Sept. 21, 1965 F. M. HAGMANN ETAL 3,207,350

SEALING CLOSURE FOR A CROWN-TYPE BOTTLE

Filed Oct. 20, 1961 2 Sheets-Sheet 1

Fig. 1

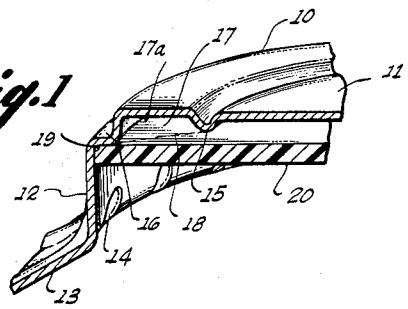


Fig. 2

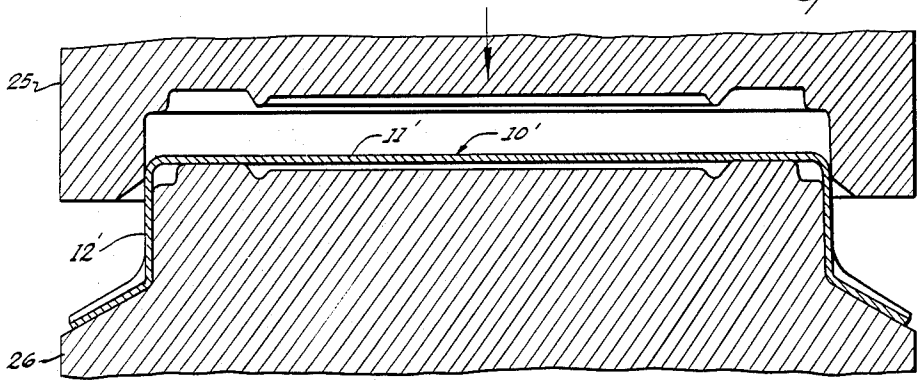


Fig. 3

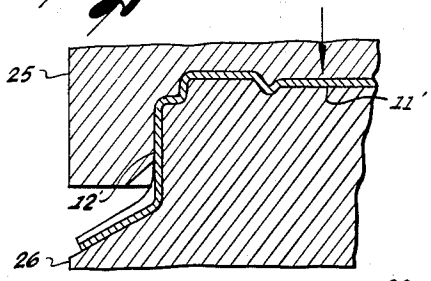
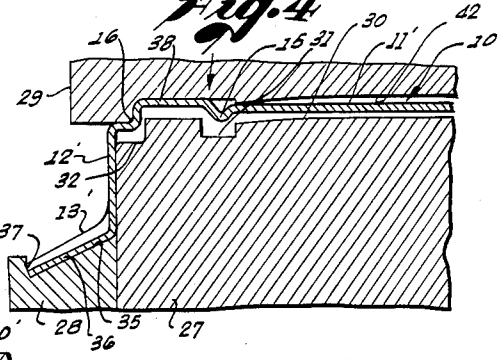


Fig. 4



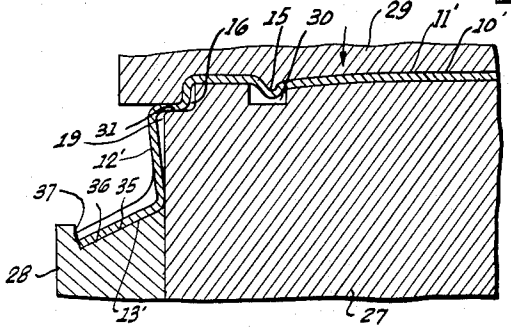


Fig. 5

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SEALING CLOSURE FOR A CROWN-TYPE BOTTLE

