

FULL APERTURE CAN END

TECHNICAL FIELD

5 This invention relates to full aperture can ends, and full aperture opening cans configured for use in pressurised applications, such as for containing soda, beer and other carbonated beverages, as well as some foods.

BACKGROUND

10 Known full aperture can ends include a main score that extends around a major portion of the can end's centre panel and defines a removable panel. A tab is attached to the removable panel by a rivet. The tab has a tail or handle end on one side of the rivet and a nose end on the opposite side of the rivet, and the tab is positioned so that its nose
15 end lies adjacent to or touching the main score. To open the can end, a user lifts the tail or handle end of the tab, which causes the tab to pivot about the rivet and presses the nose end adjacent to the score, propagating fracture of the main score until the removable panel is detached from the remainder of the can end.

20 The process of forming a can end encompasses two key stages. Firstly, a metal blank is pressed in a shell press to form a shell. Stacked shells are subsequently transferred to a conversion press ready for the second stage. The shell is gradually turned into a can end as it passes through multiple stations, with typically the penultimate station staking the tab to the rivet. Full aperture can ends may be attached to can bodies by conventional
25 seaming techniques.

In the context of foods, full aperture can ends are designed primarily to allow full product release of the foodstuff contained within the food can. Often, this foodstuff is packed under slight negative pressure. However, where pressurised food cans are proposed
30 having positive internal pressure, the internal pressures are relatively low and merely determined by the internal pressure required to maintain the structural rigidity of the food can, which is often relatively "thin-walled".

In contrast, in conventional beverage cans, the beverage product, such as carbonated
35 soft drinks or beer such as lager, is held under much higher pressures than the internal

pressures in the above-described food cans, resulting in concerns related to "blow-off" of the ends upon initial opening by a user or when subjected to adverse handling. For these reasons, the conventional beverage can has an end defining a restricted aperture, which can be safely opened by a consumer. To achieve safe venting in conventional pressurized beverage cans with openings that have an area that is less than a majority of the centre panel (such as on conventional 12-ounce (355 ml) beverage cans), beverage can makers employ a feature that pauses the propagation of a single score line that defines the perimeter of the opening. Single score lines for beverage cans usually have a check slot to pause score propagation. A check slot is a score residual (that is, the metal at the bottom of the score) that is thicker than other portions of the score. Since the score residual is thicker, the check slot inhibits propagation of the score rupture so that a portion of the internal pressure vents before the remainder of the score is ruptured. In this way, for conventional beverage ends, check slots slow or pause score propagation to provide adequate venting early in the opening process.

Conventional beverage cans are often banned from being sold at festivals and events, because the restricted aperture prevents the contents of the can being from being discharged quickly if an opened beverage can is thrown. Thus, even if a conventional beverage can is opened at the point of sale at a festival or event, it may still be usable as a dangerous missile if thrown. In contrast, a full aperture can, once opened, will discharge its contents quickly once opened such that it will not be an effective missile if thrown. Full aperture opening cans thus provide a safer alternative to a conventional beverage can if it is able to withstand the higher pressures of soda, beer and the like.

WO2011/026900A1 proposes a full aperture beverage can end for use with products pressurised to over 30 psi (207 kPa).

WO2015/070051A1 proposes a full aperture beverage can end having a vent test rating of at least 90 psi (620kPa).

SUMMARY OF INVENTION

Viewed from a first aspect, there is provided a full aperture can end comprising:

a centre panel having a rivet;

a tab staked by the rivet;

a main score extending around a peripheral region of the centre panel, the main score defining a removable panel;

a venting score disposed on the removable panel, the venting score having

5 (i) a central portion, the central portion intersecting a longitudinal axis that extends through a centre of the rivet and a centre of the centre panel, the longitudinal axis being perpendicular to a lateral axis that also extends through the centre of the rivet; and

(ii) a pair of lateral portions each including one or more segments, the pair of lateral portions extending no further forward than the lateral axis; and
10 wherein, along the longitudinal axis, the centre of the rivet is located between 0.146 and 0.246 inches from a centreline of the main score.

At least one segment of each lateral portion may extend substantially parallel to the lateral axis. The segment may be disposed along the lateral axis.

15 Optionally, the centre panel includes a coined portion proximate the rivet, and the central portion of the venting score intersects the coined portion.

Along the longitudinal axis, the centre of the rivet may be located between 0.025 and
20 0.120 inches from a centreline of the venting score.

In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.219 inches from the centreline of the main score.

25 Optionally, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.100 inches from a centreline of the venting score. Along the longitudinal axis, the centre of the rivet may be located between 0.025 and 0.050 inches from a centreline of the venting score. In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.099 inches from the centreline of the venting score.

30 The venting score may further comprise a pair of side portions, wherein each of the side portions extend from a respective lateral portion, away from the lateral axis.

