means (32) for pressurised fluid, outlet means (34) for exhaust fluid, first and second flow passages (36,36') for supplying pressurised fluid to and discharging exhaust fluid from first and second operating chambers 14,14', and a sleeve valve member (28) movable between two positions and arranged, in one position, to communicate the inlet means with the first flow passage and the second flow passage with the outlet means and, in the other position, to communicate the inlet means with the second flow passage and the first flow passage with the outlet means. Reciprocable means (56,58,58') are arranged to cause movement of the valve member between its two positions, rod 56 passing slidably through the sleeve.

FIG. 1



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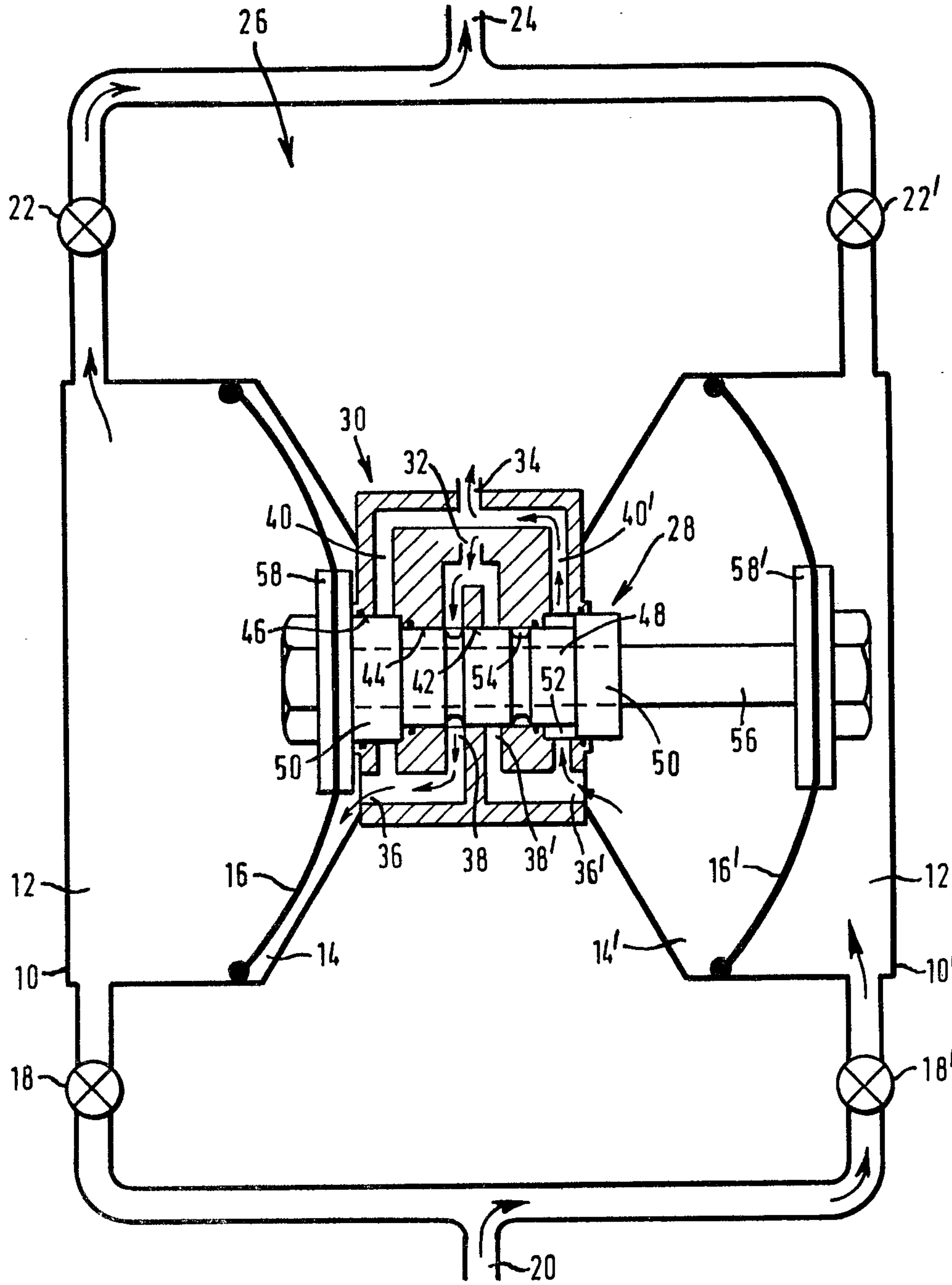
The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.
The drawings originally filed were informal and the print here reproduced is taken from later filed formal copies.

