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3,371,814

SINGLE PIECE PLASTIC BOTTLE CAP

Filed Nov. 29, 1966

FIG. 1

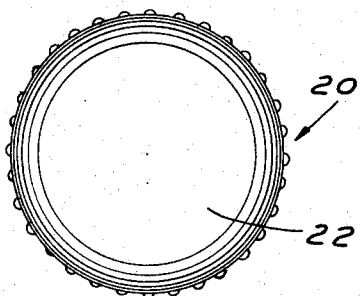


FIG. 2

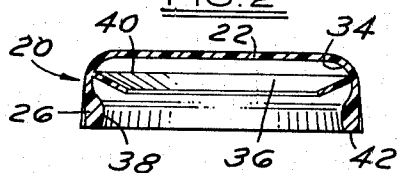


FIG. 3

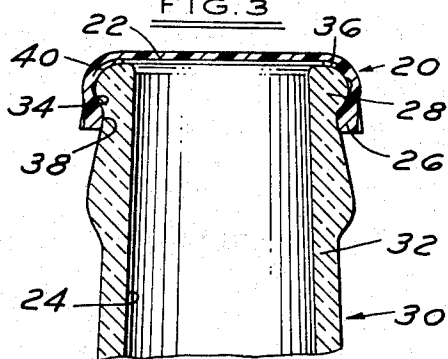


FIG. 4

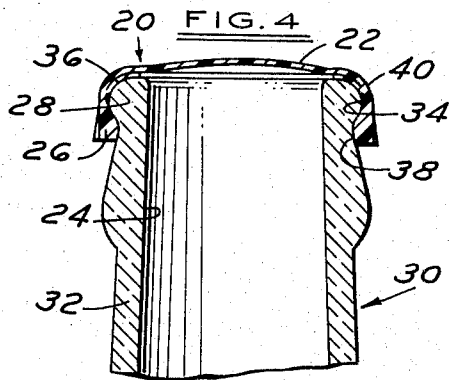


FIG. 5

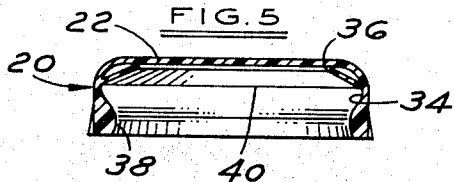


FIG. 6

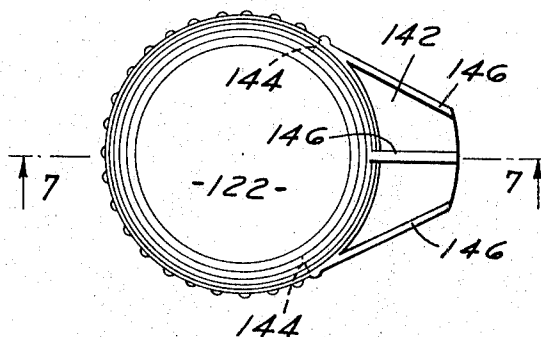
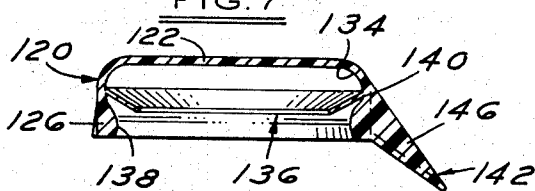


FIG. 7



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3,371,814

SINGLE PIECE PLASTIC BOTTLE CAP

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9 Claims. (Cl. 215-40)

This invention relates to an improved bottle closure, such as the type used on soft drink or malt beverage bottles. More particularly, this invention relates to an improved single piece plastic bottle cap, which provides a positive seal for conventional beverage bottles, even under relatively high pressures and temperatures.

Plastic bottle caps of the general type disclosed herein are known in the art, however such devices have not been commercially successful, because of inherent limitations or defects in their design, which make them unacceptable to commercial bottlers. One failure of previous plastic bottle caps is their inherent inability to seal bottles in the accepted range of bottle manufacturers dimensional tolerances. Another, is their high initial cost, and lack of adaptability to conventional crowning or capping operations. Further, previous bottle cap designs generally do not provide a positive seal under the relatively high temperature and pressure conditions present in the bottling of malt beverages.