The full aperture can end may further comprise an anti-fracture score extending at least
35 partially around the peripheral region, radially inside of the main score. Along the

longitudinal axis, the centreline of the anti-fracture score may be disposed between 0.030 and 0.070 inches from a centreline of the main score. In one example, along the longitudinal axis, the centreline of the anti-fracture score is disposed substantially 0.050 inches from the centreline of the main score.

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A residual thickness of the anti-fracture score may be between 0.004 and 0.008 inches and the residual thickness of the main score is between 0.002 and 0.005 inches. The residual thickness of the anti-fracture score may be substantially 0.006 inches, and the residual thickness of the main score is substantially 0.004 inches.

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The tab may include a nose, and the tab may be staked at the rivet such the nose is disposed proximate the main score, the tab being elongate along the longitudinal axis. The tab may be configured such that the tab nose contacts the can end radially outside of the main score. The tab may be configured such that the tab nose contacts the can end within 0.015 inches of the main score.

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The full aperture can end may comprise 3000 series aluminium alloy.

The full aperture can end may have a vent test rating of at least 30 psi. The full aperture can end may have a vent test rating of at least 70 psi. The full aperture can end may have a vent test rating of at least 85 psi. The full aperture can end may have a vent test rating of at least 90 psi.

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Viewed from a second aspect, there is provided a can assembly comprising the full aperture can end of the first aspect and a can body, the can end seamed onto the can body. The can assembly may be filled with a carbonated beverage.

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Viewed from a third aspect, there is provided a full aperture can end comprising:

a centre panel having a rivet;

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a tab staked by the rivet;

a main score extending around a peripheral region of the centre panel, the main score defining a removable panel;

a venting score disposed on the removable panel, the venting score having

(i) a central portion, the central portion intersecting a longitudinal axis that extends through a centre of the rivet and a centre of the centre panel, the

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longitudinal axis being perpendicular to a lateral axis that also extends through the centre of the rivet; and

(ii) a pair of lateral portions each including one or more segments; and

5 wherein, along the longitudinal axis, the centre of the rivet is located between 0.146 and 0.246 inches from a centreline of the main score and between 0.025 and 0.120 inches from a centreline of the venting score.

Optionally, the pair of lateral portions extend no further forward than the lateral axis. This may include or exclude the lateral axis.

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At least one segment of each lateral portion may extend substantially parallel to the lateral axis. The segment may be disposed along the lateral axis.

Optionally, the centre panel includes a coined portion proximate the rivet, and the central portion of the venting score intersects the coined portion.

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Optionally, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.100 inches from a centreline of the venting score. Along the longitudinal axis, the centre of the rivet may be located between 0.025 and 0.050 inches from a centreline of the venting score. In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.099 inches from the centreline of the venting score. In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.219 inches from the centreline of the main score.

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The venting score may further comprise a pair of side portions, wherein each of the side portions extend from a respective lateral portion, away from the lateral axis.

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The full aperture can end may further comprise an anti-fracture score extending at least partially around the peripheral region, radially inside of the main score. Along the longitudinal axis, the centreline of the anti-fracture score may be disposed between 0.030 and 0.070 inches from a centreline of the main score. In one example, along the longitudinal axis, the centreline of the anti-fracture score is disposed substantially 0.050 inches from the centreline of the main score.

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A residual thickness of the anti-fracture score may be between 0.004 and 0.008 inches and the residual thickness of the main score may be between 0.002 and 0.005 inches. The residual thickness of the anti-fracture score may be substantially 0.006 inches, and the residual thickness of the main score is substantially 0.004 inches.

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The tab may include a nose, and the tab may be staked at the rivet such the nose is disposed proximate the main score, the tab being elongate along the longitudinal axis. The tab may be configured such that the tab nose contacts the can end radially outside of the main score. The tab may be configured such that the tab nose contacts the can end within 0.015 inches of the main score.

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The full aperture can end may comprise 3000 series aluminium alloy.

The full aperture can end may have a vent test rating of at least 30 psi. The full aperture can end may have a vent test rating of at least 70 psi. The full aperture can end may have a vent test rating of at least 85 psi. The full aperture can end may have a vent test rating of at least 90 psi.

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Viewed from a fourth aspect, there is provided a can assembly comprising the full aperture can end of the third aspect and a can body, the can end seamed onto the can body. The can assembly may be filled with a carbonated beverage.

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Viewed from a fifth aspect, there is provided a full aperture can end comprising:
a centre panel having a rivet;

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a tab staked by the rivet;

a main score extending around a peripheral region of the centre panel, the main score defining a removable panel;

a venting score disposed on the removable panel, the venting score having

(i) a central portion, the central portion intersecting a longitudinal axis that extends through a centre of the rivet and a centre of the centre panel, the longitudinal axis being perpendicular to a lateral axis that also extends through the centre of the rivet; and

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(ii) a pair of lateral portions each including one or more segments;

an anti-fracture score extending at least partially around said peripheral region, radially inside of the main score,

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wherein, along the longitudinal axis, the centreline of the anti-fracture score is disposed between 0.030 and 0.070 inches from a centreline of the main score, and wherein a residual thickness of the anti-fracture score is between 0.004 and 0.008 inches and the residual thickness of the main score is between 0.003 and 0.005 inches.

