Jan. 9, 1968 J. A. GEIGER 3,362,569

CONTAINER CLOSURES WITH BREAKABLE OPENINGS

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Fig. 1

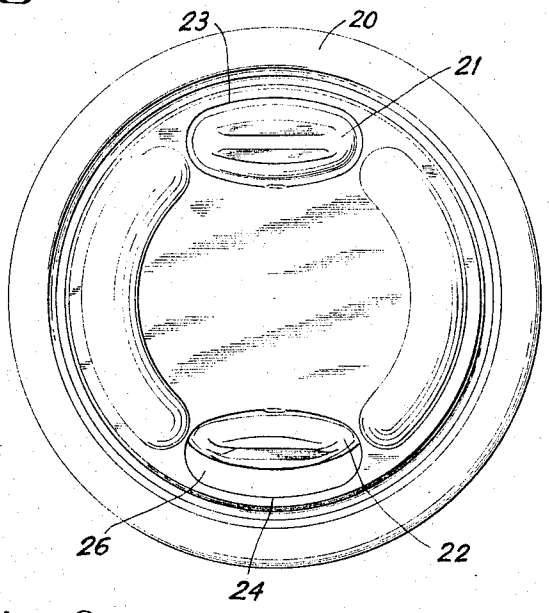

Fig. 2

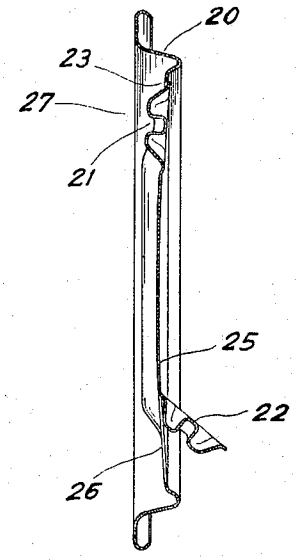

Fig. 3

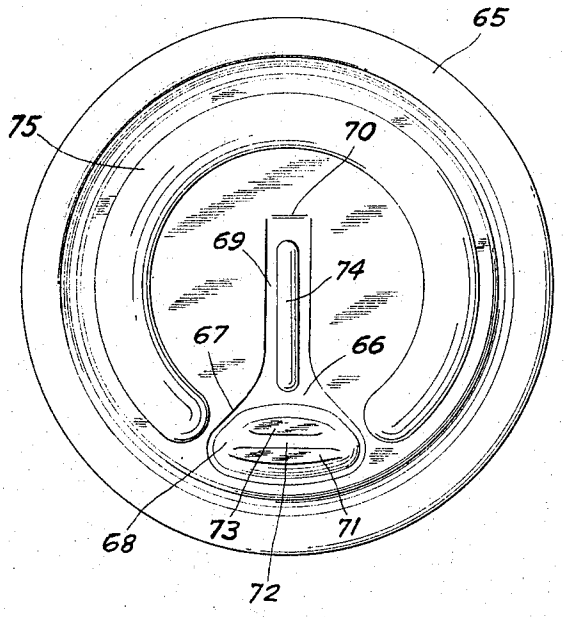

Fig. 4

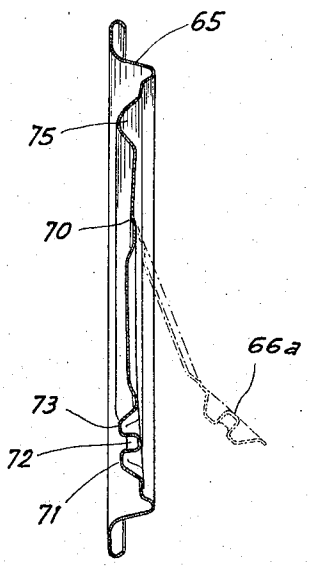

