

Dec. 9, 1969

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3,482,267

DISCHARGE VALVE, PARTICULARLY FOR WATER CLOSETS

Filed March 12, 1965

3 Sheets-Sheet 1

Fig. 1

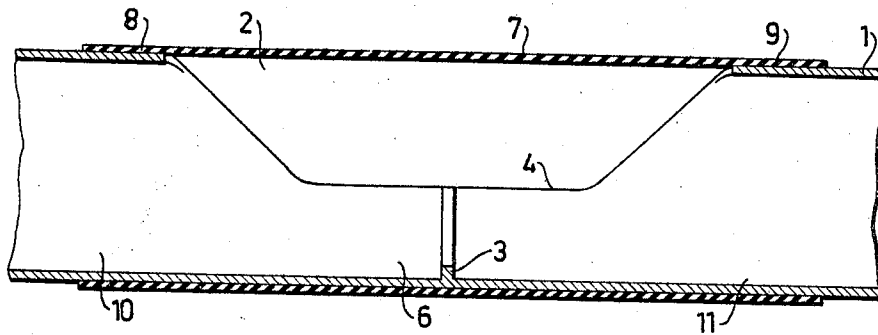


Fig. 2

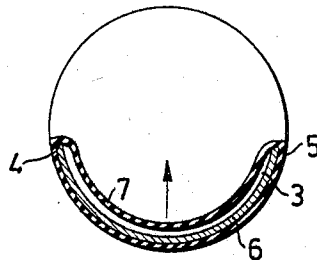
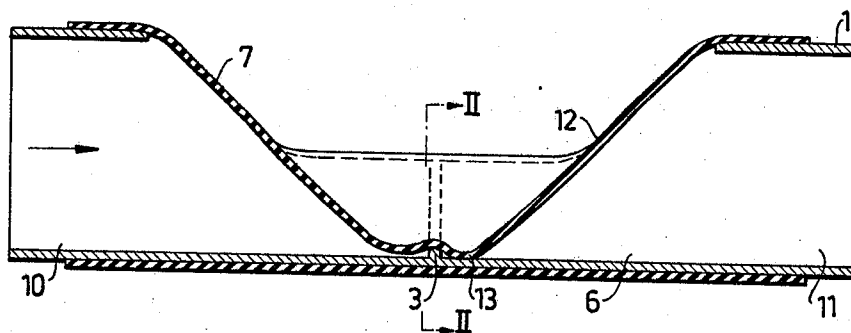