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The residual thickness of the anti-fracture score may be substantially 0.006 inches. The residual thickness of the main score may be substantially 0.004 inches. In one example, along the longitudinal axis, the centreline of the anti-fracture score is disposed substantially 0.050 inches from the centreline of the main score.

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Optionally, the pair of lateral portions extend no further forward than the lateral axis. This may include or exclude the lateral axis.

At least one segment of each lateral portion may extend substantially parallel to the lateral axis. The segment may be disposed along the lateral axis.

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Optionally, the centre panel includes a coined portion proximate the rivet, and the central portion of the venting score intersects the coined portion.

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Along the longitudinal axis, the centre of the rivet may be located between 0.146 and 0.246 inches from a centreline of the main score and between 0.025 and 0.120 inches from a centreline of the venting score.

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Optionally, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.100 inches from a centreline of the venting score. Along the longitudinal axis, the centre of the rivet may be located between 0.025 and 0.050 inches from a centreline of the venting score. In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.099 inches from the centreline of the venting score. In one example, along the longitudinal axis, the centre of the rivet is located at substantially 0.219 inches from the centreline of the main score.

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The venting score may further comprise a pair of side portions, wherein each of the side portions extend from a respective lateral portion, away from the lateral axis.

The tab may include a nose, and the tab may be staked at the rivet such the nose is disposed proximate the main score, the tab being elongate along the longitudinal axis. The tab may be configured such that the tab nose contacts the can end radially outside of the main score. The tab may be configured such that the tab nose contacts the can end within 0.015 inches of the main score.

The full aperture can end may comprise 3000 series aluminium alloy.

The full aperture can end may have a vent test rating of at least 30 psi. The full aperture can end may have a vent test rating of at least 70 psi. The full aperture can end may have a vent test rating of at least 85 psi. The full aperture can end may have a vent test rating of at least 90 psi.

Viewed from a sixth aspect, there is provided a can assembly comprising the full aperture can end of the fifth aspect and a can body, the can end seamed onto the can body. The can assembly may be filled with a carbonated beverage.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a known beverage can illustrating a full aperture can end, in which the tab is in an early stage of its actuation;
Figure 2 a perspective view of the can of Figure 1, in a reverse direction, showing the venting score ruptured and flap slightly displaced to form a vent opening;
Figure 3 is a perspective view of the can of Figure 1 showing the fully open position;
Figure 4 is a top view of the can of Figure 1, with the tab shown as transparent to illustrate the venting score;
Figure 5 is a cross sectional view of the can of Figure 1 showing its peripheral curl in its configuration before seaming on to a can body;
Figure 6 is an enlarged view of a portion of Figure 4;
Figure 7 is a top view of a punch for forming the venting score shown in Figures 4 and 6;
Figure 8 is an enlarged view of a portion of the punch of Figure 7;
Figure 9A is a top view of the can of Figure 1, with the tab shown as transparent to illustrate the venting score;
Figure 9B is a top view of a shell and a can body according to the present invention.
Figure 9C is an enlarged view of a portion of Figure 9B;

Figure 10 is a top view of the can of Figure 9B, with a tab shown attached to the can end; and

Figure 11 is a cross section of a portion of the can end of Figure 9B illustrating the relative geometries of a main score and an anti-fracture score.

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DETAILED DESCRIPTION

Figures 1 through 6 illustrate a known beverage can as taught by WO2015/070051A1. A can assembly 10 includes a single piece can body 12 and an end 14. Body 12 and end 14 are joined together by a seam, e.g. a conventional double seam 16. Body 12 is a conventional drawn and wall ironed 12 ounce (355 ml) beverage can body that is formed from a single piece of aluminium. Alternative bodies of different sizes are also known, for example, 16 ounce (473 ml), and 20 ounce (590 ml) sizes and the metric volume equivalents. Can ends 14 are typically produced in a shell press operating at greater than 300 strokes per minute, typically 450 strokes per minute.

In its unseamed state shown in Figure 5, end 14 includes a peripheral curl 23, a wall 20, a countersink 22, and a centre panel 24. As best shown in Figures 1 to 4, in its seamed state, peripheral curl has been manipulated to form a part of seam 16. The end is a 200, 202, 204, or 206 size, although the present invention encompasses any size of end, preferably a 200 or a 202 size. The present invention also encompasses any configuration of wall 20 and countersink 22. Wall configurations may include conventional B64 walls, inclined chuck walls, curved chuck walls, multipart chuck walls, chuck walls with features such as shelves, kicks, kinks, etc., and the like. Countersink configurations may include countersinks with straight sidewalls, curved sidewalls, narrow beads, broad beads, folded or pinched beads, and the like.

