United States Patent [19]

Stuard

[11] **3,741,142**

[45] **June 26, 1973**

[54] **METHOD OF MAKING A TEAR-OPEN CLOSURE**

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[73] Assignee: **The Proctor & Gamble Company**, Cincinnati, Ohio

[22] Filed: **Mar. 27, 1972**

[21] Appl. No.: **238,074**

[52] **U.S. Cl.** ..... **113/121 C**, 113/15 A

[51] **Int. Cl.** **B21d 51/00**

[58] **Field of Search** ..... 113/1 F, 15 A, 15 R, 113/121 C; 220/54

[56] **References Cited**

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3,601,279	8/1971	O'Neill	220/54
3,244,315	4/1966	Taylor	220/54
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Primary Examiner—Charles W. Lanham
Assistant Examiner—Michael J. Keenan
Attorney—Richard C. Witte, Thomas J. Sloane et al.

[57] **ABSTRACT**

A method of making a substantially full opening tear-open sheet metal closure of the type having a removable panel and a circumferentially extending U-shape rim. The resulting closure has a continuous, circumferentially extending thin wall portion formed by a radially outwardly canted score line intermediate the removable panel and the rim which, being an endless predetermined line-of-weakening, facilitates removal of the removable panel. The thin wall portion is recessed from the outside surface of the rim. The raw edge formed on the rim upon removal of the removable panel by tearing along the predetermined line-of-weakening is wholly under the rim and is nearer the container body wall than the circumferentially extending smooth residual edge of the rim at the intersection between the wall of the score line and the outside surface of the contiguous portion of the rim. The method of forming the closure comprises sequentially die-folding the peripheral area of a pre-scored blank to first form the inner chime wall and then to form the outer chime wall. While folding the inner chime wall, displacement of the edge of the blank from the plane of the removable panel portion of the blank is limited so that the outer chime wall portion of the blank is flared outwardly at the completion of forming the inner chime wall.

