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[54] **APPARATUS FOR DISPENSING LIQUID**  
 9 Claims, 6 Drawing Figs.

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 222/321, 222/382, 103/230  
 [51] Int. Cl. .... **G01f 11/06**  
 [50] Field of Search .... 222/309,  
 320, 321, 387, 385, 382; 103/230

[56] **References Cited**

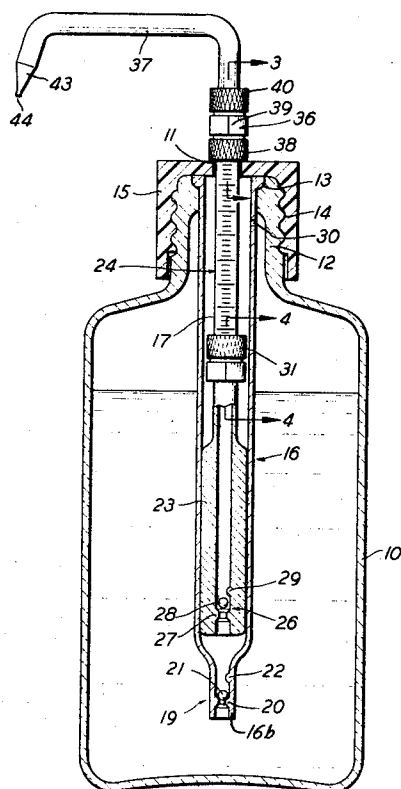
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**ABSTRACT:** Apparatus for repetitively dispensing accurately measures of liquid which comprises a bottle and a dispensing device installed thereon including a cap having a hole in it and adapted to fit on the neck of the bottle. The device also includes a glass barrel having a shoulder about its upper end for seating upon the upper end of the inside of the neck of the bottle so as to depend beneath the hole in the cap through the neck and into the bottle. A delivery tube has a lower end opening into the barrel and extends upwardly therefrom through the barrel and the hole in the cap to a spout on its outer end. A first check valve is disposed within the barrel beneath the lower end of the delivery tube for normally closing the lower end of the barrel, and a second check valve is disposed within the delivery tube for normally closing its lower end. A glass plunger on the delivery tube is reciprocal within the barrel, in response to raising and lowering of the outer end of the delivery tube, between different vertical positions in the barrel above the lower check valve. A first stop surrounds the delivery tube above the plunger and below the cap, and a second stop surrounds the delivery tube above the cap. A volumetric scale is arranged along the length of the delivery tube below the second stop and above the plunger and the first stop is adjustable along the length of the delivery tube to permit it to be moved to an adjusted position along the scale for varying the stroke of the plunger and thus the volume of liquid to be dispensed.



