United States Patent [19]

Vogel, Jr.

[11] B 3,921,845

[45] Nov. 25, 1975

[54] **CLOSURE DEVICE OF PLASTIC FOR TUBES AND CONTAINERS**

[75] Inventor: **Herman J. Vogel, Jr.**, Parkersburg, W. Va.

[73] Assignee: **Corning Glass Works**, Corning, N.Y.

[22] Filed: **Dec. 11, 1972**

[21] Appl. No.: **314,271**

[44] Published under the Trial Voluntary Protest Program on January 28, 1975 as document no. B 314,271.

[52] **U.S. Cl.** **215/320**

[51] **Int. Cl.**[2] **B65D 41/30**; B65D 41/22

[58] **Field of Search** ..... 215/38 R, 41, 47, 56, 319, 215/320

[56] **References Cited**

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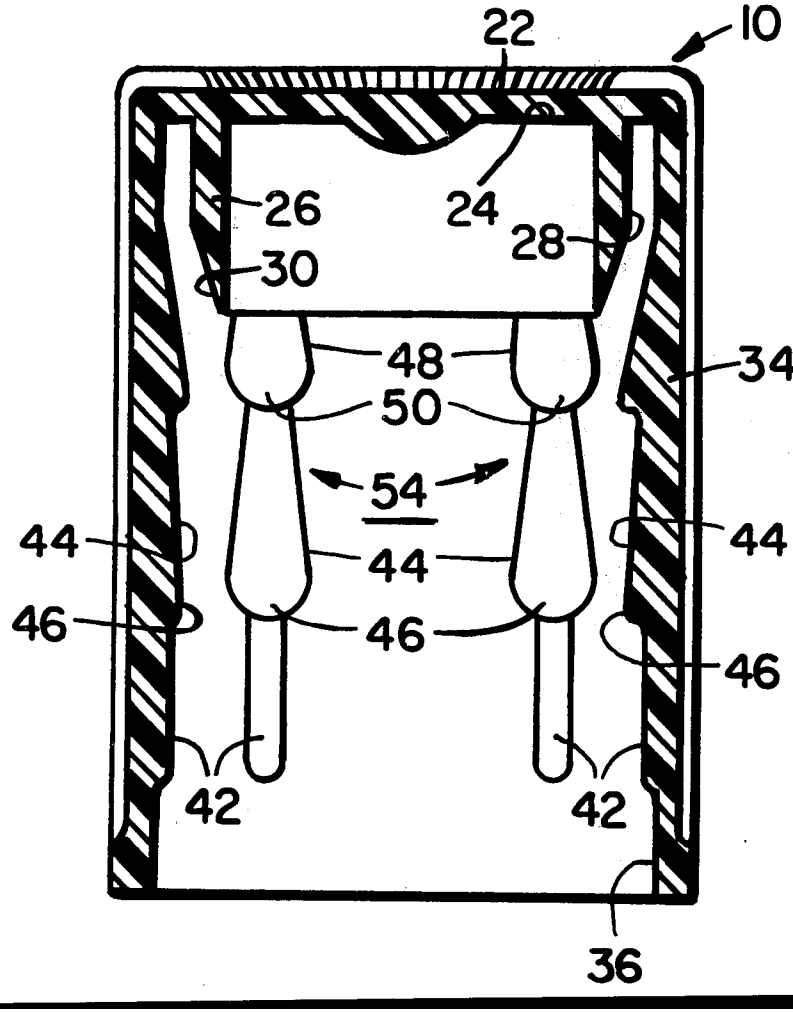
Primary Examiner—William I. Price
Assistant Examiner—Ro E. Hart
Attorney, Agent, or Firm—Thomas J. McNaughton; Burton R. Turner; Clarence R. Patty, Jr.

[57] **ABSTRACT**

A plastic closure device for tubes and containers having smooth-walled, generally cylindrical outlet portions, the closure device including an annular plug member depending from the closure top portion which fits snugly and gas/liquid tightly within the outlet (when fully applied) and a cylindrical skirt portion also depending from the top portion, with the skirt inner surface having a plurality of longitudinally extending stepped abutments of varying heights to permit varying degrees of loose and interference fits between the closure skirt portion and the container outlet portion to permit the closure device to be successively used as a loose dust and breather cap, a fixed dust cover and breather cap, as well as a fixed dust cover and gas/liquid tight cap (in conjunction with the plug member).

