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(54) **EASY OPEN CLOSURE**

LEICHT ZU ÖFFNENDER VERSCHLUSS

FERMETURE À OUVERTURE FACILE

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Description

TECHNICAL FIELD

[0001] The invention relates to an easy-open closure with improved abuse resistance and opening performance and, in particular to an easy-open can end. The can end is typically of the "full aperture opening" type, in which the end has a circumferential score which enables a generally circular panel of the end to be removed and thereby give full access to a product within the can body to which the can end is fixed.

BACKGROUND

[0002] Easy-open metal closures, and in particular easy-open can ends, are known to comprise a metal panel, defined by a score (i.e. a line where the metal is of reduced thickness), which when broken allows the panel to be removed. The panel is removed by the use of a tab, whose main features are a strong front end and a ring, and which is attached to the panel by a rivet. The ring is lifted, levering the strong front end into the score, thereby initiating a tear in the score. The ring is then pulled to complete the removal of the panel, thereby opening the can without the need for a can opener. Easy-open can ends can be made of steel or aluminium and come in a variety of shapes including round, rectangular and oval. They are typically used in food or beverage cans.

[0003] Easy-open can ends have a number of functional requirements to fulfil. They must provide long-term, high-integrity seals capable of resisting internal and external pressures, and capable of resisting a wide range of temperatures which may be applied during can sterilisation/pasteurisation and cooling processes. They must be resistant to abuse occasioned by can-handling systems used in can mass-production and distribution. They must also be easy to open by the end consumer. An effect that may occur during processing, handling and storage of filled metal cans is increased internal pressure which can give rise to so-called "peaking" which may deform the can end, possibly even causing accidental fracturing along the score.

[0004] Each of the functional requirements of the easy-open can end must be balanced against the others. For example, whilst increasing the thickness of the can end and score may improve the can end integrity and ability to resist pressure, it comes at the cost of being more difficult to open; defeating the purpose of being an easy-open can end. An alternative to increasing thickness is to introduce "furrows", also known as beads, into the can end to provide additional strength whilst minimising the metal thickness requirement. These beads are elongate beads.

[0005] One issue faced by can manufacturers and designers is that even small changes in can design may have significant cost consequences when scaled up to the high-volume mass production that takes place in can manufacturing plants. A small increase in metal used per can may increase the total production cost significantly when scaled to production rates in the hundreds of thousands or more cans per day. Another issue faced by can manufacturers and designers is that design changes may require production lines to be stopped while new machines are fitted, tested and calibrated before production can resume. Time during which production is "offline" may significantly increase costs. Another problem that arises from changes in design is that each of the features is highly dependent on the others. Varying the size, position, shape and/or thickness of one feature can result in other features no longer functioning as intended. For example, a feature in one position intended to provide strength to the can end may weaken the can end if moved to another position. As a result, even small design changes may require a redesign of the entire can end and/or recalibration of the machines and tools on a production line to ensure consistent production to within accepted dimension error margins.

[0006] A plan view of a known easy-open can end is shown in Figure 1. The can end includes a series of terraces 101, a circumferential score 102, a seaming panel 103, and wing shaped beads 104 adjacent a rivet 105. The can end of the type shown in Figure 1 has a specific chord length along which the panel folds when the tab 106 is raised for opening. This chord is illustrated by the broken line 109. The can end design of Figure 1 may achieve improved pressure performance by including a bead 107 that extends around the entire circumference of the closure, and which passes between the score 102 and the nose portion 108 of the tab 106. The bead 107, and its location close to and parallel with the score 102, strengthens the closure in the region of the score 102, tending to prevent unintended fracturing of the score.

[0007] The can end of the type shown in Figure 1 has a number of disadvantages. Whilst it does achieve a satisfactory pressure performance, its opening performance is not satisfactory primarily due to the short length of the chord 109 between the two points where it intersects with the score 102 which tends to prevent an initial fracture of the score, induced when the tab is raised, from propagating around the score to a sufficient extent.

[0008] A solution to this problem is to terminate the bead 107 on each side of the tab 106, i.e. to provide a break in the bead 107 in the region behind the tab. However, it has been found that merely terminating the bead 107 results in an increased risk of peaking along the score line in the region of the break. A further solution to this problem, proposed in EP1577222, is to maintain the bead 107 as shown in Figure 1 but also to introduce an additional pair of relatively short beads on either side of the rivet. The additional beads provide a fold line about which the closure tends to fold when the tab is raised, counteracting the strengthening effect of the bead 107 and ensuring the can remains easy to open.

