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A PUMP FOR SUPPLYING A LIQUID ADDITIVE
TO A FLOW OF LIQUID

This invention relates to a pump for supplying a liquid additive to a flow of liquid.

Pumps for this purpose are well known, see for example U.K. Patent Nos. 1243732 and 1387880. Both of those 5 pumps are primarily for use in horticulture i.e. for introducing quantities of liquid fertilizer into irrigation water. Whilst they operate satisfactorily in their intended environment, in particular they overcome the problem of injecting additive into flowing 10 liquid, they are not the first choice of pump for certain other environments e.g. environments where there is no electricity i.e. remote rural areas, or environments where fire hazards have to be avoided at all costs e.g. in petro-chemical industrial plant. For use in 15 petro-chemical industrial plant, pumps may be flame proofed and other appropriate measure may be taken. However these measures in themselves tend to greatly increase the production costs of the pumps.

It is therefore an object of the present invention to provide a pump which is suitable for use in a wide range of environments, whether industrial, agricultural or horticultural, and which does not depend for its operation on an electricity supply, and finally, which is of a simple and economic construction to manufacture and service. According to one aspect of the present invention there is provided a pump for supplying liquid additive to a flow of liquid, comprising a dosing chamber communicating with an inlet opening and an outlet opening for a liquid additive, each said opening being controlled by a non return valve, a first displaceable member arranged in said dosing chamber and operative to dispense said liquid additive, said first displaceable member being operatively connected by connection means to a second displaceable member arranged in an operating chamber, said second displaceable member being arranged to partition said operating chamber into first and second operating chambers, each of said first and second operating chambers having a respective port for communication with a supply of operating fluid, operating switching means for controlling the supply of operating fluid to said ports of said first and second operating chambers, said operating switching means being operative such that when one of said first and second operating chambers is being supplied with operating fluid the respective other operating chamber is being evacuated whereby successive switching of said operating switching means effects reciprocation of said connection means and thereby dispensing of measured quantities of liquid additive from the dosing chamber, wherein said operating switching means is fluid actuated, and a pilot switching means is mechanically associated with said reciprocating connection means

and is operatively coupled by fluid couplings to the fluid actuated operating switching means, the pilot switching means and the fluid actuated switching means thus coupled being operable such that, at the end of each stroke of the reciprocating connection means, said fluid actuated switching means is actuated to change the supply of operating fluid from one to the other of said operating chambers, and wherein the volume of liquid additive dispensed by the dosing chamber on each actuation thereof is adjustable by means of a variable lost motion coupling associated with the connection means between said first displaceable member and the second displaceable member, variation of the respective lost motion coupling effecting an adjustment to the effective stroke of the respective connection means.

The above defined pump enables the volume of additive passed by the (or each) dosing head on each actuation thereof to be adjustable. Advantageously the lost motion coupling has calibration means giving a visual indication of the dosing rate of the dosing chamber for different settings of the lost motion coupling.

In the preferred embodiment said first displaceable member is a piston, said dosing chamber is arranged within a dosing head, said second displaceable member is an operating diaphragm, said operating chambers are defined by an operating head, and the connection means includes piston rod means coupled with both displaceable members.

Embodiments of such a pump may be constructed to operate with either hydraulic or pneumatic actuation i.e. with either a liquid, for example water, or air as the operating fluid which is supplied and evacuated from the first and second operating chambers.

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In a particular application namely in a water purification system for the supply of purified water for domestic purposes in isolated villages in under-developed territories, the operating fluid may be the water which is being purified. This water may be pumped, for example, by a diesel pump to a village reservoir and the pressure of the water in transit may be employed to drive this pump for the additive (i.e. agent for purifying the water). In this case, it should be appreciated that the water evacuated from the first and second operating chambers is directed back to source, whereby the precious commodity (water) is not lost.

On the other hand, the pump may be pneumatically actuated, for example, in industrial environments where it is commonplace for there to be an abundant supply of compressed air for driving industrial plant. In this case since the volumes of air used by this pump are relatively small, the air from the first and second operating chambers may be evacuated to atmosphere.

In a preferred embodiment, the fluid actuated switching means is a spool valve or a slide valve which is actuated under fluid control by the pilot switching means, the condition of said pilot switching means controlling the application of pilot operating fluid from said pilot switching means to said fluid actuated switching means and thereby the selection of which of said first and second operating chambers is supplied with operating fluid.

