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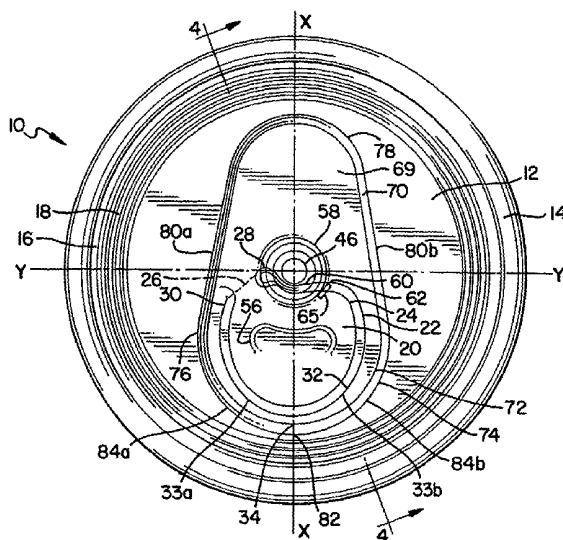
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(54) Title: CAN END FOR A CONTAINER



(57) Abstract: A can end (10) has a peripheral seaming edge (14) for fastening to a can sidewall and a central panel (12). The deboss panel (70) has first and second spaced apart end portions (76, 78) joined by first and second sidewalls (80a, 80b). The first spaced apart end portion has an apex (82) and first and second arcuate portions (84a, 84b). A distance between the first and second arcuate portions is defined by a plurality of progressively increasing secant lengths (88a-88d). The score groove (22), in the deboss panel, has first and second ends (28, 30) connected by a curvilinear segment (32) that includes first and second curved segments (33a, 33b) joined by a transition point located adjacent the apex of the deboss panel and is defined by a plurality of progressively increasing chordal lengths (31a-31d). A ratio of the increasing secant lengths to the increasing chordal lengths increases along respective lengths of the first and second arcuate portions.

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## CAN END FOR A CONTAINER

### DESCRIPTION

#### Technical Field

The present invention relates to end closures for two-piece beer and beverage metal containers having a non-detachable  
5 operating panel. More specifically, the present invention relates to improved forming techniques to produce a lightweight end closure.

#### Background of the Invention

Common end closures for beer and beverage containers have a central panel that has a frangible panel (sometimes called a “tear  
10 panel,” “opening panel,” or “pour panel”) defined by a score formed on the outer surface, the “consumer side,” of the end closure. Popular “ecology” can ends are designed to provide a way of opening the end by fracturing the scored metal of the panel, while not allowing separation of any parts of the end. For example, the  
15 most common such beverage container end has a tear panel that is retained to the end by a non-scored hinge region joining the tear panel to the remainder of the end, with a rivet to attach a leverage tab provided for opening the tear panel. This type of container end, typically called a “stay-on-tab” (“SOT”) end has a tear panel that is  
20 defined by an incomplete circular-shaped score, with the non-scored segment serving as the retaining fragment of metal at the hinge-line of the displacement of the tear panel.

The container is typically a drawn and ironed metal can, usually constructed from a thin plate of aluminum. End closures for  
25 such containers are also typically constructed from a cut-edge of thin plate of aluminum or steel, formed into a blank end, and

manufactured into a finished end by a process often referred to as end conversion. These ends are formed in the process of first forming a cut-edge of thin metal, forming a blank end from the cut-edge, and converting the blank into an end closure which may be  
5 seamed onto a container. Although not presently a popular alternative, such containers and/or ends may be constructed of plastic material, with similar construction of non-detachable parts provided for openability.

These types of "stay-on-tab" ecology container ends have  
10 been used for many years, with a retained tab and a tear panel of various different shapes and sizes. Throughout the use of such ends, manufacturers have sought to save the expense of the metal by down-gauging the metal of the ends and the tabs. However, because ends are used for containers with pressurized contents and are  
15 sometimes subject to pasteurization, there are conditions causing great stresses to the components of the end during pasteurization, transit and during opening by a user. These conditions limit the available gauge reduction of the end metal, and make it difficult to alter design characteristics of the end, such as by reducing metal  
20 gauge or the thickness of the metal residual in the score defining the tear panel.

The pressurized contents of the container often causes the end to buckle. The pressurized contents will also force the tabs upwardly. There is a maximum allowable distance that the tab can  
25 be displaced without the tab extending upwardly above the remainder of the container. This is called tab-over-chime. Tab-over-chime leads to ship abuse problems wherein the frangible panel prematurely fractures during distribution of filled beverage containers.

As manufacturers reduce the thickness of the metal used to make the ends, buckle and tab-over-chime become more and more of a problem. Therefore, a need for can end with improved ability to withstand buckle and tab-over-chime is needed.

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### Summary of the Invention

It is an object of the present invention to provide an end closure for a container having a circumferential sidewall and a peripheral seaming edge adapted to be integrally connected to the sidewall. The end has a central panel wall with a deboss portion recessed therein. The deboss panel includes a means for opening a frangible panel segment of the panel wall and a rivet adapted to integrally attach a tab lever having a nose portion overlying at least a vent region of the frangible panel segment and a lift end opposite the nose. A score groove is formed in the central panel wall to define an outer perimeter of the frangible panel. The score groove has a first end adjacent the vent region and a second end joined to the first end by a curvilinear segment, whereby the first end and the second end are separated by a generally linear hinge segment of the central panel wall. The hinge segment is non-frangible to integrally connect the frangible panel segment to an adjacent area of the panel.

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It is also an object of the present invention to provide such an end member wherein the central panel has a stepped profile along an outer peripheral portion.

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It is another object of the present invention to provide an end member whereby the score groove is a generally v-shaped recess having a score depth into the thickness of the central panel, and the second groove is also a generally v-shaped recess having a groove depth into the thickness of the central panel less than that of the

score groove. The score groove includes a check slot region for naturally slowing the fracture of the score to allow the container to vent safely.

5 It is further an object of the invention to provide an end member having a countersink with an inner wall, a curved segment, and an outer wall. The outer wall has a lower portion joined to an outer arcuate portion of the curved segment, a crease portion angled outwardly of the central panel, and an upper portion.

10 Other features and advantages of the invention will be apparent from the following specification taken in conjunction with the following drawings.

#### Brief Description of the Drawings

15 Figure 1 is a top view of a can end of the present invention without a tab;

Figure 1A is a top view of the can end of Figure 1 with a tab staked thereto;

Figure 2 is a partial top view of the can end of Figure 1;

20 Figure 3A is a partial cross-sectional view of taken along 3A-3A of Figure 2;

Figure 3B is a partial cross-sectional view of taken along 3B-3B of Figure 2;

Figure 4 is a cross-sectional view of the can end of Figure 1 taken along 4-4;

25 Figure 5 is a partial view of a deboss panel of the present invention; and

Figure 6 is a top view of a can end of the present invention without a tab.