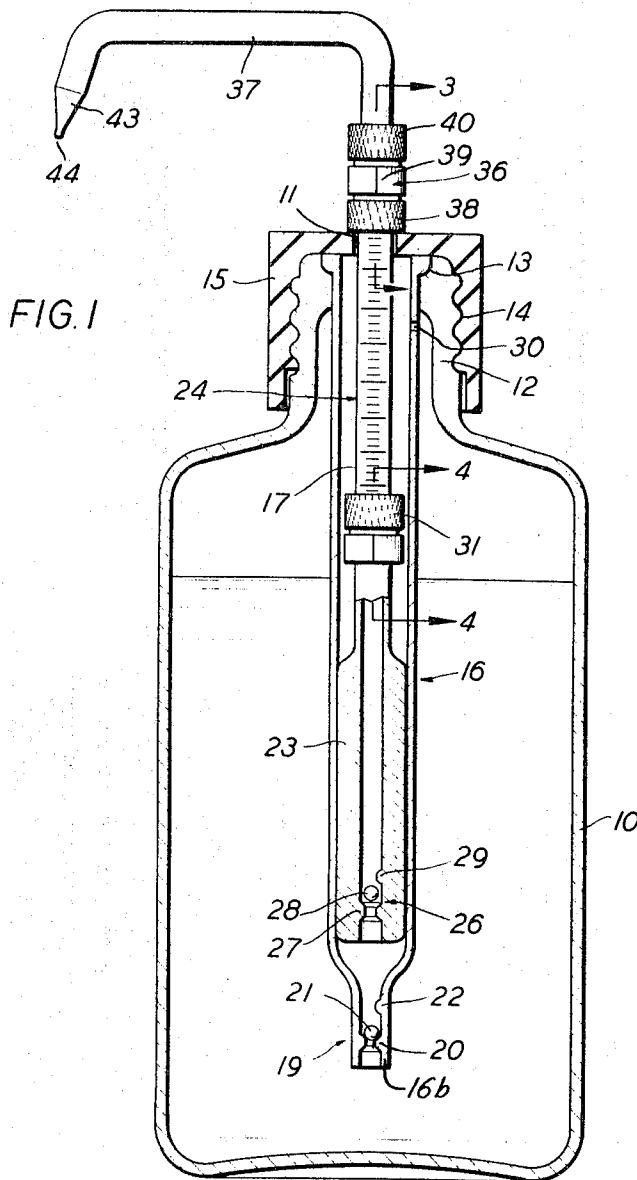


FIG. 2

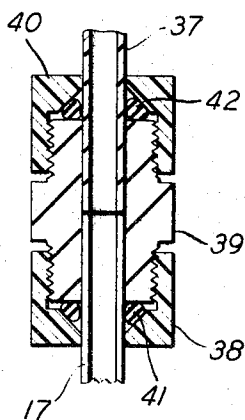
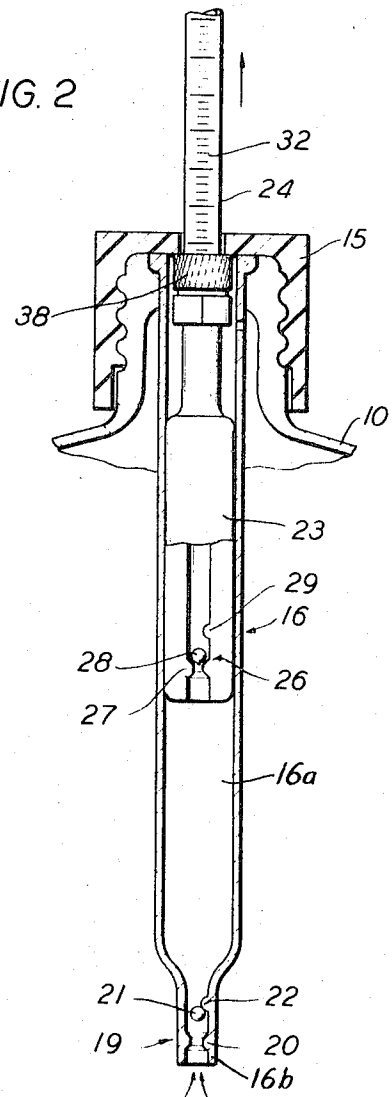


FIG. 3

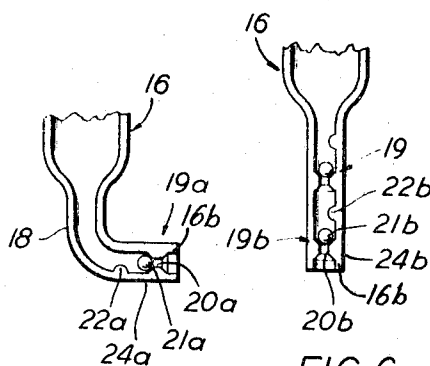


FIG. 5

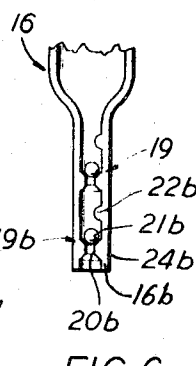


FIG. 6

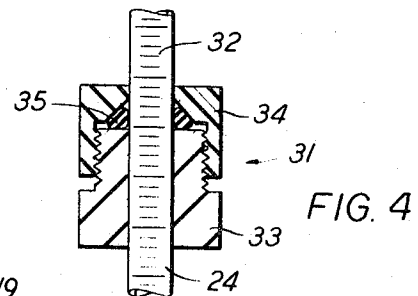


FIG. 4

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## APPARATUS FOR DISPENSING LIQUID

This invention relates generally to apparatus for dispensing liquids; and, more particularly, to improved apparatus of this type including a device adapted to depend from a bottle cap and into liquid within the bottle to permit repetitive dispensing of accurately measured quantities of such liquid.