4 Claims, 10 Drawing Figures

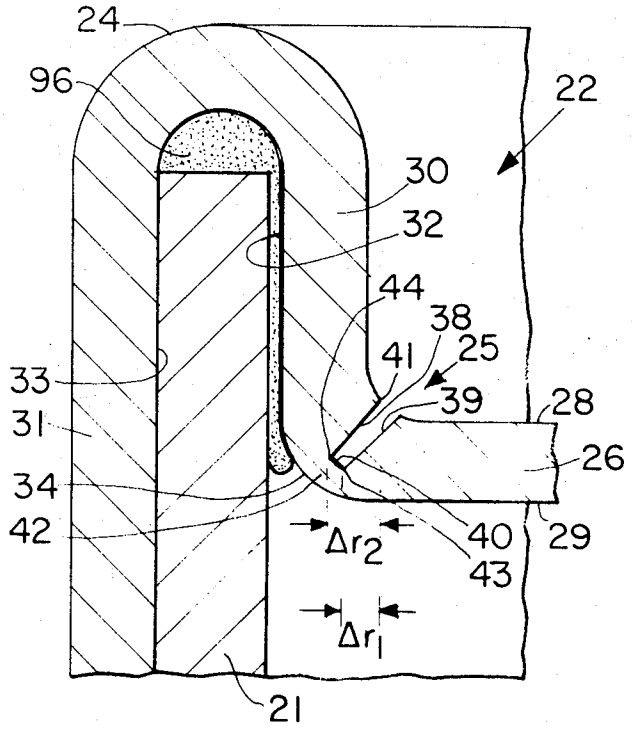


Fig. 1

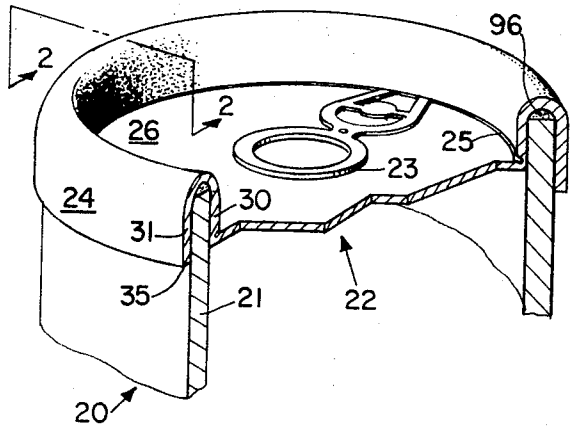


Fig. 2

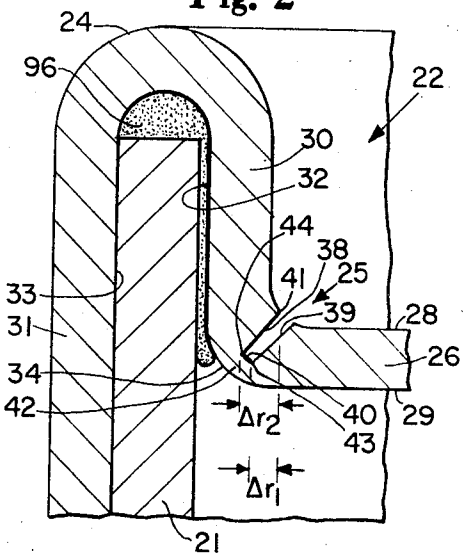


Fig. 3

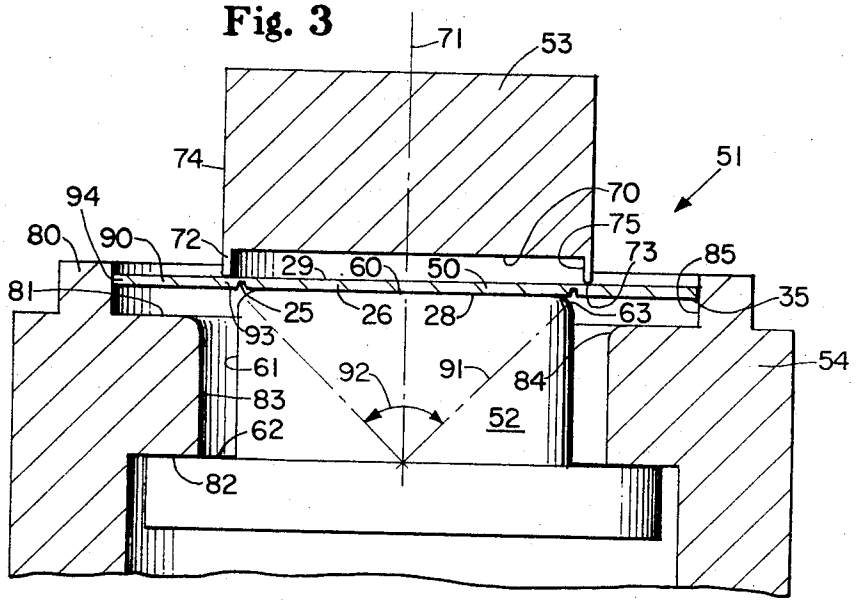


Fig. 4

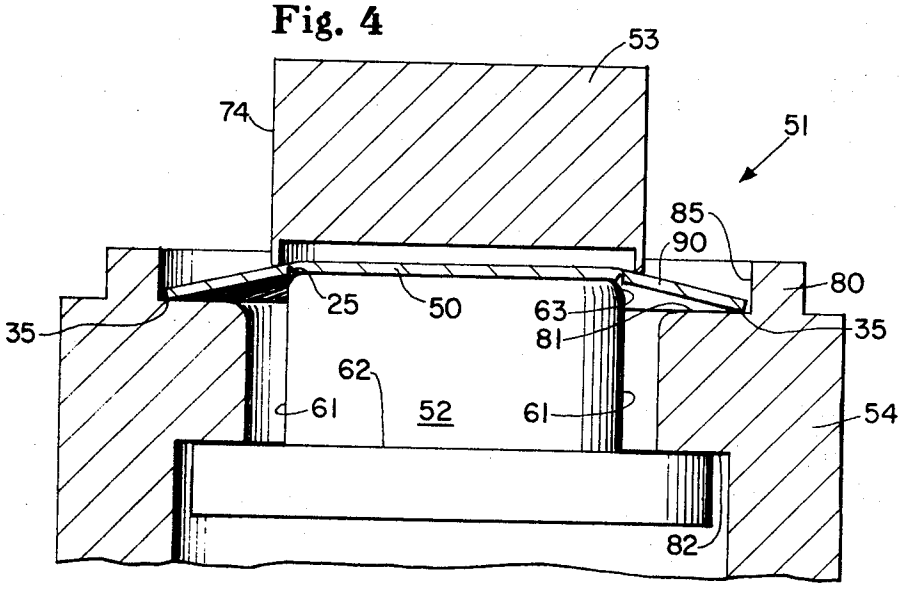

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Fig. 5

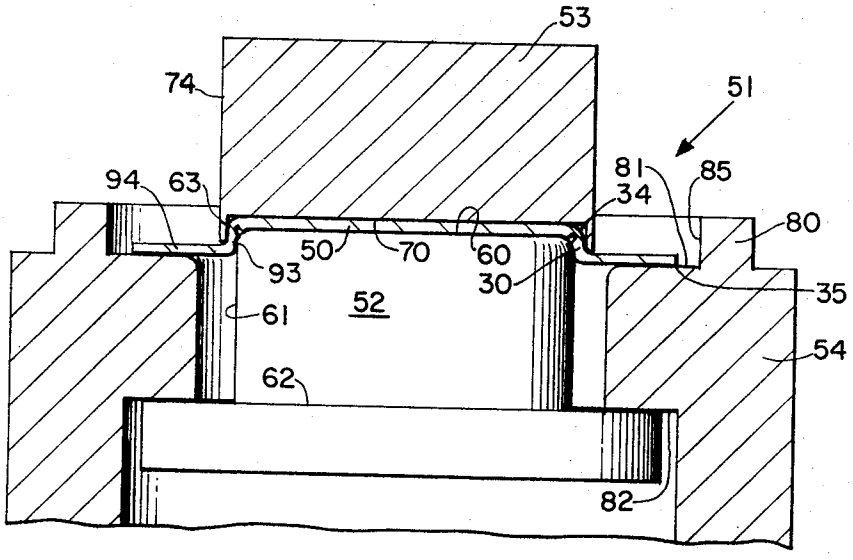

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Fig. 6

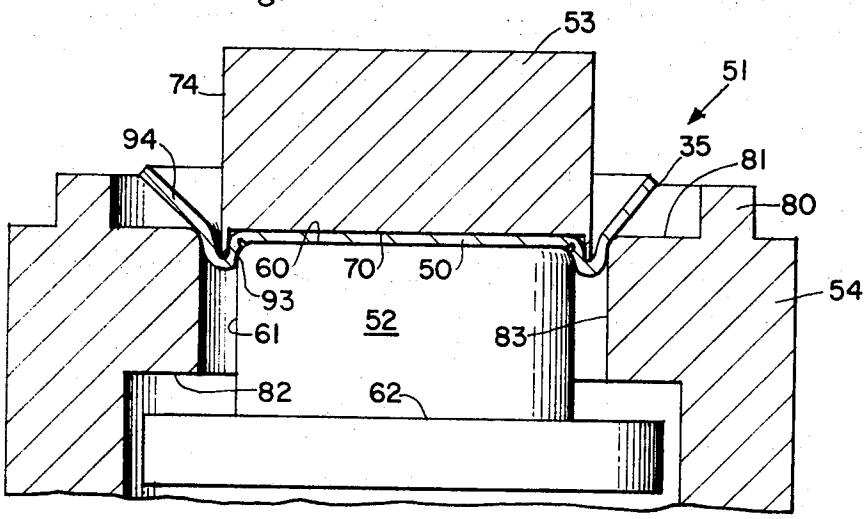

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Fig. 7

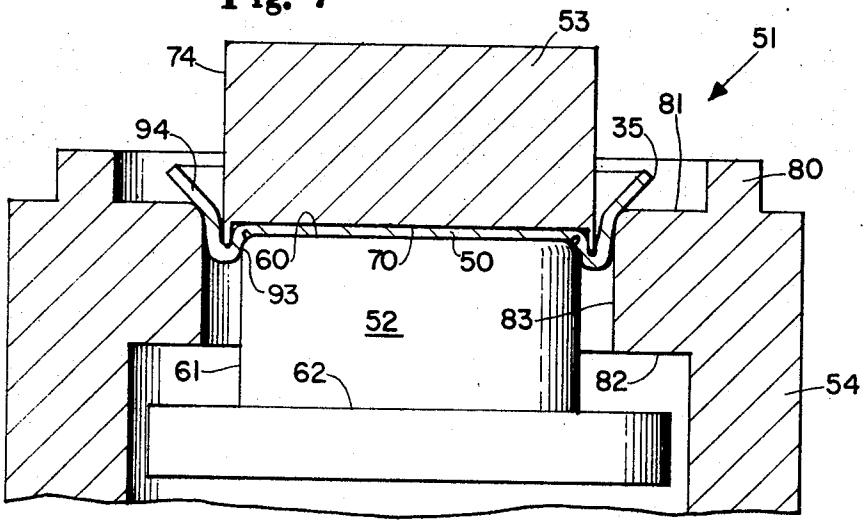

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Fig. 8

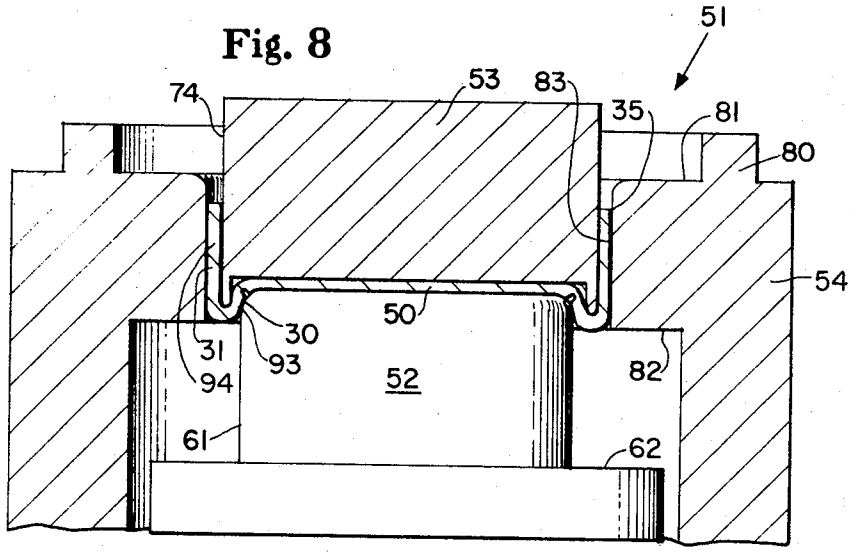


Fig. 9

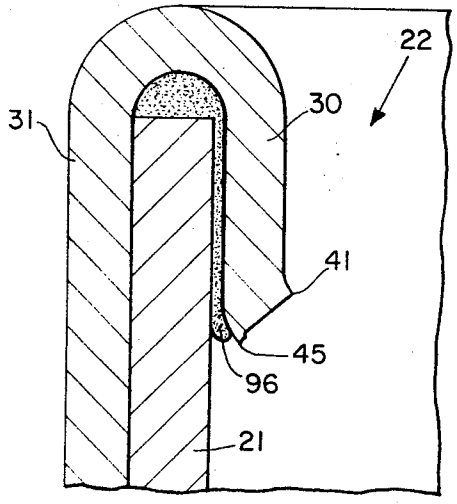
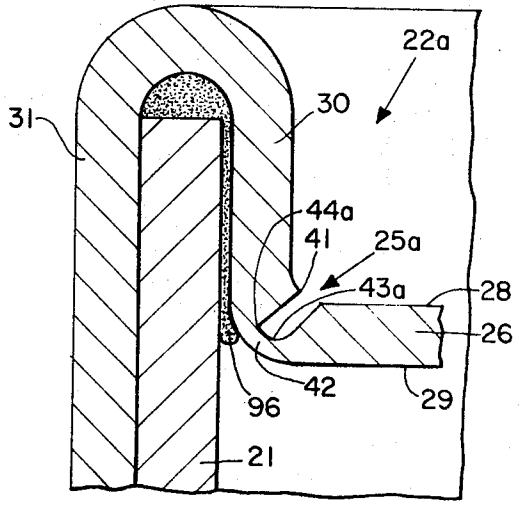


Fig. 10



METHOD OF MAKING A TEAR-OPEN CLOSURE

CROSS REFERENCE TO RELATED APPLICATION

This application is related to the commonly assigned concurrently filed application of Charles D. Stuard entitled A TEAR-OPEN CLOSURE filed Mar. 27 , 1972, Ser. No. 238,217 which includes closures manufactured through the use of the instant invention.

FIELD OF THE INVENTION

This invention relates generally to a method of making sheet metal, tear-open closures having an integral U-shape rim extending around the periphery of a removable panel with a predetermined line-of-weakening therebetween.

BACKGROUND OF THE INVENTION

End closures for tubular containers commonly have a U-shape rim having a channel adapted to receive the wall of a tubular container body and to be secured thereto by crimping, rolling, gluing, or the like.