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Fig. 5

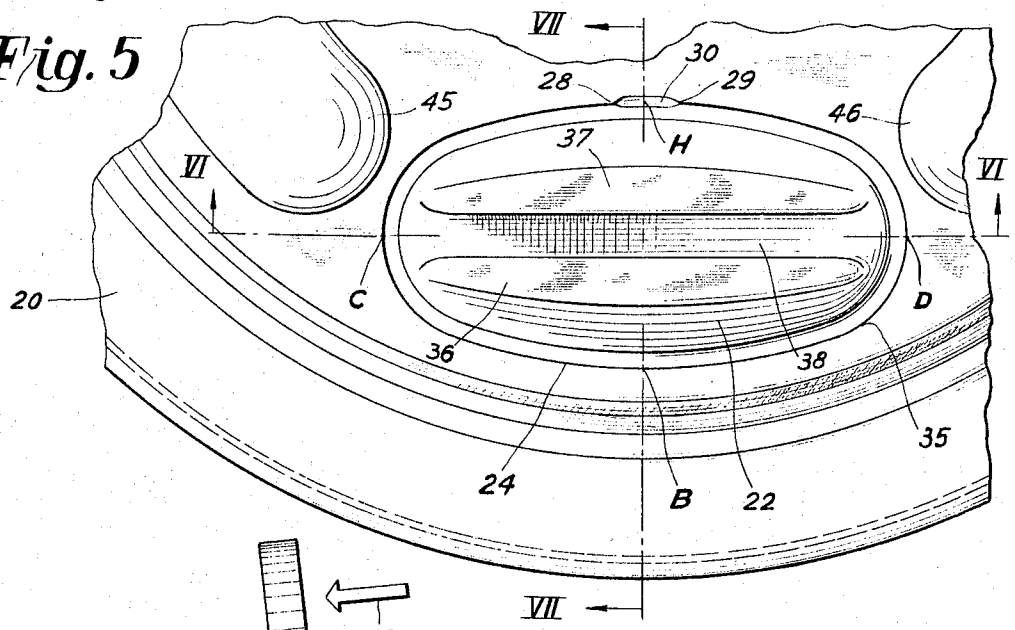

Fig. 7

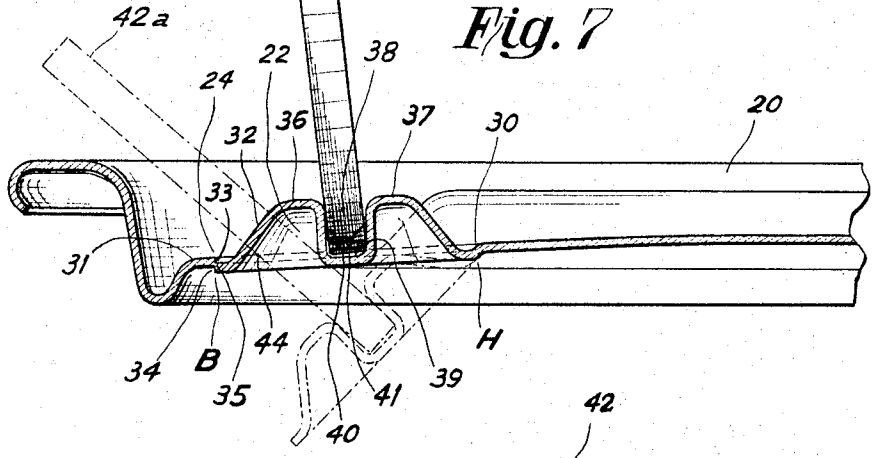

Fig. 6

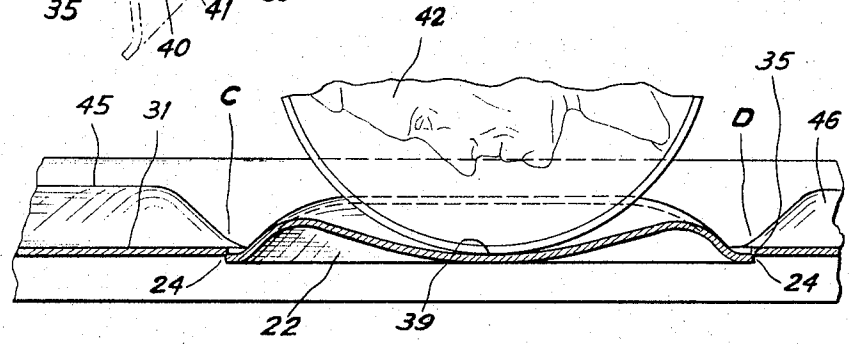

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Fig. 8

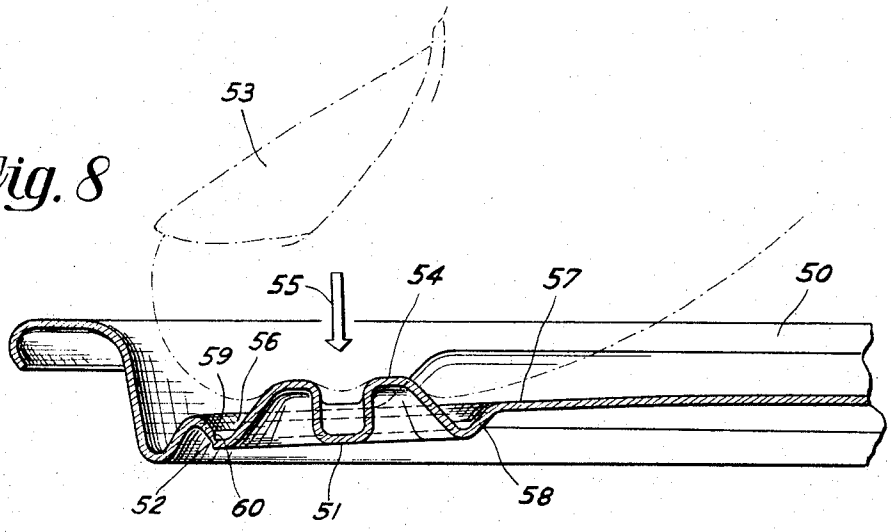

Fig. 9