In the preferred embodiment, said pilot switching means is a spool or slide valve arranged to control by fluid control the fluid actuated switching means and itself being mechanically actuated to change state at each end of each stroke of the reciprocating connection means by

means of actuating stops associated with the reciprocating connection means.

5 It should be appreciated that the chambers in the operating head and dosing head may be relatively proportioned (that is to say the effective piston area and diaphragm area may be relatively proportioned) as to ensure that the pressure of the additive leaving the dosing head is sufficient for injection of the additive
10 into the liquid into which it is to be mixed. It will be readily appreciated that the outlet of the dosing head may be coupled to a vessel or pipework through which said liquid is flowing. Typical values of the mechanical advantage which may be obtained with
15 embodiments of the pumps herein defined are from 11:1 down to 2.5:1. A ratio of 11:1 indicates that the pressure of the liquid to be dosed may be eleven times greater than the pressure of the operating fluid. It is an advantageous feature of the construction of
20 embodiments of the invention that the size of dosing head and piston associated therewith may be a customised unit with the remainder of the structure defining the pump being of standard components.

25 The foregoing defined pump with a single dosing head may be termed a "simplex" pump. By the addition of a second dosing head itself having a second connection means operatively connected with said member, a "duplex" pump is provided whereby the pump is capable of metering
30 additive via each of the two dosing heads. The additives dosed by the two dosing heads may be the same additives, for example, to two different flows of liquid or different additives, for example, to the same flow of liquid. The dosing capacity of the two dosing heads may
35 be the same or different.

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An embodiment of the invention will now be described by way of example only, with reference to the accompanying drawing which shows in sectional elevation a pump for supplying a liquid additive
5 to a flow of liquid.

In the drawing there is shown a "simplex" pump for supplying a liquid additive to a flow of liquid. A dosing head 10 defines a dosing chamber 11
10 communicating with an inlet opening 12 and an outlet opening 13 for a liquid additive. Each of the openings 12, 13 is controlled by a respective non return valve 15. A first displaceable member 20, which is in the form of a piston member, is arranged in the dosing chamber 11
15 and is operative to dispense said liquid additive through the outlet opening 13. This first displaceable member 20 is operatively connected by connection means 30 (to be further described) to a second displaceable member 40, the latter being arranged in an operating
20 chamber 50. The second displaceable member 40, which is in the form of a diaphragm, is arranged to partition operating chamber 50 into first and second operating chambers 51, 52. Each of the first and second operating chambers 51, 52 having a respective port 53, 54 for
25 communication with a supply of operating fluid 55. Operating switching means 60 controls the supply of operating fluid 55 to the ports 53, 54 of the first and second operating chambers 51, 52. This operating switching means 60 is operative such that when one of
30 said first and second operating chambers 51, 52 is being supplied via supply line 61 with operating fluid 55, the respective other one of the operating chambers 52, 52 is being evacuated via evacuation line 62. Successive switching operations of the operating
35 switching means 60 thereby effects reciprocation of

the connection means 30 and also thereby the dispensing of measured quantities of liquid additive from the dosing chamber 11. The operating switching means 60 is fluid actuated, i.e. the pressure in
5 control lines 81, 82 (to be further described) controls the position of the slide or spool valve therein. A pilot switching means 70 is mechanically associated (as will be further described) with the reciprocating connection means 30. The pilot switching
10 means 70 is operatively coupled by fluid couplings via lines 81 to 85 to the operating switching means 60. The pilot switching means 70 and the operating switching means 60 are operable such that, at the end of each stroke of the reciprocating connection means 30, the
15 operating switching means 60 is actuated to change the supply of operating fluid 55 from one to the other of the ports 53, 54 and hence from one to the other of the operating chambers 51, 52.

20 The operating chambers 51, 52 are defined by an operating head 90 which, as is evident from the drawing, is in two parts 91, 92 bolted together at 93 to clamp the diaphragm means 40 (of the second displaceable member) about its periphery. The two operating head
25 parts 91, 92 are formed so as to define the chamber 50 therebetween which is partitioned into operating chambers 51, 52 by the diaphragm means 40. Diaphragm means 40 is itself provided with stiffening discs 41 maintained in clamped attitude by locking means 42 threadedly
30 engaged with one portion 32 of the connection means 30. In addition head parts 91, 92 are formed to define passages 95, 96 which at their outer ends are threadedly engaged by connecting pieces 97, 98. These connecting pieces 97, 98 couple lines 63, 64 to the operating
35 head 90 and also define the aforesaid openings 53, 54.