Fig. 3



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Fig. 4

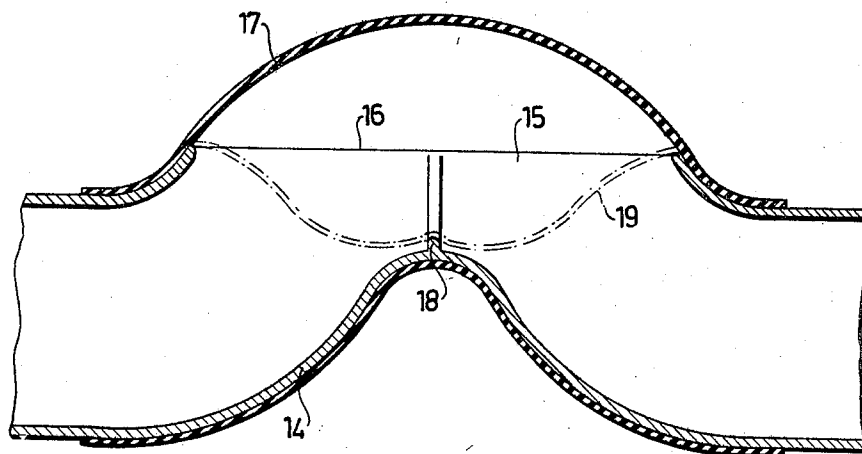
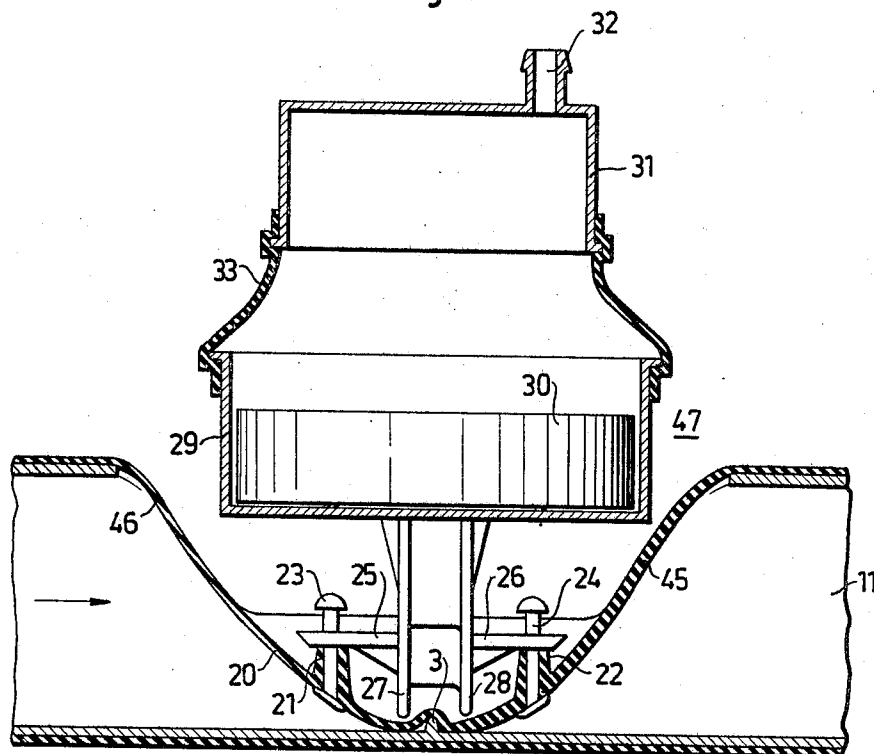


Fig. 5



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Fig. 6

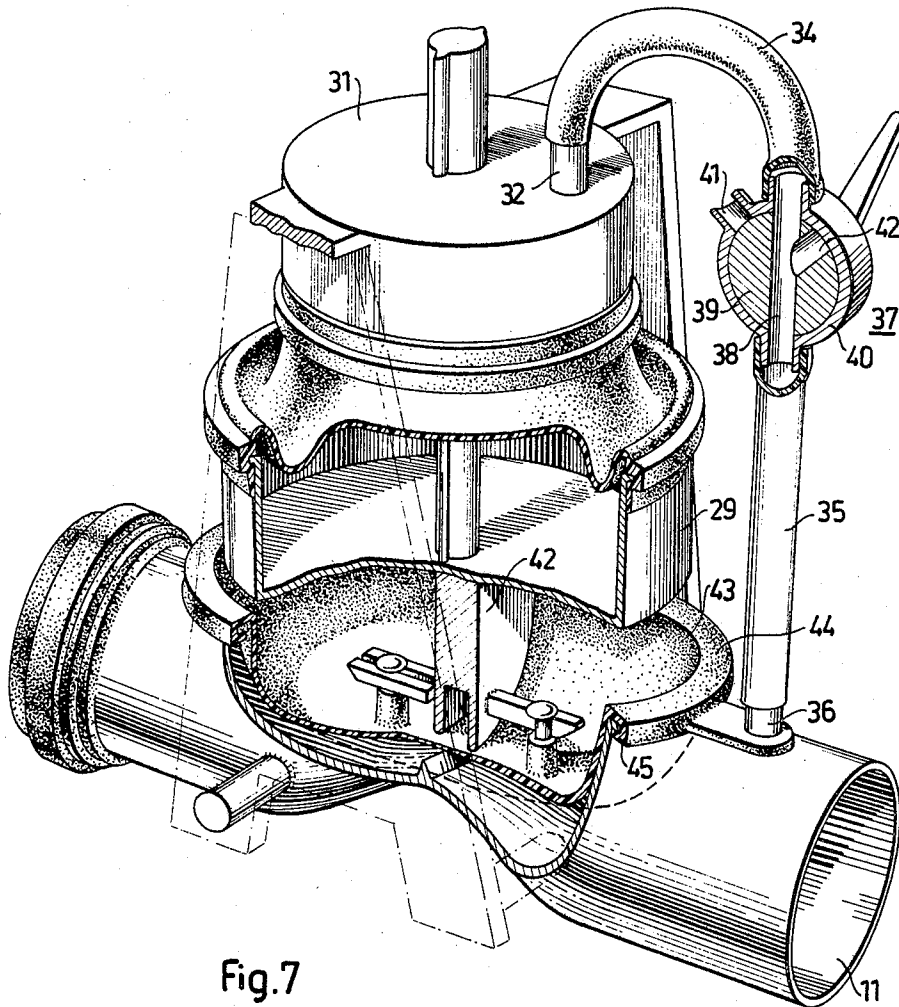
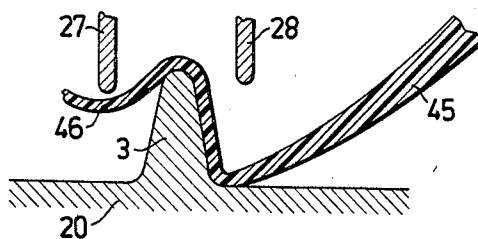