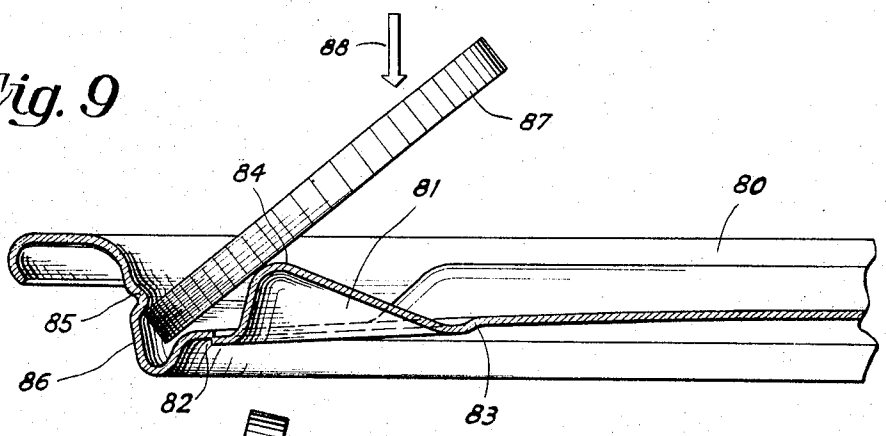

Fig. 10

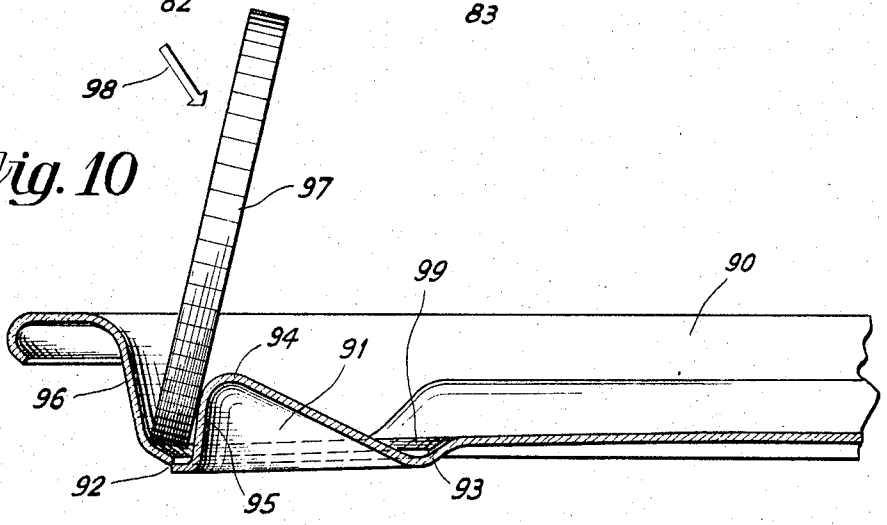

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Fig. 11

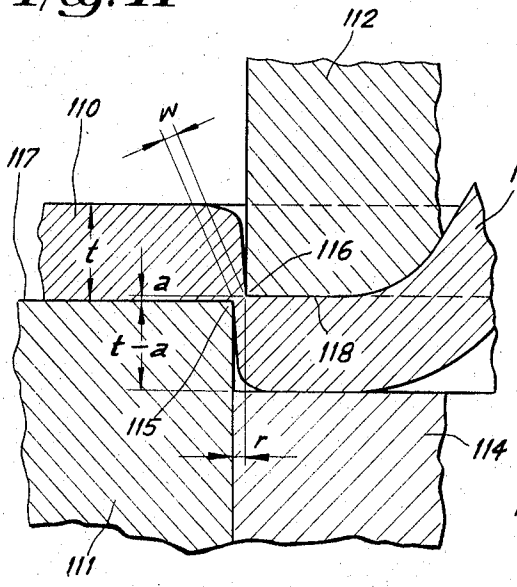


Fig. 12

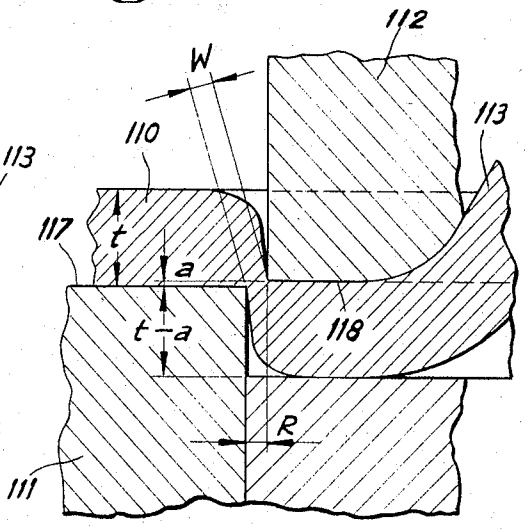


Fig. 13

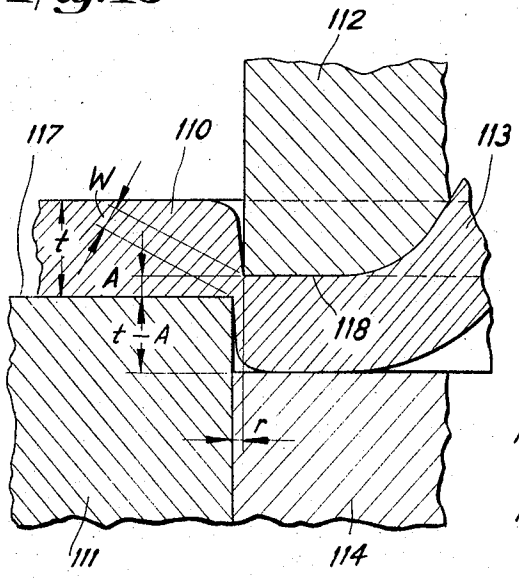
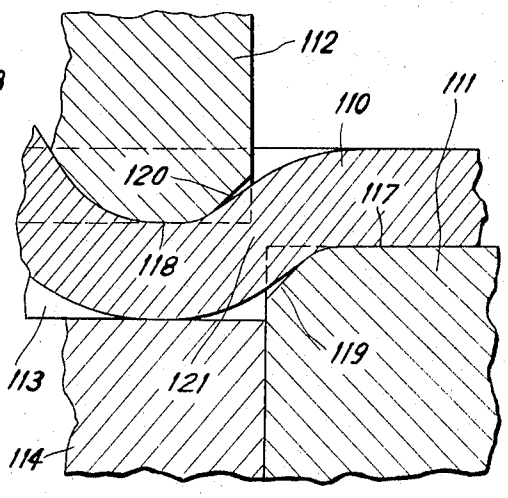


