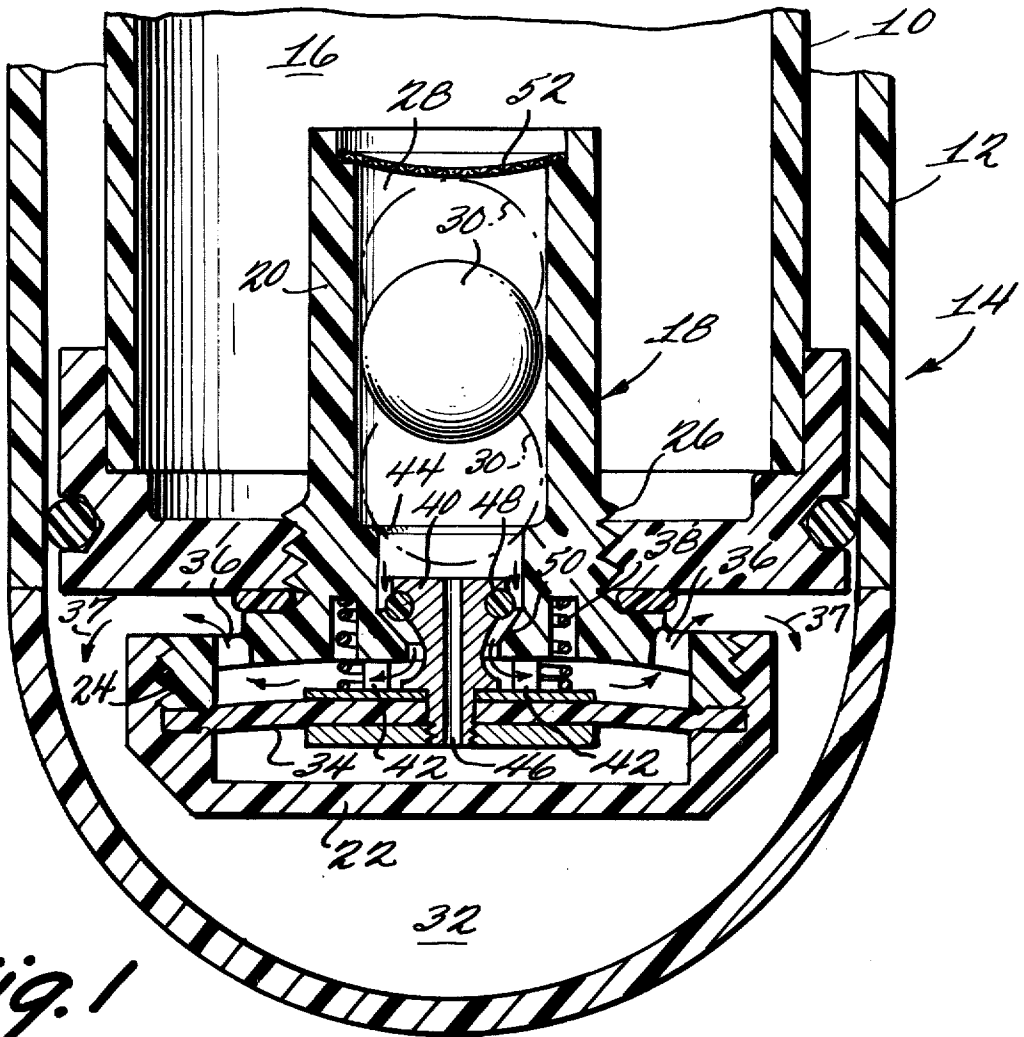
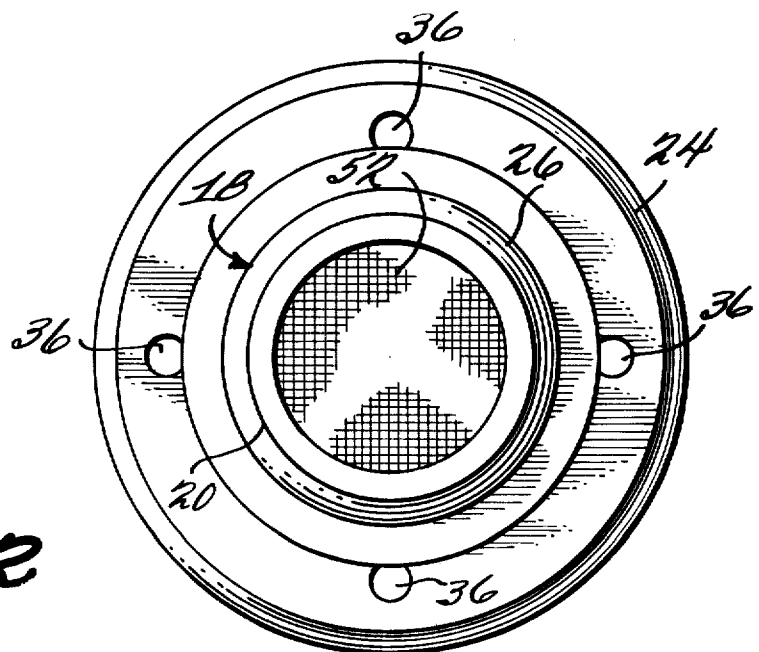