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Fig. 6

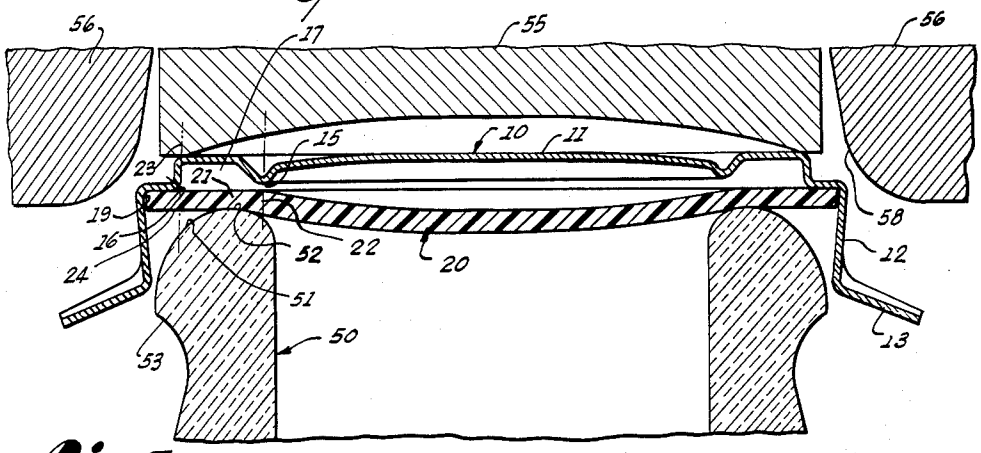


Fig. 7

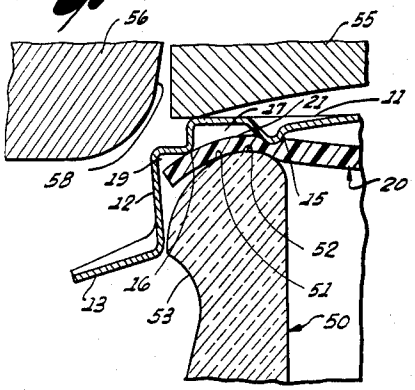


Fig. 8

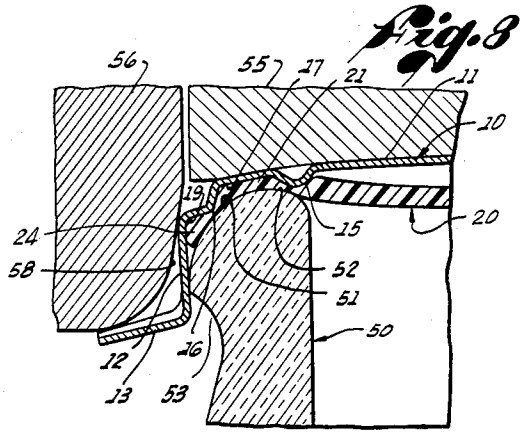
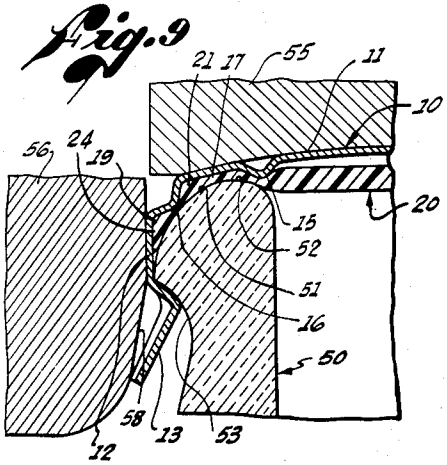


Fig. 9



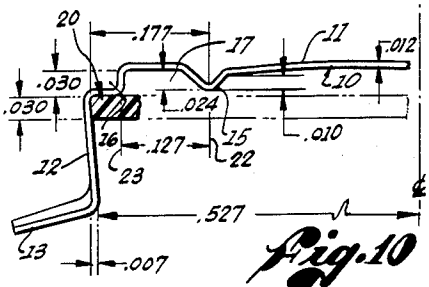


Fig. 10

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SEALING CLOSURE FOR A CROWN-TYPE BOTTLE

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6 Claims. (Cl. 215—40)

This invention relates generally to sealing closures, and more particularly to an improved sealing closure especially adapted for use on a crown-type bottle.

This application is a continuation-in-part of our copending application entitled Seal, Serial No. 61,749 filed October 10, 1960, now Patent No. 3,122,253, granted February 25, 1964, and a continuation-in-part of our copending application entitled Seal, Serial No. 14,707 filed March 14, 1960, now Patent No. 3,122,116, granted February 25, 1964.

Sealing closures presently in use on crown-type bottles normally include a flat disk or sealing-lining element formed of cork. The seal provided by such an element is of limited utility from the standpoints of providing an initially effective pressure or vacuum seal and then maintaining that seal over a prolonged period. The inefficiency of these closures limits the shelf life of the products stored in the containers. This is especially true in the case of beverages which are necessarily stored under substantial pressure.

In addition, materials such as cork have a tendency to contaminate or adversely flavor the product. Moreover, they are so permeable to liquid and gas in the container as to permit it to pass through the sealing-lining element into contact with the metal crown or cap. This escaped liquid and gas, in turn, cause corrosion of the metal and eventually failure of the seal, as well as further contamination of the stored product.

To prevent this contamination and corrosion, a disk or "spot" of metal foil has been cemented or otherwise secured to the lower surface of the cork disk. The intended purpose of the spot is to prevent the product from contacting the cork and also to prevent passage of liquid or gas through the element into contact with the metal of the cap. In regard to the elimination of the contamination and corrosion problem, the spot has been partially successful. However, the resulting increase in the overall cost of the sealing closure has been such as to make this solution economically undesirable and it, of course, does not offer any solution to the shelf life problem.

The aforesaid problems have long been known in the art, and there have been many different attempts to solve them by the use of other sealing and lining materials. Plastic materials have been tried without any degree of success, because it was soon discovered that a flat sealing-lining element of plastic in a standard crown-type cap will not seal properly. This, in turn, has led the workers in the are to experiment with various shaped plastic elements, either molded in place or in separate forming dies, as for example, in our own earlier applications to which reference has been made. However, the economic conditions on the bottling industry are such that an increase in cost makes the closure unsaleable for the mass market. Shaped plastic lined caps cannot be produced and inspected at a cost comparable with flat cork lined caps by any known production methods. Accordingly, substantially all crown-type caps today are still sealed with the unsatisfactory cork liners.

