

Nov. 22, 1966

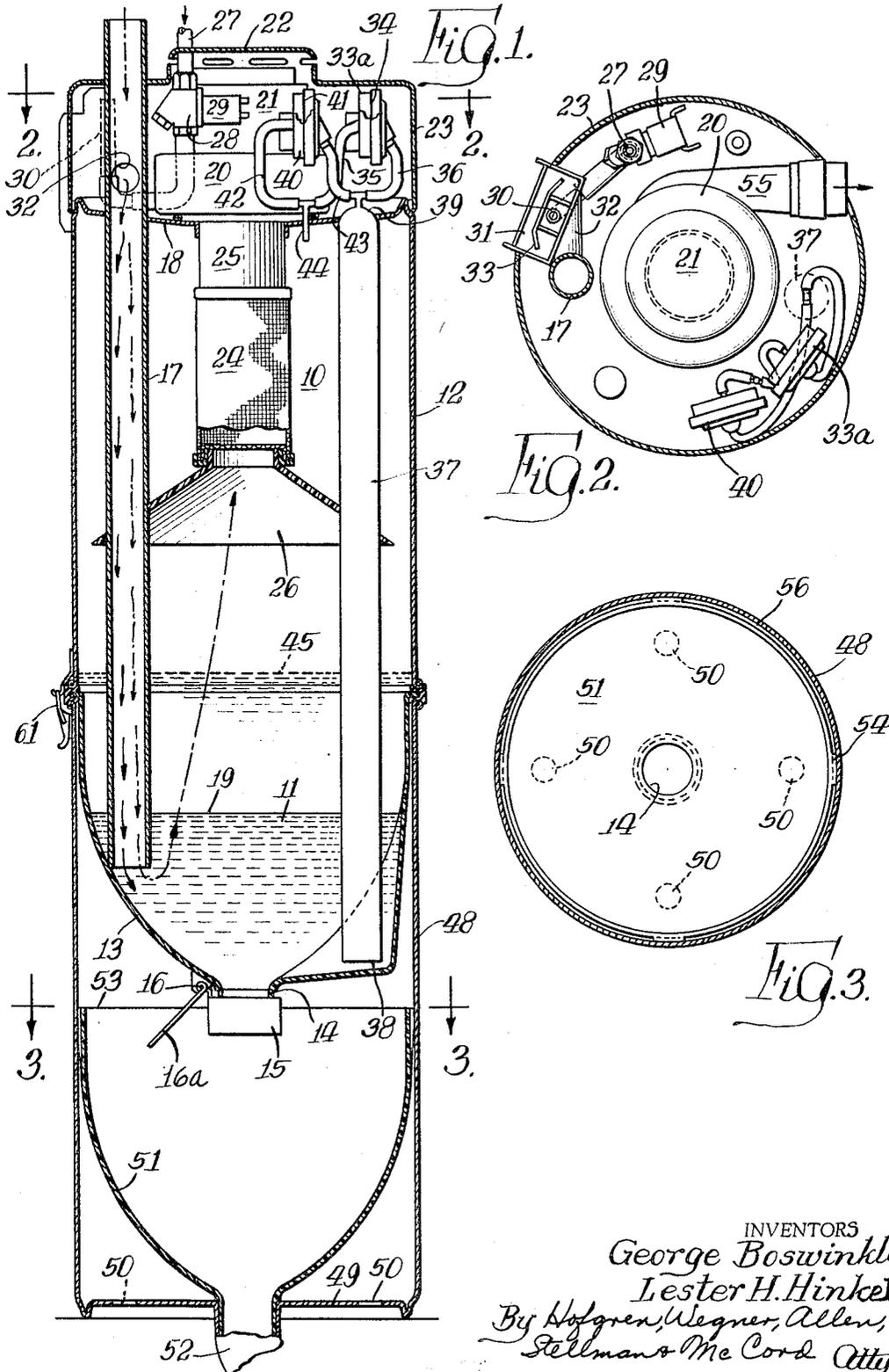
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3,286,444