Fig. 7



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DISCHARGE VALVE, PARTICULARLY FOR WATER CLOSETS

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16 Claims

ABSTRACT OF THE DISCLOSURE

The present invention relates to discharge valves of the type wherein passage of fluid through said valve may be prevented by the movement of a resilient part of the wall of a pipe to a closing position against an opposed rigid wall portion, and wherein control means are adapted to act on said elastic wall portion to maintain it, when said valve is in a closed position, in sealing contact with said rigid wall portion, and when said valve is in an open position, to maintain said elastic portion in spaced relationship with said rigid wall portion.

An object of the present invention is to make possible the employment of valves of this kind in a field where up to now such valves have not been used. The valve according to the present invention is adapted to be fitted in the discharge conduit of a water closet bowl in the bottom portion of which a quantity of water is maintained by the valve being in its closed position, a vacuum or partial vacuum existing in the conduit and acting on the discharge side of the valve. The bowl of said water closet will be caused to discharge through said valve by the valve being opened, atmospheric pressure both driving the water through the discharge conduit and at the same time acting on the outside of the elastic wall portion in a closing direction.

According to this invention there is provided a valve for the discharge passage a water closet or the like, said valve comprising a pipe with an elastic wall portion and an opposed rigid wall portion, control means being adapted to act on said elastic wall portion to maintain it, when said valve is in a closed position substantially in sealing contact with said rigid wall portion, and when said valve is in an open position to maintain said elastic portion in spaced relationship with said rigid wall portion, wherein said valve when in its closed position maintains a head of water in said water closet or the like, and wherein said water is discharged by the valve being opened and by air pressure driving the water through the discharge conduit, said air pressure simultaneously acting on the outside of said elastic wall portion in a valve closing direction.

On account of the atmosphere having a higher pressure than the pressure in the discharge conduit and being permitted to act on the elastic wall portion in a closing direction, said portion, in the closed position of the valve, will surround tightly any solid objects on all sides that may have been left in the valve passage so that leakage inwardly into the conduit system of any large air quantities is prevented. Up to now this surprising effect has not been attainable in valves which have been used in installations of this type. It has also been possible to make the valve silent and very fast in operation, which latter property is of great importance in vacuum operated water closet installations of the Liljendahl system.

According to one feature of the invention said elastic wall portions and rigid wall portions may be so formed

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and dimensioned relatively to each other that when said valve is in an open position, air passing therethrough will be subjected to a drop in pressure and thus may cause the elastic portion to be drawn towards its closed position.

