June 2, 1964 G. BALLIN 3,135,302

BOTTLE DROPPER AND CLOSURE

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Fig. 1.

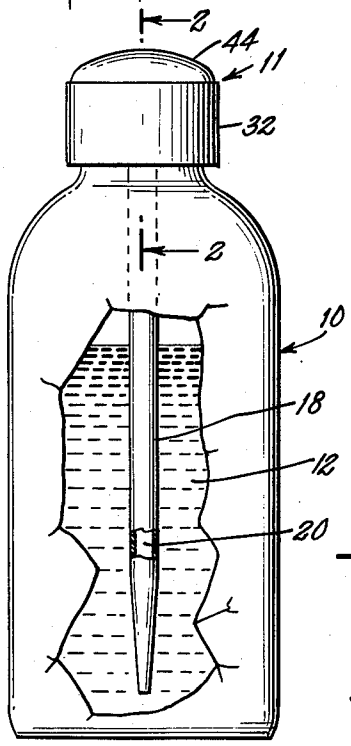


Fig. 2.

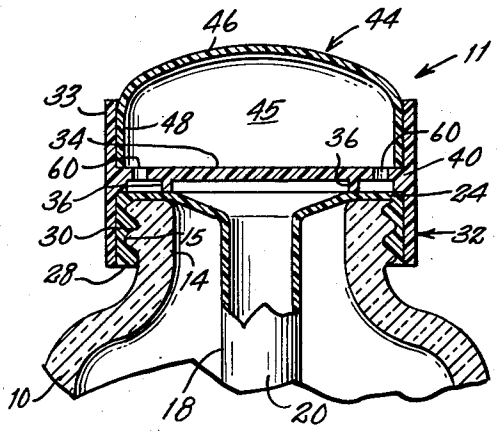


Fig. 3A.

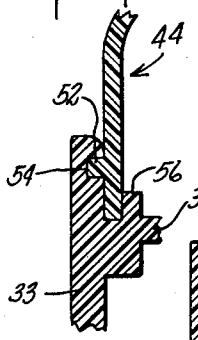


Fig. 3.

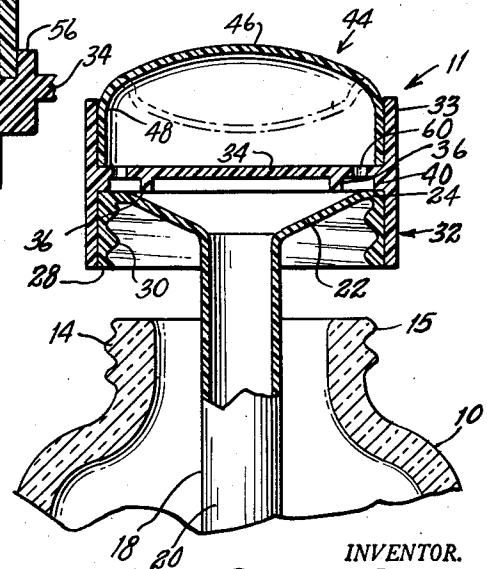
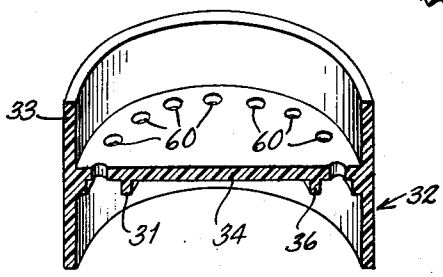


Fig. 4.



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Fig. 5.

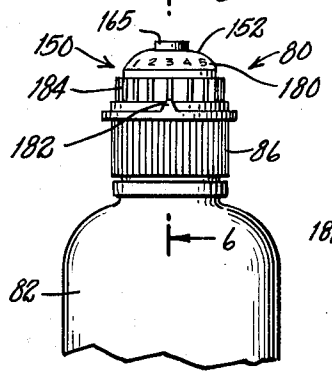


Fig. 6.

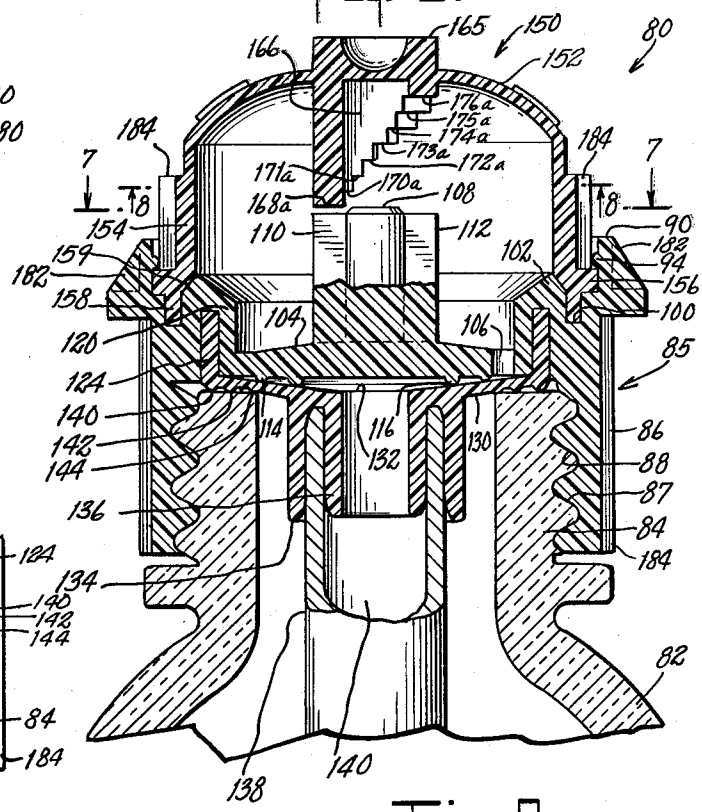


Fig. 6A.

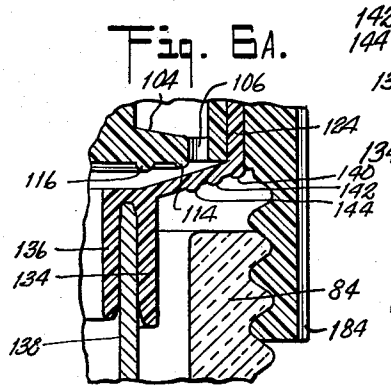


Fig. 7.

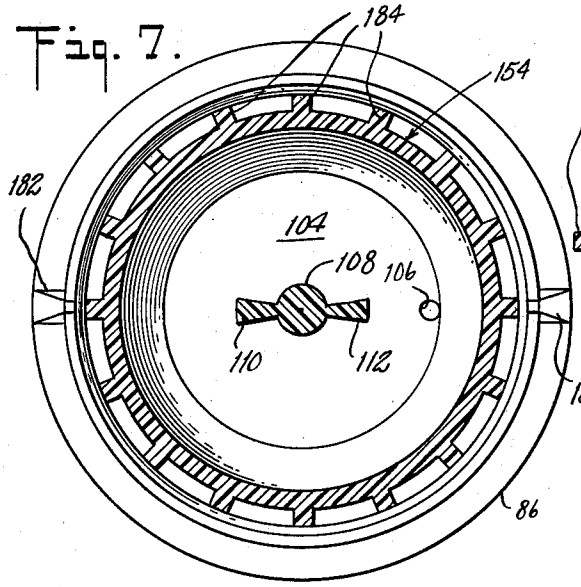
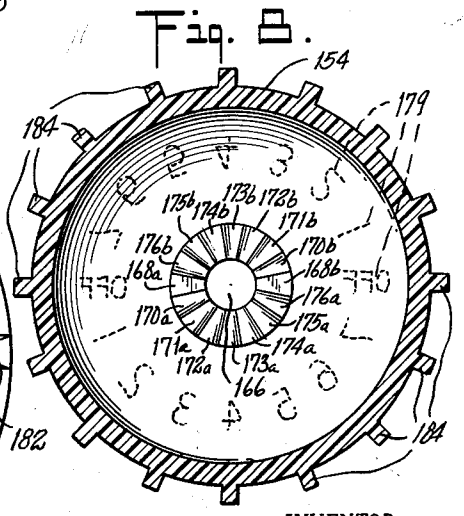


Fig. 8.



