March 31, 1970 J. L. MOLLER 3,503,534

BOTTLE CAP HAVING PROTECTIVE SKIRT EDGE

Filed Nov. 26, 1968 4 Sheets-Sheet 1

FIG. 1

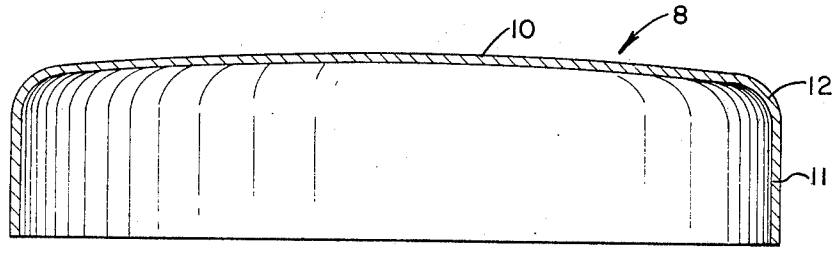


FIG. 2

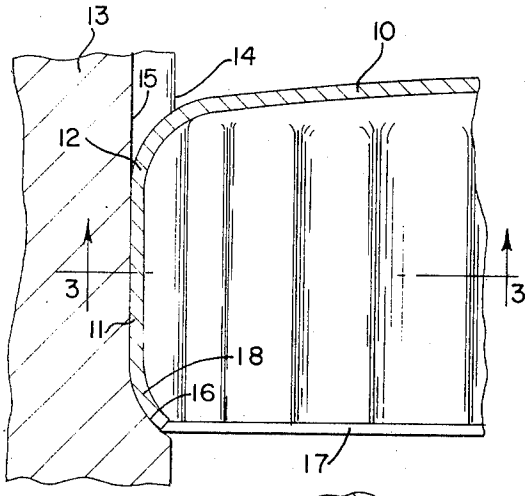
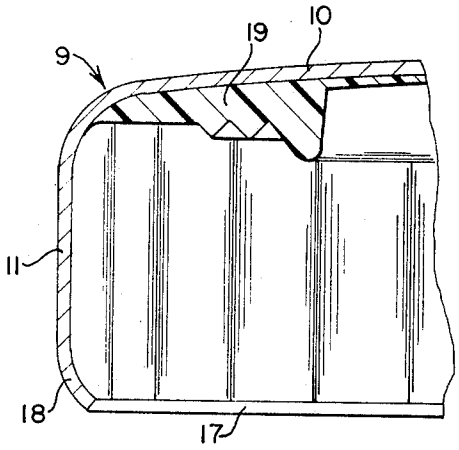


FIG. 4



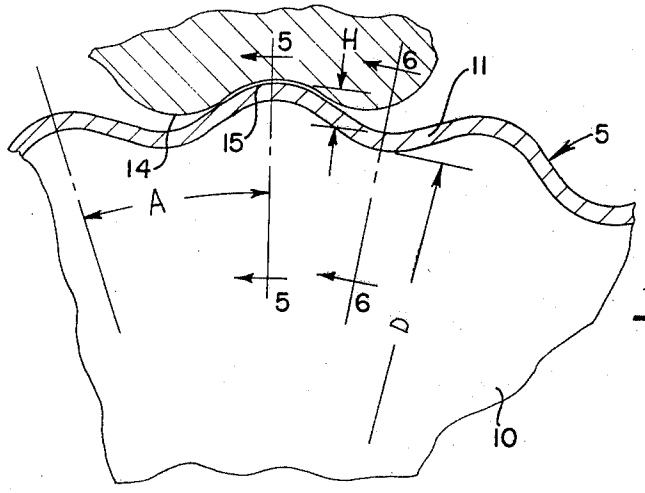


FIG. 3

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March 31, 1970 J. L. MOLLER 3,503,534