FIG. 1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24
22
22'
30
32
34
40
40'
28
58
58'
46
48
44
42
54
52
50
56
50
36
38
38'
36'
12
16
16'
12'
10
14
14'
10'
18
18'
20

FIG.2

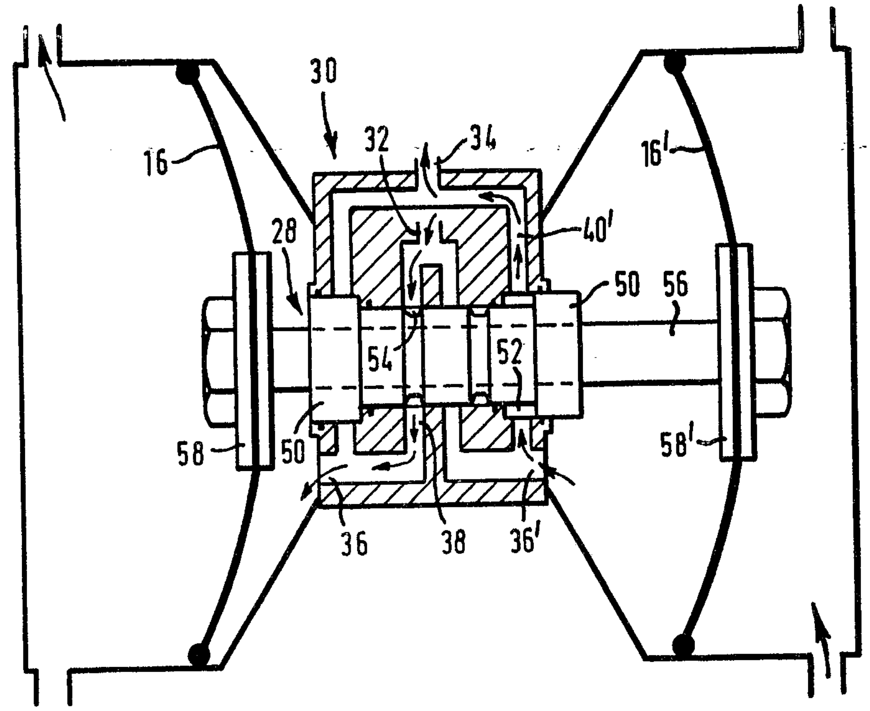
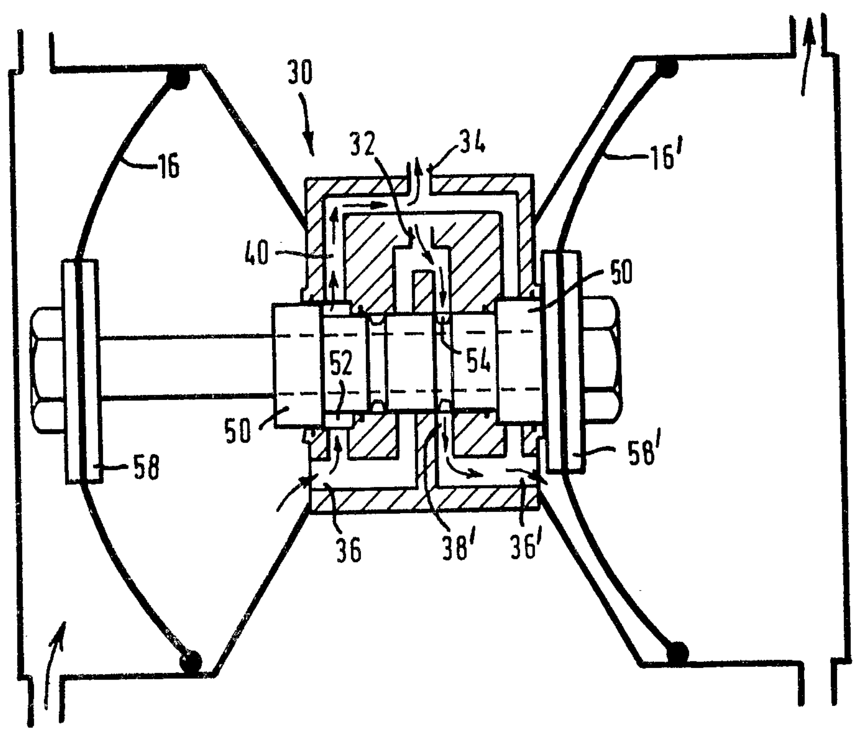

30
32
34
16
16'
28
40'
50
56
54
52
58
50
58'
36
38
36'

FIG.3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32
34
16
16'
40
50
52
54
50
58
58'
36
38'
36'