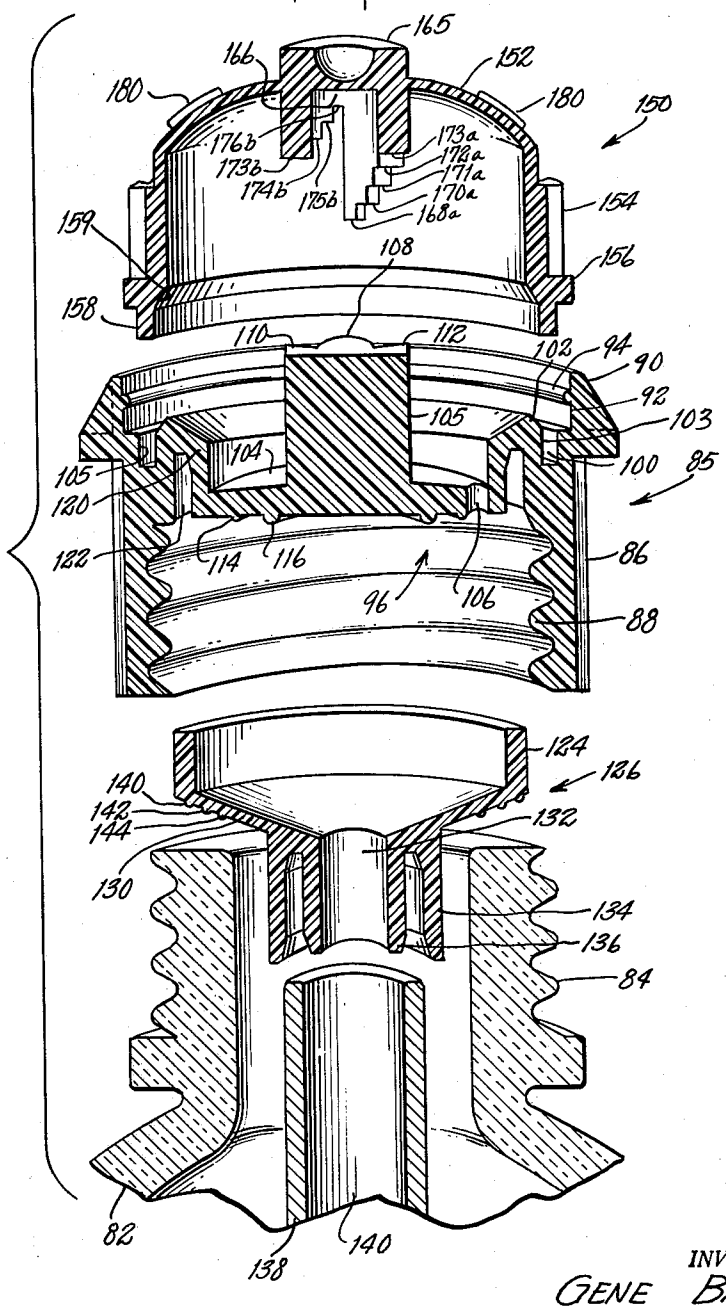
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Fig. 9



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3,135,302

BOTTLE DROPPER AND CLOSURE

Gene Ballin, Valley Stream, N.Y., assignor to Dosamatic Dropper Corporation, Valley Stream, N.Y., a corporation of New York

Filed Dec. 23, 1959, Ser. No. 861,498
25 Claims. (Cl. 141—24)

This invention relates to droppers for liquids, and more particularly to a combined bottle closure and dropper suitable for use in dispensing medicaments, reagents and other preparations of a type administered or measured out drop by drop or in other small measured amounts.

Conventional liquid droppers are provided with a resilient, rubber-like bulb fitted upon the upper end of a glass dropper tube or pipette. Upon squeezing the bulb, a portion of the air therein is forced out and, upon releasing the bulb or relaxing the force on it, the liquid to be dispensed is drawn into the lower end of the tube and may thereafter be dispensed by again squeezing the bulb. In the packaging and use of such droppers, an important problem has been the possibility of chemical interaction between the material of the bulb and the liquid being dispensed. If a rubber bulb dropper is used with a liquid having an oil base, care has to be taken to be certain that the liquid does not contact the bulb, since the rubber part deteriorates very rapidly in contact with oil. Also, many medicinal preparations and reagents are delicately balanced and unstable, and undergo definite chemical changes on contact with air or rubber, not only causing a deterioration and discoloration of the preparation, but also having an adverse effect on the bulb material.

Since in the conventional dropper, the pipette directly communicates with the bulb, attempts have been made to restrict this communication in order to prevent the liquid from contacting the rubber bulb. However, these attempts have not been satisfactorily successful in preventing leakage of the liquid or fluid into the bulb during use, particularly when the dropper is inverted or even placed on a horizontal surface.

In addition, in packaging medicaments or the like in bottles with dropper dispensers, these factors have introduced undesirable complexities and costs.

One of the requirements for shipping medicaments and like liquids in bottles is that the bottle or containing vessel be completely and tightly sealed; this seal must be fully positive and effective, and, in distinction to the normal closure of the vessel between uses (for which the requirements are less stringent), is known as a primary seal. To maintain a primary seal and to avoid contact between the liquid in the bottle and the dropper bulb during shipment or shelf storage, it has become customary to utilize a separate primary seal cap closure for the bottle, and to provide a separate dropper in the same package. This, of course, is bulky and costly to package and awkward to use, since in use the cap must first be removed, the dropper inserted and utilized, and then the cap must be replaced and the separate dropper then becomes awkward to store, since it is generally still wet from the liquid dispensed. In addition, sanitary problems are created as well as creating the possibility of misplacing the dropper and not having it available when needed. In an attempt to overcome these problems, the dropper has been provided with a cap structure, so that the purchaser first removes the primary seal cap used in shipment, and substitutes a dropper-cap packaged together with but independent from the capped bottle. Thereafter the same problem exists of deterioration between bulb material and the liquid to be dispensed. In this arrangement the primary seal has been separate from the dropper-cap, and no satisfactory arrangement has been thus far devised for avoiding the necessity of such a separate primary seal.

According to the present invention, a dropper and cap arrangement is provided which creates a primary seal for the bottle and also isolates the pipette from the bulb to avoid deterioration of the contained liquid.

It is a primary object of the present invention to provide a dropper closure which incorporates a primary seal suitable for producing a leakproof closure for the container suitable both for ordinary storage and for withstanding the vicissitudes of shipment and handling before receipt by the ultimate user.

It is another object of the present invention to provide a liquid dropper closure construction which eliminates communication between the pipette and the bulb of the dropper when the dropper is tightened on the container, and automatically restores that communication when the dropper is loosened preparatory to use.

Still another object of the present invention is to provide a liquid dropper assembly wherein the dropper provides a cap for a container for the liquid to be dispensed, thus eliminating a separate sealing cap, for all types of preparations.

Prior art droppers have also been extremely unreliable in dispensing medicament or other preparations with accuracy. With the ordinary, elongated rubber bulb, the mechanical force required to compress the bulb for ejecting the liquid from the pipette is so small that normally the force exerted on the bulb is far greater than necessary for ejecting the few drops usually needed, and normally the bulb is entirely collapsed, thus ejecting or aspirating a much larger quantity of the fluid than desired. With certain drugs the excess may even be harmful. In an attempt to overcome this danger, pipettes have been often marked or graduated, so as to indicate approximately the number of drops of liquid which have been drawn into the pipette. However, this has not proven satisfactory. Unless the bulb is compressed only enough to draw in the desired amount of liquid, removing the lower end of the pipette from the liquid after the desired amount of liquid is drawn into the pipette, and allowing the bulb to return to its original position, interposes air bubbles in the liquid in the pipette, which is not desirable.

In another attempt to control the quantity of fluid aspirated from the pipette, the bulb has been made of such a shape as to increase the pressure required to compress the bulb for drawing the liquid into the pipette. Also, bulbs have been made of less pliable material than rubber to increase the force required to compress the bulb so as to impose an approximate control over quantity. However, none of these attempts has been successful in controlling uniformly or accurately, the quantity of liquid aspirated from the dropper.

My prior application Serial No. 838,678 for Liquid Dropper Assembly, filed September 8, 1959, now U.S. Patent No. 3,020,938, discloses and claims a structure which overcomes this difficulty. The present invention, according to another feature, provides improved structures for solving this same problem.

Accordingly, another object of the present invention is to provide a liquid dropper which has quick accurate means for measurement and dispensing of a selected dosage.

A further object of the present invention is to provide a liquid dropper having positive discharge control so as to accurately and repeatedly determine the number of drops of liquid which can be drawn into the pipette or be aspirated from the dropper.

A still further object of this invention is to provide an improved liquid dropper having precise metering and indicating means which are adjustable at will for controlling the number of drops which are aspirated from the pipette regardless of the pressure exerted upon the bulb.

Another object is to provide a dropper-cap assembly

having precise metering means for preselecting the amount of liquid desired and having a positive seal between the pipette and bulb when the cap is tightened, thus permitting the use of any type of material for the bulb, regardless of the nature of liquid.

Still another object of this invention is to provide an improved liquid dropper arrangement incorporating the above features, which is capable of easy manufacture and assembly, is sanitary and simple in construction and operation, and is durable and convenient to use.

These and other objects and advantages of the present invention will be apparent from the following description of preferred embodiments thereof, taken with the accompanying drawings, wherein

FIGURE 1 is an elevational view, partially broken away, showing the general arrangement of a liquid dropper assembly in accordance with the present invention in combination with a liquid-containing bottle for which the assembly serves as a closure cap;

FIG. 2 is an enlarged, fragmentary, cross-sectional elevational view taken alone line 2—2 of FIG. 1 showing one form of dropper-cap assembly according to one aspect of the present invention, in its closed or sealed position;

FIG. 3 is a cross-sectional view similar to FIG. 2 but showing the dropper-cap assembly unthreaded and separated from the bottle neck;

FIG. 3A is a fragmentary cross-sectional view of a modified construction showing an alternative manner of joining the bulb and cap pieces of FIGS. 2 and 3;

FIG. 4 is a perspective view in section showing the cap piece of the dropper-cap assembly of FIGS. 2 and 3;

FIG. 5 is an elevational view showing another embodiment of a liquid dropper-cap construction for a bottle, providing a primary seal in accordance with one aspect of the present invention and additionally providing drop-metering means in accordance with another aspect of the invention;

FIG. 6 is an enlarged cross-sectional elevational view taken along lines 6—6 of FIG. 5, showing the dropper-cap in its closed or sealed position;

FIG. 6A is a fragmentary view similar to FIG. 6, but with the dropper-cap assembly loosened on the bottle;

FIG. 7 is a transverse cross-sectional view of the structure of FIGS. 6 and 7 taken along line 7—7 of FIG. 6;

FIG. 8 is a similar cross-sectional view of the same structure taken along line 8—8 of FIG. 6; and

FIG. 9 is an exploded, front elevational, cross-sectional view of the embodiment of the dropper assembly of FIGS. 6 to 8, showing the parts thereof in their disassembled state.