A number of such closures have been devised which incorporate tear-open means such as a pull tab secured to a removable panel, the removable panel being defined by a circularly extending, endless, predetermined line-of-weakening. In order to provide a large dispensing aperture in such a closure, to facilitate passage of commodities or fingers or the like therethrough, the line-of-weakening is generally disposed in a disc-shape central portion of the closure close to the inner chime wall of the U-shape rim. Thus, the dispensing aperture can be almost as large as the bore of the tubular container body.

Freshness preserving characteristics and cost of such closures are often critical. Also, appearance, convenience and consumer safety are important considerations. In general, closures formed of sheet metal are acceptable for the use intended, and in some respects such as cost and freshness preserving, sheet metal closures are sometimes superior to closures fabricated from other materials.

However, upon opening such sheet metal end closures, the raw edges formed by tearing along the predetermined lines-of-weakening become cut hazards. That is, a circularly extending raw edge on the rim around a dispensing aperture through which a consumer's hand or fingers may be extended has too often resulted in a cut, scrape, or contusion. The present invention is addressed to forming a suitable closure of the general type delineated hereinabove wherein the cut hazard has been substantially eliminated.

Of course, others have recognized the cut hazard precipitated by tear-open containers and have devised closure configurations directed to reducing or eliminating such hazard. For instance, U.S. Pat. No. 3,601,279 issued Aug. 24, 1971 to David C. O'Neill discloses a score line having a radius along at least one edge of the bottom wall thereof to insure tearing along a predetermined portion of the score line to reduce the cut hazard around the dispensing opening. Some other representative approaches to vitiating the cut hazard problem are disclosed in U.S. Pat. No. 3,543,961 issued Dec. 1, 1970 to James E. Kennedy and James R. Pound; U.S. Pat. No. 3,557,997 issued Jan. 26, 1971 to Thomas R. Stanley; U.S. Pat. No. 3,447,713 issued June 3, 1969 to Frederick J. Stec; U.S. Pat. No. 3,527,377 issued Sept. 8, 1970 to E.E. Colby et al.; and U.S. Pat. No. 3,195,764 issued July 20, 1965 to L. Fried et al. However, none of these approaches has solved the problems associated with tear-open closures in the manner nor to the degree of the instant invention.

For instance, the end closure configuration disclosed by Kennedy and Pound in U.S. Pat. No. 3,543,961 has a line-of-weakening formed by a score line having side walls extending from the inside surface of the closure towards its outside surface at the convex juncture of the inner chime wall and the removable central panel. Thus, the line-of-weakening is immediately adjacent the inner wall of the container body when the closure is assembled thereto. Such a score line can be formed by axially movable die members after the inner chime wall has been substantially fully formed. However, when the removable panel is removed, the raw edge formed on the rim at the base of the inner chime wall is not wholly disposed under and radially outward from the contiguous portion of the inner chime wall.

The instant invention provides a substantially full-opening closure having a predetermined line-of-weakening defined by an outwardly canted score line having circular extending side walls which extend from the outside surface of the closure towards its inside surface at the concave juncture of the inner chime wall with the removable panel. There is a circularly extending, die-formed, smooth residual edge at the intersection of the residual inner chime wall with the adjacent side wall of the score line. Both side walls of the score line are canted radially outwardly from the outside surface of the closure so that the raw edge formed on the rim upon removal of the removable panel by tearing along the line-of-weakening is wholly disposed radially outwardly from the smooth edge described just above. Through the use of a radially outwardly canted score line at the juncture of the inner chime wall with the removable panel, the raw edge formed upon removal of the removable panel will always be disposed wholly below and radially outward from the smooth residual edge on the inner chime wall. That is, the raw edge will always be neared the wall of the container than the smooth residual edge. Thus, the cut hazard commonly generated by tear-open containers is virtually eliminated.

Forming such a tear-open closure having a circular, oval, polygonal with rounded corners, or continuously-curved lineament which closure has an outwardly canted score line depressed from its outside surface at the juncture of the inner chime wall with a centrally disposed removable panel requires an election of scoring a blank before forming the inner chime wall which scoring can be done by conventional die stamping, or alternatively, electing to impress the score line after the inner chime wall has been formed. The latter might be done by a rolling operation but is believed to be inherently more difficult than the former. It is believed that die-forming a U-shape rim of the peripheral area of a pre-scored blank is the better choice.

However, die-draw-forming an integral U-shape rim on a pre-scored blank so that the score line is ultimately outwardly canted and disposed at the juncture of the rim with the central removable portion of the closure has been found to be difficult because the forces required for draw-forming tend to tear or fracture pre-scored parts along such score lines. This is especially true if the sheet metal is hard or brittle such as 5052–H19 aluminum or the like. The problem of pre-

maturely fracturing predetermined lines-of-weakening is further aggravated by making the score lines relatively deep to reduce the thickness of the thin wall portion of residual metal between the bottom of the score line and the opposite surface of the part to enable easy, tear-open operation of such closures.

SUMMARY OF THE INVENTION

The nature and substance of the invention will be more readily appreciated after giving consideration to its major aims and purposes. The principal objects of the invention are recited in the ensuing paragraphs in order to provide a better appreciation of its important aspects prior to describing the details of a preferred embodiment in later portions of this description.

A major object of the invention is a method of making a tear-open sheet metal closure having a predetermined line-of-weakening defined by a radially outwardly canted score line depressed from its outside surface at the juncture of the inner chime wall and a removable panel.

Another object of the invention is a method of making a tear-open sheet metal closure for a tubular container, the closure having a circumferentially extending U-shape rim separated from a removable panel by an endless, radially outwardly canted score line depressed from its outside surface at the juncture of the inner chime wall of the rim and the removable panel.

Yet another object of the invention is a method of forming a circularly extending U-shape rim on a pre-scored blank to form a tear-open closure having an endless radially outwardly canted score line recessed from the outside surface of the closure at the juncture of the inner chime wall of the rim and a wholly removable panel.