One group of prior art plastic bottle caps provides an annular lip, or other sealing means, which extends into the bottle opening to seal against the internal bottle wall. This group includes the following patents: 2,699,369, 2,820,563, 2,914,206, 2,953,272, 2,987,206, 2,991,902, 3,038,624, 3,069,040, 1,107,541, Germany (allowed application) May 1961.

The inside diameter, however, of conventional beverage bottles, may vary from 0.040 to 0.060 inch, which make such closures unacceptable without bottle redesign, because the sealing means is intended to seal against the inside diameter of the bottle. Conversely, the external diameter of the annular bottle rib, which is gripped by the more conventional metal cap, is held within 0.005 inch. Further, such closures do not adequately seal under pressure.

Another group of plastic closures, shown by the prior art, relies primarily on one or more sealing lips which engage the external top portion of the bottle. Such caps are typically threaded to the bottle neck, because the sealing means must be continuously urged against the bottle top to maintain sealing engagement. An air gap is generally provided between the top of the bottle and the cap, on the theory that the pressure within the bottle will urge the lip into the sealing position. Examples of this group of closures are as follows: 3,053,406, 3,067,900, 3,151,757, 3,160,303, 202,476, Austrian, Mar. 1959, 1,213,812, French, Nov. 1959.

Such designs are unacceptable for the more conventional "snap-on" beverage bottles which have an annular rib on the bottle neck adjacent the opening, and have not been commercially accepted even in threaded containers, where pressure within the container varies with temperature. Such closures are also relatively expensive to manufacture, because of the complexity of their design.

A final group of plastic closures will be discussed herein, involves an attempt to retain the basic configuration of the conventional two-piece metal bottle cap, by providing a plastic sealing disc, which sealingly engages the bottle top, and is positioned within the cap. Such bottle cap designs have little advantage over the more conventional metal bottle cap, and generally do not seal as well as the metal cap, because the plastic skirt portion cannot be crimped over the external annular bottle rib. An example

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of this type of closure is United States Patent No. 2,906,421.

A suitable replacement for the conventional metal bottle cap has long been sought by the bottling industry, as evidenced by the above-listed references. The two part metal bottle cap is relatively expensive to produce, requires crimping of the skirt portion against the bottle in the crowning operation, and may permit deterioration of the contained beverage on extended storage. The metal cap has a separate cork seal insert, which will shrink as it dries, permitting leakage around the cork seal. Further, the metal cap is rigid, and therefore cannot yield to permit pressure relief, without leakage.

An object of the closure of this invention is to provide a single piece plastic bottle closure, which will seal conventional beverage bottles in the range of bottle manufacturers dimensional tolerances.

Another object of this invention is to provide a closure for soft drink and malt beverage bottles which will not be affected by changes in temperature or pressure.

An object of this invention is to provide a plastic bottle cap which can easily be adapted to conventional crowning processes.

Another object of this invention is to provide a plastic bottle closure which is less expensive than conventional metal bottle caps, and which is not subject to leakage or deterioration of the seal.

A further object of this invention is to provide a bottle cap which is capable of relieving pressure within the bottle, without leakage or bottle fracture.

Another object of this invention is to provide a plastic closure which may easily be removed, without sacrificing the sealing capability of the closure.

The bottle cap of this invention has internal annular groove, defined in the skirt portion, which closely overlies and substantially conforms to the annular rib of the conventional beverage bottle, adjacent the bottle opening. A thin annular sealing lip is joined to the skirt portion, within the annular groove, which has a downwardly and inwardly extending portion. The annular lip is reversely biased over the upper portion of the annular bottle rib, during the crowning operation, which stretches the lip to closely conform to the annular rib. Considerable forces are set up in the annular lip, which maintains the lip in sealing relation. These forces may be characterized as "hoop stress" or "hoop tension," and provides a perfect seal between the lip portion and the bottle top, without the necessity of an air gap therebetween. The integral top portion of the plastic bottle cap of this invention may be a thin elastic membrane, which is capable of yielding to relieve pressure within the bottle, without leakage or fracture of the bottle.

According to one embodiment of the bottle cap of this invention, the skirt portion is provided with a radially outwardly extending integral tab, and the skirt portion has been weakened, adjacent the joiner of the tab and the skirt portion, to yield on upward urging of the tab. This closure may thus be easily removed without sacrificing the sealing potential of the basic closure design.

