SEALING OF CROWN CAP BOTTLES

Fig. 1

Fig. 2

Fig. 3

Inventor
Enzo Caviglia

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Enzo Caviglia, Crawfordsville, Ind., assignor to Hoosier Crown Corporation, a corporation of Indiana

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This invention relates to the sealing of crown cap bottles, and more particularly to a resilient liner for a crown cap which provides an excellent seal when maintained against the mouth of a crown cap bottle.

Crown cap bottles are narrow necked glass bottles which, when used separately, form a locking or integrally locking ring about the mouth thereof about which a crown cap may be crimped to provide a gripping action. A liner of a resilient material, such as cork, is located on the underside of the plate of the crown cap in order to provide a seal when the crown cap is crimped about the sealing ring of the bottle. Initially, substantially all bottle cap liners were made of cork composition, since this material was extremely resilient and conformed readily to the configuration of the top of the bottle and thereby provided an excellent seal. Composition cork has small voids or passages between its cork particles and permits the liquid content of the bottle in some instances to pass through to the metal shell, thereby imparting to the liquid undesired odor or color. To avoid this, it has been necessary in many instances to coat the cork composition with an impervious layer, which may be applied by the method hereinafter disclosed, and which is superimposed upon the cork composition.

In order to avoid the expense and disadvantages of cork liners, liners of highly resilient plastic materials have been made. Materials such as rubber and plasticized polyvinylchloride have been used since such materials are readily deformable and can conform, to some extent, to the shape of the lip of the crown cap bottle.

In accordance with the present invention, there is provided a sealing liner which is particularly adaptable for use with plastic materials of limited resilience, such as low density polyethylene. In particular, there is provided a sealing liner for a crown cap for a narrow mouth standard crown bottle which comprises a thin generally disc-shaped unitary element made of a resilient material, said element having a circular ridge on one surface thereof spaced from the periphery of said disc-shaped element, said ridge having a slope on its outer surface which is steeper than the slope on its outer surface, and said ridge being dimensioned to contact the mouth of a standard crown bottle at an annular lip portion thereof, said liner being brought into sealing position with respect to said bottle, and defining a surface at the inner portion of the mouth which curves upwardly and outwardly and has an inner extremity defining the inner diameter of the bottle mouth and has an outer extremity merging with a planar annular end face of the bottle.

When sealing cap liners are composed of composition cork, no particular shaping of the cork is required since the cork is sufficiently compressible to conform to the shape of the mouth of the bottle when the crown cap is crimped into position. Any irregularities in the shape or size of the mouth of the bottle are automatically compensated for by the high resilience of the cork composition. When a highly resilient elastomeric material, such as rubber or plasticized polyvinylchloride is used in place of cork composition, the resilience, although high, is less than that of cork composition and generally, some pre-shaping of the sealing liner is required. Liners of this type have been pre-shaped so that, in spite of their lesser resilience, they can still conform, under pressure, to the shape of the mouth of the bottle and provide sealing contact with the glass over a substantial area.

However, when the sealing liner is made of a material having sufficient resilience to be able to conform to the shape of the lip of the bottle over an extended area, the minor variations in dimensions of the lip, are of little consequence, since the designed area of contact is a large one and substantial contact will be achieved even if the actual surface of the lip of the bottle differs to some extent from the standard. When a sealing liner is made of a material of limited resilience, such as polyethylene, slight variations in the dimensioning of the bottle mouth may preclude complete contact between the bottle mouth and the contour of the liner.

In addition, there are problems caused by the chipping of crown cap bottles in use, particularly about the mouth thereof. Crown cap bottles are often used to contain materials which are sold on a bottle return basis. Over the course of a number of cycles of use, many bottles become chipped around the mouth thereof. To provide complete contact between a sealing liner and a bottle mouth which has been chipped is extremely difficult when the liner materials has only limited resilience.