A further object of the invention is a method of making the aforesaid closures from a relatively hard temper metal such as 5052–H19 aluminum.

These and other objects are achieved by sequentially die-folding the peripheral area of a suitably pre-scored sheet metal blank to first form an inner chime wall and then forming the outer chime wall. During the folding formation of the inner chime wall, the displacement of the edge of the blank is limited so that upon completion of the inner chime wall, the outer chime wall portion of the blank is flared somewhat radially outwardly.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter regarded as forming the present invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a fragmentary perspective view of the top of a tubular container having a tear-open end closure produced through the use of the instant invention.

FIG. 2 is an enlarged fragmentary sectional view through the rim of the tubular container of FIG. 1 taken along line 2—2 thereof.

FIG. 3 is a fragmentary sectional view of a pre-scored sheet metal, closure-forming blank disposed in a three-member die assembly with which the instant invention can be practiced.

FIGS. 4–8 are fragmentary sectional views of the die assembly and closure-forming blank of FIG. 3 showing the sequence of folding the peripheral portion of the blank to form an integral, circularly extending U-shape rim around a score-line-defined removable panel by moving the die members generally axially with respect to each other.

FIG. 9 is a fragmentary sectional view of the container rim of FIG. 2 after a dispensing aperture has been opened in the container by removing the removable panel from the end closure.

FIG. 10 is a fragmentary sectional view of the rim of a container similar to the container shown in FIG. 2 but which has an alternate embodiment closure thereon having an alternate score line configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Container **20**, FIG. **1**, comprises a tubular body having a wall **21**, closure **22**, and tear-tab **23**. Although wall **21** is shown to have a right circular cylindrical geometry and tear-tab **23** is of the ring type, it is not intended to thereby limit the instant invention.

Closure **22**, FIG. **2**, embodying the instant invention, comprises a disc shape removable panel **26** having rim **24** integrally formed thereon with score line **25** disposed therebetween. Closure **22** has an outside surface **28** and an inside surface **29**. Rim **24** has a U-shape cross section and comprises an inner chime wall **30** and an outer chime wall **31** both of which, in the preferred configuration, are substantially right circular cylindrical in form. The radially outwardly facing surface **32** of inner chime wall **30** is spaced from the radially inwardly facing surface **33** of outer chime wall **31** to form a circularly extending, vaulted channel therebetween for receiving an end of wall **21**. A circularly extending fillet **34** is formed at the juncture of the inner chime wall **30** with panel **26**. Score line **25**, depressed from the outside surface **28** of closure **22**, comprises a circularly extending radially outwardly canted, radially outermost wall **38**, a circularly extending, radially outwardly canted, radially innermost wall **39**, and a bottom wall **40**. The circularly extending intersection of wall **38** with the adjacent outside surface **28** of inner chime wall **30** is a circularly extending smooth edge which is hereby designated residual edge **41**. As will hereinafter be delineated, residual edge **41** is the most radially inwardly extending portion of closure **22** after container **20** has been opened by removing panel **26**. That is, the smooth residual edge **41** is spaced farther from wall **21** than the predetermined line-of-weakening created by score line **25** before panel **26** is removed and, as will hereinafter be amplified, residual edge **41** is spaced farther from wall **21** after removal of panel **26** than raw edge **45**, FIG. **9**, formed by tearing along the predetermined line-of-weakening to remove panel **26**. The metal disposed between the bottom wall **40** of score line **25** and the adjacent inside surface **29** of fillet **34** is hereby designated thin wall portion **42**. As is well known to those having ordinary skill in the art, the thickness of thin wall portion **42**, relative to the thickness of the other portions of a tear-open closure, defines a predetermined line-of-weakening which is relatively easily torn to separate the portions of the closure adjacent the line-of-weakening.

Score line **25**, as shown in FIG. **2**, has relatively sharp, unrounded, circularly extending corners **43**, **44**. Both of the corners **43**, **44** of the score line, because of the radially outwardly canted geometry of score line **25** are radially outwardly disposed from residual edge **41**.

That is, corner 43 is a distance Δr_1 radially outwardly from residual edge 41, and corner 44 is a distance Δr_2 radially outwardly from residual edge 41. As is well known to those having ordinary skill in the art, such a score line will tear along either corner 43 or 44 or through the thin wall portion 42 which insures that the circularly extending raw edge 45, FIG. 9, formed by tearing along the line-of-weakening will always be wholly radially outward from residual edge 41.

Closure 22, the preferred configuration shown in FIGS. 1 and 2, is preferably fabricated from a pre-scored blank 50, FIG. 3, of sheet metal through the use of a three-element, axially acting, two-stroke die assembly 51.

A preferred die assembly 51, FIG. 3, comprises a male die member 52, a rim die member 53, and a female die member 54. The three-member preferred die assembly 51 is suitable for making preferred configuration closures 22. The three die members 52–54 are coaxially disposed bodies of revolution which are sequentially displaced axially with respect to each other to transform pre-scored blank 50 into closure 22.

The male die member 52, FIG. 3, of the preferred die assembly 51 has a substantially flat circular face 60, an outwardly facing right circular cylindrical surface 61, a shoulder 62, and a circularly extending convex edge 63 at the intersection of circular face 60 with cylindrical surface 61.

The rimmed die member 53, FIG. 3, of preferred die assembly 51 has a right circular cylindrical shape having a counterbore in one end thereof forming planar face 70 perpendicular to axis 71. Rim 72 having a rounded cross-section nose 73 is disposed intermediate the radially outwardly facing cylindrical surface 74 and face 70. The depth of the counterbore is approximately the same as the desired height of inner chime wall 30 of closure 22. Rim 72 has a radially inwardly facing surface 75 having a diameter approximately equal to the outer diameter of inner chime wall 30 and a radially outwardly facing cylindrical surface 74 having a diameter approximately equal to the inner diameter of the outer chime wall 31 of closure 22.