Other objects, advantages, and meritorious features will more fully appear from the following specification, claims, and accompanying drawings, wherein:

FIGURE 1 is a top view of one embodiment of the closure of this invention;

FIGURE 2 is a side cross-sectional view of the closure shown in FIGURE 1;

FIGURE 3 is a side cross-sectional view of the closure shown in FIGURES 1 and 2, received on a bottle;

FIGURE 4 is a view, similar to FIGURE 3, illustrating the effect of increased internal bottle pressure;

FIGURE 5 is a side cross-sectional view of the closure

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embodiment of FIGURES 1 to 4, after the closure is removed from the bottle;

FIGURE 6 is a top view of another embodiment of the closure of this invention; and

FIGURE 7 is a side cross-sectional view of the closure embodiment shown in FIGURE 6, in the direction of view arrows 7-7.

FIGURES 1 to 5 illustrate one embodiment of the plastic closure 20, of this invention. The closure has a top portion 22, which overlies the opening 24 of the bottle 30, and an integral skirt portion 26, which extends from the top portion of the closure to overlie the external annular rib 28 of the bottle. The neck portion of the bottle 32, illustrated in FIGURES 3 and 4, is conventional in soft drink and malt beverage bottles. The annular rib 28, which is gripped by the conventional metal bottle cap, is held within 0.005 inch on the diameter to assure sealing in the crowning operation.

An annular groove 34 is defined in the skirt portion, which closely overlies, and substantially conforms to the external annular rib 28 of the bottle. An inwardly extending thin conical lip 36 is joined to the skirt portion, within the annular groove, to provide a positive seal adjacent the bottle opening 24. Prior to the crowning or capping operation, the lip extends generally downwardly and inwardly, as shown in FIGURE 2.

During the crowning operation, i.e. as the cap is mounted on the bottle mouth, the lip is reversely biased and stretched over the upper portion of the annular bottle rib 28, as shown in FIGURES 3 and 4, to assume a concave-convex cross-sectional shape. The reverse biasing of the annular lip 36, over the bottle rib 28, produces considerable forces in the lip, which are directed inwardly, toward the axis of the annular lip, and cause the lip to closely conform to the upper portion of the annular bottle rib. These forces may be characterized as "hoop stress," or "hoop tension," as they are the resultant axially directed forces in a "hoop" or annulus as it is stretched away from its axis. The forces set up in the annular lip, during the crowning operation, are sufficient to maintain an extremely tight seal, without the necessity of crimping the skirt portion over the annular rib, as is required with conventional metal caps. The lip also serves to aid in the retention of the closure on the bottle top, much as a shrink fitted metal ring is retained on a shaft. The ring is retained by hoop stress, directed toward the axis of the shaft.

It can be seen from FIGURES 3 and 4, that the top portion 22 of the closure is slightly biased over the annular lip 36, which eliminates formation of an air gap, which is characteristic of many prior art bottle closures. Further, the lower portion of the skirt 38, defines an internal annular rib, which is received beneath the external annular rib 24 of the bottle, to prevent upward motion of the closure under pressure within the bottle, acting against the underside of the top portion.

The top portion 22, of this embodiment of the plastic closure, may be characterized as an elastic membrane, capable of compensating for changes in pressure within the bottle, without sacrificing the sealing potential of the closure. It can be seen from FIGURE 4, that the top of the closure will yield to assume a concave or convex configuration, without affecting the seal provided by the annular lip 36. The seal is independent of this portion of the closure top, and therefore the seal will be substantially independent of changes in pressure and temperature.

FIGURE 5 illustrates the condition of the annular lip 36, after the closure has been removed from the bottle, and the forces exerted on the lip during the crowning operation.

The location of the lip, within the annular groove 34, is an important feature to the sealing potential of the closure of this invention. As described hereinabove, the annular lip cooperates with the annular bottle rib 28 and the annular groove 34, to seal the bottle opening. This cooperation will be affected by the location of the joiner of the annu-

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lar lip to the skirt portion 40. In the embodiment of the closure shown in the drawings, the lip is joined to the skirt portion substantially at the center of the annular groove 34, which generally coincides with the mid portion of the annular bottle rib 28. This relationship has been found to provide an excellent seal, however the critical relationship is that the lip is joined to the skirt portion, within the annular groove, below the top of the annular bottle rib, to provide the stress relationship described hereinabove.

