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(54) Fluid flow control device.

(57) A fluid flow control device (10) which is employed in conjunction with a fluid pump (12) and which functions to restrict reverse flow of liquid which is induced by the fluid pump to flow in a forward direction through the device from a source (11) of the liquid. The device comprises a housing (20 or 50) which contains first and second chambers (21 and 22 or 51 and 52), and a tube (26 and 37 or 54 and 60) is located in each of the chambers. The tubes (26, 37, 54 and 60) define fluid passageways (27, 36, 55 and 61) through which the liquid is induced to flow in passing into the respective chambers (21, 22, 51 and 52), and the tubes extend upwardly through the respective chambers to a level above the level of liquid which is contained in the chambers. Valve members (30, 39, 59 and 63) are located at the upper end of the respective tubes (26, 37, 54 and 60), the valve members providing for forward flow of liquid into the chambers from the respective tubes and serving to prevent the liquid from leaking in a reverse direction along the fluid passageways (27, 36, 55 and 61). A control port (32 or 64) enters the housing (20 or 50) and is connectable to the fluid pump (12) for the purpose of applying alternating negative and positive pressurisation to the chambers whereby the liquid is induced to flow into and through the chambers.

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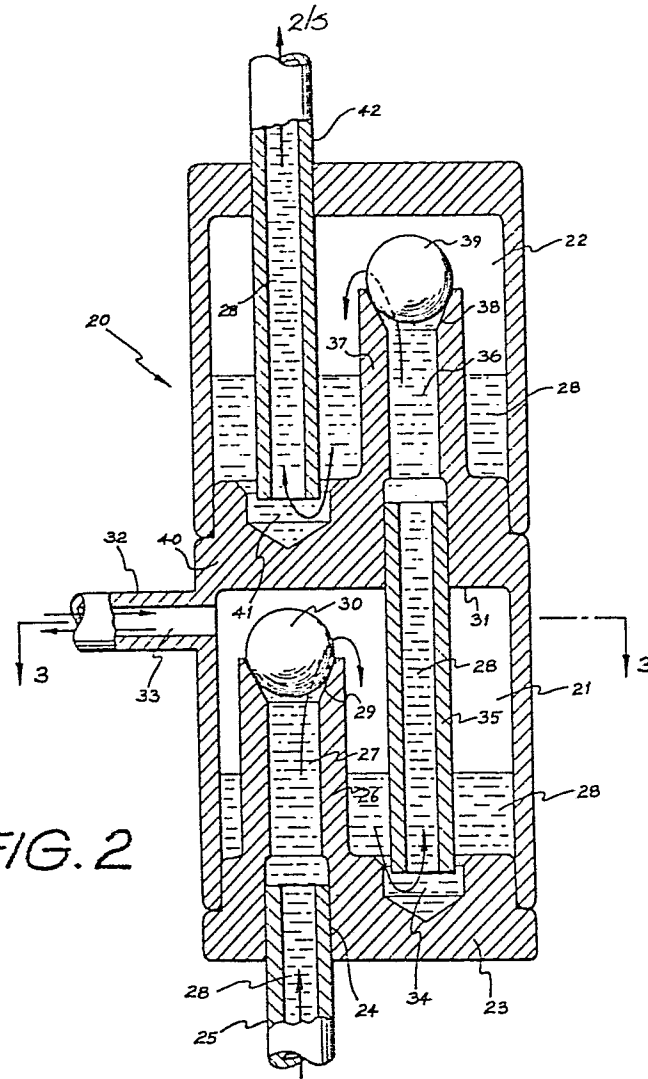


FIG. 2

Attorney's file: 50 164

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FLUID FLOW CONTROL DEVICE

5 This invention relates to a fluid flow control device which is suitable for use in conjunction with a fluid pump and which serves in use to restrict reverse flow of a fluid which is induced to flow in a forward direction through the device.

10 The device has application in a mechanism which is employed for pumping a small quantity of a first liquid, such as a chemical additive, into a second liquid such as water. In such an application, it is highly desirable that the first liquid should be available in the device whenever it is required to be pumped into the second liquid and that the first  
15 liquid should be prevented from leaking back to its reservoir if a long period of time elapses between successive pumping operations. Such a need exists inter alia in a mechanism which is employed for delivering metered quantities of an additive, such as  
20 a bactericide, into toilet systems or the like, and the invention is hereinafter described in the context of such a system for convenience of reference.

25 European Patent Application No. 80102391.2 discloses a mechanism for use in delivering metered quantities of a chemical additive into the flush water of a toilet system, and the mechanism incorporates

a valved pumping chamber which is located in circuit with a reservoir of the chemical additive. The valved pumping chamber as disclosed in the referenced patent application may be equated with a preferred  
5 form of the fluid flow control device of the present invention, at least in terms of the operational requirements of the respective devices, and its functions, when subjected to alternating positive and negative pressures, to meter a quantity of the chemical additive  
10 into the flush water of a toilet system.