5 Claims, 8 Drawing Figures



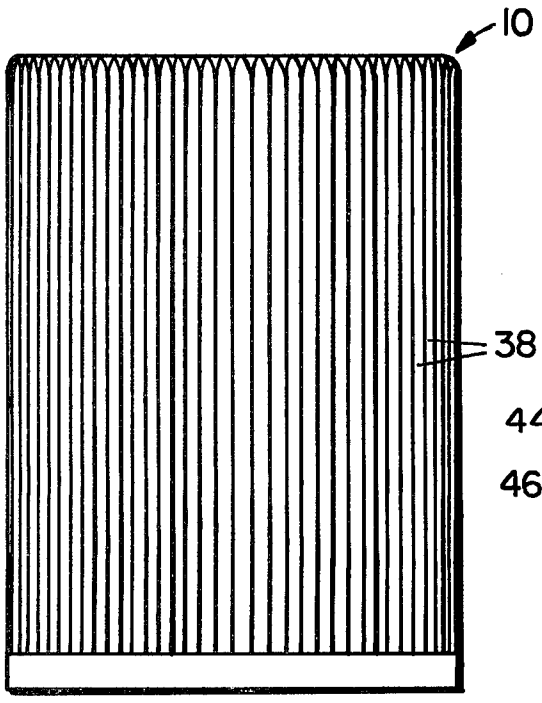


Fig. 1

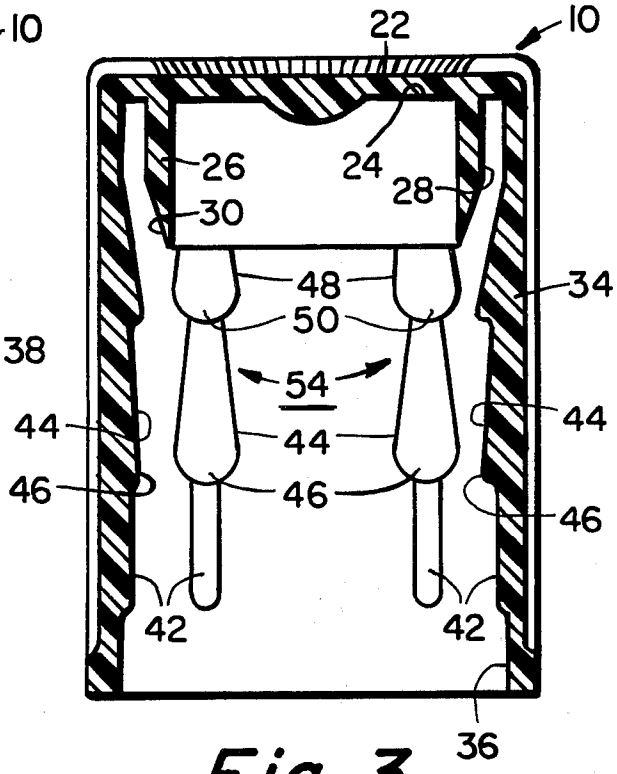


Fig. 3

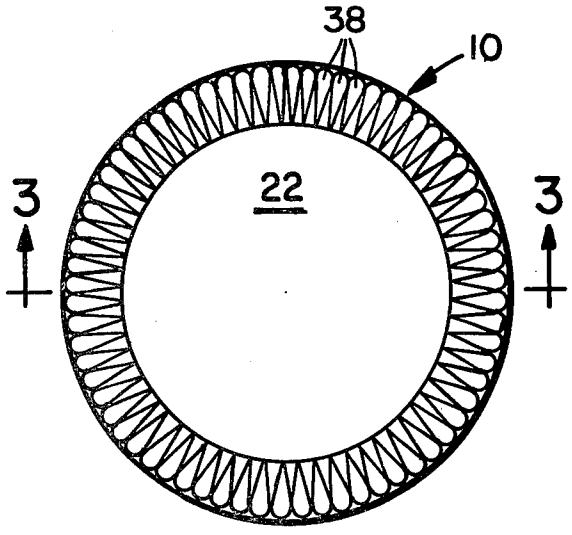


Fig. 2

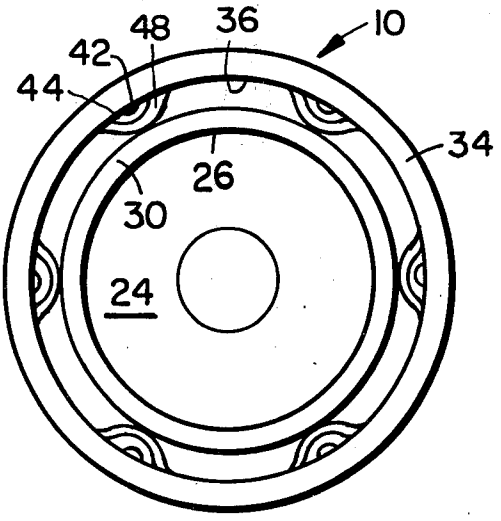


Fig. 4

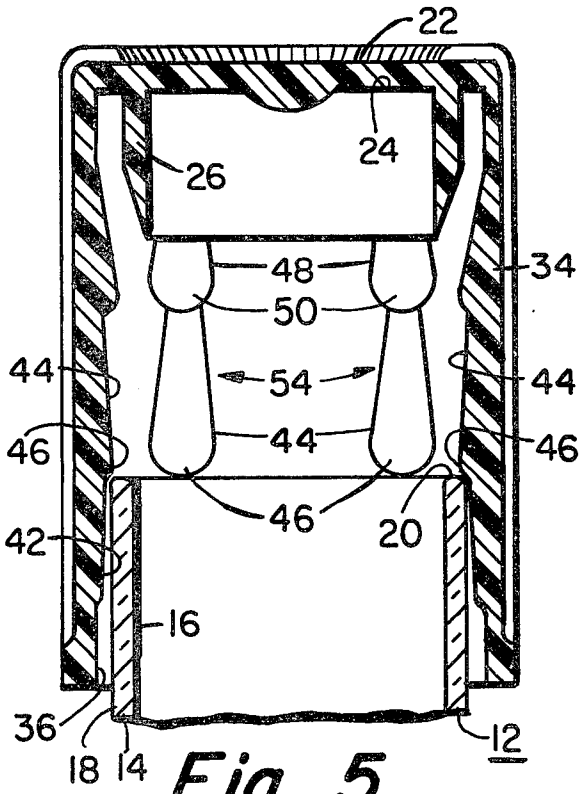


Fig. 5

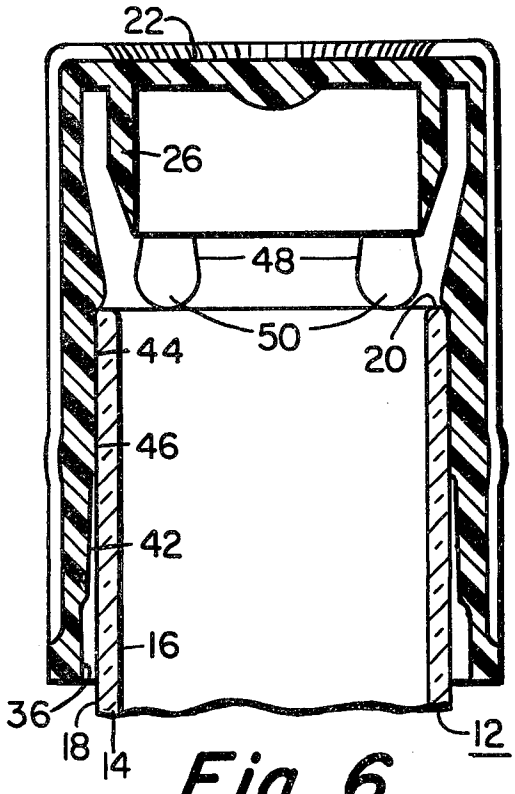


Fig. 6

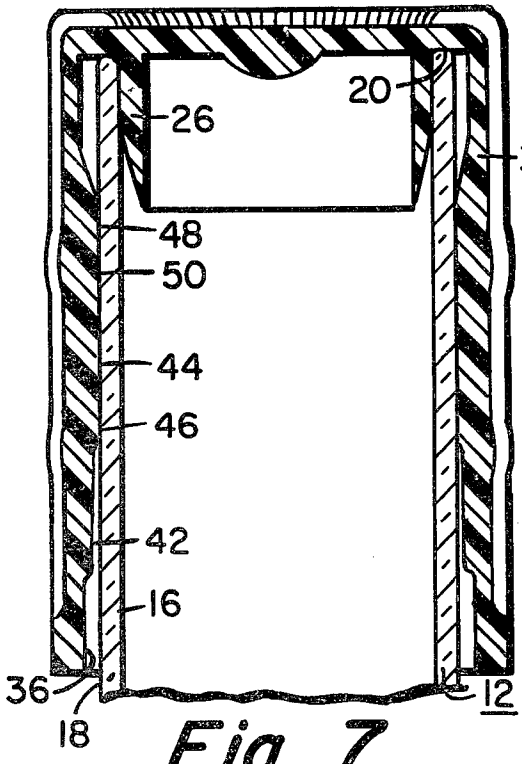


Fig. 7

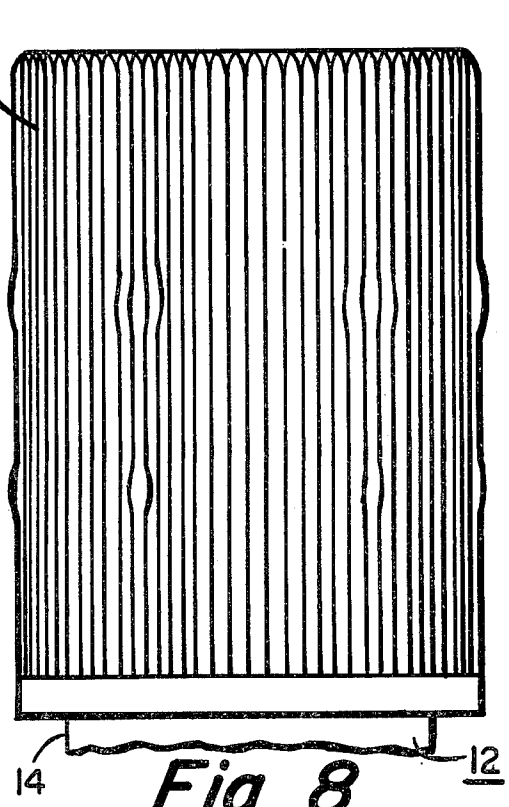


Fig. 8

CLOSURE DEVICE OF PLASTIC FOR TUBES AND CONTAINERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field to which this invention pertains is that of closure devices for tubes, cans, bottles or other containers having smooth-walled generally cylindrical outlet portions, particularly laboratory-type culture or test tubes.

2. Prior Art

The prior art is replete with test tube closures of both the slip-on type and the well-known screw cap type.

Slip-on types, for example, are shown in U.S. Pat. No. 2,287,746 to Morton, U.S. Pat. No. 3,085,705 to Varney and U.S. Pat. No. 3,640,418 to Williams, whereas a number of different screw cap closures are shown in the Corning Lab 2 Catalog published by Corning Glass Works of Corning, N.Y.