Fig. 14



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CONTAINER CLOSURES WITH BREAKABLE OPENINGS

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Filed Aug. 24, 1964, Ser. No. 391,520
11 Claims. (Cl. 220—48)

The present invention relates to container closures with easy-opening features and more particularly to metallic container closures with prepared easy-breakable opening sections. The invention has particular merit when embodied in hermetically sealed cans for liquids, such as carbonated beverages, which are subjected to internal pressures.

Many efforts have been made in recent years to develop containers with new and better opening features. The present developmental trend in the rigid container industry is to eliminate previously required special opening tools through the provision of scoring lines or other appropriate local weakening in the container wall, so that a section of it can be torn off with relatively little effort, using finger force for pulling.

Containers featuring integral tear-open devices have received widespread acceptance as beverage cans and in particular as beer and soft drink cans. However, the presently available designs, featuring in general an elongated tear-section with a short pull-tab, have been the subject of serious criticism, based upon mainly the following three objections: (a) the relatively hard pull required to initiate tearing, and the resultant danger of injury to the pulling fingers; (b) the hazard of inadvertantly cutting ones fingers or lips on the sharp edges created along the outside of the tear-section and around the opening; and (c) the hazard of foot injuries to children on public sand beaches and play grounds where carelessly discarded tear-sections represent a growing problem.

On the other hand it is necessary for most of these containers to withstand considerable internal pressures which may occur during in-package pasteurization, in-package cooking, or as a result of carbonation. The provision of an easy-opening feature in such a container, therefore, calls for the inherently difficult combination of easy breakability of the container wall with structural strength and leak-tightness.

In addition to the mechanical and physical features referred to above it is a primary and decisive requirement for any such container, or container component, to be as inexpensive as possible to justify mass production.

It is therefore one of the objects of this invention to provide an inexpensive one-piece metallic end closure for a pressure-resistant container, having easily breakable wall portions defined by a line of weakening in the closure wall.

It is another object of this invention to provide an end closure of the type mentioned above with breakable wall portions hinged to the closure wall and hence non-detachable.

A further object of this invention is to provide an end closure of the type mentioned where the breakable wall portions are pivoted toward the inside of the container and no cutting edges are exposed to the exterior.

It is still a further object of this invention to provide an end closure with easily breakable wall portions where the severance at the line of weakening can be initiated by either the direct pressure of a finger or the assisting leverage of a rigid object, such as a coin, flat door key or other readily available object.

Various other objects and advantages of the invention will become apparent as it is better understood from

the following description which, taken in connection with the accompanying drawings, discloses several preferred embodiments thereof.

In accordance with the above objects, and as a feature of this invention, there is provided a one-piece metallic end closure for a container with predetermined removable wall portions on its surface defined by lines of weakening in the closure wall and produced by partially shearing the wall in a die and displacing it toward the interior of the closure, with the central part of the removable wall portions protruding to the exterior and shaped with a groove where a coin or flat key can be applied to sever the removable wall portions and pivot them toward the interior of the container.

Accordingly also, as another feature of this invention, provision is made for a metallic end closure as outlined above, with lines of weakening of non-uniform residual width and resistance against severance, in correspondance with the stress pattern of the closure under internal pressure, and rib structures on the removable wall portions facilitating the initiation of severance under an exterior force, through load concentration at specific points on the line of weakening. Ordinarily, direct thumb pressure will suffice to initiate this severance. However, a mechanical advantage will be gained with the utilization of a coin or key as stated above. The versatility thus provided is intended to increase the usefulness of the invention.

The above and other features of the invention, including various novel details of construction and combination of parts will now be more specifically described with reference to the accompanying drawings and pointed out in the claims. It will be understood that the particular end closures embodying the invention are shown by way of illustration only and not as a limitation of the invention. The principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention.

In the drawings in which like reference characters indicate like parts throughout the several views:

FIGURE 1 is a top plan view of an end closure having two removable wall portions, one of them broken open, and embodying the invention.

FIGURE 2 is a sectional view of the end closure of FIG. 1.

FIGURE 3 is a top plan view of an end closure having a single elongated removale wall portion as a modified embodiment of the invention.

FIGURE 4 is a sectional view of the end closure of FIG. 3.

FIGURE 5 is an enlarged fragment of FIG. 1.

FIGURE 6 is a fragmentary sectional view taken along lines VI—VI of FIG. 5.

FIGURE 7 is a fragmentary sectional view taken along lines VII—VII of FIG. 5.

FIGURE 8 is a fragmentary sectional view similar to FIG. 7, illustrating a modified embodiment of the invention.

FIGURES 9 and 10 are fragmentary sectional views similar to FIGS. 7 and 8, illustrating two further embodiments of the invention.