VACUUM CLEANER

Filed Dec. 30, 1964

2 Sheets-Sheet 1



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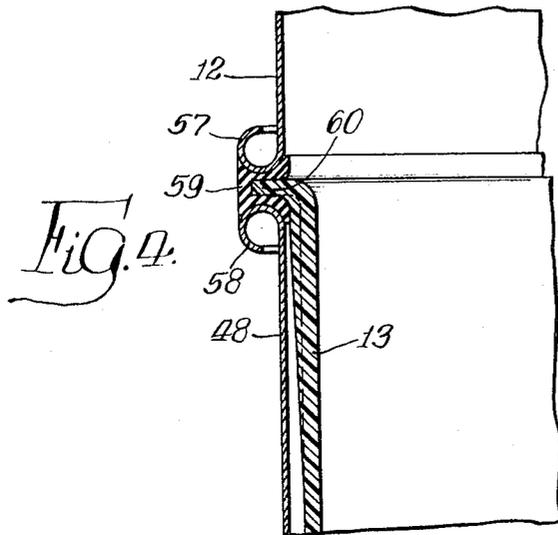
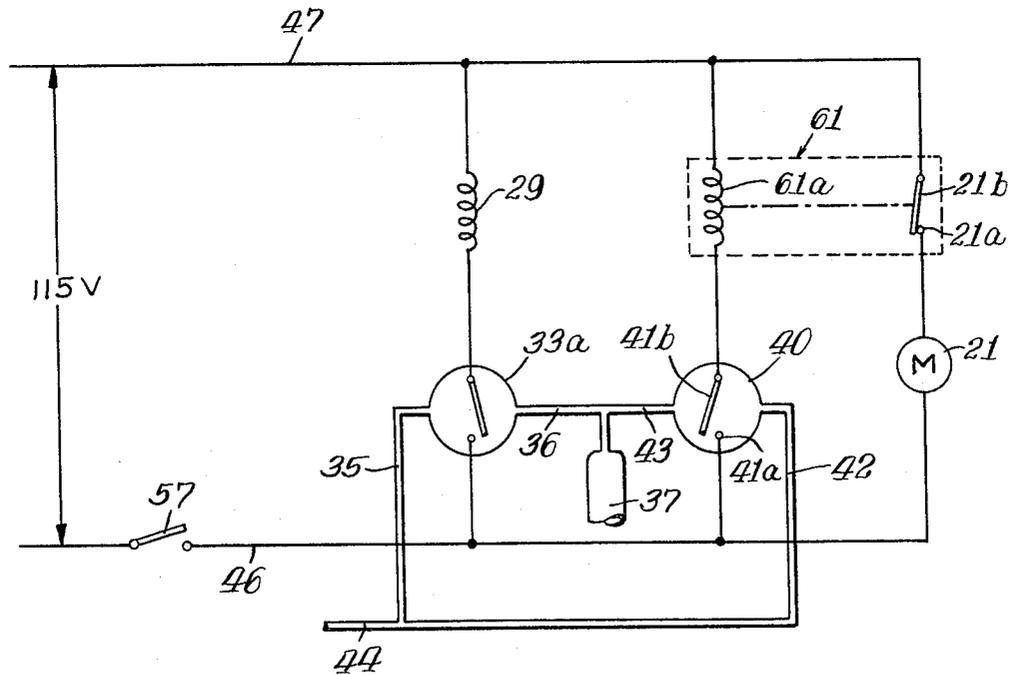


Fig. 5.



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VACUUM CLEANER

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Filed Dec. 30, 1964, Ser. No. 422,190

5 Claims. (Cl. 55—215)

This invention relates to a device for separating solids from fluids and relates particularly to a vacuum cleaner apparatus having a central location for removing dust and the like from a flowing air stream.

