

[54] LIQUID CIRCULATION APPARATUS

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[22] Filed: June 26, 1972

[21] Appl. No.: 266,168

[52] U.S. Cl. 137/565, 95/89 R

[51] Int. Cl. G03d 3/02

[58] Field of Search. 137/566, 562, 565; 128/214 F, 128/DIG. 12; 95/89 R; 128/214 E, 214.2, 230 UX

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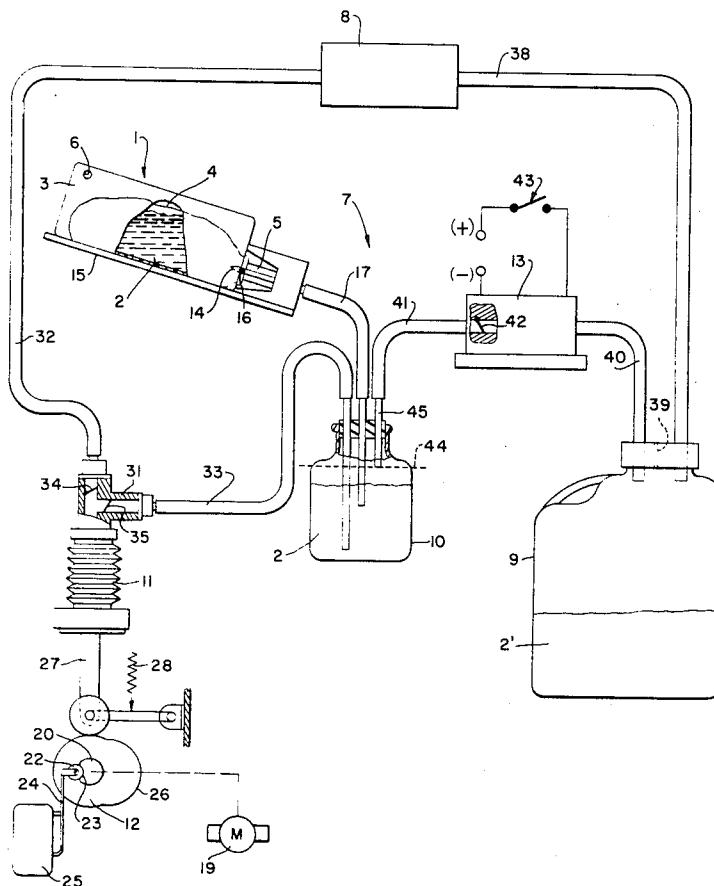
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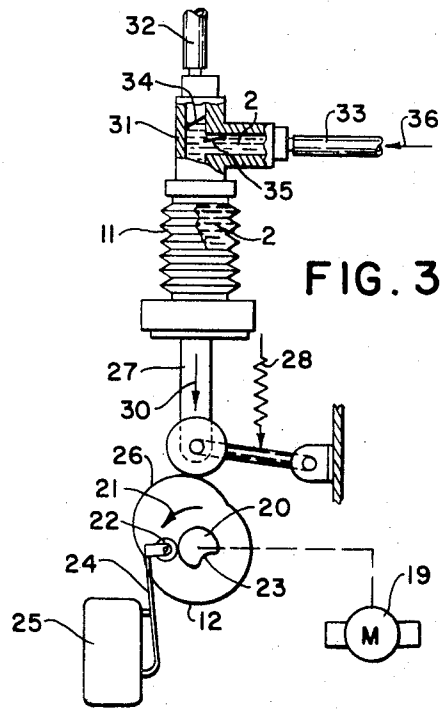
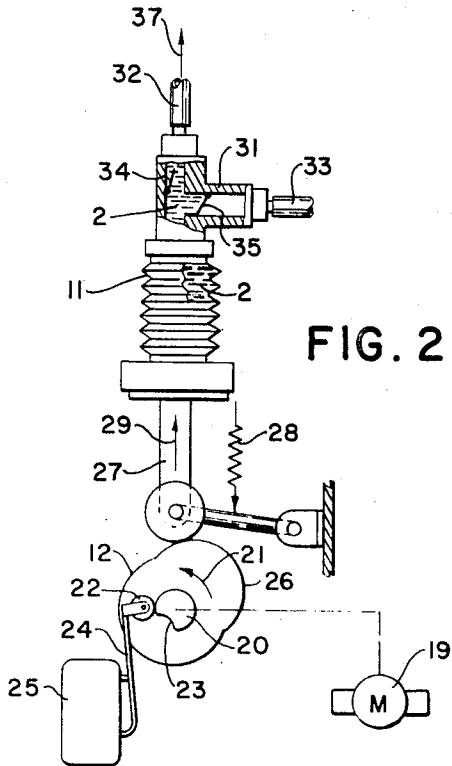
Primary Examiner—Henry T. Klinksiek