The valved pumping chamber which is described and illustrated in European Patent Application No. 80102391.2 is connected by way of a suction tube to a reservoir which contains the chemical additive and it  
15 includes a pair of valves which are arranged in series to permit unidirectional flow of liquid through the pumping chamber from the reservoir. A suction pressure is first applied to a chamber which is located between the two valves and this induces  
20 the chemical additive to flow through a first of the valves and into the chamber from the reservoir. Thereafter, when a positive pressure is applied to the chamber, the chemical additive which is contained within the chamber is forced to flow through the  
25 second of the two valves and is thereby expelled from the pumping chamber. However, should a long delay occur following priming of the chamber and application of positive pressure to the chamber, and should the first valve fail to provide a perfect seal against  
30 backflow of the chemical additive in the chamber, it is possible that all of the additive which is drawn into the chamber may leak back to the reservoir. Then, when the chamber is next subjected to a positive pressure, no additive will be available to be dispensed into the flush water and, depending upon the length of the suction line between the pumping chamber and

the reservoir, a number of flushing operations may need be performed before the additive is restored to the chamber for delivery to the flush water. Total leakage of the additive from the chamber may occur because of the extremely small amount of additive which normally would be required to be dispensed from the chamber with each flushing operation and due to the fact that a long period of time (say, up to 8 hours) may elapse between successive flushing operations.

This problem might be avoided if a perfect seal could be achieved between the valve member and its seat, but normal manufacturing constraints preclude the achievement of a perfect seal in every case. Also, because of the relatively small amount of energy which normally is available for inducing flow of the additive through the pumping chamber, it is not feasible to enhance the valve-to-seat sealing by subjecting the valve member to a high closure force.

The present invention seeks to provide a fluid flow control device which avoids the abovementioned difficulties, which provides a chamber through which a liquid may be pumped in a forward direction and which is constructed to preclude or, at least, restrict leakage of the liquid back to a reservoir from which the liquid is supplied.

Thus, the invention is broadly defined as providing a fluid flow control device comprising a chamber and an inlet port connectable with a source of liquid which, in use of the device, is induced flow into the chamber by way of the inlet port. A tube is located within the chamber and is connected in fluid passage communication with the inlet port, the tube defining a fluid passageway and extending upwardly through the chamber to a level above the level of liquid which, in use of the device, is contained within the chamber.

A valve seat is formed by an upper end portion of the tube, and a valve member is normally supported on the valve seat but is displaceable from the valve seat to permit unidirectional flow of the liquid into the chamber from the fluid passageway. Also an outlet port is located in fluid passage communication with the chamber and through which the liquid within the chamber can be induced flow.

In use of the device as above defined, liquid is induced to flow into the chamber from a reservoir by way of the fluid passageway and, in so doing, it lifts the valve member from the valve seat. Having flowed upwardly through the fluid passageway and the valve, the liquid which enters the chamber then falls to a level below that of the upper end of the tube and, when a predetermined quantity of the liquid has been induced to flow into the chamber, the valve member closes onto the valve seat to prevent back flow of the liquid to the reservoir. Thus, the upper end of the tube is located above the level of the liquid within the chamber and back flow of liquid from the chamber as such is thereby precluded. Also, residual liquid on the valve seat co-operates with the valve member to form a fluid-tight seal whereby liquid which is located within the fluid passageway at the underside of the valve member is prevented from leaking back into the reservoir (which normally would be located below the level of the chamber) from the fluid passageway.

Liquid may be induced by an external pump to flow into the above defined device. However, liquid flow through the device is preferably induced by applying alternate negative and positive pressures to the chamber from a fluid pump and, in such case, the chamber would be provided with a fluid delivery port (herein termed a "control port") which is connectable

to a fluid pump device for applying alternate negative and positive pressure to the interior of the chamber. The control port would be located above the level of the liquid within the container so that, when the interior of the chamber is subjected to a negative pressure, the liquid will be induced to flow into the chamber, by way of the fluid passageway, from the reservoir. Conversely, when the interior of the chamber is subjected to a positive pressure, the liquid within the chamber will be induced to flow from the chamber via the outlet port and the valve member will be subjected to a closing force.

The valve member preferably comprises a spherical valve element and the valve seat is preferably formed as a conical seat. However, the valve member and seat may be shaped otherwise, provided that a meniscus might be formed between the inter-engaging surfaces of the valve member and seat to aid in the sealing between the valve member and the seat.

The fluid flow control device most preferably incorporates two chambers, with a passageway-defining tube being located within each chamber. Then, one of the passageway-defining tubes will be connected in fluid passage communication with the inlet port and the other passageway-defining tube will be connected in fluid passage communication with the outlet port. The chambers may be located side-by-side, one above the other or be completely separate but, in each case, the chambers will be interconnected to permit liquid flow from one of the chambers to the other. With such an arrangement, the liquid which is induced to flow into a first of the chambers will thereafter flow into the second chamber by way of the passageway-defining tube in the second chamber, and then toward the outlet port. Thus, flow of liquid through the

device occurs unidirectionally and a valve member associated with each of the passageway-defining tubes will serve to prevent back flow of the liquid through the device.