ONE-SHOT METERING VALVE

This invention generally relates to metering valves and/or devices and in particular relates to a "one-shot" metering valve whereby a predetermined amount of liquid is discharged upon actuation of the valve with the valve being thereafter disabled from further operation until after the lapse of a predetermined time period. The one-shot metering valve of this invention has particular application, for instance, when adapted for use in combination with a reciprocating piston pump assembly such as those commonly used on portable toilet facilities for pumping effluent therefrom. For instance, such a pump assembly together with a prior art metering valve is disclosed in the commonly assigned copending application Ser. No. 259,602 of Ronald O. Browne.

Typically, hand operated reciprocating pumps are used for pumping effluent from portable toilet facilities and it is desirable to discharge a predetermined amount of chemical sanitizing and/or deodorizing agent into the effluent for each such flushing operation.

However, if conventional metering valves are utilized in conjunction with such an operation, the metered quantity is discharged into the pumping chamber each time the pump piston is reciprocated thus permitting excessive discharge of the chemical agent due to unnecessary extra pumping strokes which often occur when portable toilet facilities are used by the public at large and/or without special instructions, etc. Furthermore, vandals and/or children often find the hand operated pump of such a portable toilet facility an interesting plaything to operate. Thus, conventional metering valves often result in unnecessary discharge and consequent loss of the chemical agent.

Accordingly, the one-shot metering valve of this invention represents a significant improvement in metering valves for use in such operations where it is required to discharge a predetermined quantity of some liquid for each use regardless of a number of pumping strokes that might be involved in any one particular use. That is, if the metering valve is connected to discharge the chemical directly into the pumping chamber (as in the preferred embodiment) then the one-shot metering valve of this invention will discharge the predetermined quantity of chemical on the first filling stroke of the pump's piston but will not repeat such discharges on any immediately subsequent strokes. Rather, the one-shot metering valve of this invention requires a significant time lapse from the last pumping stroke (for example, 30 seconds or more) to reset itself so that the required quantity of chemical will thereafter be discharged only on the next use of the pump.

In other words, during any given flushing operation for the portable toilet facility, the one-shot metering valve of this invention will discharge the required quantity of chemical and no more regardless of the number of pumping strokes utilized by the operator for one such flushing operation. Then, after a predetermined time delay subsequent to the last pumping stroke, the one-shot metering valve of this invention is automatically reconditioned in readiness for a similar subsequent use in the next flushing operation.

The predetermined time delay involved in the reconditioning or resetting of the one-shot metering valve is produced in the exemplary embodiment by a ball valve floating upwardly within a close fitting bore. A pressure

sensitive diaphragm valve is provided so that upon a reduction of pressure within the pumping chamber (such as accompanies the filling stroke of the piston pump), the diaphragm discharge valve opens allowing chemical to be drawn out from below the floating ball which then moves downwardly within the close fitting bore until it contacts a lower valve seat surface thus sealing off and stopping further flow of the chemical. Furthermore, the diaphragm discharge valve is arranged such that, when the discharge valve is opened, the pressure on both sides of the diaphragm tends to equalize once the floating ball has seated on its lower valve seat surface thus causing the discharge valve to close again and positively prevent any further discharge of liquid.