The present invention relates to a uniquely shaped crown-type cap that is combined with a flat, separately

formed plastic sealing-lining element to produce a highly satisfactory sealing closure at a low cost suitable for the mass market. The seal provided by the invention has extremely good sealing characteristics and permits a long shelf life. It protects the metallic cap from corrosion and simultaneously prevents any contamination of the taste of the product that is bottled. Because the sealing-lining element is flat and of uniform thickness, it can be produced at extremely low cost, either by stamping or cutting operations. It is adapted to extremely high production methods without the necessity for individual inspection and by reason of its unique relationship to the metallic cap, is retained in place without the necessity for adhesives or bonding agents.

Preferably, our sealing-lining element is formed of polyethylene. This material is particularly desirable, since it is non-corrosive, non-contaminating, and impermeable to most all liquids and gases. Since it is resilient, deformable, and substantially incompressible, it is adapted for effective high pressure sealing. However, even though it has been known that polyethylene has highly desirable characteristics for use in this kind of closure, it has not heretofore been successfully used because, like other plastic materials, it has a tendency to extrude or cold-flow when subjected to pressure in an unconfined state. Also, it is "self-lubricating," i.e. it has a relatively low coefficient of friction, and thus friction cannot be relied upon to hold it in position. As a result, the sealing-lining element formed of such plastic material was not self-retaining in the cap prior to the capping operation. While this feature was in itself highly inconvenient and costly for production techniques, it is more important to note that the coldflow of the material prevented it from making and holding effective sealing contact with the bottle lip.

To overcome the problems associated with a plastic liner, such as one formed of polyethylene, two general approaches have been taken by prior workers. The first approach has been to mold the plastic material into a special shape within a grooved portion of an associated cap. In some instances, this solution has served to at least partially maintain the plastic material in the desired location in registration with the bottle lip as sealing pressure is applied and, hence, has resulted in generally adequate sealing. However, it will readily be appreciated that both the initial cost of the apparatus to perform such a molding operation and the unit operating costs are relatively high. Moreover, closely controlled inspection is necessary in the case of such an operation to insure uniform quality. For these reasons, the cost of closures of this type is too great to justify their widespread use on disposable containers, such as beverage bottles.

Another approach to preventing the extrusion of the polyethylene sealing material is to provide a grooved cap in combination with a separately formed sealing-lining element of a special shape. Although the sealing results achieved with such a closure are generally adequate for low pressure beverages, the costs involved in shaping such an element are again so great as to limit its use.

In view of the foregoing, it is a primary object of the invention to provide a highly effective, yet low cost sealing closure for a crown-type bottle, the closure embodying a cap and an associated, separately formed polyethylene sealing-lining element which is flat and of uniform thickness.

Another object of the invention is to provide a sealing closure for a crown-type bottle, comprising a cap having seal-confining grooves and a separately formed plastic sealing-lining element, which is flat and of uniform thickness, associated with a cap in a manner whereby ring portions of the element are adapted to be confined

by the cap grooves and urged into sealing contact with an opposed surface of the bottle lip.

A further object is to provide a sealing closure of the type described and further characterized in that the voids of the cap grooves and the volumes of the respective confined ring portions of the sealing-lining element are volumetrically sized to one another to achieve optimum void-volume relationship during the bottle capping operation.

Still another object of the invention is to provide a sealing closure of the type described which is adapted to provide an effective seal in spite of the surface irregularities or tolenances in the beaded lip or sealing surface of the crown-type bottle.

It is a still further object to provide a sealing closure incorporating a metal cap and a separately formed polyethylene sealing-lining element, which is flat and of uniform thickness, the element being free to deform and to move radially relative to the cap, yet being permanently held in assembly therewith prior to installation on it or after removal from the bottle.

A further object is to provide apparatus for shaping a metal cap in such a manner that its associated sealing-lining element is adapted to be permanently retained in assembly therewith.

It is still another object of this invention to provide a method for forming a crown-type cap from a standard crown cap blank in such a manner that the cap is adapted to retain an associated and separately formed polyethylene sealing-lining element in assembly therewith.

These and other objects and advantages of our invention will be more fully understood by referring to the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is an enlarged fragmentary perspective view of the crown-type closure of the invention.

FIGURE 2 is a full section of apparatus for partially forming a cap blank into the shape shown in FIGURE 1, the apparatus and the cap blank being shown in their respective positions prior to forming.

FIGURE 3 is a partial section illustrating the apparatus and the cap blank of FIGURE 2 after forming.

FIGURE 4 is a partial section of apparatus for finally forming the cap blank into the shape illustrated in FIGURE 1, the apparatus and the partially formed cap blank being shown prior to final forming.

FIGURE 5 is a view similar to FIGURE 4, illustrating the apparatus and the cap after final forming.

FIGURE 6 is a full section showing the sealing closure of the invention in place on a standard crown-type bottle and the elements of the capping press at the start of the capping operation.

FIGURE 7 is a partial section showing the sealing closure, the elements of the capping press, and the bottle at their relative postions at the completion of the first stage of the capping operation.

FIGURE 8 is a partial section similar to FIGURE 7, showing the various parts at the completion of the second stage of the capping operation.

FIGURE 9 is a partial section similar to FIGURES 7 and 8, showing the various parts at the completion of the third and final stage of the capping operation.

FIGURE 10 is a partial section on an enlarged scale of the sealing closure of the invention, this view showing the controlling dimensions of the closure as adapted for use on a standard crown-type bottle.

