United States Patent [19]

Spransy

[11] **3,864,763**

[45] **Feb. 11, 1975**

[54] **DISPENSING CAP FOR DISCHARGING LIQUID INTO FLUSH TANK FROM A BOTTLE DURING A FLUSHING CYCLE**

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[22] Filed: **Aug. 6, 1973**

[21] Appl. No.: **385,791**

[52] **U.S. Cl.** **4/227,** 4/228, 222/420

[51] **Int. Cl.** **E03d 9/03**

[58] **Field of Search** 4/222, 227, 228; 222/185, 222/420, 541

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[57] **ABSTRACT**

A fitment for controlling the discharge of liquid from a bottle into a toilet flush tank is operated for each flush tank cycle. The fitment defines a chamber which is closed by the water level in the tank during standby. The relative volume of fitment chamber and bottle together with diameter and length of a fine passage, the angle of a discharge well and other parameters are set forth more fully in the specification.

3 Claims, 5 Drawing Figures

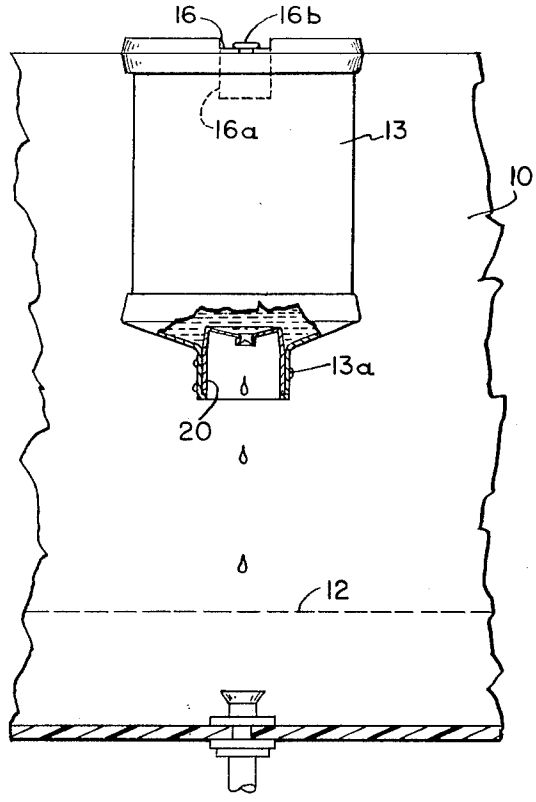


FIG. 1

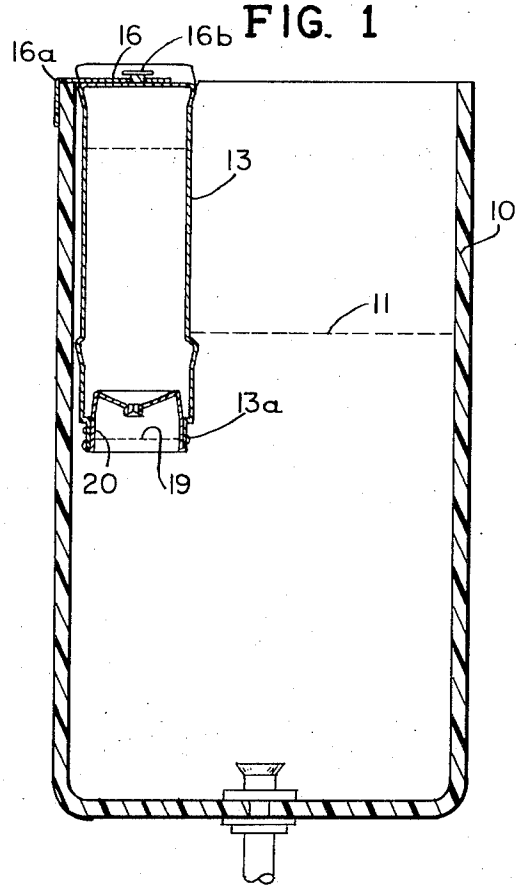


FIG. 2

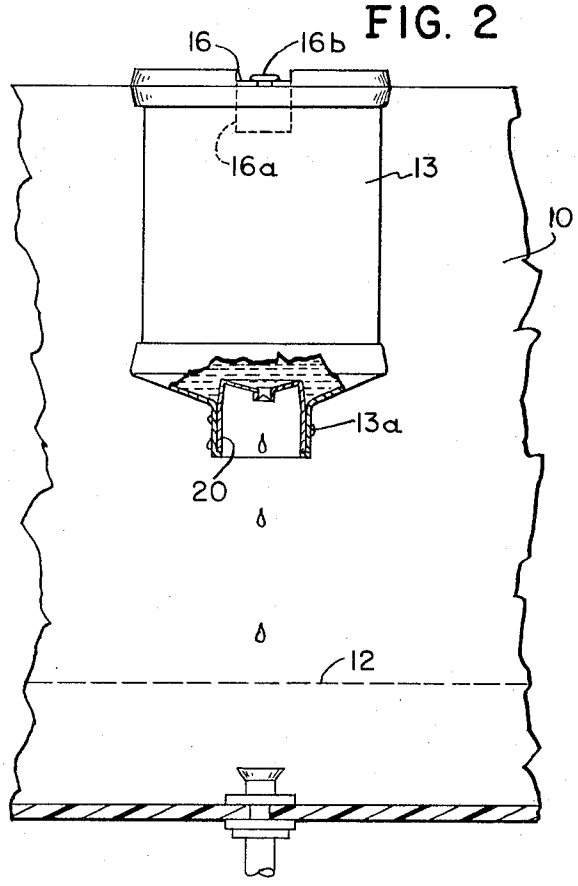


FIG. 3

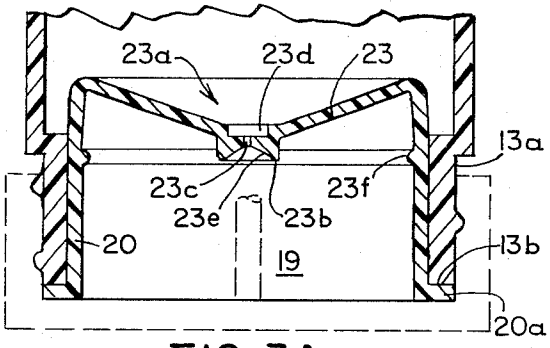


FIG. 3A

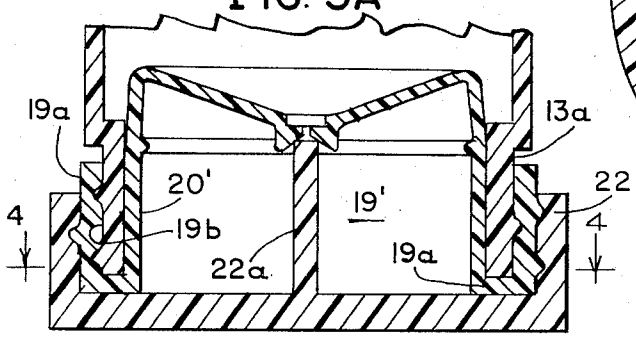
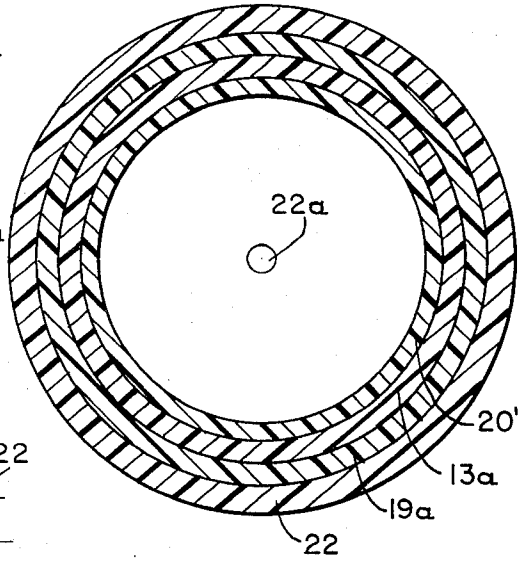


FIG. 4



DISPENSING CAP FOR DISCHARGING LIQUID INTO FLUSH TANK FROM A BOTTLE DURING A FLUSHING CYCLE

GENERAL DISCUSSION OF THE PROBLEM RELATING TO THE PRESENT INVENTION