[57] ABSTRACT

Liquid circulation apparatus is adapted to furnish metered quantities of photographic processing solution to a photographic material processing station, on a demand basis, and to accumulate spent solution emptying from the processing station in a waste container. In operation, the metered solution quantities are drawn from a fixed volume reservoir and fed to the processing station by means of a solution reservoir bellows and cam pump assembly. A processing solution storage bag of the kind which is to be discarded after completed removal of the processing solution, supplies the processing solution to the fixed volume reservoir for use at the processing station. For ecology purposes, any unused processing solution remaining in the solution supply bag is removed, prior to discarding such bag, by a scavenging pump which draws the unused solution into the fixed volume reservoir. If the amount of processing solution in the fixed volume reservoir exceeds a given quantity, then the excess solution will be fed by the scavenging pump from the fixed volume reservoir into the waste container.

6 Claims, 4 Drawing Figures





LIQUID CIRCULATION APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly assigned, copending U.S. Pat. Application Ser. No. 120,017, entitled APPARATUS FOR PIERCING A CONTAINER, filed in the name of Lloyd A. Mengel on March 1, 1971, and now U.S. Pat. No. 3,688,399 issued on Sept. 5, 1972.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to photography and, in particular, to apparatus for processing photographic material by fluid-treating such material.

2. Description of the Prior Art

Liquid circulation apparatus which is adapted to furnish metered quantities of photographic processing solution to a photographic material processing station and to accumulate spent solution emptying from the processing station in a waste container, is generally known. See, for example, U.S. Pat. Nos. 2,989,911 and 3,149,550. Recently, a processing solution supply package has become available to the trade, consisting essentially of a collapsible solution holding bag which is to be discarded after removal of the processing solution. In use with the liquid circulation apparatus, the bag is punctured and the processing solution is gradually removed to enable processing of photographic material at the processing station. The bag contains a sufficient quantity of processing solution to process a fixed amount of photographic material. After the fixed amount of photographic material has been processed, the punctured bag is discarded and a fresh solution holding bag substituted therefor. However, some unused processing solution may still remain in the punctured bag. This residual unused processing solution tends to have a negative ecological affect, when discarded with the punctured bag. Moreover, such practice of less-than-total usage of the processing solution may contribute to the expense of processing the photographic material.

Generally, liquid circulation apparatus which is adapted to furnish metered quantities of processing solution to a photographic material processing station includes, as shown in U.S. Pat. No. 3,149,550, several piston pumps for effecting the solution metering. Each piston pump is provided with a solution holding chamber and with a piston mounted for reciprocal movement within the chamber. In operation, movement of the piston in one direction serves to draw a regulated amount of processing solution into the chamber and movement of the piston in an opposite direction serves to expel the same amount of processing solution from the chamber. However, since the means for effecting reciprocal movement of the piston usually includes a piston drive shaft which extends through an opening in the chamber, leakage of processing solution about this chamber opening may occur.

SUMMARY OF THE INVENTION

It is therefore a general object of the present invention to provide liquid circulation apparatus which is improved so as to avoid the foregoing difficulties existing with respect to those devices previously known.

Another object of the present invention is to provide liquid circulation apparatus which is adapted to substantially completely draw off liquid from a liquid supply container prior to discarding such container.

Yet another object of the present invention is to provide a pump, for use in liquid circulation apparatus, which is generally leakproof.