Devices of this type are frequently used in scientific laboratories where measured quantities of chemical reagents or the like must be transferred from storage bottles to test tubes or other small receptacles. Prior devices of this type have in common a delivery tube which extends through the cap and connects at its lower end with a barrel depending into the bottle beneath the cap. A plunger is reciprocal within the barrel and check valves are disposed above and below the connection of the barrel with the delivery tube. Thus, upon lifting of the plunger by means of a part above the cap, liquid in the bottle is alternately drawn into the delivery tube above the lower check valve and then forced past the upper check valve and out the outer end of the tube upon lowering of the plunger. A volumetric scale indicates the displacement of the plunger when it is lifted and stops limit the movement of the plunger to a desired amount so that the operator may repetitively dispense measured quantities of liquid. At least the portions of the delivery tube, barrel, and plunger constantly exposed to such liquids are made of glass in order to protect them against the deleterious effects of the bottled liquids.

In one such device, which is shown in Shapiro U.S. Pat. No. 3,143,252, the barrel is supported from the neck of the bottle and beneath a hole in the cap, and the delivery tube extends concentrically within the barrel to a level above the cap and then laterally outwardly to a spout on its outer end. The plunger of this device is disposed above the lateral extent of the delivery tube and carries stops for alternately engaging the barrel to limit reciprocation of the plunger. The volumetric scale is along the length of the barrel above the cap and one of the stops is adjustable lengthwise of the scale to permit varying the stroke of the plunger.

In another such device, the delivery tube and barrel are instead arranged side by side and extend into the bottle through holes in the cap. In this device, the lower end of the barrel has a lateral connection with the delivery tube intermediate the upper and lower check valves and beneath the plunger in the barrel. There is a volumetric scale on the delivery tube above the cap, and the upper end of the plunger above the cap carries a stop which alternately engages with the top of the cap and an adjustable part on the delivery tube.

In both of these devices, the adjustable stop is disposed outside of the bottle and above the cap in a position where it may be accidentally displaced. Also, neither produces the accuracy in dispensing which is often required, particularly when the plunger is reciprocating at a fast rate.

In addition to the foregoing, the device disclosed in the Shapiro Patent necessarily has a large portion of the glass barrel and the plunger extending above the cap, even when the device is inactive. This portion is not only subject to breakage, but also consumes considerable headroom and thus makes **stocking** more difficult. Furthermore, in this particular device, the delivery tube and barrel are integral parts which complicate their cleaning and general upkeep.

The other device, on the other hand, requires a special large diameter cap and, thus, cannot be used with standard laboratory bottles. Furthermore, although the barrel and delivery tube may be separated for cleaning, they nevertheless are connected by tubing not made of glass and which is thus constantly exposed to the deleterious effects of the liquid in the bottle. Still further, a vent in the cap is always open and thus permits evaporation of the liquid when the device is inactive over long periods of time.

An object of this invention is to provide apparatus including a device of this type which does not require a special cap and further which has minimum headroom requirements and minimum exposure to breakage.

Another object is to provide a device of the character described in the foregoing object which consists of a minimum number of parts which may be easily taken apart for cleaning or repair and which require no plastic tubing for interconnection within the bottle.

Still another object is to provide such a device in which a vent in the cap is automatically closed when the device is inactive.

A further object is to provide a device of this type in which the adjustable stop is so arranged as to be protected against accidental displacement.

A still further object is to provide such a device in which all parts normally disposed within the bottle are made of glass and the remaining parts normally outside the bottle are made of plastic or other less fragile material.

A still further object is to provide such a device having a high degree of accuracy, even when the plunger is operated at a rapid rate.

These and other objects, advantages, and features of the invention are accomplished, in accordance with the illustrated embodiments of the invention, by apparatus comprising a bottle, a cap for attachment to the bottle and having a hole in it, and a glass barrel for extension through the neck of the bottle beneath the hole in the cap. A delivery tube connects with the barrel at its lower end and extends upwardly within the barrel and through the hole in the cap to project from the hole in the cap. A first check valve normally closes the barrel beneath the connection therewith of the delivery tube, and a second check valve normally closes the tube above its lower end. A glass plunger on the delivery tube is reciprocated in the barrel, by means of the outer end of the delivery tube, between different vertical positions in the barrel above the first check valve.

A first stop surrounds the delivery tube above the plunger and below the cap to limit upward movement of the plunger, as by engagement with the bottom of the cap. A second stop surrounds the delivery tube above the cap and normally rests on the top of the cap to limit downward movement of the plunger. Thus, the stroke of the plunger, and thus the volume of liquid to be dispensed, is dependent upon the position of the two stops. That is, upon lifting of the tube from its normally lowered position, liquid in the bottle is drawn into the barrel past the first check valve, and upon lowering the tube, this liquid drawn into the barrel is forced past the second check valve to dispense an equal volume of liquid through the outer end of the tube.