Referring first to the embodiment shown in FIGS. 1 through 4 of the drawings, numeral **10** generally designates a bottle, vessel or container with which one embodiment of a liquid dropper-cap assembly **11** constructed in accordance with the present invention may be used. Bottle **10** may contain a liquid **12**, and is provided with an exteriorly threaded neck or mouth **14**. The dropper-cap assembly **11** comprises a longitudinally extending pipette or applicator **18** in the form of a tube having a passage **20** formed therein which extends the full length of pipette **18** and is open at both ends. As shown in FIG. 1, pipette **18** may be slightly tapered at its lower end, so that the lower end has a somewhat smaller diameter than its upper end. The upper end of pipette **18** has an outwardly and upwardly flared section **22** terminating in a rim **24**. Rim **24** has a diameter substantially equal to the outer diameter of threaded bottleneck **14**. Depending downwardly from rim **24** and preferably integral or unitary therewith is a skirt portion **28** which is substantially coaxial with pipette **18**. The inner surface of skirt **28** is preferably provided with threads **30** adapted to be engaged with the corresponding threads of neck **14** of bottle **10**. Advantageously the flared upper end portion **22** of pipette **18** is made of a flexible, resilient material and it has been found convenient to mold the entire pipette and skirt portion **28** integrally from a flexible synthetic plastic material such as polyethylene. However the lower portion of pipette **18** may be made of glass or other material and interconnected in airtight relation in any convenient manner with outwardly flared section **22**.

Surrounding the outer peripheral surface of skirt portion **28** of pipette **18** is a generally cylindrical and preferably integral and generally rigid cap piece **32** extending upwardly beyond rim **24**. Disposed between the ends of cap piece **32** and spaced above the upper surface of rim **24** of pipette **18** is a transverse wall or disc **34** extending across the interior of cap **32**. Depending from and formed on the lower surface of transverse wall **34** is an annular bead or rib **36**. The lower surface of rib **36** is spaced from the flared neck portion **22** of pipette **18** when the dropper-cap assembly is loosened or removed from the bottle **11**, as shown in FIG. 3. Rib **36** is preferably positioned radially so that it is spaced inwardly from the outer wall **33** of cap piece **32** and overlies the inner top edge of bottle neck **14** as illustratively shown in FIG. 2. About the inner peripheral surface of cap piece **32** and abutting the lower peripheral edge of disc **34** is a rib **40** which extends downwardly from disc **34** substantially the same distance as rib **36** to abut the upper surface of rim **24** of pipette **18** in the closed position. Cap wall **33** and skirt **28** of pipette **18** are joined together in any suitable manner for forming an airtight seal, such as by heat sealing, cementing, pressed fitting, or the like.

A dome or bulb-shaped piece **44** of a pliable and resilient material, such as rubber or polyethylene, encloses an air space over disc **34**. Advantageously, bulb **44** has a comparatively thin, upwardly domed, flexible central portion **46** and a depending skirt portion **48**. The bulb skirt portion **48** is dimensioned to fit tightly against the inner peripheral surface of cap wall **33** above disc **34**. The outer surface of bulb skirt portion **48** is securely joined in any suitable manner to the inner surface of cap wall **33** to form an air-tight seal. This may be done by cementing, heat-sealing, pressed fitting, or the like. One convenient manner of accomplishing this is shown in FIG. 3A. About the outer peripheral surface of bulb skirt portion **48** is an outwardly projecting annular rib or flange **52**. The interior peripheral surface of cap wall **33** is formed with a cooperating interiorly facing annular groove **54**. Groove **54** is spaced upwardly from disc **34** and is complementary to rib **52**, so that rib **52** is tightly received in groove **54** upon assembly of bulb **44** and cap **32**, thus forming an airtight seal. Advantageously, an annular rib **56** extends upwardly from disc **34** spaced from the inner surface of cap wall **33** a distance sufficient to receive skirt portion **48** of bulb **44** therebetween. Rim **56** aids in holding the bulb in airtight relation with cap **32** and ensures a dependable seal even upon severe flexing or continued usage. Other arrangements for joining bulb **44** to cap **32** may also be used, such as having bulb **44** surrounding and sealed to cap **32**, as by a rib and groove arrangement similar to that of FIG. 3A.

Disc **34** has a plurality of passages or apertures **60** passing therethrough between downwardly extending rib **36** and flange **40**. Thus, bulb **44**, cap piece **32** and pipette **18** are joined into a unitary dropper-cap assembly structure **11**, with an air space **45** within bulb dome **46** communicating with the interior **20** of pipette **18** only by way of passages **60**. While a plurality of passages are shown, this is illustrative and if desired only one may be used, with further advantages described below relative to FIGS. 5 to 9.

As shown in FIG. 3, rib **36** of disc **34** is normally spaced from the upper flared portion **22** of pipette **18** when the dropper assembly **11** is withdrawn from bottle **11**. As seen best in FIG. 2, upon engaging the threads **30** on the inner surface of pipette skirt **28** with the corresponding threads **15** on the neck of bottle **14**, and upon

tightening cap 32, disc 34 and the flared portion 22 of pipette 18 are carried downwardly toward the upper rim 24 of neck 14 until flared portion 22 engages the upper rim 24 to form a tight seal and due to its yieldability accommodates itself to any slight production variations in shape or dimensions of the bottle neck 14. At the same time, tightening of cap 32 causes the pipette flared portion 22 to distort from the shape shown in FIG. 3 to conform more closely to the upper rim 28 of bottle neck 14, and forces rib 36 into engagement with the upper surface of tapered portion 22 of pipette 18, to form a positive seal therebetween, as shown best in FIG. 2. Since air passages 60 in disc 34 are disposed radially outwardly of rib 36, all communication between pipette 18 and the interior of bulb 44 is terminated. In this condition, as shown in FIG. 2, even if bottle 10 is inverted or shaken, no liquid can escape or enter into the bulb 44. Hence, dropper assembly acts as a positive sealing cap for bottle 10 and provides a primary seal as required during transporting or storing bottle 11, with complete isolation of liquid 12 from bulb 44.

To use assembly 11 as a dropper, cap 32 is loosened by unthreading it from bottle neck 14. When cap 32 has been rotated sufficiently so that downwardly extending rib 36 is no longer in contact with flared neck portion 22 of pipette 18, pipette passageways 20 once again communicate with bulb 44. Dome section 46 may then be compressed into a position such as indicated by the dotted lines in FIG. 3. In a manner well known to the art, this inward pressure forces air from within bulb 44 through passageways 60 of disc 34, through pipette passageway 20, and outwardly of the lower end of pipette 18. On release of center portion 46 of bulb 44, the bulb 44 resumes its normal position shown in solid lines, and due to the reduction in pressure within pipette 18, the desired liquid charge is drawn into pipette 18. The dropper assembly 11 may then be removed from the neck 14 of the bottle 10 and used in the usual manner.

While cap 32 and pipette 18 have been indicated as separate pieces, the cap wall 33 and pipette 18 may be made from a single piece construction which can be molded of any suitable material such as any one of the many available, appropriate, synthetic organic resins. In such case, disc 34 may be a separate piece suitably secured within cap wall 33. Pipette 18, for example, may be molded of polyethylene, which gives to the flared portion 22 the flexibility and resiliency which is highly desirable for providing a tight sealing fit upon the mouth of neck portion 14 of the bottle cap without the use of auxiliary washers or gaskets. Also, the outer surface of cap 32 is preferably roughened or knurled so as to provide easy gripping for tightening or loosening. Further, if desired, the threaded skirt portion 28 of pipette 18 can be eliminated and a separate means for clamping the flared neck portion 22 to the rim of bottle 10 may be used. In this embodiment rim 24 would be sealed in some convenient manner to disc 34, and cap wall 33 may be provided with integral internal threads to engage threads 15 of bottle 10.

FIGS. 5 to 9 show a modified form of dropper-cap assembly which incorporates a primary seal arrangement generally similar to that already described, in combination with liquid-metering means forming a further feature of this invention. In this form of the present invention, by adjusting the relative rotative position of the cap with respect to the bulb, it is possible to adjust the extent to which the bulb may be depressed for selectively determining the desired amount of liquid which is drawn into the tube or pipette of the liquid dropper upon release of the bulb to its normal position or for determining the amount of liquid expelled from the pipette upon once more depressing the bulb.