The floating ball valve will begin to float upwardly within the bore but because of the relatively low buoyancy of the ball in combination with the relatively close tolerance fitting of the ball within the bore, the ball will float upwardly at a relatively slow rate thus taking a predetermined time period to complete its upward movement and trap another predetermined quantity of chemical therebelow for a subsequent cycle of operation.

In the exemplary embodiment, the ball valve is stopped at its top-most position by a filter screen capping the metering chamber, which screen has a mesh sized such that it prevents the entry of any particles larger than the diametral clearance of the ball valve within its bore. Accordingly, if the pump is consecutively stroked there will be very little time lapse between successive strokes and the ball valve will remain substantially in its lower-most position without permitting the measuring chamber of the valve to refill to any significant extent.

Accordingly, the metering valve will discharge only the predetermined quantity of chemical regardless of the number of times the pump is repeatedly stroked in a single sequence of pump operation such as that which might be encountered during a single flushing operation of a portable toilet facility. On the other hand, when such a sequence of pumping actions has finally subsided and the pump has been idle for the requisite time period, the floating ball valve will eventually float to the top of its bore thus refilling the chemical metering chamber therebelow in readiness for another chemical metering operation whenever the next sequence of pumping operation is initiated.

It will be appreciated that the one-shot metering valve of this invention is activated by a pressure reduction and may find other advantageous uses besides that of metering chemicals into a reciprocating pump chamber.

The many advantages and improvements of my invention will be better understood and appreciated from the following detailed description taken in conjunction with the drawings, of which:

FIG. 1 is a cross section view of part of a reciprocating piston pump incorporating the one-shot metering valve of this invention; and

FIG. 2 is a plan view of the main valve body for an exemplary embodiment of the one-shot metering valve as shown in FIG. 1.

A preferred embodiment of the one-shot metering valve is shown in FIG. 1 as being incorporated within the operating end of a piston 10 which is adapted for reciprocating pumping action within a cylinder cham-

ber 12 of a reciprocating pump assembly generally indicated as 14.

In this exemplary embodiment, the interior 16 of the piston 10 constitutes a supply chamber wherein the chemical to be metered by the one-shot metering valve 18 is maintained. The one-shot metering valve 18 as shown in FIG. 1 is in the actuated or open position as it would exist during part of an actual metering cycle.

The one-shot metering valve 18 comprises an upper main body 20 and a lower cap portion 22 which are threadably secured together at 24 as shown in FIG. 1. Also, as shown in FIG. 1, the upper main valve body 20 is threadably secured at 26 through an aperture in the lower operating face of the piston 10.

As may be seen in FIG. 1, the main upper body 20 of the valve comprises an inner cylindrical bore 28 within which a floatable ball valve 30 is disposed. The ball valve 30 is sufficiently smaller than the inside dimension of bore 28 and of a predetermined specific gravity less than that of the liquid in the supply chamber 16 so that, under quiescent conditions, the ball valve 30 is free to float upwardly within the bore 28. Of course, the upward floating movement of the ball valve 30 is necessarily accompanied by movement of the heavier liquid within the clearance area between the ball and bore so that, when the ball finally finds its way at the top-most portion of the bore 28, a predetermined quantity of chemical or other desired liquid from chamber 16 will be trapped below the ball 30 within the bore 28.

When the piston 10 is drawn upwardly within the cylinder 12 during the filling stroke of the pump, the pressure within the pumping chamber 32 will be abruptly reduced. Since the upper surface of diaphragm 34 is exposed to the ambient fluid pressure within chamber 32 through apertures 36, this will cause the diaphragm 34 to flex upwardly and compress the coil spring 38 thus moving the discharge valve stem 40 upwardly into the position as shown in FIG. 1. Accordingly, the previously trapped chemical below the ball valve 30 will be drawn outwardly around the raised valve stem 40 through apertures 42 and 36 into the receiving chamber or pumping chamber 32 of the pump 14 as shown by arrows 37.