In accordance with this invention, contact between the liner and the bottle mouth is restricted to a region of contact between a seal face provided by an outer sloped surface of a ridge on the liner and the inner lip portion bordering the mouth of the bottle. It has been found that chipping of the bottle mouth is far less frequent on this inner annular lip portion of the mouth than it is on the outer regions thereof. It has also been found that providing a ridge on the sealing liner which has a slope on its inner surface steeper than the slope of the seal face on its outer surface permits the desired region of sealing contact to be obtained in spite of the minor variations in dimension among the standard bottles. Sealing contact is contact between the bottle and the plastic with sufficient pressure to cause visible deformation of the plastic.

The invention will be described by reference to the accompanying drawings, of which:

FIG. 1 shows a contour of one lip of a standard crown cap bottle.

FIG. 2 shows a contour of a crown cap, including a liner.

FIG. 3 shows an enlarged contour showing the cross section of the ridge of the embodiment of FIG. 2.

FIG. 4 is an enlarged contour showing the initial contact between the ridge of the liner of FIG. 3 and the lip of the bottle having the largest mouth opening permitted by the standard.

FIG. 5 is an enlarged contour showing the initial contact between the ridge of the liner of FIG. 3 and the lip of the bottle having the smallest mouth opening permitted by the standard.

FIG. 6 is an enlarged contour generally showing contact between the ridge of the liner of FIG. 3 and the lip of a bottle of average diameter after compression of the
cap into sealing position, with the space between the top of the bottle, and the flat portion of the liner being exaggerated for clarity though, in many cases, there may be no space between these elements and they may be in actual contact;

FIG. 7 is related to FIG. 4 and illustrates an enlarged contour showing the final sealed contact between the ridge of the liner of FIG. 3 and the lip of a bottle having the largest mouth opening permitted by the standard;

FIG. 8 is related to FIG. 5 and illustrates an enlarged contour showing the final sealed contact between the ridge of the liner of FIG. 3 and the lip of a bottle having the smallest mouth opening permitted by the standard.

The profile of FIG. 1 is based upon a standard adopted by the Committee on Standards for Finishes of the Glass Container Manufacturers Institute, Inc. on January 8, 1959. It is referred to as "Standard Glass Finish No. 600." The important dimensions, insofar as the liner and cap of this invention are concerned, are dimension A, the diameter of the outermost portion of the locking ring, dimension B, the distance between the flat portion of the mouth of the bottle and the beginning of the entry portion on the side of the bottle where gripping by the crimped cap takes place, dimension I, the inside diameter of the neck or mouth of the bottle, and the radii R1, R2, and R3. Dimension I and radius R3 are particularly important with respect to the dimensioning of the liner of this invention since it is intended that the ridge of the liner make contact with the mouth of the bottle along the upper region of the annular lip portion defined by radius R3.

In the various drawings, the annular lip portion of the bottle is designated L and this annular lip portion curves upwardly and outwardly from its inner extremity which defines the inner diameter I of the mouth to its outer extremity E where the annular lip portion merges with a planar annular end face portion F of the bottle.

In accordance with the above defined Standard Glass Finish No. 600 size 26, dimension A is 1.050 inches, with a possible variation of plus 0.013 or minus 0.012 inch. Dimension B, in accordance with the above standard, is 0.151 inch plus or minus 0.005 inch. Dimension I, may range from a minimum of 0.610 inch to a maximum of 0.672 inch.

Radius R1 is 0.094 inch, radius R2 is 0.156 inch, and radius R3 is not to exceed 0.720 inch (0.047 inch) when dimension I is at a maximum. In actual practice, some bottles for ease of filling, use bottles which depart from the standard in that radius R3 may be as large as 0.720 inch when dimension I is at a maximum (as shown in FIG. 4).

In FIG. 2, the crown cap is shown with the conventional flat portion, or top plate 11 and the conventional depending skirt portion 12. The end plate 11 presents a smooth, substantially planar, underface 11F of the bottle. FIG. 2 shows the cap prior to crimping. The skirt portion 12 of the crown cap is fluted at its lower portion in the conventional manner.

Located on the underface of top plate 11 is the liner body. In each of the disclosed embodiments, the liner body is comprised of a base layer 13 overlying and integrally merging with a depending annular ridge inward of its outer periphery and designated generally as 14. Ridge 14 is situated between two essentially flat portions of the base layer, the central portion 16 and the outer marginal portion 15.