FIG.4

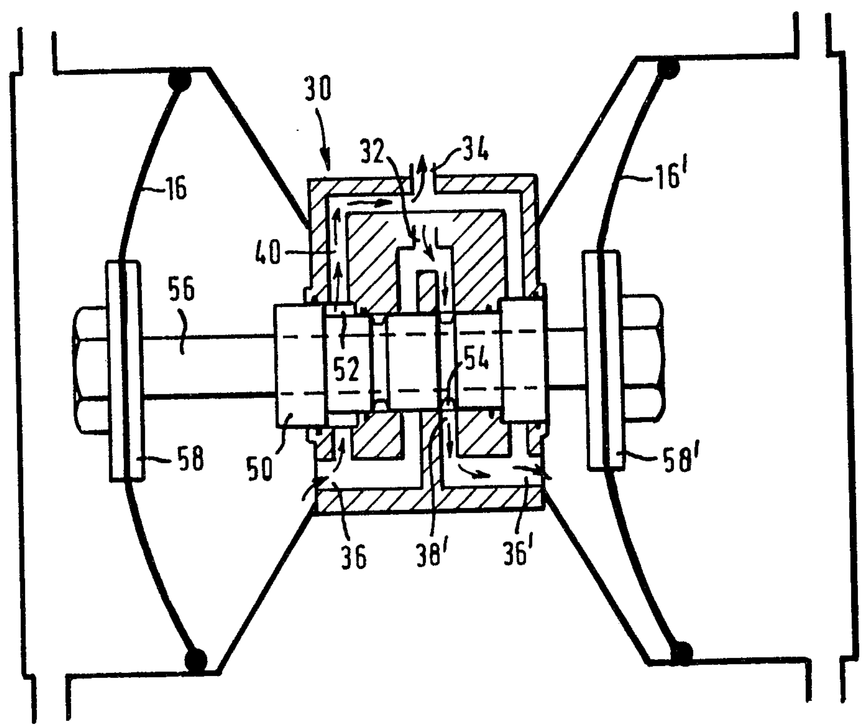
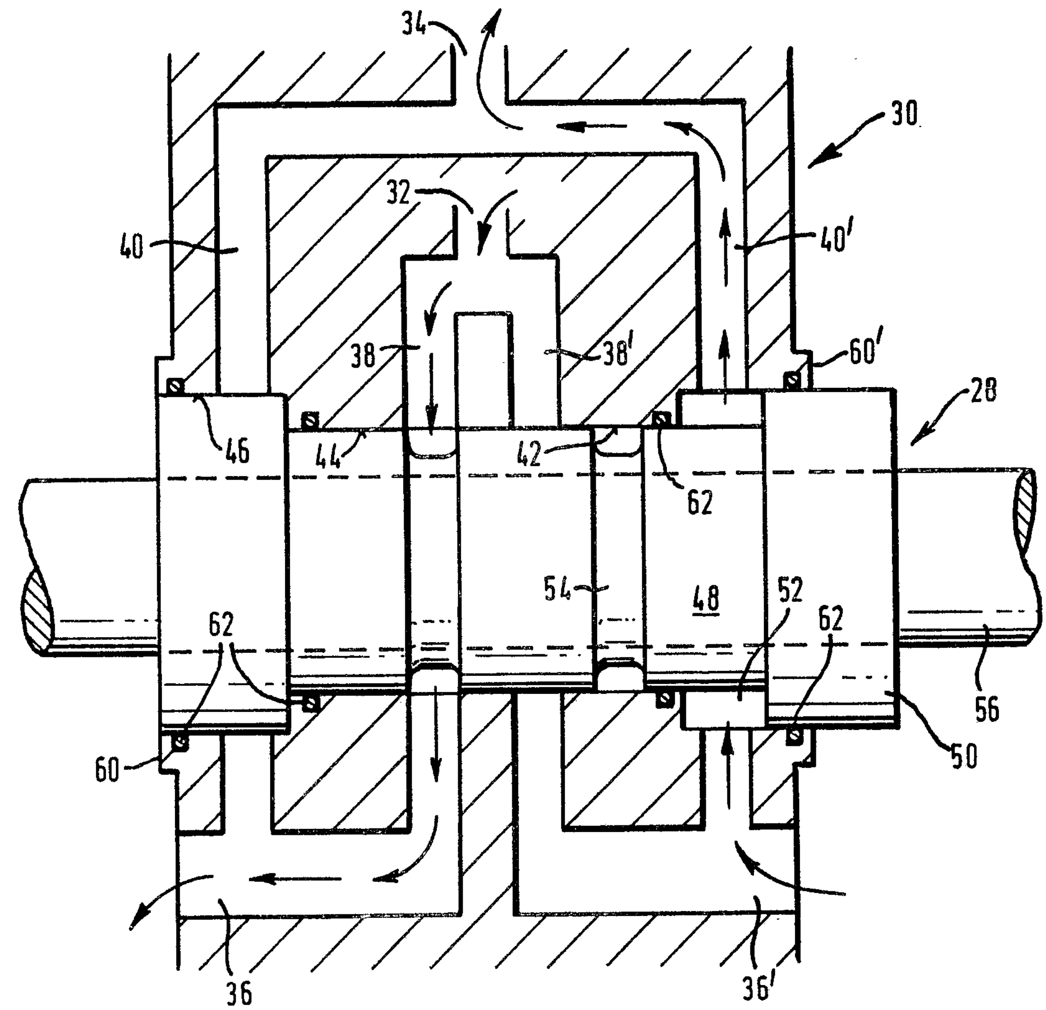