A vacuum cleaner of the type that is the subject of the present invention is disclosed and claimed in the copending application of G. L. Congdon Serial No. 29,991, filed May 18, 1960, and now Patent 3,173,164, assigned to the same assignee as the present application. This type of cleaner employs a separating chamber adapted to contain solids entrapping liquid, means for supplying liquid to the separating chamber, a conduit for air carrying entrained solids for entrapment by the liquid and liquid supply means for supplying liquid to the chamber to raise the liquid level therein.

One of the features of the present invention is to provide improved means for controlling the liquid level in the separating chamber by sensing the differential pressure between the pressure in the chamber and the pressure caused by the liquid level in a pressure dome means.

Another feature of the invention is to provide improved means for limiting the maximum liquid level in the chamber.

A further feature of the invention is to provide improved drain means for the liquid in the chamber that employs an improved safety feature to prevent backflow of liquid in the drain means from entering the separating chamber.

Other features and advantages of the invention will be apparent from the following description of one embodiment thereof taken in conjunction with the accompanying drawings. Of the drawings:

FIGURE 1 is a longitudinal sectional view through a vacuum cleaner apparatus embodying the invention.

FIGURE 2 is a horizontal sectional view taken substantially along the line 2-2 of FIGURE 1.

FIGURE 3 is a horizontal sectional view taken substantially along the line 3-3 of FIGURE 1.

FIGURE 4 is a fragmentary enlarged vertical sectional view through a portion of FIGURE 1.

FIGURE 5 is a wiring diagram for this embodiment.

In the embodiment illustrated in the accompanying drawings there is provided a vertical cylindrical separating chamber 10 adapted to contain a liquid 11 which is customarily water. The separating chamber 10 comprises an upper vertical cylindrical housing 12 and a depending bowl-shaped portion 13 having an exit opening 14 in the bottom thereof.

This exit opening 14 is normally closed, when the pressure in chamber 10 is lower than atmospheric, by a hinged counterweighted closure 15 hinged as indicated at 16 beyond which extends the counterweight 16a. The closure 15 is so arranged that when the pressure in the interior of the chamber 10 is sub-atmospheric external atmospheric pressure is sufficient to hold the closure 15 closed as shown in FIGURE 1 against the weight of liquid 11. However, when the sub-atmospheric pressure in the chamber 10 approaches atmospheric pressure, the weight of water 11 is sufficient to force the closure 15 open around its hinge 16. A closure of this same general type is illustrated at 40 in the above-mentioned prior patent.

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An air conduit or pipe 17 leads through the top 18 of the chamber 10 to adjacent the bottom of the bowl 13. This pipe extends to beneath the first or normal water level 19 so that air flowing through the pipe 17, as indicated by the arrows in FIGURE 1, will be bubbled through the water 11 to remove entrained solids from the air.

Suction is created within the separating chamber 10 by means of an ordinary suction fan 20 located above the chamber top 18 and operated by a customary electric motor 21. Ventilating means for the motor 21 is provided by the perforated top 22 of the casing 23 that serves as an upper extension of the housing 12 and that surrounds the fan 20 and motor 21.

The fan 20 draws air, as indicated by the arrows in FIGURE 1, with the air entering the fan 20 by way of a cylindrical screen 24 attached to a depending air pipe 25. Extending downwardly from the screen 24 is a conical baffle 26 preferably made of a rigid plastic material which aids in preventing water 11 from splashing to the upper regions of the apparatus when agitated by incoming air.

The cylindrical screen 24 functions as a safety screen to prevent entrance of large particles into the fan or blower 20.

Water is supplied to the bottom of the housing 12 through a water pipe 27 controlled by a valve 28 operated by an electrical solenoid 29. When the valve is in open position, water is supplied to the interior of the air pipe 17 in essentially the same manner as is disclosed in the above-mentioned patent, that is, the water flows upwardly from a top opening pipe 30 and falls into a trough 31 and from there through a short pipe 32 into the incoming air pipe 17. As in the prior patent, this provides an air gap between the incoming water pipe 30 and the air pipe 17 so that reverse flow in the air pipe 17 will not draw the dirty water from the bottom of the housing 12 into the water supply. Also, as in the prior patent identified above, a splash guard 33 is provided surrounding the inlet pipe 30 to confine all of the water leaving the pipe 30 to the trough 31.