As the chemical is being withdrawn from the metering chamber 28, the ball valve 30 will follow in a downward direction since the clearances between the ball valve 30 and the inside of the bore 28 are insufficient to permit the heavier liquid to flow rapidly thereabout and replace that fluid which is being extracted into the receiving chamber 32. Accordingly, the ball valve 30 will eventually find itself at the bottom of the bore 28 where it seals against a valve seat 44 to prevent any further fluid from passing around the ball valve 30 through the diaphragm operated discharge valve into the receiving chamber 32.

Furthermore, since the lower side of the diaphragm 34 is vented through a central opening 46 within the valve stem 40, the pressures on both sides of the diaphragm 34 will tend to equalize when the valve is in an open position as shown in FIG. 1 and the ball valve 30 is seated against the valve seat 44 in its lower most position as should now be appreciated.

Accordingly, in this condition, where pressures are approximately equalized on both sides of the diaphragm 34, the spring 38 will cause the diaphragm operated discharge valve stem 40 to move downwardly thus sealing the O-ring 48 against a seating surface 50

to positively prevent any further discharge of chemical from the chamber 28.

Then, after completing the filling stroke, the piston 10 of pump 14 will be moved downwardly in a discharge stroke whereupon the fluid pressure in chamber 32 will increase. This increase in pressure is communicated to the top-side of diaphragm 34 through the apertures 36 thus causing a slight downward depression of the diaphragm. Although this downward depression of the diaphragm cannot further move the valve stem 40 since it is already in its lower most position with the O-ring 48 sealed against the seat surface 50, it does nevertheless tend to increase the pressure of the fluid trapped beneath the lower side of the diaphragm 34 and this increase in pressure is then communicated to the lower side of the ball valve 30 through the aperture 46 in the valve stem 40 thus positively unseating the ball valve 30 from its seating surfaces 44 and beginning it on its upward floating movement through the bore 28.

Of course, the upward floating movement of the ball valve 30 requires a significant amount of time to complete its journey to the top of the bore 28. The exact amount of time required will, of course, depend upon the viscosity of the chemical in supply chamber 16, the specific gravity of the chemical in comparison to the specific gravity of the ball valve 30 and the mechanical clearance tolerances between the outside dimensions of the ball valve 30 and inside dimensions of the bore 28.

The ball valve 30 is finally stopped on its upward movement through bore 28 by engagement with a filter screen 52 topping the bore 28 as shown in FIG. 1. Besides serving the function of stopping the ball 30 at a predetermined location to trap a predetermined quantity of chemical therebeneath within the metering chamber of bore 28, the filter screen 52 is preferably of a size that has opening holes smaller than the diametral clearance of the ball valve 30 within its bore 28 to prevent particles from wedging the ball valve 30 within its bore as should now be apparent.

It is possible to merely let the ball valve 30 seat upon the edge of a suitably shaped seating surface 44 but, preferably, an O-ring or some other type of conventional plyable sealing means should be used to assure more accurate control of flow.

While the diaphragm 34 could be positioned to normally bias the valve stem in a downward position thus eliminating the need for a spring 38, it is preferable to use the spring 38 as shown in FIG. 1 and to position the diaphragm 34 neutrally since the force and rate of a more conventional spring 38 may be more accurately controlled.

As previously stated, the exact amount of time delay obtained by the time required for the ball valve 30 to float within bore 28 to its uppermost position is dependent upon several parameters of the particular chemical being metered and a particular application for which the meter valve is to be adapted. However, for purely explanatory purposes, the following typical values of parameters are given as being generally applicable to the adaptation of the one shot metering valve for use in reciprocating pumps of portable toilet facilities where the chemical to be metered has a viscosity substantially similar to that of a mixture of 50 percent water and 50 percent glycerin

