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CAN ENDS FOR BEVERAGE CONTAINERS AND RELATED METHODS

- (57)

Can ends for beverage containers and related methods are disclosed. An example can end includes a center panel, the center panel having a first area, and a pour panel formed on the center panel, the pour panel
- to define a pour opening having a second area, where a first area-to-second area ratio is approximately 0.22 inches.

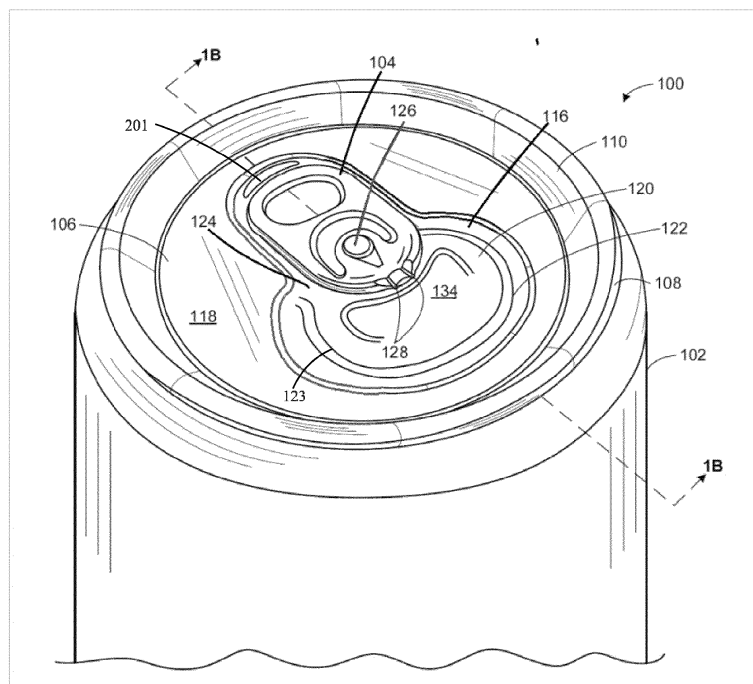


FIG. 1A

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent claims the benefit of U.S. Provisional Patent Application No. 63/506,761, which was filed on June 7, 2023, entitled "Can Ends For Beverage Containers and Related Methods." U.S. Provisional Patent Application No. 63/506,761 is hereby incorporated herein by reference in its entirety. Priority to U.S. Provisional Patent Application No. 63/506,761 is hereby claimed.

FIELD OF THE DISCLOSURE

[0002] This disclosure relates generally to can ends and, more particularly, to can ends for beverage containers and related methods.

BACKGROUND

[0003] Beverage containers are used to store soft drinks, beer and other consumable liquids. Beverage containers generally include a body (e.g., an aluminum body) and are interconnected to a beverage end closure or can end after being filled. The can end sealingly interconnects to an upper end of the beverage container (e.g., via a double seam).

BRIEF DESCRIPTION OF THE DRAWINGS

[0004]

FIG. 1A is a perspective view of an example container having an example can end constructed in accordance with the teachings of this disclosure.

FIG. 1B is a cross-sectional view of the example can of FIG. 1A taken along line 1B-1B of FIG. 1A.

FIG. 1C is an enlarged portion of the cross-sectional view of FIG. 1B.

FIG. 2A is a top view of the example can end of FIG. 2A.

FIG. 2B is a bottom view of the example can end of FIG. 2A.

FIG. 3A is a top view of the example can end of FIGS. 2A-2B illustrating example dimensions of the example can end of FIGS. 1A-1B and 2A-2B.

FIG. 3B is a schematic top view of an example center panel and pour opening of the example can end of FIGS. 1A-1C and 2A-2B.

FIG. 4A is a top view of the example tab of FIGS. 1A-1B and 2A-2B.

FIG. 4B is a bottom view of the example tab of FIG. 4A.

FIG. 5 is a cross-sectional view of the example tab of FIG. 4A taken along line 3-3 of FIG. 4A.

FIG. 6A is a cross-sectional view of the example tab of FIG. 4A taken along line 4-4 of FIG. 4A.

FIG. 6B is a cross-sectional view of the example tab

of FIG. 4A taken along line 5-5 of FIG. 4A.

FIG. 7 is a perspective view of the example can end of FIGS. 1A and 1B shown in a partially open position.

FIG. 8A is a cross-sectional view of the example can end of FIGS. 1A and 1B shown in a closed position. FIG. 8B is a cross-sectional view of the example can end of FIGS. 1A and 1B shown in a fully open position.

FIG. 9A is a perspective view of the example can end of FIGS. 1A and 1B.

FIG. 9B is another perspective view of the example can end of FIG. 9A.

FIG. 9C is a top view of the example can end of FIG. 9A.

FIG. 9D is an enlarged, top view of the example can end of FIG. 9A.

FIG. 9E is a bottom view of the example can end of FIG. 9A.

FIG. 9F is a side view of the example can end of FIG. 9A.

[0005] The figures are not to scale. Instead, to clarify multiple layers and regions, the thickness of the layers may be enlarged in the drawings. Wherever possible, the same reference numbers will be used throughout the drawing(s) and accompanying written description to refer to the same or like parts. As used in this patent, stating that any part (e.g., a layer, film, area, or plate) is in any way positioned on (e.g., positioned on, located on, disposed on, or formed on, etc.) another part, indicates that the referenced part is either in contact with the other part, or that the referenced part is above the other part with one or more intermediate part(s) located therebetween. Stating that any part is in contact with another part means that there is no intermediate part between the two parts. Stating that a part is coupled or connected to another part indicates that the parts are joined directly or through one or more intervening parts. Thus, physical contact is not required for two parts to be coupled or connected.

[0006] As used herein substantially or approximately means that a specified value or dimension may not be exact and can be within a manufacturing tolerance of plus or minus 5% to 10%, of a stated value or range.

DETAILED DESCRIPTION

[0007] Large volumes of metal are consumed each year to manufacture billions of beverage containers and cans. To reduce manufacturing or material costs, manufacturers are constantly striving to reduce amounts of materials (e.g., a gauge of metal) used to manufacture tabs, can ends and/or can bodies. However, reducing the size of can ends may result in reduced pour opening area, which reduces flow rate of contents from container. Additionally, reducing volume of materials (e.g., reducing a gauge of metal) may affect (e.g., reduce) strength characteristic(s) of the tabs, can ends and/or can bodies.

[0008] For example, beverage containers employ easy-open ends. Easy-open ends typically include a tear or opening panel and an attached leverage tab for pushing the pour panel into the container to open the end and access contents (e.g., liquid) stored inside the container. Can ends are made in a variety of sizes from 202 to 211 (using conventional can makers' terminology). For example, can ends come in different sizes including, but not limited to, 209 size can ends (6.50 cm); 207.5 size can ends (6.27 cm); 206 size can ends (6.03 cm), 204 size can ends (5.71 cm), 202 size can ends (5.39 cm) and/or any other size can ends. For example, a 209 size can end provides a larger pour opening than a 206 size can end, and a 206 size can end provides a larger pour opening than a 202 size can end, etc.

[0009] To open a can end, the leverage tab displaces the pour panel of the can end. Specifically, the tab remains attached to the can end after the tab is used to open the pour panel. Such known can ends are commonly referred to as "ecology" or "stay-on-tab" (SOT) ends. The pour panel is formed in the can end via a score. When the tab is lifted and forced against the pour panel, the tab applies a force (e.g., an opening force) against the pour panel to cause the score to rupture or sever along a length of the score. The tab displaces the pour panel at an angular orientation relative to the remaining container end to create a pour opening through which the contents may be dispensed from the container.

[0010] To improve pourability and/or drinkability through the pour opening, some known beverage container ends employ a large-opening end (LOE). For example, large-opening ends provide a larger area and/or opening for easier drinking and pouring. In a 206 LOE, the pour opening has an area that is generally about 0.5 square inches (e.g., between approximately 0.57 - 0.59 square inches). Typically, rupturing the score of a LOE may require a greater amount of force to be imparted to the pour panel via the leverage tab than, for example, a conventional size pour panel (e.g., a pour panel providing a pour opening that is less than 0.5 square inches in area). For example, the relative size of a pour panel also affects the rupture performance of a pour panel because a panel of larger area tends to bend more and, thus, distributes the opening force applied by the tab more than a smaller score panel of the same metal gauge. Moreover, pour panels providing larger pour openings may require rotation of the tab about a rivet (e.g., a vertical axis of the rivet) to apply tab nose forces in a plurality of locations on the pour panel to bend the pour panel into the container as the pour panel separates along the score. Such larger forces may not be achievable with conventional tabs and/or may make it more difficult to open the pour panel. Thus, such larger forces may necessitate a longer or larger size tab. However, through the use of ecology of can ends, manufacturers have sought to save the expense of the metal by down gauging metal of the can ends and/or tabs. Therefore, increasing the size of the tab (e.g., thickness and/or length of the tab) to in-

crease leverage force may increase material costs.

[0011] Alternatively, a smaller score residual may be used to reduce an amount of opening force required to open a large-opening end. The score residual is an amount of material thickness of the score between an outer surface of the pour panel and an inner surface of the pour panel. However, smaller score residuals may limit an application of the can end. For example, beverage containers store pressurized contents (e.g., carbonated liquids) and/or contents that require heat treatment or pasteurization. Decreasing a score residual (e.g., a score residual that is too thin) makes the score residual prone to accidental opening or score failure more likely to occur. For example, a smaller score residual may cause the score of the pour panel to rupture prematurely (e.g., during the pasteurization process, shipping, etc.). Thus, the score of the pour panel should have sufficient score residual to withstand such pressure, temperature changes, heat treatments, etc.

[0012] In turn, however, a larger score residual requires that the tab have a sufficient thickness of metal to provide sufficient opening force to rupture the score of the pour panel. Thus, for example, a larger score residual may require increasing material gauge, thereby increasing material costs. Thus, a score line depth that is too deep can subject the can ends to rupture during production, packaging and/or shipping operations. On the other hand, if the score depth is too shallow, excessive force may be required to rupture the score. In such a situation, even if the user is physically able to apply sufficient force to rupture the score line, the tab may deform (e.g., the tab may buckle) in a manner to prevent complete rupture of the full length of the score. For example, a larger score residual increases an amount of pop force and/or opening force required by the tab. An increase in pop force and/or opening force typically requires increasing a strength of the tab by increasing dimensional characteristics (e.g., thickness, length, etc.) of the tab, which increases material costs. Thus, pour openings can be limited by the size of a tab if a tab cannot generate sufficient lift travel and/or lift force to propagate or sever a score of the pour panel to (e.g., fully) open the pour panel. In other words, even if a pour panel of a can end can be made larger to increase a pour area of a pour opening of a can end, a size of the pour panel may be limited by the tab.

[0013] There is continual pressure to reduce the size of can ends. For example, 206 size can ends are conventionally used for all beverage cans and these size ends are still used on many of the beer cans in Europe. Thus, preferably, can ends are produced with smaller diameter ends to provide cost savings through lightweighting when possible. Thus, increasing a size (e.g., a diameter) of the can end to achieve a larger pour rate and/or pour opening area may not be an option because it may require increasing a size (e.g., a diameter, for example, from a 206 size can end to a 209 size can end) of a container end, thereby increasing manufacturing

costs and opposing a market trend of producing smaller diameter can ends.

[0014] Example can ends disclosed herein provide a 206 size can end with a pour opening having a pour area of approximately between 0.65 square inches and 0.70 square inches. Specifically, a pour area of an example pour opening disclosed herein can be approximately 0.652 square inches (in²), 0.6607 square inches (in²) (e.g. plus or minus 5%). Thus, example can ends disclosed herein have a pour panel or pour opening that is greater than a pour panel or pour opening of known 206 size can ends. For example, some example pour panels disclosed herein can have an aspect ratio (e.g., a length-to-width ratio) of approximately between 1.42 and 1.44 (e.g., 1.43) and a pour opening area greater than 0.6 square inches (e.g., approximately between 0.65 and 0.66 square inches (in²)). By comparison, other known 206 sized can ends have pour opening areas of approximately between 0.57 and 0.59 square inches (in²). Additionally, some known 209 size can ends have a pour opening area of approximately between .69 and .70 square inches (in²). As a result, example 206 size can ends disclosed herein can have a pour area that is approximately 95% (e.g., 94.9%) of a pour area (e.g., 0.696 square inches) of a pour opening of a 209 size can end. Thus, examples disclosed herein provide a 206 size can end while providing a substantially similar pour opening area (e.g., 95%) of a pour opening area of a 209 size can end enables use of a smaller diameter can end compared to a 209 size can end.

[0015] Additionally, providing a length-to-width ratio of a pour panel that is greater than 1 or 1.25 increases a force required to open the pour panel. Specifically, when an aspect ratio or length-to-width ratio is greater than 1.25 and a pour opening area is greater than 0.5 square inches (in²), a larger force and/or lift angle is required by the tab to rupture or propagate a score of a pour panel to open (e.g., fully open) the pour panel. As the length-to-width ratio of a pour panel approaches 1.4 or greater and a pour opening area is greater than 0.5 inches (in²), the pour panel has a significantly wider length than the width and extends much wider laterally way from the tab compared to a pour panel having a length-to-width ratio of less than 1.25 (e.g., 1.23 length-to-width ratio) and a pour opening area of 0.57 square inches (in²). Thus, a larger opening force is needed to propagate a frangible score. Example 206 size can ends disclosed herein employ a tab that can be used on 202 size can ends, 204 size can ends, etc. This facilitates manufacturing as similar tooling and/or tabs can be used across various size can ends.

[0016] Thus, example can ends disclosed herein advantageously provide a larger opening than traditional 206 size can ends and/or can provide similar pour opening areas compared to 209 size can ends. As a result, example can ends disclosed herein provide flow rates that are similar (e.g., within 10-11 percent of flow rates achieved with use of 209 size can ends). Some example

can ends disclosed herein provide flow rates that are approximately 25 to 32 percent (e.g., 31.6%, 27.6%, etc.) faster than flow rates of known 206 size can ends.