BOTTLE CAP HAVING PROTECTIVE SKIRT EDGE

Filed Nov. 26, 1968 4 Sheets-Sheet 2

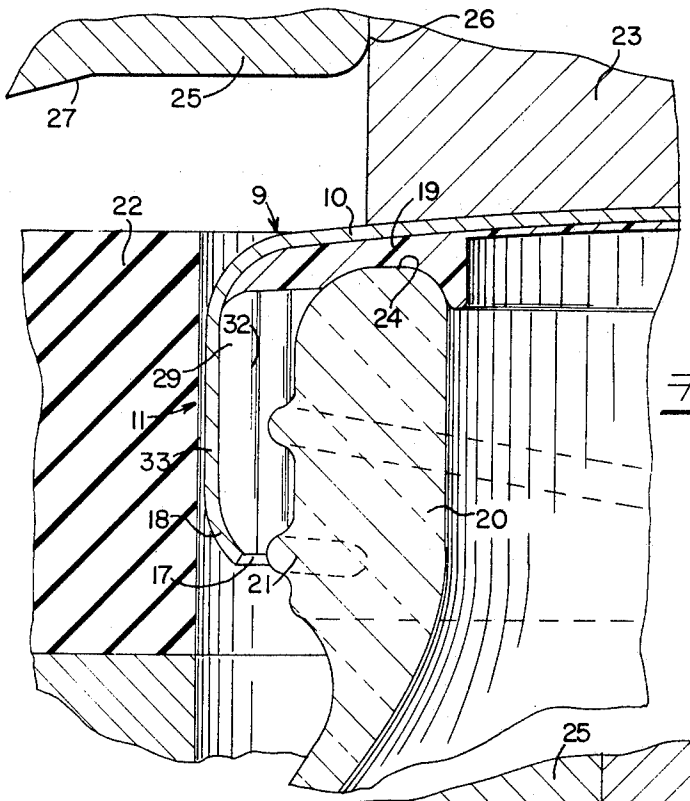


FIG. 5

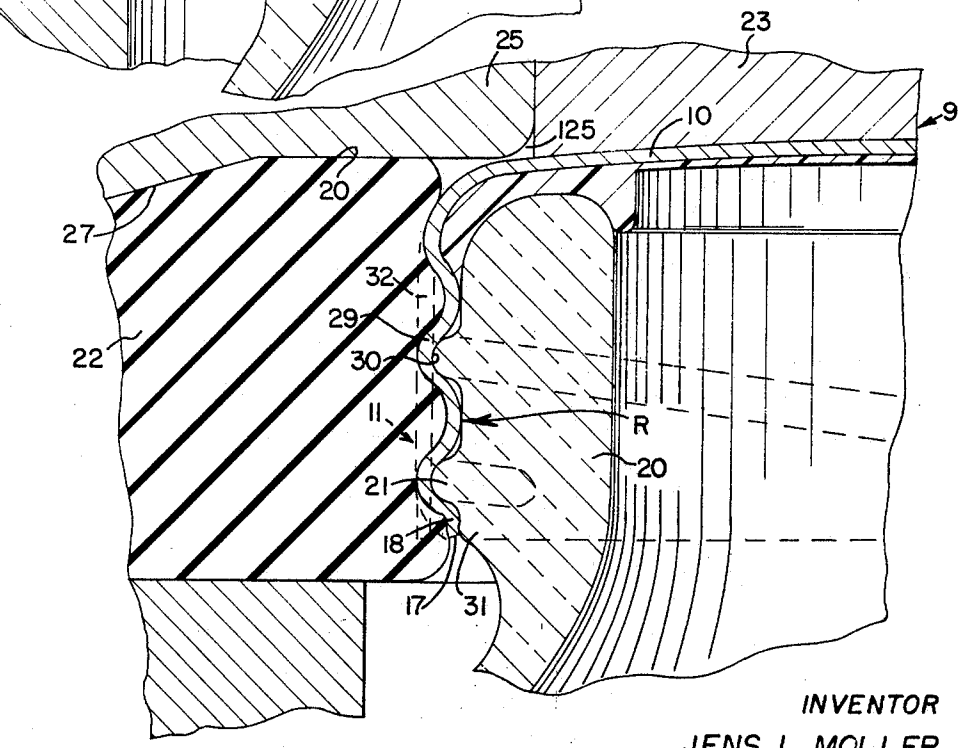


FIG. 6

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BOTTLE CAP HAVING PROTECTIVE SKIRT EDGE