5           The invention will be more fully understood from the following description of two exemplary embodiments of a fluid flow control device, the description being given with reference to the accompanying drawings wherein:

10           Figure 1 shows a schematic representation of the fluid flow control device in conjunction with associated elements,

          Figure 2 shows a sectional elevation view of one embodiment of the fluid flow control device,

15           Figure 3 shows a sectional plan view of the device which is illustrated in Figure 2, the view being taken in the direction of section plane 33 as indicated in Figure 2,

          Figure 4 shows a sectional elevation view of a second embodiment of the fluid flow control device,

20           Figure 5 shows a sectional plan view of the device which is illustrated in Figure 4, the view being taken in the direction of section plane 5-5 as indicated in Figure 4, and

25           Figure 6 shows on an enlarged scale a valve member/ seat arrangement which forms a part of the devices which are illustrated in Figures 2 and 4.

          As shown in Figure 1 of the drawings, the fluid flow control device 10 is located in circuit with a  
30           reservoir 11 of a liquid which is to be pumped through the device, and a fluid pump 12 is coupled to the device by way of tube 13. The fluid pump 12 is operated to apply alternate negative and positive gas pressurisation to the interior of the device 10,  
35           whereby liquid within the reservoir 11 is induced to

flow into, through and from the device 10 by way of a liquid feed tube 14. The liquid which is pumped through the device 10 is conveyed from the device by way of a delivery tube 15, and the liquid may be injected as an additive into a further liquid reservoir (not shown). The fluid pump 12 may be of a type as described in European Patent Application No. 80102391.2 and be operated with rise and fall of water into which the liquid from the delivery tube 15 may be injected.

Alternative embodiments of the fluid flow control device 10 are now described, firstly with reference to Figures 2 and 3 and then with reference to Figure 4 and 5.

As illustrated in Figures 2 and 3 of the drawings, the device 10 comprises a plastics material housing 20 which includes first and second chambers 21 and 22. The first (lower) chamber 21 is closed by a base portion 23 which is formed with an inlet port 24 into which a liquid feed tube 25 extends. The feed tube 25 corresponds with that indicated by numeral 14 in Figure 1 and it is connectable to a reservoir of a liquid which is induced to flow through the device in operation of the device.

A first tube 26 which is formed as an integral part of the base 23 is located within the first chamber 21 and it defines a first fluid passageway 27. The tube 26 and hence the passageway 27 extends upwardly through the chamber to a level above the level of the liquid 28 which is contained within the first chamber in use of the device. The passageway 27 forms an extension of the feed tube 25.

The upper end of the tube 26 is formed with a conical valve seat 29 and a spherical valve member 30 is normally supported upon the valve seat. The valve member 30 is displaceable from the valve seat to  
5 permit the liquid 28 to flow into the first chamber 21 from the passageway 27, but the valve member is located adjacent the upper wall 31 of the chamber 21 so that it will be constrained from dislodging from the tube 26.

10 A fluid line 32 is connected to the housing 20 and communicates with a control port 33. The port 33 opens into the first chamber 21 above the level of the liquid 28 within the chamber, and the line 32 is connected with a fluid pump 12 (Figure 1) which is  
15 employed to apply alternating positive and negative pressurisation to the interior of the first chamber 21.

The base portion 23 of the first chamber 21 is formed with a depression 34 and a liquid transfer  
20 conduit 35 extends upwardly from the region of the depression to communicate with a second fluid passageway 36. The second fluid passageway 36 is defined by a second tube 37 which is located in the second chamber 22.

25 The arrangement which exists in the second chamber 22 is similar to that in the first chamber, to the extent that the second tube 37 extends upwardly through the second chamber to a level above that of the liquid 28 which normally is contained within the  
30 chamber. Also, the upper end of the second tube 37 is formed with a conical valve seat 38 and is fitted with a spherical valve member 39.

Additionally, the base portion 40 of the second chamber 22 is formed with a depression 41, and a

liquid discharge tube 42 extends upwardly through the chamber from the region of the depression 41 for conveying liquid from the second chamber 22.

5 In operation of the device as shown in Figures 2 and 3, a suction pressure is applied to the first chamber 21 by way of the fluid line 32 and liquid is thereby induced to flow upwardly through the feed tube 25 and the first passageway 27 to enter the first chamber 21. In so doing, the liquid causes unseating  
10 of the valve member 30 and the liquid falls from the valve seat 29 toward the base of the first chamber 21. The amount of liquid which is caused to flow into the first chamber is determined by the volume of air displaced from the chamber along the line 32 by the  
15 fluid pump 12 (Figure 1), and this is always controlled such that the level of the liquid in the chamber 22 does not rise to that of the upper end of the tube 26.

Assuming that the device has already been primed with liquid, as shown in the drawings, the second  
20 valve member 29 will prevent reverse flow of liquid from the transfer conduit 35 when suction pressure is applied to the first chamber 21.

When application of the suction pressure is terminated, liquid will cease to flow into the first  
25 chamber 21 and the first valve member 30 will close to prevent reverse flow of liquid in the first passageway 27. The way in which the valve members 30 and 39 seal against their respective seats 29 and 38 is to be hereinafter described with reference to Figure 6.

30 In order to displace the liquid from the device, a positive pressure is applied to the interior of the first chamber 21 by way of the fluid line 32. Then, a portion of the liquid which is contained within the first chamber 21 will be forced to flow upwardly

through the transfer conduit 35 and to spill into the second chamber 22. In so doing, the second valve member 39 will be unseated and the level of the liquid within the second chamber 22 will tend to rise.