[0017] Additionally, tabs disclosed herein can withstand or provide larger opening forces and/or pressures without increasing material costs compared to conventional tabs. Additionally, example tabs may be employed with large-opening ends (LOE). Specifically, example tabs disclosed herein may be employed with pour panels of LOEs having a greater range residual scores than residual scores of conventional LOEs. In particular, example container ends disclosed herein employ tabs having improved strength characteristics or properties. To improve strength characteristics, example tabs disclosed herein include one or more cleats to direct or target an opening force and/or pressure to a pour panel of the container end. To this end, a dimensional characteristic (e.g., a thickness and/or length) of (e.g., a nose) of the tab does not require additional thickness or added material compared to a conventional tab that does not employ the cleats. In other words, example tabs disclosed herein may be formed to have a length to accommodate or fit smaller can end sizes (e.g. 202 size can ends) having larger opening ends (LOE) and provide force characteristics to open pour panels configured as LOEs.

[0018] FIG. 1A is an example can end 100 (e.g., a beverage can end) constructed in accordance with the teachings of this disclosure that may implement a container 102. FIG. 1B is a cross-sectional view of the example can end 100 of FIG. 1A taken along line 1B-1B of FIG. 1A. FIG. 1C is an enlarged portion of the cross-sectional view of FIG. 1B. The can end 100 of the illustrated example has a center panel 106 separated from a seaming curl 108 by a circumferential wall 110. The seaming curl 108 of the illustrated example defines an outer perimeter of the can end 100 (e.g., a 206 size can end). The seaming curl 108 of the illustrated example is generally centered about a longitudinal or vertical axis 112 (FIG. 1B). The circumferential wall 110 of the illustrated example extends (e.g., downward) from the seaming curl 108 to a strengthening member 114 (e.g., a bend) that is jointed to (e.g., integral with) the center panel 106. The can end 100 of the illustrated example is joined to the container 102 via the seaming curl 108. The center panel 106 has a surface 118 defining a peripheral edge 119 that extends to the strengthening member 114 of the can end 100. Thus, the surface 118 of the panel 106 defines an area on which other components of the can end 100 can be formed.

[0019] For example, the center panel 106 (e.g., the surface 118) of the illustrated example includes a deboss panel 116. The deboss panel 116 of the illustrated example defines a perimeter having a key-hole shape or profile. The deboss panel 116 of the illustrated example is recessed relative to the surface 118 of the center panel 106. To provide a pour opening, the can end 100 of the illustrated example includes a pour panel 120. The deboss panel 116 of the illustrated example circumscribes

the pour panel 120 and the tab 104. The deboss panel 116 of the illustrated example increases a relative stiffness of the pour panel 120 to improve openability of the pour panel 120. In some examples, a can end implemented with the example tab 104 may not include the deboss panel 116.

[0020] The pour panel 120 of the illustrated example is defined by a frangible score 122, a non-frangible score 610 (e.g., an anti-fracture score), and a non-frangible hinge 124. The pour panel 120 of the illustrated example may be severed from the center panel 106 via the frangible score 122 and displaced at an angular orientation relative to the center panel 106 while the pour panel 120 remains connected to the center panel 106 via the hinge 124. Displacing the pour panel 120 relative to the center panel 106 provides a pour opening of the can end 100.

[0021] To open or displace the pour panel 120 relative to the center panel 106, the can end 100 of the illustrated example includes a tab 104. The tab 104 is positioned in the deboss panel 116. The tab 104 of the illustrated example is pivotally and/or rotatably coupled to the center panel 106 via a rivet 126 (e.g., rotates about a longitudinal axis of the rivet). The tab 104 of the illustrated example at least partially extends over the pour panel 120. The can end 100 of the illustrated example includes an access recess 201 (e.g., a finger access) to facilitate lifting the tab 104 away from the center panel 106 when opening the pour panel 120.

[0022] To enhance openability of the pour panel 120, the tab 104 of the illustrated example includes one or more cleats 128. As discussed in greater detail below, the cleats 128 of the illustrated example increase a pushing pressure and/or force to the pour panel 120, thereby allowing score depth latitude and/or allowing manufacturing of the tab 104 using a thinner material (e.g., a lower gauge aluminum). For example, the cleats 128 increase a contact area on the pour panel to increase a pressure on the teal panel. Additionally or alternatively, the cleats 128 increase strength of the tab 104 (e.g., provide added stiffness) that enables a user to apply a greater force to the pour panel 120 (e.g., allows a user to pull harder) without causing the tab 104 to deform and/or buckle. In some examples, the cleats 128 of the illustrated example increase the overall longitudinal length of the tab 104, thereby increasing a leverage force of the tab 104 against the pour panel when the tab 104 is lifted. Additionally or alternatively, the cleats 128 of the illustrated example reduce the likelihood of the tab 104 slipping or sliding (e.g., backwards) relative to pour panel 120 in a direction toward the rivet 126, thereby reducing tuck under opening failures. As described in greater detail below, the cleats 128 enable use of a tab from a 202 sized can end to be used on a 206 size can end having a larger sized pour panel 120 as disclosed herein.

[0023] In this manner, a frangible residual 51 (e.g., a score residual) and/or a non-frangible residual 53 (e.g., an anti-fracture residual) may be greater than score and/or anti-fracture residuals of conventional can ends

(e.g., 202 can ends, 206 can ends, etc.). The frangible residual 51 is a material thickness of the pour panel 120 resulting from the frangible score 122 that is between an inner surface 132 (e.g., a product side) of the pour panel 120 and an outer surface 134 (e.g., a public side) of the pour panel 120. Likewise, the non-frangible residual 53 is a material thickness of the pour panel 120 resulting from the non-frangible score 610 that is between the inner surface 132 and the outer surface 134. For example, the frangible residual 51 is defined by a depth of the frangible score 122 measured from the outer surface 134 and the non-frangible residual 53 is defined by a depth of the non-frangible score 610 measured from the outer surface 134. In the illustrated example, the frangible residual 51 can have a thickness of between approximately 0.003 inches and 0.004 inches and the non-frangible residual 53 can have a thickness of between approximately 0.005 inches and 0.006 inches. In the illustrated example, a delta 55 between the frangible residual 51 and the non-frangible residual 53 can be between approximately 0.002 inches and 0.003 inches. However, in other examples, the frangible score 122 and/or the non-frangible score 610 can have any other depth and/or the delta 55 can be any other value.

[0024] FIG. 2A is a top view of the example can end 100 of FIG. 1A. FIG. 2B is a bottom view of the example can end 100 of FIG. 2A. The pour panel 120 of the illustrated example is defined by the frangible score 122 that surrounds the pour panel 120. The frangible score 122 of the illustrated example has a generally curvilinear profile extending between a first end 602 and a second end 604. A portion 606 of the deboss panel 116 positioned between the first end 602 and the second end 604 of the frangible score 122 forms the non-frangible hinge 124. The frangible score 122 of the illustrated example ruptures from the first end 602 and propagates along the frangible score 122 to the second end 604 in a clockwise direction 608 in the orientation of FIG. 2C.

[0025] The non-frangible score 610 (e.g., the anti-fracture score) is provided adjacent, but spaced relative to, the frangible score 122. In the illustrated example, the non-frangible score 610 and the frangible score 122 have substantially the same or identical profiles. The non-frangible score 610 does not separate from the center panel 106 to provide a pour opening. On the contrary, the non-frangible score 610 is provided to restrict can end material flow during a scoring operation when forming the frangible score 122. To open the pour panel 120, the pour panel 120 is severed from the center panel 106 along the frangible score 122 rather than the non-frangible score 610, which is not severed.

[0026] The pour panel 120 of the illustrated example includes a first segment 612a at least partially positioned under a nose 204 of the tab 106. The first segment 612a of the illustrated example defines a vent region 614. The vent region 614 is a portion of the frangible score 122 that initially fractures during opening of the pour panel 120 to vent pressure from the container 102 prior to dis-

placing the pour panel 120 relative to the center panel 106. The frangible score 122 of the illustrated example further includes a curvilinear second segment 612b extending from the first segment 612a toward an outer peripheral edge 616 of the pour panel 120. The second segment 612b of the illustrated example is between a 3:00 to 4:00 clock position in the orientation of FIG. 2A (e.g., with the rivet 126 and the nose 204 being in the 12:00 o'clock position and a point at an outermost portion of the pour panel 120 intersecting the center axis 218 at the 6:00 o'clock position). The second segment 612b of the illustrated example leads to a curvilinear third segment 612c within a transition region 618. The transition region 618 of the illustrated example is approximately between a 5:00 to 7:00 o'clock position. A fourth segment 612d continues from the third segment 612c through the remainder of the frangible score 122 and terminates adjacent the hinge 124. During opening, the pour panel 120 initially ruptures (e.g., the frangible score 122 is severed) in the vent region 614 of the frangible score 122 of the pour panel 120. After the frangible score 122 is severed in the vent region 614, the sever in the frangible score 122 propagates in sequence through the second segment 612b, the third segment 612c, and the fourth segment 612d, in the clockwise direction 618.

[0027] FIG. 3A is a top view of the can end 100 of FIG. 2A. FIG. 3B is a schematic illustration of the panel 106 and a panel opening 10 when the pour panel 120 is in an open position and/or removed. Referring to FIGS. 3A and 3B, the can end 100 is a 206 size can end. For example, the 206 size can end has an outermost diameter of approximately 6.0 centimeters (cm) (e.g., 6.03 cm). Thus, the surface 118 has a diameter 15 that provides an area 11 that enables placement of the deboss 116, the pour panel 120, and the tab 104. For example, the diameter 15 of the center panel 106 of a 206 size can end is approximately between 1.88 inches and 1.92 inches (e.g., between 1.90 inches to 1.91 inches, e.g., 1.90 inches, e.g., 1.91 inches). Thus, the surface 118 of the center panel 106 of the illustrated example has an area of approximately between 2.80 and 2.85 square inches (in²) (e.g., 2.84 square inches (in²), 2.841 square inches (in²)).

[0028] The frangible score 122 of the illustrated example has a score length 12 (e.g., a first length, a pour opening length, a pour panel length, a major axis) and a score width 14 (e.g., a first width, a pour opening width, a pour panel width, a minor axis). In the illustrated example, the score length 12 is greater than one inch. Specifically, the score length 12 is approximately between 1.0 inches and 1.1 inches (e.g., 1.053 inches). The score width 14 is approximately between 0.71 inches and 0.74 inches (e.g., 0.735 inches). In the illustrated example, the pour panel 120 and/or the pour panel opening 10 provides a length-to-width ratio of approximately between 1.40 and 1.45 (e.g., 1.43). The panel opening 10 provides a pour opening area 13 (e.g., a pour panel area) of approximately 0.64 and 0.67 square inches (e.g., 0.652 square inches).

In other words, a score-to-panel area ratio is approximately between 0.22 and 0.25 (e.g., 0.229).

[0029] The hinge 124 of the illustrated example enables the pour panel 120 to depend or hang from the center panel 106 when the pour panel 120 is in an open position. The hinge 124 of the pour panel 120 of the illustrated example has a length 16 of approximately between 0.2 and 0.3 inches (e.g., 0.23 inches). However, in some examples, the length 16 can be between 0.3 inches and 0.34 inches, and/or any other suitable length. The larger the length, a larger lift angle and/or force is needed to fully propagate the frangible score 122 between the first end 602 and the second end 604. Thus, reducing the length 16 of the hinge 124 can improve openability of the pour panel 120 by enabling a smaller lift force and/or a smaller length tab.

[0030] The down panel 134 of the pour panel 120 of the illustrated example has a down panel length 18 (e.g., a major axis) and a down panel width 20 (e.g., a minor axis). In the illustrated example, the down panel length 18 is approximately between 0.55 inches and 0.70 inches (e.g., 0.56 inches) and a down panel width 20 of approximately between 0.20 inch and 0.35 inches (e.g., 0.235 inches).

[0031] The deboss panel 116 of the illustrated example has a key-hole shape or profile 23. Specifically, the deboss panel 116 of the illustrated example has a first width 25 and a second width 27 different than the first width 25. The first width 25 of the deboss panel 116 accommodates the tab 104 and the second width 27 of the deboss panel accommodates the pour panel 120. The pour panel 120 has a larger width than the tab 104. Thus, the second width 27 is larger than the first width 25. An end of the deboss panel 116 opposite the access recess 201 (e.g., a finger access in the deboss panel 116) is spaced from the peripheral edge 119 of the center panel 119 by a panel clearance 30. Specifically, the panel clearance 30 provides a clearance distance between the center panel 106 (e.g., the peripheral edge 119) and the deboss panel 116. The panel clearance 30 of the illustrated example is approximately between 0.04 and 0.05 inches (e.g., 0.048 inches). In some examples, the panel clearance 30 is less than 0.05 inches (e.g., 0.04 inches). In this manner, the pour panel 120 can be made larger on a 206 size can end to provide a larger pour opening area and, thus, a larger flow rate of contents through the pour opening 10.

[0032] FIG. 4A is a top view of the tab 104 of FIG. 1. FIG. 4B is a bottom view of the tab 104 of FIG. 4A. Referring to FIGS. 4A and 4B, the tab 104 of the illustrated example includes a lift end 202 and a nose 204. The tab 104 of the illustrated example includes a central webbing 206 located between the lift end 202 and the nose 204. The central webbing 206 of the illustrated example includes a rivet island 208 (e.g., a hinge region) that includes an opening to receive the rivet 126 (FIG. 1A and 1B). The central webbing 206 of the illustrated example includes an opening or void region 210 that provides an

exposed area of the center panel 106 when the tab 104 is coupled to the can end 100. The void region 210 of the illustrated example has a curvilinear geometry that borders the rivet island 208 and at least partially surrounds the rivet 126 such that the void region 210 of the illustrated example defines a first leg 212 and a second leg 214 different than the first leg 212. The second leg 214 of the illustrated example is positioned on a first side 216 of a longitudinal axis or center axis 218 (e.g., a diametrical line) of the tab 104 and the first leg 212 is positioned on a second side 220 of the center axis 218 opposite the first side 216.

[0033] The rivet 126 of the illustrated example enables the lift end 202 to rotate and/or pivot relative to the center panel 106. The rivet island 208 of the illustrated example bends adjacent the rivet 126 across a hinge line 222. In other words, the hinge line 222 provides a fulcrum about which the lift end 202 of the tab 104 pivots relative to the pour panel 120 when the lift end 202 of the tab 104 is lifted away from the center panel 106. The hinge line 222 of the illustrated example is defined by a substantially straight line passing between a terminal end 224 of the first leg 212 and a terminal end 226 of the second leg 214.