Filed Nov. 26, 1968 4 Sheets-Sheet 3

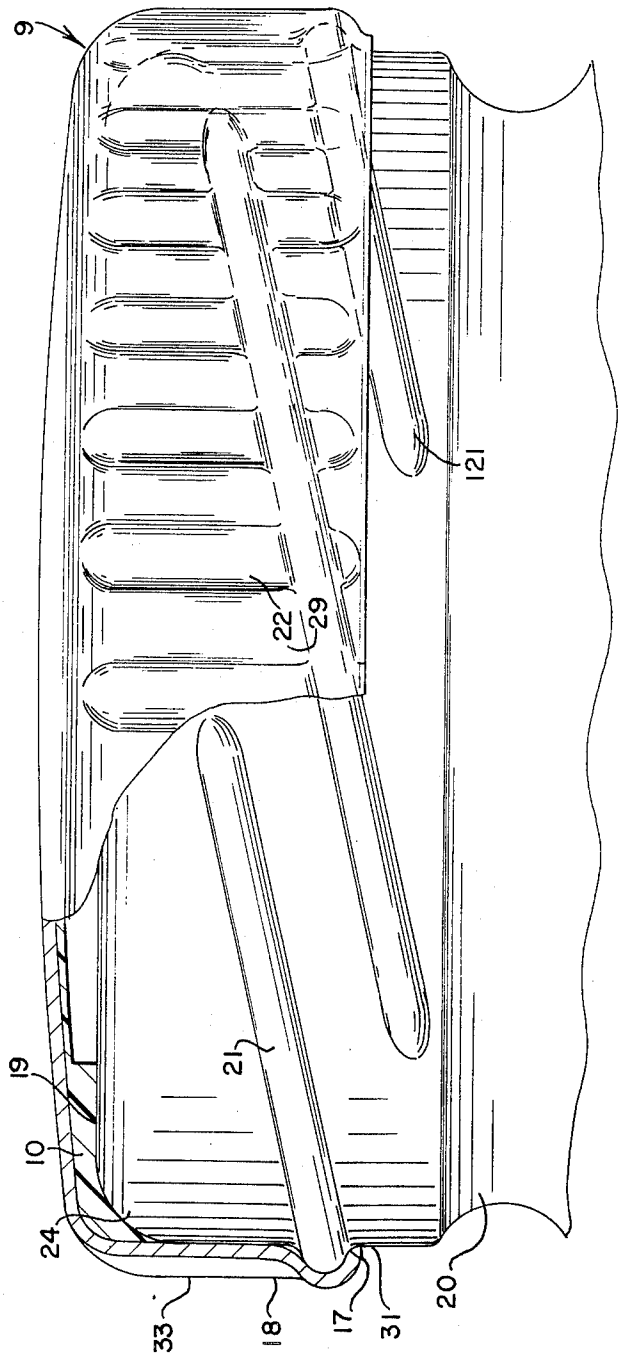


FIG. 7

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BOTTLE CAP HAVING PROTECTIVE SKIRT EDGE

Filed Nov. 26, 1968 4 Sheets-Sheet 4

FIG. 8

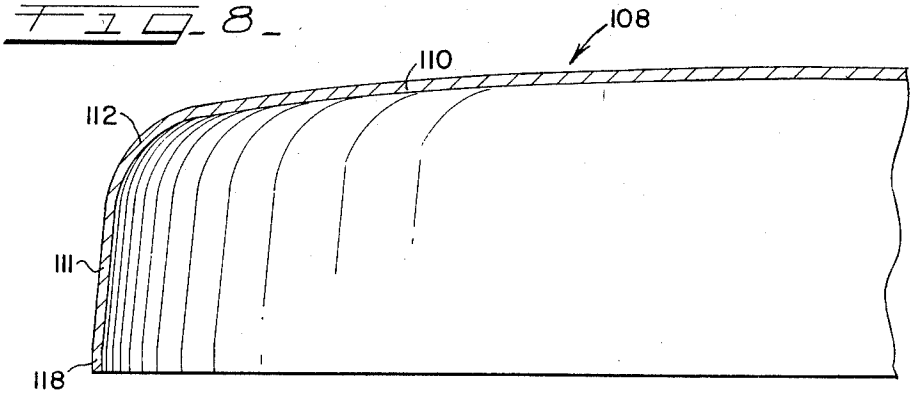
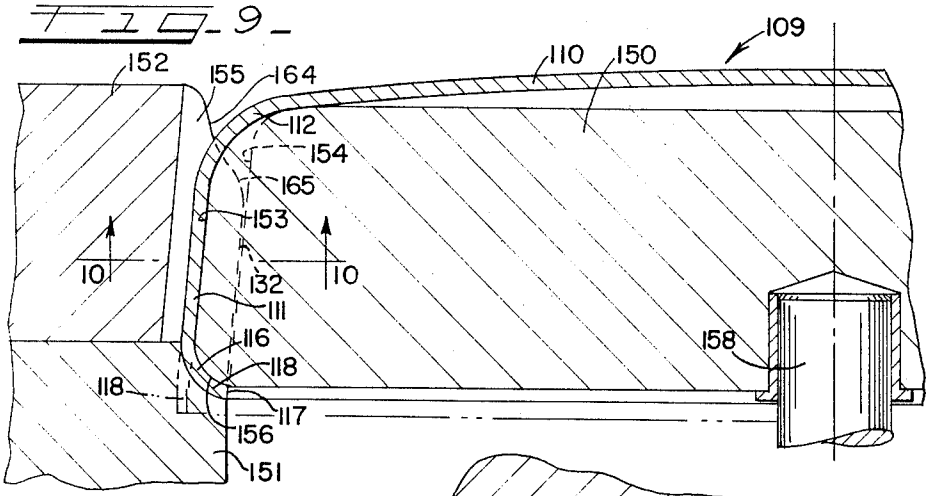