FIGURES 11 through 14 are greatly enlarged fragmentary cross sections of the end closure at different points on the line of weakening, illustrating methods of producing the latter in accordance with the invention.

Referring to the figures enumerated above, FIGURES 1 and 2 illustrate a particular embodiment of the invention, represented by a metallic end closure **20** adapted to be secured to the body of a container by a double seam or some other convenient construction. Two removable wall portions **21** and **22** are arranged diametrally

opposite one another as breakable openings and defined in their outline by lines of weakening 23 and 24.

The removable wall portion 22 is shown broken and pivoted toward the interior of the surrounding closure wall 25, thus creating a pouring spout 26. In a similar manner removable wall portion 23 can be broken and pivoted to create a corresponding air-admitting spout 27.

Referring now to FIGURES 5, 6 and 7, where the same embodiment is illustrated in fragmentary enlarged views, FIG. 5 shows the removable wall portion 22 with line of weakening 24 defining a symmetric oval contour conveniently composed of four circular arc sections. Line of weakening 24 is shown discontinued between points 28 and 29 situated on the interior big arc of the contour at equal distances from point H on the intersection with the center line. The bending hinge 30 thus created is better illustrated in FIG. 7 at H. This view also shows a section through line of weakening 24 at the diametrally opposite point B. Closure wall 31 is partially sheared and removable wall portion 32 is displaced toward the interior side of closure 20 forming two narrow shear faces 33 and 34, separated by a residual wall section 35 which is intended to break when removable wall portion 32 is pushed downward with respect to closure wall 31.

The removable wall portion 32 is provided with an exterior rib 36 and an interior rib 37 and an approximately U-shaped groove 38 with a concave bottom wall 39. Groove 38 is flanked by an exterior face 40 and an interior face 41, the distance between these two upright faces being approximately .080 inch. A coin 42 is shown engaged in groove 38 with a force applied at its upper edge along arrow 43. The thus created mechanical advantage permits the exertion of a leverage force to exterior rib 36 and, consequently, to line of weakening 24 at point B and over portions of the exterior big arc to both sides of point B.

The leverage achieved with a nickel, for example, would be about eightfold, so that a finger pressure of ten pounds would produce a breaking force of about eighty pounds at line of weakening 24 adjacent to point B. As this force tends to push the exterior rib 36 toward the periphery, and to a lesser degree also toward the interior of the closure, it causes the residual section 35 of line of weakening 24 to be sheared rather than torn. This represents a distinct advantage in terms of opening ease, as most all metals offer less resistance against shear stress than against tensile stress.

It should be self-evident that the use of a coin is mentioned by way of illustration only and that other readily available objects, such as a flat door key or car key or a spoon handle, may be equally well or even better suited for the same purpose.

Once the severence along line of weakening 24 is initiated as described above, it takes comparatively much less effort for its continuation along the remaining contour of line of weakening 24. As it is pushed downward and to the interior of closure 20, removable wall portion 22 pivots around hinge 30 where the closure wall will bend rather than break. This pivoting displacement stops when coin 42 comes in contact with the narrow shear face 33 of the opening contour at point 44 indicated by coin position 42*a*. This prevents coin 42 from being accidentally pushed through the spout opening.

The wall structure of removable wall portion 22, as illustrated in FIGURES 5, 6 and 7, besides permitting the aforementioned use of a coin under a mechanical advantage, is purposely designed for an alternate method of opening, using the direct pressure applied with a finger and eliminating the need of an auxiliary object such as coin 42. This will become more apparent under the following theoretical considerations.

The end closure embodying this invention and illustrated in FIG. 2, for example, would represent a substantially flat end section for a pressure-resistant container. Subjected to a uniform internal pressure, the end

closure would yield toward the outside in the sense of bulging to a dome-shaped position. Comparing now the stress occuring along the line of any radial vector with the stress in tangential direction, i.e. along a concentric circular line passing for example through the center of removable wall portions 22 and 23 (FIG. 1), it becomes apparent that, while tensile stress and elongation occurs along both lines, they will be far greater along the radial vector line. This explains the comparative flexibility of flat end sections where it takes considerable bulging before the vectorial line is sufficiently elongated to offer the necessary resistance. Material failure, consequently, occurs as a result of radial stress rather than tangential stress. The radial stress increases as the distance from the center increases.

Considering now the contour of removable wall portion 22 in FIG. 5 it will be noticed that the residual wall section 35 along the contour of line of weakening 24 will be subjected to non-uniform stress under internal pressure. This stress will be at a maximum along the exterior big arc including point B, the arc being concentric with the periphery of the end closure. It will be less at point H which is nearer the closure center, and it will be at a minimum at the small arcs around points C and D.

In accordance with the above considerations the residual wall section 35 is provided with a non-uniform width, whereby the sections of greatest weakening, or least residual width, are provided along the small arcs including points C and D. Two different methods of creating this non-unform width are disclosed further below in this specification. The actual residual width that should be chosen varies with the material and alloy of the end closure, with the dimensions chosen for the removable wall portions, their distance from the closure center, and particularly, with the requirements of pressure-resistance for the container. The precise dimensions are best determined by a series of routine experiments and pressure tests. For most aluminum alloys the width of residual wall section 35 should preferably be about .002 inch around points C and D, and .004 inch around points B, 28 and 29 with gradual transitions between these points. The above would be suitable, for example, for an aluminum end closure of a beer can of 2.6 inches diameter. While it is preferable to use an aluminum alloy for end closures embodying this invention, they can also be made of tin plate, in which case higher precision tooling is required.