[0034] The hinge line 222 of the illustrated example intersects the center axis 218 at a non-perpendicular angle (e.g., an oblique angle). Thus, the hinge line 222 of the illustrated example is oriented at the angle (e.g., an oblique angle) that is neither parallel nor perpendicular to the center axis 218. To provide the hinge line 222 at an angle relative to the center axis 218, the first leg 212 of the void region 210 of the illustrated example has a length that is greater than a length of the second leg 214. For example, the terminal end 224 of the first leg 212 of the illustrated example is positioned closer to the nose 204 and the pour panel 120 (FIG. 1A) than the terminal end 226 of the second leg 214.

[0035] The hinge line 222 of the illustrated example is at an angle 228 (e.g., a hinge line angle) relative to a reference line 230 (e.g., relative to normal, relative to a horizontal reference line in the orientation of FIG. 4A that is perpendicular to the center axis 218). For example, the angle 228 of the hinge line 222 relative to the reference line 230 is approximately between 4 degrees and 12 degrees. In some examples, the angle 228 of the hinge line 222 relative to the reference line 230 is approximately between 8 degrees and 8.5 degrees. In some examples, the angle 228 of the hinge line 222 relative to the reference line 230 is approximately 8 degrees or 8.5 degrees. When the lift end 202 is lifted, a rotational path of the tab 104 and a downward path of the nose 204 is at an oblique angle relative to the center axis 218 due to the angle 228 of the hinge line 222, and not in alignment with or parallel relative to the center axis 218.

[0036] To strengthen the tab 104 and/or hide any sharp edges, the tab 104 of the illustrated example has a curled portion 232 (e.g., having a radius of curvature) about its perimeter. The curled portion 232 is generally about an entire perimeter of the tab 104 with slit portions 234 to

accommodate rounded contours of the tab 104 and avoid wrinkling of metal of the tab 104. The curled portion 232 of the illustrated example is at least formed from the terminal end 224 of the first leg 212 to the terminal end 226 of the second leg 214 through the nose 204. The curled portion 232 is formed by rolling downwardly metal from the tab 104.

[0037] To enhance openability of the can end 100, the tab 104 of the illustrated example includes the cleats 128. In particular, the tab 104 of the illustrated example includes a first cleat 236 and a second cleat 238. The first cleat 236 of the illustrated example is spaced or separated from the second cleat 238. More specifically, a wall or bridge 240 is positioned between the first cleat 236 and the second cleat 238 (e.g., separates the first cleat 236 and the second cleat 238).

[0038] The first cleat 236 and the second cleat 238 of the illustrated example are offset relative to the center axis 218. The first cleat 236 of the illustrated example is positioned on the first side 216 of the center axis 218 and the second cleat 238 of the illustrated example is positioned on the second side 220 of the center axis 218. Specifically, the first cleat 236 and the second cleat 238 are positioned at angles relative to the center axis 218. For example, a longitudinal axis 242 of the first cleat 236 is positioned at a first angle 244 relative to the center axis 218 and a longitudinal axis 246 of the second cleat 238 is positioned at a second angle 248 relative to the center axis 218. In some examples, the first angle 244 and the second angle 248 of the illustrated example are the same as the angle 228 of the hinge line 222. In some examples, the first angle 244 and the second angle 248 of the illustrated example may be approximately within 2 degrees greater than or less than the angle 228 of the hinge line 222. In some examples, the first angle 244 and the second angle 248 may be approximately 4 degrees greater than or less than the angle 228 of the hinge line 222. In some examples, the first angle 244 and the second angle 248 may be approximately within 0.5 degrees of the angle 228 of the hinge line 222. In some examples, the first angle 244 and the second angle 248 of the illustrated example may be different than the angle 228 of the hinge line 222. In some examples, the first angle 244 of the illustrated example may be different than the second angle 248 and/or the angle 228 of the hinge line 222. In some examples, the tab 104 of the illustrated example may only include the first cleat 236 or the second cleat 238.

[0039] Additionally, formation of the first and second cleats 236 and 238 forces the curled portion 232 outwardly from the nose 204 in a direction relative to the longitudinal axes 242 and 246, respectively, to effectively lengthen the tab 104 in a direction along the center axis 218. In other words, the first cleat 236 increases a length L of the tab 104 along the center axis 218 from a center of the rivet 126 to the nose 204 of the tab 104 defined by an outermost edge of the first cleat 236. The second cleat 238 increases a length L' of the tab 104 along the center

axis 218 from the center of the rivet 126 to the nose 204 of the tab 104 defined by an outermost edge of the second cleat 238. In the illustrated example, the length L is the same as the length L'. However, in some examples, the length L may be different than the length L'. In other words, a longitudinal length of the tab 104 between the rivet 126 and an outermost edge of the first cleat 236 may be longer than a longitudinal length of the tab 104 between the rivet 126 and an outermost edge of the nose 204 aligned or passing through the center axis 218. The increase in length along the center axis 218 and/or along the first cleat 236 and/or the second cleat 238 increases the amount of force to be provided by the tab 104 when the tab 104 is lifted without having to increase material gauge of the tab 104 and/or form a tab having a longer length, which would require additional material and increase material costs.

[0040] FIG. 5 is a cross-sectional view of the nose 204 of the tab 104 taken along line 3-3 of FIG. 4A. The first cleat 236 of the illustrated example has a first wall 302 and a second wall 304 separated by a bottom area 306 (e.g., a V-shaped profile). The bottom area 306 of the illustrated example is a curved segment with a radius of curvature, rather than a sharp point having a substantially smaller radius of curvature. The first wall 302 and the second wall 304 may form an angle 308 of approximately between 5 degrees and 70 degrees.

[0041] The second cleat 238 of the illustrated example is substantially similar to the first cleat 236. For example, the second cleat 236 of the illustrated example has a first wall 310 and a second wall 312 separated by a bottom area 314 (e.g., a V-shaped profile). The bottom area 314 of the illustrated example is a curved segment with a radius of curvature, rather than a sharp point having a substantially smaller radius of curvature. The first wall 310 and the second wall 312 may form an angle 316 of approximately between 5 degrees and 70 degrees.

[0042] The first and second cleats 236 and 238 of the illustrated example are formed by striking (e.g., stamping) an upper surface 318 of the tab 104. This compresses the curled portion 232 at the upper surface 318 and forces a bottom surface 320 of the tab 104 downwardly. Thus, each of the first cleat 236 and the second cleat 238 of the illustrated example has an upper surface 322 exhibiting a V-shaped crevice and a lower surface 324 extending downwardly towards the outer surface 134 of the pour panel 120. The lower surface 324 of the respective first and second cleats 236 and 238 differs structurally from the upper surface 322. The lower surface 324 forms a bow-shaped surface transverse to the center axis 218 rather than the V-shape exhibited by the upper surface. This structural characteristic also reduces an angle or distance between the lower surface 324 of the tab 104 and the outer surface 134 of the pour panel 120, providing a shorter path to contact between the tab 104 and the pour panel 120 during opening and reducing some rocking of the tab 104 on the rivet 126.

[0043] FIG. 6A is a partial, cross-sectional view of the

can end 100 taken along line 4-4 of FIG. 4A. Referring to FIG. 6A, a bottom surface 402 of the bridge 240 is spaced from the outer surface 134 of the pour panel 120 at a distance 404 (e.g., between 2 and 3 millimeters). The bottom surface 402 of the illustrated example is substantially planar or flat. In other words, the bottom surface 402 is substantially parallel relative to the outer surface 134 of the pour panel 120. In this manner, the bottom surface 402 of the tab 104 of the illustrated example is substantially planar or flat to restrict (e.g., prevent) the tab 104 from sliding (e.g., backwards) relative to the outer surface 134 of the pour panel 120 and towards the rivet 126 (e.g., prevents tab tuck under).

[0044] FIG. 6B is a cross-sectional view of the can end 100 taken along line 5-5 of FIG. 4A. Referring to FIG. 6B, a bottom surface 502 of the lower surface 324 of the first cleat 236 is spaced from the outer surface 134 of the pour panel 120 by a distance 504 (e.g., between 0.5 and 2 millimeters), which is significantly less than the distance 404 of FIG. 6A. Thus, the distance 504 between the bottom surface 502 of the tab 104 and the outer surface 134 of the pour panel 120 is reduced by the first cleat 236. In this manner, the first cleat 236 engages the pour panel 120 prior to adjacent portions of the nose 204 when the lift end 202 of the tab 104 is raised or lifted in a direction away from the center panel 106. This structural characteristic also results in less tab pull travel to achieve contact between the tab 104 and the pour panel 120 during opening to provide a reduced pop angle (e.g., FIGS. 8A and 8B) and/or reducing some rocking of the tab 104 on the rivet 126. Additionally, although not shown, a distance between a bottom surface of the second cleat 238 and the outer surface 134 is the same as the distance 504. Additionally, the bottom surface 502 of the first cleat 236 is substantially flat or planar to provide an increased frictional force to restrict (e.g., prevent) the tab 104 from sliding (e.g., backwards) relative to the outer surface 134 of the pour panel 120 and towards the rivet 126 (e.g., prevents tab tuck under) when the lift end 202 is lifted away from the center panel 106.

[0045] FIG. 7 illustrates the pour panel 120 in a partially open position 700 relative to the center panel 106. To open the pour opening, the tab 104 is lifted away from the center panel 106. When the lift end 202 of the tab 104 is lifted away from the center panel 106, the tab 104 pivots about the hinge line 222. The initial rupture of the frangible score 122 is primarily caused by a lifting force imparted to the tab 104 (e.g., via a finger of a person) resulting in lifting of a central region of the center panel 106 immediately adjacent the rivet 126 that causes separation of the residual metal of the frangible score 122. The force required to rupture the frangible score 122 in the vent region 614, typically referred to as the "pop" force, is less than a force required to propagate or sever the other segments 612b-d of the frangible score 122. Therefore, it is preferable that the center panel 106 in an area around the rivet 126 only lifts enough to assist with initial score rupture, or "pop," of the vent region 614 and

remains substantially stiff and flat to provide the needed leverage for the tab 104 to propagate the tear through the remaining segments 612b-d of the frangible score 122. To continue the rupturing the frangible score 122 after the initial "pop" or venting of the pour panel 120, a push or opening force (e.g., a tear force) is provided by lifting the lift end 202 of the tab 104 away from the center panel 106 and about the hinge line 222 to cause the nose 204 to push downwardly against the pour panel 120.

[0046] As the tab 104 is lifted, due to the angle of the hinge line 222 relative to the center axis 218 of the tab 104, a rotational path of the tab 104 and the nose 204 is likewise at an angle relative to the hinge line 222. In this manner, the tab 104 pivots at an angle relative to the center axis 218 of the tab 104 and causes the nose 204 and the first cleat 236 to impart an opening force directed to the first side 216 of the center axis 218 of the tab 104. In this manner, the pour panel 120 begins to rupture at the first end 602 and the frangible score 122 continues to propagate as the lift end 202 of the tab 104 is rotated away from the center panel 106. As the opening operation is continued, the pour panel 120 is displaced downward and is rotated about the hinge 124 to be deflected into the container 102 (FIG. 1A).

[0047] The opening force required to rupture the frangible score 122 is greater than the pop force required to rupture the vent region 614 of the pour panel 120. Specifically, the frangible score 122 in certain regions or areas of the large-open pour panel such as, for example, the pour panel 120 may be more difficult to open by the tab 104 leveraging against the pour panel 120. For example, certain regions of the frangible score 122 may require a greater amount of force to rupture or sever than other regions of the frangible score 122. For example, the second segment 612b (e.g., a 3:00 o'clock position) and/or the transition region 618 of a large-open pour panel may require the greatest amount of force to sever the frangible score 122. In some examples, a peak opening force may be required to sever the pour panel 120 at the 3 o'clock position (e.g., the second segment 612b). In some examples, the transition region 618 of the frangible score 122 may exhibit a relatively large resistance to the opening force when the lift end 202 is lifted, at least partly due to the curvilinear geometry of the frangible score 122, the large-open pour panel being substantially wider than the tab 104, and/or the nose 204 being at a greatest distance from the transition region 618. In some examples, although a peak opening force may not be required to sever the fourth segment 612d, a significant opening force may be required to sever the fourth segment 612d due to the width and/or size of the pour panel 120 (e.g., a width in the horizontal direction, a distance between the 3 o'clock position and the 9 o'clock position) and the relatively narrow or smaller width of the tab 104.

[0048] Additionally, larger opening forces required to open large-open pour panels such as, for example, the pour panel 120 and/or larger score residuals, may increase a possibility of opening failure that results in "tuck

under" of the tab 104. This type of opening failure occurs when the nose 204 of the tab 104 slips relative to the pour panel 120 in a direction toward the rivet 126 when the lift end 202 of the tab 104 is pivoted away from the center panel 106. Simply increasing a length of the tab 104 will significantly increase manufacturing costs due to increased material(s) needed to manufacture a longer tab 104 and/or may not fit certain size can ends (e.g., the 206 size can end). Further, making the nose 204 a flat or blunt surface (e.g., smash nose) (e.g., making a wide cleat that encompasses the first and second cleats 236 and 238 in width in the orientation of FIG. 6A) may cause the nose 204 to weaken or lose strength, thereby requiring the nose 204 to have a thicker dimensional profile provided by additional material, thereby increasing manufacturing costs. In some instances, a tab may not have enough material (e.g., material gauge) to support a smash configuration.

[0049] The first and second cleats 236 and 238 of the illustrated example provide increased opening forces to open the pour panel 120. Such increased opening forces provided by the first and second cleats 236 and 238 enable the tab 104 to have a smaller dimensional profile or footprint (e.g., a tab with less material) than conventional tabs. Specifically, the increased opening forces provided by the first and second cleats 236 and 238 of the illustrated example reduce the likelihood of opening failure when employed with frangible scores having larger score residuals. Also, as the industry continually seeks to downgauge the metal of the tab 104 (e.g., use thinner gauge material to reduce costs), increased efficiency in opening by the tab 104 permits the use of a tab made of thinner and/or less material.