Referring to the drawings and in particular to FIGURE 1, the sealing closure of the invention may be seen to comprise a crown-type cap **10** and associated sealing-lining element **20**.

The cap **10** is formed of a thin workable material, such as sheet metal, and includes generally a circular lid portion **11** and a skirt portion **12** depending from the periphery of the lid portion. In order to achieve retention of the sealing-lining element **20** in a manner to be more fully explained, the skirt portion **12** of the cap tapers slightly inwardly from its junction with the lid portion. The marginal edge **13** in the skirt portion **12** is flared outwardly and serrated, as at **14**, and is adapted to be crimped inwardly during the bottle capping operation.

The lid portion **11** is formed with annular and generally downwardly facing, inner and outer pressure ridges **15** and **16**, respectively, adjacent its periphery. The ridges **15** and **16** are concentric and radially spaced from one another, so as to define the boundaries of an annular groove **17** in the interior of the cap. For descriptive purposes, the vertical depth of the groove **17** is considered to be the distance between the construction line **18** extending between the ridges and the opposite wall **17***a* of the groove **17**. Similarly, the void of the groove **17** is considered as the space within the groove bounded by the plane of the reference line **18**.

As may be seen, the outer ridge **16** is formed adjacent the junction of the lid and skirt portions **11** and **12**, respectively. In addition to facing generally downwardly, the outer ridge **16** also faces slightly inwardly in the preferred construction. Further, because of the specified shape of the outer ridge **16** and its eventual position on the bottle lip, in effect, a second annular groove **19** is provided in the interior of the cap. This latter groove **19** is located at the junction of the lid and skirt portions and is spaced radially outwardly and downwardly of the groove **17**. The void of the corner groove **19** is established, i.e. the groove boundaries are defined, as the skirt portion **12** of the cap is moved down over and shaped around the bottle lip during the capping operation.

The sealing-lining element **20** comprises a flat disk formed of a resilient, deformable, and substantially incompressible plastic. Polyethylene is preferred because of its many desirable sealing and lining properties, some of which were noted above, however, other plastics having similar physical characteristics may also be used to advantage.

As may be seen, the thickness of the element **20** is approximately equal to the maximum depth of the groove. The particular cap construction described above in relation to the size and shape of the bottle lip to which the cap is to be applied, make it possible for a flat polyethylene disk to be used effectively.

It will be recalled that an object is to provide a closure in which a separately formed sealing-lining element is permanently retained in assembly with its associated cap **10**. Retention is here accomplished by forming the cap **10** with the specified tapered skirt construction and the element **20** of a diameter greater than the minimum inside diameter of the tapered skirt portion **12** of the cap. More specifically, the diameter of the element **20** is approximately equal to the diameter of the lid portion **11** and at least greater than the minimum inside diameter of the skirt portion **12**. Preferably, in order to achieve even more positive element retention, the diameter of the element is slightly greater than that of the lid portion.

In assembling the element **20** and the cap **10**, the element is merely sprung past the minimum diameter section of the skirt portion **12** and positioned adajcent and generally parallel to the lid portion **11**. As may be seen in FIGURE 6, the peripheral edge of the element **20** is disposed in the corner groove **19**. By virtue of the preferred element having an outside diameter just slightly greater than the diameter of the lip portion, the element tends to bow slightly away from the lid portion **11**, as shown in FIGURE 6. However, sealing takes place adjacent the ridges **15** and **16** and grooves **17** and **19** and, hence, this slight bowing of the element **20** in no way effects sealing.

When the element **20** is slightly larger in diameter than the lid portion, there is virtually no possibility of the element dropping free of the cap, even during shipment through cold climates. In order for the element to inadvertently separate from the cap, it would necessarily

shrink in size relative to the cap **10** at least as much as the difference between the diameter of the element **20** and the minimum inside diameter of the skirt portion **12**. Such relative shrinkage would not take place, even under the worst of conditions likely to be encountered.

It will be seen in FIGURE 6 that the void of groove **17** is initially somewhat less than the volume of the annular ring portion **21** of the element **20** in registration with the groove, this ring portion **21** being shown in cross section between the reference lines **22** and **23**. Sizing of the groove **17** and ring portion **21** to achieve an equal void-volume relationship takes place during the bottle capping operation. Moreover, it is when this equal void-volume relationship is obtained that maximum sealing pressure is exerted and optimum sealing takes place. Since the void of the groove **17** is initally less than the volume of the ring portion **21**, a reduction in the volume of the portion **21** necessarily takes place during capping.

A second annular ring portion **24** of the element **20** located radially outwardly of the outer ridge **16** (and reference line **23**) is in registration with the groove **19**. The ring portion **24** changes in volume during capping, and is finally confined within the corner groove **19** and deformed into sealing contact with the lip **51**. As in the case of the groove **17** and corresponding ring portion **21** of element **20**, sizing of the groove **19** and ring portion **24** to achieve an equal void-volume relationship takes place during capping.

The sealing closure including the cap **10** and the sealing-lining element **20** is adapted to be applied to a standard crown-type bottle. The controlling dimensions of a typical closure constructed in accordance with the invention and adapted to be applied to a standard crown-type bottle are shown in FIGURE 10. As may be seen, the maximum depth of the groove **17** is 0.030" and the preferred minimum thickness of the material is also 0.030". Further, the skirt portion **12** preferably tapers inwardly approximately 0.007" on each side from maximum to minimum radius.