A test tube closure should preferably serve at least three functions: (1) Act as a loose dust cover and breather cap (such as for use with culture media); (2) Act as a fixed dust cover and breather cap; and (3) Act as a fixed dust cover and snap-on cap so as to provide a positive inside diameter seal for use where a gas/liquid tight seal is necessary. These functions should be accomplished quickly and with a minimum of effort. In addition, these tube and closure combinations should also only cost a fraction of the tube and screw cap combinations commonly used at this time. None of the presently used slip-on type or screw-cap type closures meet all of the stated functions or cost objectives.

SUMMARY OF THE INVENTION

The instant invention responds to the previously-described shortcomings in a manner so as to substantially eliminate any further concern regarding such problems.

The closure device of this invention, which is preferably made of a flexible plastic material, is designed to be used with containers or the like having smooth-walled, generally cylindrical, outlet portions.

The closure includes a top wall or top portion overlying and closing the open end of the container, an integral annular plug member depending from the top portion which is of a size so as to fit snugly and gas/liquid tightly within the container outlet when fully closed, and a long cylindrical wall or skirt portion which also depends from the top portion and is concentric with the plug member. The skirt member, which has a slightly larger diameter than the external diameter of the container outlet portion, also has a plurality of preferably equally circumferentially spaced first raised and longitudinally extending areas on the inner surface near the open end thereof, with these first raised areas being of a size so as to preferably still provide a loose fit with the container outlet portion thus permitting the closure to act as a loose dust cover and breather cap. A plurality of second raised areas, which preferably are adjacent to the first raised areas, are of a size to provide a slight interference fit with the container outlet portion, thus permitting the closure to act as a fixed dust cover and breather cap. A plurality of third raised areas, which preferably are adjacent to the second raised areas, are of a size to provide a moderate interference fit with the container outlet portion, with these third raised areas, in conjunction with the plug member (when the closure is fully applied), providing a gas/liquid tight seal and a fixed dust cover.