### Detailed Description

While this invention is susceptible of embodiment in many different forms, there are shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

The container end of the present invention is a stay-on-tab end member 10 with improved physical properties including strength. Essentially, the present invention provides a lightweight end member 10 which embodies the physical characteristics and properties required in the beverage container market, as explained below.

In the embodiment of Figures 1 through 6, the end member 10 for a container (not shown) has a central panel wall 12 having a seaming curl 14 for joining the wall to the container. The container is typically a drawn and ironed metal can, usually constructed from a thin plate of aluminum or steel, such as the common beer and beverage containers. End closures for such containers are also typically constructed from a cut edge of thin plate of aluminum or steel, formed into blank end, and manufactured into a finished end by a process often referred to as end conversion. In the embodiment shown in the Figures, the central panel 12 is joined to a container by a seaming curl 14 which is joined to a mating curl of the container. The seaming curl 14 of the end closure 10 is integral with the central panel 12 by a countersink area 16 which is joined to the panel outer peripheral edge 18 of the central panel 12. This type of means for joining the central panel 12 to a container is presently the typical

means for joining used in the industry, and the structure described above is formed in the process of forming the blank end from a cut edge of metal plate, prior to the end conversion process. However, other means for joining the central panel 12 to a container may be employed with the present invention.

The outer peripheral edge 18 of the central panel 12 is typically coined to add strength to can end 10. Coining is the work hardening of metal between tools. The metal is typically compressed between a pair of tools, generally an upper and lower tool.

The central panel wall 12 has a displaceable tear panel 20 defined by a curvilinear frangible score 22 with an adjacent anti-fracture score 24 on the tear panel 20, and a non-frangible hinge segment 26. The hinge segment 26 is defined by a generally straight line between a first end 28 and a second end 30 of the frangible score 22. The tear panel 20 of the central panel 12 may be opened, that is the frangible score 22 may be severed and the tear panel 20 displaced at an angular orientation relative to the remaining portion of the central panel 12, while the tear panel 20 remains hingedly connected to the central panel 12 through the hinge segment 26. In this opening operation, the tear panel 20 is displaced at an angular deflection, as it is opened by being displaced away from the plane of the panel 12.

The first and second ends 28, 30 of the frangible score 22 are joined by a curvilinear segment 32. The curvilinear segment 32 includes first and second curved segments 33a, 33b joined by an arcuate transition region 34 which lies adjacent the outer peripheral edge 18 of the center panel 12 and are defined by a radius of curvature  $R_4$ . (See Figure 5). The first and second curved segments 33a, 33b are separated by a series of chordal lengths 31a-33d. (See



Figure 5).

As best shown in Figure 3B, the frangible score 22 is preferably a generally V-shaped groove 35 formed into the public side 34a of the panel wall 12. Similarly, the anti-fracture score 24, is preferably a generally V-shaped groove 38 formed into the public side 34a of the panel wall 12 on the tear panel 20. As is explained in more detail below, the frangible score groove 35 is preferably deeper than the anti-fracture score groove 38. Accordingly, the score residual 40, being the amount of frangible material remaining below the frangible score groove 35, is less than the adjacent anti-fracture score residual 42. This difference between score residual 40 and adjacent anti-fracture score residual 42 is the score residual differential.

The frangible score 22 and the second groove or anti-fracture score 24 are formed using conventional-type of scoring operation during the can end forming process, using tools including an upper (public side) die with a score knife and a lower (product side) die with an anvil surface.

The score residual differential is adapted to provide a tear panel 20 with a score 22 more readily frangible than the anti-fracture score 24, a significant factor for providing efficient opening of the end member 10. Having a double score of a frangible score 22 and an anti-fracture score 24 wherein there is a score residual differential is common in the industry.

As illustrated in Figure 1A, end member 10 has a tab 44 secured to the end panel 12 by a rivet 46. The tab 44 has a lift end 48, a central region 50, and a nose portion 52. The lift end 48 and the nose portion 52 are generally aligned along a central longitudinal axis passing through the rivet 46. A bead 56 is optionally formed in

the tear panel 20 inward of the score 22 and the anti-fracture score 24. The tear panel bead 56 is useful to draw excess metal, or slack of metal, from the tear panel 20 to tighten the metal of the tear panel 20 and improve opening characteristics of the end member 10 by the  
5 tab 44 being lifted to push against the tear panel 20.

The rivet 46 is formed in the typical manner. It is the conventional practice to coin the metal on the central panel 12 proximate the base of the rivet 46 during formation thereof. When the rivet 46 is completely formed in the central panel 12, a coined  
10 region 58 having a generally circular periphery is also formed and is located about the rivet 46. This coined region 58 is typically called a button coin.

The user initiates opening of the end member 10 by lifting the lift end 48 of the tab 44. This lifts the rivet 46 which causes the  
15 score groove 22 to fracture in a vent region 60 which is located at least partially within the bounds of the coined region surrounding the rivet 46. As the nose portion 52 presses against the tear panel 20, the fracture of the score 22 propagates around the tear panel 20, preferably in progression from the first end 28 of the score 22  
20 toward the second end 30 of the score 22.

The frangible score 22 includes a length defined by a thickened portion of the residual. This length is often referred to as a check slot region 62. As illustrated in Figure 3A, the check slot 62  
25 includes an area of thickened residual 64. The area thickened residual 64 causes the propagation of the fracture of the frangible score 22 to slow naturally as the fracture reaches the check slot region 62. This allows the container to vent safely before the fracture of the frangible score 22 continues.

Typically, the check slot 62 is located within the bounds of

the coined region 58. The check slot 62 of the present invention, however, is located beyond the boundary of the coined region 58. Thus, the check slot 62 is not located within the thinned metal of the coined region 58 surrounding the rivet 46. This is advantageous for reasons which will be discussed below.

Preferably, the check slot region 62 includes a dual step residual differential. (See Figure 3A). The dual step residual differential includes two levels of residual thickness. Thus, the check slot region 62, rather than having a constant residual thickness, includes a first step 63a wherein the residual differential between the first step 63a and substantially the remaining portions of the frangible score 22 is approximately 0.0020 inches and a second step 63b wherein the residual differential between the second step 63b and substantially the remaining portions of the frangible score 22 is approximately 0.0016 inches thick.

The end member 10 also includes a vent coin 65. The vent coin 65 is a small rectangularly shaped coin placed near the frangible score 22. The vent coin 65 has a leading end 66 placed adjacent the frangible score 22 and a trailing end 67 directed outwardly and at an angle from the frangible score 22. An intermediate section 68 of the vent coin 65 intersects the anti-fracture score 24.

One purpose of the vent coin 65 is to prevent the tear panel 20 from missiling during the opening of the container. Missiling is a jutting upward of the tear panel 20 upon venting. Missiling is caused when the frangible score 22 fracture propagates beyond the vent region 60, before the container pressure is fully relieved. The loose tear panel 20 is then forced upward due to the internal pressure of the container.