In a manner generally similar to that shown in FIGS. 1–4A, liquid dropper-cap assembly 80 is shown in combination with a bottle 82 which has a neck portion 84 with threads 87 thereon. As previously indicated, bottle 82 may contain a liquid to be dispensed by the dropper assembly. Dropper assembly 80 has a cap 85 with a depending skirt portion 86. The inner surface of skirt 86 is provided with threads 88 which are adapted to engage with the corresponding threads 87 of bottle neck 84. The outer peripheral surface of skirt 86 is preferably knurled or roughened or provided with longitudinal ribs, as best seen in FIG. 5, to aid in gripping and rotating the dropper assembly 80 upon bottle neck 84. Cap 85 has an upwardly projecting rim 90 which is provided with an interiorly facing annular bead or rib 94 forming an annular groove 92 which has its upper edge peripherally defined by rib 94. At the bottom of groove 92 is a transverse structure indicated generally at 96 in FIG. 9, which extends across the inner bore of cap 85 and supports a central structure 105 described more in detail below. Formed in the transverse structure 96 is an annular downwardly directed groove 100 spaced inwardly of rib 94 of rim 90. The upper edge of the inner wall 103 of groove 100 extends above the upper edge 105 of groove 100 and is slanted or inwardly beveled as shown at 102. The central section of transverse structure 96 is in the form of a disc 104 having an aperture 106 therethrough. When one aperture is shown in the drawing, and is preferred, a plurality may be used having substantially the same radius. Centrally disposed on the upper surface of disc 104 and preferably coaxial with cap 85 and upwardly extending therefrom is a generally cylindrical post 108. As seen best in FIG. 7, post 108 has a pair of diametrically opposed radially outwardly extending arms 110 and 112, respectively, substantially axially coextensive with post 108. Downwardly extending from the bottom surface of disc 104 and radially inwardly of aperture 106 are a pair of concentric, annular ribs or beads 114 and 116. The inner rib or bead 116 extends downwardly slightly more than the outer rib or bead 114. The outer rib 114 is disposed in such radial relation to skirt 86 that upon threading cap 85 on the bottle neck 84, rib 114 will be substantially vertically aligned with the inner edge of the rim of the threaded neck portion 84 of bottle 82, as seen best in FIG. 6. While two ribs have been found to provide positive sealing in a manner to be described, the number may be varied either to one or more, depending on the material used and results desired. About the periphery of disc 104 there is integrally formed an upstanding cylindrical wall 120 joining disc 104 to the inner wall of groove 100. Wall 120 is spaced from the inner surface of skirt 86 to form an annular groove 122 therewith, concentric with respect to cap 85 and adapted to receive and hold in a tight, hermetic seal the upper cylindrical rim 124 of a diaphragm 126, as best seen in FIG. 6. Diaphragm 126 is advantageously made of a flexible resilient plastic material, such as polyethylene, and, extending from the lower edge of cylindrical rim 124, has a downwardly, inwardly sloping flexible wall 130, of a generally frusto-conical shape surrounding a central aperture 132 therein. Extending downwardly from sloping wall 130 and surrounding aperture 132 are preferably two downwardly projecting sleeves 134 and 136 providing an annular space therebetween which is adapted to receive and hold the upper end of a pipette or tube 130 in airtight relation. Pipette 138 has a passage 140 formed therein that extends the full length of the tube, which is not shown. Pipette 138 may be of any convenient material such as glass or synthetic plastic, impervious to the liquid within bottle 82.

On the underside of sloping wall 130 of diaphragm 126 are a plurality of annular, preferably concentric, downwardly protruding beads illustratively shown as three, 140, 142 and 144, respectively, which are preferably positioned to overlie the upper edge of bottle neck 84 for providing a positive seal upon being urged in contact therewith, as shown best in FIG. 6. While pipette 138 is shown as fabricated separate from diaphragm 126, these elements may be molded in one piece.

Dropper assembly 80 is completed by a bulb piece indicated as a whole by reference character 150, which encloses a space above cap 85 and contains the metering device. Advantageously, bulb 150 has a comparatively thin, flexible, generally domed, central portion 152 and a depending skirt portion 154. The outer surface of skirt section 154 has an outwardly projecting circumferential rib or flange 156 and a downwardly extending substantionally cylindrical boss 158. Flange 156 is complementary to interior groove 92 in rim 90 of cap 85 and boss 158 is receivable in groove 100 in transverse structure 96 of cap 85, for securing the parts together with an airtight seal, as well as providing for relative rotational movement. As an aid in providing an hermetic seal, the lower inner peripheral edge of skirt portion 154 is beveled at 159 to be complementary to beveled surface 102 of transverse structure 96. Advantageously, bulb 150 is made of a resilient and pliable material, such as polyethylene, rubber or other like material so that, upon being pressed into the concavity of the upper portion of cap 84 the downwardly extending boss 158 may be yieldably forced into groove 100 and outwardly extending flange 156 yields inwardly and snaps into groove 92 in cap 86. Annular bead 94, defining the top of groove 92, aids in rotatably retaining bulb 150 in place and the tight engagement of boss 158 by groove 100 and rib 156 into groove 92 and the mating of beveled surfaces 102 and 159 as shown in FIG. 6 forms a tight hermetic seal between the bulb and the cap and insures a dependable seal between those parts while permitting relative rotation, despite relatively severe flexure of bulb 150.

Extending coaxially through the dome portion 152 of bulb 150 and integral therewith is a plunger 165. Advantageously plunger 165 is rigid and extends upwardly a small extent from the center of the dome portion 152 to form an area to which the user's finger may be applied to exert compression pressure on the dropper bulb for customary operation. Plunger 165 extends downwardly into the space enclosed by bulb 150 and is of substantially hollow cylindrical shape with a central bore 166 substantially axially aligned with post 108 which extends upwardly from transverse structure 96 of cap 85. Bore 166 has a diameter substantially equal to the outer diameter of post 108 and has a wall thickness substantially equal to the radial extent of each projecting arm 110 and 112 of post 108. The wall portion of plunger 165 has a series of successively descending inverted steps or cutouts extending around one half of its circumference, and the series is repeated with diametral symmetry for the remaining half-circumference or 180°, so that as shown in FIG. 8, each pair of diametrically opposed steps is at the same height or axial position along the length of the plunger 165. One such diametral pair of steps is shown in FIGS. 6 and 9 at 168*a* and 176*a*. The two series of steps in the cylindrical wall are of graduated increasing distance from the lowermost edge 168 of plunger 165 to dome portion 152 of bulb 150, so that a line connecting the ends of the steps in each series is of helical contour. Illustratively shown in FIGS. 6 and 9 are a first series of eight steps indicated by the reference numerals 168*a*, 170*a*, 171*a*, 172*a*, 173*a*, 174*a*, 175*a* and 176*a*, respectively. The other series of steps is shown in FIG. 8 and is indicated by 168*b* and 170*b* to 176*b*, inclusive, with steps or cutouts having like numerals being complementary and of like height.

With bulb 150 in assembled position in cap 84, the lowermost surface 168 of plunger 165 is spaced a small distance from the upper surface of arms 110 and 112, respectively, as illustrated in FIG. 6. Preferably the upper surfaces of arms 110 and 112, respectively, are each equal to the surface area of each steps 168 and 170–176, inclusive, and as shown these surfaces are in the form of a sector of an annulus. It is apparent that the relative angular position of plunger 165 with respect to arms 110 and 112 about their common axis will determine the extent to which plunger 165 can be moved downwardly before plunger 165 will be stopped by having one of its step pairs engage arms 110 and 112, and hence the plunger determines how far bulb 150 can be depressed. In the position shown in FIG. 6, the lowermost surfaces 168*a* and 168*b* of plunger 165 are disposed opposite arms 110 and 112 so as to allow the minimum inward movement of plunger 165. In this position there is no effective downward movement of the dome portion 152 of bulb 150 and hence no drawing in or dispensing of liquid into or from pipette 138. Upon relative rotational movement of cap 85 and bulb 150, such as 1/16 of a revolution of bulb 150 is the counterclockwise direction, which in the illustrative case is one step, arms 110 and 112 become vertically aligned with steps 170*a* and 170*b*, respectively, allowing plunger 165 to be moved inwardly a predetermined distance equivalent to one step. In a similar manner, by selected relative rotation of cap 85 and bulb 150, plunger 165 can be depressed inwardly a selected predetermined distance, with the maximum distance occurring when arms 110 and 112 are vertically aligned with the top steps, here indicated at 176*a* and 176*b*, respectively. The vertical distance (or rise) between the steps 170–176, inclusive, can be selected to be equal or varied, as desired, and advantageously as shown in FIGS. 5–9 the vertical distance of each step is selected so that for the first step 170, upon depression and release of plunger 165 one drop of liquid is drawn into or expelled from pipette 138. For each succeeding step, the step rise or height is designed so that one additional drop is thus measured. Thus, in the example illustrated, any number of drops from 0 to 7 may be selected by suitably positioning dome 150 relative to cap 85. It will be understood that any desired number of steps and any desired incremental amount of liquid to be metered may be employed. As an aid to the user for quickly determining the number of drops (or other incremental amount) which may be drawn into or expelled from pipette 138, the outer surface of dome portion 152 of bulb 150 is provided with a pair of numerical scales 179 each reading from 0 (or "Off") to 7 about one-half the circumference, and with each numeral being aligned with a respective step, such that the numerals 1 are aligned with steps 170*a* and 170*b*; numerals 2 are aligned with steps 171*a* and 171*b*; and so on, up to numerals 7 aligned with steps 176*a* and 176*b*, as seen best in FIG. 8. The notations "Off" are advantageously placed aligned with steps 168*a* and 168*b*, respectively. Arrows or other index marks 182 on opposite sides of the upper, outer peripheral edge of rim 90 of cap 85 and axially aligned with arms 110 and 112, cooperate with a series of vertical ridges 184 on the outer peripheral surface of skirt portion 154 aligned with scales 179, as shown best in FIG. 5. Thus marks 182 cooperate with the calibrated numerical scale 179 to determine the rotational position of bulb 150 so that the numbers to which arrows 182 point indicate the number of drop (or other incremental amounts) which can be drawn into pipette 138 on depression of plunger 165 and can be expelled upon later compression.