5 However, as the level of the liquid within the second chamber does tend to rise, it will cause compression of air within the second chamber and this will in turn cause the liquid to be displaced from the chamber by way of the discharge tube 42. Thus, liquid in an  
10 amount approximately equal to that transferred from the first to the second chamber will be discharged from the device.

The amount of liquid which is displaced from the first to the second of the chambers will be determined  
15 by the volume of air which is pumped into the first chamber by way of the line 32, and this will be adjusted to equal the volume of air which is sucked from the chamber during the preceding suction stroke.

Reference is now made to the second embodiment of  
20 the fluid flow control device which is shown in Figures 4 and 5 of the drawings.

This device comprises a housing 50 which includes first, second and third chambers 51, 52 and 53 respectively. A first tube 54 is located within the first chamber  
25 51, and the tube 54 defines a first fluid passageway 55 which is connected in fluid passage communication with a liquid feed tube 56. The feed tube 56 is connectable with a liquid reservoir 11 (Figure 1).

The first tube 54 extends upwardly into the first  
30 chamber 51 to a level above that of liquid 57 which is contained within the chamber 51 in use of the device, and the upper end of the tube 54 is formed with a conical valve seat 58 upon which a first spherical-

form valve member 59 normally seats.

The second chamber 52 incorporates a second tube 60 which defines a second fluid passageway 61, and the second tube extends upwardly to a level above that of liquid which is contained within the second chamber 52 in use of the device. The second tube 60, like the first tube, is formed with a conical valve seat 62 at its upper end and a second valve member 63 normally rests upon the seat.

The third chamber 53 is located intermediate the first and second chambers 51 and 52, and a fluid line 64 connects with the interior of the third chamber. The fluid line 64 extends upwardly into the third chamber to a level above that of the liquid 57 which is contained within the third chamber during use of the device and it is connected to a fluid pump device 12 (Figure 1). The fluid pump device 12 effects alternating negative and positive pressurisation of the third chamber 53 and, in so doing, induces liquid flow through the device.

A first liquid transfer port 65 interconnects the first and third chambers 51 and 53, and a second liquid transfer port 66 provides for fluid passage communication between the third chamber 53 and the second fluid passageway 61. Also, a third liquid transfer port 67 provides for fluid passage between the second chamber 52 and an outlet port 68.

A liquid discharge tube 69 extends from the outlet port 68 and is employed for conveying from the device liquid which is induced to flow through the device.

The device which is illustrated in Figures 4 and 5 functions in much the same manner as the device which has previously been described with reference to Figures 2 and 3. Thus, when suction pressure is

applied to the third chamber 53 by way of the fluid line 64, the liquid 57 is induced to flow into the first and third chambers 51 and 53 by way of the first fluid passageway 55. Then, when a positive pressure is subsequently applied to the third chamber 53 by way of the fluid line 64, liquid within the first and third chambers 51 and 53 is caused to transfer into the second chamber 52 by way of the second fluid passageway 61. At the same time, liquid which is contained within the second chamber 52 is forced into the outlet port 68 and from the device by way of the discharge tube 69.

In each of the above described embodiments of the device, when the device has been primed, the column of liquid 28, 57 within the first and second tubes 26, 54 and 37, 60 is held against back flow by the respective valve members 30, 59 and 39, 63. Thus, as shown in Figure 6 of the drawings, when forward flow of fluid from the first or second tubes ceases, an annular ring 70 of the liquid will be retained at the interface between the valve member 30, 39, 59 or 63 and the valve seat 29, 38, 58 or 62 and will form a seal against flow of air in a reverse direction through the valve. In the absence of any reverse flow of air through the valve, the column of liquid 28 or 57 will be precluded from flowing in a reverse direction back down the tube 26, 37, 54 or 60. In fact, when the column of liquid 28 or 57 tends to flow in a reverse direction down the tube, a suction force is applied to the annular ring 70 of the liquid and causes the ring of liquid to form a meniscus. Then, as the meniscus is "stretched" by the suction pressure, the surface tension effect between the boundary layer of the meniscus and the surface of the valve elements tends to balance against the suction force exerted by the

liquid column 28 or 57 and, hence, the sealing effect provided by the valve elements is maintained.

CLAIMS:

## 1. A fluid flow control device comprising:

a housing (20 or 50) defining a chamber (21 or 51),

an inlet port (25 or 56) located in the housing, the inlet port being connectable with a source (11) of liquid which, in use of the device, is induced to flow into the chamber (21 or 51), and

an outlet port (42 or 69) located in fluid passage communication with the chamber (21 or 51) and through which liquid from the chamber can be induced to flow;

characterised in that:

a tube (26 or 54) is located within the chamber (21 or 51) and is connected in fluid passage communication with the inlet port (25 or 56), the tube defining a fluid passageway (27 or 55) and extending upwardly through the chamber (21 or 51) to a level above the level of liquid which is, in use of the device, contained within the chamber (21 or 51),

a valve seat (29 or 58) is formed by an upper end portion of the tube (26 or 54), and

a valve member (30 or 59) is supported on the valve seat (29 or 58) and is displaceable therefrom to permit unidirectional flow of liquid into the chamber (21 or 51) from the fluid passageway (27 or 55).