The can ends described herein are typically formed from a 5000 series aluminium alloy. Specifically, 5000 series aluminium alloy used for can end making has an ultimate tensile strength of 375 to 415 MPa. This ultimate tensile strength range is appropriate for the given internal pressure of the can given a standard diameter end used in the field. This ultimate tensile strength range is also associated with a relatively greater tendency to tear at the end of the scores with respect to softer metals. One example of a 5000 series aluminium alloy is 5182, with the general chemical composition (%) provided in the table

below. The temper is H49. It should be noted that the composition of the same grade of aluminium alloy may vary slightly from supplier to supplier.

Mn	Mg	Si	Fe	Cu	Cr	Zn	Others	Others total	Al
0.20 – 0.50	4.0 – 5.0	0.13 max	0.35 max	0.1 max	0.1 max	0.25 max	0.05 max	0.15 max	Balance

Table 1

5 The can ends described herein are not limited to this particular alloy but also encompass steel, such as tin plate, other grades of aluminium, and the like.

For example, a 3000 series aluminium alloy may be used from time to time but may require thicker material. The 3000 series aluminium alloys are more typically used in can
10 body making but feasibly they may be used to make can ends. This is particularly useful during times of supply shortages. An example of a 3000 series aluminium alloy is 3104 with the chemical composition (%) from one supplier provided in the table below. The temper is H19. Typically, the 3000 series aluminium alloy used for can body making has a tensile strength (as rolled) of 290 to 330 MPa.

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Mn	Mg	Si	Fe	Cu	Zn	Others	Others total	Al
0.80 – 1.4	0.8 – 1.3	0.6 max	0.8 max	0.25 max	0.25 max	0.05 max	0.15 max	Balance

Table 2

Centre panel 24 of the can end 14 is circular and has a periphery 25 adjacent bead 22. The can end 14 further includes main score 26 disposed proximate the periphery 25 of the centre panel. The main score 26 is continuous so as to form a removable panel 34.
20 As can best be seen in Figure 4, the can end comprises an anti-fracture score 57 extending at least partially around the centre panel, radially inside of the main score 26. The anti-fracture score 57 reduces stress and provides a means to take up slack metal during production. A tab 32, including a nose 31, is affixed to the removable panel 34 of centre panel 24 by rivet 30, such that the nose 31 is disposed proximate the main score
25 26. A button coin 29 is formed on the centre panel 24 around rivet 30 when tab 32 is staked to the centre panel 24. Button coin 29 is defined by the coined portion of the

centre panel 24 that is formed during the conversion process, prior to staking the tab on to the end.

To aid in the description of centre panel 24, primary or centre reference axis line P_L is defined as extending through the centre of rivet 30 and through the longitudinal centreline of tab 32 (Figure 4). Tab 32 is elongate along line P_L . For the vast majority of commercial tabs, and as shown in the Figures, primary reference line P_L will extend through the point of initial contact between the nose of tab 32 and its point of initial contact on the centre panel. Centre panel may include anti-rotation features such as beads or dimples (not shown in Figure 4 but visible in e.g. Figures 9B and 9C) that at least partially restrict rotation of the tab out of alignment with the longitudinal axis. Transverse reference axis or line T_L is defined as extending through the centre of rivet 30 and perpendicular to the primary reference line P_L . The plane defined by lines P_L and T_L is parallel to the plane defined by the top of the seam and parallel to centre panel 24, to the extent that centre panel 24 defines a plane in its seamed or unseamed state. Transverse reference line T_L divides can end 14 into a front portion on the side of the tab nose and a rear portion on the side of the tab heel.

Venting score 40 includes a central portion 42 that intersects line P_L , a pair of check slots 45a and 45b (Figure 6) disposed on either side of line P_L about the central portion 42, and a pair of lateral portions 46a and 46b that extend from the check slots 45a and 45b. Each of lateral portions 46a and 46b includes a segment 47a, 47b that is approximately parallel to the lateral axis and a pair of side portions 50a and 50b that extend from the lateral portions 46a and 46b, respectively, away from line T_L .

As best shown in Figure 4, where only the periphery of the tab is shown with the tab interior being transparent for ease of explanation, central portion 42 of venting score 40 has a rounded segment that extends around the rivet 30 (where P_L and T_L intersect) spaced apart from button coin 29. Central portion 42 may be at least partially defined by a radius 0.140 inches, or alternatively a radius of at least 0.140 inches, that extends from the centre of the rivet 30. Alternatively, central portion 42 may be at least partially defined by a radius in the range of 0.132 - 0.150 inches. For example, the central portion 42 may be at least partially defined by a radius of 0.132, 0.133, 0.134, 0.135, 0.136, 0.137, 0.138, 0.139, 0.140, 0.141, 0.142, 0.143, 0.144, 0.145, 0.146, 0.147, 0.148, 0.149, 0.150 inches (and their corresponding metric values of 3.35, 3.37, 3.39, 3.41, 3.43, 3.45, 3.47, 3.49,

3.51, 3.53, 3.55, 3.57, 3.59, 3.61, 3.63, 3.65, 3.67, 3.69, 3.71, 3.73, 3.75, 3.77, 3.79, 3.81 mm), or a range of radii encompassed by at least two of the radii recited herein. Central portion 42 extends from a point of intersection with P_L forward while extending around rivet 30 to approximately 3 o'clock and 9 o'clock. The radius dimension may be
5 chosen according to known parameters, such as centre panel thickness, score thickness, check slot thickness, material choice, and like parameters.