FIG. 9



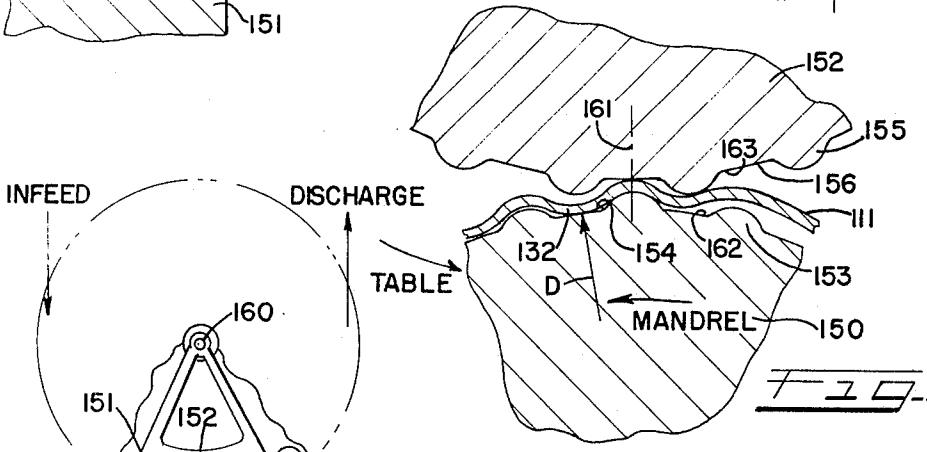


FIG. 10

FIG. 11

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United States Patent Office 3,503,534
Patented Mar. 31, 1970

3,503,534

BOTTLE CAP HAVING PROTECTIVE SKIRT EDGE

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Int. Cl. B65d 41/10
U.S. Cl. 215—39 3 Claims

ABSTRACT OF THE DISCLOSURE

The subject is a bottle cap of the type which is first pushed on, but thereafter may be twisted off and on. A shell is made from a cupped blank having a substantially straight skirt. The skirt is then knurled or fluted, the inside root diameter of the flutes being a close sliding fit on the crests of the bottle finish threads to which the cap is to be applied. When knurling, the rim of the skirt is curled inward slightly to an insde diameter about the same as the inner root diameter of the flutes. After inserting a suitable seal ring or disc, the shell is pushed down over the threaded finish of the bottle into sealing engagement with the lip. While so holding the cap, portions of the skirt are conformed to the thread formations on the bottle finish, thus providing a releasable threaded engagement. As the threads are formed in the skirt, the inwardly turned edge is closely conformed to the finish, in which position the edge is shielded against accidental contact by the fingers, when unscrewing the cap to open the bottle.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to caps of the type primarily intended for sealing bottles of carbonated beverages, more particularly the type which can be applied and sealed in a manner similar to the conventional crowning procedures, but which may thereafter be unscrewed and used as a reclosure in the manner of screw or lug caps.

The prior art

In recent years, there has been an increasing demand for beer and soft drinks in large bottles, such as half quarts and quarts. This demand has been stimulated in large part by price and convenience factors. However, a major deterrent to wider acceptance of larger bottles for home consumption is possible wastage by virtue of unused contents losing carbonation and going flat.

Conventional crown caps cannot ordinarily be used as reclosures, since they are almost invariably spoiled in removing them. Various types of reclosure stoppers, plugs, and caps have been brought on the market, but have not met with substantial acceptance. Convenience is best served by providing a reusable cap on each bottle, for example, a thread or lug cap. Such a cap is also desirable for small bottles, not usually requiring reclosure, to enable the user to remove the cap without a bottle opener.

Tooling and equipment problems, particularly in the soft drink bottling field, generally require that press-on cap application be retained, to be generally adaptable to crowning presses, or comparable equipment, which has been found most satisfactory and economical in the bottling conditions involved. It has heretofore been proposed that caps be made of substantially conventional crown form, in sizes to fit over a finish with suitable thread formations and threaded in situ. However, the conventional crown cap entails a configuration in which the skirt is flared out, or at least substantially spaced

from the bottle finish, with a sharp edge for engagement by prying bottle opener. A cap of this basic configuration does not lend itself to turning with the fingers, particularly because of the hazard in cutting fingers on the exposed edge. Also, threaded closure quality and the characteristics obtained with conventional crown forming and crimping techniques have not been found entirely satisfactory. Various modifications and alternatives have been proposed to overcome the several problems, but prior to this invention, no fully satisfactory arrangement, has been devised, at an acceptable market price for volume sale.

Prior cap designs which theoretically fulfill the quality requirements have been found difficult and uneconomical to manufacture, by virtue of complex operations, excess labor and material requirements and related objections in commercial practice. As a result, commercial forms represent some compromise in quality or performance. In consequence of unreliable twist characteristics and limited public acceptance, the twist caps generally offered and normally available in the volume market are such as may be alternatively applied and removed as conventional crowns, having a configuration with a suitable pry edge. Except for costlier varieties available only at premium prices, the "combination" caps in general use are dangerous, in that the sharp pry edge is exposed to contact with the fingers of a user twisting the cap.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a bottle cap for push-on application, with dependable twist-off removal and reclosure, which is simple and economical to manufacture and apply.