[0009] An important feature of can ends is their ability to resist abuse during transport and stacking. A particular

problem in this regard is the possibility that when a filled can is stacked on top of another filled can, e.g. during transport, the base of the upper can pushes down on the tab of the lower can causing the score on the lower can to fracture in some instances. This problem can also arise more generally in other contexts where a force pushes down on the tab (e.g. accidentally by an end consumer). With particular reference to Figure 1, downwards pressure on the nose portion 108 of the tab 106 may cause an unintentional initial fracturing of the score 102. A known solution to this problem is to form a pair of downwardly projecting points or nibs on either side of the tab which project slightly further than the point of the tab nose. These additional points typically make contact with the surface of the can end and, in the event of impact e. g. due to stacking, prevent the nose from coming into contact with the surface. When the handle of the tab is raised to open the can however, the tab tends to pivot about these points allowing the nose to impact and fracture the score. It is possible to achieve a similar effect by providing a pair of raised dimples or so-called "pips" on the can end, under and intended to be in contact with the tab. Whilst pips may prevent the tab nose from coming into contact with the surface, they introduce weakness into the surface of the can end and therefore reduce the can end's pressure resistance. US2016/0325880 A1 and US 2004/099665 A1 propose a lid for a container made of metal, according to the preamble of claim 1. US2004099665 discloses a closure comprising raised beads for helping to control the bending of a removable panel. EP1182140 discloses reinforcing ribs which assist in controlling the opening of a can end. The ends of the ribs terminate under a tab.

SUMMARY

[0010] According to a first aspect of the invention there is provided a metal closure for seaming onto the end of a container, the closure comprising a centre panel defined by a circumferential score, a tab fixed to the panel by a rivet formed in the panel. The tab has a heel portion radially inside of the rivet and a nose portion radially outside of the rivet and adjacent to a radially inner edge of the score, such that lifting of the heel portion forces the nose portion into contact with a region of the panel adjacent to the radially inner edge of the circumferential score, thereby causing the closure to fracture partially along the score. The closure comprises two spaced apart, elongate raised beads formed in the panel, extending with a circumferential component of direction, and each having an end terminating under the tab radially between the rivet and the score to allow the tab to pivot about the two raised beads.

[0011] According to an embodiment, the two raised beads may be substantially parallel to the circumferential score.

[0012] According to an embodiment, each of the ends terminating under the tab may terminate at an angular extent of between 5 degrees and 15 degrees, or preferably between 7 degrees and 13 degrees, from a line defined between the geometric centre of the rivet and the geometric centre of the centre panel.

[0013] According to an embodiment, each of the two raised beads may have an angular extent of between 25 degrees and 35 degrees, or between 15 degrees and 25 degrees, or between 5 degrees and 15 degrees.

[0014] According to an embodiment, there is provided a circumferentially extending strengthening bead in the panel, adjacent to and substantially parallel to the circumferential score.

[0015] According to an embodiment, the regions between the circumferential strengthening bead and the two raised beads may slope substantially continuously with respect to the plane of the centre panel.

[0016] According to an embodiment, each of the ends terminating under the tab may terminate in a region radially between the rivet and the circumferential strengthening bead.

[0017] According to an embodiment, one or more terracing features formed in the centre panel is provided.

[0018] According to an embodiment, a circumferential countersink and chuck wall radially outside of the score is provided.

[0019] According to a second aspect of the invention, a container is provided comprising a container body and a metal closure according to the first aspect of the invention. The closure is seamed onto the container body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Figure 1 shows a plan view of a prior art easy-open closure.

Figure 2 shows an isometric view of an easy-open closure according to an embodiment.

Figure 3 shows a plan view of the easy-open closure of Figure 2.

Figure 4a shows a section view of the easy-open closure of Figure 2 through the line A-A in Figure 3.

Figure 4b shows an isolated cross-section view taken from Figure 4a.

Figure 5a shows a section view of the easy-open closure of Figure 2 through the line B-B in Figure 3.

Figure 5b shows an isolated cross-section view taken from Figure 5a.

Figure 6 shows an isometric view of a can onto which the easy-open closure of Figure 2 has been seamed.