Check slots 45a, 45b extend from the central portion 42 and have a score that is shallower than the central portion, such that the metal in the area of the check slots 45a,
10 45b is thicker relative to the metal in the central portion 42. Each of the check slots 45a, 45b yields to corresponding inner ends of lateral portions 46a and 46b through transitions 44a and 44b. Lateral portions 46a and 46b extend generally laterally (that is, generally parallel to transverse reference line T_L) and outwardly relative to rivet 30. Side portions
15 50a and 50b extend generally rearward from outer ends of lateral portions 46a and 46b through transitions 48a and 48b. Side portions 50a and 50b end at terminations 52a and 52b. The venting score terminations may be curved, curled, or angled relative to the side portions of the venting score, or they may simply be the ends of straight side walls, as shown in the figures.

20 In some examples, venting score 40 does not have check slots. Although venting score 40 has similar dimensions to can ends with check slots, when no check slot is used, central portion 42 extends directly to transitions 44a and 44b. Lateral portions 46a and 46b extend from the transitions 44a and 44b through transitions 48a and 48b. Side portions 50a and 50b end at terminations 52a and 52b.

25 As shown in Figure 6, a hinge 54 is formed on the removable panel 34 between terminations 52a and 52b of side portions 50a and 50b. A flap 56 is defined by venting score 40 and hinge 54. A front portion of flap 56 is defined by lateral portions 46a and 46b. Sides of flap 56 are defined by side portions 50a and 50b. The rear of flap 56 is
30 formed (with less specificity in its location) by hinge 54.

In the can end of WO2015/070051A1, dimensional information of venting score 40 is provided with reference to the enlarged view of the tool 80 for forming the venting score as is shown in Figure 8. Specifically, a portion of venting score 40 extends to (or
35 approximately to) or forward of the transverse reference line T_L to promote movement or

hinging of the tab and rivet. For example, lateral portions 46a and 46b extend forward of transverse line T_L by a dimension D_1 . D_1 is positive and between 0 and 0.050 inches, and more typically between 0.010 inches and 0.032 inches. In the example shown in the Figures 1 to 6, D_1 is approximately 0.021 inches.

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Side portions 50a and 50b are mutually spaced apart and extend rearwardly such that flap 56 creates sufficient area for venting. The vent opening is identified in Figure 2 with reference numeral 41. In this regard, side portions 50a and 50b extend rearwardly from transverse reference line T_L by a distance D_2 that may be between 0.15 and 0.4 inches, and more typically is between 0.2 and 0.3 inches. In the example shown in Figures 1 to 6 of WO2015/070051A1, D_2 is 0.217 inches. The ends of side portion terminations 52a and 52b are spaced apart by a distance of between 0.5 inches and 1.0 inches and between 0.6 and 0.8 inches. In this case, the distance between 52a and 52b is 0.746 inches.

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Venting score sides may be curved or straight, and oriented at any angle A , measured relative to primary reference line P_L . For example, A may be approximately zero (that is, the venting score sides may be approximately parallel to primary reference line P_L), between ± 10 degrees, between ± 20 degrees, or between ± 30 degrees. In the example shown in Figures 1 to 6, angle A is 5 degrees. Central portion 42 and lateral portions 46a and 46b may be shapes other than as shown in the Figures.

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Venting score 40 has an approximately uniform score residual dimension at least through score central portion 42, lateral portions 46a and 46b, and the front portion of score side portions 50a and 50b. In WO2015/070051A1, the score residual dimension for the score central portion 42, lateral portions 46a and 46b, and the front portion of score side portions 50a and 50b is between 0.0020 and 0.0045 inches. The check slots 45a, 45b have a score residual that is generally greater than that of score central portion 42, lateral portions 46a and 46b, and the front portion of score side portions 50a and 50b. Specifically, the score residual for the check slots may be greater by approximately 0.0040 inches such that the residual for the check slot is between 0.0060 and 0.0085 inches. The anvil against which tool 80 acts optionally has a step to control the residual dimension.

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To describe the operation of a can assembly 10, reference is made especially to Figures 1 to 3 and 6. Prior to opening, can assembly 10 has an internal pressure created when filled with a carbonated soft drink, beer, or the like. Scores 26 and 40 are intact and tab 32 is in its conventional rest position of approximately flat against centre panel 24 or approximately horizontal.