This invention relates to a combination including a dispensing fitment for discharging liquid into a toilet flush tank from a bottle during a flushing cycle and is particularly concerned with having a supply of liquid, such as detergent, sterilizing agent or the like, supported within the flush tank of a toilet and adapted to be periodically conditioned for releasing a measured quantity of such liquid into the flush tank whenever a flush tank is emptied. As a rule, a toilet flush tank usually has water therein under the control of a manually operable valve which can be opened to discharge the tank water to a toilet bowl, after which the tank fills up for a new flush cycle. It is desirable to discharge into a flush tank during flushing a small quantity of a liquid from a bottle, such liquid being used either for sterilizing purposes, neutralizing unpleasant odors, or other purposes, and hereinafter identified as supplementary liquid. The supplemental discharge occurs and in fact results from the reduction in level of the flush tank water contents, after which the subsequent refilling of the tank functions to condition the system to repeat the supplemental discharge in connection with a new toilet flushing cycle.

The construction to be described hereinafter relates to a precision fitment for cooperation with a measured bottle of supplementary liquid to be discharged in measured quantities into the flush tank during each flushing cycle. Inasmuch as the quantity of supplementary liquid to be discharged into a flush tank is relatively small, of the order of about 30 or 40 drops, the dispensing fitment must be a precision device to function according to specifications.