## 2. A fluid flow control device comprising:

a housing (20 or 50) defining separate first and second chambers (21 and 22 or 51 and 52), and

an inlet port (25 or 56) located in the housing (20 or 50), the inlet port being connectable with a source (11) of liquid which, in use of the device, is induced to flow into the chamber (21 or 51);

characterised in that:

a first tube (26 or 54) is located within the



first chamber (21 or 51) and is connected in fluid passage communication with the inlet port (25 or 56), the first tube (26 or 54) defining a first fluid passageway (27 or 55) and extending upwardly through the first chamber (21 or 51) to a level above the level of liquid which is, in use of the device, contained within the first chamber (21 or 51),

a first valve seat (29 or 58) is formed by an upper end portion of the first tube (26 or 54) and a first valve member (30 or 59) is supported on said valve seat, the valve member (30 or 59) being displaceable from the valve seat (29 or 58) to permit unidirectional flow of liquid into the first chamber (21 or 51) from the first fluid passageway (27 or 55),

a second tube (37 or 60) is located within the second chamber (22 or 52) and is connected in fluid passage communication with a lower region of the first chamber (21 or 51), the second tube (37 or 60) defining a second fluid passageway (36 or 61) and extending upwardly through the second chamber (22 or 52) to a level above the level of liquid which is, in use of the device, contained within the second chamber (22 or 52),

a second valve seat (38 or 62) is formed by an upper end portion of the second tube (37 or 60) and a second valve member (39 or 63) supported on the second valve seat (38 or 62), the second valve member (39 or 63) being displaceable from the second valve seat (38 or 62) to permit uni-directional flow of liquid into the second chamber (22 or 52) from the second fluid passageway (36 or 61), and



an outlet port (42 or 69) is in the housing (20 or 50), the outlet port (42 or 69) being located in fluid passage communication with a lower region of the second chamber (22 or 52).

3. A device as claimed in claim 2 wherein the first and second chambers (21 and 22 or 51 and 52) are arranged one above the other.

4. A device as claimed in claim 2 wherein the first and second chambers (21 and 22 or 51 and 52) are disposed about respective vertically extending, spaced-apart, parallel axes.

5. A device as claimed in any one of the preceding claims wherein a control port (32) opens into the first chamber (21) at a level above the level of liquid which is, in use of the device, contained within such chamber, the control port (32) being connectable to a fluid pump (12) which, in use of the device, functions to apply alternating negative and positive pressurisation to the chamber (21).

6. A device as claimed in claim 4 wherein a third chamber (53) is located intermediate the first and second chambers (51 and 52), the third chamber (53) being connected in fluid passage communication with a lower region of the first chamber (51) and with the second fluid passageway (61).

7. A device as claimed in claim 6 wherein a control port (64) opens into the third chamber (53) at a level above the level of liquid which is, in use of the device, contained within the first and third chambers (51 and 53), the control port (64) being connectable to a fluid pump (12) which, in use of the device, functions to apply alternating negative and positive pressurisation to the third chamber.

8. A device as claimed in any one of the preceding claims wherein the or each valve seat (29, 38, 58 or

62) comprises a conical valve seat, and wherein the or each valve member (30, 39, 59 and 63) comprises a spherical valve member.

9. A device as claimed in claim 2 wherein each of the tubes (54 and 60) is located concentrically within the respective chamber (51 and 52).