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In addition part 91 is provided with a passage 94 which accommodates a guide piece 99 in threaded engagement therewith. Guide piece 99 guides the connecting means 30 in the head part 91. O-ring seals 18 are located in passage 94 to co-operate with guide piece 99. It will be appreciated that as shown head part 92 has a recess axially aligned with the passage 94 to accommodate the end 37 of the connection means 30 on its rightward travel (as seen in the drawing). It should be appreciated from the foregoing generalised comments concerning a "duplex" pump, that for such a pump the operating head part 92 would also have a passage 94 extended through the outer wall thereof to accommodate its respective connection means 30 for another dosing head 20 (not shown).

The connection means 30 includes piston rod means 31, 32 connected respectively to the displaceable members 20, 40 (i.e. the piston and the diaphragm). As shown the piston rod means 31, 32 are associated with a main piston rod part 33. Part 33 is directly connected with piston rod means 32 and thereby the diaphragm means (second displaceable member 40). Part 33 is connected to piston rod means 31 by means of a lost motion coupling including members 34, 35. By the setting of member 35 relative to the part 33 so the degree of lost motion will be determined. It will be seen that the forward end 36 of the part 33 enters an axial cavity in the part 31, this ensures that the end 36 is supported at all times. However, as the part 33 advances to the left (in the drawing) no motion of the part 31 (and hence piston or first displaceable member 20) occurs until member 35 abuts member 34 of the lost motion coupling. It will be seen that the member 35 is threadedly engaged at 38 with the part 33 whereby the degree of lost motion may be varied. In this way the volume of additive dispensed by the

dosing head 10 on each actuation thereof is adjustable. By varying the position of the member 35 relative to the part 33, the effective stroke of the connection means 30 is adjusted.

5 As can be seen, the lost motion coupling formed by members 34, 35 is associated with calibration means comprising a threaded member 111 threadedly engaging a threaded passage in the member 34 and freely
10 displaceable with respect to an associated passage 112 in the member 35. This member 111 carries a pair of calibration discs 113, 114. On part 33 of the connection means 30 is calibrated marker piece 115 which is threadedly engageable therewith at the threaded portion
15 38. The disposition of the calibration discs 113, 114 relative to the calibrated marker piece 115 enables the dosing capacity of the dosing head 10 to be read off for each of a series of adjustments of the lost motion coupling (34, 35).

20 It will be observed that the dosing head 10 accommodates the piston or displaceable member 20 in the cavity therein 11. It will be noted that dosing head 10 is bolted at 122 to a framework 120 which is connected to the
25 operating head 90 by further bolts 121. Within dosing head 10 are passages which are threaded to accommodate the members 16, 17 incorporating the non return valves 15. It will be noted that O-ring seals 18 seal the joints between members 16, 17 and the dosing head 10.
30 Likewise, within the chamber 11 the piston 20 carries piston rings 21 to ensure a seal with respect to chamber 11. Piston 20 is guided by guide piece 29.

The fluid actuated switching means 60 is a spool valve
35 or slide valve. It is actuated under fluid control by

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the pilot switching means 70. As can be seen the pilot switching means 70 has a spool 77 (it could be a slide). The position of this spool 77 (which is determined as will be further described) determines

5 the internal condition of said pilot switching means 70. This internal condition determines whether pilot pressure fluid issues from port 71 or port 72 and thus enters switching means 60 via a respective one of lines 81, 82. When the pilot pressure fluid is applied

10 along line 81, the internal condition of the switching means 60 is such that the operating fluid 55 passes to line 63 and thence operating chamber 51, whilst pressure fluid in chamber 52 is permitted to be evacuated since line 64 is now in communication with evacuation line 62.

15 However, when switching means 70 changes its internal condition, the pilot fluid pressure is then applied along line 82. This causes the internal condition of switching means 60 to change state. In consequence line 64 is connected to the line 61 so that chamber 52

20 is pressurized, whilst chamber 51 is evacuated as line 63 is now coupled to evacuation line 62. Thus the condition of the pilot switching means 70 controls the application of pilot operating fluid from said pilot switching means 70 to the switching means 60 and thereby

25 the selection of which of the first and second operating chambers 51, 52 is supplied with operating fluid 55.