GENERAL STATEMENT OF THE INVENTION

The dispensing fitment itself is normally disposed within the neck of a supplementary liquid containinig bottle to be supported in inverted position in a flush tank, the dispensing fitment being positioned in such a manner that normally the exterior is submerged a short distance below the normal stand-by level of water in the flush tank but well above the water level after the flush tank has been emptied or substantially emptied of its charge of water. In accordance with the invention, a general volumetric relationship between an air chamber forming part of the fitment structure and the volume of the bottle containing the supplementary liquid to be discharged is maintained for proper operation of the dispensing fitment. In addition, suspension of the bottle within a flush tank in relation to the two extreme limits of water level within a flush tank comes into play during normal operation of the dispensing fitment. A bottle containing the supplemental liquid, covered with the new dispensing fitment, is supported in inverted position in the tank.

As will be explained in further detail later, the rise of the water level within a flush tank, after the water has been discharged from the tank, is utilized to change air pressure within the bottle containing the supplementary liquid. As a result of such pressure, air pressure within such inverted bottle may be changed from normal. Upon the filling of the flush tank to its stand-by level, conditions in the entire dispensing system remains generally static until the tank is flushed. Thereupon the water level drops below the dispensing fitment, permitting a discharge of a small amount of liquid into the tank. By controlling various parameters such as the diameter and length of a discharge nozzle in the fitment and the discharge angle, as well as the differences in pressure to which the dispensing fitment is subject, and also the volumetric capacity of the bottle containing the liquid to be dispensed and the air chamber forming part of the fitment structure, a desired mode of operation can be established.

The structure embodied in the invention requires a high degree of precision in its manufacture and is advantageously embodied in a cap molded of a suitable plastic.

DESCRIPTION OF THE DRAWINGS

The invention will now be described in connection with the drawings wherein:

FIG. 1 shows a sectional elevation of a flush tank filled with water in normal stand-by condition and having suitably suspended therein a bottle in inverted position containing the supplementary liquid to be dispensed, the bottle having a neck containing the new dispensing fitment at a suitable level below the level of the flush tank water.

FIG. 2 shows the assembly illustrated in FIG. 1 but from a different angle to illustrate the bottle support means, the flush tank having been cycled with the water therein at a lower level and the fitment functioning to discharge some supplementary liquid from the bottle.

FIG. 3 is an enlarged view of the fitment to illustrate the various parameters governing the construction and operation of the dispensing cap.

FIG. 3A illustrates a modified fitment.

FIG. 4 is a section on line 4—4 of FIG. 3A.

DESCRIPTION OF THE PREFERRED SPECIES OF THE INVENTION

The structure embodying the present invention is made to function within toilet flush tank **10** connected to a water supply pipe, not shown. The water is such flush tank normally is adapted to remain at a level indicated by **11** for stand-by, such level being generally controlled by an automatic float valve which permits water to enter until the level, indicated by **11**, is reached, at which time the float valve shuts off such water supply. Inasmuch as there are various types of float control valves in use, and since such valves are well-known, a detailed description thereof is unnecessary. As a rule such flush tanks will have a manual control, not shown, for permitting water within the flush tank to run out through a discharge pipe at the bottom of the tank and flush the toilet. The discharge of the water through the bottom of the tank normally results in the level of the tank water dropping to some arbitrary level such as **12.**

Bottle **13** containing supplementary liquid to be dispensed may be of plastic, or any suitable material, and as will be shown later must have a volumetric capacity having a prescribed ratio with the volumetric capacity of an air chamber for the fitment to be described. As an example, bottle **13** may have a capacity of the order of about 12 ounces (or about 310cc), a depth of the

order of about 4 inches, a width of the order of about 3¼ inches, a thickness of the order of about 1⅜ inches, a neck of the order of about 1¼ inches and a tapering portion of the order of about 1 inch. The depth of bottle **13**, that is, the distance between the generally flat bottom of the bottle (this appears at the top in the inverted position of the bottle) and neck **13***a* of the bottle and transverse dimensions of the bottle are preferably within prescribed limits, as will be hereinafter explained in connection with the operation of the system.

Bottle **13** is normally supported at a level within a range of values, hereinafter set forth with respect to water level **11** by a suitable bracket **16** from angle portion **16***a* over the top edge of tank **10**. Bracket **16**, which may be of metal as aluminum or other suitable material is attached to button **16***b* molded to bottle **13**, the bracket having slotted hole for coupling the two. Bottle **13** has conventional bottle neck **13***a* whose interior surface may be smooth and whose exterior surface may be smooth or provided with a coarse thread. Preferably, bottle neck **13***a* has a smooth free edge **13***b* with the neck having a suitable length for supporting the fitment to be described. The operation of the fitment to be described is best obtained when level **11** of water in the flush tank in stand-by is from about ½ inch to about 2½ to 4 inches above edge **13***b* of the neck of bottle **13**.