FIG.5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40'
38
38'
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46
44
42
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54
48
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60
50
36
36'

FIG.6

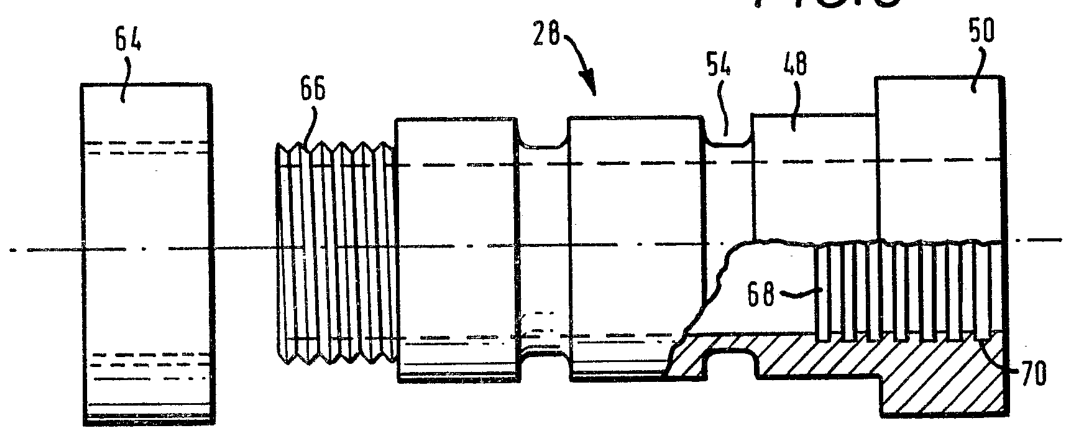
64
66
28
54
48
50
68
70

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FIG.7

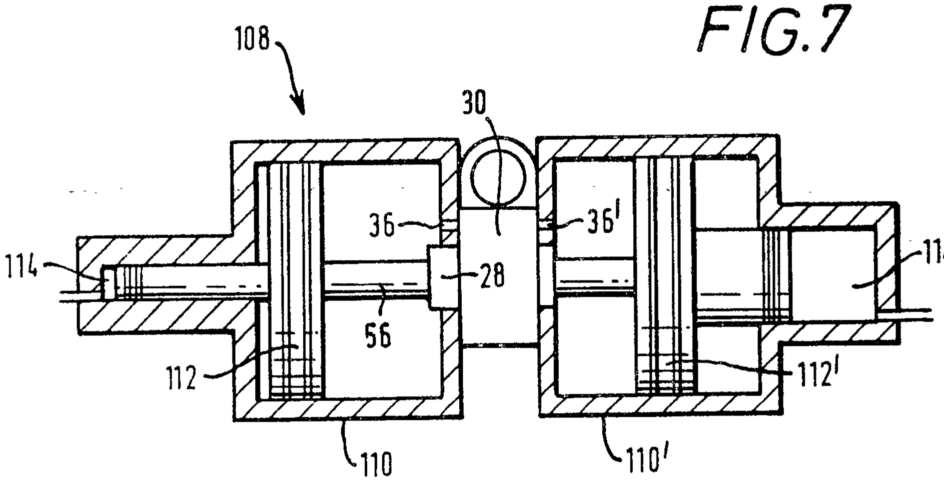


FIG.8

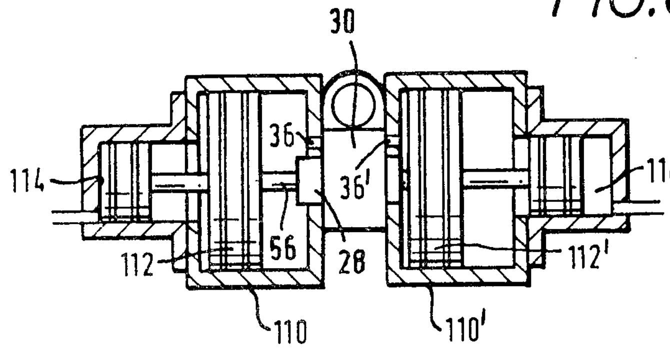
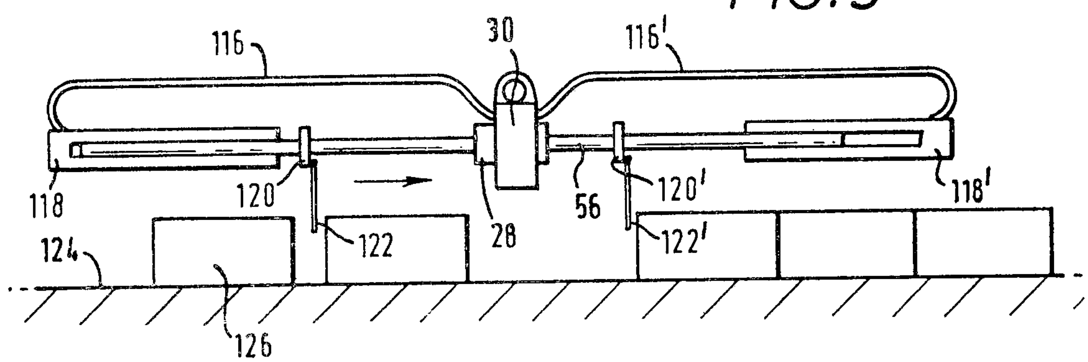


FIG.9



SPECIFICATION

Valve system

This invention concerns a valve system for use particularly but not solely in a double diaphragm pump.

Conventionally, a double diaphragm pump features two diaphragm housings face to face with one another and each containing an operating chamber and a pumping chamber separated by a diaphragm. The pumping chambers are connected to a common inlet through respective one-way inlet valves and to a common outlet through respective one-way outlet valves. In use, the diaphragms are displaced in unison to and fro within their housings by appropriate supply of compressed fluid to the operating chambers so that the suction stroke of one diaphragm coincides with the pumping stroke of the other and vice versa. A valve system mounted between the two housings controls the supply of compressed fluid.

The valve system usually comprises a main inlet for pessurized fluid, a main outlet for exhaust fluid, a valve member for controlling communication between the main inlet and main outlet and the operating chambers of the pump, and means for causing the valve member to switch the supply of compressed fluid alternately between the two operating chambers and, correspondingly, to switch the two operating chambers alternately into communication with the main outlet.

A significant drawback of a number of such known valve systems is the complexity of the means for operating the valve member.

The present invention provides a particularly simple and effective valve system.

According to the invention, a valve system comprises a main inlet for pressurized fluid, a main outlet for exhaust fluid, first and second flow passages for supplying pressurized fluid to and discharging exhaust fluid from first and second operating chambers, a valve member moveable between two positions and arranged, in one position, to communicate the main inlet with the first flow passage and the second flow passage with the main outlet and, in the other position, to communicate the main inlet with the second flow passage and the first flow passage with the main outlet, and reciprocable means arranged to cause movement of the valve member between its two positions, the reciprocable means being adapted, in use, to perform a reciprocating cycle and, at predetermined moments during the reciprocating cycle, to apply a force to the valve member to move it from its existing position into its other position.