Referring again to FIGURES 5, 6 and 7, it can be seen that the rib structure impressed upon wall 32 of removable wall portion 22 gives it relative stiffness in the longitudinal direction of ribs 36 and 37, i.e. in the axis containing points C and D (FIG. 6), while giving it relative flexibility in the transverse axis containing points B and H (FIG. 7). Accordingly, a downward force applied to the center of removable wall portion 22 will be transmitted mainly to the small arc portions containing points C and D, resulting in a concentration of load at and near these points.

In a similar way, the non-removable wall portion 31 of end closure 20 is provided with ribs 45 and 46 giving it additional stiffness in the areas surrounding points C and D. Closure wall 31 will therefore offer its greatest resistance against downward deflection near points C and D of the line of weakening 24. The combination of load concentration at and near points C and D under a downward force as described, together with the provision for maximum bending resistance of the wall outside points C and D, and a minimum residual width on the line of weakening at and near the same points, results in a pronounced local load concentration and a comparatively easy initiation of severance on either point C or D, depending on whether this downward force is closer to the one or the other.

In FIGURE 8 this alternate method of opening is illustrated by a thumb 53 exerting downward pressure upon

removable wall portion 54 in the direction of arrow 55. This embodiment of the invention is similar to the one just described in detail. FIG. 8 also shows a metallic end closure 50, a removable wall portion 51, a line of weakening 52 defining the removable wall portion, and in addition to the features of the earlier described embodiment, an inwardly slanting rim portion 56 impressed upon closure wall 57 adjacent and surrounding line of weakening 52. Thus the opening created by breaking and pivoting removable wall portion 51 around hinge 58 has a recessed and protected edge 59. In addition, edge 59 of this design is blunt, i.e. the angle defined by rim portion 56 and the narrow exterior shear face 60 will be greater than ninety degrees.

FIGURES 3 and 4 illustrate an alternate embodiment of the invention comprising a metallic end closure 65 with the same peripheral design as the embodiment of FIGS. 1 and 2. A single elongated removable wall portion 66 defined by a line of weakening 67 is provided to produce a combined pouring and air-admitting spout, when broken along line of weakening 67 and pivoted inwardly as indicated by position 66*a*. Removable wall portion 66 comprises a generally triangular portion 68 near the periphery of the closure and a narrow radial section 69 continuing inwardly toward and preferably beyond the center of the closure. At its inner end where the line of weakening 67 is discontinued, removable wall portion 66 terminates in a hinge 70. The wall of removable wall portion 66 is provided with a rib structure similar to the one of the earlier-mentioned designs, an exterior rib 71, a groove 72 and an interior rib 73. A slight radial rib 74 is provided to apply additional pivoting force to the severed removable wall portion 66*a*. The closure area outside the removable wall portion is reinforced by an annular rib profile 75. The two different ways of initiating severance, the characteristics of the line of weakening and the other features described on earlier embodiments are or can be incorporated in this design in the same or a similar manner.

In FIGURES 9 and 10 still two other embodiments of the invention are illustrated. The two types are basically similar, as can readily be seen from the drawing. End closure 80 of FIG. 9 comprises a removable wall portion 81 with a line of weakening 82 of the previously disclosed type, a hinge 83, and in its profile, a hump-like protrusion 84. An inwardly extending bead 85 on the peripheral chuck wall 86 serves as a fulcrum for coin 87 which, as mentioned earlier, can be substituted by various equivalent or better objects. Finger pressure on coin 87 along arrow 88 will result in a leverage downward force to protrusion 84 of removable wall portion 81, thereby initiating severance at the line of weakening 82.

The embodiment of FIGURE 10 comprises a similar end closure 90 with a removable wall section 91, a line of weakening 92, a hinge 93, and a similar hump-like protrusion 94. Vertical wall 95 of removable wall section 91, being arranged at a close distance from chuck wall 96, no bead of the kind shown in FIG. 9 is required for the creation of mechanical advantage with coin 97. However, the direction of arrow 98 implies that a slightly greater effort will be required in this case, as a certain vertical force component is required to keep coin 97 engaged against chuck wall 96; this component contributes little to the leverage. A slanted rim portion 99, similar to the one shown in FIG. 8, serves as a protective feature and, in addition, avoids undesirable contact between the seaming chuck (not shown) and line of weakening 92. It will be noticed that the embodiments of FIGS. 9 and 10 do not offer the advantage of shearing action at the initiation of severance, as is the case with the groove-type removable wall portion of earlier embodiments (compare FIG. 7). The removable wall portions of FIGS. 9 and 10 could also be broken by direct finger pressure but they will require comparatively more effort, in view of the less favorable wall profile with respect to load concentration.

In FIGURES 11 through 14 details indicating ways of producing a line of weakening and, in particular, two alternate methods of providing a non-uniform residual width along the line of weakening are illustrated.