Referring to FIGURE 6, the bottle **50** has a curved and overhanging lip **51** with a crest **52** and an annular shoulder **53** facing oppositely from the surface of the lip. The minimum inside diameter of the cap **10** is just slightly greater than the maximum outside diameter of the bottle lip **51**, so that the cap may be readily positioned over the lip in preparation for capping.

The capping operation is schematically shown at the completion of successive stages of progress in FIGURES 7, 8, and 9.

A capping press, including a pressure foot **55** and a crown block **56**, is shown for applying the assembled sealing closure to the bottle **50**. The pressure foot **55** is cylindrical in shape and has an outside diameter substantially equal to the maximum outside diameter of the lip **51** of the bottle. The lower cap-engaging surface **57** of the pressure foot **55** is concave in shape so as to conform generally to the contour of the lip **51**. The pressure foot **55** is adapted for vertical movement relative to the bottle **50** which, in turn, may be considered as held stationary.

The crown block **56** is concentrically mounted relative to the pressure foot **55** and adapted for vertical movement. The lower end of the crown block **56** is flared or tapered outwardly, as at **58**, to accommodate the outwardly flared marginal edge **13** of the skirt portion **12** of the cap.

In preparation for the capping operation, the cap **10** is placed over the lip **51**, as illustrated in FIGURE 6. The ridges **15** and **16** are arranged so as to be in registration with the top of the lip **51**. More specifically, the inner ridge **15** is annularly spaced radially inwardly of the crest **52** of the bottle, whereas the outer ridge is annularly spaced radially outwardly of the crest. By virtue of the ridge positioning, the groove **17** is located over the crest **52** of the lip, whereas the groove **19** is spaced radially outwardly thereof.

As illustrated in FIGURE 7, in the first stage of the capping operation, the pressure foot **55** is lowered into contact with the lid portion **11** of the cap. This pressure foot contact causes the inner ridge **15** of the cap to urge a subjacent, limited area of the element **20** into pressural contact with the lip **51**. Direct contact of the ridge **15** and the lip **51** is, of course, prevented by the intermediate portion of the element **20**. However, since the element is relatively thin and formed of a deformable material and the area of contact is relatively small in relation to the area of the lip **51**, high unit pressure exists at the region of contact, and, for descriptive purposes, the ridge **15** is considered to be in pressural engagement with the lip **51**.

The unit pressure at the region of ridge engagement is sufficiently high to effect some sealing and, more important, to prevent extrusion or coldflow of the element **20** between the opposed surfaces of the ridge **15** and the bottle lip **51**. As the inner ridge **15** is urged into pressural engagement with the lip **51**, a subjacent portion of the sealing element **20** is deformed to provide space for the ridge. Part of this deformed material moves outwardly into registration with the groove **17** and part moves in the opposite direction.

During the second stage of the capping operation, as illustrated in FIGURE 8, the pressure foot **55** further descends relative to the stationary bottle **50**, and the crown block **56** partially descends around the pressure foot and bottle to contact the marginal edge **13** of the cap. Such pressure foot and crown block descent cause the portion of the cap **10** outwardly of the inner pressure ridge **15** to pivot downwardly about the ridge **15** as a fulcrum. As may be seen, the inner ridge **15** preferably has a larger radius of curvature than the outer ridge **16**. This is desirable for the reason that the ridge **15**, when so constructed, will more readily bend and thus function as a fulcrum in the manner described.

As pivoting of the outer portion of the cap takes place, sizing of the groove **17** and ring portion **21** to another takes place, and the excess plastic material under the groove **17** is flowed or moved outwardly. It is to be noted that the element **20** is free to move radially relative to the cap as sizing takes place. Such movement is possible, since the element is neither bonded nor adhesively secured in any way to the lid portion **11** of the cap. Moreover, movement is aided by virtue of the polyethylene being self-lubricating. Thus, since the excess material of the ring portion **21** is neither restrained against radial movement by adhesion or friction, it readily deforms or moves outwardly as downward pivoting of the outer portion of the cap takes place.

An advantage of the specified capping action is that air initially within the groove **17** is forced radially outwardly ahead of the plastic filling the groove **17**. Air entrapment has been a serious problem with prior closures, however, with the present closure, the groove **17** is filled from inside out and the problem is eliminated.

Continued downward pivoting of the portion of the cap outwardly of the ridge **15** results in the outer ridge **16** "biting into" the subjacent area of the element **20**. As in the case of the inner ridge **15**, the area of engagement is small and, accordingly, the unit pressure is high. Under normal circumstances, volumetric sizing of the groove **17** and ring portion **21** to one another has taken place. Therefore, at the instant the ridge **16** pressurally engages the lip **51** and prevents further movement or extension of the plastic into or out of the groove **17**, the void of groove **17** is equal to the volume of the confined ring portion **21**. When this equal void-volume relationship has been established, maximum sealing pressure is exerted by the confined ring portion **21** for a given force applied to the cap **10**.