The female die member 54 of the preferred die assembly 51, FIG. 3, comprises a guide ring 80, a flaring-shoulder 81, a stop-shoulder 82 and a radially inwardly facing right circular cylindrical wall 83. The intersection between cylindrical wall 83 and flaring shoulder 81 is a circularly extending convex edge 84. The diameter of the radially inwardly facing surface 85 of guide ring 80 is chosen to provide a clearance fit for the outer diameter of blank 50. This clearance fit enables a blank 50 to be easily positioned within the confines of guide ring 80 so that blank 50 is properly indexed with die assembly 51. The diameter of wall 83 is essentially equal to the desired outer diameter of outer chime wall 31 of closure 22. However, the portion of wall 83 contiguous to edge 84 may be chamfered in order to guide the outer chime forming portion of wall 83 as will hereinafter be further delineated. It will be understood by those having ordinary skill in the art that integral guide ring 80 could be functionally replaced by a detachable ring or a plurality of detachable stops or blocks disposed to properly position blank 50 with respect to female die member 54.

The blank 50, preferably of a relatively hard temper aluminum such as 5052–H19 used for covers for beer and beverage cans, is from about six to about twelve-thousandths of an inch thick. Blank 50 comprises a removable-panel-forming, disc-shape portion 26 and a peripheral or rim forming portion 90 divided by circularly extending score line 25. The bottom wall of score line 25 is essentially parallel to the inner surface 29 of blank 50. Score line 25, enlarged in FIG. 2 to more clearly show its features, has radially outwardly canted side walls 38, 39 and a flat bottom wall 40, after the rim forming folding sequence. The intersections between bottom wall 40, and side walls 38, 39 are circularly extending oblique corners 43, 44. The width of the bottom wall 40 of score line 25 of the preferred configuration closure 22, which is the distance between the oblique corners 43, 44, is desirably about three thousandths of an inch but may vary from about zero to about five thousandths of an inch so long as the total geometry of the finished closure 22 provides a predetermined line-of-weakening wholly radially outward from residual edge 41. The thickness of thin wall portion 42 is preferably in the range of from about two to about four thousandths of an inch. The mean diameter of score line 25 relative to the diameter of male die member 52, FIG. 3, is such that when blank 50 is folded over edge 63, score line 25 will be disposed on edge 63 substantially symmetrically about the intersection of edge 63 with an imaginary conical surface 91 having an included angle 92 of approximately 90°, the imaginary conical surface 91 substantially bisecting convex radiused corner 63 of male die member 52. The peripheral portion 90 of blank 50 comprises an inner chime forming portion 93 and an outer chime forming portion 94.

The sequence or cycle for forming closure 22 from blank 50 is graphically depicted in FIGS. 3 through 8.

Referring now to FIG. 3, before the cycle begins, the following relationships exist: die members 52, 53 and 54 are axially aligned; shoulder 62 of male die member 52 is juxtaposed stop-shoulder 82 of female die member 54 whereby flaring-shoulder 81 is axially spaced below face 60 of male die member 52 at least the height of a finished inner chime wall 30 but less than the radial dimension of peripheral portion 90 of blank 50; blank 50 is positioned so that the central portion of its outside surface 28 is contiguous with face 60 of male die member 52 and has its edge 35 juxtaposed surface 85 of guide ring 80 of female die member 54; and, the nose 73 of rimmed die member 53 is juxtaposed the inside surface 29 of blank 50.

Referring now to FIG. 4, initiation of the two-stroke closure forming sequence is begun by moving the rimmed die member 53 downwardly while holding the other two die members 52, 54 fixed relative to the female die member 54. Shoulder 62 remains in contact with stop-shoulder 82. This exerts, through nose 73, a circularly extending downwardly acting line of force on blank 50 just radially outward from score line 25. This downwardly acting force causes the peripheral portion 90 of blank 50 to bend downwardly until the circular edge 35 of blank 50 contacts flaring-shoulder 81 of female die member 54. Continued axial displacement downwardly of rimmed die member 53, FIG. 5, with respect to blank 50 and the other two die members 52, 54 causes the inner chime wall 30 and the fillet 34 of closure 22 to be folded around edge 63 and the radially outwardly facing surface 61 of male die member 52. During this interval, downward displacement of the outer chime wall forming portion of the blank has been limited by its edge 35 contacting flaring-shoulder 81

causing the outer chime forming portion **94** to be flared outwardly with respect to inner chime wall **30**. Thus, at the completion of the first stroke of the two-stroke sequence, FIG. **5**, the outer chime portion of the blank is flared somewhat radially outwardly from its juncture with inner chime wall **30** so that the outer chime portion can subsequently be acted on by female die member **54** to fold it upwardly around nose **73**. Although FIG. **5** depicts the outer chime forming portion of blank **50** to be continguous to and parallel with flaring-shoulder **81** at the completion of the first stroke, the degree of flaring can be varied considerably so long as the outer chime wall forming portion of the blank can be engaged by flaring-shoulder **81** of female die member **54**.

Referring now to FIGS. **4** and **5**, the changed space between edge **35** of blank **50** and surface **85** of guide ring **80** from FIG. **4** to FIG. **5**, indicates that the diameter of blank **50** is reduced during the folding to form inner chime wall **30**. Because there are substantially no forces present to reduce the length of the edge **35** of blank **50** during the folding of inner chime wall **30**, radially extending corrugations or wrinkles develop in the outer chime wall forming portion **94** of blank **50** during the folding of inner chime wall **30**.