Disposed tightly within bottle neck **13***a* in sealing relation thereto is fitment **19** having body **20**. Since the fitment is preferably made of molded plastic, and by providing a slight taper usually required for draft in molding and by utilizing the compressibility of plastic, a friction fit can be sufficient. As a rule, the height or depth of bottle **13** together with the low pressures in the system operation will permit the use of a friction fit. In all cases, fitment **19** must provide an airtight seal for bottle **13**.

A modification of fitment **19** is illustrated in FIG. 3A wherein wall **20'** is extended over itself to provide outer skirt **19***a*, whose inner face **19***b* is threaded to engage the external thread on neck **13***a*.

Molded fitment **19** may be of any suitable plastic, such as for example polyethylene. Bottle **13** may be of plastic or glass. Fitment **19** in its simplest form shown in FIG. **3** has a generally cylindrical body **20**, the outer surface of which is fitted into bottle neck **13***a*. The outer edge of fitment **19** at the bottom (inverted position) end of body **20** preferably contains an external flange **20***a* which normally overlies edge **13***b* of bottle neck **13***a* to limit the insertion of fitment **19** into the neck of the bottle. Fitment **19** has cylindrical body **20** and as an example body **20** may have an outer diameter a bit larger than about one inch and the inside diameter can be somewhat less, depending upon the desired thickness of body **20**. The thickness of body **20** of the fitment is not critical and may be tailored to the desired mechanical strength of the cap and as an example may be of the order of about 0.050 of an inch while the length along the axis of the cap may be of the order of about 0.7 of an inch. However, it is understood that these dimensions are purely exemplary and may be varied over wide limits consistent with the principles of the invention.

The inside diameter of body **20** may as an example by of the order of a bit less than about one inch while the thickness of flange **20***a* may be about the same as the thickness of body **20**. The dimension radially of flange **20***a* may vary within wide limits and may for example be of the order of about one-fifth of an inch. Preferably the radial dimension of flange **20***a* will be so selected with reference to the thickness of edge **13***b* of bottle neck **13***a* so that the outer edge of flange **20***a* will be substantially flush with the outer edge or surface of the bottle neck. The outer portion of bottle neck **13***a* may have an externally threaded portion **13***c* to accommodate a screw cap used in connection with shipping and handling the bottle when purchased. The inside diameter of body **20** of the cap and height of the air chamber therein are parameters of importance in the design of the cap but have a range of variations.

The top of fitment **19**, as shown in its inverted position, consists of a generally conical dished wall portion **23** having sufficient thickness to be mechanically stable. In practice, wall portion **23** may have a thickness of about the same as that of body portion **20**. The thickness of wall portion **23** must be great enough to avoid molding problems and also insure mechanical stability. Wall portion **23** may be flat or even convex rather than dished, the particular angle between wall portion **23** and body portion **20** not being critical. Wall portion **23** supports a nozzle structure **23***a* which may be symmetrically disposed with reference to the wall portion if other than flat. In fact the direction of dishing is not important and while shown as being concave from the top operating end of the fitment (in inverted position), the dishing may be convex if desired. However the concave dishing is desirable for guiding liquid toward the nozzle structure supported by the wall, as well as mechanically shielding the nozzle structure.

Nozzle structure **23***a* includes fine metering nozzle or passage **23***c* therethrough extending along the axis of the fitment (or if the nozzle structure is offset from the axis then parallel to such axis). The length and diameter of passage **23***c* are two important parameters in the fitment structure and the operation thereof. It is important that passage **23***c* be smooth, of uniform diameter, and have close tolerances both as to diameter and length. Passage **23***c* terminates in well **23***d* on the bottle side of the fitment. The shape of well **23***d* may vary within wide limits and is here shown as a rectangular well, but circular in plan view.

One of the functions of the wells on both sides are for ease in molding and controlling the length of fine passage **23***c* as well as terminating the passage ends. It is to be understood that well **23***d* is the entrance well for supplemental liquid to be discharged while well **23***e* is the discharge well. The flat bottom for well **23***d* prevents sediment in bottle **13** from settling over the end of fine passage **23**. The liquid in bottle **13** should be filtered before filling the bottle. The height between the open end of fitment **19** and the lower end of passage **23***c*, as well as the diameter of the chamber bounded by the inside surface of wall **20** and the plane of the outer edge of flange **20***a* are also parameters governing the design and operation of the fitment.

Fitment **19** has internal rib **23***f* provided along the inside surface of wall **20** at a distance from wall **23**. The location of rib **23***f* may vary and the thickness of the rib may also vary. The location, dimensions and nature of the internal rib will be determined in part by the mechanical requirements for the fitment, molding requirements as to where the die cavity is opened and the like. As shown here by way of example, internal rib **23***f* is substantially even with end **23***b* of the nozzle structure.