In order that the invention may be more readily understood, various embodiments thereof will now be described by way of example and with reference to the accompanying drawings in which FIGURE 1 is a diagrammatic illustration of a discharge pipe showing a valve, such pipe and valve being shown in longitudinal section;

FIGURE 2 is a cross sectional view taken along the line II-II in FIGURE 3.

FIGURE 3 shows the embodiment of FIGURE 1 but with the valve in a closed position.

FIGURE 4 is a longitudinal section of a modified embodiment of the invention.

FIGURE 5 shows diagrammatically as a longitudinal sectional view a further embodiment of valve including a switching device.

FIGURE 6 is a practical embodiment of valve shown in perspective and with certain parts cut away, and

FIGURE 7 is an enlarged fragmentary view of FIGURE 5.

In the embodiment illustrated by FIGURES 1 to 3 a metal pipe 1 is provided on its upper side with an aperture 2 extending down to the edges 4 and 5 of the pipe 1.

In the central portion of the aperture a ridge 3 is provided extending circumferentially around the inside of the pipe 1 between the two edges 4 and 5. The wall portion between said edges 4 and 5 defines a rigid wall portion 6. A rubber hose 7 of soft rubber is placed over the pipe 1, and is of sufficient length to extend over the aperture 2 with its two ends 8 and 9 in sealing engagement with the uncut portions of the pipe 1.

If a vacuum exists inside the pipe 1, and the air pressure acting on the outside of the hose 7 is atmospheric, then the hose will be pressed down forcibly to the position shown in FIGS. 2 and 3 in which it is in sealing engagement with the ridge 3 which forms part of a contact zone between the rubber hose 7 and the rigid wall portion 6. However, it is not necessary for the entire portion of the hose forming the elastic wall portion 7 to be exposed to the pressure differential between the atmospheric pressure and the vacuum in the pipe. Even if a slight reduction of pressure occurs between the inlet end 10 and the outlet end 11 of the pipe 1 the elastic wall portion 7 will be exposed to a certain downward suction. Said suction will cause the portion 7 to be drawn inwardly which in turn will increase the pressure differential. This will further increase the concavity of the elastic wall and the valve will be moved towards its closed position as shown in FIGURE 3 with an accelerating speed. When the valve is in its closed position, the pressure differential will act only on that part 12 of the elastic wall portion which is facing the outlet end 11 of the pipe 1, and force this part 12 to abut against the rigid wall portion 6 as shown at 13 at the downstream side of the ridge 3. On account of the elasticity of the rubber this part 12 will tightly enclose even solid objects, if any, which for some reason may have become lodged in the discharge conduit. A simple calculation shows that even if the vacuum at the outlet end 11 does not exceed one half of the atmospheric pressure, the total inward pressure on the wall part 12 will be considerable.

In order to increase the tendency of the elastic wall portion 7 to be sucked into its closed position, the pipe system connected with the outlet end 11 may have a slightly larger diameter than the pipe 1 at the valve whereby a drop of pressure will occur in the valve if air passes through the pipe.

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If the valve portion of the pipe is connected to a conduit system having a pipe area which is equal to or slightly smaller than the cross sectional area of the valve device, then a closing tendency can be induced by temporarily reducing the cross sectional area of the pipe on the inlet side 10, or by means of a downwardly directed member pressing the rubber hose downwardly whereby the accelerated closing process mentioned above is initiated.

If it is desirable to maintain a full passage area in the opened position of the valve, a smaller drop of pressure can be obtained in the opened position of the valve according to FIG. 4 by the pipe 14 being shaped as an inverted U whereby the rigid wall portion 15 can be defined by an even oval cutting edge 16 which is covered by the elastic wall portion 17. Hereby the ridge 18 will be in the topmost bottom part of the rigid wall portion 15. In its closed position the elastic wall portion will assume the position shown with dash dot lines at 19.