In this particular instance, acceptable time delay operation of the one-shot metering valve has been obtained using a polypropylene or polyethylene ball valve 30 having a specific gravity of 0.9 with approximately 0.010 inches of clearance between the ball valve 30 and the bore 28. In this particular application, a 0.510 inch bore of sufficient length to permit the ball valve 30 to have a stroke of 0.555 inches will result in approximately one-fifteenth of an ounce of chemical being discharged into the receiving chamber 30 for each sequence of pumping operations. In this example, the ball valve 30 requires approximately 60–90 seconds to rise completely to the top of bore 28. Furthermore, in this example, a diaphragm 34 and spring 38 is designed to open the diaphragm operated discharge valve when the pressure within receiving chamber 32 has been reduced by approximately 1–2 pounds per square inch. Typically, the diaphragm 34 may be made of an impervious flexible material such as neoprene, urethane, etc. The valve stem 40 is preferably made of stainless steel as is the spring 38. Filter screen 52 may be made of either stainless steel or plastic while the main body 20 and cap 22 may be made from PCV plastic or suitable material as should now be appreciated by those in the art.

While only one specific exemplary embodiment of this invention has been described in detail, those in the art will appreciate that the exemplary embodiment may be modified in many obvious respects without in any way departing from the spirit and teaching of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention.

What is claimed is:

1. A liquid metering valve operated by pressure reductions, said valve comprising:

a cylindrical chamber having a predetermined diameter dimension and connected to continuously and freely receive a supply of said liquid through an upper port,

said chamber having a valve seat formed therewithin about a lower port, and

a free body disposed within the chamber,

said free body having a predetermined specific gravity and predetermined diametral dimensions substantially equal to the predetermined diameter dimension of said chamber to substantially limit the upward floating movement of the free body within the liquid in the chamber to a limited predetermined rate,

a stop means disposed to limit said upward floating movement at a predetermined location thus defining a predetermined quantity of said liquid substantially confined between the free body, the cylindrical chamber walls and the lower port when the free body is at its uppermost location,

said free body also being adapted to move downwardly while also preventing substantial fluid flow therearound because of the substantially equal free body and chamber dimensions thus forcing said predetermined quantity of liquid from the lower port when the fluid pressure is lowered thereat and said free body also being adapted to cooperate with said valve seat when in its lowermost position and thus positively preventing further liquid from leaving said lower port until the fluid pressure at said lower port has been thereafter raised thus permitting the free body to float upwardly within the

chamber but only at said limited predetermined rate to recondition the valve for another operation after a predetermined elapsed time.

2. A liquid metering valve as in claim 1 wherein said free body is spherically shaped.

3. A liquid metering valve as in claim 1 wherein said liquid has a specific gravity substantially the same as a 50–50 mixture of glycol and water and said free body has a specific gravity of approximately 0.9.

4. A liquid metering valve as in claim 1 wherein said stop means comprises a filtering screen disposed within said upper port and having openings therein less than a predetermined dimension for screening out particles larger than the clearance dimensions between the chamber and the free body therewithin.

5. A liquid metering valve as in claim 1 further comprising:

a diaphragm operated discharge valve connected to said lower port for positively opening said lower port in response to a reduction in fluid pressure thereabout

one surface of the diaphragm in the diaphragm valve being exposed to the ambient fluid pressure thereabout while the other surface of the diaphragm is exposed to the pressure existing at said lower port.

6. A liquid metering valve as in claim 1 mounted with said lower port in fluid communication with the pumping chamber of a piston pump for metering fluid into said pumping chamber.

7. A liquid metering valve as in claim 1 in combination with a reciprocable piston pump, said metering valve being mounted on the piston of the pump for metering fluid into said pumping chamber.

8. A liquid metering valve as in claim 7 wherein the piston of the pump comprises a supply chamber for said liquid and wherein said metering valve is mounted on the operating face of said piston.