Edge 23*b* of the nozzle structure is at the large end of discharge well 23*e*. This well has a conical shape and the cone angle has an important bearing on the operation of the nozzle. Mathematically, the sine of the cone angle is a determinant in nozzle function. As the cone angle approaches zero, the discharge well begins to function generally as an extension of fine passage 23*c*. In practice, the angle of the cone side to the cone axis (half cone angle) can be 60°, but this value is not critical.

An outer cap 22 having a general cup-shape is adapted to screw over the outer threading of bottle neck 13*a* for fitment 19 or the outer threading on skirt 19*a* of modified fitment 19'. Cap 22 has upwardly extending pin 22*a* which can reach into nozzle well 23*e* for sealing. This cap 22 is provided with a fitment initially at purchase of bottle 13 with liquid so that no liquid can leak out and collect within the fitment chamber. This will obviate the possibility of a purchaser, when removing cap 22 in connection with installing a new bottle 13 of liquid, spilling some liquid on himself. Cap 22 is molded and expendable.

GENERAL OPERATION OF THE SYSTEM

As suggested in FIGS. 1 and 2 showing the respective bodies of liquid within bottle 13 and tank 10, the mounting of bottle 13 within tank 10 is such that bottle 13 is inverted with the outer edge of fitment flange 20*a* being submerged below the normal stand-by liquid level 11 when flush tank 10 has its full charge of water. Bottle 13 contains its charge of supplementary liquid to be dispensed, the bottle having an initial air space. Due to the submersion of the open bottom end of fitment 19 there will be a water pressure above atmosphere due to the difference in height from about ½ inch to about 2½ inches between liquid level 11 of full tank 10 and the bottom end of fitment 19. This pressure will be developed when the tank water rises, after flushing, within fitment 19 and will result in some compression of air within the chamber within body 20 and wall 23. Some air will be forced through fine passage 23*c* in wall 23 and result in air being forced within bottle 13. It is important that the volume of the air chamber in fitment 19 not be too small with relation to any air chamber in bottle 13. Thus the compression of air within the chamber in fitment 19 and the expulsion into the air chamber within bottle 13 will provide some increase in the air pressure within bottle 13. Having a volumetric relationship between fitment air chamber and the volume of bottle 13 of at least about one-two hundredths will permit some increase in air pressure within bottle 13 when the liquid level 11 in tank 10 is at its maximum value, as illustrated in FIG. 1. By proper proportioning of the various parts, the change in air pressure within bottle 13 will suffice for expulsion of some liquid through passage 23*c* after the tank level has dropped below the fitment bottom.

Assuming that conditions have become stabilized, as illustrated in FIG. 1, there will be a small amount of water from flush tank 10 entering into the open bottom (as illustrated in FIG. 1) of fitment 19. Upon the occurrence of a flush tank operating cycle, this usually being occasioned by the manual raising of a stopper or other closure at the bottom end of the flush tank, the level of the water within flush tank 10 will rapidly drop below the bottom of the end of fitment 19. In practice, as the level of water within tank 10 drops below the open bottom end of fitment 19, some vacuum may be created, with the principal effect of the sudden lowering of the water level within tank 10 being effective to permit air pressure above the liquid level in bottle 13 to exert some force to expel a small amount of liquid from the interior of bottle 13 through the fine passageway in wall 23 of the cap and permit drops to fall freely into the flush tank. When bottle 13 is first applied, the first few cycles may cause an excessive amount of liquid to be discharged. Thereafter the operation is stabilized. The discharge of liquid from within bottle 13 will also be determined by such factors as the liquid head within bottle 13 above fine passage 23*c* in wall 23 tending to promote some liquid discharge with a counter tendency of a vacuum being created within bottle 13 above the liquid tending to restrict or stop the flow of liquid, in addition to the factors of surface tension and capillary action within the system acting to limit the flow of water, as well as friction.

By having discharge passage 23*c* fine enough in relation to the length of such passage as well as the viscosity and surface tension of liquid within bottle 13, a generally liquid-tight closure may be created even though the level of water within flush tank 10 is below the bottom of the fitment. By proper control of parameters a substantial range of quantity of liquid discharge from bottle 13 may be effected, all within a flushing cycle and a sufficient number of flushing cycles may be provided so that bottle 13 need not be changed for weeks with normal use of a toilet.

The dimensions of the bottle for containing the material to be dispensed are given by way of example of a suitable volume in comparison to the volume of the chamber (about 10cc) formed by the fitment. While the bottle dimensions may vary, it is preferred that the dimension of the bottle corresponding to the depth when the bottle is in standing position be of the general order as given here, this being due to the amount of hydraulic head acting upon the liquid within the bottle at the nozzle or fine passageway. It is even possible to have the bottle somewhat shorter in height or depth and have the transverse dimensions somewhat larger so long as the liquid head above the nozzle when the bottle is full is at least about two or three inches.