A device 47 adapted to positively cause the shifting movement and render the closing of the valve reliable and controllable can be provided as shown in principle in FIG. 5. In this figure the elastic wall portion 20 is provided with reinforcement ridges 21 and 22 in which lifting tags 23 and 24 are vulcanized. These tags are adapted to co-operate closely with extending bars 25, 26 which are fastened on two spades 27 and 28 of the switching device 47. One of the spades 27 engages the elastic wall portion 20 on the upstream side of the ridge 3. This spade is provided for ensuring that the valve can be brought into a closed position even when no vacuum exists at the outlet end 11 of the pipe 1 since it is still desirable to prevent the water in the water closet bowl from running out through the valve. The spades 27 and 28 have a semicircular operative edge, as shown at 42 in FIG. 6, which has a slightly smaller radius than the rigid wall portion 6 so that the spade can engage the elastic wall portion along the whole engagement edge and press said portion to sealing abutment with the inner side of the rigid wall portion. The spade 28 is provided at the downstream side of the ridge 3 and can have a slightly shorter radius than the spade 27. The spades 27 and 28 are fastened to the bottom of a cylindric vessel 29 in which a metal weight 30 is placed. A fixedly mounted inverted cylindric vessel 31 can be connected to a vacuum source or to the atmosphere via the pipe 32. The cylinders 29 and 31 are in airtight connection with each other by means of an annular resilient diaphragm 23, such as of rubber. The member 47 is caused to shift to its open position by connecting the pipe 32 to a vacuum source whereby the cylinder 29 and the weight 30 are lifted forcibly, and via the spades 27 and 28, the bars 25 and 26 and the tags 23 and 24, the elastic wall portion 20 is raised to its uppermost outwardly convex position as shown in FIGURE 1. This lifting movement must be carried out with sufficient force to overcome the downwardly acting force which may be exerted by the pressure differential between the surrounding air and the vacuum in the outlet end 11 of the pipe 1. In the closing process, air is introduced at atmospheric pressure through the pipe 32 whereby the member 27 immediately starts its closing movement assisted by the weight 30. If a vacuum exists in the portion of the pipe adjacent the outlet end 11, the closing movement will be accelerated as mentioned above.

In the embodiments described above, the ridges 3 and 18 have been shown extending at right angles to the longitudinal axis of the pipe. It is, of course, not necessary that the angle is a right angle but also smaller angles may be used provided that the necessary sealing contact can be secured.

In the embodiment illustrated by FIG. 6, the elastic wall portion is arranged as a separate rubber part with an edge ridge 44 which fits in air-tight engagement over an outwardly bent edge 45 around the aperture of the pipe.

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In the embodiment of FIG. 6, the pressure in the cylinder 31 can be varied by means of a coupling comprising a hose 34 connected to the pipe 32 and a hose 35 connected to a pipe 36 at the outlet end 11 of the pipe. Between the hoses 34 and 35 a two-way switch 37 is provided, which in one position, as shown in FIG. 6 connects the pipe on the down-stream side of the valve with the cylinder 31 via the hoses 35 and 34 and a duct 38 causing the pressure in the cylinder 31 to decrease rapidly. If the disc 39 of the switch 37 is rotated 90° counterclockwise from its position in FIG. 6 the bottom end of the duct 38 will then be closed against the housing 40 while the opposite end of the duct will be connected with a port 41 in free communication with the atmosphere. Air will then flow through the ducts 38 and 42 and through the hose 34 and the pipe 32 into the cylinder 31 causing the pressure in the cylinder 31 to increase and thus the cylinder 29 will move downwardly.

Particularly, in the case, where a valve is intended for controlling the discharge of water from a water closet by means of vacuum in the discharge pipe it is very desirable that the valve can be opened sufficiently rapidly to prevent any appreciable amount of water passing the valve before it has been completely opened. This is in practice not difficult, since the vacuum is normally completely built up on the downstream side of the valve and the switching speed of the arrangement depends on, inter alia the flow area of the hoses 34 and 35 and the duct 38, and, of course, the valve of the vacuum. The water quantity on the upstream side has an inertia which depends mainly on the length of the water between its surface in the water closet bowl and the closing point of the valve. By arranging the pneumatic properties of the valve arrangement relative to the inertia of the water quantity cut off by the valve it is possible to ascertain that the opening speed of the valve is sufficiently high and its opening position suitable for the above conditions to be fulfilled.