The end member 10 is opened by the lifting of the rivet and

subsequently by the force of the tab 44 pushing down on the tear panel 20. Initially, the frangible score 22 should only be severed in the vent region 60. This allows a small portion of the tear panel 20 metal to be pushed below the central panel 12 to open and vent the pressure within the container.

The vent coin 65 functions by displacing metal near the juncture of the check slot 62 and the vent region 60. The displaced metal in the area causes an elastic, compressive state. As such, when the frangible score 22 is severed in the vent region 60, the metal of the tear panel 20 springs out to underlap the metal of the central panel 12 in that region. This underlapping portion of the tear panel 20 is believed to keep the remainder of the tear panel 20 in place so as to avoid premature fracture of the remainder of the frangible score 22 and thereby prevent the tear panel 20 from missing.

Typically, the vent coin 65 is located within the coined region 58. Similar to the check slot 62 of the present invention, the vent coin 65 is moved outside of the periphery of the coined region 58 surrounding the rivet 46. It is believed that by moving the vent coin 62 outside of the coined region 58 boundary, the compressive stress on the frangible score 22 is increased. Therefore, the depth of frangible score 22 in the vent region 60 may be increased, and the strength requirement of the tab 44 to begin fracture of the frangible score 22 can be decreased.

The vent coin 65 also interacts with the check slot 62 to slow the propagation of the fracture along the frangible score 22 during venting of the container.

According to another aspect of the present invention, a deboss panel 69 is formed in the public side 34a of the central panel

12. The deboss panel 69 is formed in the central panel 12 using conventional die-forming techniques. As shown in Figures 1 and 1A, the deboss panel 69 has a substantially gibbous-shaped deboss profile 70 which is, in turn, defined by an inner radius line 72 and an  
5 outer radius line 74. As illustrated in Figure 4, the outer radius line 74 may have a radius of curvature of about 0.015 inches with a center of curvature below a product side 34b of the central panel 12 and the inner radius line 72 may have a radius of curvature of 0.015 inches with a center of curvature above public side 34a of the central  
10 panel 12. The depth of the deboss profile 70, i.e., the vertical distance between outer radius line 74 and inner radius line 72 may be about 0.019 inches. The width of the deboss profile, i.e., the lateral distance between the outer and inner radius lines 74, 72, may be about 0.015 inches. The deboss panel 69 has bilateral symmetry  
15 with respect to a plane defined by axes X-X and Y-Y.

The deboss profile 70 includes first and second opposing end portions 76, 78 joined by a pair of sidewalls 80a, 80b. The first end portion 76 includes an apex 82. The apex 82 is joined to the sidewalls 80a, 80b by first and second arcuate portions 84a, 84b.  
20 The apex 82 lies between the transition region 34 of the frangible score 22 and the outer peripheral edge 18 of the center panel 12. The first and second arcuate portions 84a, 84b extend outwardly equally from the apex 82 along a first angle 86 such that a series of secant lengths 88a-88d arranged parallel to the Y-Y axis and  
25 opposite the apex 82 become progressively longer in length until the first and second arcuate portions 84a, 84b blend smoothly with the sidewalls 80a, 80b. (See Figure 5). The apex 82 may also be described as having a radius of curvature  $R_s$  wherein the arcuate portions 84a, 84b become increasingly farther and farther apart until

each blends with a respective sidewall 80a, 80b.

It should be noted that in the embodiment illustrated in Figure 5, the sidewalls 80a, 80b are substantially straight segments. The sidewalls 80a, 80b, however, may curvilinear or any shape without departing from the spirit of the invention. For instance, Figure 6 illustrates sidewalls 80a, 80b having a curvilinear shape.

Typically, the deboss profile 70 and the frangible score 22 remain equidistant throughout the first end portion 76. The distance between the frangible score 22 and the first end portion 68 of the deboss profile 70 is generally on the order of 0.05 inches.

As illustrated in Figure 5, the present invention discloses a widening of the distance between the first end portion 76 of the deboss profile 70 and the curved segments 33a, 33b of the frangible score 22. At the apex 82 of the first end portion 76, the distance  $D_0$  between the deboss profile 70 and the frangible score 22 is about 0.05 inches. The distances  $D_1$ - $D_3$  increase gradually as the ratio of the secant lengths 88a-88d of the deboss profile 70 to the chordal lengths 31a-33d of the frangible score 22 increases. At the points where the first and second arcuate portions 84a, 84b blend into the sidewalls 82a, 82b, the distance  $D_4$  between the deboss profile 70 and the frangible score 22 is about 0.1 inches.

Alternatively, as illustrated in Figure 6, the distance between the deboss profile 70 and the frangible score 22 can be increased while remaining substantially constant. In this embodiment, the distance between the deboss profile 70 and the frangible score 22 is increased from 0.050 inches to approximately 0.1 inches. The distance is preferably maintained at 0.1 inches but also may be within the range of 0.05-0.1 inches, or any range or combination of ranges therein.

The relationship between the deboss panel 69 and the frangible score 22 is important. The deboss panel 69 takes up metal displaced during the scoring process and the coining of the peripheral edge 18. Also, by moving the deboss panel 69 outwardly from the frangible score 22, it is believed that the stresses created on the frangible score 22 during the forming of the deboss panel 69 are greatly reduced. This is believed to enhance score rupturing by taking up metal slack near the rivet 46 and also immediately adjacent to the frangible score 22 along its entire length from the 6 o'clock past the 9 o'clock position, the region where score rupture failure is most likely to occur. Thus, the widening of the deboss panel 69 also increases burst values by relieving the stresses on the frangible score 22. The end member 10 is also strengthened because the movement of the deboss panel 69 outwardly allows the panel to be recessed deeper, taking up even more loose metal.

Generally, the central panel 12 experiences stress gradients. As the distance from the rivet 46 (center of the central panel 12) becomes greater, the stress lessens. Thus, by moving the deboss panel 69 away from the frangible score 22, the component of stress supplied by the deboss panel 69 is reduced. Thus, the depth of frangible score 22 may be increased as much as 50% without incurring premature failure of the frangible score 22.

According to another aspect of the present invention and as illustrated in Figures 5 and 6, a curvilinear bead 89 is formed in the public side 34a of the central panel 12. The bead 89 is preferably formed to have a curvilinear length, adapted to at least partially surround the coined region 58, thereby partially surrounding the rivet 46. Further, the bead 89 is preferably an emboss bead or a raised portion in the public side 34a of the central wall 12.

The bead 89 provides the desirable stiffness of the central panel 12 in the region around the rivet 46, thereby reducing the amount of panel lift resulting from the force of the tab 44 on the tear panel 20 during opening. The stiffness of the tear panel 20 is primarily provided by the bead 89 being formed as drawn metal in the public side 34a of the central panel 12 immediately adjacent the coined region 58 and the rivet 46.

The bead 89 preferably has an arcuate portion and a substantially linear portion. The arcuate portion partially surrounds the coined region 58, extending a slightly longer distance on one side of the coined region 58 than on an opposing side of the coined region 58. This allows the first end 28 of the score 22 to extend upwardly so that it wraps slightly around the rivet 46. The substantially linear portion is located on an opposite side of the coined region 58 as the frangible score 22.