In a preferred form of the invention, the reciprocable means are arranged to act directly on the valve member for moving it between its two positions.

For example, the reciprocable means may include a piston and parts connected to the piston which bear respectively on associated ends of the valve member for moving it from one position to the other. In this case, the valve member may be in the form of a sleeve on the piston and the piston may be slidable within the valve member during the reciprocating cycle.

When the valve system is employed in a double diaphragm pump, the reciprocable means may comprise plates mounted on the two diaphragms so as to engage the valve member in predetermined positions of the diaphragms to displace the valve member in to its new position.

The invention is described further, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of a double diaphragm pump incorporating a valve system according to the present invention, showing the valve system in a first stage of its operating cycle;

Figure 2 is a diagrammatic view of the valve system in a second stage of its operating cycle;

Figure 3 is a diagrammatic view of the valve system in a third stage of its operating cycle;

Figure 4 is a diagrammatic view of the valve system in a fourth stage of its operating cycle;

Figure 5 is an enlarged view partly in section of the valve body and the controller of the valve system;

Figure 6 is an exploded view partly in section of the controller; and

Figures 7 to 9 illustrate further applications of the valve system shown in Figures 1 to 4.

Referring firstly to Figure 1, a double diaphragm pump includes first and second diaphragm housings 10,10′, each separated into a pumping chamber 12,12′ and an operating chamber 14,14′ by a diaphragm 16,16′. The pumping chambers 12,12′ are connected by way of respective one-way inlet valves 18, 18′ to a common pump inlet 20 and by way of respective one-way outlet valves 22, 22′ to a common pump outlet 24. As described below, the diaphragms 16, 16′ are movable in unison to and fro within their housings 10, 10′ so that the volume of one pumping chamber increases while that of the other decreases. Consequently, the suction stroke of one diaphragm coincides with the pumping stroke of the other.