To open can assembly 10, a user lifts the heel end of tab 32, which moves the tab nose toward centre panel 24 while deflecting the metal around the rivet until score central portion 42 ruptures, as shown in Figure 2.

Typically, a portion of venting score 40 ruptures before any portion of the main score 26 ruptures to achieve venting. Propagation of the venting score 40 is restrained as check slots 45a, 45b rupture. The thickened metal in the areas of the check slots 45a, 45b (if used) fracture more slowly than the remainder of the venting score 40. The rupture of venting score 40 then propagates through lateral portions 46a and 46b and rearward through score side portions 50a and 50b as flap 56 moves upwardly about hinge 54. In this regard, the can internal pressure actuates flap 56 to quickly produce a relatively large open area for can venting. Then, similar to the opening of conventional can ends, the user continues to actuate tab 32 until the main score 26 ruptures and removable panel 34 is detached so as to create the full aperture 60.

As indicated above, Figures 1 to 8 are provided for illustrative purposes and illustrate a known can end as described in WO2015/070051A1.

Figures 9A to 9C illustrate differences between an end according to an embodiment of the present invention and the known full aperture can end of WO2015/070051A1. Like features from Figures 1 to 8 are indicated by like-numbered reference numerals. Figure 9A corresponds to Figure 4 whereas Figures 9B shows a full aperture can end according to an embodiment of the present invention. Figure 9C shows an enlarged detail of the can end of Figure 9B.

As can be seen by comparing the distance L1 between the line A-A (through the centre of the can end) to T_L and the distance L2 line A-A to T_L' in Figures 9A and 9B, the rivet 30 of the can end of the embodiment of the present invention is disposed further away from the centre of the centre panel and closer to the main score. The associated coined

portion 29 around the rivet and geometry of the venting score 40 are also shifted to match the new positioning of the rivet 30 closer to the main score 26. As can be seen in Figure 9C, the distance, along the longitudinal axis P_L , between the centre of the rivet 30 and the centreline T_L'' of the main score 26 is indicated by distance L3 and the distance, along the longitudinal axis P_L , between the centre of the rivet 30 and the centreline of the venting score 40 is indicated by distance L4. The term centreline of a score refers to the line indicating the middle of the base of the score, as shown for example by lines T_L'' and T_L''' in Figure 11. L3 is envisaged to be between 0.146 and 0.246 inches, preferably 0.219 inches, whereas L4 is envisaged to be between 0.025 and 0.120 inches, for example 0.099 inches. Distance L2 is envisaged as to be between substantially 0.590 – 0.629 inches, for example 0.602 inches. Unlike in WO2015/070051A1, the venting score 40 intersects the coined portion.

Shifting the position of the rivet 30 closer to the main score 40 allows a smaller tab and in particular a tab with a shortened front part. The ability of the can end to withstand typical internal pressures of soda, beer, lager and the like (e.g. between 30-90 psi, or 206-620 kPa) is maintained at least in part by disposing the central portion 42 of the venting score 40 through the coined portion 29. A shorter, more rigid, tab uses less metal and accordingly contributes to light-weighting. Moreover, the length of the tab makes it compatible with more modern, higher speed conversion presses, enabling higher output volumes. The shifting of the rivet 30 and subsequent use of a shorter tab do not have a detrimental effect on the use-parameters of the container such as pop value, tear value and tab strength. For example, a container having the can end of the present disclosure was found to achieve a pop value of around 4.5 ± 1.5 lbs (20.0 N), a tear value of around 3.4 ± 1.1 lbs (15.1 N) and a tab strength of 7 lbs (31.1 N) minimum, which are all within accepted industry standards.

Further, as can be seen in Figure 9C, positioning of the rivet 30 closer to the main score 26 as described above enables the lateral portions 46a, 46b of the venting score to be positioned approximately at or radially inside of line T_L' , i.e. closer to the centre of the end, without having a detrimental effect on the correct functioning of the venting score 40. This contrasts Figure 8 of WO2015/070051A1 where the lateral portions 46a, 46b extend outside of the line T_L by distance D1.

Whilst not shown in Figures 9A to 9C, the positioning of the rivet 30 closer to the main score 26 also allows the side portions 50a, 50b of the venting score 40 to be reduced in length, as compared with of WO2015/070051A1, or removed entirely, thereby simplifying the can end, without detrimentally effecting the ability of the venting score to fracture first during opening, and controlling the pressure differential between the external surface and internal surface of the centre panel to allow the main score 26 to tear in a controlled and reliable manner. For example, whilst the side portions 50a, 50b, may be approximately 0.217 inches as in WO2015/070051A1, in the certain embodiments of the present invention they may be less, for example between 0 – 0.1539 inches for example, 0.1377 inches, 0.0885 inches, 0.0393 inches or less.