In the embodiment shown in FIGURE 6 the lifting tags 23 and 24 are identical and placed substantially symmetrically relative the ridge 3. Under certain conditions it can be preferable instead to make the arrangement asymmetric, i.e., by making the play between the tags 23, 24 and the bars 25, 26 different on opposite sides and/or to place the tags with the ridges 21, 22 differentially spaced from a plane through the ridge 3 and/or making the tags of different length. By any of these methods the initiation process at opening movement of the valve can be controlled.

When the valve as shown in FIGURE 6 is closed and a vacuum exists on its downstream side, the elastic wall portion in a zone 45 at the downstream side is exposed to the differential between the atmospheric pressure and the vacuum and, consequently, the material must be dimensioned accordingly so that no disadvantage occurs if the rubber here is slightly thicker and/or stiffer from strength requirements. On the other side, the pressure differential, if any, on the elastic wall portion in the zone 46 at the upstream side is not substantial. Partly, for these reasons, and partly on account of the desirability of any solid objects in the discharge being tightly enclosed by the zone 46 of the wall portion this zone must be made considerably thinner and more flexible than in the zone 45 and this should be the case both upstream the contact zone and within said zone.

In order to ensure that any solid objects, e.g., a string, a pin, a rag or the like, which may have stuck in the valve passage are effectively closed by the elastic wall in its closing position, special provisions must be made. Consequently, as illustrated in FIGURE 7 the edges of the two spades 27 and 28 in the closed position of the valve are spaced from the rigid wall portion 20 and from the ridge 3 so that the elastic wall portion 46 is not pressed tightly against the ridge 3 or against the portion 20 of the pipe.

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As shown in FIGURE 7 the portion of the elastic wall portion which is over and immediately downstream the ridge 3 is pressed by the pressure differential between the atmospheric pressure and the vacuum in the pipe 11 to sealing abutment with the ridge, tightly enclosing any solid objects in this position.

What I claim is:

1. A liquid passageway valving arrangement comprising:

- (a) a pipe section including,
 - (1) inlet and outlet ends,
 - (2) an elastic wall portion intermediate said inlet and outlet ends having an interior side that is at least periodically subjected to subatmospheric pressure and an exterior side that is subjected to the force of atmospheric pressure, and
 - (3) a substantially rigid wall portion intermediate said inlet and outlet ends and disposed opposite to said elastic wall portion;
- (b) a source of subatmospheric pressure operatively connected to the outlet side of said pipe;
- (c) lifting means operatively coupled to said elastic wall portion by coupling means for moving said elastic wall portion from
 - (1) a first position wherein a section of the elastic wall portion is sucked against said rigid wall portion so as to restrict liquid flow, to
 - (2) a second position wherein the elastic wall portion is at least partially spaced away from said rigid wall portion so as to provide more open communication between the inlet and outlet ends of said pipe section,
- said lifting means being responsive to a pressure differential,
- said coupling means being attached to said elastic wall portion in such a way that in said first (closed) position the section of the elastic wall portion that is being sucked against said rigid wall portion is attached to the coupling means in a sufficiently loose manner that the elastic wall portion has freedom to take up different shapes in its closed position and thus be capable of surrounding any solid object that may have been left in the valve passageway, and
- (d) means operatively coupling and uncoupling the outlet side of said pipe to said lifting means for selective intermittent communication of said pipe with said lifting means so as to intermittently establish a pressure differential which can be used to move said elastic wall portion to said second position,
- whereby
 - when said elastic wall portion is in its aforesaid first position it presses against said rigid wall portion so as to maintain a head of liquid on inlet side of said pipe, and leakage is prevented, and
 - when said elastic wall portion is in its aforesaid second position it is spaced away from said rigid wall portion so that any liquid on the inlet side of said pipe can be discharged toward the outlet side of said pipe by virtue of the intermittent pressure differential between the inlet and outlet ends of said pipe.