The pilot switching means 70, which is also a spool or slide valve, is itself mechanically actuated to change

30 state at each end of each stroke of the reciprocating connection means 30. The spool 77 (it may be a slide) is acted upon by stops 131, 132 arranged to contact, and displace, a respective end of spool 77 at the transition point in the movement of connection means

35 30. Stop 131, which in this embodiment is formed by a

bolt, is carried by the lost motion coupling member 35 and is adjustable relative thereto, whereby the switching point may be adjusted. Stop 132 is carried by a member 133. Member 133 is slideably mounted on the connection means part 33 and adjustably secured thereto by fastening means 134. Since the position of member 133 relative to part 33 may be adjusted, as may member 132 relative to member 133, it follows that the switching point of the switching means 70 may also be adjusted or tuned relative to the respective transition or end of stroke of the connection means 30. As stated, direct contact of the spool 77 with one of the stops 131 or 132 causes the position of spool 77 to change with respect to the housing thereof. In consequence the condition of the switching means 70 changes with the resultant change of pilot pressure fluid between the lines 81, 82 (as described above). It will be noted that pilot switching means 70 has five ports 71 to 75 communicating with lines 81 to 85. Lines 81, 82 have been explained. Line 85 is the pressure fluid supply line and is connected to the main supply line 61. Lines 83, 84 are the exhaust lines for exhausting as appropriate a respective one of lines 81, 82 when the other of those lines is pressurised, and these lines 83, 84 are connected to the main evacuation line 62.



CLAIMS:

1. A pump for supplying liquid additive to a flow of liquid, comprising a dosing chamber communicating with an inlet opening and an outlet opening for a liquid additive, each said opening being controlled
- 5 by a non return valve, a first displaceable member arranged in said dosing chamber and operative to dispense said liquid additive, said first displaceable member being operatively connected by connection means to a second displaceable member arranged in an
- 10 operating chamber, said second displaceable member being arranged to partition said operating chamber into first and second operating chambers, each of said first and second operating chambers having a respective port for communication with a supply of operating fluid,
- 15 operating switching means for controlling the supply of operating fluid to said ports of said first and second operating chambers, said operating switching means being operative such that when one of said first and second operating chambers is being supplied with
- 20 operating fluid the respective other operating chamber is being evacuated whereby successive switching of said operating switching means effects reciprocation of said connection means and thereby dispensing of measured quantities of liquid additive from the dosing
- 25 chamber, wherein said operating switching means is fluid actuated, and a pilot switching means is mechanically associated with said reciprocating connection means and is operatively coupled by fluid couplings to the fluid actuated operating switching means, the
- 30 pilot switching means and the fluid actuated switching means thus coupled being operable such that, at the end of each stroke of the reciprocating connection means, said fluid actuated switching means is



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actuated to change the supply of operating fluid from one to the other of said operating chambers, and wherein the volume of liquid additive dispensed by the dosing chamber on each actuation thereof is adjustable by means of a variable lost motion coupling associated with the connection means between said first displaceable member and the second displaceable member, variation of the respective lost motion coupling effecting an adjustment to the effective stroke of the respective connection means.

2. A pump as claimed in Claim 1, wherein said first displaceable member is a piston, said second displaceable member is an operating diaphragm, and the connection means includes piston rod means coupled with both displaceable members.

3. A pump as claimed in either Claim 1 or Claim 2, wherein the fluid actuated switching means is a spool valve or a slide valve which is actuated under fluid control by the pilot switching means, the condition of said pilot switching means controlling the application of pilot operating fluid from said pilot switching means to said fluid actuated switching means and thereby the selection of which of said first and second operating chambers is supplied with operating fluid.

4. A pump as claimed in any one of Claims 1 to 3, wherein said pilot switching means is a spool or slide valve arranged to control by fluid control the fluid actuated switching means and is itself mechanically actuated to change state at each end of each stroke of the reciprocating connection means by means of actuating stops associated with the reciprocating connection means.



5. A pump as claimed in any one of Claims 1 to 4, wherein said dosing chamber is arranged within a dosing head and said first and second chambers are defined by an operating head.

6. A pump as claimed in Claim 5, which is provided with a single dosing head.

7. A pump as claimed in Claim 5, which is provided with a second dosing head itself having a second connection means operatively connected between a displaceable member associated with a respective second dosing chamber in said second dosing head and said second displaceable member associated with the operating chambers, a second variable lost motion coupling being associated with said second connection means and adapted to function similarly to said first connection means, whereby the pump is capable of metering liquid additive via each of the two dosing heads.

8. A pump as claimed in any one of Claims 1 to 7, wherein the or each lost motion coupling has calibration means giving a visual indication of the dosing rate of the dosing chamber for different settings of the respective lost motion coupling.

9. A pump for supplying liquid additive to a flow of liquid, arranged, constructed and adapted to operate substantially as herein before described with reference to the accompanying drawing.