Preferably, there is very little thinning of the metal during formation of the bead 89, and the bead 89 is instead created by forming or drawing the metal between two opposed dies to take up slack metal. The bead 89 formation thereby draws available loose metal in the region, such as loose metal caused by scoring, coining of the metal while forming the rivet 46, or coining of metal while staking the tab 44. The bead 89 also serves as a stiffening beam in the panel 12 wall immediately adjacent the rivet 46 and the coined region 58. By drawing loose metal and providing a stiffening beam, the bead 89 is adapted to provide stiffness in the panel wall 12 around the coined region 58 to decrease the panel lift and enhance the leverage by the tab 44 during opening of the end tear panel 20.

Referring to Figure 4, the countersink 16 of the end member 10 includes an inner wall 90, a curved segment 92, and an outer wall



94. The curved segment 92 has an inner arcuate portion 96 joined to an outer arcuate portion 98 along an annular base 100. The inner wall 90 has an upper portion 102 joined to the outer peripheral edge portion 18 of the central panel 12 and a lower portion 104 joined to the inner arcuate portion 96 of the curved segment 92. The outer wall 94 has a lower portion 106 joined to the outer arcuate portion 98 of the curved segment 92, a crease portion 108 angled outwardly of the central panel 12, and an upper portion 110. The crease 108 has a radius of curvature of approximately 0.005 inches and is positioned at a height  $H_1$  of approximately 0.065 inches above the annular base 100.

The outer peripheral edge 18 of the central panel 12 includes a stepped profile. The stepped profile includes a first panel radius 114 interconnected to a second panel radius 116 by the previously coined portion of the outer peripheral edge 18. The first panel radius 114 has a height  $H_2$  which is approximately 0.108 inches above the annular base 100. The second panel radius 116 is joined to the inner wall 90 of the countersink 16 and has a height  $H_3$  which is approximately 0.093 inches above the annular base 100.

The dimensions of the first panel radius 114, the second panel radius 116, and the crease portion 108 were selected to optimize resistance to burst and tab-over-chime. Burst is the ability of the pour panel 20 to withstand internal pressure. Tab-over-chime is also the ability of the end member 10 to withstand internal pressure. Tab-over-chime occurs when the internal pressure forces the tab 44 upwardly. When the tab 44 is displaced upward, it can lead to ship abuse during distribution of filled containers which can cause premature failure of the pour panel 20. Thus, tab-over-chime is the internal pressure at which the tab is displaced an undesirable

amount.

As the height  $H_3$  of the second panel radius 116 increases, buckle values increase; however, the tab-over-chime value decreases as the height  $H_3$  of the second panel radius 116 increases. Thus, the height  $H_1$  of the crease portion 108 can be 0.060-0.075 inches or any height or range of heights therein, and the height  $H_3$  of the second panel radius 116 can be 0.080-0.095 inches or any height or range of heights therein. It should be noted that for forming reasons, the height  $H_1$  of the crease 108 is preferably lower than the height  $H_3$  of the second panel radius 116.

According to another aspect of the invention, a method for reforming a can end shell to produce the end member 10 described herein is disclosed. The method is used to produce a lightweight end member 10, for example from an 0.0080 inch thick aluminum stock for attachment to a container necked to a 202 (2.125 inches) open end. End members 10 of the present invention are generally manufactured using a multi-stage reforming method.

In an the initial stage, the outer peripheral edge 18 of the central panel 12 is coined and reformed in the conventional manner as disclosed, for example, in U.S. Patent No. 5,527,442. The coining operation creates slack metal produced by the compression of the peripheral edge 18 between the coining tools. This coining operation forces metal in the outer peripheral edge to flow both radially inwardly and radially outwardly from the peripheral edge 18.

The slack metal is removed as the countersink 16 is reformed. In this operation, the countersink 16 is reformed so that metal in the countersink 16 is moved downwardly with respect to the central panel 12. This decreases the countersink 16 depth which

causes the central panel 12 height to increase. To further improve end member 10 rock and buckle performance, the outer wall of the countersink 16 may also be creased or kinked radially outwardly, as illustrated in Figure 4, during the reforming operation. This type of operation is disclosed in U.S. Patent 4,093,102.

Next, the deboss panel 69 is formed within the central panel 12. The forming of the deboss panel 69 places the central panel 12 into the desirable tension state. The deboss panel 69 also takes up any slack metal created during the coining of the peripheral edge 18 and the scoring of the central panel 12 when the frangible score 22 and the anti-fracture score 24 are formed.

Once the tab 44 has been staked to the rivet 46, the step portion is formed at the outer peripheral portion 18. The step portion increases the height of the central panel 12 above that of the initial reform increase. The forming of the step portion increases the end member's 10 buckle resistance even higher. Also, since no slack metal is remaining from the coining and scoring operations, it has been found that the deboss panel 69 will roll up or the recess will become shallower subsequent to the step portion being formed.

In an initial trial, can ends 10 were produced with a check slot region 62 having a single step of residual thickness of 0.0016 ins., a vent coin 65 positioned below the anti-fracture score 24, and a 6:00 - 12:00 score residual differential of only 0.0002 - 0.0004 ins. This trial resulted in improved openability.

A second trial was carried out on can ends 10 as illustrated in Figures 5. The lengths of increased residual 62 of these can ends 10 were modified to create the dual step residual differential to the frangible score 22 of 0.0020 ins. and 0.0016 ins. All of the can ends 10 exhibited improved openability and passed the missiling test. It

is believed that these favorable results are attributable to the tear panel 20 hinging at, or opening to, the vent coin 65 when the can end 10 end is "popped" or when opening is initialized. This creates a larger vent opening and allows the can end 10 to vent and pass the missiling test.

Since the can ends 10 successfully passed the missiling test, a complete evaluation was performed. Further tests on a total of eight sets of can ends 10, as illustrated in Figures 1-4 were performed. All of the forming variables of the eight sets of can ends 10 were identical except for the score residuals of the frangible score 22. The different score residuals are summarized in Table 1.

Table 1: Score Residuals (in inches)

Test Group	Residual at the 12:00 Position	Residual at the 3:00 Position	Residual at the 9:00 Position	Residual at the 6:00 Position
A	0.0030	0.0029	0.0029	0.0028
B	0.0033	0.0033	0.0033	0.0032
C	0.0034	0.0034	0.0034	0.0032
D	0.0036	0.0035	0.0035	0.0034
E	0.0038	0.0037	0.0037	0.0035
F	0.0042	0.0042	0.0042	0.0040
G	0.0045	0.0044	0.0044	0.0041
H	0.0047	0.0046	0.0046	0.0043

The can ends 10 were also tested for pressurized openability (for beer). No failures were found until test group H.