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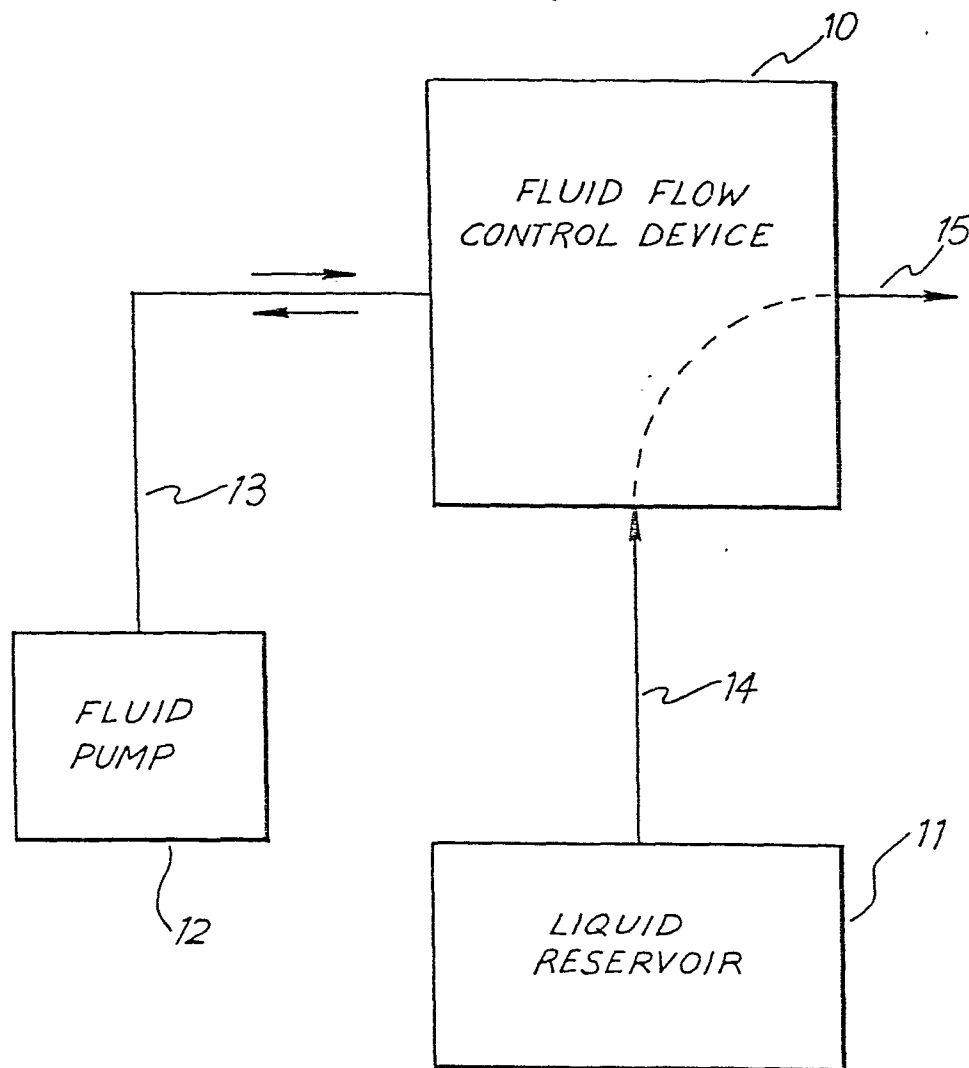
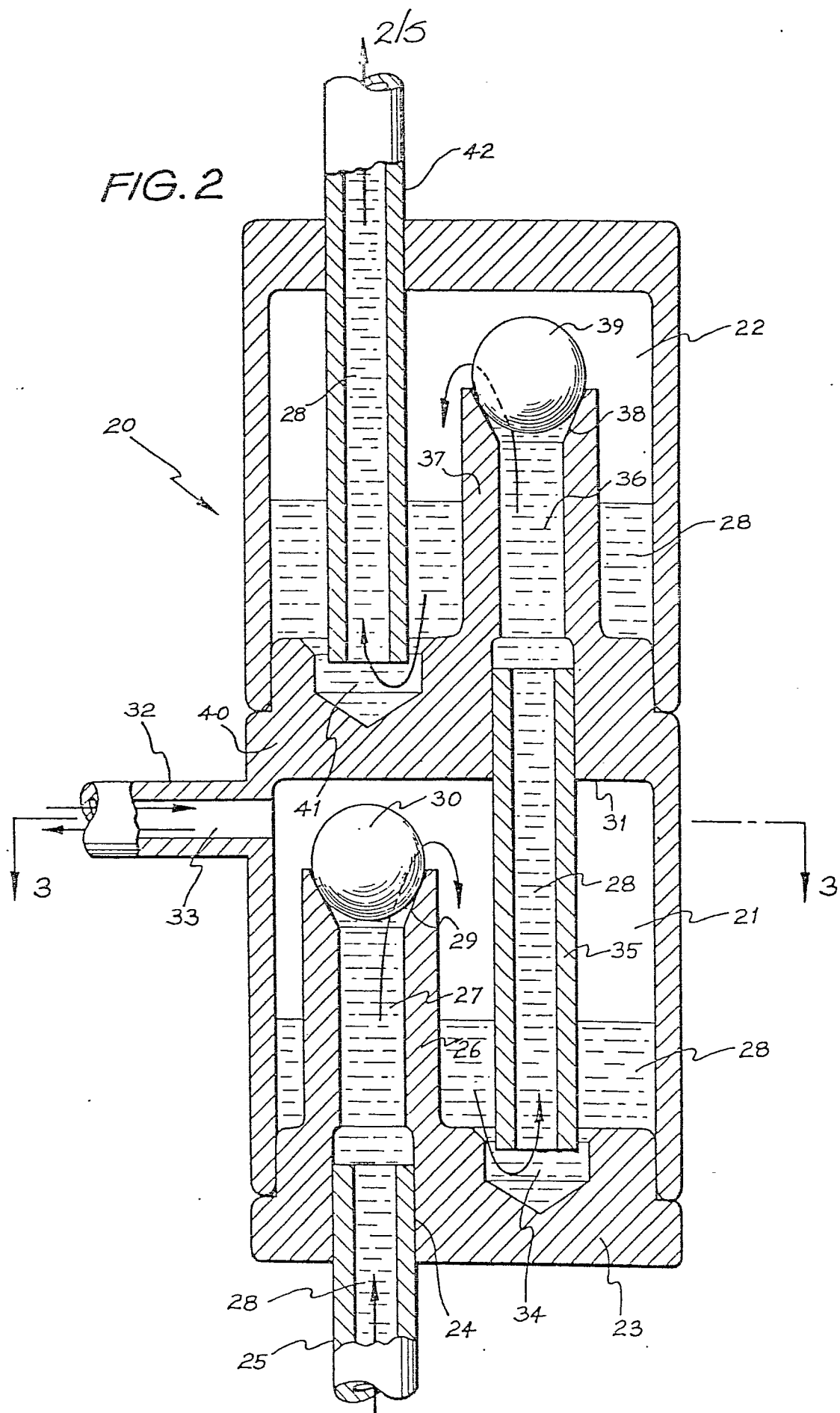