The base layer 13 presents a smooth substantially planar contact face to the underface 11F of the cap. In addition, the base layer 13, which is disc shaped in each of the disclosed embodiments, in effect defines a base plane BP (see FIG. 3) at its region of merger with the ridge 14.

The transverse cross sectional profile for the annular ridge 14 with respect to the disclosed embodiment is pictured in the enlarged views of FIG. 3 for the circumstance wherein the ridge is in unstrained condition. The ridge profile has a steep slope 17 presenting an inwardly facing free face sloping downwardly and outwardly from an inner annular merger line 17M with the base plane and a more gradual slope 18 presenting an outwardly facing seal face sloping downwardly and inwardly from an outer annular merger line 18M with the base plane.

The free face 17 and seal face 18 merge at the peak of the ridge to define an apex line 20 spaced closer to the inner merger line 17M than to the outer merger line 18M to provide that the seal face 18 have less mean slope than the free face 17.

In sealing position, contact is made between the ridge on its slope 18 and the upper region of the annular lip portion L of the mouth of the bottle as defined by radius R3. The precise location of the line of contact with respect to its position on slope 18 or its position on the annular lip portion L of the mouth of the bottle is dependent upon the dimensioning of the bottle and of the annular ridge.

The positioning of the initial line of contact of the ridge of FIG. 3 with respect to a bottle having a large mouth opening and the positioning of the initial line of contact between the ridge and the lip of a bottle having a relatively small mouth opening are shown in FIGS. 4 and 5, respectively. FIG. 6 shows that pressure of slope 18 against the annular lip portion L of the mouth of the bottle when the crown cap is pressed down into sealing position tends to force the peak of the ridge inwardly to a moderate degree. This distortion permits minor adjustment of the line of contact to compensate for discrepancies in the size and shape of the bottle. If the inner surface of ridge 14 defined a gradual slope similar to the slope of 18, it would not be possible to shift the peak of the ridge inwardly to the degree required, since the peak of the ridge would be butted against lateral inward movement by the larger amount of resilient material on the gradual slope.

As described above with reference to FIG. 6, there may be contact between the top surface of the bottle and the flat portion of the liner when the cap is compressed into sealing position.

The gradual slope 18 is broken to contain a shoulder 19 at an elevation below that of the peak 20 of the ridge. The shoulder 19 provides a site for a line of initial contact with the annular lip L of the bottle when the mouth is relatively large, as shown in FIG. 4. With a relatively small mouth, initial contact of the ridge with the annular lip portion L of the bottle is near the peak of the ridge as shown in FIG. 5. If desired, the shoulder may be provided along the seal face 18 of the ridge.

In accordance with either of the above-described aspects of this invention, the ridge 14 is dimensioned to bring its outer surface into contact with the mouth of a standard crown bottle at the annular lip portion thereof when the liner is brought into sealing position with respect to said bottle. In the preferred dimensioning, the height of the ridge above the base plane BP of the liner is about 0.040 inch. The height of the shoulder 19 is about 0.020 inch. The diameter of the inner merger line 17M is preferably about 0.657 inch, while the diameter of the outer merger line 18M is preferably about 0.825 inch. The diameter of the ridge at its peak 20 is preferably about 0.700 inch. The total diameter of the liner body is generally about one inch.

Variations in the above dimensions may be made within the spirit of this invention, provided that they still permit contact of the ridge along its seal face with the annular lip portion L of the mouth of the bottle. For example, the ridge height from the base plane may vary from about 0.050 inch to about 0.050 inch and a diameter at the ridge peak 20 may vary from about 0.680 inch to about 0.720 inch. To some extent variations in dimensions may ensue from the method of manufacture of the
liners since, although die dimensions may be fixed, the amount of shrinkage on the cooling of the polyethylene may vary.

It will now be apparent from the drawings and the dimensions previously given that the outer merger line 18M is outward and the inner merger line 17M is inward of the annular lip portion L of the annular lip portion for all tolerance conditions encountered with standard crown bottles. It will also be apparent that the width of the ridge 14 at the region of the base plane BP being about (0.825-0.657/2 inches) 0.084 inch is substantially greater than (20) the depth of the ridge, 0.050 inch. By reason of these dimensions, an intermediate region of the seal face 18 effects initial contact with the annular lip portion L when the cap first seats the liner body on the bottle.