The can ends 10 were further tested for score burst. None of the can ends 10 burst open before the maximum pressure of the test

was reached. It is believed that the excellent results of this test are directly attributable to the greater distance from the deboss panel 69 to the frangible score 22.

5 While the invention has been described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the broader aspects of the invention. Also, it is intended that broad claims not specifying details of the particular embodiments disclosed herein as the best mode  
10 contemplated for carrying out the invention should not be limited to such details.

CLAIMS

## WE CLAIM:

1. An end member for a container, the end member having a  
5 central panel wall with a product side and a public side, the public side  
having a means for opening a frangible panel segment, the end member  
comprising:  
a deboss panel recessed in the central panel, the deboss panel  
having a profile defined by first and second spaced apart end portions  
10 joined by first and second sidewalls;  
a score groove within the deboss panel defining an outer  
perimeter of the frangible panel segment, the score groove having a  
portion adjacent the first spaced apart end portion of the deboss panel  
wherein a distance between the deboss profile and the score groove has  
15 an increased length.
2. The end member of Claim 1 wherein the distance between the  
deboss profile and the score groove is greater than 0.050 inches.
- 20 3. The end member of Claim 1 wherein the distance between the  
deboss profile and the score groove is between 0.050 inches and 0.1  
inches.
4. The end member of Claim 1 wherein the second spaced apart  
25 end portion of the deboss panel includes first and second arcuate  
portions extending outwardly from an apex, and the distance between  
the score groove and the deboss profile becomes progressively longer  
along at least the first or second arcuate portion.

5. The end member of Claim 4 wherein the distance between the deboss profile and the score groove becomes progressively longer along the first and second arcuate portions.

5 6. The end member of Claim 1 wherein the first spaced apart end  
portion includes an apex and first and second arcuate portions joining  
the apex with the first and second sidewalls respectively wherein a  
distance between the first and second arcuate portions is defined by a  
plurality of progressively increasing secant lengths located in spaced  
10 relation from the apex, and the score groove includes a first end and a  
second end joined to the first end by a curvilinear segment, the  
curvilinear segment including a generally arcuate transition region  
adjacent the apex of the deboss panel, the generally arcuate transition  
region defined by a plurality of progressively increasing chordal  
15 lengths located in spaced relation from the apex of the deboss panel  
wherein a ratio of the plurality of progressively increasing secant  
lengths to the progressively increasing chordal lengths increases along  
respective lengths of the first and second arcuate portions of the deboss  
panel.

20

7. The end member of Claim 6 further comprising:

a rivet located within the deboss panel and adapted to integrally  
attach a tab lever to the panel, the tab lever having a nose portion  
overlying at least a portion of the frangible panel and having a lift end  
25 opposite the nose; and

a coined region having an outer periphery located about the  
rivet wherein the score groove has a portion separated from the product  
side of the central panel by a residual, and the score groove includes a

vent region located within the coined region and adjacent the rivet, and a length defined by a thickened portion of the residual located beyond the periphery of the coined region wherein the frangible panel segment initially opens within the vent region in response to a pulling force on the lift end of the tab lever.

5  
8. The end member of Claim 7 further comprising a vent coin adjacent the length of the score groove defined by a thickened portion of the residual for placing a compressive stress on the length of the score groove defined by a thickened portion of the residual.

10  
9. The end member of Claim 7 further comprising an anti-fracture score adjacent the score groove wherein the vent coin intersects the anti-fracture score.

15  
10. The end member of Claim 1 wherein the central panel has an outer peripheral edge segment including a stepped portion having at least a first panel radius interconnected to a second panel radius.

20  
11. The end member of Claim 10 further comprising a countersink portion connected to the central panel by the outer peripheral edge portion, the countersink including an inner wall, a curved segment, and an outer wall, the curved segment having an inner arcuate portion joined to an outer arcuate portion along an annular base, the inner wall having an upper portion joined to the outer peripheral edge portion of the center panel and a lower portion joined to the inner portion of the curved segment, and the outer wall having a lower portion joined to the outer portion of the curved segment, a crease portion angled outwardly  
25  
of the center panel, and an upper portion wherein the crease is



positioned at a first height above the annular base and the second panel radius is positioned at a second height, the second height being greater than the first height.

5 12. A method of producing the end member of Claim 1, the method comprising the steps of:

providing an end member including a central panel wall with a product side and a public side, a countersink, and an outer peripheral edge;

10 forming the score groove within the central panel;

coining the outer peripheral edge of the metal blank;

reforming the countersink downwardly with respect to the central panel;

15 forming the deboss panel within the central panel and spaced from the outer peripheral edge; and

reforming the outer peripheral edge of the end member wherein the outer peripheral edge portion includes a first panel radius interconnected to a second panel radius.

20 13. An end member for a container having a circumferential sidewall, the end member having a peripheral seaming edge adapted to be integrally connected to the sidewall, and having a central panel wall with a product side and a public side, the public side having a means for opening a frangible panel segment, the end member comprising:

25 a rivet positioned within the central panel and adapted to integrally attach a tab lever to the panel; the tab lever having a nose portion overlying at least a portion of the frangible panel segment and having a lift end opposite the nose;

a coined region substantially surrounding the rivet, the coined

region coin having an outer periphery;

a score groove in the central panel defining an outer perimeter of the frangible panel segment, the score groove having a portion separated from the product side of the central panel by a residual;

5 a vent region located adjacent the rivet, a portion of the vent region located within the coined region, the frangible panel segment opening initially within the vent region in response to a pulling force on the lift end of the tab lever; and

10 a length of the score groove defined by a thickened portion of the residual located beyond the periphery of the coined region.

14. The end member of Claim 13 further comprising a vent coin adjacent the length of the score groove defined by a thickened portion of the residual for placing a compressive stress on the length of the score groove defined by a thickened portion of the residual.

15. The end member of Claim 14 further comprising an anti-fracture score adjacent the score groove wherein the vent coin intersects the anti-fracture score.

20 16. The end member of Claim 15 wherein the vent coin is located beyond the periphery of the coined region substantially surrounding the rivet.

25 17. The end member of Claim 16 wherein the length of the score groove defined by a thickened portion of the residual is located entirely beyond the periphery of the coined region substantially surrounding the rivet.

18. The end member of Claim 13 wherein the central panel has an outer peripheral edge segment including a stepped portion having at least a first panel radius interconnected to a second panel radius.

5 19. The end member of Claim 18 further comprising a countersink portion connected to the central panel by the outer peripheral edge portion, the countersink including an inner wall, a curved segment, and an outer wall, the curved segment including an inner arcuate portion  
10 including an upper portion joined to the outer peripheral edge portion of the center panel and a lower portion joined to the inner portion of the curved segment, and the outer wall including a lower portion joined to the outer portion of the curved segment, a crease portion angled outwardly of the center panel, and an upper portion wherein the crease  
15 is positioned at a first height above the annular base and the second panel radius is positioned at a second height, the second height being greater than the first height.