FIG. 1

FIG. 2



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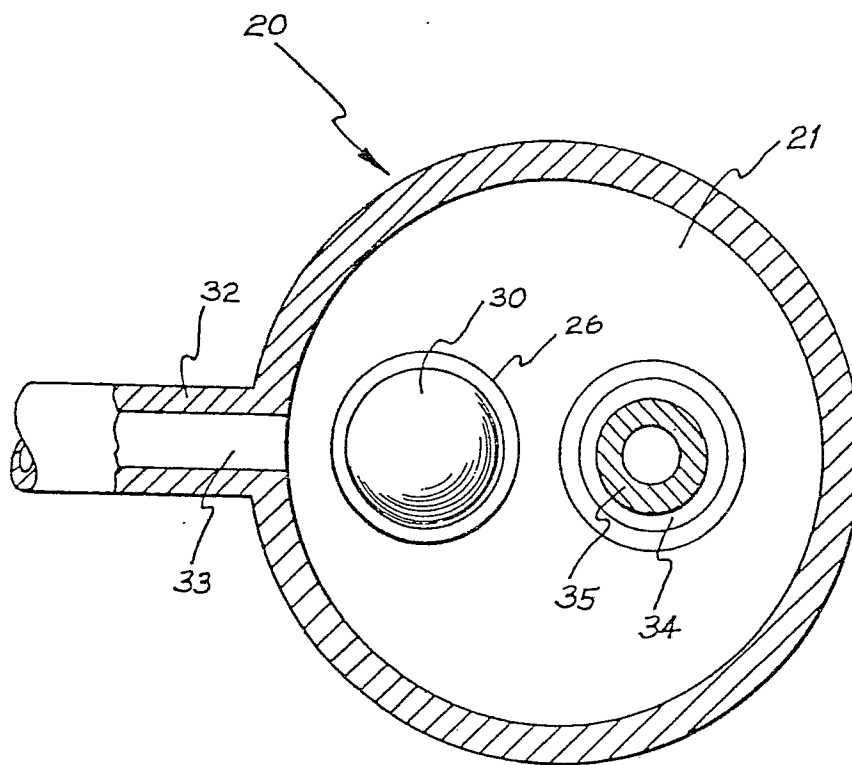
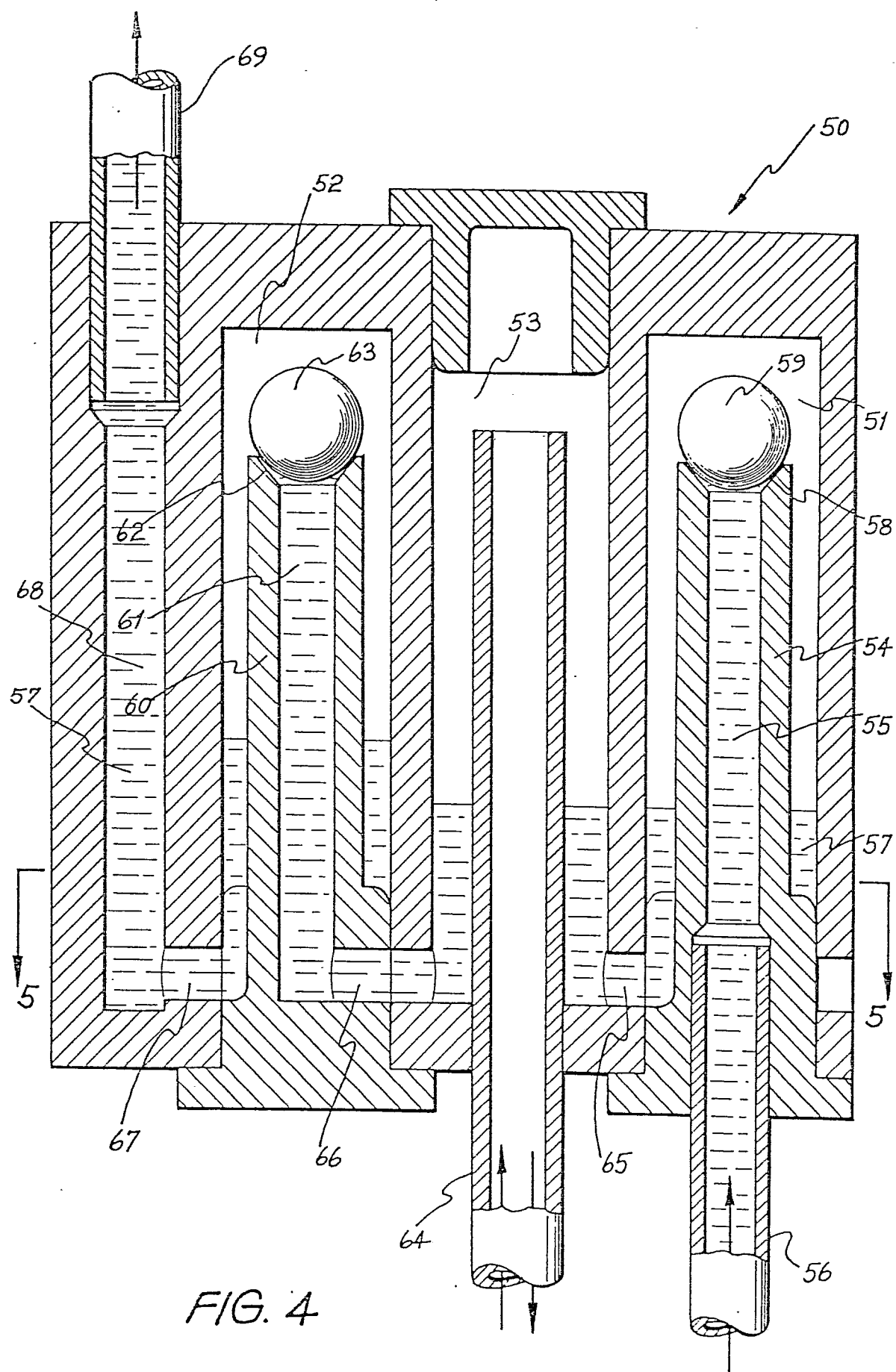