In assembled position, upon tightening cap 85 upon threaded neck portion 84, concentric ribs 114 and 116 on the lower surface of disc 104 are forced downwardly on the flexible, tapered portion 130 of the diaphragm, and hence concentric ribs 140, 142 and 144 on diaphragm 126 are forced into sealing engagement with the upper rim of bottle neck 84, as shown best in FIG. 6. Since ribs 114 and 116 form a sealing engagement with the upper surface of sloping section 130 of diaphragm 126, any communication between aperture opening 106 in disc 104 and aperture 132 in diaphragm 126, which in turn communicates with opening 140 of pipette 138, is cut off. Thus, in its closed position on a bottle, dropper 80 prevents any flow of liquid from the bottle into the bulb. At the same time, the seal between diaphragm 126 and

the bottle rim completes the closure for the bottle, and the structure provides a highly effective primary seal.

Upon loosening cap **85** from threaded bottle neck **84**, the seal between disc **104** and diaphragm **126** is broken, and a passageway is opened from the pipette opening **140** through aperture **106** into the space enclosed by bulb **150**. Upon rotating bulb **150** relative to cap **85** to the selected numbered position and upon depressing plunger **165** downwardly with the tip of a finger until the plunger cannot be depressed any further due to contact of the pair of selected steps and arms **110** and **112**, respectively, and then upon release of plunger **165**, it returns to its normal position, and the desired amount of liquid is drawn into opening **140** by pipette **138**; upon a further depression of plunger **165** to its maximum point of depression or until arms **110** and **112** respectively contact the steps, the measured amount of liquid in pipette **138** is expelled therefrom.

While in the description just given, the bulb position was selected before sucking liquid into the pipette, this is not necessary. For example, a larger than necessary amount of liquid may be sucked into the pipette; thereafter, the bulb may be set to the desired dose, and upon depressing the bulb, only that dose will be expelled. In this way, successive measured doses may be expelled from the same dropperful of liquid.

The use of but a single opening **106** between the bulb space and the pipette interior has an added advantage. As is well known, where an enclosed space has but a single small entrance or exit aperture, liquid either within or outside the space cannot pass through the aperture because of the absence of any means for air to exchange place with the liquid. Where the air space within the bulb is smaller than the volume of the space within the pipette, the single aperture **106** prevents any liquid from getting into the bulb space, even if the filled dropper should be inverted or placed on its side. It is therefore possible to fill the pipette, and lay the dropper down without either spilling liquid or having it enter the bulb space. In this way, the liquid is kept from contact with the bulb itself, and the necessity for carefully selecting liquid impervious materials for the bulb is avoided.

It will be understood that many variations in structure from those embodiments described above are possible without deviating from the present invention.

Although the skirt portions of the bulbs were shown to be sealed to the inside surfaces of the caps, they may equally well be sealed to the outer surface of the caps. Further, while the bulbs were shown to have dome shaped portions, any type may be used, such as the conventional spherical or elongated type.

While pressure fits have been described above with respect to interfitting diaphragm **126** into cap **85**, and pipette **138** into diaphragm **126**, suitable adhesives, cements or other types of seals may be employed if desired. Further, while bulb **150** and diaphragm **126** were indicated as advantageously made from a pliable resilient material, such as polyethylene, cap **85** and pipette **138** may be of the same material or of different materials. Further, with slight modification of structure diaphragm **126** and portions of cap **85** may be formed integrally of polyethylene or like material, or diaphragm **126** and cap **85** may be of the same or different materials and joined together in any convenient manner forming an airtight seal such as disclosed above.

Though screw threads have been shown for engaging the threads on a bottle neck, other means of holding the dropper assembly on a container mouth may of course be used.

While the plunger was shown to have the step sequence and the stop member the fixed arms, this may be interchanged if desired. Further, while two series of steps were shown, this is not essential and any convenient number of step series and of stop arms such as **110**, **112** may be used. Also, other ways of causing plunger **165** to be rotated relative to stop arms **110** and **112** may be used to avoid any necessity of rotating bulb **150** in cap **85**; for example, plunger **165** may be made rotatable relative to bulb **150**, in which case bulb **150** may be made unitary with cap **85**.

A dropper-cap assembly has thus been disclosed for use on threaded or other vessels adapted to form a primary seal when fully closed or tightened onto the bottle, to prevent any egress of liquid into the bulb with consequent possible deterioration of the liquid or of the bulb. A dropper-cap assembly has also been disclosed having a plunger and a stop member in the path of the compressive movement of the plunger, with the plunger and stop so interrelated that upon relative rotational movement of them about their axis the plunger travel is selectively limited thereby to receive and dispense accurately and consistently a selected amount of liquid.

It will be apparent to those skilled in the art that various other changes may be made in the construction of the dropper without departing from the spirit and scope of this invention.

What is claimed is:

1. A liquid dropper and closure for a container having a threaded mouth opening comprising a cap member having a depending cylindrical skirt portion provided with screw threads adapted for interengaging with the threaded mouth of said container, said cap having an upwardly extending rim, an interior transverse wall projecting from the inner peripheral surface of said cap and disposed between said downwardly depending skirt portion and upwardly extending rim portion, said upstanding rim having an interiorly facing groove on its inner peripheral surface spaced above the upper surface of said transverse wall, said transverse wall having an annular groove in its upper surface adjacent the inner peripheral surface of said rim, a frustro-conical diaphragm of resilient material having an aperture inwardly of its peripheral edge, said diaphragm having a rim portion extending upwardly from the upper surface thereof adjacent its outer peripheral edge, a longitudinally extending tube open at its opposite ends having its longitudinal axis substantially parallel to said cap, means integral with the lower surface of said diaphragm and surrounding said aperture for retaining said tube in air-tight communication, means integral with the lower surface of said transverse wall for retaining said last mentioned upstanding rim in air-tight communication, said transverse wall having an aperture passing therethrough disposed radially inwardly of said last mentioned upstanding rim, a concentric rib disposed downwardly from the lower surface of said transverse wall disposed radially inwardly from said aperture and concentric with said cap, said rib being adapted to sealingly engage the upper surface of said diaphragm upon the cap being threadedly assembled on the mouth of the container, and a normally expanded bulb defining a space above said transverse wall, said bulb including a thin-walled outwardly concave dome evertable inwardly for volume reduction, said bulb having a depending cylindrical skirt portion with an outwardly projecting circular rib complementary to said interiorly facing groove on said rim and having a depending rib complementary to said annular groove in the upper surface of said transverse wall, both of said ribs fitting in their respective grooves for providing an air-tight seal between said bulb member and said rim and said transverse wall.

2. A liquid dropper and closure for a container having a threaded mouth opening comprising a cap member having a depending cylindrical skirt portion provided with screw threads adapted for interengaging with the threaded mouth of said container, said cap having an upwardly extending rim, an interior transverse wall projecting from the inner peripheral surface of said cap and disposed between said downwardly depending skirt portion and upwardly extending rim portion, said upstanding rim having an interiorly facing groove on its inner peripheral surface

spaced above the upper surface of said transverse wall, said transverse wall having an annular groove in its upper surface adjacent the inner peripheral surface of said rim, a longitudinally extending tube open at its opposite ends having its longitudinal axis substantially parallel to said cap, said tube having a resilient outwardly flared flexible neck portion on one of its ends, an upstanding rim integrally formed on said upper surface of the flared neck portion of said tube, said rim being radially spaced outwardly from said tube and concentric therewith, means integral with the lower surface of said transverse wall for retaining said last mentioned upstanding rim in air-tight communication, said transverse wall having an aperture passing therethrough disposed radially inwardly of said last mentioned upstanding rim, a concentric rib disposed downwardly from the lower surface of said transverse wall disposed radially inwardly from said aperture and concentric with said longitudinal tube, said rib being adapted to sealingly engage the upper surface of said flared neck portion of said tube upon the dropper being threadedly assembled on the mouth of the container, and a normally expanded bulb defining a space above said transverse wall, said bulb including a thin-walled outwardly concave dome evertable inwardly for volume reduction, said bulb having a depending cylindrical skirt portion with an outwardly projecting circular rib complementary to said interiorly facing groove on said rim and having a depending rib complementary to said annular groove in the upper surface of said transverse wall, both of said ribs fitting in their respective grooves for providing an air-tight seal between said bulb member and said rim and said transverse wall.