9. A metering apparatus for metering a predetermined quantity of liquid into a receiving chamber when the pressure therein is first reduced but which valve will not again furnish such liquid on subsequent reductions of the pressure in the receiving chamber until a predetermined time has elapsed after the first such pressure reduction, said metering apparatus comprising:

a supply chamber for holding a supply of said liquid, a cylindrical metering chamber having a predetermined diameter dimension and connected for continuous and free flowing fluid communication with said supply chamber for holding said predetermined quantity of liquid and for discharging same through an outlet,

a floatable body of predetermined diametral dimensions substantially equal to the predetermined diameter dimension of said chamber and disposed within said metering chamber to limit the controlled passage of said fluid with respect to said floatable body and to permit only controlled upward movements at a limited predetermined rate of the floatable body with respect to said metering chamber,

a stop disposed to limit the upward movement of said floatable body,

a valve seat disposed at said outlet of said metering chamber and adapted to cooperate and seal with said floatable body when it is in its lowermost position thereby preventing further liquid flow from said outlet, and

a pressure actuated valve operatively disposed between the outlet of the metering chamber and the receiving chamber whereby the outlet and the receiving chamber are placed in fluid communication upon the first pressure reduction in the receiving chamber thereby drawing the predetermined quantity of liquid from below the floatable body until the floatable body cooperates with said valve seat to prevent further withdrawal,

said floatable body having predetermined characteristics including its said dimensions relative to the chamber diameter to prevent its subsequent upward movement and consequent refilling of the metering chamber until a predetermined time has elapsed after the last pressure reduction in the receiving chamber.

10. A metering apparatus as in claim 9 wherein said floatable body is spherically shaped.

11. A metering apparatus as in claim 9 wherein said liquid has a specific gravity substantially the same as a 50-50 mixture of glycol and water and said floatable body has a specific gravity of approximately 0.9.

12. A metering apparatus as in claim 9 wherein said stop comprises a filtering screen disposed to stop the floating movement of said floatable body and having apertures of a predetermined maximum dimension to screen out particles larger than the clearance dimensions between the metering chamber and the floatable body.

13. A metering apparatus as in claim 9 wherein said pressure actuated valve comprises:

a diaphragm operated discharge valve for positively opening and closing a fluid passage between said metering chamber and said receiving chamber in response to ambient pressure changes in said receiving chamber

one surface of a diaphragm in the diaphragm valve being exposed to the ambient fluid pressure in said receiving chamber while the other surface of said diaphragm is exposed to the pressure at the outlet of said metering chamber.

14. In combination with a reciprocating piston pump comprising a piston and a chamber within which the piston is reciprocatably positioned for drawing a first liquid into the chamber and for subsequently forcing the first liquid out of the chamber, a one-shot metering valvae means for discharging a predetermined quantity of a second liquid into the said chamber during the first reciprocation of the pump and for preventing any further such discharge until the pump has been quiescent for a predetermined time period.

15. A liquid metering valve operated by pressure reductions, said valve comprising:

a chamber adapted to receive a supply of said liquid through an upper port,

said chamber having a valve seat formed therewithin about a lower port,

a free body disposed within the chamber, said free body having a predetermined specific gravity and dimensions to permit a predetermined rate of upward floating movement within the liquid in the chamber,

a stop means disposed to limit said upward floating movement at a predetermined location thus defining a predetermined quantity of said liquid between the free body and the lower port when the free body is at its uppermost location,

said free body also being adapted to move downwardly thus forcing said predetermined quantity of liquid from the lower port when the fluid pressure is lowered thereat and to cooperate with said valve seat when in its lowermost position thus preventing further liquid from leaving said lower port until the fluid pressure at said lower port has been thereafter raised thus permitting the free body to float upwardly within the chamber to recondition the valve for another operation after a predetermined elapsed time, and

a diaphragm operated discharge valve connected to said lower port for positively opening said lower port in response to a reduction in fluid pressure thereabout, said diaphragm operated discharge valve comprising:

a diaphragm,

a valve stem mounted for movement upon said diaphragm, and

a discharge valve seat,

said valve stem having sealing means for cooperation with said discharge valve seat to prevent the discharge of said liquid when the diaphragm is in a first unactuated position and to permit the discharge of said liquid when the diaphragm is in a second actuated position, and

one surface of said diaphragm being exposed to the ambient fluid pressure thereabout while the other surface of said diaphragm is maintained at the pressure existing at said lower port.

16. A liquid metering valve as in claim 15 wherein said valve stem includes vent means for placing said other diaphragm surface in fluid communication with said lower port.