20 20. The end member of Claim 19 further comprising a deboss panel recessed in the central panel, the deboss panel including a profile defined by first and second spaced apart end portions joined by first and second sidewalls, the first spaced apart end portion including an apex and first and second arcuate portions joining the apex with the first and second sidewalls respectively wherein a distance between the first and  
25 second arcuate portions is defined by a plurality of progressively increasing secant lengths located in spaced relation from the apex, and the curvilinear segment of the score groove including a generally arcuate transition region adjacent the generally arcuate apex portion of the deboss panel, the generally arcuate transition region defined by a

plurality of progressively increasing chordal lengths located in spaced relation from the apex of the deboss panel wherein a ratio of the plurality of progressively increasing secant lengths to the progressively increasing chordal lengths increases along respective lengths of the first and second arcuate portions of the deboss panel.

5  
21. The end member of Claim 13 the thickened portion of the residual includes a first region and a second region, the residual located within the first region having a greater thickness than the residual located within the second region.

10  
22. The end member of Claim 21 wherein the first region is located adjacent the coined region substantially surrounding the rivet.

15  
23. An end closure for a container, comprising:  
a central panel having a public side and an opposing product side and an outer peripheral edge segment, the outer peripheral edge segment including a stepped portion including a first panel radius interconnected to a second panel radius;  
20 a countersink connected to the central panel by the outer peripheral edge portion, the countersink including an inner wall, a curved segment, and an outer wall, the curved segment including an inner arcuate portion joined to an outer arcuate portion along an annular base, the inner wall including an upper portion joined to the outer peripheral edge portion of the center panel and a lower portion joined to the inner portion of the curved segment, and the outer wall including  
25 a lower portion joined to the outer portion of the curved segment, a crease portion angled outwardly of the center panel, and an upper portion wherein the crease is positioned at a first height above the

annular base and the second panel radius is positioned at a second height, the second height being greater than the first height; and  
a seaming curl joined to the upper portion of the outer wall for joining the end closure to a container.

5

24. The end closure of Claim 23 further comprising:  
a rivet centrally recessed within the central panel and adapted to integrally attach a tab lever to the panel;

10

a coined region substantially surrounding the rivet, the coined region having an outer periphery;

a score groove in the central panel defining an outer perimeter of the frangible panel segment, the score groove having a first end and a second end joined to the first end by a curvilinear segment, the score groove including a portion separated from product side of the central panel by a residual;

15

a vent region, a portion of the vent region located within the coined region adjacent the rivet, the frangible panel segment opening initially within the vent region in response to a pulling force on the lift end of the tab lever; and

20

a length of the score groove defined by a thickened portion of the residual located within the vent region and beyond the periphery of the coined region.

25

25. The end closure of Claim 24 further comprising a vent coin adjacent the length of the score groove defined by a thickened portion of the residual for placing a compressive stress on the length of the score groove defined by a thickened portion of the residual.

26. The end closure of Claim 25 further comprising an anti-fracture

score adjacent the score groove wherein the vent coin intersects the anti-fracture score.

5 27. The end closure of Claim 24 wherein the vent coin is located beyond the periphery of the coined region substantially surrounding the rivet.

10 28. The end closure of Claim 23 further comprising a deboss panel recessed in the central panel, the deboss panel including a profile defined by first and second spaced apart end portions joined by first and second sidewalls, the first spaced apart end portion including an apex and first and second arcuate portions joining the apex with the first and second sidewalls respectively wherein a distance between the first and second arcuate portions is defined by a plurality of progressively increasing secant lengths located in spaced relation from the apex, and the curvilinear segment of the score groove including a generally arcuate transition region adjacent the generally arcuate apex portion of the deboss panel, the generally arcuate transition region defined by a plurality of progressively increasing chordal lengths located in spaced relation from the apex of the deboss panel wherein a ratio of the plurality of progressively increasing secant lengths to the progressively increasing chordal lengths increases along respective lengths of the first and second arcuate portions of the deboss panel.

25 29. An end member for a container, the end member comprising:  
a central panel wall having a product side and a public side, the public side a frangible panel segment and a means for opening the frangible panel segment;  
a deboss panel recessed in the central panel, the deboss panel

having a substantially gibbous-shaped profile defined by first and second spaced apart end portions joined by first and second substantially linear sidewalls;

5 a score groove within the deboss panel defining an outer perimeter of the frangible panel segment, the score groove having a portion adjacent the first spaced apart end portion of the deboss panel wherein a distance between the deboss profile and the score groove has an increased length.

10 30. The end member of Claim 29 wherein the distance between the deboss profile and the score groove is greater than 0.050 inches.

15 31. The end member of Claim 29 wherein the distance between the deboss profile and the score groove is between 0.050 inches and 0.1 inches.

20 32. The end member of Claim 29 wherein the second spaced apart end portion of the deboss panel includes first and second arcuate portions extending outwardly from an apex, and the distance between the score groove and the deboss profile becomes progressively longer along at least the first or second arcuate portion.

25 33. An end member for a container, the end member comprising:  
a central panel wall having a product side and a public side, the public side a frangible panel segment and a means for opening the frangible panel segment;

a deboss panel recessed in the central panel, the deboss panel having a substantially pear-shaped profile defined by first and second spaced apart end portions joined by first and second curvilinear

sidewalls;

5 a score groove within the deboss panel defining an outer perimeter of the frangible panel segment, the score groove having a portion adjacent the first spaced apart end portion of the deboss panel wherein a distance between the deboss profile and the score groove has an increased length.

10 34. The end member of Claim 33 wherein the second spaced apart end portion of the deboss panel includes first and second arcuate portions extending outwardly from an apex, and the distance between the score groove and the deboss profile becomes progressively longer along at least the first or second arcuate portion.

15 35. The end member of Claim 33 wherein the distance between the deboss profile and the score groove is greater than 0.050 inches.

20 36. The end member of Claim 35 wherein the distance between the deboss profile and the score groove remains substantially constant throughout the second end portion of the deboss profile.

37. The end member of Claim 33 wherein the distance between the deboss profile and the score groove is between 0.050 inches and 0.1 inches.

25 38. The end member of Claim 37 wherein the distance between the deboss profile and the score groove remains substantially constant throughout the second end portion of the deboss profile.