FIGURE 11 shows the cross section of a line of weakening with a small residual width *w* which would be found at points C and D of FIGS. 5 and 6, for example. Closure wall 110 is supported by a die tool 111 while a corresponding punch tool 112 is partially shearing and displacing wall 113 in a guided downward movement. The amount of shearing displacement (*t*–*a*) is precisely determined and limited by stop 114 which is fixed with respect to die tool 111 and opposes punch 112. The respective cutting edges 115 and 116 of the tools leave a residual width *w* between wall portions 110 and 113. Width *w* is the geometric sum of the axial clearance *a* between tool faces 117 and 118 and the radial clearance *r* along the contour of their edges 115 and 116.

FIGURE 12 shows the cross section of a line of weakening with a large residual width W which would be found at point B of FIGS. 5 and 7, for example. The general arrangement is the same as in FIG. 11. However, the radial clearance between die 111 and punch 112 has been increased to R by providing the tool with a non-identical contour. The axial clearance *a* is uniform on all parts of the contour. This method of providing a non-uniform line of weakening, while expensive in initial tooling costs, allows for ready re-sharpening of the tools by grinding their respective faces 117 and/or 118.

FIGURE 13 shows the cross section of a line of weakening with a large residual width W approximately equal to the one of FIG. 12 but oriented differently. Again the general arrangement is the same as in FIGS. 11 and 12. In this case, however, the radial clearance *r* is uniform on all parts of the contour, while the axial clearance between faces 117 and 118 is increased to A by providing the tools with non-parallel faces 117 and 118. This is achieved by locally re-grinding face 117 of the die to reduce the step (*t*–*a*) to (*t*–A). This alternate method of providing a non-uniform line of weakening, while less expensive in initial tooling costs, makes re-grinding of face 117 more difficult.

In comparison with regard to the requirements of container resistance and ease of opening, the method of radial clearance variation (FIGS. 11 and 12) is preferable over the method of axial clearance variation (FIGS. 11 and 13) for these two reasons: (a) the greater "overlap" represented by R ensures better leak-tightness and safety, even under a certain limited amount of closure deformation; (b) the comparatively lesser resistance against initial severance under shearing stress, as would occur on the groove-type removable wall portion when opened with a coin.

FIGURE 14, finally, shows the cross section of the discontinuation on the line of weakening, adapted as a bending hinge, such as hinge 30 with point H of FIGS. 5 and 7, for example. The general arrangement of the tools is again the same. However, die 111 and punch 112 have their edges ground off to respective bevels 119 and 120, thereby forming a step 121 in the closure wall without thereby shearing and weakening the cross section.

It will be appreciated that the dimension of the axial clearance *a* may be reduced to zero, or even be chosen to be slightly negative, so that punch face 118 reaches a position below die face 117. A negative dimension for *a* may be indicated for end closures of relatively resilient material. On container end closures of average aluminum alloy the radial clearance variation method, with clearance *r* varying between .002 inch and .004 inch and with clearance *a* uniform at .0005 inch is suggested.

In the foregoing the invention has been described in reference to specific illustrative embodiments. It will be

understood, however, that certain variations and modifications, as well as the substitution of equivalent elements for those shown for illustration, may be made without departing from the scope and spirit of the invention as defined in the appended claims. The foregoing specification and drawings are accordingly to be regarded in an illustrative rather than in a restrictive sense.

I claim:

1. A sheet metal end closure for a pressure-resistant container with a weakening line defining the contour of a predetermined removable wall portion from a non-removable wall portion where

(a) the wall material on one side of the weakening line is displaced substantially at right angles to the initially undisplaced surface without being severed from the adjacent wall material on the opposite side of the weakening line,

(b) the removable wall portion is relatively depressed toward the inside of the end closure as a result of said displacement,

(c) the edge defined by the periphery of the removable wall portion underlaps the corresponding edge of the non-removable wall portion, and the upper face of the removable wall portion is at or above the lower face of the non-removable wall portion in the area of the weakening line,

(d) the cross-sectional wall thickness in the area of the weakening line decreases abruptly from full wall thickness to the narrowest residual connection between the two wall portions so as to cause conditions of stress concentration under tensional stress,

said end closure thus providing considerably differing resistance against severance at the weakening line, depending on whether it is subjected to uniform internal pressure causing compression stress at the weakening line, or whether it is subjected to an opening force applied from outside to the removable wall portion causing tension stress augmented by the condition of stress concentration.

2. A sheet metal end closure as set forth in claim 1 where

(e) the wall material on one side of the weakening line is displaced only substantially at right angles to the initially undisplaced surface, involving substantially no lateral displacement of material.

3. A sheet metal end closure as set forth in claim 1 where

(f) the weakening line is discontinued and the wall material remains unweakened over a portion of the general contour of the removable wall portion,

said end closure thus providing in addition a bending hinge for the removable wall portion.

4. A sheet metal end closure as set forth in claim 1 where

(g) the width of the residual cross-sectional connection between the two wall portions varies gradually from a minimum width on one portion of the weakening line to a maximum width on another portion,

said end closure thus providing in addition a predetermined place on the contour of its weakening line where the said resistance against severance under an opening force applied from outside is the lowest.

5. A sheet metal end closure as set forth in claim 1 where

(h) the width of the residual cross-sectional connection between the two wall portions varies in accordance with the variation in stress over the length of the weakening line as caused by deflection of the closure wall under uniform internal pressure,

said end closure thus providing in addition substantial uniformity over the length of the weakening line in said resistance against severance under uniform internal pressure.