It is a further object of this invention to provide a cap of the general type designated which is producible with minimum material of ordinary commercial quality, reliably conformable to simple thread-form finishers, and which can be applied thereto on substantially standard capping machines at high production rates.

It is a still further object of this invention to provide a cap of the general class indicated, in which a shielded edge may be formed without extra material or extra operations as compared with conventional crown caps of similar size and sealing requirements.

The foregoing and other objects and advantages derive from a novel formation and application of the cap, utilizing a cupped blank having a straight skirt so formed as to produce a shell with fluted or knurled skirt, the skirt retaining its generally straight character. In the same die forming operation, the skirt rim is coaxed inward to an edge diameter substantially congruent with the diameter at the knurl valleys, which diameter is slightly larger than the bottle thread or lug crest diameter. The finished cap, having a seal ring, disc, or gasket in the shell, is pushed down with force to compress the seal on the bottle lip. While the cap is thus held, coacting die members form portions of the skirt upon the thread formations, seating the rim with its edge in shielded position at a diameter less than that of the knurl crests.

By virtue of the structure and procedure described, not only are the cap threads well formed and even, but a lead thread of substantial extent is formed through the rim, so that the cap can be unscrewed without distorting the inturned rim. The cap can be easily retightened, with minimum cross-threading hazard, and without pounding or snap action. Thus, the cap operates after its initial application as a twist cap, assuring the advantages thereof in ease of removal and reclosure, with the mechanical advantage of the thread or lug formations to effect a tight seal upon reclosure. The knurling affords an excellent finger grip, the crests acting to keep the fingers safely away from the sharp rim edge.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a vertical section of a cupped shell which constitutes the blank for subsequent operations of forming and applying a cap according to this invention;

FIGURE 2 is a somewhat enlarged section, similar to FIGURE 1, showing a portion of the shell and tooling with which the shell is fluted or knurled and the edge is coaxed inward;

FIGURE 3 is a section through a portion of the shell skirt taken on line 3—3 of FIGURE 2, showing the circumferential contour of the fluting or knurling;

FIGURE 4 is a section similar to the section of FIGURE 2, showing the configuration of the shell after withdrawal from the tooling and upon insertion of the seal element;

FIGURE 5 is a section through a portion of a bottle neck having a threaded finish, showing the application of the cap of FIGURE 4, with the cap held in sealing position, just prior to actuation of the thread-forming die part;

FIGURE 6 is a section similar to that of FIGURE 5 showing the fully formed cap held in the crimping die, just prior to die retraction;

FIGURE 7 is an elevation of a bottle top with a cap according to this invention applied thereto, a portion of the cap being broken away to show the bottle thread formation;

FIGURE 8 is a section similar to FIGURE 1, taken through a modified cup, showing a skirt variation;

FIGURE 9 is a section similar to FIGURE 2, illustrating a different knurling method, as applied to the cup shown in FIGURE 8;

FIGURE 10 is a horizontal section of line 10—10 of FIGURE 9, showing the modified knurling tools and action; and

FIGURE 11 is a schematic plan view of a production set-up employing the tooling of FIGURES 9 and 10.

DESCRIPTION OF PREFERRED EMBODIMENT

FIGURE 1 shows the first stage in the preparation of the cap. At this stage, the shell blank **8** is a simple cup having a slightly crowned top panel **10** and a straight cylindrical skirt **11**, joined by radius **12**. Such caps are readily mass-produced by blanking and forming in well-known manner from metal strip of suitable analysis and temper, generally comparable to that used for conventional crowns.

FIGURE 2 shows the configuration of the fully formed shell, seen as resting against the tool **13** at the completion of the knurl. Tool **13** is a roll, rail or segment, according to the type of equipment selected for the operation. That is, the part may be clamped and tool **13** rolled about skirt **11**; the tool **13** may be held stationary and the part rolled against the working face; or tool **13** may oscillate as the part revolves on a mandrel. In any case, the action being generally that of rolling, tool **13** is hereafter referred to as a roll. The view is fragmentary, it being understood that the part is symmetrical about the vertical axis. The rim of roll **13** is circumferentially undulated or ribbed, with the traverse peaks **14** tangent to a cylinder whose diameter is less than the outside diameter of the shell blank skirt **11**, whose maximum diameter is controlled by the undulation root diameter, at roots **15**. When roll **13** is pressed and rolled against cylindrical shell shirt **11**, the undulated or ribbed surface forms corresponding undulations, flutes or knurling by deformation of skirt **11**, the resulting configuration being in effect a straight knurl. As best seen in FIGURE 3, the resulting skirt contour is generally sinusoidal in cross-section, with peaks and valleys on the outer surface thereof constituting elements of cylinders, as determined by the corresponding roll elements **14** and **15**.