As mentioned above, the inner ridge **15** registers with the lip **51** inwardly of the crest **52**, whereas the outer ridge **16** registers with the lip outwardly of the crest. Thus,

the ridges pressurally engage the lip 51 radially inwardly and outwardly, respectively, of the crest 52. This, in turn, results in the ridges clamping inwardly toward each other from opposite sides of the curved lip 51 and in the groove being pulled downwardly over the crest of the lip to deform the ring portion 21 of the element into confinement therein and to urge it into sealing contact with the opposed surface of the lip 51.

Descent of the crown block 56 and resulting pivoting of the outer portion of the cap, causes the inner wall of the skirt portion to make ring contact with the bottle lip 51 adjacent its outermost edge 54. Because of this metal to glass contact and the pressural engagement of the ridge 16, the boundaries of the groove 19 are established. As may be seen in FIGURE 8, the ring portion 24 of element 20 is disposed within the groove 19. The volume of this ring portion 24 is determined as the outer ridge 16 pressurally engages the lip 51, the volume being that portion of the element 20 outwardly of the ridge. At this stage, the void of the groove 19 is somewhat greater than the volume of the associated ring portion 24. Sizing to achieve an equal void-volume relationship takes place during the remaining phase of the capping operation.

The sealing closure, the elements of the capping press, and the bottle are shown in their relative positions at the completion of the third and final stage of the bottle capping operation in FIGURE 9. During the final stage of capping, the crown block 56 further descends around the pressure foot 55 and the bottle 50. As descent takes place, the skirt portion 12 of the cap is moved downwardly over the lip 51. This decreases the void of the groove 19 and thereby urges the confined portion 24 of the element into sealing contact with the lip 51.

The reduction of the groove void or groove sizing and resulting urging of the confined portion 24 of the element into sealing contact with the lip 51 continue during the final stage of the capping operation until the equal optimum void-volume relationship is established. As previously discussed in conjunction with the groove 17 and its associated ring portion 21, the optimum relationship is when the void of the groove 19 is equal to the volume of the confined ring portion 24 of the element, i.e. when no unfilled space remains within the groove. When this equal relationship is achieved, maximum sealing pressure is exerted by the confined ring portion 24 against the lip 51 for a given force applied to the cap 10.

Since the element 20 is here constructed of polyethylene which is substantially incompressible, a limiting condition is imposed in the cases of both grooves 17 and 19 and their associated ring portions 21 and 24 by the rigidity of the cap material. However, this limit is well above the pressures encountered in normal conditions and it, in fact, serves as a safety feature to prevent bursting of the bottles. An advantage of the present closure is that the cap material is sufficiently resilient to give slightly to permit the escape of excess pressure, but not to release the confined ring portions 21 and 24, and then to spring back to reseal the container. By selecting a suitable cap material, it is, therefore, possible to relieve pressures above a predetermined magnitude without causing permanent seal failure.

When the skirt portion 12 is pulled down sufficiently over the lip 51 to establish an equal relationship between the void of the groove 19 and the volume of the ring portion 24, the crown block 56 wipes or slides over the marginal edge 13 of the skirt portion 12. This causes the latter to be crimped inwardly against the annular shoulder 53 at the lower edge of the lip 51 to lock the cap and bottle and maintain sealing pressure.

In retrospect, sealing is accomplished by the closure of the invention in various regions. Primary sealing results from the confined ring portions 21 and 24 of the element 20 being urged against the bottle lip 51. In addition, secondary sealing is accomplished by virtue of the ridges 15 and 16 urging subjacent, limited areas of the element 20 into pressural contact with the lip 51. As explained, the ring portion 21 is first confined and urged into sealing engagement with the lip 51 and then the ring portion 24 is likewise confined and urged into sealing engagement with the lip 51. Also, it should be noted that since the ring portions 21 and 24 are trapped in position, coldflow is prevented. Thus, the product may be stored indefinitely under pressure without leakage, and higher carbonation pressures for the beverage may be used.

Deviations of the sizes and shapes of any or all of the bottle lip 51, the cap 10, and the element 20 from their respective standards and norms are compensated by either more or less of the skirt portion 12 being moved downwardly over the lip 51 and crimped inwardly against the shoulder 53. Equal void-volume relationships are established between the voids of the grooves 17 and 19 and the volumes of the ring portions 21 and 24, respectively, in spite of normal working tolerances, thus it is not necessary to precisely specify the sizes and shapes of the various cooperating parts. As an example, if the bottle lip 51 is out of flat on the low side in a limited region, a greater extent than usual of polyethylene will be required to fill the groove 17. Accordingly, less material is moved or deformed outwardly during capping, resulting in the ring portion 24 of the element 20 being smaller by corresponding amount. Thus, in order to establish an equal void-volume relationship between the groove 19 and its ring portion 24, a greater extent than usual of the skirt portion 12 is moved downwardly over the lip and crimped inwardly against the shoulder 53.

When the closure of the invention is applied to a crown-type bottle, a highly effective seal which eliminates the corrosion and contamination problems of the prior art is provided. However, such sealing is achieved without resorting to costly manufacturing procedures. To the contrary, the closure comprises a grooved cap and a separately formed, polyethylene sealing-lining element which is flat in shape and of uniform thickness. Accordingly, the closure can be produced at an extremely low cost. The many advantages are gained by virtue of portions of the sealing-lining element being confined within the cap grooves and by virtue of sizing of the cap grooves and their associated portions of the element to achieve equal void-volume relationships being accomplished during the capping operation.