The plastic closure of this invention is particularly adapted to conventional crowning techniques used by commercial bottlers, and commercial crowners. In a commercial crowner, the metal bottle caps are delivered to a rotating crowner head from a hopper. Bottles are delivered, on a conveyor, beneath the crowner head, which retains a plurality of caps parallel to the bottle tops. The moving bottles are brought into contact with the caps, and the skirt portions are crimped, beneath the annular bottle rib, by a reciprocating piston. The crimping operation may cause fracture of the bottles, requiring shutdown of the line, and adjustment of the head.

The closure of this invention may be secured in a similar manner, utilizing a commercial crowner, however the crimping operation has been eliminated. The closures are retained in the rotating crowner head, parallel to the top of the moving bottles, and seated as the bottles are lifted into the crowner head. The elimination of the crimping operation reduces the maintenance on the crowner, and eliminates fracture of the bottles during the crimping operation.

FIGURES 6 and 7 illustrate another embodiment of the plastic closure of this invention, which is designed to be easily removed from a bottle. The basic features of the closure are similar to the closure described hereinabove in reference to FIGURES 1 to 5, and have been numbered accordingly.

The closure of this embodiment is provided with a radially outwardly extending tab 142, and the skirt portion 126 has been weakened adjacent the joiner of the tab and the skirt portion, at 144, on opposite sides of the tab. The closure may be removed by urging the tab upward, which causes the skirt portion to yield at the weakened areas 144.

The weakened areas of the skirt 144, may extend through the joiner of the lip and the skirt portion 140, to break the seal as the tab is urged upwardly. The tab may also be provided with structural reinforcements, as required, such as the reinforcing ribs 146, shown in FIGURE 6.

The lip 136, of this embodiment of my closure, has been joined to the skirt portion 126 slightly below the center of the annular groove 134. The lip portion will be stretched over the annular bottle rib below the axis of the rib. This will increase the hoop tension as the lip is reversely biased over the bottle rib, in the crowning operation.

Any of various materials may be used for the closure of this invention, however polyethylene, especially linear polyethylene, has proven to be satisfactory. Linear polyethylene is tasteless, and may be injection molded. Further, linear polyethylene provides the structural characteristics required for the features disclosed hereinabove.

What is claimed is:

1. A bottle closure for sealing the opening of a bottle having an external annular rib adjacent the top of the bottle neck portion, comprising: an annular skirt portion adapted to overlie an annular rib of the bottle neck, and an integral top portion adapted to overlie the bottle opening, said skirt portion having an internal annular groove which closely overlies and substantially conforms to the external annular rib of the bottle, and an inwardly extending thin conical lip joined to said skirt portion within said annular groove adapted to be reversely biased over the upper portion of the external annular rib of the bottle

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in stressed relation to seal the bottle opening when said skirt portion is seated over the annular rib of the bottle.

2. The bottle closure defined in claim 1, characterized in that said conical lip is adapted to closely conform to the internal annular groove of said skirt portion and the upper portion of the annular rib of the bottle in the biased condition, to prevent formation of an air gap between said skirt portion and the bottle top.

3. The bottle closure defined in claim 1, characterized in that said thin conical lip is joined to said skirt portion generally at the center at said annular groove.

4. The bottle closure defined in claim 1, characterized in that said inwardly extending thin conical lip extends downwardly at an acute angle to the axis of the closure.

5. The bottle closure defined in claim 1, characterized in that said top portion is a thin elastic sheet adapted to relieve pressures within the bottle.

6. The bottle closure defined in claim 1, characterized in that said skirt portion terminates in an elastic rib which is received beneath the annular rib of the bottle neck to inhibit removal of the cap from the bottle top.

7. The bottle closure defined in claim 1, characterized in that said skirt portion includes a radially outwardly projecting tab portion and said skirt portion includes weakened areas adjacent the joinder of said tab and said skirt

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portion to aid in the removal of the bottle cap by lifting said tab.

8. In combination, a bottle having a neck portion including a central opening and an adjacent external annular rib, and a single piece plastic closure having a skirt portion overlying said annular rib and a top portion overlying said bottle opening, said skirt portion having an internal annular groove closely overlying and substantially conforming to said annular bottle rib and a thin annular lip joined to said skirt portion within said annular groove, said annular lip stretched over the upper portion of said annular bottle rib and conforming to said annular rib and said annular groove without formation of an air gap between said closure top portion and the bottle top opening.

9. The invention defined in claim 8, characterized in that said thin annular lip is joined to said skirt portion within said annular groove below the top of said annular bottle rib.

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25 DONALD F. NORTON, *Primary Examiner*.