DETAILED DESCRIPTION

[0021] With reference to Figure 1, the problems associated with known can closures have been discussed above. In particular, a need has been identified for a can closure that has both satisfactory abuse resistance and satisfactory opening performance, whilst retaining satis-

factory pressure performance. Such a can closure will now be described with reference to Figures 2 to 5.

[0022] Figures 2 and 3 respectively show an isometric view and a plan view of an improved can closure, indicated generally as 201. The can closure 201 includes a number of conventional features including:

- A panel 202.
- A circumferential score 203 that is fractured to open the can closure which extends around the panel 202.
- A shaped circumference 204 suitable for seaming onto a can.
- A tab 205 riveted to the can closure with rivet 206. The tab has a nose portion 207.
- Panel steps 210 which give rise to a terracing profile across the diameter of the can closure, such that the region in which the tab 205 is riveted to the closure is raised with respect to a finger receiving region 211. These panel steps 210 also improve pressure and opening performance.
- A chuck wall 212.
- A circumferential strengthening bead 209 inside the score 203 following the line of the inner edge of the score 203 around the closure in so far as it is adjacent to and parallel with the score 203.

[0023] In order to provide a satisfactory pressure performance and abuse resistance, two spaced apart, elongate raised beads 208 are provided inside the score 203, terminating under the nose end of the tab 205 but not extending so far as to underlie the nose portion 207. Unlike "furrowed" beads which dip into the surface of the panel 202, the two raised beads 208 are ridge-like in appearance, protruding above the surface of the panel 202, and are situated radially on the inside of and in proximity to the circumferential strengthening bead 209. The two raised beads 208 are substantially parallel to the circumferential strengthening bead 209.

[0024] The ends of the strengthening beads which are located under the tab are located at an angle, measured with respect to a line A-A defined between the geometric centre of the rivet and the geometric centre of the closure (see Figure 3), of between 5 and 15 degrees, more preferably between 7 and 13 degrees, and more preferably still of substantially 10 degrees. Each of the beads extends over an angle of 30 degrees or less, optionally 20 degrees or less, or optionally 15 degrees or less. In a particularly preferred embodiment, each bead extends from 10 degrees to 40 degrees measured with respect to the line A-A.

[0025] As is apparent in Figure 3, both the panel and the tab have reflection symmetry about line A-A. When opening a can closure in accordance with its envisaged normal use, the symmetry of the tab is approximately aligned with that of the panel as this ensures the nose portion 207 is in an optimal position to fracture the score 203 when the tab 205 is lifted. Whilst is may be possible to force the can closure open without such an alignment, doing so would be difficult as the nose portion 207 would no longer be aligned in an optimal position with the score 203. This would defeat the purpose of the can closure being "easy-open". Thus, whilst in some instances the tab may rotate about the rivet outside of normal use (e.g. in storage, in transit, or during other abuse), the symmetry of the tab is intended to be re-aligned with that of the can-closure prior to normal use.

[0026] The two raised beads 208 are formed in the panel and terminating under the nose end of the tab 205. When downward pressure is exerted on the nose portion 207 (e.g. caused by can stacking), the pressure may cause the nose end of the tab 205 to come into contact with the two raised beads 208. The pressure is thereby transferred through the nose end of the tab 205 and onto the two raised beads 208 which provide support against the downward pressure. In this way, the two raised beads 208 prevent the nose portion 207 (situated above the gap between the ends of the two raised beads 208) from accidentally contacting and fracturing the score 203 when the closure is subject to abuse from e.g. stacking. This functionality is similar to a pip. However, unlike with pips which create weakness in the panel 202 and which are not elongate, the two raised beads 208 strengthen the panel 202 by providing additional resistance against internal and external pressures. When the handle of the tab 205 is raised to open the can, the tab 205 tends to pivot about the two raised beads 208 allowing the nose portion 207 to impact and fracture the score 203. The two raised beads 208 therefore provide the functionality of a pip whilst simultaneously improving closure strength.

[0027] The two raised beads 208 additionally assist in maintaining satisfactory "ease of opening" performance by providing a suitable lever point about which the nose portion 207 can be levered during opening. The closer the lever point is to the score 203, 303, the less force is required when handle of the tab 205 is raised.

[0028] By providing support to the tab 205, the two raised beads 208 additionally prevent the nose portion 207 from accidentally contacting other surfaces of the closure, thereby countering the risk of nose breakage.