In a preferred way of making the resilient liner of this invention the measured amount of conventional polyethylene is placed in the shell of the crown cap in molten state. Pressure is applied to the molten polyethylene with a relatively cold plunger having the female pattern of the desired liner and the polyethylene is held by the plunger until a desired change of shape has been effected. Usually about 180 milligrams of polyethylene per lineal inch is required, the time and temperature of molding depending upon the precise plastic material used, as is known to those skilled in the art.

The preferred resilient plastic is low density polyethylene of relatively high molecular weight and relatively low melt index. Other plastic materials having the limited resiliency of polyethylene are also suitable for this invention. Such plastic materials include copolymers of ethylene with propylene and copolymers of ethylene with butylene. In general, materials of limited resilience resembling polyethylene may be used as the materials of the liner of this invention. Such materials may be defined as having a tensile modulus from about 5,000 to about 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50. Such materials are generally also characterized as producing no break in the load-impact strength test carried out in accordance with ASTM D-256.

It will be apparent from the ridge and bottle dimensions given hereinbefore and from the illustration of FIG. 6, that the arrangement achieves effective sealing contact between the seal face 18 and the bottle essentially only with intermediate regions of the seal face, even when the cap fully seats the liner body on the bottle. In this fully seated or fully loaded relationship, the ridge has a distorted transverse cross sectional profile, illustrated in FIG. 8 in which it is capable of internal pressures capable of being held by the cap. It may also be seen that this distorted ridge profile is characterized by the apex line 20 and the portion of the seal face thereadjacent being free of contact with the bottle. The stability of the ridge profile is a result of its contour, its spatial relationship to the annular lip portion L and the limited compressibility, resilience and cold flow characteristics of the thermoplastic materials specified herein.

One important relationship evident from the liner and bottle dimensions given hereinbefore is that when the ridge is unstressed, the inner merger line 17M of the ridge profile corresponds approximately (actually is slightly less) than the maximum permissible diameter of the inner extremity I of the annular lip portion L (see FIG. 4). For these same conditions, the apex line 20 is outward of the inner extremity I of the lip portion L of the relationship line 17M to the lip portion L in conjunction with the steep slope of the free face 17 insures that intermediate regions of the seal face 18 effects final sealing contact with intermediate regions of the lip L. It will also be apparent from the drawings that the seal face 18 has a main radius of curvature greater than that of the annular lip portion L. The seal face is substantially convex and has an intermediate relieved region defining the shoulder 19. The lip portion L has a radius of curvature of 3/16 inch according to the industry standards, however, in practice, the larger mouth bottles sometimes have a radius of curvature for the lip of about 5/32 inch. For comparison, the main radius of curvature of the seal face 18 may be said to have an effective main radius of curvature that is also about 5/32 inch.

Because of the geometry of these relationships, the ridge 14 is thus not permitted to squeeze down into the vertical walled region of the mouth of the bottle and the stability of the liner body material insures that the apex line 20 and the immediately adjacent regions of the seal face 18 are not in contact with the bottle when the cap is fully seated.

One of the significant advantages of the liner of this invention resides in the control achieved over the location of the contacting regions between the seal face 18 and the bottle. The provision of sealing contact on the curved lip L for all tolerance conditions obviates almost all seal problems occasioned by chipping, cracking or other imperfections. Elaborate study has shown that such imperfections are extremely rare in the case of the annular lip portion L.

The distorted ridge profile relationships are shown with greater particularity in FIGS. 7 and 8 which are blown up illustrations of actual seated cap, liner and bottle combinations. These views are based on samples that were not to reveal the actual cross sectional profile of a liner fully seated on a cap.