3. A liquid dropper and closure assembly for use with a container having an opening therein, comprising a longitudinally extending tube open at its opposite ends, a frustro-conical member of resilient material having an opening therein integrally mounted on one end of the tube having its opening coaxial thereto, said member having a rim portion extending radially outwardly and substantially transverse to the longitudinal axis of said tube, said rim portion adapted to overlie the mouth of said container, an upstanding rim integrally mounted on the upper side of said radially extending surface of said frustro-conical member, said rim being concentric to said tube, an interiorly transverse wall integrally projecting from the inner peripheral surface of said upstanding rim and spaced from the upper surface of the transverse area of said frustro-conical member, said annular rim having an interiorly facing groove extending entirely around said rim and spaced above said transverse wall, an annular rim extending downwardly from said transverse wall having its lower surface spaced from said upper surface of said frustro-conical member in operative position, said annular rib being positioned to engage said upper surface of said frustro-conical member along a circular contact line for forcing said frustro-conical surface against the mouth of said container upon removably securing said dropper assembly to the mouth of a container, a compressible bulb member enclosing the space above said transverse wall and normally having maximum internal volume, said bulb including a thin walled outwardly concave spherical dome evertable inwardly for volume reduction and having a depending skirt portion fitting tightly against the interior surface of said upwardly extending rim and having an outwardly projecting circular rib complementary to said inwardly facing groove in said rim and fitting therein to provide an air-tight seal between said bulb and said rim and an aperture passing through said transverse wall and disposed radially therein between said downwardly extending conical rib and said skirt portion of said bulb and means for removably clamping said frustro-conical member against the upper edge of a mouth of a container by axial pressure applied at the periphery of said rim for forming a positive seal upon said downwardly extending concentric rib urging said frustro-conical member into contact with said mouth of said container whereby communication between said tube and said bulb is closed.

4. A liquid dropper and closure assembly for a container having an externally threaded mouth comprising a longitudinally extending tube open at its opposite ends, said tube having an outwardly flared flexible neck portion at one of its end with the area adjacent the peripheral edge of said flared neck portion being substantially transverse to the longitudinal axis of said tube, said transverse area extending radially outwardly a distance for overlying the upper edge of the mouth of said container, a downwardly depending rim integrally formed on the neck portion of said tube and having its inner surface threaded for engagement with the threaded mouth of said bottle, a cylindrical cap member mounted on the outer surface of said depending rim, said cap extending upwardly beyond the upper surface of the transverse area of said neck portion of said tube, said cap having an interior transverse wall intermediate of its ends and spaced from the upper surface of the transverse area of said neck of said tube, said transverse wall having a depending annular rib being positioned to substantially overlie the inner edge of the mouth of said container and adapted to engage the transverse area of said flared neck portion of said tube along a circular contact line for clamping said neck portion against the rim of the mouth of said container upon said depending rim being threadedly engaged with the mouth of said container, said transverse wall having an aperture therethrough disposed radially between the cylindrical cap and said depending rib therefrom, an upwardly domed bulb of resilient material enclosing an airspace between the domed portion of said bulb and said transverse wall, said bulb having a depending cylindrical skirt portion fitting tightly against the interior surface of said cylindrical body member, and means hermetically sealing said skirt portion of said bulb to said inner surface of said body member.

5. A liquid dropper assembly comprising a tubular body member having an interior transverse wall, a pipette having its axis substantially parallel to the axis of said body member, said pipette having a resilient outwardly flared neck portion, means mounted to the under surface of said transverse wall for retaining said flared neck portion of said pipette in air-tight relation with said transverse wall, a normally expanded compressible bulb defining an air space above said transverse wall and being in hermetic-sealed relation with said body member and said transverse wall, said transverse wall having an aperture therethrough interconnecting said pipette and the space defined by said bulb, and means for sealing said aperture in response to clamping said body member against the rim of a bottle neck by an axial force on said body member without compressing said bulb.

6. A liquid dropper and cap assembly for a liquid-containing vessel having a mouth, comprising a bulb, a pipette adapted to be inserted into said vessel through said mouth, means defining an air-tight passage between said bulb and said pipette to provide a dropper assembly therewith, means cooperating with said dropper assembly to provide a closure for said vessel mouth, and means responsive to tightening of said closure upon said vessel without compressing said bulb for blocking said passage to isolate the interior of said bulb from said pipette, whereby a primary closure seal for said vessel is provided.

7. A liquid dropper and cap assembly for use with a liquid-containing vessel having a neck, comprising a closure cap adapted to be placed upon said vessel neck to form a closure for said vessel, a pipette, a normally expanded compressible bulb hermetically sealed to said cap, means hermetically sealing said pipette to said cap and including means defining an air passage between said pipette and said bulb, and means responsive to tightening of said cap on said vessel neck without compressing said bulb for blocking said passage to isolate the interior of said bulb from the interior of said pipette, whereby a primary closure seal for said vessel is provided.

8. A liquid dropper closure for a container having a threaded mouth opening comprising a cap member having a depending cylindrical skirt portion provided with screw threads adapted to interengage with the threaded mouth of said container, said cap having an upwardly extending rim, an interior transverse wall projecting from the inner peripheral surface of said cap and disposed between said downwardly depending skirt portion and upwardly extending rim portion, said upstanding rim having an interiorly facing groove on its inner peripheral surface spaced above the upper surface of said transverse wall, said transverse wall having an annular groove in its upper surface adjacent the inner peripheral surface of said rim, a longitudinally extending tube open at its opposite ends having its longitudinal axis substantially parallel to said cap, said tube having a resilient outwardly flared flexible neck portion on one of its ends, an upstanding rim integrally formed on said upper surface of the flared neck of said tube, said rim being radially spaced outwardly from said tube and concentric therewith, means integral with the lower surface of said transverse wall for retaining said last mentioned upstanding rim in air-tight communication, said transverse wall having an aperture passing therethrough disposed radially inwardly of said last mentioned upstanding rim, an annular rib disposed downwardly from the lower surface of said transverse wall and radially inwardly from said aperture and concentric with said longitudinal tube, said rib being adapted to sealingly engage the upper surface of said flared neck portion of said tube upon the dropper being threadedly assembled on the mouth of the container, an annular rib extending downwardly from the lower surface of said flared neck portion of said tube being so positioned as to abut the upper edge of the mouth of the container when the closure is disposed thereon, a normally expanded bulb defining a space above said transverse wall, said bulb including a thin-walled outwardly concave spherical dome evertable inwardly for volume reduction, said bulb having a depending cylindrical skirt portion with an outwardly projecting circular rib complementary to said interiorly facing groove on said rim and having a depending rib complementary to said annular groove in the upper surface of said transverse wall, both of said ribs fitting in their respective grooves for providing an air-tight seal between said bulb member and said rim and said transverse wall, said bulb being rotatably movable with respect to said cap, and metering means for predetermining the quantity of liquid flowing into and out of said tube, said metering means comprising a stop member extending upwardly from said transverse wall into the space enclosed by said bulb, said stop member having a pair of outwardly extending, diametrically opposed identically shaped arms having their upper surfaces coplanar, and a substantially cylindrically shaped plunger depending from the dome portion of said bulb and axially aligned with said stop member and having its lower end surface adjacent the upper surfaces of said arms of said stop member, said plunger having a series of stepped surfaces at preselected distances from said end surface in the outer wall of said plunger for 180 degrees and repeating said series for the remaining 180 degrees, so that corresponding stepped surfaces are diametrically opposed and lie in the same transverse plane, each of said stepped surfaces being cooperatively shaped to receive said arms of said stop member whereby depending upon the relative position of said bulb with respect to said cap, said plunger and said stop member being so positioned and adapted to limit the inward movement of the dome portion of said bulb member thereby allowing the user to eject a preselected volume of liquid.