2. A valving arrangement according to claim 1 wherein said elastic wall portion and said rigid wall portion define between them a flow passage when said elastic wall portion is moved to said second position, said flow passage being smaller in size than the cross sectional area of the pipe on the outlet side of said elastic wall portion so that when said elastic wall portion is in said second position, any air passing therethrough will be subjected to a drop in pressure which will in turn cause the elastic wall portion to close toward its said first position.

3. A valving arrangement as recited in claim 1 wherein the rigid wall portion, adjacent its area of contact with said elastic wall portion includes an inwardly extending

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ridge which is disposed at an angle to the direction of flow.

4. A valving arrangement as recited in claim 1 wherein said lifting means includes a piston operatively connected to said elastic wall portion, said piston having a first surface in contact with atmospheric pressure and a second surface in selective intermittent communication with the subatmospheric pressure created in said pipe, said piston being moved by atmospheric pressure to open said elastic wall portion to said second position when said second surface of said piston is placed in communication with the subatmospheric pressure in the pipe.

5. A valving arrangement as recited in claim 4 wherein said piston is movable with respect to a chamber, said chamber including a flexible wall portion operatively connected to said piston, said flexible wall portion permitting reciprocal displacement of said piston with respect to said chamber, said chamber being in selective intermittent communication with said pipe on the outlet side of said elastic wall portion.

6. A valving arrangement as recited in claim 1 wherein the elastic wall portion is provided with two zones of different thickness and elasticity, the zone comprising the thicker and stiffer material substantially forming the elastic wall portion on the downstream side of the area of contact between the rigid and elastic walls and the zone comprising the thinner and more resilient material forming the elastic wall portion on the upstream side of said contact position.

7. A liquid passageway valving arrangement comprising:

- (a) a pipe section including,
 - (1) inlet and outlet ends,
 - (2) an elastic wall portion intermediate said inlet and outlet ends having an interior side that is at least periodically subjected to subatmospheric pressure and an exterior side that is subjected to the force of atmospheric pressure, and
 - (3) a substantially rigid wall portion intermediate said inlet and outlet ends and disposed opposite to said elastic wall portion;
- (b) a source of subatmospheric pressure operatively connected to the outlet side of said pipe;
- (c) holding means operatively associated with the exterior side of said elastic wall portion for holding said elastic wall portion adjacent sealing engagement with said rigid wall portion,
- (d) lifting means operatively coupled to said elastic wall portion by coupling means for moving said elastic wall portion and said holding means from
 - (1) a first position wherein the elastic wall portion contacts said rigid wall portion so as to restrict liquid flow, to
 - (2) a second position wherein the elastic wall portion is at least partially spaced away from said rigid wall portion so as to provide more open communication between the inlet and outlet ends of said pipe section,
- said lifting means being responsive to a pressure differential,
- said coupling means being attached to said elastic wall portion in such a way that in said first (closed) position, the section of the elastic wall portion that is being sucked against said rigid wall portion is attached to the coupling means in a sufficiently loose manner that the elastic wall portion has freedom to take up different shapes in its closed position and thus be capable of surrounding any solid object that may have been left in the valve passageway, and
- (e) means operatively coupling and uncoupling the outlet side of said pipe to said lifting means for selective intermittent communication of said pipe with said lifting means so as to intermittently establish a pressure differential which can be used to move said elastic wall portion to said second position,

whereby

when said elastic wall portion is in its aforesaid first position it presses against said rigid wall portion so as to maintain a head of liquid on inlet side of said pipe, and leakage is prevented, and

and when said elastic wall portion is in its aforesaid second position it is spaced away from said rigid wall portion so that any liquid on the inlet side of said pipe can be discharged toward the outlet side of said pipe by virtue of the intermittent pressure differential between the inlet and outlet ends of said pipe.

8. A valving arrangement according to claim 7 wherein said elastic wall portion and said rigid wall portion define between them a flow passage when said elastic wall portion is moved to said second position, said flow passage being smaller in size than the cross sectional area of the pipe on the outlet side of said elastic wall portion so that when said elastic wall portion is in said second position, any air passing therethrough will be subjected to a drop in pressure which will in turn cause the elastic wall portion to close toward its said first position.