[0050] The first cleat 236 of the illustrated example is offset relative to the center axis 218 to engage the first side 216 of the pour panel 120 adjacent the first segment 612a and the second segment 612b of the frangible score 122. In this manner, due to the fulcrum provided by the hinge line 222 and the offset position of the first cleat 236, the first cleat 236 of the illustrated example directs an opening force toward the first side 216 of the center axis 218 of the tab 104. In other words, the offset of the first cleat 236 and the distance 504 ensures that the first cleat 236 imparts an initial opening force to the pour panel 120. More specifically, the first cleat 236 engages the pour panel 120 at an angle provided by the hinge line 222 and directs an opening force offset relative to the center axis 218 by the first angle 244 in a direction toward the second segment 612b and the third segment 612c of the pour panel 120 when the tab 104 is lifted and pivoted about the hinge line 222. Thus, the first cleat 236 provides or directs an increased opening force (e.g., a peak opening force) toward the second segment 612b and an opening force to the third segment 612c of the frangible score 122. Thus, when the first cleat 236 is engaged with the pour panel 120, the first cleat 236 provides an increased opening force and/or pressure to rupture the frangible score 122 from the first segment 612a (e.g.,

the vent region 614), the second segment 612b and/or the third segment 612c (e.g., through the transition region 618). Additionally, the nose 204 (e.g., the bridge 240) imparts an opening force to the pour panel 120 as the frangible score 122 ruptures through the transition region 618.

[0051] Similarly, the second cleat 238 of the illustrated example is offset to the second side 220 relative to the center axis 218 to direct or concentrate an opening force on the pour panel 120 in a direction towards the second side 220 of the center axis 218. As the first cleat 236 applies or directs an opening force toward the second and third segments 612b-c of the frangible score 122 (e.g., between the 3:00 and 7:00 o'clock positions), the second cleat 238 applies or directs a concentrated high pressure toward the fourth segment 612d of the frangible score 122 (between the 9:00 and 11:00 o'clock positions). After the transition region 618 is ruptured, the second cleat 238 continues to apply an opening force to the pour panel 120 to rupture the frangible score 122 along the fourth segment 612d to the second end 604 of the frangible score 122. In some instances, in addition to directing or concentrating an opening force toward the fourth segment 612d, the second cleat 238 aids the first cleat 236 to rupture the transition region 618 of the frangible score 122.

[0052] Thus, in operation, the first cleat 236 initially contacts or engages (e.g., grabs) the pour panel 120 to rupture the frangible score 122 along the second and third segments 612b-d (the transition region 618) and the second cleat 238 contacts or engages the pour panel 120 to finish rupturing the frangible score 122 along the fourth segment 614d to the second end 604 as the nose 204 rolls over the pour panel 120 to open the pour panel 120. The first and second cleats 236 and 238 provide the increased opening force due to an increase in frictional force between the bottom surfaces 502 of the respective first and second cleats 236 and 238 and the outer surface 134 of the pour panel 120. In some examples, the first and second cleats 236 and 238 grip the outer surface 134 of the pour panel 120 with greater amount of resistance to nose slippage when the lift end 202 is lifted. By preventing or restricting slippage between the nose 204 and the outer surface 134 of the pour panel 120, the first and second cleats 236 and

[0053] 238 can impart a greater amount of opening force to the pour panel 120 (e.g., which can open more difficult or larger residual scores).

[0054] FIG. 8A illustrates a cross-sectional view of the example can end 100 showing the pour panel 120 in a closed position 800 (e.g., a non-ruptured condition).

[0055] FIG. 8B illustrates a cross-sectional view of the example can end 100 showing the pour panel 120 in an open position 802 (e.g., a ruptured condition). To rupture the vent region 614 (e.g., provide a pop force required to sever the region of the frangible score 122 defining the vent region 614), the lift end 202 of the tab 104 is pivoted away from the center panel 106 a rotational dis-

tance defined by a pop angle 804. The tab 104 of the illustrated example, due to the opening force provided by the first and second cleats 236 and 238, enables the pop angle 804 to be less than a pop angle of conventional tabs without the cleats. The pop angle 804 is an angle that the lift end 202 of the tab 104 needs to rotate relative to the center panel 106 to rupture the vent region 614 of the pour panel 120.

[0056] Decreasing the pop angle 804 of the tab 104 provides a greater amount of rotational distance for the tab 104 to apply the opening force before the tab reaches a termination angle 806. The termination angle 806 is an angle at which the opening force (e.g., a leverage force) provided by the tab 104 to the pour panel 120 decrease (e.g., decrease to almost zero pounds). Thus, the termination angle 806 occurs when the pour panel 120 completely opens and no longer provides resistance against the tab 104. At this point, the pour panel 120 should be ruptured along the entire frangible score 122. Thus, if the tab 104 reaches the termination angle 806 and the pour panel 120 is not in the fully open position 802 (e.g., in the partially open position 700 of FIG. 7), the tab 104 may be ineffective to move the pour panel 120 to the fully open position 802. Thus, it is desirable to move the pour panel 120 to the fully open position 802 prior to the tab 104 reaching the termination angle 806. For example, the termination angle 806 of the illustrated example may be approximately between 70 and 80 degrees relative to the center panel 106 (e.g., horizontal). In some instances, if the pour panel 120 is not in the fully open position 802 when the tab 104 reaches the termination angle 806, the nose 204 may flip open and the tab 104 will not move the pour panel 120 to the fully open position 802.

[0057] During opening of the pour panel 120, the first cleat 236 of the illustrated example concentrates or directs the opening force of the tab 104 to the first side 216 of the center axis 218 of the tab when the lift end is rotated, for example, between an initial position (e.g., a zero-degree position, a position shown in FIG. 8A, etc.) and a first angular position 808. The first angular position 808 of the illustrated example may be an angle at which the frangible score 122 ruptures through the transition region 618. The second cleat 238 of the illustrated example concentrates or directs the opening force of the tab 104 to the second side 220 of the center axis 218 of the tab 104 when the lift end 202 is rotated, for example, between the first angular position 808 and a second angular position 810 different than the first angular position 808. The second angular position 810 of the illustrated example may be an angle at which the frangible score 122 ruptures from (e.g., an end of) the transition region 618 to the second end 604 of the frangible score 122 (e.g., the fully open position 802). In some examples, the second angular position 810 is the termination angle 806. In other words, the first cleat 236 of the illustrated example concentrates or directs the opening force to open or rupture the frangible score 122 through the second segment 612b and/or the transition region 618, and the second

cleat 238 of the illustrated example concentrates or directs the opening force to open or rupture the frangible score 122 from the transition region 618 to the second end 604 (e.g., the fourth segment 612d) as the nose 204 (or generally the tab 104) rotates or pivots about the vertical axis 112 of the rivet 126. Such rotation about the vertical axis 112 is due to the hinge line 222 being at the non-perpendicular angle relative to the center line 218.

[0058] Further, as noted above in connection with FIGS. 6A and 6B, the bottom surface 502 of the first cleat 236 (and the lower surface of the second cleat 238) are immediately adjacent the pour panel 120. In this manner, to cause the first and second cleats 236 and 238 and/or the nose 204 to engage the pour panel 120, the lift end 202 of the tab 104 can be pivoted a relatively small angular rotation relative to the center panel 106. As a result, the first and second cleats 236 and 238 do not affect (e.g., increase) an amount of travel of the lift end 202 to achieve the termination angle 806 of the tab 104. For example, rotation of the lift end 202 relative to the center panel 106 between approximately less than one degree and 2 degrees causes the bottom surface 502 of the respective first and second cleats 236 and 238 to engage the outer surface 134 of the pour panel 120.

[0059] FIG. 9A is a perspective view of the example can end 100 of FIGS. 1A and 1B. FIG. 9B is another perspective view of the example can end 100 of FIG. 9A. FIG. 9C is a top view of the example can end 100 of FIG. 9A. FIG. 9D is an enlarged, top view of the example can end 100 of FIG. 9A. FIG. 9E is a bottom view of the example can end 100 of FIG. 9A. FIG. 9F is a side view of the example can end 100 of FIG. 9A.

[0060] Although certain example methods, apparatus and articles of manufacture have been disclosed herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the claims of this patent.

Claims

1. A can end comprising:

a center panel having a diameter of between approximately 1.88 and 1.92 inches;
a pour panel formed on the center panel defined by a score, the score having a score length and a score width, the score length and the score width defining a length-to-width ratio of between approximately 1.40 and 1.45, the pour panel to provide a pour opening for the center panel, the pour opening having a pour area of between approximately 0.64 and 0.67 square inches (in²).

2. The can end of claim 1, wherein the score length is between approximately 1.0 inch and 1.1 inches and the score width is between approximately 0.71 inch-

es and 0.74 inches.

3. The can end of claim 1, wherein a clearance distance between a deboss panel formed on the center panel and a peripheral edge of the center panel is between approximately 0.04 inches and 0.05 inches.

4. The can end of claim 1, wherein the center panel defines a non-frangible hinge between a first end of the score and a second end of the score, the non-frangible hinge having a length of between approximately 0.2 inches and 0.3 inches.

5. The can end of claim 1, wherein the center panel has an area of between approximately 2.80 square inches and 2.85 square inches and the pour opening has an area of between approximately 0.64 square inches and 0.67 square inches.

6. The can end of claim 1, further including: a tab to pivot relative to the center panel to apply an opening force to rupture the score and displace the pour panel relative to the center panel to provide a pour opening, the tab including:

a lift end and a nose spaced from the lift end;
a first cleat formed on the nose, the first cleat being offset relative to a center axis of the tab, the first cleat to concentrate the opening force in a first direction that is non-parallel relative to the center axis when the tab is lifted relative to the center panel of the can end between an initial position and a first angular position; and
a second cleat formed on the nose, the second cleat being offset relative to the center axis of the tab, the second cleat to concentrate the opening force in a second direction that is non-parallel to the center axis when the tab is lifted relative to the center panel between the first angular position and a second angular position greater than the first angular position, the first direction being different than the second direction, wherein the first cleat is to concentrate the opening force to a first side of the center axis when the tab is lifted between the initial position and the first angular position.

7. The can end of claim 6, wherein the first angular position is approximately between 40 degrees and 60 degrees relative to the center panel.

8. The can end of claim 7, wherein the second cleat is to concentrate the opening force to a second side of the center axis when the tab is lifted between the first angular position and the second angular position, the first side being opposite the second side, wherein the second angular position is approximately between 60 degrees and 80 degrees relative to

the center panel.

9. A can end comprising:
 - a center panel, the center panel having a first area; and
 - a pour panel formed on the center panel, the pour panel to define a pour opening having a second area, wherein a first area-to-second area ratio is approximately between 0.22 inches and 0.23 inches.
10. The can end of claim 9, wherein the first area is approximately 2.84 square inches (in²) and the second area is approximately 0.65 square inches (in²).
11. The can end of claim 9, wherein the pour panel has a score length of approximately 1.05 inches and a score width of approximately 0.735 inches.
12. The can end of claim 9, further including a tab to move the pour panel from a sealed condition to a non-sealed condition.
13. The can end of claim 12, wherein the tab includes:
 - a lift end and a nose opposite the lift end, the nose to at least partially extend over a pour panel of the can end;
 - a central webbing interposed between the lift end and the nose, the central webbing defining a hinge line about which the tab is to pivot away from a center panel of the can end when the tab is coupled to the can end; and
 - a first cleat formed on the nose, the first cleat being offset relative to a first side of the center axis of the tab such that a longitudinal axis of the first cleat intersects the center axis at a first angle.
14. The can end of claim 13, wherein the tab includes a first cleat.
15. The can end of claim 14, wherein the first angle of the first cleat is approximately within plus or minus 5 degrees of the pivot angle.
16. The can end of claim 15, further comprising a second cleat formed on the nose.
17. The can end of claim 16, wherein the second cleat is formed on a second side of the center axis opposite the first side.
18. The can end of claim 17, wherein the second cleat is offset relative to the first side of the center axis of the tab such that a second longitudinal axis of the second cleat intersects the center axis at a second

angle.

19. The can end of claim 18, wherein the second angle is substantially equal to the first angle.
20. The can end of claim 18, wherein the second angle is approximately within plus or minus 4 degrees of the pivot angle.