Figure 10 illustratively shows in plan view the can end of Figures 9B to 9C assembled with a can body 12 and now also showing a tab 32. Given the position of the rivet 30 closer to the main score 26 as described above, the front part of the tab 32, i.e. the part of the tab outside of the rivet 30 and having the nose 31, is substantially shorter than the tab of Figure 4, thereby using less metal and contributing to light-weighting.

Figure 11 illustratively shows an axial cross section of a portion of the can end of Figures 9B, 9C and 10 in the vicinity of the main score 26. As shown in Figure 11, the can end comprises the anti-fracture score 57 extending at least partially around the centre panel, radially inside of the main score 26. This particular anti-fracture score is configured to increase the process window for the main and vent score residuals, which is advantageous from a production point of view. Whilst it is envisaged that the anti-fracture score 57 extends around the entire circumference of the centre panel, it may extend only partially, for example 90%, 80%, 70% or less around the centre panel. Along the longitudinal axis, the centreline T_L''' of the anti-fracture score 57 is preferably disposed 0.030 and 0.070 inches from the centreline T_L'' of the main score 26. In this embodiment, along the longitudinal axis, the centreline T_L''' of the anti-fracture score 57 is disposed substantially 0.050 inches from the centreline T_L'' of the main score 26. The residual thickness 58 (that is, the remaining material thickness after the score is formed) of the anti-fracture score 57 is between 0.004 and 0.008 inches, and the residual thickness 59 of the main score 26 is between 0.002 and 0.005 inches. Preferably, the residual thickness 58 of the anti-fracture score 57 is substantially 0.006 inches and the residual thickness 59 of the main score 26 is substantially 0.004 inches.

The width of the main score 26 at its base is envisaged to be no more than approximately 0.0012 inches, whereas the width of the anti-fracture score 57 at its base is envisaged to be no more than approximately 0.003 inches. The aforementioned width of the main score 26 and of the anti-fracture score 57 assumes that the base of the score is planar, and in parallel with the centre panel 24. However, the base of either or both scores 26, 57 may descend to a point (not shown).

It is envisaged that the metal of the can end has an approximate thickness 60 of between 0.008 – 0.013 inches, preferably 0.008 inches.

The embodiment shown in the Figures and described above illustrate embodiments and aspects of the present invention. The present invention is not limited to the particular embodiment shown in the Figures, but encompasses structures and broader than the disclosure and limited only by the claims.

For example, where it is described that the pair of lateral portions extend no further forward than the lateral axis, this means that the lateral portions do not cross beyond the lateral axis in a direction parallel to the longitudinal axis and away from the centre of the centre panel.

For example, the present invention encompasses materials, chuck wall configuration, seam structure and processes, that are not shown in the figures unless limited in the claims.

In further examples, the can end may comprise beading on the centre panel to increase the strength of the centre panel and ability to withstand pressure from inside the can and external forces applied to the can during, for example, handling.

In further examples, central portion 42 of the vent score may be at least partially defined by a radius 0.160 inches, or alternatively a radius of at least 0.160 inches, that is centred on line P_L. Alternatively, central portion 42 may be at least partially defined by a radius in the range of 0.132 -0.180 inches. For example, the central portion 42 may be at least partially defined by a radius of 0.132, 0.133, 0.134, 0.135, 0.136, 0.137, 0.138, 0.139, 0.140, 0.141, 0.142, 0.143, 0.144, 0.145, 0.146, 0.147, 0.148, 0.149, 0.150, 0.151, 0.152, 0.153, 0.154, 0.155, 0.156, 0.157, 0.158, 0.159, 0.160, 0.161, 0.162, 0.163, 0.164, 0.165,

0.166, 0.167, 0.168, 0.169, 0.170, 0.171, 0.172, 0.173, 0.174, 0.175, 0.176, 0.177, 0.178, 0.179, 0.180 inches or a range of radii encompassed by at least two of the radii recited herein.

5 In further examples, the structure and operation of the tab affects the reliability and predictability of the main score 26 fracture. In this regard, if tab nose 31 is too far from main score 26, the opening forces become excessively high, and may cause the tab to bend or break. Depending on the position of the rivet and the design of the tab, the tab
10 nose may contact the can end in one of three positions: radially inwards of the main score; at or over the main score; or radially outside of the main score. Optionally, the tab is configured such that the tab nose contacts the can end radially outside of the main score, and within 0.015 inches of the main score (measured from the outer edge thereof). Ideally, contact occurs along the centreline of the can end. Alternatively, the tab may be configured such that the tab nose contacts the can end radially inside of the main score,
15 and within 0.015 inches of the main score (measured from the inner edge thereof). Again, ideally with this configuration, contact would occur along the centreline of the can end.