9. A liquid dropper and closure for a container having a threaded mouth opening comprising a cap member having a depending cylindrical skirt portion provided with screw threads adapted for interengaging with the threaded mouth of said container, said cap having an upwardly extending rim, an interior transverse wall projecting from the inner peripheral surface of said cap and disposed between said downwardly depending skirt portion and upwardly extending rim portion, said upstanding rim having an interiorly facing groove on its inner peripheral surface spaced above the upper surface of said transverse wall, said transverse wall having an annular groove in its upper surface adjacent the inner peripheral surface of said rim, a frustro-conical diaphragm of resilient material having an aperture inwardly of its peripheral edge, said diaphragm having a rim portion extending upwardly from the upper surface thereof adjacent its outer peripheral edge, a longitudinally extending tube open at its opposite ends having its longitudinal axis substantially parallel to said cap, means integral with the lower surface of said diaphragm and surrounding said aperture for retaining said tube in air-tight communication, means integral with the lower surface of said transverse wall for retaining said last mentioned upstanding rim in air-tight communication, said transverse wall having an aperture passing therethrough disposed radially inwardly of said last mentioned upstanding rim, a concentric rib disposed downwardly from the lower surface of said transverse wall disposed radially inwardly from said aperture and concentric with said cap, said rib being adapted to sealingly engage the upper surface of said diaphragm upon the cap being threadedly assembled on the mouth of the container, a normally expanded bulb defining a space above said transverse wall, said bulb including a thin-walled outwardly concave spherical dome evertable inwardly for volume reduction, said bulb having a depending cylindrical skirt portion with an outwardly projecting circular rib complementary to said interiorly facing groove on said rim and having a depending rib complementary to said annular groove in the upper surface of said transverse wall, both of said ribs fitting in their respective grooves for providing an air-tight seal between said bulb member and said rim and said transverse wall, a generally tubular plunger having one end coupled to the inner surface of said bulb for axially moving its other end towards said transverse wall upon axial compression of said bulb, said plunger having a series of stepped surfaces in its wall at predetermined distances from its said other end, a stop member fixedly mounted on the upper surface of said transverse wall in coaxial relationship to said plunger, said stop member having a shank extending outwardly from said transverse wall and adapted to extend slidably into the bore of said tubular plunger, and an arm extending radially outwardly from said shank and having an upper surface in opposed spaced axial relationship with said other end of said plunger upon said bulb being expanded and said surface being shaped to cooperatively coact with said stepped surfaces, said bulb being turnable about its axis for disposing a selected stepped surface of said plunger in axially opposed spaced relation to said arm, thereby selectively varying the inward movement of said bulb.

10. A liquid dropper and closure for a container having a threaded mouth opening comprising a cap member having a dependent cylindrical skirt portion provided with screw threads adapted for interengaging with the threaded mouth of said container, said cap having an upwardly extending rim, an interior transverse wall projecting from the inner peripheral surface of said cap and disposed between said downwardly depending skirt portion and upwardly extending rim portion, said upstanding rim having an interiorly facing groove on its inner peripheral surface spaced above the upper surface of said transverse wall, said transverse wall having an annular groove in its upper surface adjacent the inner peripheral surface of said rim, a frustro-conical dia-

phragm of resilient material having an aperture inwardly of its peripheral edge, said diaphragm having a rim portion extending upwardly from the upper surface thereof adjacent its outer peripheral edge, a longitudinally extending tube open at its opposite ends having its longitudinal axis substantially parallel to said cap, means integral with the lower surface of said diaphragm and surrounding said aperture for retaining said tube in air-tight communication, means integral with the lower surface of said transverse wall for retaining said last mentioned upstanding rim in air-tight communication, said transverse wall having an aperture passing therethrough disposed radially inwardly of said last mentioned upstanding rim, a concentric rib disposed downwardly from the lower surface of said transverse wall disposed radially inwardly from said aperture and concentric with said cap, said rib being adapted to sealingly engage the upper surface of said diaphragm upon the cap being threadedly assembled on the mouth of the container, a normally expanded bulb defining a space above said transverse wall, said bulb including a thin-walled outwardly concave spherical dome evertable inwardly for volume reduction, said bulb having a depending cylindrical skirt portion with an outwardly projecting circular rib complementary to said interiorly facing groove on said rim and having a depending rib complementary to said annular groove in the upper surface of said transverse wall, both of said ribs fitting in their respective grooves for providing an air-tight seal between said bulb member and said rim and said transverse wall, a plunger fixed to said bulb for axial movement inwardly toward said transverse wall upon compression of said bulb, said plunger having a series of sequential stepped surfaces therein of different distances from said transverse wall, and a cooperating member fixed on the upper surface of said transverse wall coaxially to said plunger and having stop means thereon for cooperative engagement with selected ones of said stepped surfaces of said plunger for selectively limiting the inward movement of said bulb.

11. A liquid dropper and closure assembly for a container having an externally threaded mouth comprising a longitudinally extending tube open at its opposite ends, said tube having an outwardly flared flexible neck portion at one of its ends with the area adjacent the peripheral edge of said flared neck portion being substantially transverse to the longitudinal axis of said tube, said transverse area extending radially outwardly a distance for overlying the upper edge of the mouth of said container, a downwardly depending rim integrally formed on the neck portion of said pipette and having its inner surface threaded for engagement with the threaded mouth of said bottle, a cylindrical cap member mounted on the outer surface of said depending rim, said cap extending upwardly beyond the upper surface of the transverse area of said neck portion of said tube, said cap having an interior transverse wall intermediate of its ends and spaced from the upper surface of the transverse area of said neck of said tube, said transverse wall having a depending annular rib being positioned to substantially overlie the inner edge of the mouth of said container and adapted to engage the transverse area of said flared neck portion of said tube along a circular contact line for clamping said neck portion against the rim of the mouth of said container upon said depending rim being threadedly engaged with the mouth of said container, said transverse wall having an aperture therethrough disposed radially between the cylindrical cap and said depending rib therefrom, an upwardly domed bulb of resilient material enclosing an air space between the domed portion of said bulb and said transverse wall, said bulb having a depending cylindrical skirt portion fitting tightly against the interior surface of said cylindrical body member, means hermetically sealing said skirt portion of said bulb to said inner surface of said body member, a generally tubular plunger having one end coupled to the inner surface of said bulb for axially moving its other end towards said transverse wall upon axial compression of said bulb, said plunger having a series of stepped surfaces in its wall at predetermined distance from its said other end, a stop member fixedly mounted on the upper surface of said transverse wall in coaxial relationship to said plunger, said stop member having a shank extending outwardly from said transverse wall and adapted to extend slidably into the bore of said tubular plunger, and an arm extending radially outwardly from said shank and having an upper surface in opposed spaced axial relationship with said other end of said plunger upon said bulb being expanded and said surface being shaped to cooperatively coact with said stepped surfaces, said bulb being turnable about its axis for disposing a selected stepped surface of said plunger in axially opposed spaced relation to said arm, thereby selectively varying the inward movement of said bulb.

12. A liquid dropper and closure assembly for a container having an externally threaded mouth comprising a longitudinally extending tube open at its opposite ends, said tube having an outwardly flared flexible neck portion at one of its ends with the area adjacent the peripheral edge of said flared neck portion being substantially transverse to the longitudinal axis of said tube, said transverse area extending radially outwardly a distance for overlying upper edge of the mouth of said container, a downwardly depending rim integrally formed on the neck portion of said pipette and having its inner surface threaded for engagement with the threaded mouth of said bottle, a cylindrical cap member mounted on the outer surface of said depending rim, said cap extending upwardly beyond the upper surface of the transverse area of said neck portion of said tube, said cap having an interior transverse wall intermediate of its ends and spaced from the upper surface of the transverse area of said neck of said tube, said transverse wall having a depending annular rib being positioned to substantially overlie the inner edge of the mouth of said container and adapted to engage the transverse area of said flared neck portion of said tube along a circular contact line for clamping said neck portion against the rim of the mouth of said container upon said depending rim being threadedly engaged with the mouth of said container, said transverse wall having an aperture therethrough disposed radially between the cylindrical cap and said depending rib therefrom, an upwardly domed bulb of resilient material enclosing an air space between the domed portion of said bulb and said transverse wall, said bulb having a depending cylindrical skirt portion fitting tightly against the interior surface of said cylindrical body member, means hermetically sealing said skirt portion of said bulb to said inner surface of said body member, a plunger fixed to said bulb for axial movement inwardly towards said transverse wall upon compression of said bulb, said plunger having a series of sequential stepped surfaces thereon of different distances from said transverse wall, and a cooperating member fixed on the upper surface of said transverse wall coaxially to said plunger and having stop means thereon for cooperative engagement with selected ones of said stepped surfaces of said plunger for selectively limiting the inward movement of said bulb.

13. A liquid dropper assembly comprising a tubular body member having an interior transverse wall, an elongated tube having a longitudinal opening therein, means mounting said tube with its longitudinal axis aligned substantially parallel to the axis of said body member on the under surface of said transverse wall in air-tight relation therewith, a normally expanded compressible bulb having a resilient continuous wall defining an air space above said transverse wall and being in hermetic-sealed relation with said body member and said transverse wall, said transverse wall having an aperture therethrough offset from its axis for interconnecting said opening in said tube and the space defined by said bulb, a generally tubular plunger having one end coupled to the inner sur-

face of said bulb for axially moving its other end towards said transverse wall upon axial compression of said bulb, said plunger having a series of stepped surfaces in its wall at predetermined distances from said other end, a stop member fixedly mounted on the upper surface of said transverse wall in coaxial relationship to said tubular body member and said plunger, said stop member having a shank extending outwardly from said transverse wall and adapted to extend slidably into the bore of said tubular plunger and an arm extending radially outwardly from said shank and having an upper surface in opposed spaced axial relationship with said other end of said plunger upon said bulb being expanded and said surface being shaped to cooperatively coact with said stepped surfaces, said bulb being turnable about its axis for disposing a selected stepped surface of said plunger in axially opposed spaced relation to said arm, thereby selectively varying the inward movement of said bulb.