FIG. 7 which illustrates the liner applied to a large mouth bottle shows that the distortion of the cap as it is tightly turned onto the neck of the bottle effects a bodily rotation of the ridge 14 and an actual inward cold flow of the apparent inner merger line 17M. This rotation of the ridge results in part from the angled seal face 18 reacting against the angled surface of the bottle lip L and this resultant distorted profile clearly evidences that the ridge apex 20 and adjacent region of the seal face 18 are free of contact with the bottle. FIG. 8 shows another liner seated fully upon a small mouth bottle and the ridge profile has again undergone a turning and an inward cold flow though the ridge distortion is not as pronounced in the case of FIG. 7.

The above detailed description of this invention has been given for clearness of understanding only. Necessary limitations should be understood therefore, as modifications will be obvious to those skilled in the art. Reference to the bottle and cap assume an upright position for the bottle, but no unnecessary limitations are intended as it is recognized that the bottle may be oriented in any position after having been seated by the cap.

What is claimed is:

1. A sealing liner for a crown cap for a narrow mouthed standard crown bottle which comprises a thin generally disc-shaped unitary element made of polyethylene having a tensile modulus from about 5,000 to about 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50, said element having a circular ridge on one surface thereof, spaced from the periphery of said disc-shaped element, said ridge having a slope on its inner surface which is steeper than the slope on its outer surface, and at least one shoulder on the outer surface of said ridge, said shoulder being of lesser height than said first-named ridge.

2. A sealing liner for a crown cap as recited in claim 1 in which the height of said ridge is from about 0.030 inch to about 0.050 inch.

3. A sealing liner for a crown cap as recited in claim 1 in which the width of said shoulder is about 0.020 inch.

4. A sealing liner for a crown cap as recited in claim 1 in which the inner diameter of said ridge is about 0.657 inch, the outer diameter of said ridge is about 0.825 inch and the diameter of said ridge at its peak is about 0.700 inch.

5. A sealing liner for a crown cap as recited in claim 1 in which the inner surface of said ridge has a slope where
it joins said disc-shaped element which is substantially vertical.

6. A crown cap for a narrow-mouthed standard crown bottle, said cap comprising a top plate and a skirt depending therefrom to fit over and grip the mouth of said bottle, a generally disc-shaped sealing liner on the under-surface of said plate, said liner being of unitary construction and composed of polyethylene having a tensile modulus from about 5,000 to about 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50, said liner having a circular ridge on one surface thereof, spaced from the periphery of said disc-shaped liner, said ridge having a slope on its inner surface which is steeper than the slope on its outer surface, and at least one shoulder on the outer surface of said ridge, said shoulder being of lesser height than said first-named ridge.

7. A crown cap for a narrow-mouthed standard crown bottle, said cap comprising a top plate and a skirt depending therefrom to fit over and grip the mouth of said bottle, a generally disc-shaped sealing liner on the under-surface of said plate, said liner being of unitary construction and composed of polyethylene having a tensile modulus from about 5,000 to about 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50, said liner having a circular ridge on one surface thereof, said ridge having a slope on its inner surface which is steeper than the slope on its outer surface, said ridge having predetermined diameter dimensions relative to said bottle to constitute said outer surface as the sole seal face presented to said bottle by said ridge, at least one shoulder located intermediate on the seal face of said ridge to be of lesser depth than its apex line, said seal face having engagement with said bottle only at regions spaced substantially from said inner surface, said seal face having a convex, continuously curving annular surface regions intersecting and defining a shoulder at an intermediate region of the seal face.

8. In a closure combination comprised of a standard crown bottle and a crown cap, the bottle having a central mouth bordered by an upwardly and outwardly curving annular lip portion having an inner extremity defining the inner diameter of the mouth and having an outer extremity merging with a planar annular end face portion of the bottle and the cap having a top plate presenting a substantially planar underface facing and spanning the end face portion of the bottle and the cap carried by said cap and underface and comprised of a liner body of molded thermoplastic material of limited compressibility, resilience and cold flow characteristics substantially similar to that of a like body of low density polyethylene, said liner body presenting a smooth substantially planar contact face to the underface of the cap including a substantially flat outer marginal annular wall portion encircling and integrally merging with an annular depending ridge portion, said marginal annular wall portion defining a base plane and said annular ridge portion having, when in unstrained condition, a transverse cross sectional profile presenting a seal face sloping downwardly and inwardly from an outer annular merger line with the base plane, and presenting a free face sloping generally downwardly and outwardly with a transverse cross sectional profile with lip portion when the cap first seats the liner body on the bottle and to achieve effective sealing contact between the seal face and the bottle essentially only with intermediate regions of the seal face when the cap fully seats the liner body on the bottle, said ridge having a distorted transverse cross sectional profile with lip portion when the cap first seats the liner body on the bottle and which is characterized by the apex line and a portion of the seal face adjacent the apex line being free of contact with the bottle.