In any event, the ratio of volume of the entire bottle as compared to the volume of the chamber defined by the fitment should be as previously pointed out, not less than about 200 to 1, for obtaining desirable pressure changes in bottle 13 when cycling the tank. Such a ratio is also generally desirable to prevent tank water from reaching the fine passage when the tank water level is rising. In the latter case diffusion of one liquid into the other may occur. Assuming that the submersion of the free end of the cap below the water level when the tank is full (this being determined by the float valve) is no more than about 4 inches, then the operation of the system will be generally satisfactory. It is assumed that the liquid within the bottle to be dispensed will have a viscosity and surface tension of the general order of that of the water within the tank. These characteristics will normally be true of the materials available on the market and in general may easily be adjusted by the addition of a small amount of detergent, this tending to reduce viscosity and surface tension.

The following analysis hereinafter given makes use of conventional mathematical equations in texts on the flow of liquid through a nozzle. While the flow in the

invention is not continuous, the analysis is sufficient to indicate what parameters are important and significant. In particular, the analysis shows that the critical factors in the nozzle are the diameter and length of such nozzle, the diameter in the pertinent equations involving the fourth power thereof. Furthermore, the length of the nozzle is an inverse factor. The nozzle has a limiting diameter which indicates that the diameter of 0.010 inches is close to the bottom limit for using a device of the character set forth, assuming of course that the liquid within the bottle has generally about the same viscosity and surface tension as that of water. As the analysis indicates, a liquid having a lower viscosity and lower surface tension can be used with a finer passage or nozzle and still obtain some feed of liquid therethrough. The length of the nozzle may be of the order of about ⅛ inch. The tolerances on the nozzle diameter are quite small and in practice should be less than of the general order of about 10 percent. The other dimensions involved are neither fine nor critical and are well within manufacturing tolerances generally prevelant in industry. The 10 percent tolerance, or even smaller, of the nozzle diameter is readily obtainable in plastic molding. By experiment, a nozzle diameter of from about 0.005 inch to about 0.020 inch works satisfactorily. The nozzle length (length of fine passage **23***c*) is preferably about 0.125 inch although this may vary within substantial limits.

The relative volumetric relationships between the volume of the fitment chamber and the volume of the bottle will involve to some extent the depth of immersion of the free end of the fitment. For practical purposes, a nozzle diameter from about 0.010 inch to about 0.015 inch may be used with the length of the nozzle running about the order of ⅛ inch. When using a new bottle containing a filling of liquid, preferably there should be an initial air space within the body of about 5 percent of the entire volume of the capacity of the bottle. Even then, the first two or three cycles of a cap with such a new bottle will generally be erratic insofar as the volume of discharge from the bottle is concerned. As a rule, the amount of such liquid discharge is substantially greater than what has been designed as normal during operation of the system after the system has begun to cycle.

A bottle containing the liquid to be discharged can have a rib around the body thereof for functioning as a guide in correctly supporting the bottle in the tank. Thus the rib can limit the elevation of the bottle in its inverted position and, assuming that the level of water in the tank when the tank is full is constant, the immersion of the fitment beneath the surface of the water when the tank is full will or can be made to lie within about ½ inch as one extreme and about 2½ inches as the other extreme. The immersion can go up to about 4 inches. As a rule, the less the immersion of the free end of the fitment below the level of the tank water, as a rule the less will be the amount of liquid discharged for each flushing cycle. Thus if a bottle of material is adjusted for immersion of the order of about ½ inch with reference to the free edge of the fitment, the amount of liquid discharged per flushing cycle will be found to be less than with a deeper immersion into the tank water. In consequence, a bottle of liquid may last for about one week, assuming normal use of the toilet.

It is thus evident that while the structure of the fitment and the dimensions thereof are important with relation to other parts of the system (this including the relative volume of the fitment chamber and the bottle volume as well as the depth of immersion of the free edge of the fitment in the tank water), the fitment structure and particularly the dimensions thereof must be designed and used with a suitable bottle containing liquid to be used and suspended a suitable distance for immersion within the tank, in order for the system as a whole to operate properly.

PERFORMANCE CHARACTERISTICS OF FLUID DISPENSING NOZZLE

Flow through the nozzle previously described can be characterized by an equivalent circuit containing three resistances in series.