In a representative size, the desirable flute pitch angle is about 12°, that is, there are about 30 flutes. Ample

stiffening is effected with flute depth on the order of twice the thickness of a representative suitable material, it being understood that the number of flutes may vary according to the cap diameter, as well as thickness and temper of the material selected. In general, the cap made and applied according to this invention has characteristics conducive to use of somewhat thinner material than heretofore feasible in crown caps of comparable size.

Referring again to FIGURE 2, the forming roll is provided with a bottom radius **16**, blending outward from the undulation valleys **15**, toward the peaks **14**. As skirt **11** is being knurled, the radius **16** coaxes edge **17** inward, correspondingly forming the radiused, inturned rim **18**, which is virtually waveless at edge **17**. The roll **13** is so contoured that the finished diameter of edge **17** is substantially the same as diameter D, FIGURE 3, resulting in a smooth blending of fluted skirt **11** into the rim **18**, free of raggedness or irregular formation, the skirt remaining generally straight.

A liner, gasket, or a sealing ring of substantially any type ordinarily used with crown caps, may be readily adapted as a seal for use in the cap of this invention. FIGURE 4 shows the cap of FIGURES 2 and 3 with a preferred liner **19**, which has been found most suitable to the application and serivce conditions here involved. The design and performance characteristics of the liner here shown, as they obtain in association with crown caps, are described in U.S. Patent 3,127,920, issued to Henry J. Dorn, June 8, 1965.

FIGURES 5 and 6 show a preferred mode of applying the cap of FIGURE 4 to the finish of a typical bottle **20**. The tooling shown fragmentarily is that which is suitable for use in the crowning presses generally employed in operations of the character involved. The bottle finish is provided with exterior thread formations **21**. Formations **21** are not necessarily complete turns, but may be merely elements of threads, or thread-form lugs. However, best results are obtained if formations **21** constitute the equivalent of about 2-thread length. The threading may be single or compound.

The cap **9** is pushed over the top of bottle **20**, which is centered in die ring **22**, in turn centering cap **9** on bottle **20**. Edge **17** and flute valleys **32** closely telescope the thread formation **21**. Punch **23** is brought down on cover panel **10** with sufficient pressure to seal liner **19** on lip **24**, which pressure may be established by spring-loading punch **23** in a well-known manner. Punch **23** is compounded with a follower ring **25**, guided by punch **23** at the interface **26**. In the stage of FIGURE 5, follower **25** is in partially retracted position.

Referring now to FIGURE 6, the view is rotated one-half the fluting pitch from the view of FIGURE 5, as indicated by section lines in FIGURE 3. While punch **23** holds cap **9** in sealing position, follower **25** advances toward die **22** and cap **9**. The die **22** is of the resiliently collapsible type, made of rubber, for example. The depth of die **22** is somewhat greater than the depth of cap **9**, the tooling and part being so positioned that the top face **28** of die **22** is initially in or slightly above the plane of cap cover panel **10**, with cap **9** in its sealed position. Follower **25** has a shallow conical lead face **27**, while collapsible die **22** is an annulus of normally rectangular cross-section. As ring **25** advances toward die **22**, the leading face **27** first contacts die face **28**, compressing ring **22**, thereby setting up fluid pressure conditions characteristic of rubber or other polymeric materials, with an intensified radially inward bias in consequence of the component in that direction established by the conical face **27**, which tends to crowd the die material inward and distribute the deformation pressure uniformly around the circumference of die **22** as follower **25** advances. The pressure of die **22** against skirt **11** and consequent flow of die material into flute valleys **32** causes the valley walls **29** to press against the crests of thread elements **21**, with an accompanying collapsive

effect, due to pressure above and below the thread crests, forming interrupted female thread elements **30** in skirt **11**. The flute peaks **33**, not being subject to the concentrated stresses, are substantially undistorted by the die pressure, assuring resistance to destructive collapse, and retaining the generally stiff characteristics of the fluted skirt **11**. Also, the general stiffness of skirt **11** is sufficient to minimize ovality or other irregular formation due to imperfect distribution of constrictive pressure.

At the same time that die **22** forms the thread elements **30** in skirt **11** the pressure on inturned rim **18** collapses portions thereof inward along the lowermost bottle thread formations **21** against collar **31**, the diameter whereof is the same as, or slightly greater than, the root diameter of threads **21**. Thus, the lowermost skirt thread formations **30***a* extend into the rim **18**, constituting thread leads, while the edge **17** hugs the finish without general bending relative to the line of skirt **11**, minimizing residual stresses in skirt **11**, and aiding retention of thread conformation in subsequent removal and reclosure.