At least that portion of the delivery tube between its lower end and the second stop is made of glass, so that all the parts which are exposed to liquid within the bottle when the device is inactive are made of a material resistant to the deleterious effects of the liquid. In a preferred embodiment of the invention, the second stop comprises a coupling between this glass portion of the tube and a plastic portion thereof which extends externally of the cap to its outer end.

In accordance with another novel aspect of the preferred embodiment of the invention, the first stop is slidably movable along the delivery tube to permit adjustment of the stroke of the plunger. Since this stop is therefore within the barrel, it is not exposed to accidental displacement. In this preferred embodiment, a volumetric scale is arranged on the delivery tube above the plunger so that the operator can adjust the stop to a position for dispensing a desired volume of liquid.

In accordance with another novel aspect of the preferred embodiment of the invention, a vent hole is positioned in the cap so as to be closed by the second stop when the latter rests on top of the cap. Also, there is a vent in the barrel connecting its interior with the upper end of the bottle, so that the air space above the liquid in the bottle is vented when the delivery tube is lifted upon actuation of the device, but normally closed when the device is inactive, so as to thereby prevent evaporation of the liquid.

A high degree of accuracy is obtained in the use of the device, even when the delivery tube is reciprocated at a fast rate, by using a nozzle on the outer end of the delivery tube

having an orifice therein which is sufficiently small to create considerable back pressure in the tube above the check valve therein. Thus, even when the stop on the delivery tube above the cap is jarred downwardly against the cap, there is little tendency for the first or lower check valve to be moved upwardly off its seat. Consequently, there is very little chance for an excessive amount of liquid to move into the barrel on this downward stroke of the plunger. Toward this same end, the lower or second check valve may be of a special construction for minimizing this leakage past it upon jarring of the cap. In one form, there is a third check valve mounted beneath the second or lower check valve, which has been found to reduce any such leakage by approximately 50 percent. In another form, the lower or second check valve is arranged in a laterally extending portion of the lower end of the barrel, so that the valve member moves laterally between seated and unseated positions. In this latter form, therefore, downward jarring has little or no tendency to move the check valve member off its seat.

In the drawings, wherein like reference characters are used throughout to designate like parts:

FIG. 1 is a vertical section view of the preferred embodiment of this invention, with the cap of the dispensing device installed on a reagent bottle and with the delivery tube and plunger thereon in their lowered inactive positions;

FIG. 2 is a partial view of such device, similar to FIG. 1, but with the delivery tube and plunger raised to charging position;

FIG. 3 is an enlarged sectional view through the coupling forming the second stop on the delivery tube, as seen along broken line 3-3 of FIG. 1;

FIG. 4 is an enlarged sectional view through the adjustable first stop, as seen along broken line 4-4 of FIG. 1;

FIG. 5 is a sectional view of one form of the modified lower check valve construction; and

FIG. 6 is a sectional view of the other modified form of the lower check valve construction.

With reference now to the details of the drawings, and particularly FIG. 1, the overall apparatus includes a bottle 10 for reagents or the like and having a neck 12 which is in standard use in laboratories. This neck 12 has a circular groove 13 on the inside of its upper end, and threads 14 about its outer upper side to receive a cap 15. For the dispensing device to be installed on the bottle, there is an opening 11 in the top of the cap of a diameter less than the inner diameter of the neck 12 of the bottle.

A glass barrel 16 has a circular shoulder 17 at its upper end which seats in the groove 13 in the neck of the bottle, so as to support the barrel for depending through the neck and into the liquid in the bottle. Barrel 16 includes a plunger chamber 16a and a reduced lower end or nozzle 16b which communicates with the interior of the bottle. A check valve 19, which is disposed in the reduced lower end of the barrel, includes a tapered seat 20 having a ball 21 adapted to seat thereon for normally closing the lower end of the barrel. There is a projection 22 within the reduced lower end of the barrel, but above the seat 20, to limit upward movement of the ball 21 as it is unseated.

Delivery tube 24 has an open lower end connecting with the interior of the barrel 16 and extends upwardly therefrom through the barrel and the hole 11 in the cap. The lower portion of the delivery tube is enlarged to provide a glass plunger 23 sealably slidable within the barrel above the check valve 19 and below the cap. Another check valve 26 disposed in the lower end of the delivery tube 24 includes a tapered seat 27 and a ball 28 adapted to rest on the seat to normally close the lower end of the delivery tube. As in the case of the check valve 19, upward, unseating movement of the ball 28 of the valve 26 is limited by a projection 29 on the interior of the tube above the seat 27.