17. A liquid metering valve as in claim 15 further comprising a spring disposed to positively maintain said diaphragm in said first position whenever the pressure on said one surface is higher than the pressure on said other surface.

18. A metering apparatus for metering a predetermined quantity of liquid into a receiving chamber when the pressure therein is first reduced but which valve will not again furnish such liquid on subsequent reductions of the pressure in the receiving chamber until a predetermined time has elapsed after the first such pressure reduction, said metering apparatus comprising:

a supply chamber for holding a supply of said liquid, a metering chamber in fluid communication with said supply chamber for holding said predetermined quantity of liquid and for discharging same through an outlet,

a floatable body disposed within said metering chamber and arranged to permit the controlled passage of said fluid with respect to said floatable body and to permit upward and downward movements of the floatable body with respect to said metering chamber,

a stop disposed to limit the upward movement of said floatable body,

a valve seat disposed at said outlet of said metering chamber and adapted to cooperate and seal with said floatable body when it is in its lowermost position thereby preventing further liquid flow from said outlet, and

a pressure actuated valve operatively disposed between the outlet of the metering chamber and the receiving chamber whereby the outlet and the re-

ceiving chamber are placed in fluid communication upon the first pressure reduction in the receiving chamber thereby drawing the predetermined quantity of liquid from below the floatable body until the floatable body cooperates with said valve seat to prevent further withdrawal,

said floatable body having predetermined characteristics to prevent its subsequent upward movement and consequent refilling of the metering chamber until a predetermined time has elapsed after the last pressure reduction in the receiving chamber, and wherein

said supply chamber is located within the piston of a reciprocable piston pump.

19. A metering apparatus for metering a predetermined quantity of liquid into a receiving chamber when the pressure therein is first reduced but which valve will not again furnish such liquid on subsequent reductions of the pressure in the receiving chamber until a predetermined time has elapsed after the first such pressure reduction, said metering apparatus comprising:

- a supply chamber for holding a supply of said liquid,
- a metering chamber in fluid communication with said supply chamber for holding said predetermined quantity of liquid and for discharging same through an outlet,
- a floatable body disposed within said metering chamber and arranged to permit the controlled passage of said fluid with respect to said floatable body and to permit upward and downward movements of the floatable body with respect to said metering chamber,
- a stop disposed to limit the upward movement of said floatable body,
- a valve seat disposed at said outlet of said metering chamber and adapted to cooperate and seal with said floatable body when it is in its lowermost position thereby preventing further liquid flow from said outlet, and
- a pressure actuated valve operatively disposed between the outlet of the metering chamber and the receiving chamber whereby the outlet and the receiving chamber are placed in fluid communication

upon the first pressure reduction in the receiving chamber thereby drawing the predetermined quantity of liquid from below the floatable body until the floatable body cooperates with said valve seat to prevent further withdrawal,

said floatable body having predetermined characteristics to prevent its subsequent upward movement and consequent refilling of the metering chamber until a predetermined time has elapsed after the last pressure reduction in the receiving chamber, and wherein

said pressure actuated valve comprises a diaphragm operated discharge valve for positively opening and closing a fluid passage between said metering chamber and said receiving chamber in response to ambient pressure changes in said receiving chamber, said diaphragm operated discharge valve including:

- a diaphragm,
- a valve stem mounted for movement with said diaphragm, and
- a discharge valve seat,

said valve stem having sealing means for cooperation with said discharge valve seat to prevent the discharge of liquid when the diaphragm is in a first unactuated position and to permit the discharge of liquid when the diaphragm is in a second actuated position, and

one surface of said diaphragm being exposed to the ambient fluid pressure in said receiving chamber while the other surface of said diaphragm is maintained at the fluid pressure existing at the outlet of said metering chamber.

20. A metering apparatus as in claim 19 wherein said valve stem includes vent means for placing said other diaphragm surface in fluid communication with the outlet of said metering chamber.

21. A metering apparatus as in claim 19 further comprising a spring disposed to positively maintain said diaphragm in said first position whenever the pressure on said one surface is higher than the pressure on said other surface.

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