R_T — Resistance in turbulent flow region

R_L — Resistance in laminar flow region (Reynolds number <2,000)

R_{ST} — Resistance of surface tension in fluid at nozzle

The pressure drop across the nozzle is therefore made up of three pressure loss components due to the three resistances.

$$P_T = f(L/D)(V^2/2g) \tag{1}$$

P_T — Pressure drop across the orifice due to turbulent flow

f — Friction coefficient of nozzle in turbulent flow

For the nozzle the turbulent flow factor will be neglected as we are not dealing with turbulent flow.

$$P_L = 8\mu LQ/\pi R4 \tag{2}$$

P_L — Pressure drop across the nozzle due to laminar flow

μ — Dynamic viscosity

L — Nozzle length

Q — Flow rate

R — Nozzle radius

$$P_{ST} = 2\sigma \mathrm{Sin}\beta/R$$

P_{ST} — Pressure drop across the nozzle due to fluid surface tension

σ — Surface tension of fluid

β — Angle of nozzle (from vertical)

We can therefore set up the following equation for the system.

$$\Delta P = 8\mu LQ/\pi R^4 + 2\sigma \mathrm{Sin}\beta/R$$

or

$$Q = \pi R^4/8\mu L\ [\Delta P - 2\sigma \mathrm{Sin}\beta/R]$$

This basic formula provides a clear understanding of the factors controlling the performance of the metering nozzle. The surface tension factor acts as a switch since below a specific threshold pressure it will cut off flow entirely. The calculation for flow of water through a 0.010 diameter nozzle shows that this is close to a minimum or limiting diameter. For a fluid of lower surface tension some flow would occur with this size orifice. The cone angle of the orifice also controls the switching property. An angle of 60° (120° included) is desirable for a production nozzle.

The flow rate from the nozzle can be seen to be proportional to the fourth power of the nozzle radius (or

diameter) and inversely proportional to fluid viscosity and nozzle length. To obtain desired flow one would search for a compromise of nozzle diameter and length. Calculations would indicate that a nozzle diameter of 0.015 inch and a length of 0.125 inch should provide a desirable flow rate for a pressure pulse of 2 inches of water. Control of the nozzle diameter in molding will be critical since the flow is proportional to the fourth power.

A key design feature in the performance of the nozzle is the nozzle air chamber. It is this trapped volume of air which allows a balancing bubble of air to enter the nozzle when the tank water rises, closing off the open end of the nozzle and immersing the bottle. For a given immersion level (2 inches has been used) air is forced into the bottle and an equilibrium established. When the tank level falls again exposing the nozzle to atmospheric pressure an unbalance exists which forces liquid from the bottle until the pressure difference across the bottle again balances the column of fluid in the bottle. It is important that the air volume in the nozzle air chamber be of sufficient size to prevent the orifice tip from contacting the tank water. If contact of the tank water is permitted an uncontrolled continuous diffusion of the two liquids would take place. The volume of a circular air chamber is $V = \pi R^2 H$, where h is the height of the fixment from the open end **23***b* of the conical well and the bottom open end of the fixment chamber. I have determined that h must be a minimum of 0.1 inch for practical size bottles **13** and 2 inch immersion. In practice, h will be much greater. If this volume is called V_1, atmospheric pressure P_1 and I the immersion depth one could calculate the volume change upon immersion. This would be $V = V_1 P_1/(P_1 + I)$.

For an immersion depth of 2 inches of water (p = 0.0722 psi).

$$V_2 = V_1\,[14.7/14.7+0.0722] = 14.7/\mathbf{14.772}$$

or

$$V_2 \approx 0.995\ V_1.$$

This represents the magnitude of the height of rise of tank water into the nozzle air chamber. When the bottle empties V becomes the nozzle air chamber volume plus the bottle volume. The tank water will enter the bottle if the nozzle air chamber volume is less than one-two hundredth the bottle volume. Nozzle length L in practice can be about ⅛ inch. However, nozzles about one-half this length will function, the flow rate being greater, other factors remaining the same.

CALCULATION FOR 0.010 DIAMETER — 0.050 LONG NOZZLE — FOR WATER

$$\phi = [\Delta P - 2\sigma \mathrm{Sin}\beta/R]\ \pi\ R^4/8\mu L$$

$R = 0.005$ in. $L = 0.050$ in.
$\beta = 30°$
$\Delta P = 2$ INCHES $H_2O = 0.722$ LB/in^2
σ(WATER AT 60°F) $= 4.23 \times 10^{-4}$ LB/in
μ(WATER AT 60°F) $= 1.64 \times 10^{-7}$ LB SEC/in^2

$$\phi = [0.0722 - 2(4.23 \times 10^{-4})(0.500)/0.005]\ \pi(0.010)^4/(8)(1.64 \times 10^{-7})(0.050)$$