During the suction stroke of a respective diaphragm 16, the associated inlet valve 18 is drawn open to admit fluid from the pump inlet 20 to the pumping chamber 12 while the associated outlet valve 22 is held closed to prevent such fluid from passing to the pump outlet 24. In the pumping stroke, the diaphragm 16 forces the fluid out through the outlet valve 22 to the pump outlet 24 and the pressure in the pumping chamber 12 holds the inlet valve 18 closed.

In the condition illustrated in Figure 1, the diaphragm 16 is about to commence its pumping stroke and the diaphragm 16' is about to commence its suction stroke.

Operation of the diaphragms 16,16' is controlled by a valve system shown diagrammatically in Figures 1 to 4 and generally designated 26. This valve system comprises a valve member or controller generally designated 28 and a valve body generally designated 30, which houses the controller 28 and which is mounted between the two diaphragm housings 10, 10'.

The controller 28 is operable to control the supply of pressurized fluid from a main inlet 32 for pressurized fluid in the valve body 30 to each of the pump operating chambers 14, 14' and to control venting of each of the pump operating chambers 14,14' to a main outlet 34 for exhaust fluid in the valve body 30.

For this purpose, the valve body 30 is provided with fluid flow passages 36, 36' in communication with the pump operating chambers 14, 14' and with supply passages 38,38' extending respectively between the main inlet 32 and the flow passages 36,36' and exhaust passages 40,40' extending respectively between the flow passages 36,36' and the main outlet. The supply and exhaust passages 38 and 40 intersect a generally cylindrical chamber 42 within the valve body 30. This chamber 42 contains the controller 28 which is movable axially within the chamber for opening and closing the supply and exhaust passages 38 and 40. The arrangement is such that the supply passage 38 to the operating chamber 14 is open simultaneously with the exhaust passage 40' from the operating chamber 14' and, conversely, the exhaust passage 40 from the operating chamber 14 is open simultaneously with the supply passage 38' to the operating chamber 14'.

More especially, the chamber 42 has a stepped configuration with its central portion 44 having a reduced diameter relative to its ends 46. The supply passages 38 intersect the central portion 44 of the chamber 42 and the exhaust passages 40 intersect the ends 46. The controller 28 also has a stepped configuration with a reduced central portion 48 which is a snug sliding fit within the central portion 44 of the chamber 42 and with enlarged ends 50 which are each a snug sliding fit within a respective end 46 of the chamber 42. The reduced portion 48 of the controller 28 is axially longer than the reduced portion 44 of the chamber 42. Thus, the controller 28 is slidable within the chamber 42 between two end positions, in each of which a respective end 50 of the controller 28 abuts an associated shoulder provided by the reduced portion 44 of the chamber 42.

In each end position of the controller 28, one of its ends 50 engages the relevant shoulder in the chamber 42 as mentioned and an annular space 52 is provided between the other end 50 and its associated shoulder. The space 52 opens the adjacent exhaust passage,e.g. 40', while the other exhaust passage, e.g. 40, is blocked by the near end 50 of the controller 28. Additionally, the controller 28 contains in its reduced portion 48 two annular grooves 54. These are positioned so that in each end position of the controller 28 one groove 54 opens a respective one of the supply passages, e.g. 38, while the other supply passage, e.g. 38', is blocked by the controller 28.

Thus, the controller 28 is operable to bring each operating chamber 14,14' alternately into communication with the main inlet 32 and the main outlet 34.

Operation of the controller 28 is achieved as follows:

The controller 28 is in the form of a sleeve received on a piston 56 which extends between the two diaphragms 16,16'. Mounted on the diaphragms 16,16' are pairs of plates 58,58' and each pair is connected to the associated end of the piston 56. As the diaphragms 16,16' reciprocate within their housings 10,10', the piston 56 and the pairs of plates 58,58' move to and fro relative to the valve body 30. In each of its end positions, one end 50 of the controller 58 projects into the adjacent operating chamber,e.g. 14'. As the associated diaphragm 16' completes its suction stroke, the plates 58' mounted on the diaphragm are brought into engagement with the projecting end 50 to force the controller 28 into its other end position. The plates 58 on the other diaphragm 16 offer no resistance to this, of course, because that diaphragm is then completing Its pumping stroke and is remote from the controller 28.

The operating cycle of the valve system 26 will now be explained with reference to Figure 1 to 4.