In accordance with a preferred embodiment of the present invention there is disclosed, in detail hereinafter, liquid circulation apparatus which is adapted to furnish metered quantities of photographic processing solution to a photographic material processing station, on a demand basis, and to accumulate spent solution emptying from the processing station in a waste container. In operation, the metered solution quantities are drawn from a fixed volume reservoir and fed to the processing station by means of a solution reservoir bellows and cam pump assembly. A processing solution storage bag of the kind which is to be discarded after completed removal of the processing solution, supplies the processing solution to the fixed volume reservoir for use at the processing station. For ecology purposes, any unused processing solution remaining in the solution supply bag is removed, prior to discarding such bag, by a scavenging pump which draws the unused solution into the fixed volume reservoir. If the amount of processing solution in the fixed volume reservoir exceeds a given quantity, then the excess solution will be fed by the scavenging pump from the fixed volume reservoir into the waste container.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and objects of the present invention and the manner of obtaining them will become more apparent by reference to the following detailed description of a preferred embodiment of such invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is an elevation view of liquid circulation apparatus which is adapted to furnish metered quantities of photographic processing solution to a photographic material processing station and to accumulate spent solution emptying from the processing station, in accordance with a preferred embodiment of the present invention;

FIGS. 2 and 3 are elevation views of a solution reservoir bellows and cam pump assembly for use in the liquid circulation apparatus, schematically showing the manner of operation of such assembly; and

FIG. 4 is a schematic diagram of an electrical circuit for the solution reservoir bellows and cam pump assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

It may be well before proceeding with a description of the preferred invention embodiment to first consider a photographic processing solution supply package with which such invention embodiment can be used. Referring to FIG. 1, there is shown a photographic processing solution supply package 1 of the kind which is to be discarded after removal of a photographic processing solution 2. The package 1 consists essentially of a box-like enclosure 3 in which is located a collapsible, solution holding bag or bladder 4. The bag 4 is constructed of a flexible material, such as a suitable artificial rubber, and can be punctured at a neck-like exten-

sion 5 in order to remove the processing solution 2. As the processing solution 2 is removed from the bag 4, the bag gradually collapses and air is drawn into the enclosure 3, through an enclosure opening 6, to occupy a space formerly occupied by the bag. Of course, in place of the enclosure opening 6, other means can be provided to facilitate the drawing of air into the enclosure 3. For example, the enclosure 3 can be constructed of a porous material, such as a cardboard, through which air can readily flow.

Coming now to the preferred invention embodiment, there is shown in FIG. 1, liquid circulation apparatus generally indicated by the reference number 7 and which is adapted for use with the photographic processing solution supply package 1. In use with the package 1, the liquid circulation apparatus 7 furnishes metered or regulated quantities of the photographic processing solution 2 to a photographic material processing station 8, on a demand basis, and accumulates spent solution 2' emptying from the processing station in an open waste container 9. Each metered quantity of the processing solution 2 is drawn from a closed, fixed volume reservoir 10 and fed to the processing station 8 by means of a solution reservoir bellows 11 and a cam 12. As can be realized from FIG. 1, the fixed volume reservoir 10 receives the processing solution 2 from the solution holding bag 4. For ecology purposes, any unused processing solution 2 remaining in the bag 4 is removed, prior to discarding the bag, by a scavenging pump 13 which draws the residual unused solution into the fixed volume reservoir 10. If the amount of processing solution 2 in the fixed volume reservoir 10 should exceed a given quantity, then, as will become apparent from the description hereinafter, such excess solution will be fed by the scavenging pump 13 from the fixed volume reservoir into the waste container 9.

A hollow piercing member 14 is mounted on a shelf 15 for the purpose of puncturing the solution holding bag 4, at the neck-like extension 5, after the photographic processing solution supply package 1 has been placed on the shelf in the manner shown by FIG. 1. Further structural details of the piercing member 14 are disclosed in commonly assigned, copending U.S. Pat. Application Ser. No. 120,017, now U.S. Pat. No. 3,688,399 issued on Sept. 5, 1972. As viewed in FIG. 1, the shelf 15 supports the package 1 at an elevation which is higher than that of the fixed volume reservoir 10. Accordingly, the force of gravity will initially cause some of the photographic processing solution 2 to flow from the bag 4 into the piercing member 14 via a solution ingress opening 16 in the piercing member and from the piercing member into the fixed volume reservoir 10 via a conduit 17 which hydraulically interconnects the piercing member and the fixed volume reservoir. Any air bubbles flowing with the processing solution 2 from the solution holding bag 4 into the fixed volume reservoir 10 will rise above the solution level in the fixed volume reservoir. In this way, the fixed volume reservoir 10 serves as a bubble chamber which removes any air bubbles from the processing solution 2.