9. A valving arrangement as recited in claim 7 wherein the rigid wall portion, adjacent its area of contact with the interior side of said elastic wall portion includes an inwardly extending ridge which is disposed at an angle to the direction of flow.

10. A valving arrangement as recited in claim 7 wherein said holding means includes a pair of spaced spades which are adapted to press downwardly along the opposed sides of said ridge and thereby force the elastic wall portion into contact with said ridge.

11. A valving arrangement as recited in claim 7 wherein said lifting means includes a piston operatively connected to said elastic wall portion, said piston having a first surface in contact with atmospheric pressure and a second surface in selective intermittent communication with the subatmospheric pressure created in said pipe, said piston being moved by atmospheric pressure to open said elastic wall portion to said second position when said second surface of said piston is placed in communication with the subatmospheric pressure in the pipe.

12. A valving arrangement as recited in claim 7 wherein said rigid wall portion adjacent its area of contact with the interior side of said elastic wall portion includes an inwardly extending ridge which is disposed at an angle to the direction of flow, and said holding means includes a pair of spaced spades which are adapted to press downwardly along the opposite sides of said ridge and thereby force the elastic wall portion into contact with said ridge.

13. A valving arrangement as recited in claim 7 wherein said piston is movable with respect to a chamber, said chamber including a flexible wall portion operatively connected to said piston, said flexible wall portion permitting reciprocal displacement of said piston with respect to said chamber, said chamber being in selective intermittent communication with said pipe on the outlet side of said elastic wall portion.

14. A valving arrangement as recited in claim 11 wherein said surfaces of said piston exposed to said pressure differential are dimensioned relative to the dimension of said elastic wall portion to permit said piston to overcome the pressure differential on said elastic wall portion as well as the holding force exerted by said holding means to move said elastic wall portion from a closed first position to said open second position by the force exerted by pressure differential created with the subatmospheric pressure on the outlet side of said elastic wall portion.

15. A valving arrangement as recited in claim 7 wherein the elastic wall portion is provided with two zones of different thickness and elasticity, the zone comprising the thicker and stiffer material substantially forming the elastic wall portion on the downstream side of the area of contact between the rigid and elastic walls and the zone comprising the thinner and more resilient material forming the elastic wall portion on the upstream side of said contact position.

16. A controlled discharge water closet arrangement comprising:

- (a) a water closet bowl,
- (b) a pipe defining a discharge passageway operatively connected to said bowl,
 - (1) said pipe having inlet and outlet ends,
 - (2) an elastic wall portion intermediate said inlet and outlet ends having an interior side that is at least periodically subjected to subatmospheric pressure and an exterior side that is subjected to the force of atmospheric pressure, and
 - (3) a substantially rigid wall portion intermediate said inlet and outlet ends and disposed opposite to said elastic wall portion;
- (c) a source of subatmospheric pressure operatively connected to the outlet side of said pipe;
- (d) lifting means operatively coupled to said elastic wall portion for moving said elastic wall portion
 - (1) from a first position wherein the elastic wall portion contracts said rigid wall portion so as to restrict liquid flow from said water closet bowl, to
 - (2) a second position wherein the elastic wall portion is at least partially spaced away from said rigid wall portion so as to permit flow of a slug of liquid from said water closet bowl,
 said lifting means being responsive to a pressure differential,
- (e) means for operatively coupling and uncoupling the outlet side of said pipe to said lifting means for selective intermittent communication of said pipe with said lifting means so as to intermittently establish a pressure differential which can be used to move said elastic wall portion to said second position,

whereby

when said elastic wall portion is in its aforesaid first position it presses against said rigid wall portion so as to maintain a head of liquid in the discharge passageway of said water closet bowl, and leakage is prevented, and

when said elastic wall portion is in its aforesaid second position it is spaced away from said rigid wall portion so that a slug of liquid can be discharged from said water closet bowl by virtue of the intermittent pressure differential between the inlet and outlet ends of said pipe.

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RICHARD GERARD, Assistant Examiner

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