[0029] Figures 4a and 4b respectively show a section view of the improved easy-open closure, indicated generally by reference numeral 201, through the line A-A in Figure 3, and an isolated cross-section view of the profile through line A-A. As noted above, whilst the two raised beads (not shown in Figures 4a and 4b) extend at least partially under the nose end of the tab 205, they do not extend so far as to underlie the nose portion 207. Thus, as is apparent in Figures 4a and 4b, there is a direct path for the nose portion 207 to take to contact and fracture the score 203 when the handle of the tab 205 is raised sufficiently to pivot around the two raised beads. Figures 4a and 4b also illustrate that the circumferential strengthening bead 209 is situated inside of and adjacent to the score 203 but outside of the rivet 206.

[0030] Figures 5a and 5b respectively show a section view of the improved easy-open closure, indicated gen-

erally by reference numeral 201, through the line B-B in Figure 3, and an isolated cross-section view of the profile through line B-B. One of the two raised beads 208 is shown in contact with and supporting the nose end of the tab 205. If downward pressure is applied to the tab (e.g. from can stacking), the raised radial beads 208 provide support against that pressure. When the handle of the tab 205 is raised sufficiently to pivot around the raised beads 208, the can is opened in the usual way. It is also apparent from Figures 5a and 5b that the raised radial beads 208 are not only parallel to but also coincide with the circumferential strengthening bead 209 in that the regions between the circumferential strengthening bead 209 and the two raised beads 208 slope continuously with respect to the plane of the centre panel 202. In other words, the circumferential strengthening bead 209 is positioned radially close enough to the two raised beads 208 such that the slopes 214 between the lowest part of the strengthening bead 209 and the highest parts of the raised beads 208 are continuous.

[0031] Figure 6 shows an isometric view of a can 213 onto which the easy-open closure 201 has been seamed.

[0032] It will be appreciated by the person skilled in the art that various modifications may be made to the above described embodiment without departing from the scope of the present invention. For example, the size of the two raised beads 208 shown in Figures 2-5 are optimised and sized for the purpose of that design but may be increased to improve light weighting or alternatively decreased in size in response to other design considerations. Additionally, the shape of the can 213 in Figure 6 is illustrative only and other shaped cans (e.g. shorter/taller, narrower/wider, and/or non-circular shapes such as rectangular) are also envisaged. Whilst the arc ranges of the raised beads 208 above are such that the extreme ends of the beads do not meet, it is also envisaged that the arc of each bead may extend around the circumference of the closure such that they join each other at the opposite side of the closure to the nose end of the tab 205. The angles given above are whole numbers but deviations from these within accepted margins are also envisaged.

Claims

1. A metal closure (201) for seaming onto the end of a container, the closure (201) comprising:

   a centre panel (202) defined by a circumferential score (203);
   a tab (205) fixed to the panel (202) by a rivet (206) formed in the panel (202), the tab (205) having a heel portion radially inside of the rivet (206) and a nose portion (207) radially outside of the rivet (206) and adjacent to a radially inner edge of the score (203), such that lifting of the heel portion forces the nose portion (207) into contact with a region of the panel (202) adjacent to the radially inner edge of the circumferential score (203), thereby causing the closure (201) to fracture partially along the score (203); and
   two spaced apart, elongate raised beads (208) formed in the panel (202), extending with a circumferential component of direction, **characterised in that** each raised bead (208) has an end terminating under the tab (205) radially between the rivet (206) and the score (203) to allow the tab (205) to pivot about the two raised beads (208).

2. A closure (201) according to claim 1, wherein the two raised beads (208) are substantially parallel to the circumferential score (203).

3. A closure (201) according to claims 1 or 2, wherein each said end of the two raised beads (208) terminating under the tab (205) terminates at an angular distance of between 5 degrees and 15 degrees, or preferably between 7 degrees and 13 degrees, from a line A-A defined between the geometric centre of the rivet and the geometric centre of the centre panel (202).

4. A closure (201) according to any one of the preceding claims, wherein each of the two raised beads (208) has a circumferential angular extent from beginning to end of between 25 degrees and 35 degrees, or between 15 degrees and 25 degrees, or between 5 degrees and 15 degrees.

5. A closure (201) according to any one of the preceding claims and comprising a circumferentially extending strengthening bead (209) in the panel (202), adjacent to and substantially parallel to the circumferential score (203).