This cycle is repetitive but it is convenient to consider the condition illustrated in Figure 1 as the first stage. At this moment, the diaphragm 16 has just completed its suction stroke and the diaphragm 16' has just completed its pumping stroke. The diaphragm plates 58 mounted on the diaphragm 16 have just moved the controller 28 into a new end position opening the supply passage 38 and the exhaust passage 40'. Consequently, the supply of compressed fluid from the main inlet 32 through the flow passage 36 to the operating chamber 14 is just commencing and the diaphragm 16 will now start to move away from the controller 28 in its pumping stroke. Similarly, the exhaust of fluid from the operating chamber 14' through the flow passage 36' to the main outlet 34 is beginning and the diaphragm 16' is starting to advance towards the controller 28.

Turning to Figure 2, it can be seen that the controller 28 remains in the state in which it was set in the stage of the operating cycle represented in Figure 1. This is because the end 50 of the controller 28 facing the operating chamber 14 is exposed to the pressure of the compressed fluid being supplied to that chamber, whereas the other end 50 of the controller 58 projecting into the operating chamber 14' is exposed to the lesser pressure of the fluid being exhausted from that chamber. Thus, the controller 28 is subjected to a force tending to hold it in place.

In the next stage of the operating cycle, shown in Figure 3, the plates 58' mounted on the diaphragm 16' have reached the associated end 50 of the controller 28 and have engaged that end. The force applied to the controller 28 by the plates 58' is sufficient to overcome the resistance of the fluid pressure acting on the other end 50 of the controller 28 and the controller 28 has been moved to its other end position. This signifies the end of the pumping stroke of the diaphragm 16 and of the suction stroke of the diaphragm 16'. The operating chamber 14 is now connected to the main outlet 34; and the main inlet 32 is now connected to the operating chamber 14'.

The movement of the diaphragms 16,16' is thus reversed, as illustrated in Figure 4, with the diaphragm 16 performing a suction stroke and the diaphragm 16' performing a pumping stroke. Figure 4 shows again how the controller 28 remains in the end position into which it has been moved, even when the diaphragm plates 58' withdraw from contact with it.

Next, the parts return to the condition illustrated in Figure 1 and the cycle is repeated.

A continuous reciprocating motion of the diaphragms 16,16' is thus achieved, resulting in continuous pumping by the double diaphragm pump.

The basic construction of the valve system is described above. Some further details are shown in Figures 5 and 6.

Referring to Figure 5, it can be seen that the valve body 30 is formed with two collars 60,60' encircling the ends 46 of the valve chamber 42. These collars 60,60' provide stops for the diaphragm plates 58,58' to prevent the plates moving into intimate contact with the valve body 30 and thereby partially obscuring the flow passages 36,36', which open into the operating chambers 14,14' in the vicinity of the valve chamber 42. O-ring seals 62 are also shown in the wall of the valve chamber 42. These are in fact not primarily for sealing but serve to provide a frictional brake on the controller 28 to inhibit it from sliding, at the end of a pumping operation, into a position from which it would be difficult to restart the pump.

Turning to Figure 6, this shows that the controller 28 is of two part construction for ease of assembly in the valve chamber 42. In particular, one end 50 of the controller 28 is in the form of an internally threaded collar 64 which is engageable on a threaded extension 66 projecting from the central portion 48 of the controller. The threaded extension 66 and the other end 50 of the controller contain labyrinth seals 68 in the form of a plurality of annular grooves 70. These serve to inhibit flow of fluid along the piston 56 inside the controller 28 by causing turbulence in any fluid flow which does occur. The controller itself is formed from carbon filled PTFE, which is a selflubricating material, and so oil free operation of the valve system is possible.

Various modifications may be made in the described valve system. For example, the illustrated main inlet and main outlet could be changed over so that the port 32 and the passages 38,38' are employed for exhaust purposes and the port 34 and passages 40,40' are employed for the supply of compressed fluid; the O-ring seals 62 may be omitted; and the controller 28 could be made from materials other than carbon filled PTFE and could be oil lubricated in operation.

Finally, Figures 7 to 9 exhibit other applications of the valve system previously described. In each case, the valve system includes a valve body generally designated 30 and it operates in the manner already specified.

Referring initially to Figure 7, this shows portions of a gas intensifier generally designated 108 having booster housings 110,110'. The booster housings contain piston drive assemblies 112,112' movable within the housings by appropriate supply of compressed fluid through the valve body 30 and the passages 36,36'. The piston 56 is mounted between the piston drive assemblies 112,112' as indicated and these assemblies are engageable with the controller 28 to move it between its two end positions.

A first staging chamber 114' is provided in the housing 110' and a second, smaller, staging chamber 114 is provided in the housing 110. Reciprocation of the piston drive assemblies 112,112' causes gas to be drawn into the chamber 114' and compress therein and subsequently supplied by passages (not shown) to the chamber 114 for further compression.