A particular advantage of the sealing closure of the invention is that a polyethylene sealing-lining element is incorporated. The use of an element constructed of polyethylene, which has many desirable sealing and lining properties, is made possible by the particular cap construction described above in relation to the sizes and shapes of the other cooperating parts. With the specified cap construction, the ring portions 21 and 24 of the sealing-lining element is confined within the cap grooves and, hence, prevented against extruding. Moreover, because of this confining, the effectiveness of the seal is not reduced, even if the closure is subjected to high temperatures, shock, or other conditions tending to reduce the effectiveness of a crown-type closure.

In order to form or shape the cap 10 of the closure from a standard crown cap blank 10' having a flat lid portion 11' and a skirt portion 12 depending therefrom at a right angle, basically a two-step method is utilized. The first step is for forming the lid portion 11 with ridges 15 and 16 and the groove 17 defined therebetween. In the second step, the skirt portion 12 is tapered inwardly, so as to provide for retention of the sealing-lining element 20. Although more desirable results are obtained by using a two-step operation, it will be understood that the cap 10 can be formed in a single step.

Apparatus for so forming the cap 10 is shown in FIGURES 2 through 5. For accomplishing the first step of the forming operation, a pair of cooperating dies 25 and 26 shaped in accordance with the above described ridge and groove configuration of the final cap 10 are provided. A standard crown cap blank 10' is positioned between the

dies **25** and **26**. Force is then exerted to move the dies **25** and **26** into mating relationship, thereby shaping the flat lid portion **11'** in the desired manner.

The second step of the forming operation is accomplished by means of three cooperating dies illustrated in FIGURES 4 and 5, and including a lower, central die **27**, a holding die **28**, and an upper die **29**. The lower, central die **27** has an upper surface **30** with annular grooves **31** and **32** to receive the projecting ridges **15** and **16** of the partially formed cap blank. As may be seen, the die grooves **31** and **32** are oversize so they will not deform the ridges **15** and **16** during shaping the skirt portion **12'**. The die **27** is cylindrical in shape with an outside diameter just slightly greater than that of the bottle lip to which the cap is to be applied. This is to insure that the cap is adapted to be positioned over the lip in preparation for capping.

Concentrically mounted in fixed relation on the lower, central die **27** is the holding die **28**. This last mentioned die **28** has a notch or groove **35** in its upper end providing a pair of angularly spaced shoulders **36** and **37**. The holding die **28**, as shown in FIGURE 4, is constructed and arranged so that when the partially formed cap blank **10'** is positioned over it, the marginal edge **13'** of the skirt portion **12'** rests against both shoulders. In this position, it can be seen that the lid portion **11'** is spaced slightly above the upper surface **30** of the die **27**. Moreover, since the marginal edge **13'** rests against both shoulders **36** and **37**, it is held against movement downwardly or outwardly relative to the relatively fixed dies **27** and **28**.

With the partially formed cap blank **10'** so positioned and held, the upper die **29** is then lowered into engagement with the lid portion **11**. This causes the lid portion **11** to "bulge" outwardly or to increase slightly in diameter and results in the upper section of the skirt portion **12'** tapering slightly inwardly in the desired manner. Similar to the lower, central die **27**, the upper die **29** is cut here with an oversized annular groove **38**, so as not to deform the ridges **15** and **16** during shaping. In addition, the portions of opposed surfaces **30** and **42** of dies **27** and **28**, respectively, in register with the section of the lid portion **11'** inwardly of the inner ridge **15** are preferably shaped and slightly upwardly convex and concave, respectively. The purpose for shaping the dies **27** and **28** in this manner is to bow the lid portion upwardly into generally horizontal alignment with the grooved section of the lid portion. Experience has shown that such a shape is desirable where the cap is to be applied with standard capping apparatus. The finished cap **10** may be easily removed from the lower, central die **27**, since the metal forming the cap is sufficiently resilient to spring slightly away from the periphery of the die when the die pressure is released. One method of facilitating removal is to provide for upward movement of the holding die **28** relative to the lower, central die **27**.

Although one embodiment of our closure is illustrated and described in some detail, as is a method and apparatus for forming the cap of the closure, it will be understood that this is by way of illustration only and that changes in the design and arrangement of the various parts and in the forming method and apparatus may be made without departing from the spirit and scope of the invention.

We claim:

1. A sealing closure for a crown-type bottle having a curved and overhanging lip adjacent its mouth with a crest and presenting an annular shoulder facing oppositely from the top of said lip, comprising: a ductile metal cap adapted to be positioned over said lip and having a central lid portion with a diameter at least equal to the maximum outside diameter of said lip and a depending skirt portion adapted for locking engagement with said shoulder, said lid portion being formed with annular, inner and outer pressure ridges projecting downwardly and cooperating to define the boundaries of an annular groove in the interior of said cap, said inner and outer ridges being in registration with the top of said lip and being spaced radially inwardly and outwardly, respectively, of said crest when said cap is positioned over said lip; and a resilient, deformable, and substantially incompressible sealing-lining disk, having a diameter greater than the diameter of said outer pressure ridge, fitted in said cap contiguous said pressure ridges, said inner ridge being adapted for pressural engagement with said lip to urge a first subjacent, limited area of said disk into pressural contact with said lip and, thereafter, said outer ridge being adapted for pivoting downwardly about said inner ridge as a fulcrum to urge a second subadjacent, limited area of said disk into pressural contact with said lip and thereby confine a ring portion of said disk within said groove, the void of said groove and the volume of the ring portion of said disk being volumetrically sized to one another during said pivoting.