The second stroke of the two-stroke sequence of die assembly **51** is depicted in FIGS. **6** through **8**. During the second stroke, the rimmed die member **53** is fixed relative to male die member **52** with blank **50** clamped and sandwiched therebetween. These two die members together with blank **50** move downwardly together relative to female die member **54** to telescope the outer chime wall forming portion **94** of blank **50** into female die member **54** thereby causing the outer chime wall forming portion **94** of blank **50** to fold upwardly. As the folding progresses, the hereinbefore noted wrinkling increases until the inner bore of female die member **54** causes the metal of the outer chime wall forming portion **94** of blank **50** to be sized around the radially outwardly facing surface **74** of rimmed die member **53**. The finished closure **22** is removed from die assembly **51** by moving the male and rimmed die members upwardly with respect to the female die member **54**, and then moving the rimmed die member **53** further upwardly with respect to the male die member **52**, it being understood that additional part removal means may be included in the die assembly without vitiating the present invention.

Referring back to FIG. **2**, closure **22** is applied to the tubular body having wall **21** to form container **20** by telescoping the end of wall **21** into the channel of the U-shape rim of closure **22** and providing an adhesive **96** to bond them together. Adhesive **96** may be placed in the channel before the end of wall **21** is telescoped thereinto whereby the end of wall **21** would displace some of the adhesive forming a bead thereof intermediate the radially inwardly facing surface of wall **21** and fillet **34** of the closure. Alternatively, a bead of adhesive **96** could be placed on the edge of wall **21** before it is telescoped into the channel of the U-shape rim of the closure. Insofar as the present invention is concerned, such securing of the rim of the closure to wall **21** through the use of adhesives or otherwise is only necessary as indicated in FIG. **2** to insure that the base of the inner chime wall **30** is prevented from bending radially inwardly upon the removal of panel **26** so that raw edge **45**, FIG. **9**, remains wholly radially outward from residual edge **41**.

At some point in the fabrication of container **20**, tear-tab **23**, FIG. **1**, must be secured to removable panel **26** through the use of an integral rivet or a discrete rivet, or otherwise so that the predetermined line-of-weakening defined by the circularly extending score line **25** can be wholly ruptured by pulling on tear-tab **23**. Thus, removable panel **26** can be wholly removed from the container thereby opening an aperture in the end of container **20** which is substantially as large as the inner diameter of wall **21** of container **20**. Because of this relationship, closure **22** is designated a substantially full opening tear-open closure.

Referring now to FIG. **9**, the fragmentary portion of container **20** of FIG. **2** is shown after the removal of removable panel **26** as by pulling on tear-tab **23**, FIG. **1**. FIG. **9** clearly shows that the raw edge **45** formed by tearing the score line defined line-of-weakening is wholly disposed radially outward from the residual edge **41** of the inner chime wall. Because the raw edge **45** is wholly disposed radially outward from the smooth residual edge **41**, the cut hazard commonly associated with tear-open containers through which fingers or hands or the like are moved is substantially obviated.

THEORY OF OPERATION

It is believed that before edge **35** of blank **50** contacts flaring-shoulder **81** during the folding of inner chime wall **30** that the peripheral portion **90** of blank **50** is quasi-cantilevered from portion **26** of blank **50**. The rim forming peripheral portion **90** of blank **50** can be considered as an infinite number of radially outwardly extending wedges which are cantilevered from their radially inwardly disposed junctures with the removable panel portion of blank **50** and which wedges have their adjacent radially extending edges connected together. Thus, the downwardly acting nose **73** simultaneously bends all of the cantilevered wedges downwardly during the first portion of the first stroke of die assembly **51**. This simultaneous bending sets up circularly extending lines of compressive force between adjacent wedges. The circularly extending compressive forces ultimately buckle the rim forming portion of blank **50** thereby forming the hereinbefore noted radially extending corrugations or wrinkles.

It is further believed that when edge **35** of blank **50** contacts flaring-shoulder **81** during the folding of blank **50** to form inner chime wall **30**, the hereinabove noted infinite number of imaginary radially extending wedges (now canted downwardly) become simple beams by virtue of being supported at both their radially inwardly and radially outwardly disposed ends. Therefore, further downward movement of nose **73** of rimmed die member **53** causes the downwardly canted, simple-beam wedges to buckle downwardly and radially inwardly which results in folding the inner chime forming portions of the wedges inwardly until the inner chime wall is fully formed. This buckling also begins the formation of the vault of the channel of the U-shape rim by bending that portion of blank **50** around nose **73** of rimmed die member **53**.

It is still further believed that during the first stroke of die assembly **51**, the downwardly acting nose **73** of rimmed die member **53** tends to cause radially extending lines of tensil stress across score line **25**. However, this tensil stress is partially offset by the stress set up in

blank **50** by the circularly extending compressive forces noted hereinabove whereby the tensil stress across score line **25** is reduced and the probability of the rupture thereof during the folding of inner chime wall **30** is virtually eliminated. Also, it is further believed, that during the upward folding of the outer chime wall forming portion **94** of blank **50**, the primary stress on blank **50** induced by the die members is between the vault portion of rim **24** and the nose **73** of rimmed die member **53**. Therefore, forces causing the folding and sizing of outer chime wall **31** are substantially isolated from the score line portion of blank **50** which isolation substantially precludes such forces from acting deleteriously on score line **25** of blank **50**.

ALTERNATE EMBODIMENTS

Although the preferred configuration closure **22**, FIG. **1**, is circular, the present invention can be utilized to form oval closures, polygonal closures having radiused corners and other shape closures having continuously curved lineaments. Also, although blank **50** and faces **60** and **70** of die members **52** and **53**, respectively, are described as being planar, embossed blanks and matching die faces are not precluded by the instant invention.