The opening 11 is somewhat larger than the outer diameter of the tube 24 to provide an angular vent hole or space between the interior of the barrel 16 and the exterior of the device. There is also a vent hole 30 in the upper portion of the

barrel to connect the interior of the barrel with the upper end of the bottle above the liquid level therein. This venting will equalize the ambient pressure outside of the bottle with the pressure in the bottle above the liquid, and thereby facilitate dispensing of the liquid upon reciprocation of the delivery tube. Thus, as previously described, and as will be apparent from this description of the drawings, when the delivery tube is lifted from its inactive, lower position, check valve 19 will be opened to permit a charge of liquid to be drawn into the barrel beneath the plunger 23. Then, upon lowering the delivery tube, the check valve 19 is closed and the check valve 26 is opened to force this charge into the delivery tube, which in turn displaces an equal volume of liquid through the outer end of the delivery tube.

The upward movement of the delivery tube and the plunger is limited by means of a sleeve 31 about the delivery tube and having an upper surface which serves as a stop upon engagement with the lower side of the cap, as shown in FIG. 2.

Downward movement of the delivery tube and plunger is limited by means of a sleeve having a lower surface which provides a stop for abutment with the top of the cap, as shown in FIG. 1. More particularly, a volumetric scale 32 is disposed along the length of the delivery tube 24, as by etching thereon, so that the position of the stop surface on the upper end of sleeve 31 along the scale indicates the volume of liquid which is dispensed upon a full stroke of the plunger.

In accordance with the present invention, the sleeve 31 is slidably movable along the delivery tube between different positions relative to the scale 32, thereby permitting the device to be adjusted for dispensing different volumes of liquid. Thus, as shown in FIG. 4, the sleeve 31 includes upper and lower threadedly connected parts 34 and 33, respectively, surrounding the delivery tube and an O-ring 35 disposed between oppositely facing surfaces on the interior of these threadedly connected parts. Thus, as the part 34 is tightened down on the part 33, the O-ring 35 is deformed to tightly engage the delivery tube 24 and thus normally hold the sleeve 31 in a desired position. However, when the part 34 is backed off of the part 33 to relax the O-ring 35, the sleeve 31 may be moved along the tube 24 to another position relative to the scale 32 after which the part 34 may then be again made up tightly with the part 33.

As best shown in FIG. 3, the sleeve 36 not only serves as a stop to limit downward movement of the delivery tube 24, but also couples a lower glass portion 17 of the delivery tube to an upper plastic portion 37. Thus, as previously described, the portion of the delivery tube which is normally disposed within the bottle and thus subject to the deleterious effects of the liquid in the bottle is made of glass, while the exterior portion of the delivery tube, which is subject to breakage or other damage is made of plastic or other more flexible material.

As shown in FIG. 3, the stop 36 thus includes a lower nut 38, an intermediate, double ended threaded connector 39, and an upper nut 40. An O-ring 41 is disposed between oppositely facing surfaces of the nut 38 and connector 39, and an O-ring 42 is placed between oppositely facing surfaces of the connector 39 and the nut 40. When the nuts are then made up with the connector, the O-rings are deformed into tight sealing engagement with the glass portion 17 and the plastic portion 37 of the delivery tube.

As can be seen from FIG. 1, the nut 38 is of greater diameter than opening 11, so that when the lower surface of the nut seats on the top of the cap in the connecting position of the dispensing device, it covers the opening 11. Thus, the venting of the upper end of the bottle above the liquid is prevented while the device is inactive so as to minimize the possibility of evaporation of the liquid. On the other hand, when the dispensing device is again put into use, lifting of the delivery tube to charge the barrel will automatically equalize the pressure within the bottle with the ambient pressure, so as to facilitate pumping of the charge of liquid in the manner described.

As shown in FIG. 1, the plastic portion 37 of the delivery tube extends a short distance above the coupling 36 and then laterally to a point beyond the outer diameter of the bottle 10, and then downwardly to a dispensing nozzle 43 on its outer end. As shown in FIG. 1, this nozzle has an orifice 44 in its outer end which is considerably smaller than the inner diameter of the delivery tube. Thus, for the purposes previously described, downward movement of the delivery tube so as to dispense a charge therefrom will impose a back pressure within the tube and on the check valve 19. This not only tends to maintain the check valve seated, even though the coupling 36 should be jarred downwardly against the cap, but also will decelerate this downward movement to a certain extent so as to reduce the jarring in any case.