FIG. 1

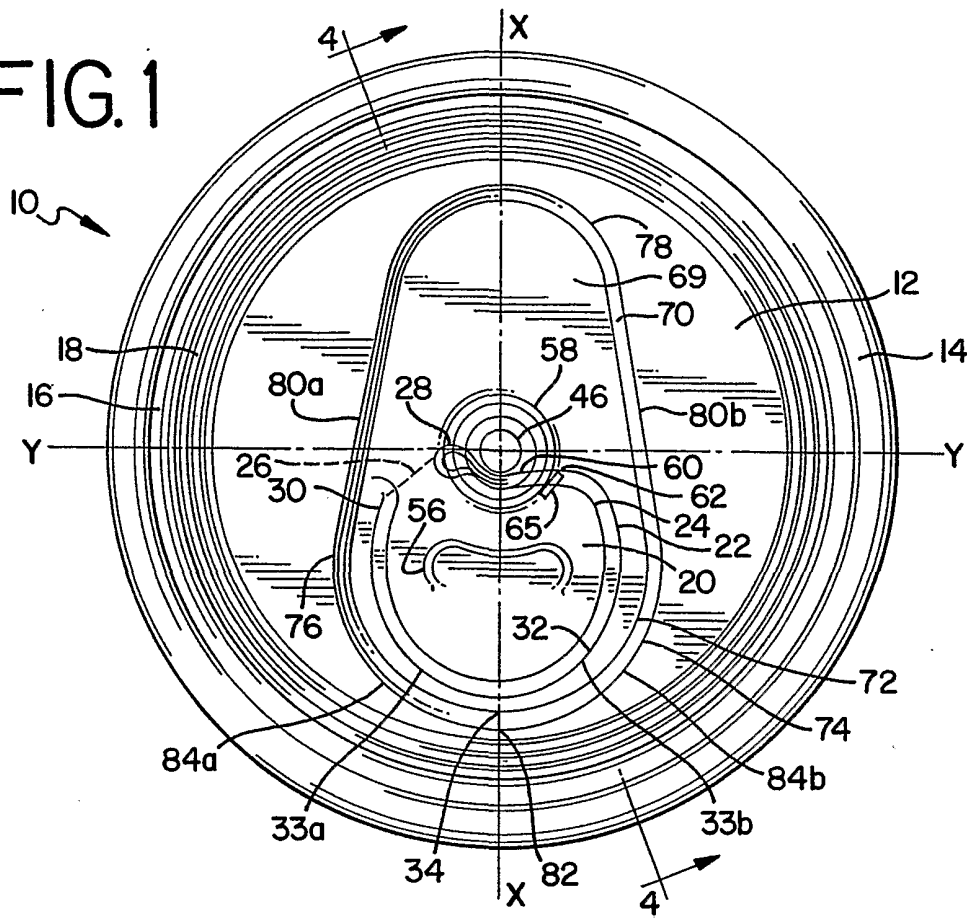


FIG. 1A

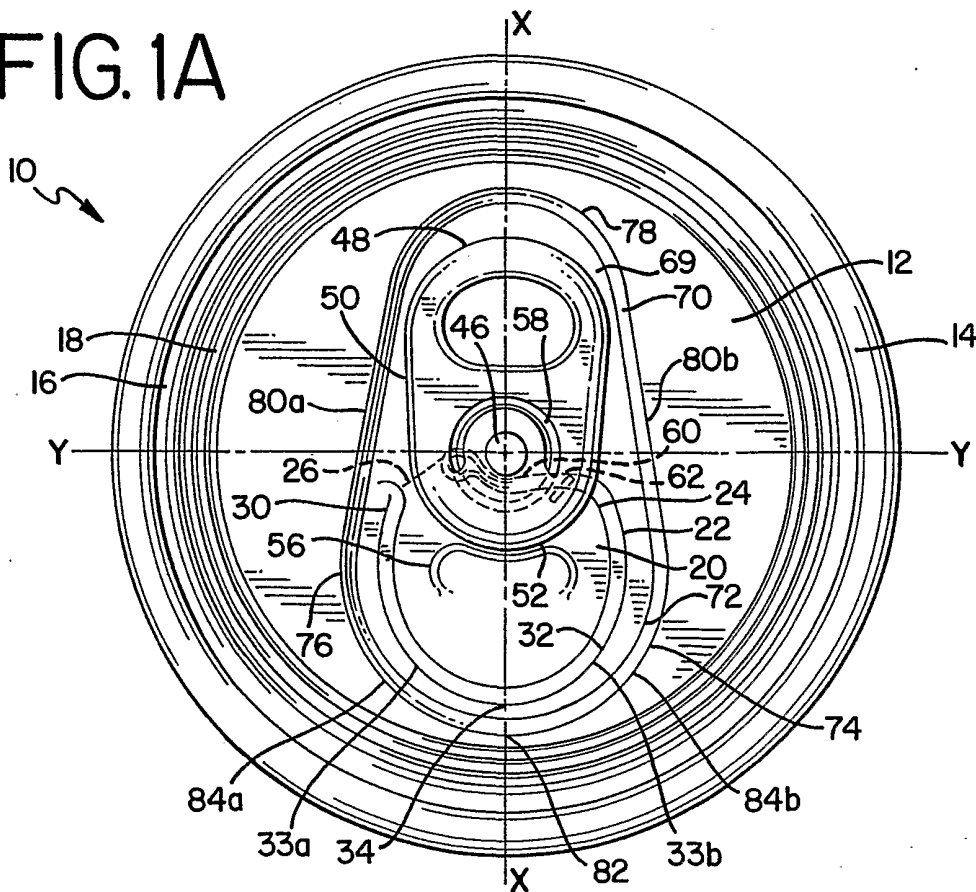


FIG. 2

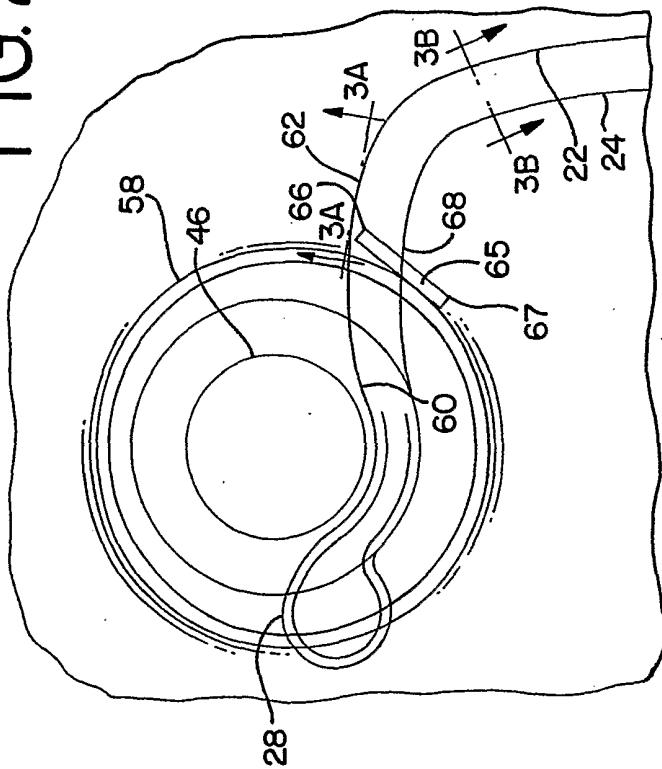


FIG. 3A

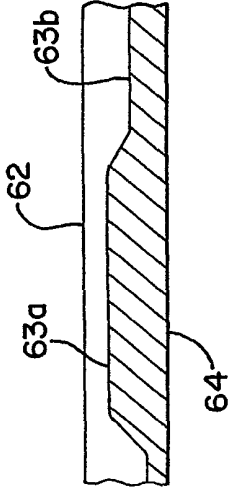


FIG. 3B

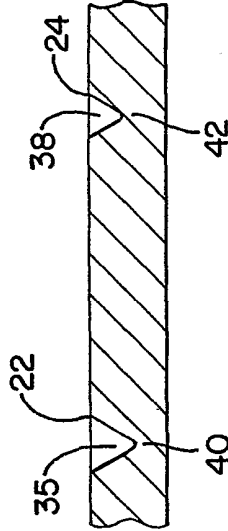


FIG. 4

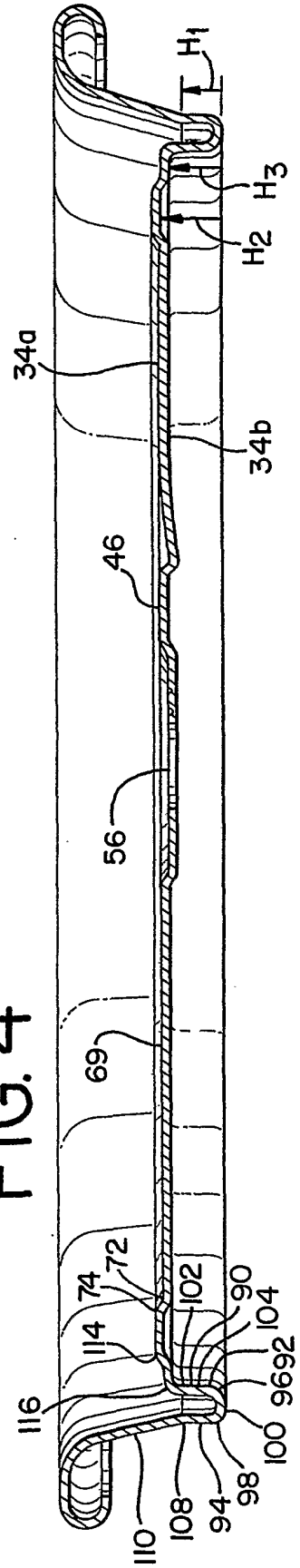


FIG. 5

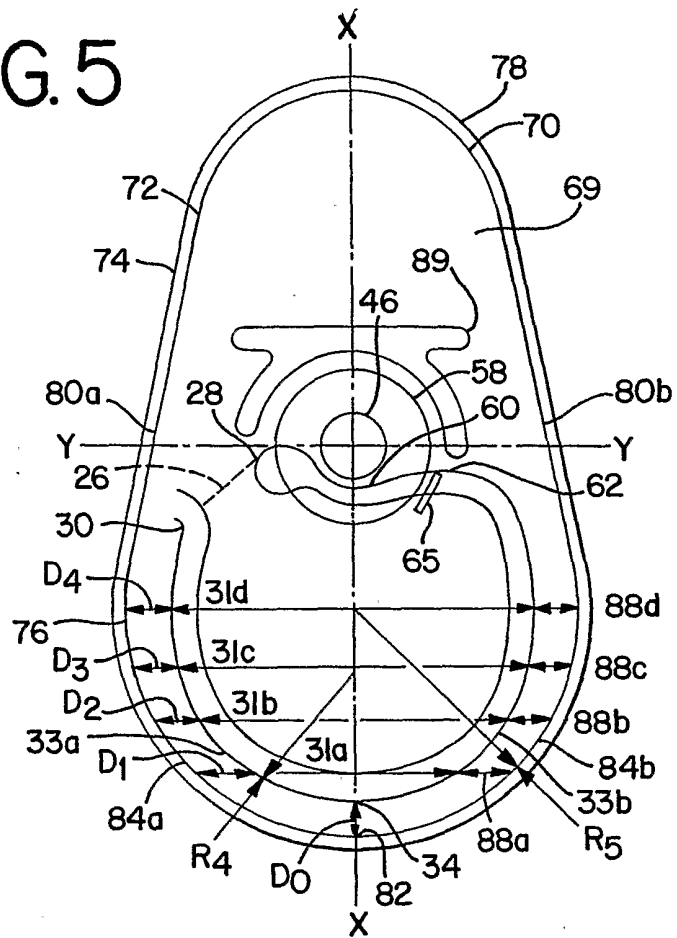
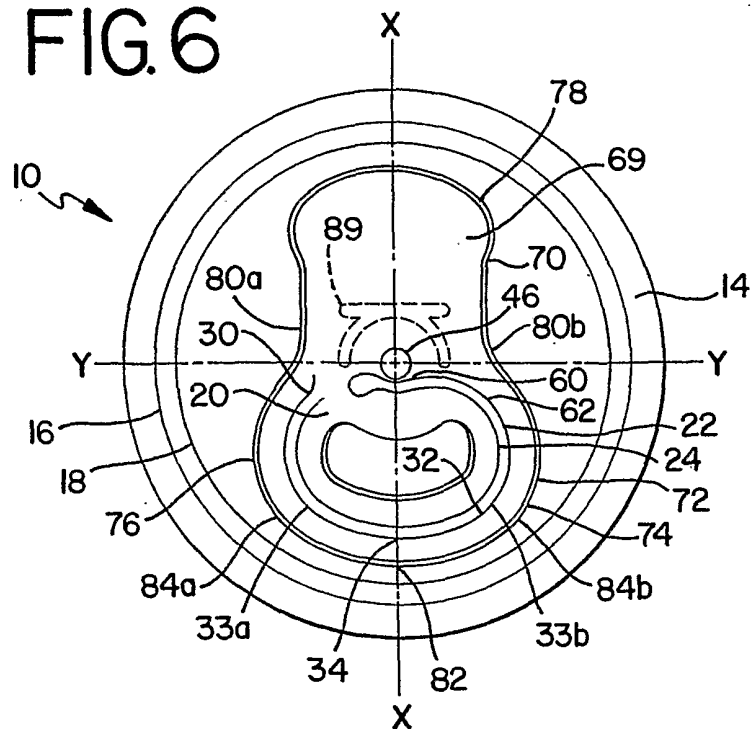


FIG. 6



**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/US01/46786

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : B65D 17/34; B21D 22/30  
 US CL : 220/269,619; 413/8

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
 U.S. : 220/269,271, 619, 620, 906; 413/6, 8, 11, 16, 17, 67

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,715,964 A (TURNER et al) 10 February 1998, see entire document.	1,4-5,33-34 ----- 2-3,10-12,29-32,35-38
X --- Y	US 4,024,981 A (BROWN) 24 May 1977, see entire document.	13 ----- 18-19,23-24
Y	US 5,149,238 A (McELDOWNEY et al) 22 September 1992, see entire document.	10-12,18-19,23-24
Y	US 5,046,637 A (KYSH) 10 Sepetmeber 1991, see entire document.	11, 19, 23
Y	US 5,711,448 A (CLARKE III) 27 January 1998, see entire document.	29-32

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

07 March 2002 (07.03.2002)

Date of mailing of the international search report

11 APR 2002

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