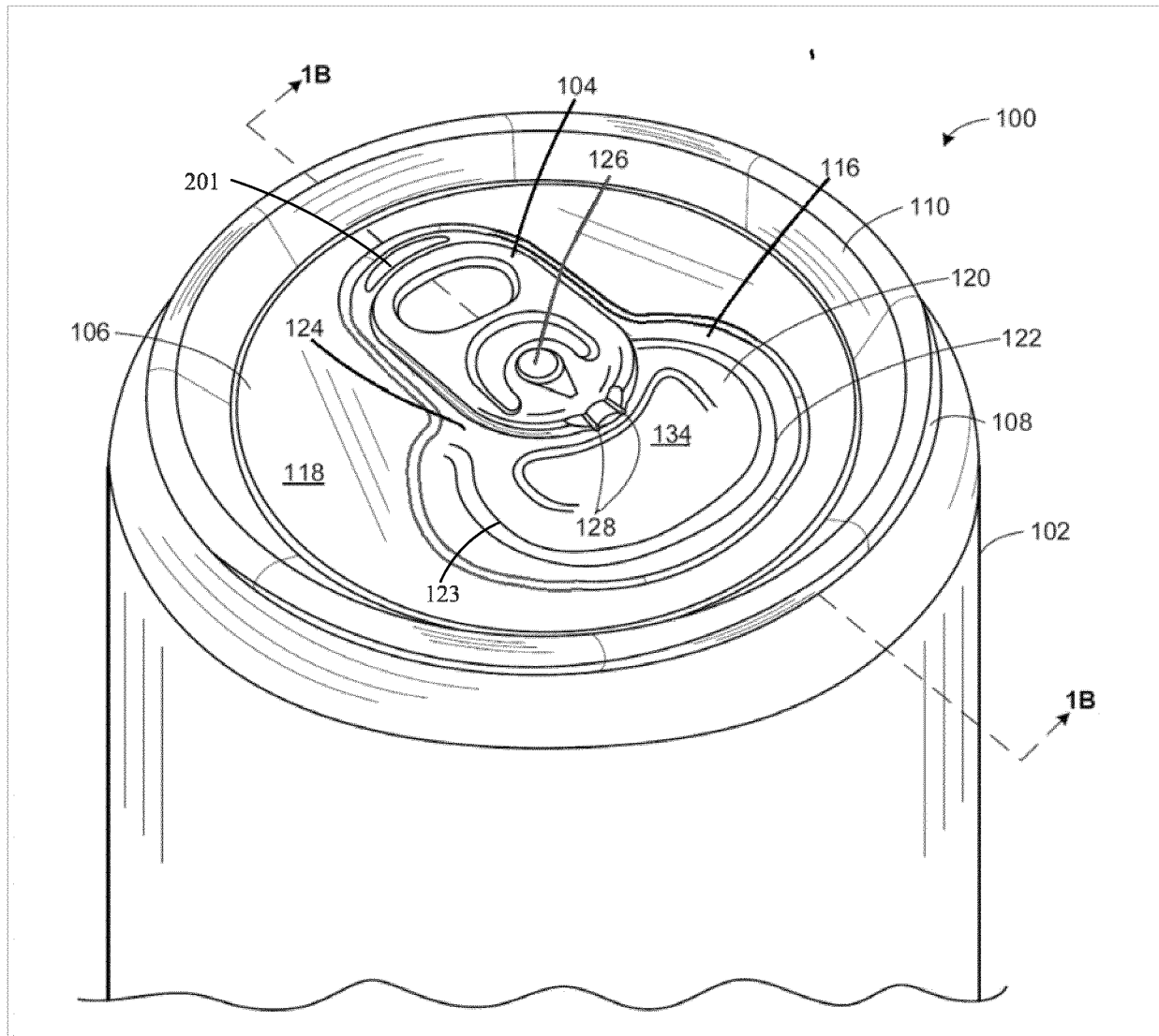
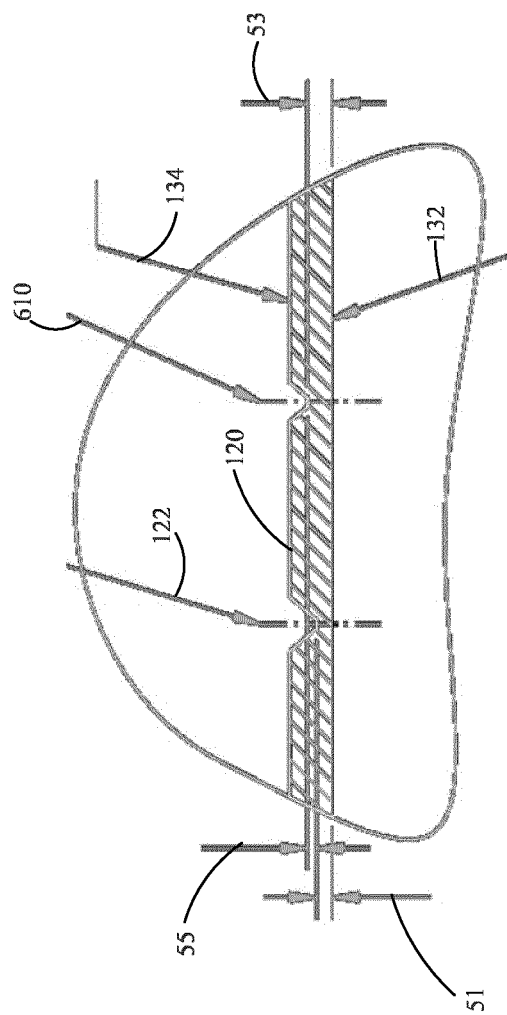
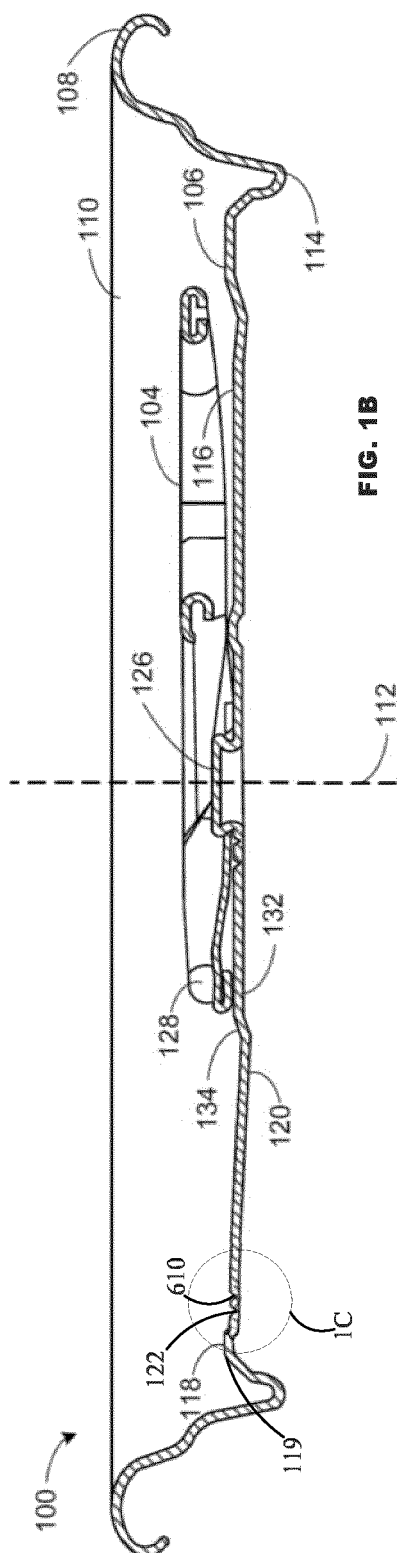