FIG. 3

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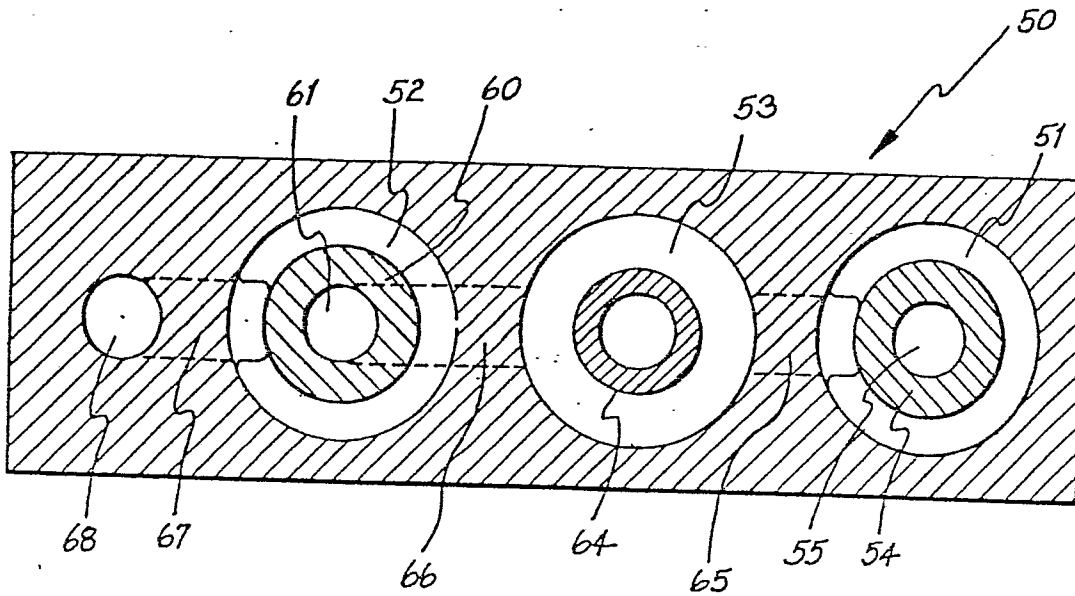


FIG. 5

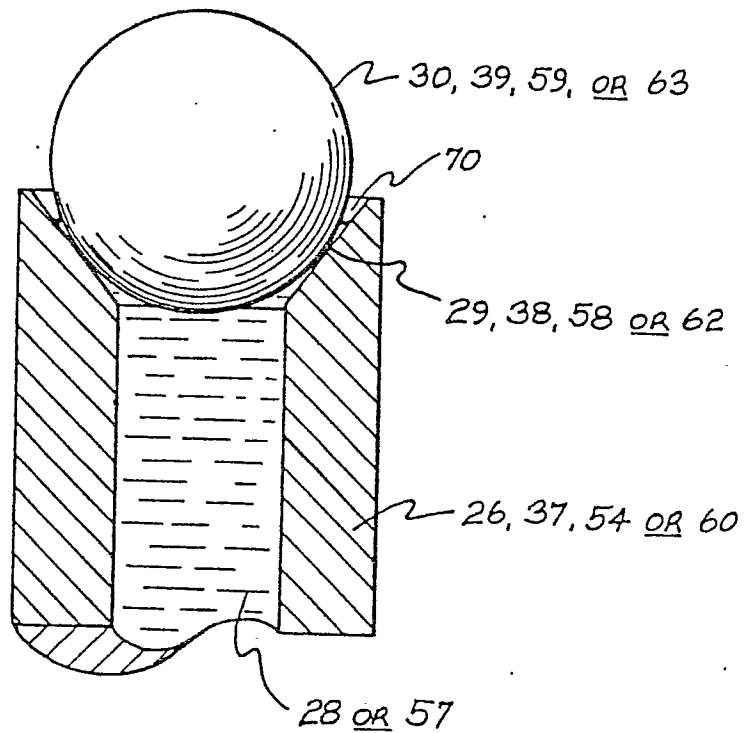


FIG. 6