14. A liquid dropper assembly comprising a tubular body member having an interior transverse wall, an elongated tube having a longitudinal opening therein, means mounting said tube with its longitudinal axis aligned substantially parallel to the axis of said body member on the under surface of said transverse wall in air-tight relation therewith, a normally expanded compressible bulb defining an air space above said transverse wall and being in hermetic-sealed relation with said body member and said transverse wall, said transverse wall having an aperture therethrough for interconnecting said opening in said tube and the space defined by said bulb, said bulb being rotatably movable with respect to said body member, and metering means for predetermining the quantity of liquid flowing into and out of said tube, said metering means comprising a stop member extending upwardly from said transverse wall into the space enclosed by said bulb, said stop member having a pair of outwardly extending, diametrically opposed identically shaped arms having their upper surfaces coplanar, and a substantially cylindrically shaped plunger depending from the dome portion of said bulb and axially aligned with said stop member and having its lower end surface adjacent the upper surfaces of said arms of said stop member, said plunger having a series of stepped surfaces at preselected distances from said end surface in the outer wall of said plunger for 180 degrees and repeating said series for the remaining 180 degrees, so that corresponding stepped surfaces are diametrically opposed and lie in the same transverse plane, each of said stepped surfaces being cooperatively shaped to receive said arms of said stop member whereby depending upon the relative position of said bulb with respect to said cap, said plunger and said stop member being so positioned and adapted to limit the inward movement of the dome portion of said bulb member thereby allowing the user to eject a preselected volume of liquid.

15. A liquid dropper assembly comprising a tubular body member having an interior transverse wall, a pipette having its axis substantially parallel to the axis of said body member, means secured to the under surface of said transverse wall for retaining said pipette in air-tight relation therewith, a normally expanded compressible bulb defining an air space above said transverse wall and being in hermetic-sealed relation with said body member and said transverse wall, said transverse wall having an aperture therethrough offset from its axis for interconnecting said pipette and the space defined by said bulb, means for closing said aperture in response to clamping of said body member against the rim of a bottle neck by an axial force on said body member, said bulb having a resilient continuous dome portion adapted for axial movement inwardly towards said transverse wall, a plunger fixed to said dome portion and extending inwardly into the space defined by said bulb and axially movable in unison with said dome portion, said plunger having a series of sequential stepped surfaces thereon of differing distances from said transverse wall and a cooperating member extending upwardly from said transverse wall and coaxially to said body member and said plunger and having stop means for cooperative engagement with selected stepped surfaces of said plunger for selectively limiting the inward movement of said dome portion of said bulb.

16. A liquid dropper assembly comprising a tubular body member having an interior transverse wall, an elongated tube having a longitudinal opening therein, means mounting said tube with its longitudinal axis aligned substantially parallel to the axis of said body member on the under surface of said transverse wall in air-tight relation therewith, a normally expanded compressible bulb having a resilient continuous wall defining an air space above said transverse wall and being in hermetic-sealed relation with said body member and said transverse wall, said transverse wall having an aperture therethrough for interconnecting said opening in said tube and the space defined by said bulb, a plunger fixed to said bulb for axial movement inwardly towards said transverse wall upon compression of said bulb, said plunger having a series of sequential stepped surfaces thereon of different distances from said transverse wall, and a cooperating member fixed on the upper surface of said transverse wall coaxially to said body member and said plunger and having stop means thereon for cooperative engagement with selected ones of said stepped surfaces of said plunger for selectively limiting the inward movement of said bulb.

17. A liquid dropper assembly comprising an elongated tube having a longitudinal opening therein and open at both ends, a normally expanded continuous resilient bulb having an opening therein at one end and defining an air space above one end of said tube, said openings in said tube and said bulb being axially aligned, means for holding said bulb and said tube in hermetic-sealed relation, said bulb having an interior transverse wall adjacent said opening therein and above said one opening of said tube, said transverse wall having an aperture therethrough for interconnecting said tube opening and the space defined by said bulb, a plunger fixed to said bulb for axial movement inwardly towards said transverse wall upon compression of said bulb, said plunger having a series of sequential stepped surfaces thereon of different distances from said transverse wall, and a cooperating member fixed on the upper surface of said transverse wall coaxially to said tube and said plunger and having stop means thereon for cooperative engagement with selected ones of said stepped surfaces of said plunger for selectively limiting the inward movement of said bulb.

18. A liquid dropper and cap assembly for use with a liquid-containing vessel having a neck comprising a closure cap adapted to be placed upon said vessel neck to form a closure for said vessel, a pipette, a normally expanded compressible bulb hermetically sealed to said cap, means hermetically sealing said pipette to said cap and including means defining an air passage between said pipette and said bulb, means responsive to tightening of said cap on said vessel neck for blocking said passage to isolate the interior of said bulb from the interior of said pipette, whereby a primary closure seal for said vessel is provided, means mounted on said bulb and said cap for adjustably limiting the compression of said bulb, whereby the change in volume of said bulb may be adapted to correspond to desired amounts of liquid to be dispensed.

19. Adjustable liquid drop dispensing apparatus comprising a bulb member having a resilient continuous portion, a body member hermetically sealed to said bulb member, and means mounted on each of said members for adjustably limiting the movement of said bulb movable portion, said last mentioned means including a plunger having an end and a series of sequential stepped surfaces thereon of different distances from said end, and a stop member coaxial to said body member and said plunger having means thereon for cooperative engagement with

selected stepped surfaces of said plunger for selectively limiting the movement of said bulb.

20. A liquid dropper and cap assembly for a liquid containing vessel having a mouth, comprising a bulb member having a movable portion, a pipette adapted to be inserted into said vessel through said mouth, means defining an airtight passage between said bulb and said pipette to provide a dropper assembly therewith, means cooperating with said assembly to provide a closure for said vessel mouth, means responsive to tightening of said closure upon said vessel for blocking said passage to isolate the interior of said bulb from said pipette, whereby a primary closure seal for said vessel is provided, and means mounted on said bulb and said assembly for adjustably limiting the movement of said bulb movable portion whereby the change in volume of said bulb may be adjusted to correspond to desired amounts of liquid to be dispensed.

21. A liquid dropper and cap assembly for use with the liquid containing vessel having a neck, comprising a closure cap adapted to be placed upon said vessel neck to form a closure for said vessel, a pipette, a normally expanded compressible bulb hermetically sealed to said cap, means hermetically sealing said pipette to said cap and including means defining an air passage between said pipette and said bulb, means responsive to tightening of said cap on said vessel neck for blocking said passage to isolate the interior of said bulb from the interior of said pipette, whereby a primary closure seal for said vessel is provided, and first and second cooperable stop members carried respectively by said bulb and said cap for limiting the advance of said bulb, one of said stop members having an end surface with portions of differing distance with respect to said other stop member and individually and selectively engageable with said other said stop member for adjustably determining the movement of said bulb.

22. A liquid dropper and cap assembly for a liquid containing vessel having a mouth, comprising a bulb member having a movable portion, a pipette adapted to be inserted into said vessel through said mouth, means defining an airtight passage between said bulb and said pipette to provide a dropper assembly therewith, means cooperating with said assembly to provide a closure for said vessel mouth, means responsive to tightening of said closure on said vessel for blocking said passage to isolate the interior of said bulb from said pipette, whereby a primary closure seal for said vessel is provided, and means mounted on said bulb and said assembly for adjustably limiting the movement of said bulb movable portion, said last mentioned means including a plunger having an end and a series of sequential stepped surfaces thereon of different distances from said end, and a stop member coaxial to said plunger having means thereon for a cooperative engagement with selected stepped surfaces of said plunger for selectively limiting the movement of said bulb.

23. A liquid dropper and cap assembly for use with a liquid containing vessel having a neck, comprising a sealed bulb member having a movable portion, a closure cap adapted to be placed upon said vessel neck to form a closure for said vessel, said cap being hermetically sealed to said bulb member, a pipette hermetically sealed to said cap, means defining an air passage between said pipette and said bulb member and means responsive to tightening of said closure cap upon said vessel neck for blocking said passage to isolate the interior of said bulb member from the interior of said pipette tube, said passage blocking means comprising a transverse wall on said cap and an annular rib projecting from the under surface of said wall, said air passage being radially outward of said annular rib, and said assembly including means cooperating with said vessel neck and said rib to block said passage.

24. A metering device comprising a first piece having a peripheral wall and with an opening at one end, a second piece mounted on said first piece and having a resilient continuous wall and completely closing and sealing said opening, means mounted on each of said pieces for adjustably limiting the movement of said resilient wall whereby the change in volume of said resilient wall may be adjusted to correspond to desired amounts of liquid to be dispensed, said means including a first member having an end and a series of sequential stepped surfaces thereon of different distances from said end, and a stop member mounted coaxially with respect to said peripheral wall and positioned and shaped to receive said first member and having means thereon for cooperative engagement with a selected stepped surface of said first member for selectively limiting movement of said resilient wall.

25. A metering liquid dropper assembly comprising a first piece having a peripheral wall and with an opening at one end, and a second piece rotatably mounted on said first piece and having a resilient continuous wall completely enclosing and sealing said opening, one of said pieces having a plunger mounted thereon, the other of said pieces having a guide member mounted coaxially with respect to said peripheral wall and positioned and shaped to receive said plunger, said plunger and guide member being axially slidable relative to one another upon deflection of said resilient wall, said plunger having an end and a series of sequential stepped surfaces thereon of different distances from said end, said guide member including stop means for cooperative engagement with selected stepped surfaces of said plunger for different relative rotational positions of said pieces.

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