The combination of one of each of these first, second and third raised areas may also be defined as a longitudinally stepped abutment of varying heights which permits varying degrees of loose and interference fits between the closure skirt portion and the outer surface of the container outlet portion.

The plug member preferably has a tapering tip portion to facilitate entry of the plug portion into the container outlet portion, with at least one portion of the plug member being capable of making an annular line contact with the outlet portion inner surface.

At least one of the pluralities of first, second and third raised areas is preferably tear-drop shaped and the outer surface of the skirt portion may be provided with a serrated pattern to facilitate manual gripping thereof.

Other advantages and features of the instant invention will be understood from the following description in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view of the closure of this invention;

FIG. **2** is a top view of the closure;

FIG. **3** is a central longitudinal section of the new closure taken along lines **3—3** of FIG. **2;**

FIG. **4** is a bottom view of the closure looking up into its interior;

FIG. **5** is a view similar to that of FIG. **3** but showing the cap or closure used as a loose dust cover and breather cap on a tube or container end;

FIG. **6** is another view similar to that of FIG. **3** but showing the closure used as a fixed dust cover and breather cap on a tube end;

FIG. **7** is yet a further view similar to that of FIG. **3** but showing the closure used as a fixed dust cover and gas/liquid tight cap on a tube end; and

FIG. **8** is a view similar to that of FIG. **1** but showing the closure as used on a tube end in the manner set forth in FIG. **7.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIGS. **1–4** illustrate the new cap or closure device of this invention and FIGS. **5–8** illustrate the closure as applied, in several modes, on a container or tube end.

The closure device or cap **10,** preferably made of a flexible plastic material, is designed to be used with tubes, cans, bottles or other containers of like kind having a smooth-walled inner and outer neck or mouth portion, generally cylindrical in shape. For example, closure device **10** may be applied on laboratory-type culture or test tubes **12,** the open end portion **14** of which is shown in FIGS. **5–7.** Test tube inner and outer surfaces **16, 18** respectively, are parallel and are joined by annular end surface **20.**

Closure device or cap **10** is provided with a circular, substantially flat top portion **22** that is adapted to overlay and close container open end portion **14.** Depending downwardly from inner surface **24** of top portion **22** is integral annular plug portion **26.** Plug **26** is annular in configuration, not only to conserve material, but also to provide resilience so that it tightly engages tube inner surface **16.** The plug may be considered as having two sections, the first section **28** having an essentially cylin-

drical outer surface and of a size to fit snugly and gas/-liquid tightly within container open end **14**. A second section **30**, depending from section **28**, has an inwardly tapering external conical wall portion so as to provide a tapering tip portion for facilitating entry of plug portion **26** into container open end **14**.

Also depending from cap top portion **22** is a long, generally cylindrical wall or tubular skirt portion **34**, concentric with plug portion **26**, having an internal wall surface **36** that has a diameter slightly larger than the diameter of tube outer surface **18** so as to permit an initial loose fit of cap **10** on tube **12**.

The generally cylindrical outer surface of skirt portion **34** is preferably provided with a longitudinally or an axially extending serrated pattern **38** for substantially the entire longitudinal extent of skirt portion **34** to facilitate manual gripping and thus help to close, open and remove closure **10** from container **12**. Preferably, serrated pattern **38** is continued from the outer surface of skirt **34** to at least an outer annular portion of top portion **22**, as best seen in FIG. **2**.

As best seen in FIGS. **3** and **4**, skirt interior wall portion **36**, near the open end of cap **10**, is provided with a plurality of preferably equally circumferentially spaced first raised and longitudinally extending areas **42**. Areas **42**, the outer surfaces of which are generally curved (FIG. **4**) in the direction normal to their axial or longitudinal extent, are of a size or height to preferably still permit a loose fit with respect to tube outer surface **18**, as best seen in FIG. **5**.