When water enters the bottom of the housing 12 by way of the water pipes 27 and 30 and air pipe 17 atmospheric pressure acting upwardly on closure 15 prevents the weight of the water, as indicated at 11, from forcing the closure 15 open. With the rising water level in the chamber 10 the pressure of air in air dome means 37 increases. Means are provided for utilizing this increasing pressure to stop the water flow after a preselected amount. This means in the illustrated embodiment comprises a pressure differential switch 33a in the electrical circuit to the solenoid 29.

In the illustrated embodiment the pressure switch 33a is provided with a movable diaphragm identified at 34 in the broken-away portion of the switch 33a in FIGURE 1. One side of this diaphragm is exposed by way of a pipe 35 to the pressure in the separating chamber 10. The other side of this diaphragm 34 is exposed by way of a pipe 36 to the interior of the air dome means 37 in the form of a vertical tube having an open lower end 38 immersed in the water 11 and adjacent the bottom of the bowl 13 and a closed upper end 39. As the level of the water 11 rises in the housing 12, this level also rises in the tube 37 with the effect that the air pressure within the tube is thereby increased. Thus, with the rising water level the pressure differential across the diaphragm 34 increases, since the pressure in chamber 10 is substantially constant while the air pressure within the tube 37 is increasing. This results in the water level 19 being held to the precise preselected level (or value), for example, 3 gallons.

A second pressure switch 40 similar to the first switch 33 is also provided. This second switch 40 also includes a movable diaphragm 41 shown at the broken-away portion of the switch in FIGURE 1 with one side of this diaphragm 41 being exposed to the interior of the chamber 10 by way of a pipe 42 and the other side of the diaphragm 41 being exposed to the interior of air dome means tube 37 by a pipe 43. As shown in FIGURE 1, the pipes 35 and 42 are joined in a depending T 44, while the pipes 36 and 43 are also joined at the top of air dome means 37.

As stated earlier, the first pressure switch 33a operates to shut off the water valve 28 when the water level has reached a predetermined first value, as indicated at 19. In a typical embodiment of the invention this amount of water is about 3 gallons. The second pressure switch 40 operates as a safety switch to shut off power to the motor 21 and thus stop the suction blower 20 when water at the bottom of the chamber 10 has reached a second higher preselected level indicated at 45. Again, in a typical embodiment of the invention this second level 45 is equivalent to about 6 gallons of water in the bottom of the chamber 10.

As shown in FIGURE 5, the water level switch 33a is connected in electrical circuit to the solenoid 29 of the valve 28 and across electrical supply lines 46 and 47. The second or safety switch 40 is electrically connected to the motor 20 and also across the supply lines 46 and 47. As can be seen in FIGURE 5, the electrical connections are purely conventional.

Positioned beneath the housing 12 and operating as an extension thereof is a second cylindrical housing 48. This housing is provided with a bottom 49 containing spaced openings 50, here shown as four. Located within the housing 48 beneath the exit 14 from the chamber 10 is a bowl-shaped receptacle 51 having a bottom exhausting through the housing bottom 49 to a drain conduit 52. The receptacle 51 has an upper overflow edge 53 located at a level lower than the bottom of the exit conduit 14. The edge 53 of receptacle 51 is spaced from the interior surface of the housing 48 by a plurality, here shown as four, of spacing lugs 54.

The bottom of the housing 12 is releasably attached to the top of the housing 48, each of which is provided with a bead 57 and 58, respectively. As is shown most clearly in FIGURE 4 there is provided between these beads a resilient rubber gasket 59 in which is embedded the outwardly extending annular edge 60 of the bottom bowl-shaped portion 13 that receives the water 11. The two beads 57 and 58 when in assembled relationship, as shown in the drawings, are clamped toward each other with the gasket 59 therebetween as by spaced clamps 61.