FIG. 1A



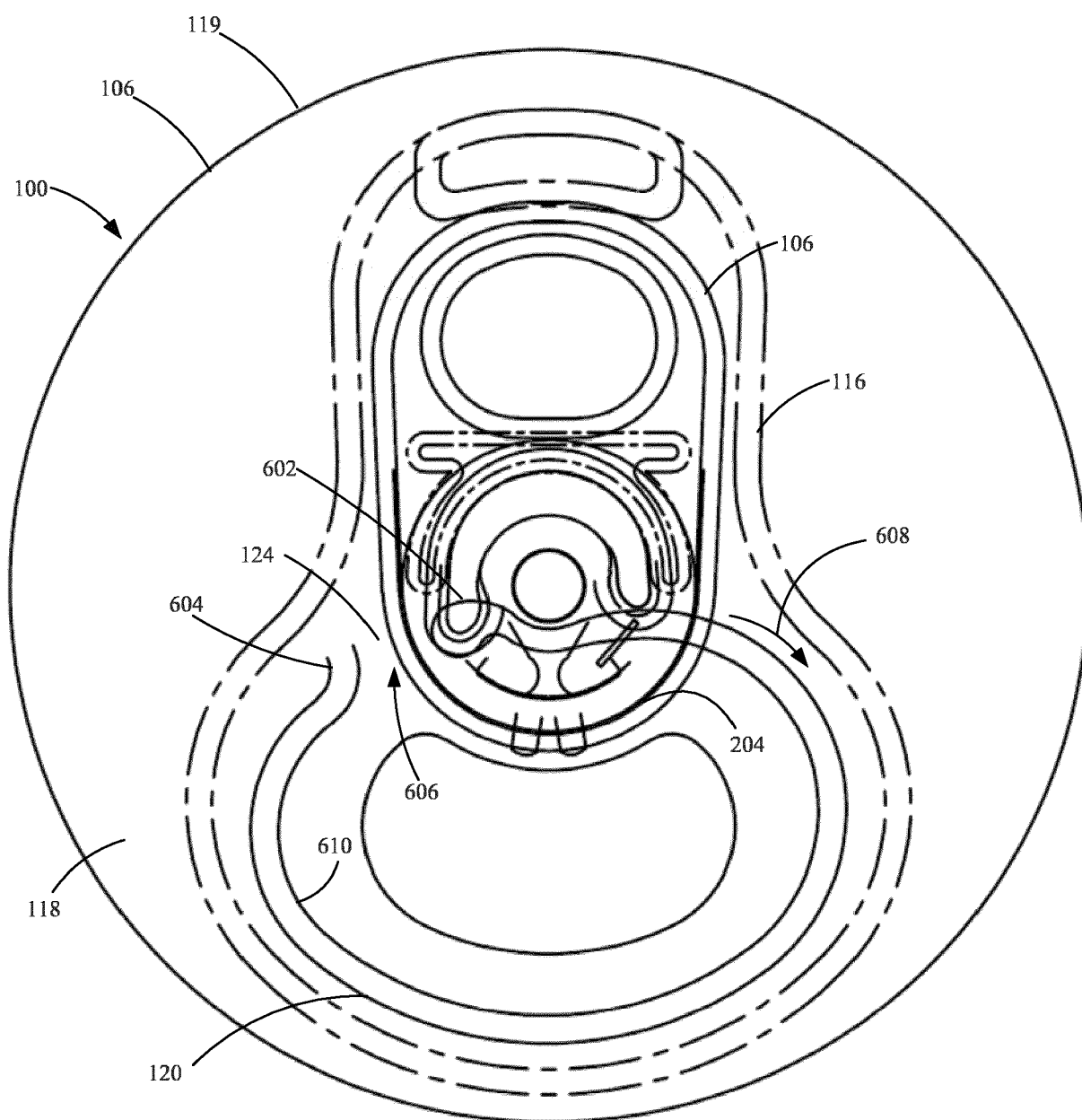


FIG. 2A

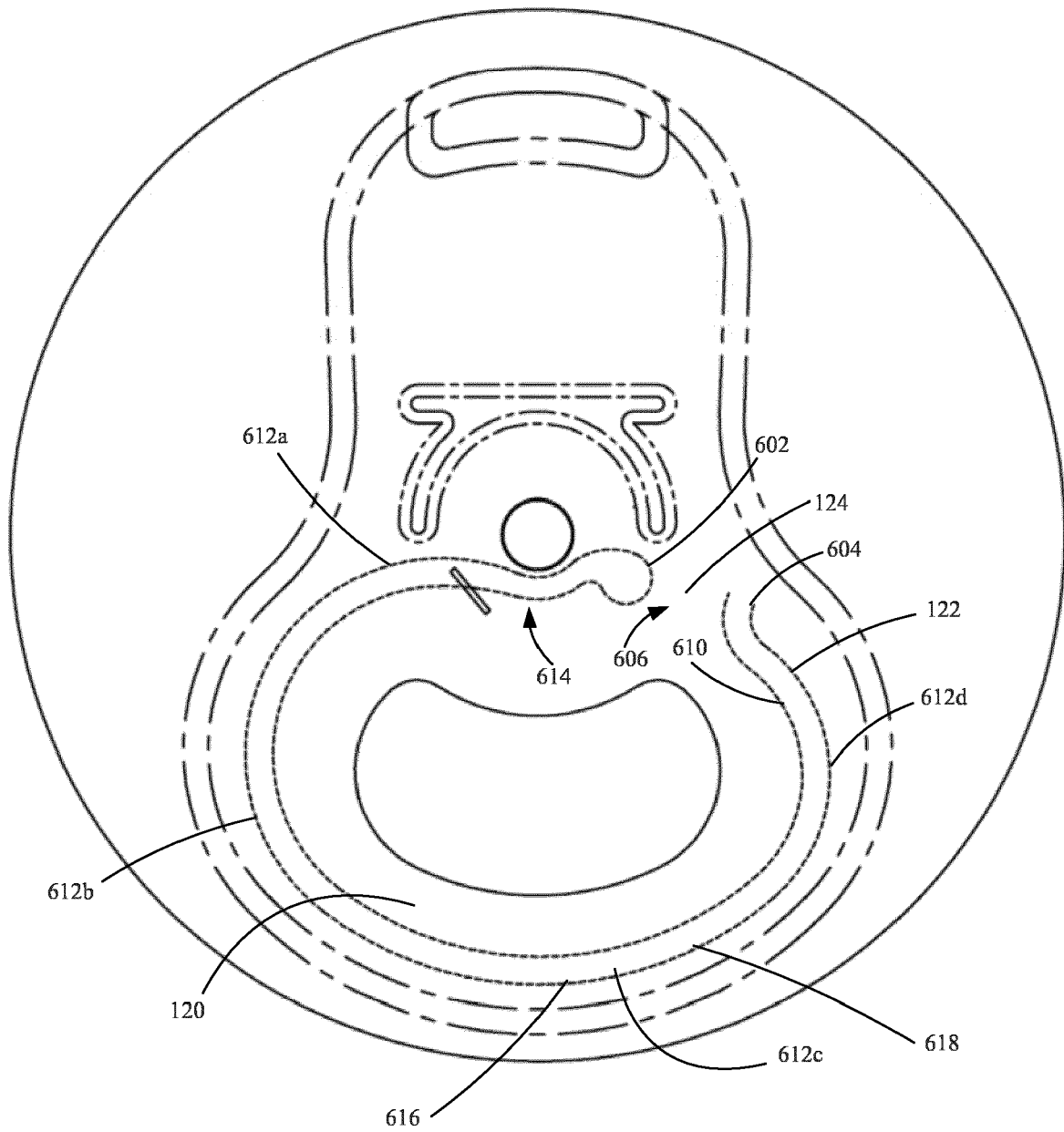


FIG. 2B

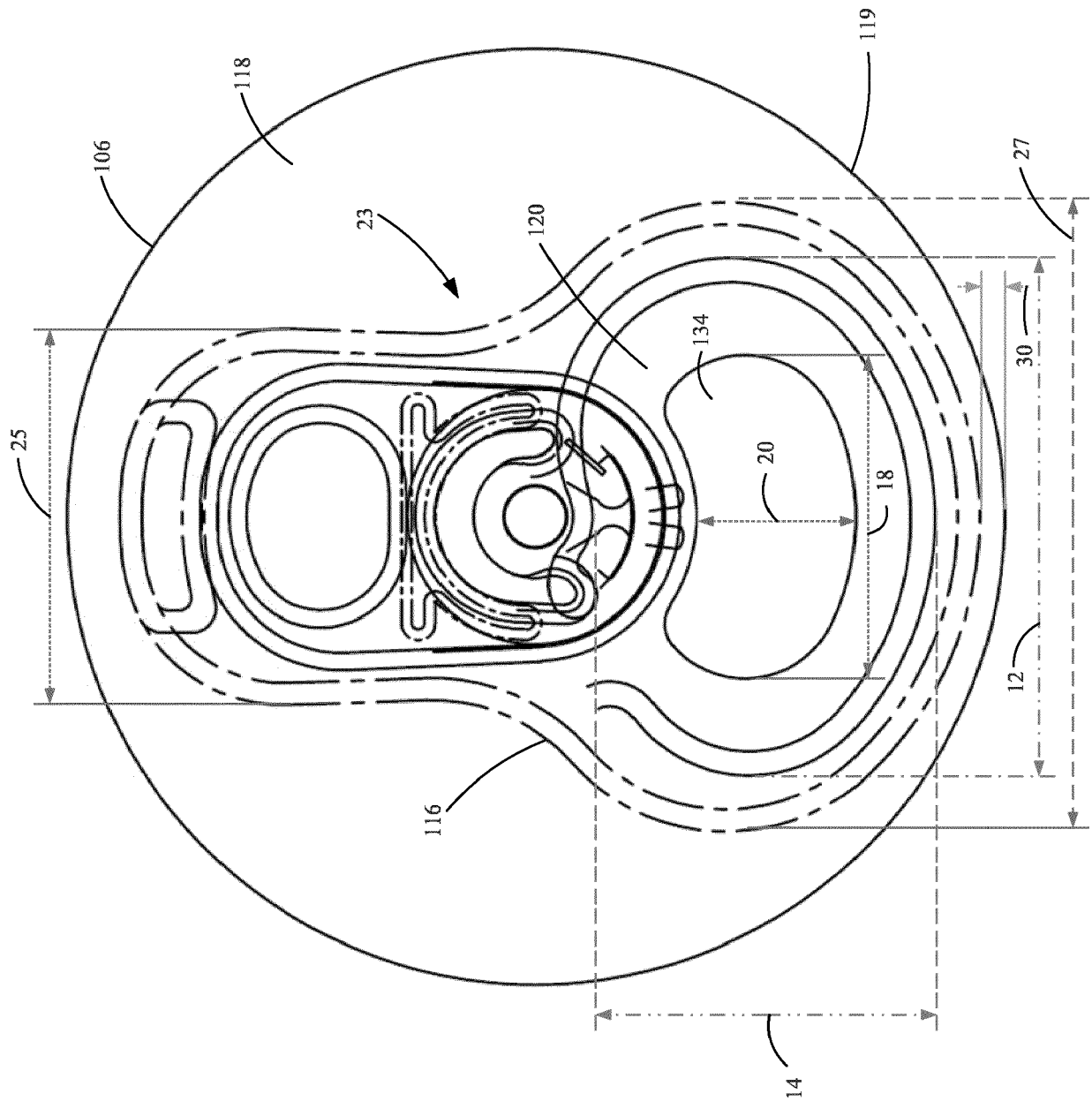


FIG. 3A

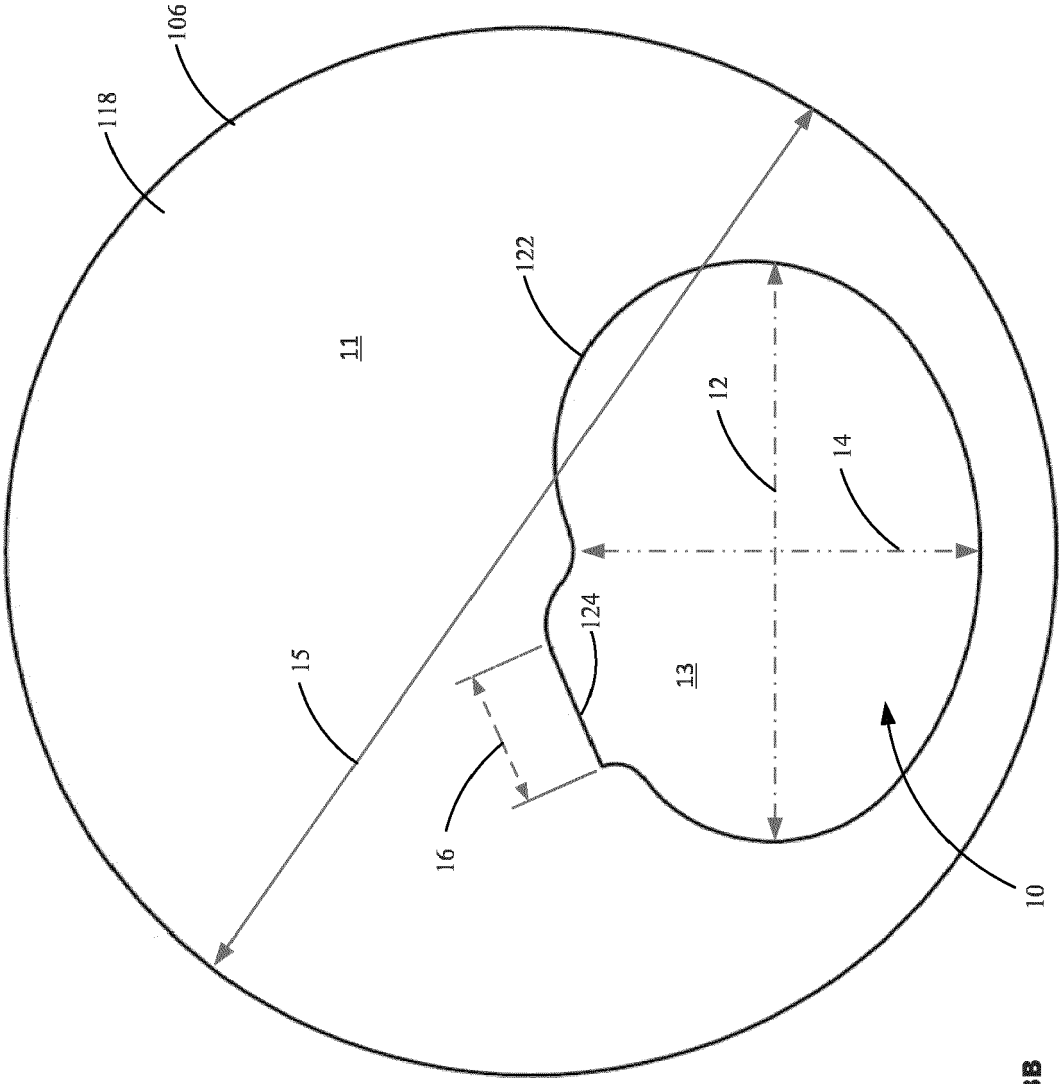


FIG. 3B

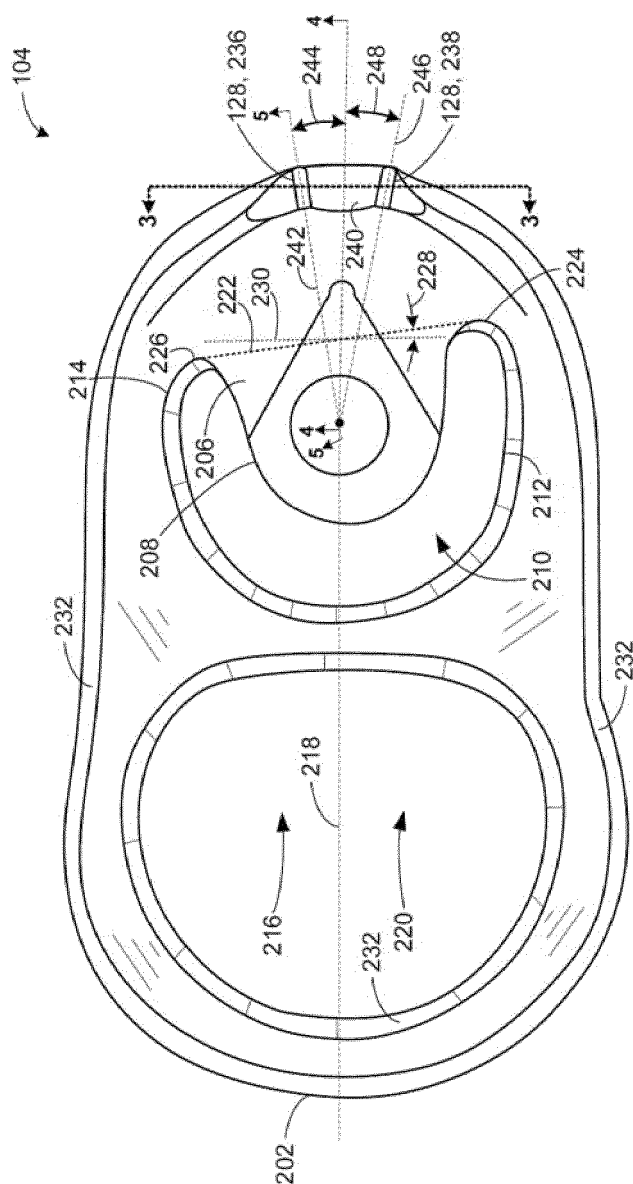


Fig. 4A

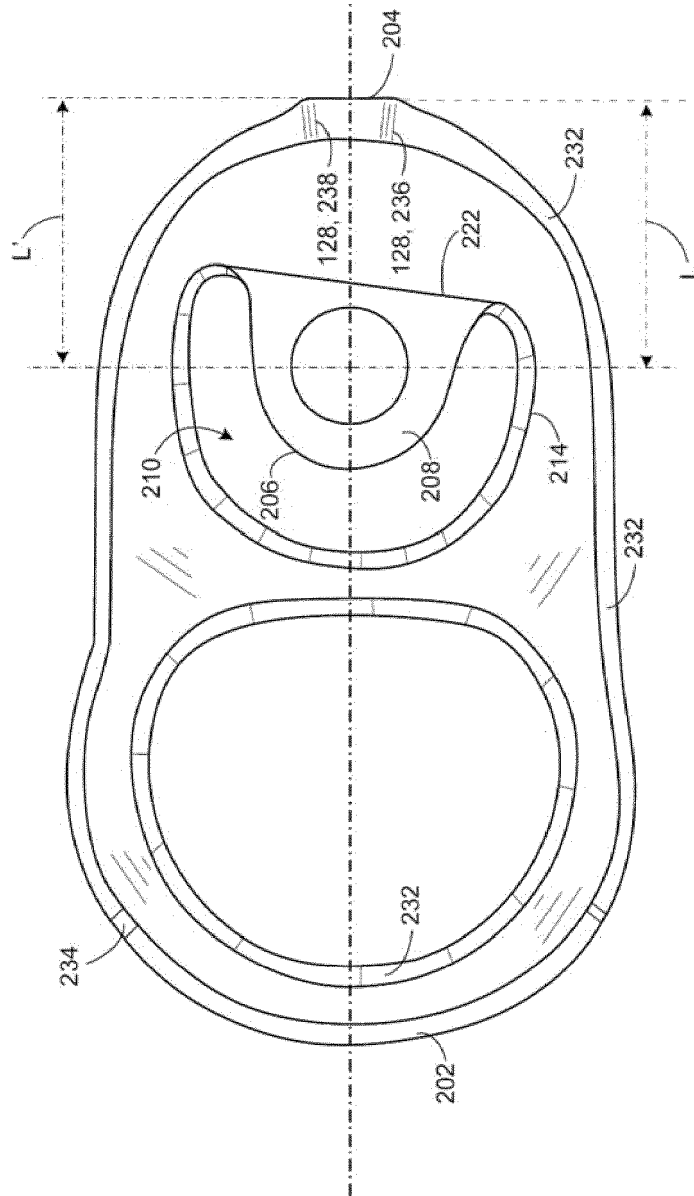
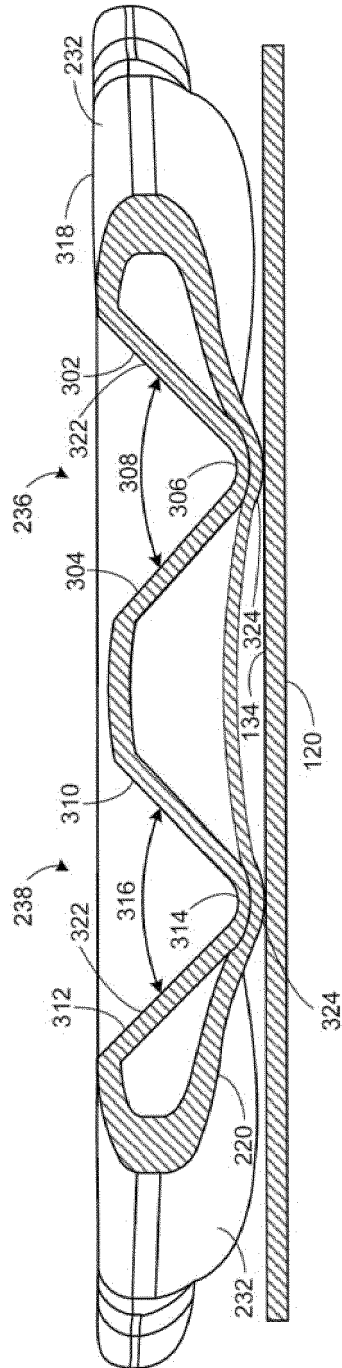