Extending from the inner or upper ends of first areas **42** is a plurality of preferably equally circumferentially spaced second raised and longitudinally extending areas **44**. Areas **44**, which may be described as generally tear-drop shaped, are of a size to provide a slight interference fit with tube outer surface **18**, as best seen in FIG. **6**. It should be noted, that due to their tear-drop shape, areas **44** have apex-containing portions **46**, with portions **46** being situated near the lower or outer extremity of areas **44**, i.e., the portion of areas **44** that are longitudinally the furthest removed from cap flat top portion **22**.

Extending from the inner or upper ends of second areas **44** is a plurality of preferably equally circumferentially spaced third raised and longitudinally extending areas **48**. Areas **48**, which similarly to areas **44** may also be described as generally tear-drop shaped, are of a size to provide a moderate interference fit with the tube outer surface **18**, as best seen in FIG. **7**. Again as areas **44**, areas **48** have apex-containing portions **50**, with portions **50** being again situated near the lower or outer extremity of areas **48**, i.e., the portion of areas **48** that are longitudinally the furthest removed from cap flat top portion **22**.

Since each raised area **44** abuts and is preferably aligned with a raised area **42** on its lower or outer end and a raised area **48** on its upper or inner end, each of these combinations of the three areas may also be defined as a longitudinally stepped abutment **54** of varying heights, (i.e., having raised areas **42, 44** and **48**) to permit varying degrees of loose and interference fits between skirt portion **34** and tube outer surface **18**. Preferably, three or six sets of equally spaced abutments **54** are used. Since raised areas **42, 44** and **48** (i.e., abutments **54**) are not circumferentially continuous around the periphery of wall **36**, but are preferably equally spaced, it should be obvious that segmented breather passages (i.e., the space between wall **36** and tube outer surface **18** as best seen in FIG. **4**) exist therebetween. This allows closure device **10** to be used as a breather cap as hereinafter described.

The use of closure device or cap **10** will now be described with reference to FIGS. **5–8** which show several modes of application. As best seen in FIG. **5** the diameter of cap skirt portion inner surface **36** is larger than the diameter of tube outer surface **18** so as to permit an initial loose fit of cap **10** on tube **12**. First raised areas **42**, each of which may for example have a height of about 0.010 inches, while decreasing the diameter of surface **36**, preferably still permit a loose fit or only a very slight diametral interference fit, preferably not to exceed 0.010 inches, of cap **10** on tube **12**. It is the function of first raised areas **42** to guide and line up cap **10** with reference to tube **12**, so as to prevent any cocking or misalignment therebetween. Furthermore, in the position shown in FIG. **5**, cap **10** acts as a substantially loose dust cover (since at least parts of apex portions **46** of raised second areas **44** abut or rest on tube annular end surface **20**) and breather cap on tube **12**.

Second raised areas **44**, each of which may for example have a height of about 0.020 inches, decrease the diameter of surface **36** to less than the diameter of tube outer surface **18** so as to provide at least a slight diametral interference fit, preferably in the range from 0.015 to 0.030 inches, between cap **10** and tube **12** as best seen in FIG. **6**. Thus, in the position shown in FIG. **6**, cap **10** acts as a fixed dust cover and breather cap. Since second raised areas **44** are generally tear-drop shaped the areas that experience the greatest interference fit are apex portions **46**. Since interference fits are only possible if at least one yieldable member is involved, and since tube **12** is substantially rigid, cap **10** deforms slightly in the areas of apex portions **46** when tube **12** is forced past apex portions **46**. This deformation is evidenced by a slight bulging or distortion on the outer surface of skirt portion **34**, i.e., in serrated pattern **38**, generally radially outwardly of apex portions **46**.

Third raised areas **48**, each of which may for example have a height of about 0.025 inches, again decrease the diameter of surface **36** to less than the diameter of tube outer surface **18** so as to preferably provide a moderate interference fit, preferably in the range from 0.025 to 0.040 inches, between cap **10** and tube **12** as best seen in FIG. **7**. In the FIG. **7** position, cap skirt portion **34** serves as a fixed dust cover and in combination with plug portion **26** (coacting with tube inner surface **16**) serves as a gas/liquid tight cap. Since areas **48** are also generally tear-drop shaped the areas that experience the greatest interference fit are apex portions **50**, when tube **12** is forced thereover, with the resulting deformation being again evidenced on the outer surface of skirt portion **34**, as best seen in FIGS. **7** and **8**. When cap **10** is fully applied on tube **12**, tube annular end surface **20** abuts cap inner surface **24**.