During operation of the apparatus of this invention the motor 21 receives its power from the lines 46 and 47 and is thereby energized to operate the fan or blower 20. This blower draws air from the chamber 10 and exhausts it from the apparatus through an exhaust conduit 55. The lower than atmospheric pressure thereby created in the chamber 10 draws air and entrained solids through the air conduit 18 to entrap these solids which may be dust, dirt and other solid particles in the water.

At the same time that the motor 21 is energized, the solenoid 29 is also energized to open the valve 28. Water then flows in the manner previously described from the pipe 27 through the valve 28, out the pipe 30 into the trough 31 and through the pipe 32 into the air conduit 17. The portion of the air conduit 17 beneath the pipe 32 thereupon serves to convey water to the bottom of the housing 12.

As the level of the water 11 rises from the bottom of the bowl portion 13 toward the preselected level 19 water in tube 37 also rises and thus the air pressure in the tube 37 rises. At a preselected differential pressure between chamber 10 and air dome 37, which corresponds to the water level 19, the diaphragm 34 moves sufficiently to

separate the customary electrical contact points of switch 33a (FIGURE 5) and break the circuit to the solenoid 29, thereby closing the valve 28 and stopping the water flow. The motor 21 continues to operate the blower 20 to maintain the lower than atmospheric pressure in the space 10 and the air flow through the conduit 17. The reduced pressure in chamber 10 is sufficient to allow atmospheric pressure to close closure member 15 and maintain it closed against the weight of water 11. Therefore, the water will not be dumped until the pressure in chamber 10 is sufficiently high to allow the weight of water 11 to overcome the force exerted on closure 15 by atmospheric pressure. Such a condition occurs when motor 21 is de-energized.

In the event the air suction is used to suck up water, as after washing a floor, or in the event of malfunction in the water control valve 29, the water level 19 will of course continue to rise. As soon as it has risen to a second preselected level, as indicated at 45 in FIGURE 1, the second or safety switch 40 goes into operation. While the water level is rising from 19 to 45, the air pressure within the tube 37 also continues to increase because of the rising water level in this tube entrapping and compressing the air above it. At a preselected value the diaphragm 41 of the safety switch 40 is moved to close its electrical contacts 41a and 41b (FIGURE 5) to energize coil 61a of relay 61 which opens contacts 21a and 21b of the electrical circuit to the motor 21. This immediately stops the blower 20 and allows the pressure in chamber 10 to return to atmospheric, whereupon the weight of the water 11 is then sufficient to displace the closure 15 and dump the water 11 into the receptacle 51 for flow out the drain conduit 52. When approximately 3 gallons of water has been dumped or when the water falls to level 19, contacts 41a and 41b in safety switch 40 open to de-energize coil 61a of relay 61. De-energization of coil 61a closes contacts 21a and 21b, energizing motor 21 of blower 20. A subatmospheric pressure is then re-established in chamber 10 and closure 15 closes, sealing opening 14 whereupon normal operation is resumed.

As described in the above-identified prior patent, any interruption in the vacuum cleaning operation will also stop the motor 21 and dump the water 11. Such a condition would occur if line switch 57 is opened, for example, at the end of use.

In the event liquid should backflow in the drain conduit 52 it will not enter the apparatus through the exit opening 14. This is prevented because the overflow edge 53 of the receptacle 51 is below the bottom of the exit opening 14. Rather than flowing into the opening 14 this backflow will overflow the edge 53 to the space 56 between the receptacle 51 and the housing 48 to the bottom of this housing. Thereupon, the liquid will flow from the housing through the openings 50.