Figure 8 relates to a generally similar type of construction intended for the high pressure pumping of caustic materials. This construction includes slightly modified piston drive assemblies 112,112' and pumping chambers 114,114' of similar rather than differing dimensions. In other respects, the operation is substantially the same as described with reference to Figure 7.

In Figure 9, the valve system is employed in a conveyor system. In this instance, it controls the supply of pressurized fluid into two extension pipes 116,116' leading to cylinders 118,118'. The piston 56 extends between the cylinders and has mounted thereon a pair of collars 120,120', each carrying a hinged finger 122,122'. These fingers depend downwardly from the piston 56 towards a conveying surface 124 on which packages 126 stand. As the piston 56 reciprocates by appropriate application of pressure to the cylinders 118,118', the collars 120,120' reciprocate relative to the valve body 30 and alternately engage the controller 28 to move it from one end position to the other. The fingers 122,122' simultaneously advance the packages in the following manner. When the piston moves to the left, the fingers are carried with it and are lifted on their hinges by the packages 126. The fingers drop behind the packages and when the piston 56 moves to the right they engage the rear ends of the packages and move them forwards.

The present invention thus offers a valve system having various applications, which is very simple to manufacture.

CLAIMS

1. A valve system comprising inlet means for pressurised fluid, outlet means for exhaust fluid, first and second flow passages for supplying pressurised fluid to and discharging exhaust fluid from first and second operating chambers, a valve member movable between two positions and arranged, in one position, to communicate the inlet means with the first flow passage and the second flow passage with the outlet means and, in the other position, to communicate the inlet means with the second flow passage and the first flow passage with the outlet means, and reciprocable means arranged to cause movement of the valve member between its two positions, the valve member comprising a sleeve and the reciprocable means comprising a piston slidably received within the sleeve, the reciprocable means further comprising first and second members connected to the piston and arranged at respective moments during the reciprocating cycle to bear on the valve sleeve to move it mechanically into a new one of its two positions.

2. A valve system according to claim 1, in which the valve sleeve is received in a valve chamber provided in a valve body, and in which the first and second members are arranged, when they bear on the valve sleeve, to urge the valve sleeve into contact with respective stops in the valve chamber defining the two positions of the valve sleeve.

3. A valve system according to claim 2, in which the valve chamber comprises a stepped bore within the valve body having enlarged ends and a reduced central portion, and in which the valve sleeve likewise has enlarged ends and a reduced central portion, the reduced central portion of the valve sleeve being longer than the reduced central portion of the valve chamber, and the stops being provided by the shoulder formed in the stepped bore.

4. A valve system according to claim 3, in which the first and second members each engage the end surface of a respective one of the enlarged ends of the valve sleeve, which is exposed beyond the associated end of the valve chamber, to move the valve sleeve into the new position.

5. A valve system according to claim 3 or claim 4, in which first and second inlet passages, which intersect the reduced central portion of the valve chamber, are provided between the inlet means and the first and second flow passages respectively.

6. A valve system according to any of claims 3 to 5, in which first and second outlet passages, which intersect the enlarged ends of the valve chamber, are provided between the first and second flow passages respectively and the outlet means.

7. A valve system according to claim 3 or claim 4, in which first and second inlet passages, which intersect the enlarged ends of the valve chamber, are provided between the inlet means and the first and second flow passages respectively.

8. A valve system according to any of claims 3, 4 and 7, in which first and second outlet passages, which intersect the reduced central portion of the valve chamber, are provided between the first and second flow passages respectively and the outlet means.

9. A valve system according to any preceding claim, in which the valve sleeve comprises two parts having complimentary threaded portions.

10. A valve system according to any preceding claim, in which labyrinth seals are provided on the interior surface of the valve sleeve at each end thereof.

11. A valve system according to any preceding claim, in which the valve sleeve is formed from carbon filled PTFE.

12. A valve system according to any of claims 3 to 8, in which the valve chamber contains O-rings for breaking movement of the valve sleeve.

13. A double diaphragm pump having two diaphragm housings, each of which contains an operating chamber and a pumping chamber separated by a diaphragm, and including a valve system according to any preceding claim for controlling supply of pressurised fluid to and discharge of exhaust fluid from the operating chambers.

14. A double diaphragm pump according to claim 14, in which the first and second members comprise plates mounted on the diaphragms.

15. A double diaphragm pump according to claim 13 or claim 14, in which the ends of

the valve sleeve are exposed to the pressures in the operating chambers whereby the valve sleeve is maintained in each of its two positions as a result of the difference in the pressures in the operating chamber, except when the first and second members bear on the valve sleeve.

16. A valve system substantially as herein particularly described with reference to and as illustrated in the accompanying drawings.

17. A double diaphragm pump substantially as herein particularly described with reference to and as illustrated in the drawings.

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