The working stroke of follower **25** is so regulated as to assure the displacement of die **22** in the amount required for conforming the knurl roots of skirt **11** to threads **21**. Overloading of the tool is prevented in the usual manner, by suitable spring loading. Follower **25** is desirably relieved at **125** so that at maximum stroke relative to punch **23**, follower **25** will not strike panel **10**, thus precluding bottoming and possible marring of cap **9**. On completion of the follower stroke, cap skirt **11** is fully formed, locking cap **9** in sealed position on bottle **20**. Punch **23** and follower **25** thereupon retract to positions of readiness for operation upon the next bottle and cap presented. It will be understood that the tooling described may be incorporated in the usual multi-station capping press for automatic, high-volume production.

The general configuration of the completed closure is best seen in FIGURE 7. As here shown, the finish has a triple thread formation **21**, each element of which is somewhat more than ⅓ turn along the helix, establishing an overlap whereby to provide two-thread engagement of substantial arcuate extent in three sectors around the circumference of the finish. The arrangement assures ample grip with the cap in sealing position, minimizes cocked engagement of the threads, and keeps thread friction minimum when turning the cap free or tightening. Edge **17**, being inturned well inside the diameter of flute peaks **33**, is fully guarded against finger contact when the user removes or replaces cap **9**. The knurled skirt surface provides an excellent non-slip finger grip.

The finish thread length is selected such that rim **18** of cap **9**, when tight, lies with edge **17** in a horizontal plane through the thread termini **121** of the lowermost thread formations **21**, whereby thread leads are formed through rim **18** when the cap **9** is applied as previously described. This provision assures easy starting for reclosure. In the case of the usual beverage bottle top, a finish length of about ¼ inch, a thread pitch of about $\frac{3}{32}$ of an inch, and a helix angle of about 10° constitute a suitable thread formation, which in the three-element configuration shown provides a desirable quick-acting removal and reclosure, with correspondingly short turn of the cap **9**. With this thread dimensioning, the uppermost formation **21** starts somewhat below the lip **24**, minimizing the chipping, galling, and splintering hazards which otherwise may obtain in a threaded glass finish. The uppermost finish band **34** is held to a diameter about the same as the thread root diameter, thus acting as a pilot for replacing the cap.

The closure structure and proportions above described can be executed in usual bottle top sizes with a cap blank and total material requirement less than that involved with conventional crown caps, effectuating excellent economy in material costs, particularly as compared to designs heretofore proposed for push-on, twist-off caps of the class involved.

MODIFICATION

The above described embodiment involves formation of the flutes and coaxed rim in a cylindrical skirt by means of a one-piece roll. Knurling and coaxing of a slightly flared skirt is illustrated in FIGURES 8, 9 and 10, in which parts corresponding to those of FIGURES 1 through 5 are given like reference numerals with the addition of 100.

The blank **108** of FIGURE 8 is similar to blank **8** of FIGURE 1, having a top panel **110** and a skirt **111**, connected by radius **112**. However, in this case, the skirt **111** is slightly flared, downwardly and outwardly, being substantially a portion of a right circular cone, except that the narow rim **118** is substantially cylindrical. Thus, the rim **118** is bent slightly inwardly of a downward extension of the main skirt portion **111**.

As seen in FIGURES 9 and 10, the final forming tool assembly consists of three principal tools, a cap mandrel **150**, a coaxing tool **151**, and a knurling tool **152**. Referring particularly to FIGURE 10, the mandrel **150** is provided with equally spaced ribs **153**, alternating with valleys **154** of substantially the same circumferential extent in each case as the corresponding rib **153**. The valleys **154** are outwardly convex, on a circle centered on the center of mandrel **150**. That is, the roots **154** constitute arcs of a common circle concentric with mandrel **150**. Knurling tool **152** is a rail segment provided with ribs **155** and valleys **156** which are complementary to the formations of mandrel **150**, so that the mandrel **150** and roll **152** can be loosely meshed as shown, with clearance for material to be formed between them.

Skirt **111** is a loose fit over the mandrel **150**. The crest diameter of ribs **153** at the base of the mandrel cone is smaller than the inside, or root, diameter of the coaxed rim **118**, at edge **117**, so that the completed shell can be stripped from mandrel **150** without interference or distortion of rim **118**. As seen in FIGURE 10, skirt **111** is knurled progressively, being held to mandrel **150** by segment **152** along that element which is instantaneously in the working plane **161**. The relief of the forming roots at **162** and **163** affords clearance to minimize jamming or seizing as the material is rolled and bent over the meshing ribs **153** and **155**.