A user may also measure the location of tab nose 31 with the tab in its at-rest state before actuation. In this regard, tab nose 31 is typically is between 0.000 and 0.008
20 inches from the outer edge of main score 26, and more typically between 0.000 and 0.005 inches, as measured radially outwardly. The difference in location of tab nose 31 relative to main score 26 between its initial contact state and its at-rest state is due to shunting during the tab actuation process. Tab shunts forward during the actuation and opening process, mostly because of deflection of the centre panel near the rivet and
25 opening of venting score 40. The magnitude of tab nose 31 shunting is also dependant on internal can pressure. In general, a higher internal pressure creates shunting of a corresponding greater magnitude. For simplicity, the dimensions provided for tab nose 31 location relative to main score 26 are measured with a microscope looking straight down on the can end. The exact location of the tab nose 31 of the shorter tab of
30 embodiments of the present invention relative to the main score 26 may be chosen according to the design parameters of the particular can end, for example main score configuration, tab design, venting score design, internal pressure, and other factors that will be understood by persons familiar with can end engineering and design.

CLAIMS

1. A full aperture can end comprising:
a centre panel having a rivet;
5 a tab staked by the rivet;
a main score extending around a peripheral region of the centre panel, the main score defining a removable panel;
a venting score disposed on the removable panel, the venting score having
10 (i) a central portion, the central portion intersecting a longitudinal axis that extends through a centre of the rivet and a centre of the centre panel, the longitudinal axis being perpendicular to a lateral axis that also extends through the centre of the rivet; and
(ii) a pair of lateral portions each including one or more segments, the pair of lateral portions extending no further forward than the lateral axis; and
15 wherein, along the longitudinal axis, the centre of the rivet is located between 0.146 and 0.246 inches from a centreline of the main score.
2. The full aperture can end of claim 1, wherein at least one segment of each lateral portion extends substantially parallel to the lateral axis.
20
3. The full aperture can end of claim 2, wherein said segment is disposed along the lateral axis.
4. The full aperture can end of claims 1, 2, or 3, wherein the centre panel includes a coined portion proximate the rivet, and wherein the central portion of the venting score intersects the coined portion.
25
5. The full aperture can end of any preceding claim, wherein, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.120 inches from a centreline of the venting score.
30
6. The full aperture can end of claim 5, wherein, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.100 inches from a centreline of the venting score.
35

7. The full aperture can end of claim 6, wherein, along the longitudinal axis, the centre of the rivet is located between 0.025 and 0.050 inches from a centreline of the venting score.
- 5 8. The full aperture can end of claim 6 or 7, wherein, along the longitudinal axis, the centre of the rivet is located at substantially 0.099 inches from the centreline of the venting score.
- 10 9. The full aperture can end of claim 8, wherein, along the longitudinal axis, the centre of the rivet is located at substantially 0.219 inches from the centreline of the main score.
- 15 10. The full aperture can end of any preceding claim, wherein the venting score further comprises a pair of side portions, wherein each of the side portions extend from a respective lateral portion, away from the lateral axis.
- 20 11. The full aperture can end of any preceding claim, further comprising an anti-fracture score extending at least partially around said peripheral region, radially inside of the main score.
- 25 12. The full aperture can end of claim 11, wherein, along the longitudinal axis, the centreline of the anti-fracture score is disposed between 0.030 and 0.070 inches from a centreline of the main score.
- 30 13. The full aperture can end of claim 12, wherein, along the longitudinal axis, the centreline of the anti-fracture score is disposed substantially 0.050 inches from the centreline of the main score.
- 35 14. The full aperture can end of claim 11, 12 or 13, wherein a residual thickness of the anti-fracture score is between 0.004 and 0.008 inches and the residual thickness of the main score is between 0.003 and 0.005 inches
15. The full aperture can end of claim 14, wherein the residual thickness of the anti-fracture score is substantially 0.006 inches, and the residual thickness of the main score is substantially 0.004 inches.

16. The full aperture can end of any preceding claim, wherein the tab includes a nose, and the tab is staked at the rivet such the nose is disposed proximate the main score, the tab being elongate along the longitudinal axis.
- 5 17. The full aperture can end of claim 16, wherein the tab is configured such that the tab nose contacts the can end radially outside of the main score.
18. The full aperture can end of claim 17, wherein the tab is configured such that the tab nose contacts the can end within 0.015 inches of the main score.
- 10 19. The full aperture can end of any preceding claim, comprising 3000 series aluminium alloy.
20. The full aperture can end of any preceding claim, having a vent test rating of at least 30 psi.
- 15 21. The full aperture can end of any preceding claim, having a vent test rating of at least 70 psi.
- 20 22. The full aperture can end of any preceding claim, having a vent test rating of at least 85 psi.
23. The full aperture can end of any preceding claim, having a vent test rating of at least 90 psi.
- 25 24. A can assembly comprising the full aperture can end of any preceding claim and a can body, the can end seamed onto the can body.
25. The can assembly of claim 24, the can assembly filled with a carbonated beverage.