It should be noted that while preferred ranges of interference fits have been set forth in the several raised areas, the degrees of interference fits of course depend on the type and resilience of the materials utilized, the wall thickness of the closure device, and the relative size of the closure, etc. The given ranges are specifically applicable for a molded polypropylene plastic cap having an inside diameter of about 0.650 inches, a wall thickness of about 0.040 inches and a skirt length of about one inch. It should also be noted that the heights of raised areas **42, 44** and **48** in the drawings are exag-

gerated for ease of understanding and illustration.

The closure devices or caps of this invention may be used on almost any type of rigid container having a smooth-walled generally cylindrical outlet portion. The caps are especially useful with test tubes, such as culture tubes, since the caps may be used successively as substantially loose dust covers and breather caps, as fixed dust covers and breather caps and as fixed dust covers and gas/liquid tight caps depending on the degree of affixation i.e., substantially loose fit with raised areas **42**; at least a slight interference with raised areas **44**; a moderate interference fit and gas/liquid tight seal with raised areas **48** and plug portion **26.**

While the invention has been described in connection with possible forms or embodiments thereof, it is to be understood that the present disclosure is illustrative rather than restrictive and that further changes or modifications may be resorted to without departing from the spirit of invention or scope of the claims which follow.

I claim:

1. In combination with a cylindrical tube, having smooth cylindrical walls as well as a closed end and an open end, a flexible plastic closure for said open end, said closure comprising:

a. a circular, substantially flat, top portion overlying and closing said open end;

b. an integral annular internal plug portion projecting downwardly from said top portion and of a size to fit snugly and gas/liquid tightly within said tube when said closure is fully applied to said open end by engagement with said smooth cylindrical interior wall; and

c. a cylindrical wall portion at right angles to and depending from said flat top portion having a slightly larger interior diameter than the external diameter of said tube sufficient to provide a loose fit thereon, said wall portion including:

i. a plurality of circumferentially spaced-apart first longitudinally extending raised areas on the interior surface thereof near an open end of said closure, and of a size to provide a loose fit with said tube, said first raised areas furthering the alignment of said tube and closure as well as permitting said closure to act as a loose dust cover and breather cap;

ii. a plurality of circumferentially spaced-apart second longitudinally extending raised areas generally of tear-drop shape continuing from said first raised areas of a size to provide a slight interference fit with said tube, thereby permitting said closure to act as a fixed dust cover and breather cap, said second raised areas having inwardly projecting apex portions to deform portions of said closure wall portion radially outwardly upon engagement with said tube; and

iii. a plurality of circumferentially spaced-apart third longitudinally extending raised areas generally of tear-drop shape, continuing from said second raised areas and of a size to provide a moderate interference fit with said tube and in conjunction with said plug portion, when said closure is fully applied, providing a gas/liquid tight seal and fixed dust cover, with said third raised areas having inwardly projecting apex portions to deform portions of said closure wall portion radially outwardly upon engagement with said tube.

2. The combination of claim **1** wherein said pluralities of first, second and third raised areas are longitudinally aligned and of progressively increased height.

3. The combination of claim **1** wherein the apex portions of said respective second and third raised areas are longitudinally furthest removed from the flat top portion of said closure.

4. A closure device of plastic for tubes, cans, bottles or other containers each having a smooth-walled inner and outer neck or mouth portion, generally cylindrical in shape, said device comprising a cap having:

a. a top wall;

b. an integral annular internal plug member depending from an inner face of said top wall, serving as means to close said container and of a size to make at least an annular line contact with said inner portion; and

c. an outer tubular skirt member concentric with said internal plug member having a slightly larger inner diameter than that of said outer portion and further having a plurality of circumferentially spaced-apart longitudinally extending continuous stepped abutments of varying heights on the inner surface of said skirt member to permit varying degrees of loose and interference fits between said skirt member and said outer portion as said cap is being applied to said outer portion to permit said cap to be used as a loose dust cover and breather cap, a fixed dust cover and breather cap, as well as a fixed dust cover and gas/liquid tight cap, with at least one step of said abutments including a tear-drop shaped area having apex means for deforming a contiguous area of said skirt member lying generally radially outwardly of said tear-drop shaped area.

5. A closure device as defined in claim **4** wherein said longitudinally extending stepped abutments progressively increase in height as they extend away from the open end of said skirt member to permit progressively decreasing loose fits and progressively increasing interference fits between said skirt member and said container as said cap is progressively applied to said container neck or mouth portion.

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