FIGURE 11 schematically illustrates a suitable tool setup in a rotary machine arrangement. A number of vertical spindles **158** are mounted around the periphery of a table **159**, which is rotatably mounted on a column **160**. Mandrels **150** are revolvably supported on spindles **158**. The knurling segment **152** and coaxing die **151** are concentric with table **159** and are fixed in position for rolling mesh traverse of mandrels **150** as table **159** rotates, the relationship being as shown in FIGURE 10. The arcuate extents of the knurling and coaxing segments **152**, **151** are such that each mandrel **150** makes at least one full revolution in traverse of full ribs **155**, which drive the mandrel on spindle **158** as the skirt **111** is knurled. The usual blend section is preferably incorporated in tools **151**, **152** to minimize chatter or jar at the beginning of the pass. Otherwise, sudden or irregular capture of the part may cause malformation and seizing. As shown in FIGURE 9, ribs **155** may be relieved at their upper ends, along line **164**, to avoid fluting through the cap radius **112**. This results in a blend radius **165** between root **132** and radius **112**, which latter is maintained around the cap.

The shell formed as shown in FIGURES 9 and 10 may be completed in a manner similar to cap **9** of FIGURE 4 and then applied to the bottle substantially as in FIGURES 5 and 6, in the manner previously described. It will also be apparent that the blank and tool combination of FIGURE 2 may be implemented as in FIGURE 11 to produce shells **88** economically in quantity.

With either cap form, **9** or **109**, the same salient advantages are realized. The generally straight skirt, **11** or **111**, can be readily constricted by essentially direct radial forces uniformly applied against substantially the entire

length and circumference at the skirt, as by the arrangement of FIGURES 5 and 6. A pressure sufficient to conform the knurl roots to the finish threads will not, and need not, alter the general configuration of the skirt, the flutes affording the stiffness necessary to prevent general distortion or localized malformation, while providing the controlled leverage and backing of sufficient magnitude to cause good thread formation in the knurl roots upon constriction. Because there is no sharp, general bending of skirt, such as required for crimping the sharply flared skirt of conventional crown caps, the cap according to this invention is not subject to the strain failures characteristic in sharp bending of sheet metal. Hence, lighter weight, ductile material of less costly analysis and temper may be used, further facilitating good thread formation and maintenance of shape for reclosure. Also, the skirt length for caps herein described is generally less than that required for conventional crimp closure, permitting a smaller cut-edge diameter for the cap blank.

The slight skirt taper of the blank and shell in the form of FIGURES 8 and 9 assists in preventing the skirt material from riding up the tool faces and holds the rim down on the coaxing die. The modified form has the same advantageous characteristics as the cap of FIGURE 4. The slight bending of the skirt relative to the top panel when constricting the skirt does not involve significant strain, being readily accommodated in the top radius.

Where particular operations or tools are separately shown or described herein, for example, formation of cups from strip, description in such manner is given only for the sake of clarity.

It will be understood that the various forming operations for either of the embodiments described are not necessarily performed in single stages of independent machines, or stations, but are preferably integrated by use of compound tools and automatic transfer devices in the manner well known in the tool and die art related to crowns, caps and similar small parts generally.

It will also be understood that such terms as "punch," "die," "roll" and "mandrel" are used herein as seems most apt in describing a particular tool or part thereof, and not to infer that one or the other is necessarily the moving part where relative motion of the several tool parts in indicated. Wherever the terms "threads" or "thread formations" are used herein, such terms are used as descriptive of the preferred embodiment, and not by way of limitation to particular such formations shown, the invention being readily adaptable to camming lug finishes and other equivalent twist engagement means.

The foregoing descriptions of particular embodiments are given by way of example. Other forms, variations, and modifications may be devised by those skilled in the art, following the teachings herein, without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A closure cap adapted for application to a finish having external thread formations, said cap comprising: a top panel and a threadless, generally straight skirt depending from said top panel, a principal lengthwise portion of said skirt having a circumferential series of axial flutes constituted by bending deformation of said skirt portion, a narrow rim portion of said skirt being turned inwardly toward the axis of said cap, with the edge of said skirt lying entirely within a circle of diameter less than the major diameter of said flutes, the roots of said flutes and the edge of said skirt being sized for close telescoping fit over said thread formations.

2. A closure cap according to claim 1, wherein the length of said skirt is so related to the length of said thread formations along said finish that, when said skirt is applied to said thread formations, said rim portion overlies portions of said thread formations.

3. A closure for a bottle or the like having a finish with external thread formations therearouund, said closure comprising: a cap having a top panel and a generally straight skirt depending from said top panel, said skirt having a circumferential series of axial flutes constituted by circumferential bending deformation of said skirt, said skirt including a narrow rim portion terminating in an edge, said rim being inturned with said edge throughout radially inward of crests of said flutes, said skirt telescoping said finish to a position with said edge in a plane through lower portions of said thread formations, said skirt, including said rim, being constricted along and about said thread formations, radially inward elements of said skirt being conformed to said thread formations with lead thread elements in said rim, thereby constituting a twistably removable and replaceable closure cap with said edge closely surrounding said finish in protected position relative to fingers gripping said cap to twist said cap relative to said finish.

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GEORGE T. HALL, Primary Examiner

U.S. Cl. X.R.

215—43