FIG. 4B



505

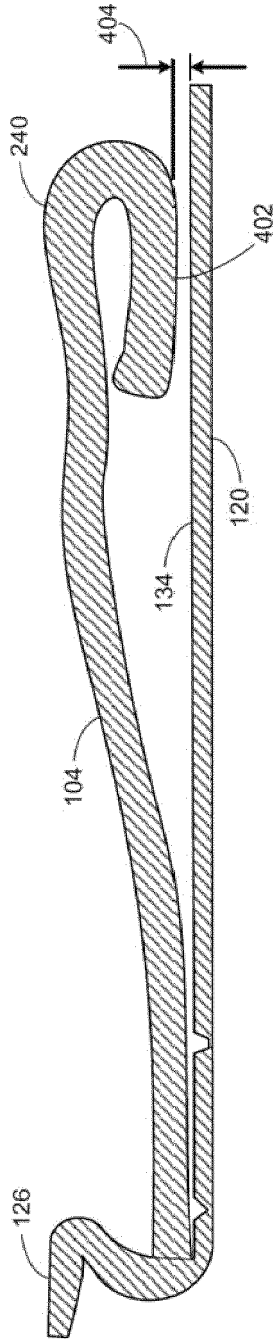


FIG. 6A

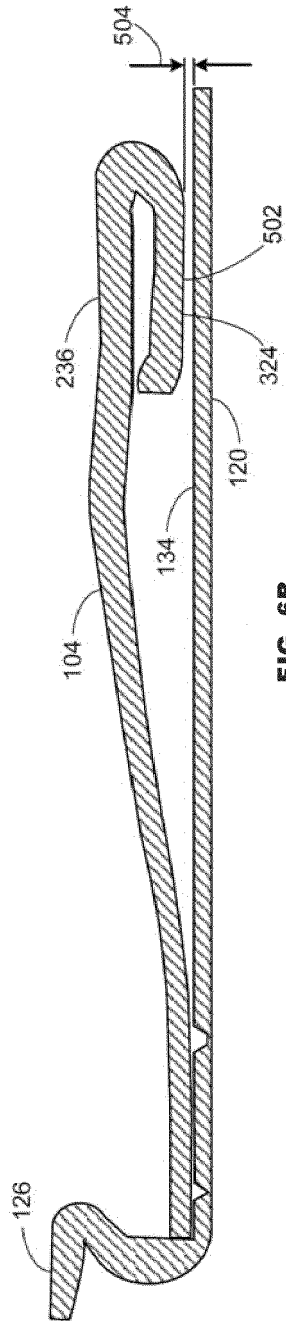


FIG. 6B

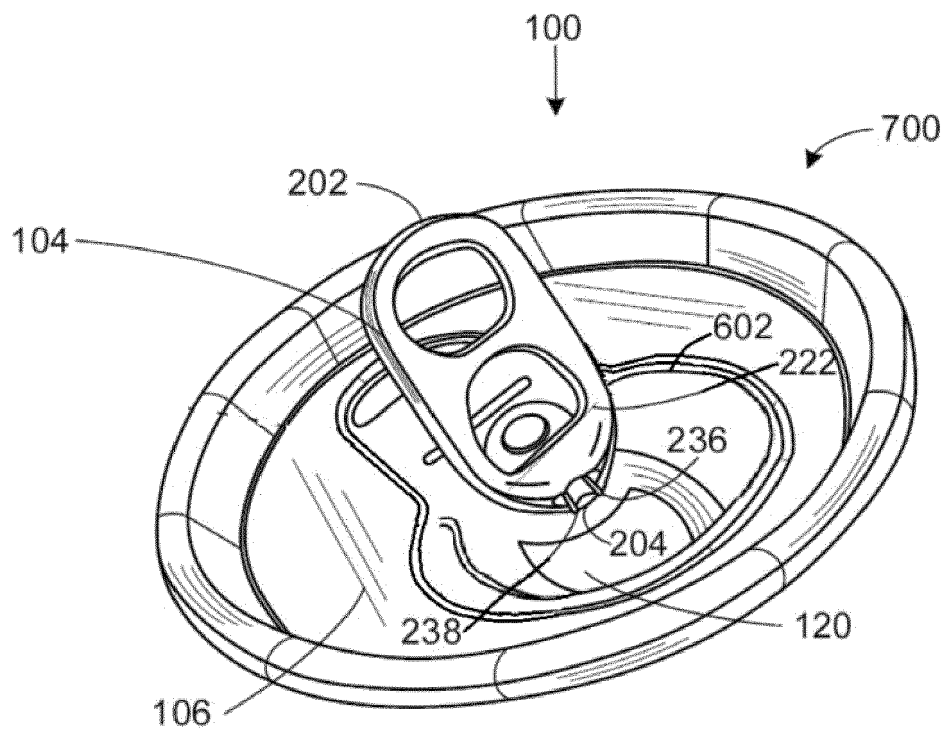


FIG. 7

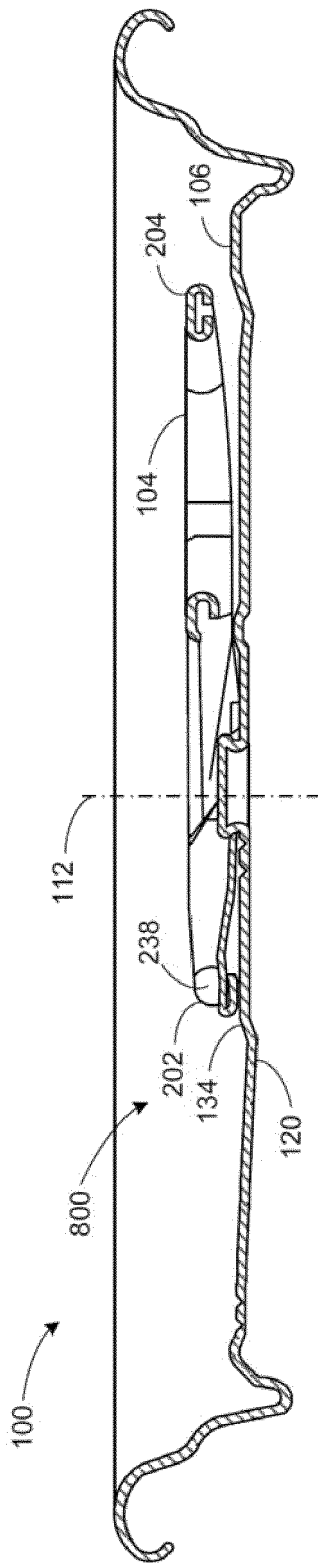


FIG. 8A

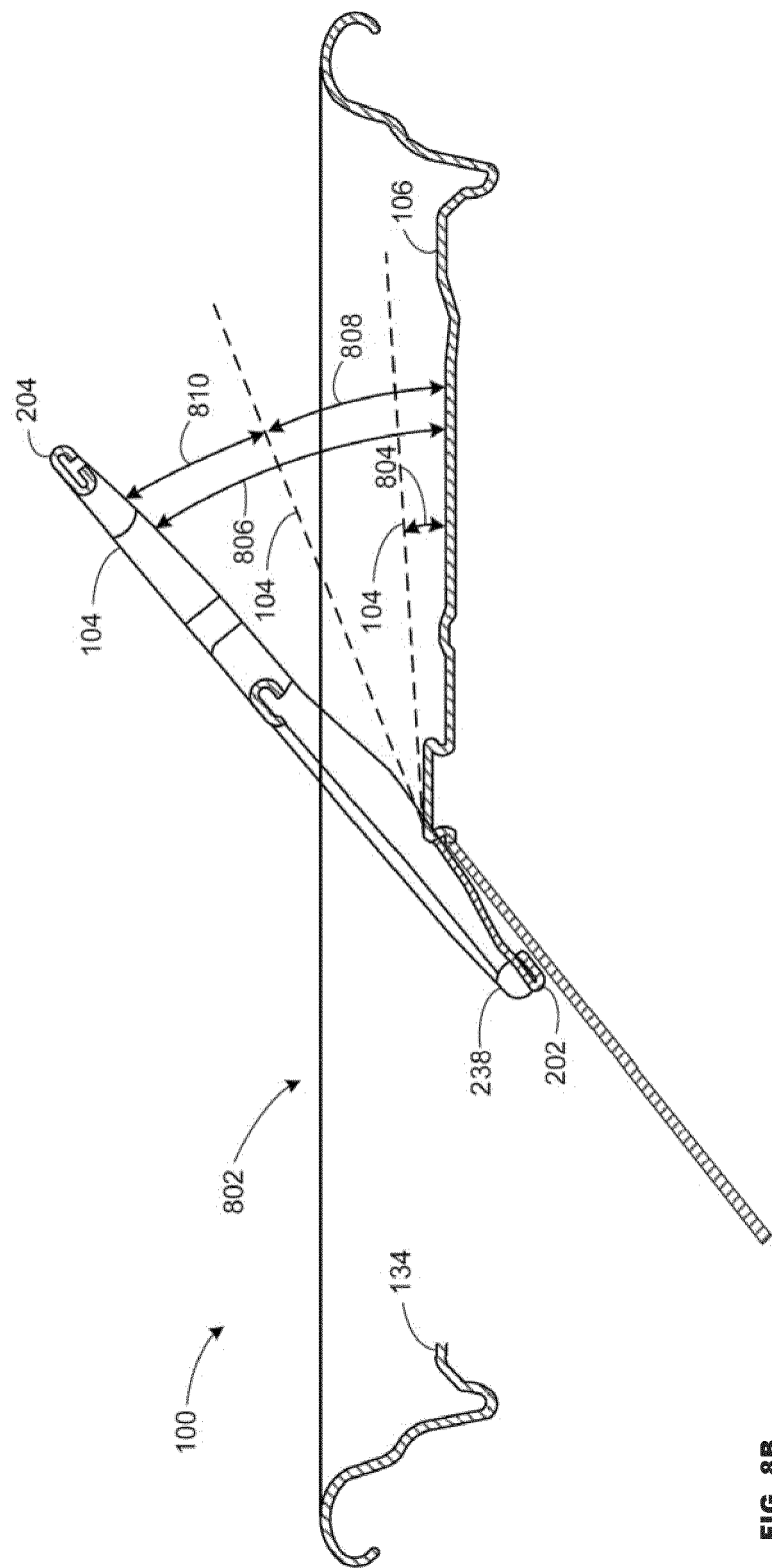


FIG. 8B

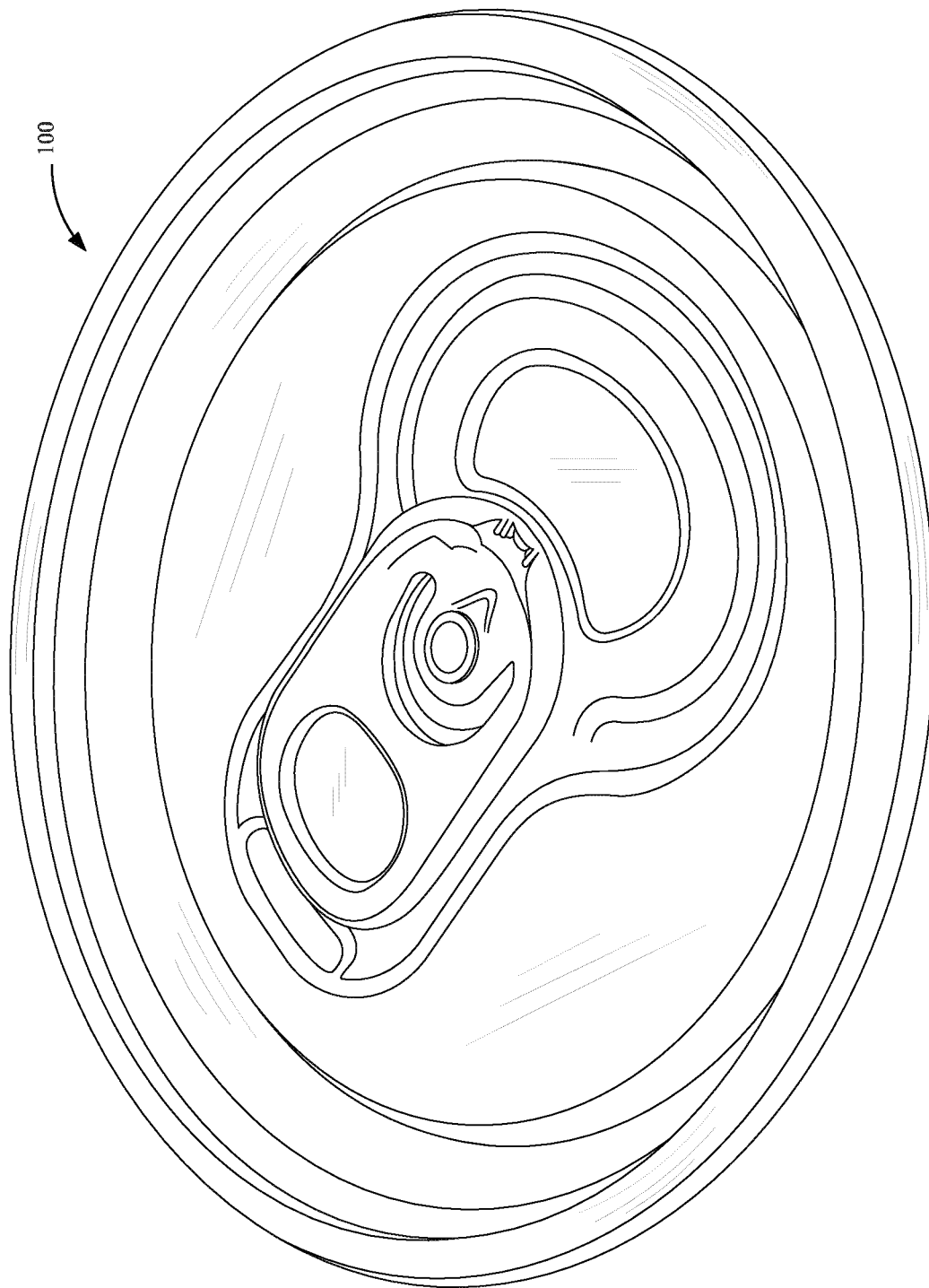