6. A sheet metal end closure for a pressure-resistant container with a weakening line defining the contour of a predetermined removable wall portion from a non-removable wall portion where

(a) the removable wall portion comprises in its wall structure an elongated stiffening profile extending across its center region and toward the weakening line,

(b) the major axis of elongation of said stiffening profile intersects the contour of the weakening line at two points,

(c) the resistance against deflection of the removable wall portion under an outside force applied to its center region is markedly higher in the axis of said stiffening profile as compared to the remainder of the removable wall portion so as to cause this force to be transmitted mainly to the points of intersection on the weakening line,

said end closure thus providing a removable wall portion which ruptures at one of two predetermined points on the weakening line when an opening force, such as produced by thumb pressure, is applied to its center.

7. A sheet metal end closure as set forth in claim 6 where

(d) the stiffening profile comprises a groove-shaped recess which is adapted to receive one end portion of an independent rigid member for forcible engagement therewith and which, upon being pivoted, transmits leverage-augmented bending load to the stiffening profile and to the points of intersection on the weakening line,

said end closure thus providing a removable wall portion which, in addition to the earlier-mentioned rupturing feature under thumb pressure, is adapted for rupturing under an alternate opening method using a rigid member and taking advantage of the leverage produced therewith.

8. A sheet metal end closure as set forth in claim 6 where

(e) the removable wall portion is of generally arcuate contour and has its center region located at a distance from the closure center,

(f) the two points where the major axis of the stiffening profile intersects the contour of the weakening line are located at equal distance from the closure center,

(g) the width of the residual cross-sectional connection between the two wall portions varies in accordance with the variation in stress over the length of the weakening line as caused by deflection of the closure wall under uniform internal pressure,

(h) the direction of the weakening line contour at the two points of intersection is substantially radial with respect to the closure center so as to coincide with portions of the weakening line where the aforementioned stress is at a minimum,

said end closure thus providing in addition to the earlier-mentioned predetermined points of rupture on the weakening line for said points to offer reduced resistance against severance without reducing the overall resistance of the end closure against uniform internal pressure.

9. A sheet metal end closure for a pressure-resistant container with a weakening line defining the contour of a predetermined removable wall portion from a non-removable wall portion where

(a) the center of the removable wall portion is located at a distance from the closure center,

(b) the contour of the weakening line is substantially oval and comprises an exterior arc alongside the closure periphery, a smaller arc on each side of said exterior arc, and an interior arc,

(c) the weakening line is discontinued and the wall material remains unweakened over a central portion of said interior arc on its contour,

(d) the wall material on one side of the weakening line is displaced substantially at right angles to the

initially undisplaced surface without being severed from the adjacent wall material on the opposite side of the weakening line,

(e) the removable wall portion is relatively depressed toward the inside of the end closure as a result of said displacement,

(f) the edge defined by the periphery of the removable wall portion underlaps the corresponding edge of the non-removable wall portion,

(g) the cross-sectional wall thickness in the area of the weakening line decreases abruptly from full wall thickness to the narrowest residual connection between the two wall portions so as to cause conditions of stress concentration under tensional stress,

(h) the width of the residual cross-sectional connection between the two wall portions varies in accordance with the variation in stress over the length of the weakening line as caused by deflection of the closure wall under uniform internal pressure and consequently has a minimum value at the central portion of the small arcs on the weakening line contour,

(i) the removable wall portion comprises in its wall structure an elongated stiffening profile consisting of two parallel ribs protruding above the general plane of the closure wall and forming a groove-shaped recess between them,

(j) the major axis of said stiffening profile coincides with the major diameter of the weakening line contour and intersects each one of the small arcs at midpoint,

(k) the resistance against deflection of the removable wall portion under an outside force applied to its center region is markedly higher in the axis of said stiffening profile as compared to the remainder of the removable wall portion so as to cause this force to be transmitted mainly to the points of intersection on the weakening line,

(l) the aforementioned groove-shaped recess is adapted to receive one end portion of an independent rigid member for forcible engagement therewith and which, upon being pivoted, transmits leverage-augmented bending load to the stiffening profile and to the points of intersection on the weakening line,

said end closure thus providing considerably differing resistance against severance at the weakening line, depending on whether it is subjected to uniform internal pressure causing compression stress at the weakening line, or whether it is subjected to an opening force, such as produced by thumb pressure applied from outside to the center of the removable wall portion, which force is transmitted mainly to the least resistant portions of the weakening line, thereby causing tension stress augmented by the condition of stress concentration and consequent rupture thereat, also providing for an alternate opening method whereby a rigid member is used to produce leverage-augmented bending forces and consequent rupture at said least resistant portions of the weakening line.

10. A sheet metal end closure as set forth in claim **9** where

(m) the exterior one of the two parallel ribs is adapted to transmit lateral foces from the groove-shaped recess to the exterior arc of the weakening line contour,

said end closure thus providing for a still further opening method whereby the aforementioned rigid member is pivoted away from the closure center, thereby producing leverage-augmented shear forces and consequent rupture at the exterior arc of the weakening line contour.

11. A sheet metal end closure as set forth in claim **9** where

(n) the wall of the non-removable wall portion comprises a marginal bevel adjacent to and surrounding the weakening line, with the weakening line and the removable wall portion being relatively recessed toward the inside of the closure,

said end closure thus providing in addition for a protective marginal bevel around any sharp edge that might be left after severance of the removable wall portion from the non-removable wall portion.

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