2. A sealing closure for a crown-type bottle having an overhanging lip adjacent its mouth and formed with an annular shoulder facing oppositely from the top of said lip, comprising: a metal cap having a central lid portion formed with a downwardly facing, inner pressure ridge and a downwardly and inwardly facing, outer pressure ridge in its lip-engaging surface, said ridges cooperating to define the boundaries of a first groove in the interior of said cap, and a depending skirt portion adapted for locking engagement with said shoulder, said lid and skirt portions cooperating at their junction to provide a second groove spaced radially outwardly and downwardly of said first groove in the interior of said cap; and a sealing-lining element, formed of a plastic, that is resilient, deformable, substantially incompressible, and relatively impermeable, flat in shape, and of uniform thickness, carried by said cap, said element having first and second ring portions in registration with said first and second grooves, respectively, said inner ridge being adapted to urge a subjacent, limited area of said element into pressural engagement with said lip, thereafter, the portion of said cap outwardly of said inner ridge being adapted for pivoting downwardly about said last mentioned ridge as a fulcrum to volumetrically size the void of said first groove and the volume of said first ring portion to one another, thereafter, said outer ridge being adapted to urge a subjacent, limited area of said element into pressural engagement with said lip to confine said first ring portion within said first groove and, thereafter, the skirt portion of said cap being adapted to be moved downwardly over said lip to volumetrically size the void of said second groove and the volume of said second ring portion to one another.

3. A sealing closure as in claim **2**, wherein the volume of said first ring portion of said element is decreased during pivoting of the outer portion of said cap and, simultaneously, the volume of said second ring portion is increased a corresponding amount.

4. A sealing closure for a crown-type bottle having an overhanging lip adjacent its mouth and formed with an annular shoulder facing oppositely from the top of said lip, comprising: a cap having a lid portion with a diameter approximately equal to the maximum outside diameter of said lip and a depending skirt portion adapted for locking engagement with said shoulder, said lid portion having annular, inner and outer pressure ridges projecting generally downwardly therefrom and cooperating to define the boundaries of a groove in the interior of said cap; and a flat plastic sealing-lining element of a uniform thickness approximately equal to the maximum depth of said groove carried by said cap in non-adhered assembly therewith, said inner ridge being adapted to urge a first limited area of said element into pressural contact with said lip and, thereafter, said outer ridge being adapted for pivoting downwardly about said inner ridge to urge a second limited area of said element into

pressural contact with said lip, said element having a ring portion initially disposed out of said groove and deformed into confinement within said groove during such engagement of said ridges.

5. A sealing closure as in claim 4 wherein each of said inner and outer ridges has an arcuate cross sectional shape and wherein the radius of curvature in cross section of said inner ridge is greater than that of said outer ridge.

6. A sealing closure for a crown-type bottle having a curved and overhanging lip adjacent its mouth with a crest and formed with an annular shoulder facing oppositely from the top of said lip, comprising: a metal cap adapted to be positioned over said lip and including a lid portion with a diameter approximately equal to the maximum outside diameter of said lip and a depending skirt portion adapted for locking engagement with said shoulder, said lid portion having an annular, inner pressure ridge projecting downwardly therefrom and an annular, outer pressure ridge projecting downwardly and slightly inwardly therefrom, said inner and outer ridges defining the boundaries of a groove in the interior of said cap and being in registration with said lip and annularly spaced radially inwardly and outwardly, respectively, of said crest when said cap is positioned over said lip; and a disk-like sealing-lining element formed of a resilient and deformable plastic material resiliently carried by said cap in the interior thereof adjacent said lid portion, said element having an annular ring portion initially disposed in registration with said groove and at slight spacing therefrom, said inner ridge being adapted when said cap is positioned over said lip to urge a first subjacent portion of said element of small area in relation to the area of said lip into pressural contact with said lip, and, thereafter, said outer ridge being adapted for pivoting downwardly relative to said lid portion about said inner ridge as a fulcrum to deform said ring portion into said groove and to urge a second subjacent portion of said element of small area in relation to the area of said lip into pressural contact with said lip, said ridges cooperating during locking engagement of said skirt portion with said shoulder to confine said ring portion of said element within said groove.

References Cited by the Examiner

UNITED STATES PATENTS

2,327,454	8/43	Punte	215—39
2,327,455	8/43	Punte	215—39
2,362,421	11/44	Von Till	113—121
2,365,350	12/44	Marek	113—121
2,923,263	2/60	Danly et al.	113—38
3,096,898	7/63	Hall et al.	215—40
3,110,409	11/63	Chaplin	215—40
3,113,540	12/63	Cresap	113—38

FOREIGN PATENTS

896,017	11/53	Germany.

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