As shown in FIG. 4, the closing of a normally open push button switch 18 completes an electrical circuit through a drive motor 19, thereby energizing the drive motor to simultaneously rotate the cam 12 and a cam drive shaft 20 in a counterclockwise direction generally indicated by the arrow 21 in FIG. 2. As can be seen from a comparison of FIGS. 1 and 2, this counterclock-

wise rotation of the cam drive shaft 20 serves to move a pressure roller 22 out of a peripherally located notch 23 in the shaft. Since the pressure roller 22 is rotatably mounted on a resiliently flexible finger member 24 of a normally open microswitch 25, movement of the pressure roller out of the shaft notch 23 results in a closing of the microswitch to complete another electrical circuit through the drive motor 19 (see FIG. 4). At this time, if the push button switch 18 is released to open, the drive motor 19 will remain energized.

Again comparing FIGS. 1 and 2, counterclockwise rotation of the cam 12 causes an eccentric cam portion 26 to move a cam follower 27, against the urging of a helical compression spring 28, in a vertically upward direction generally indicated by the arrow 29 in FIG. 2. Since the cam follower 27 is fixed to the solution reservoir bellows 11, such vertically upward movement of the cam follower serves to contract the bellows. Continued counterclockwise rotation of the cam 12 and the eccentric cam portion 26, as shown in FIG. 3, permits the spring 28 to move the cam follower 27 in a vertically downward direction generally indicated by the arrow 30. Such vertically downward movement of the cam follower 27 results in an expansion of the solution reservoir bellows 11. Because of the uniform shape of the eccentric cam portion 26, the solution reservoir bellows 11 will be contracted, as shown in FIG. 2, and expanded as shown in FIG. 3, the same volumetric amount.

After the drive motor 19 has rotated the cam 12 and the cam drive shaft 20 a single complete revolution in the counterclockwise direction, the pressure roller 22 will again be received in the shaft notch 23 so as to open the microswitch 25 and de-energize the drive motor (see FIGS. 1 and 4). The pressure roller 22, in the shaft notch 23, and the resiliently flexible finger member 24 of the microswitch 25 cause a dynamic breaking of the cam drive shaft 20.

The solution reservoir bellows 11 includes a valve head 31 which, as shown in FIG. 1, is hydraulically interconnected with the photographic material processing station 8 and the fixed volume reservoir 10 by two separate conduits 32 and 33. Such hydraulic interconnection permits the photographic processing solution 2 to flow from the fixed volume reservoir 10 into the solution reservoir bellows 11 and from the bellows to the processing station 8. A normally closed valve 34, located within the valve head 31, is arranged to prevent processing solution flow from the processing station 8 into the solution reservoir bellows 11. Another normally closed valve 35, located within the valve head 31, is arranged to prevent processing solution flow from the solution reservoir bellows 11 into the fixed volume reservoir 10. As shown in FIG. 3, upon expansion of the solution reservoir bellows 11 the valve 34 remains closed and the valve 35 is opened. Moreover, the processing solution 2 is drawn from the fixed volume reservoir 10, along the conduit 33 as generally indicated by the arrow 36, into the solution reservoir bellows 11. As shown in FIG. 2, upon contraction of the solution reservoir bellows 11, the valve 34 is opened and the valve 35 remains closed. Thus, the processing solution 2 in the solution reservoir bellows 11 is fed from the bellows, along the conduit 32 as generally indicated by the arrow 37, to the processing station 8. Since the solution reservoir bellows 11 is expanded and contracted the same volumetric amount, as described hereinbefore, a

metered quantity of the processing solution 2 will be drawn from the fixed volume reservoir 10 into the bellows and the same quantity of processing solution will be fed from the bellows to the processing station 8.