The modified lower check valve construction shown in FIGS. 5 and 6 may be used either in addition to the restricted nozzle 43 or as an alternative thereto. In the latter case, the ability of these alternative check valve constructions to lessen the likelihood of overcharging of the barrel upon jarring of the coupling 36 against the cap enables the orifice 44 in the nozzle 43 to be enlarged for quicker dispensing.

As shown in FIG. 5, in one such modified check valve construction, the lower reduced end of the delivery tube 24 is bent to provide a laterally extending portion 24a in which the lower check valve 19a is disposed. Thus, the seat 28 for this check valve extends vertically rather than horizontally across the reduced lower end of the delivery tube, so that the ball 21a moves laterally or horizontally toward and away from seating position. As a consequence, and as previously described, downward jarring upon the cap will have very little tendency to unseat the ball 21a. As in the case of the valve 19, there is a projection 22a in the tube which limits unseating movement of the ball.

In the modified lower check valve construction of FIG. 6, the lower reduced end of delivery tube 24 is elongated at 24b to receive a second lower check valve 19b beneath the check valve 19. Thus, there is a seat 20b on the inner end of this lower portion 24b for a ball 21b, and the upward unseating movement of the ball 21b is limited by a projection 22b thereabove, but below the seat for the ball 19. Since these check valve 19 and 19b are in series, they substantially lessen overcharging of the chamber by reducing any such seepage by approximately one-half. Obviously, this degree of overcharge may be further reduced by additional lower check valves in series with the check valves 19 and 19b.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departure from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. A device for repetitively dispensing liquid from a bottle, comprising a cap for attachment to the neck of the bottle and having a hole therein; a glass barrel for extension through the neck of the bottle beneath the hole in the cap; said barrel in-

cluding a plunger chamber and a nozzle at its lower end in communication with the interior of said bottle; a delivery tube disposed in said chamber and extending upwardly within said chamber and through the hole in said cap to project from the top of said cap; a first check valve normally closing said nozzle; a glass plunger on the lower end of said delivery tube and reciprocal in said chamber between different vertical positions therein above the first check valve, said plunger including an opening therethrough communicating with said delivery tube and said chamber; a second check valve in the opening in said plunger and normally closing said opening below said delivery tube; a first stop surrounding said delivery tube for sliding longitudinally thereof between adjusted positions above said plunger and below said cap to limit the upward movement of said plunger; and a second stop separate from the first stop and surrounding said delivery tube above said cap and normally resting on the top of the cap to limit the downward movement of said plunger, the portion of the delivery tube between its lower end and said second stop being glass.

2. The device of claim 1, wherein said plunger and delivery tube are integral with one another.

3. The device of claim 1, wherein said second stop comprises a coupling between said glass portion and a plastic portion of the delivery tube externally of the cap.

4. The device of claim 1 wherein said delivery tube includes a volumetric scale on the portion thereof between said first and second stops.

5. The device of claim 1 wherein said first check valve includes a pair of check valves arranged in series in said nozzle.

6. The device of claim 1 wherein said nozzle is L-shaped and includes a portion extending normal to the barrel, and said first check valve is disposed in said portion.

7. A device for repetitively dispensing liquid from a bottle, comprising a cap for attachment to the neck of the bottle and having a hole therein; a glass barrel for extension through the neck of the bottle beneath the hole in the cap, said barrel including a plunger chamber and a nozzle at its lower end in communication with the interior of said bottle; a delivery tube disposed in said chamber and extending upwardly within the barrel and through the hole in said cap to project from the top of said cap; a first check valve normally closing said nozzle; a glass plunger integral with the lower end of said delivery tube and reciprocal in said chamber between different vertical positions therein above the first check valve, said plunger including an opening therethrough communicating with said chamber; a second check valve in the opening in said plunger and normally closing said opening; an adjustable first stop slidably surrounding said delivery tube above said plunger and below said cap to limit the upward movement of said plunger; a second stop surrounding said delivery tube above said cap and normally resting on the top of the cap to limit the downward movement of said plunger, the portion of the delivery tube between its lower end and said second stop being glass, and the portion of said delivery tube above said second stop being plastic, said second stop comprising a removable coupling between said glass portion and said plastic portion and a volumetric scale on the delivery tube above said plunger.

8. The device of claim 7 wherein said first check valve includes a pair of check valves arranged in series in said nozzle.

9. The device of claim 7 wherein said nozzle is L-shaped and includes a portion extending normal to the barrel, and said first check valve is disposed in said portion.