Having described our invention as related to the embodiment shown in the accompanying drawings, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

The embodiment of the invention in which an exclusive property or privilege is claimed is defined as follows:

1. In a device for separating solids from fluids, apparatus comprising: a separating chamber adapted to contain solids-entrapping liquid and having an air space above the surface of said liquid; a conduit for air carrying entrained solids emptying into the liquid in said chamber; liquid supply means for supplying liquid to said chamber to raise the liquid level therein; suction means for maintaining a sub-atmospheric pressure in said chamber air space to draw said air through said conduit and said liquid; air pressure dome means communicating with said chamber liquid, said liquid level effecting the air pressure in said pressure dome means; pressure responsive

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means having a movable member with first and second opposite sides, said movable member being movable in the direction of said second side to terminate operation of said liquid supply means; means providing communication between said first side of said movable member and said pressure dome means for increasing pressure thereon with increasing pressure in said dome means; and means providing communication between said second side of said movable member and said chamber air space for exposing said second side to said sub-atmospheric pressure in said space, said movable member thereby being moved in the direction of its second side for terminating the operation of said liquid supply means at a preselected air pressure differential between said air space and said air pressure dome means.

2. The apparatus of claim 1 wherein said pressure dome means comprises a tube having an open lower end normally immersed in said liquid in said chamber and a closed upper end for entrapping air above the liquid level in said tube.

3. In a device for separating solids from fluids, apparatus comprising: a separating chamber adapted to contain solids-entrapping liquid and having an air space above the surface of said liquid; a conduit for air carrying entrained solids emptying into the liquid in said chamber; liquid supply means for supplying liquid to said chamber to raise the liquid level therein; suction means for maintaining a sub-atmospheric pressure in said chamber air space to draw said air through said conduit and said liquid; air pressure dome means communicating with said chamber liquid, said liquid level effecting the air pressure in said air pressure dome means of air trapped therein by said liquid; first pressure responsive means having a movable member with first and second opposite sides, said movable member being movable in the direction of said second side to terminate operation of said liquid supply means; means providing communication between said first side of said movable member and said pressure dome means for increasing pressure thereon with increasing pressure in said dome means; means providing communication between said second side of said movable member and said chamber air space for exposing said second side to said sub-atmospheric pressure in said space, said movable member thereby being moved in the direction of its second side for terminating the operation of said liquid supply means at a preselected air pressure differential between said air space and said air pressure dome means; emptying means for discharging said liquid from said chamber; second pressure responsive means having a movable member with first and second opposite sides, said movable member being movable in the direction of said second side to activate said emptying means; means providing communication between said first side of said movable member of said second pressure responsive means and said pressure dome means for increasing pressure thereon with increasing pressure in said dome means; and means providing communication between said second side of

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said movable member of said second pressure responsive means and said chamber air space for exposing said second side to said sub-atmospheric pressure in said space, said movable member of said second pressure responsive means thereby being moved in the direction of its second side for effecting the activation of said emptying means at a second preselected air pressure differential between said air space and said air pressure dome means that is greater than said first differential.

4. The apparatus of claim 3 wherein said pressure dome means comprises a tube having an open lower end normally immersed in said liquid in said chamber and a closed upper end for entrapping air above the liquid level in said tube.

5. In a device for separating solids from fluids, apparatus comprising: a separating chamber adapted to contain solids-entrapping liquid and having an air space above the surface of said liquid; a conduit for air carrying entrained solids emptying into the liquid in said chamber; liquid supply means for supplying liquid to said chamber to raise the liquid level therein; suction means for maintaining a sub-atmospheric pressure in said chamber air space to draw said air through said conduit and said liquid; means forming an exit conduit from said chamber for gravity flow of liquid there-through; pressure operated closure means for said conduit normally held closed against the weight of said liquid by said sub-atmospheric pressure and operable by the weight of liquid in said chamber in the absence of said sub-atmospheric pressure; air pressure dome means communicating with said chamber liquid, said liquid level effecting the air pressure in said air pressure dome means of air trapped therein by said liquid; air pressure responsive means communicating with said air space and with said air pressure dome means for terminating the operation of said liquid supply means at a preselected air pressure differential between said air space and said air pressure dome means corresponding to a preselected first liquid level in said chamber; and second air pressure responsive means communicating with said air space and said air pressure dome means for effecting the termination of operation of said suction means at a second preselected air pressure differential between said air space and said air pressure dome means that is greater than said first differential pressure thereby permitting opening of said closure means by said weight of liquid.

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