$$\pi/8\mu = 2.39 \times 10^6$$

$$\phi = [0.0722 - 0.0846]\ (2.37 \times 10^6)(0.010)^4/0.050$$

CALCULATION FOR 0.020 DIAMETER NOZZLE —0.050 LONG — FOR WATER

$$\phi = [\Delta P - 2\sigma \mathrm{Sin}\beta/R]\ \pi R^4/8\mu L$$

$R = 0.005$ in $L = 0.050$ in.
$\beta = 30°$
$\Delta P = 2$ INCHES $H_2O = 2 \times 62.4/\mathbf{1728} = 0.0722$ LB/in^2
σ(WATER AT 60°F) $= 0.00508$ LB/FT $= 4.23 \times 10^{-4}$ LB/in
μ(WATER AT 60°F) $= 2.36 \times 10^{-5}$ LB SEC/FT^2 $= 1.64 \times 10^{-7}$ LB SEC/IN^2

$$\phi = [0.0722 - (2)(4.23 \times 10^{-4})\ (0.5)/0.010]\ \pi\ (0.010)^4/8(1.64 \times 10^{-7})(0.050) = [0.0722 - 0.0423]\ (0.478) = 0.0143\ \mathrm{IN}^3/\mathrm{SEC}$$

$\phi = 0.246$ CC/SEC or 15 CC/MIN.

CALCULATION FOR 0.015 DIAMETER — 0.150 LONG NOZZLE — FOR WATER

$$\phi = [\Delta P - 2\sigma \mathrm{Sin}\beta/R]\ \pi R^4/8\mu L$$

$R = 0.0075$
$L = 0.150$ in
$\beta = 30°$
$\Delta P = 2$ INCHES $H_2O = 0.0722$ LB/in^2
$\sigma = 4.23 \times 10^{-4}$ LB/in
$\mu = 1.64 \times 10^{-7}$ SEC/in$^{SEC/in\ 2}$

$$\phi = [0.0722 - 2(4.23 \times 10^{-4})(0.500)/0.0075](2.39 \times 10^6)(0.0075)^4/0.150$$

$$\phi = [0.0722 - 0.0565](2.39 \times 10^6)(0.316)(10^{-8})/0.150$$

$$\phi = [0.0167](0.0503) = 0.00079\ \mathrm{in}^3/\mathrm{SEC}$$

$\phi = 0.0136$ CC/SEC
OR $\phi = 0.\delta$ 16 CC/MIN

What is claimed is:

1. An integrally molded fitment for use with a bottle of predetermined volume containing a liquid whose characteristics make it desirable to introduce a small quantity into the flush tank of a toilet during a flushing cycle, said bottle having a neck in which is supported a fitment, said fitment being cup shaped and having a concave bottom cup wall provided with a centrally located nozzle structure extending inwardly of the cup, said nozzle structure containing a fine nozzle or passageway having a diameter of between about 0.010 inches and about 0.020 inches, and a length of about 1/16 inch to about ⅛ inch, depending upon the quantity of liquid to be discharged per cycle, a specific diameter dimension being maintained to a tolerance of less than **10%** in production, said liquid in said bottle normally having a viscosity and surface tension of the same general order as that of water, said fitment having a well at each end of the passageway, the well at the liquid discharge end within said fitment being conical and having a suitable cone angle, the well at the liquid entrance end of the passageway having a flat bottom surrounding the end of said fine passageway, said fitment being adapted to be secured in an air-tight fit to said bottle and having the bottle and fitment inverted with the open ended cup chamber of the fitment extending downwardly from the bottle, said chamber defining a volume of the order of at least about one-two hundredths of the volume of the bottle interior, the water in the flush tank being adapted to cover the open end of said fitment chamber and rise therein and extend outside of said fitment above said open end for a dis-

tance of from about ½ inch to about 4 inches when said flush tank attains normal full condition in stand-by for a flushing operation, the water in said tank during flushing being adapted to drain from said tank so that the water level in said flush tank is below the bottom of said fitment with the open ended cup chamber being exposed to atmosphere, the fitment and bottle being adapted to cooperate with rising flush tank water level to force some air from said chamber through said fine passageway and into said bottle, said flush tank when water therein has drained so that the water level is below the level of said fitment permitting air in said bottle to expand and discharge a quantity of liquid from said bottle, the amount of said liquid discharged being dependent upon the dimensions of said passageway, the depth of immersion of said fitment in said tank water and the relative volumes of said fitment chamber and the bottle volume cooperating with the depth of immersion of said fitmentn below the surface of said water when said tank is in stand-by condition determining in part the amount of liquid discharged, the fitment dimensions and mounting being such that the tank water level within the fitment chamber is always below the nozzle structure.

2. The combination according to claim **1** wherein the volume of said chamber defined by said fitment is of the general order of about 10cc and the bottle volume is of the general order of about 300cc and wherein said passageway has a diameter of about 0.015 inch and a length of about 1/16 inch.

3. The construction according to claim **1,** wherein a cap is provided for closing the fitment chamber as part of the original package of bottle containing liquid and carrying a fitment, said cap carrying a pin so dimensioned and located that the free end of such pin extends into the conical well of said nozzle structure to seal the discharge end of said fine passageway whereby the bottle and fitment may be installed with minimum waste of liquid.

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