As can be realized from FIG. 1, when a metered quantity of the photographic processing solution 2 is drawn from the fixed volume reservoir 10, by expansion of the solution reservoir bellows 11, a vacuum in the fixed volume reservoir will be effected so as to cause a similar quantity of the processing solution to flow from the solution holding bag 4 into the fixed volume reservoir.

During the processing of photographic material (not shown) at the photographic material processing station 8, using a metered quantity of the processing solution 2, the spent solution 2' emptying from the processing station will flow into a conduit 38 which hydraulically interconnects the processing station and the waste container 9. As viewed in FIG. 1, the processing station 8 is located at an elevation which is higher than that of the waste container 9. Accordingly, the force of gravity will cause the spent solution 2' to flow from the processing station 8 to the waste container 9. The waste container 9 has an opening 39 through which air is expelled as the spent solution 2' flows into the waste container.

Referring again to FIG. 1, the scavenging pump 13 is hydraulically interconnected with the waste container 9 and the fixed volume reservoir 10 by two separate conduits 40 and 41. Such hydraulic interconnection permits the photographic processing solution 2 to flow from the fixed volume reservoir 10, through the scavenging pump 13, into the waste container 9. A normally closed valve 42, located within the scavenging pump 13, is arranged to prevent processing solution flow from the waste container 9 into the fixed volume reservoir 10. Prior to discarding the photographic processing solution supply package 1, unused processing solution 2 remaining in the solution holding bag 4 is removed. Such solution removal is initiated by closing a normally open pump start switch 43 to actuate the scavenging pump 13. The scavenging pump 13, once actuated, opens the valve 42 and effects a vacuum in the fixed volume reservoir 10. The vacuum, in turn, serves to draw the unused solution 2 from the solution holding bag 4, along the conduit 17, into the fixed volume reservoir 10. As the unused solution 2 is drawn from the solution holding bag 4 into the fixed volume reservoir 10, the solution level in the fixed volume reservoir will of course begin to rise. After the solution level in the fixed volume reservoir 10 exceeds a given quantity or level generally indicated by the broken line 44 in FIG. 1, the excess solution will be drawn into an extension 45 of the conduit 41 by the scavenging pump 13 and will be fed by the pump into the waste container 9.

Although not shown in the drawings, a counter or other appropriate mechanism can be provided in the liquid circulation apparatus 7 to close the drive motor switch 18, to furnish a metered quantity of the processing solution 2 to the photographic material processing station 8, each time a unit of photographic material is presented for processing at such station. Moreover, the counter can close the scavenging pump switch 43 for a sufficient time, to draw residual unused processing solution 2 from the solution supply bag 4, after a given

number of photographic material units have been processed at the processing station 8.

Although the preferred invention embodiment is adapted for use with a single processing solution supply package 1, such embodiment can be modified to handle several of these packages simultaneously.

The present invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We Claim:

1. Liquid circulation apparatus adapted for use with a liquid supply container of the kind which is to be discarded after removal of liquid therefrom, said apparatus comprising:

a liquid holding reservoir;

means, located with respect to said liquid holding reservoir, for receiving liquid from such a liquid supply container and conveying liquid into said holding reservoir;

a liquid utilization station;

means, located with respect to said liquid holding reservoir and said liquid utilization station, for moving regulated amounts of liquid, in succession, from said holding reservoir into said utilization station;

a liquid waste container;

means, located with respect to said liquid utilization station and said liquid waste container, for conveying liquid from said utilization station into said waste container; and

means, located with respect to said liquid holding reservoir and said liquid waste container, for drawing residual unused liquid from such a liquid supply container, feeding that liquid into said holding reservoir, and for feeding at least a portion of that liquid from said holding reservoir into said waste container.

2. Liquid circulation apparatus adapted for use with a liquid supply container of the kind which is collapsible and to be discarded after removal of liquid therefrom, said apparatus comprising:

a closed, fixed volume container for holding a liquid;

liquid conduit means, hydraulically connectable with such a liquid supply container, for receiving liquid from the supply container and, hydraulically connected with said fixed volume container, for conveying liquid from the supply container into said fixed volume container;

a liquid utilization station;

means, hydraulically interconnecting said fixed volume container and said liquid utilization station, for moving regulated amounts of liquid, in succession, from said fixed volume container into said utilization station;

an open, liquid waste container;

liquid conduit means, hydraulically interconnecting said liquid utilization station and said liquid waste container, for conveying liquid from said utilization station into said waste container; and

means, hydraulically connectable with such a liquid supply container and hydraulically interconnecting said fixed volume container and said liquid waste container, for drawing residual unused liquid from the supply container into said fixed volume container and for feeding at least a portion of that liq-

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uid from said fixed volume container into said waste container.