FIG. 9A

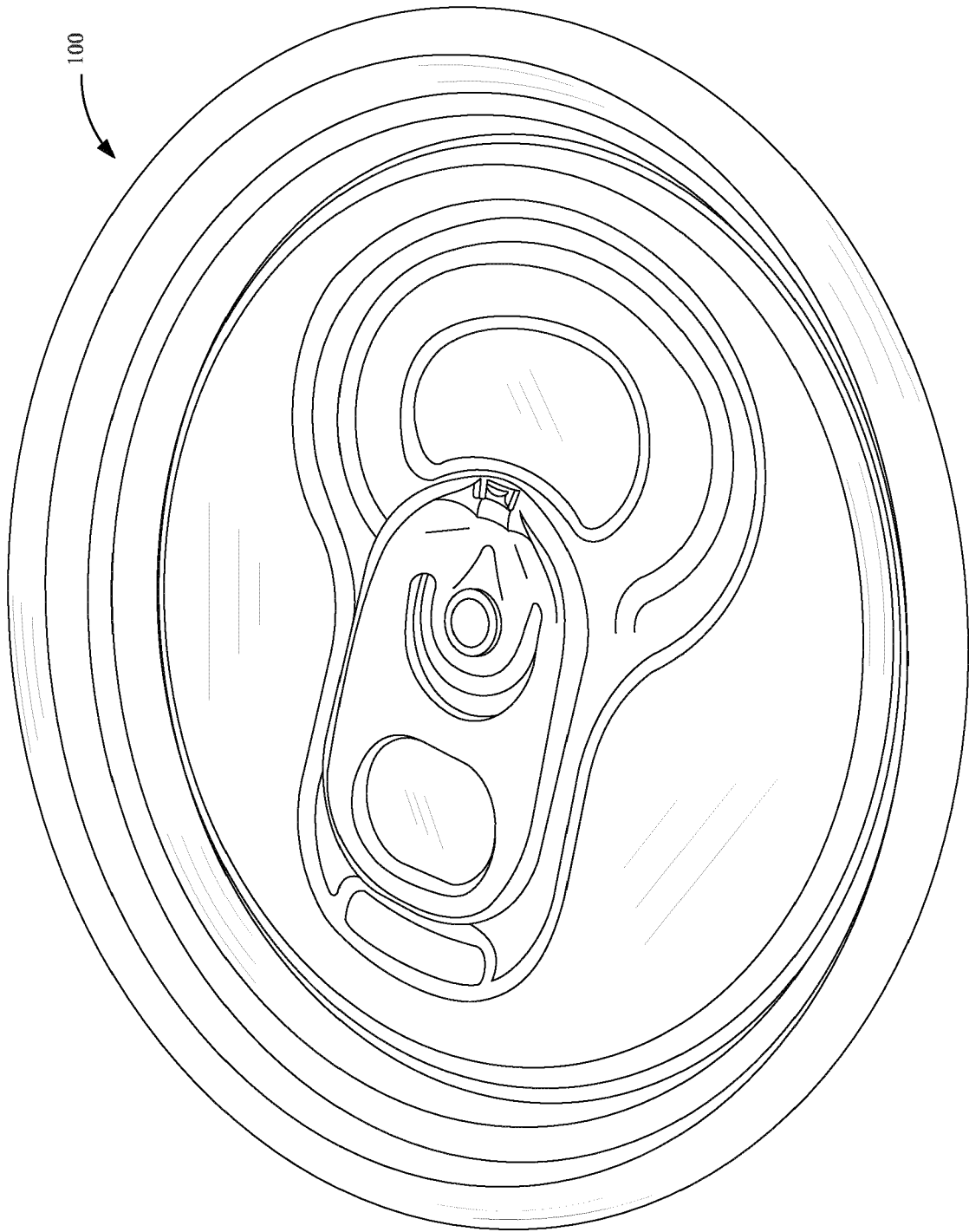


FIG. 9B

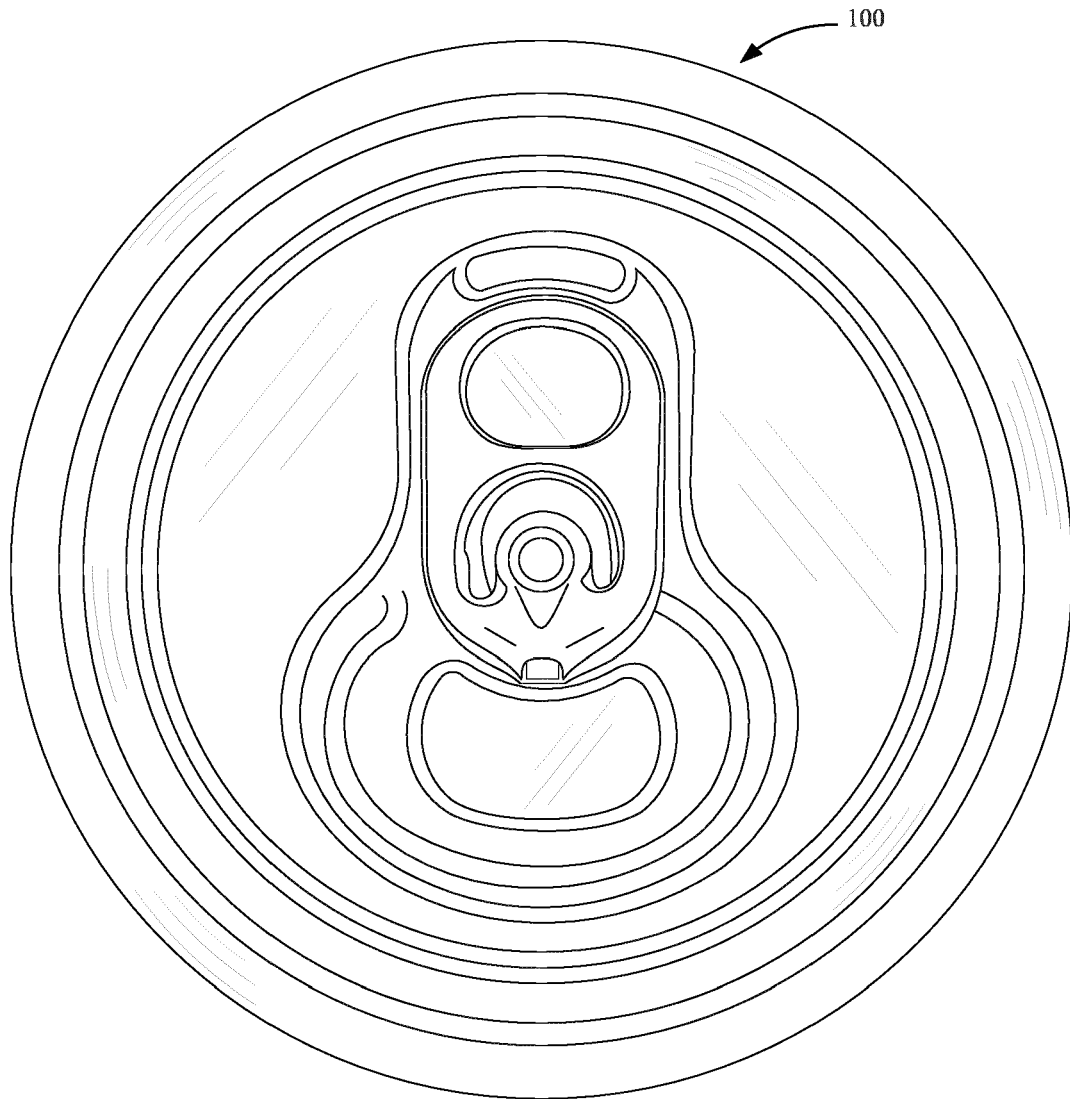


FIG. 9C

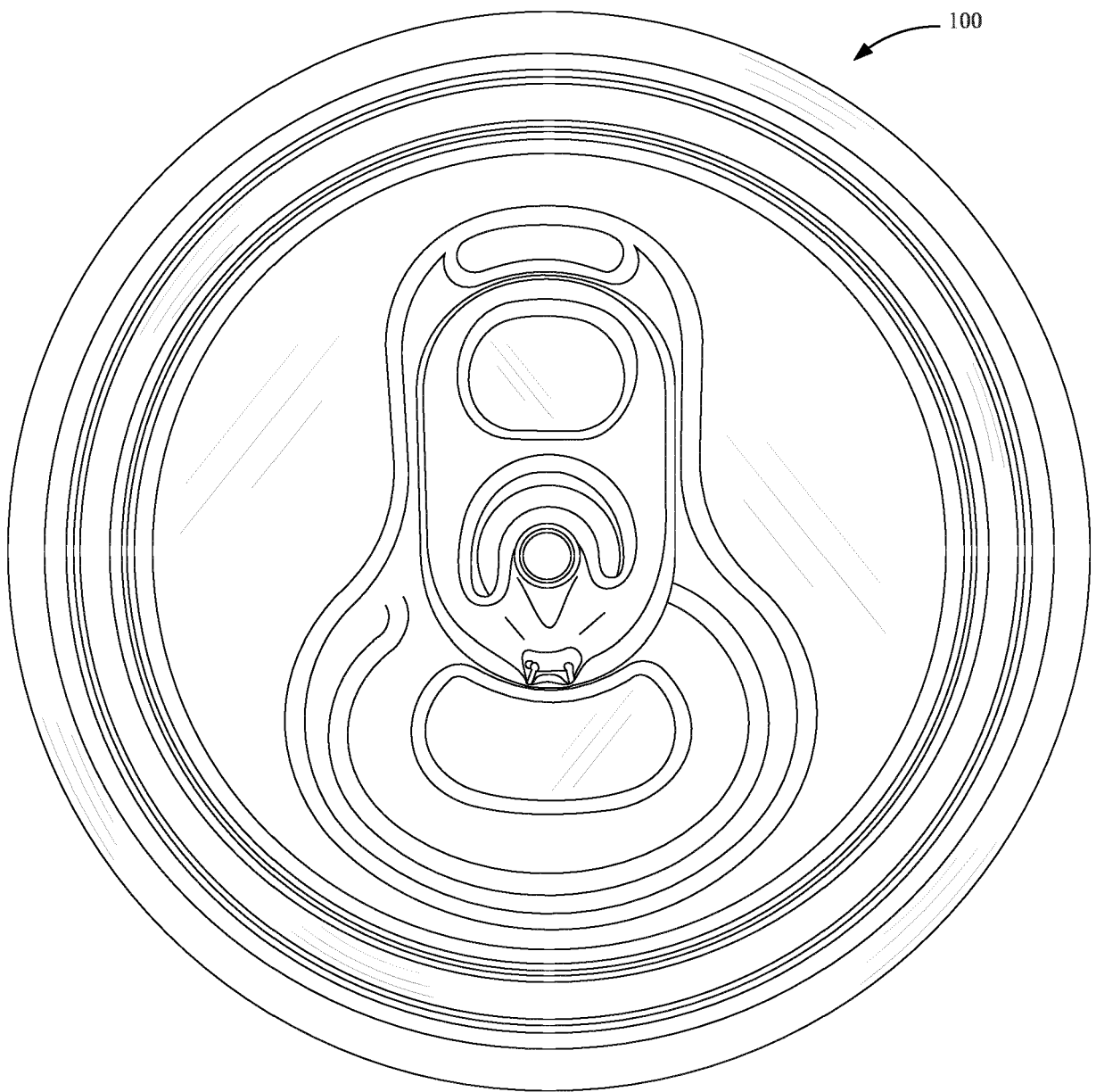


FIG. 9D

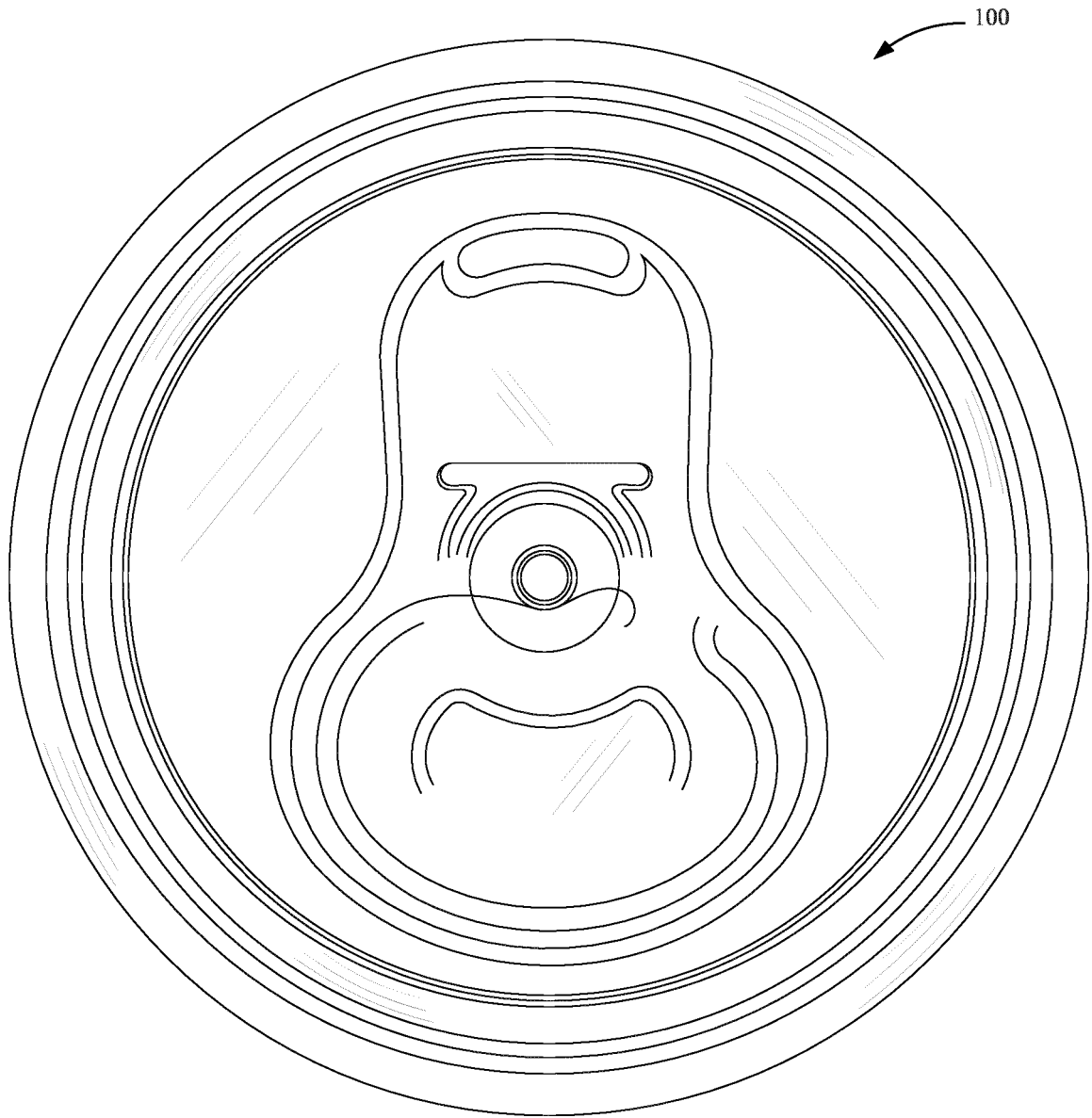


FIG. 9E



FIG. 9F

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 63506761 [0001]