An alternate closure **22***a* is shown in FIG. **10** which differs from the preferred embodiment closure **22** only in the cross sectional shape of the score line. The score line of closure **22***a* also has a radially outwardly canted score line which is designated **25***a*. However, score line **25***a* of the alternate configuration is shown to have only one sharp corner **44***a* and one rounded corner **43***a*. A score line having one rounded corner and one oblique corner is disclosed in U.S. Pat. No. 3,601,279 issued Aug. 24, 1971 to David C. O'Neill in conjunction with a planar surface. Such a score line is preferably made in a generally planar blank **50** prior to die forming the closure from the blank as described hereinbefore. During the removal of panel **26**, closure **22***a* tears through thin wall portion **42** at the sharp internal, circularly extending corner **44***a* of score line **25***a* and, in so tearing, forms a raw edge that is wholly disposed radially outward from residual edge **41** of closure **22***a*, thus providing the same cut hazard protection as the preferred embodiment closure **22**.

Alternate die assembly configurations which achieve the substantive objectives of the preferred embodiment of the present invention are within the skill range of those skilled in the art. For instance, although the operation of the preferred die assembly is described as being axial movement of the die members relative to each other, it is believed that hinged die members moving along relatively long radius circular arcs would provide substantially axial relative movement among the die members for the relatively short strokes required to form the inner and outer chime walls of closures such as those described herein.

Another alternate die assembly configuration for practicing the instant invention is achieved by subdividing the rimmed die member **53** into two co-axial parts: a cylindrical tubular member comprising nose **73** and surface **74**; and a cylinder comprising a substantial portion of face **70** adapted to fit inside the cylindrical tubular member and which is independently axially movable with respect thereto. The two co-axial parts of such a two-part rimmed die "member," are members of a four member die assembly, not illustrated, which enables securely clamping the removable panel forming portion **26** of blank **50** between faces **60, 70** during the rim forming sequence. This die assembly configuration also enables varying or otherwise adjusting the height of the inner chime wall without changing or reboring the rimmed die member **53**.

While particular embodiments of the invention have been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the invention and it is intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. A method of making a substantially full opening tear-open sheet metal closure for a container, said closure comprising a centrally disposed removable panel, and an integral U-shape rim forming a peripherally extending channel around said removable panel, said rim comprising an inner chime wall and an outer chime wall, spaced apart to form said channel intermediate said chime walls, said closure having a circumferentially extending predetermined line-of-weakening disposed intermediate said inner chime wall and said removable panel, said line-of-weakening being defined by an outwardly canted score line depressed from the outside surface of said closure, said score line being configured to form a circumferentially extending smooth residual edge at its intersection with the outside surface of said inner chime wall whereby tearing along the line-of-weakening to remove said removable panel forms a raw edge which is nearer the wall of the container than said residual edge, the method comprising the steps of:

forming said line-of-weakening in a generally planar blank of sheet metal by die stamping an endless score line in the outside surface of said blank to form a thin wall portion therein; then,

forming the periperal portion of said blank disposed outward of said score line into said integral peripheral U-shape rim while supporting the removable panel portion of said blank so that the forming of the rim causes said score line to become outwardly canted from said residual edge, said cant being sufficient to position said score line defined line-of-weakening nearer the wall of the container to which said closure is secured than said residual edge.

2. The method of making a substantially full opening tear-open sheet metal closure of claim **1** wherein said forming of said U-shape rim comprises the steps of:

folding said peripheral portion of said blank to form said inner chime wall by telescoping the rim of a rimmed die member over said scored blank while supporting the removable panel portion of said blank on a male die member;

limiting the movement of the peripheral edge of said blank while forming said inner chime wall so that the outer chime forming portion of the blank becomes outwardly flared thereby;

reverse folding the outer chime forming portion of said blank relative to said inner chime wall and sizing said outer chime forming portion in an annular space between a radially outwardly facing wall of said rimmed die member and a radially inwardly facing wall of a female die member by telescoping said male and rimmed die members with said blank

clamped therebetween into said female die member.

3. A method of making a substantially full opening tear-open sheet metal end closure for a right circular cylindrical tubular container, said end closure comprising a centrally disposed removable panel, a U-shape rim forming a peripherally extending channel around said removable panel, and a fillet intermediate said removable panel and said rim, said rim comprising a substantially right circular cylindrical inner chime wall and a substantially right circular cylindrical outer chime wall with said channel intermediate said chime walls, said closure having a circularly extending endless line-of-weakening disposed in said fillet, said line-of-weakening being defined by a radially outwardly canted score line configured to form a thin wall portion recessed from the adjacent outside surface of said rim and to form a circularly extending smooth residual edge at the intersection of said score line with the outside surface of the fillet contiguous to said inner chime wall, said cant and said recess being sufficient to position said predetermined line-of-weakening nearer the wall of said container than said residual edge whereby tearing along the line-of-weakening to remove said removable panel forms a raw edge nearer the wall of said container than said residual edge, the method comprising the steps of:

forming said line-of-weakening in a circular planar blank of sheet metal by die stamping an endless score line in the outside surface of said blank;

simultaneously folding the entire peripheral portion of said blank to form said fillet and said inner chime wall by telescoping the rim of a rimmed die member over said blank while supporting the removable panel of said blank on a male die member;

limiting the movement of the edge of said blank while forming said fillet and said inner chime wall so that the outer chime forming portion of the blank becomes outwardly flared upon completion of forming said fillet and said inner chime wall;

reverse folding the outer chime forming portion of said blank relative to said inner chime wall and sizing said outer chime forming portion into an annular space between a radially outwardly facing cylindrical wall of said rimmed die member and a radially inwardly facing cylindrical wall of a female die member by simultaneously telescoping said male and rimmed die members with said blank clamped therebetween into said female die member.

4. The method of making an end closure of claim 3 wherein said sheet metal blank is 5052–H19 aluminum having a nominal thickness of eight-thousandths of an inch, and said stamping of said score line forms a thin wall portion between the bottom of said score line and the inside surface of said closure having a thickness of from about two-thousandths of an inch to about four-thousandths of an inch.

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