3. Liquid circulation apparatus as recited in claim 2, wherein said means for moving regulated amounts of liquid includes:

an expandable and contractable bellows reservoir for receiving, holding and expelling a liquid;

liquid conduit means hydraulically interconnecting said bellows reservoir respectively with said liquid utilization station and said fixed volume container;

valve means coupled to said bellows reservoir for preventing liquid flow from said liquid utilization station into said bellows reservoir, though permitting liquid flow from said bellows reservoir to said liquid utilization station, and for preventing liquid flow from said bellows reservoir into said fixed volume container, though permitting liquid flow from said fixed volume container into said bellows reservoir; and

means for expanding and contracting said bellows reservoir the same volumetric amount respectively to draw a regulated amount of liquid from said fixed volume container into said bellows reservoir and to feed the same amount of liquid from said bellows reservoir to said liquid utilization station.

4. Liquid circulation apparatus as recited in claim 2, wherein said means for drawing and feeding residual unused liquid includes:

a scavenging pump for drawing residual unused liquid from such a liquid supply container into said fixed volume container and for feeding that liquid from said fixed volume container into said liquid waste container;

liquid conduit means hydraulically interconnecting said scavenging pump respectively with said fixed volume container and said liquid waste container; and

valve means coupled to said pump for preventing liquid flow from said liquid waste container into said fixed volume container, though permitting liquid flow from said fixed volume container into said liquid waste container.

5. Liquid circulation apparatus as recited in claim 4, wherein said liquid conduit means hydraulically interconnecting said scavenging pump respectively with said fixed volume container and said liquid waste container includes:

a liquid conduit extension which depends part way into said fixed volume container so that, if the amount of liquid in said fixed volume container exceeds a given quantity, said scavenging pump can feed such excess liquid from said fixed volume container into said liquid waste container.

6. Liquid circulation apparatus adapted for use with a liquid supply container of the kind which is collaps-

ible and to be discarded after removal of liquid therefrom, said apparatus comprising:

a closed, fixed volume container for holding a liquid; means for supporting such a liquid supply container at an elevation which is higher than that of said fixed volume container;

liquid conduit means, hydraulically connectable with such a liquid supply container, for receiving liquid from the supply container and, hydraulically connected with said fixed volume container, for conveying liquid from the supply container into said fixed volume container;

a liquid utilization station; an expandable and contractable bellows reservoir for receiving, holding and expelling a liquid;

liquid conduit means hydraulically interconnecting said bellows reservoir respectively with said fixed volume container and said liquid utilization station;

valve means coupled to said bellows reservoir for preventing liquid flow from said liquid utilization station into said bellows reservoir, though permitting liquid flow from said bellows reservoir to said liquid utilization station, and for preventing liquid flow from said bellows reservoir into said fixed volume container, though permitting liquid flow from said fixed volume container into said bellows reservoir;

means for expanding and contracting said bellows reservoir the same volumetric amount respectively to draw a regulated amount of liquid from said fixed volume container into said bellows reservoir and to feed the same amount of liquid from said bellows reservoir to said liquid utilization station; an open, liquid waste container;

means locating said liquid utilization station at an elevation which is higher than that of said liquid waste container;

liquid conduit means hydraulically interconnecting said liquid utilization station and said liquid waste container;

a scavenging pump for drawing residual liquid from such a liquid supply container into said fixed volume container and for feeding that liquid from said fixed volume container into said liquid waste container;

liquid conduit means hydraulically interconnecting said scavenging pump respectively with said fixed volume container and said liquid waste container; and

valve means coupled to said pump for preventing liquid flow from said liquid waste container into said bellows reservoir, though permitting liquid flow from said fixed volume container into said liquid waste container.

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