9. In a closure combination as defined in claim 8 and wherein, when said ridge is unstressed, said inner merger line has a diameter corresponding approximately to the maximum permissible diameter of the inner extremity of said lip portion, and said ridge apex is outward of the inner extremity of said lip portion.

10. In a closure combination comprised of a standard crown bottle and a crown cap, the bottle having a central mouth bordered by an upwardly and outwardly curving annular lip portion having an inner extremity defining the inner diameter of the mouth and having an outer extremity merging with a planar annular end face portion of the bottle and the cap having a smooth substantially planar underface facing and spanning the end face portion of the bottle, an improved sealing liner carried by the cap against said underface and comprised of a liner body of molded thermoplastic material of limited compressibility, resilience and cold flow characteristics substantially similar to that of a like body of polyethylene having a tensile modulus from about 5,000 to 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50, said liner body presenting a smooth substantially planar contact face to the underface of the cap and including a substantially flat outer marginal annular wall portion encircling and integrally merging with an annular depending ridge portion, said marginal annular wall portion defining a base plane and said annular ridge portion having, when in unstrained condition, a transverse cross sectional profile presenting a seal face sloping downwardly and inwardly from an outer annular merger line with the base plane, and presenting a free face sloping generally downwardly and outwardly from an inner annular merger line with the base plane, said seal face and free face merging to define an apex line on the ridge portion spaced closer to the inner merger line than to the outer merger line to provide that the seal face have less mean slope than the free face, at least one shoulder located intermediate on the seal face of said ridge to be of lesser depth than the apex line of said ridge, said unstressed ridge profile having a width at the base plane substantially greater than the depth determined by the apex line, said outer merger line being outward and said inner merger line being inward of the outer extremity of the aforesaid bottle lip portion for all tolerance conditions encountered with standard crown bottles to bring an intermediate region of the seal face into initial contact with lip portion when the cap first seats the liner body on the bottle and to achieve effective sealing contact between the seal face and the bottle essentially only with intermediate regions of the seal face when the cap fully seats the liner body on the bottle, said ridge having a distorted transverse cross sectional profile with lip portion when the cap first seats the liner body on the bottle and which is characterized by the apex line and a portion of the seal face adjacent the apex line being free of contact with the bottle.
of the bottle and the cap having a top plate presenting a smooth substantially planar underface facing and spanning the end face portion of the bottle, an improved sealing liner carried by the cap against said underface and comprised of a liner body of molded thermoplastic material of limited compressibility, resilience, and cold flow characteristics substantially similar to that of a like body of polyethylene having a tensile modulus from about 5,000 to about 40,000 pounds per square inch and a Shore-durometer hardness between about 20 and about 50, said liner body having a base layer overlying and integrally merging with an annular depending ridge portion, said base layer presenting a smooth substantially planar contact face to the underface of the cap and defining a base plane at the region of integral merger of the base layer with the depending ridge portion, said annular ridge portion having, when in unstressed condition, a transverse cross sectional profile presenting a seal face sloping downwardly and inwardly from an outer annular merger line with the base plane, and presenting a free face sloping generally downwardly and outwardly from an inner annular merger line with the base plane, said seal face and free face merging to define an apex line on the ridge portion spaced closer to the inner merger line than to the outer merger line to provide that the seal face have less mean slope than the free face, at least one shoulder located intermediate on the seal face of said ridge to be of lesser depth than the apex line of said ridge, said unstressed ridge profile having a width at the base plane substantially greater than the depth determined by the apex line, said outer merger line being outward and said inner merger line being inward of the outer extremity

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THERON E. CONDON, Primary Examiner.
J. B. MARBERT, Assistant Examiner.