6. A closure (201) according to claim 5, wherein the regions between the circumferential strengthening bead (209) and the two raised beads (208) slope substantially continuously with respect to the plane of the centre panel (202).

7. A closure (201) according to claims 5 or 6, wherein each said end of the two raised beads (208) terminates in a region radially between the rivet (206) and the circumferential strengthening bead (209).

8. A closure (201) according to any one of the preceding claims and comprising one or more terracing features formed in the centre panel (202).

9. A closure (201) according to any one of the preceding claims and comprising a circumferential countersink and chuck wall (212) radially outside of the score.

10. A container comprising a container body and a metal closure (201) according to any one of claims 1 to 9 seamed onto the container body.

Patentansprüche

1. Metallverschluss (201) zum Falzen an das Ende eines Behälters, wobei der Verschluss (201) Folgendes umfasst:

eine mittlere Platte (202), die durch eine umlaufende Kerbe (203) definiert wird,
eine Lasche (205), die durch einen Niet (206), der in der Platte (202) geformt ist, an der Platte (202) befestigt ist, wobei die Lasche (205) einen Fersenabschnitt, der in Radialrichtung von dem Niet (206) nach innen angeordnet ist, und einen Nasenabschnitt (207), der in Radialrichtung von dem Niet (206) nach außen angeordnet ist und benachbart zu einer in Radialrichtung inneren Kante der Kerbe (203) ist, aufweist, so dass ein Anheben des Fersenabschnitts den Nasenabschnitt (207) in Berührung mit einem Bereich der Platte (202), benachbart zu der in Radialrichtung inneren Kante der umlaufenden Kerbe (203), zwingt, wodurch bewirkt wird, dass der Verschluss (201) entlang der Kerbe (203) teilweise bricht, und
zwei voneinander beabstandete, längliche erhöhte Wülste (208), die in der Platte (202) geformt sind, wobei sie sich mit einer umlaufenden Richtungskomponente erstrecken, **dadurch gekennzeichnet, dass** jede erhöhte Wulst (208) ein Ende aufweist, das unter der Lasche (205) in Radialrichtung zwischen dem Niet (206) und der Kerbe (203) endet, um zu ermöglichen, dass die Lasche (205) um die zwei erhöhten Wülste (208) schwenkt.

2. Verschluss (201) nach Anspruch 1, wobei die zwei erhöhten Wülste (208) im Wesentlichen parallel zu der umlaufenden Kerbe (203) sind.

3. Verschluss (201) nach Ansprüchen 1 oder 2, wobei jedes Ende der zwei erhöhten Wülste (208), das unter der Lasche (205) endet, in einem Winkelabstand von zwischen 5 Grad und 15 Grad oder vorzugsweise zwischen 7 Grad und 13 Grad von einer Linie A-A endet, die zwischen dem geometrischen Mittelpunkt des Niets und dem geometrischen Mittelpunkt der mittleren Platte (202) definiert wird.

4. Verschluss (201) nach einem der vorhergehenden Ansprüche, wobei jede der zwei erhöhten Wülste (208) eine umlaufende Winkelausdehnung vom Anfang zum Ende von zwischen 25 Grad und 35 Grad, oder zwischen 15 Grad und 25 Grad oder zwischen 5 Grad und 15 Grad aufweist.

5. Verschluss (201) nach einem der vorhergehenden Ansprüche und umfassend eine sich umlaufend erstreckende Verstärkungswulst (209) in der Platte (202), benachbart zu und im Wesentlichen parallel zu der umlaufenden Kerbe (203).

6. Verschluss (201) nach Anspruch 5, wobei die Bereiche zwischen der umlaufenden Verstärkungswulst (209) und den zwei erhöhten Wülsten (208) im Wesentlichen kontinuierlich in Bezug auf die Ebene der mittleren Platte (202) abfallen.

7. Verschluss (201) nach Ansprüchen 5 oder 6, wobei jedes Ende der zwei erhöhten Wülste (208) in einem Bereich, der in Radialrichtung zwischen dem Niet (206) und der umlaufenden Verstärkungswulst (209) angeordnet ist, endet.

8. Verschluss (201) nach einem der vorhergehenden Ansprüche und umfassend ein oder mehrere Abstufungsmerkmale, die in der mittleren Platte (202) geformt sind.

9. Verschluss (201) nach einem der vorhergehenden Ansprüche und umfassend eine umlaufende Senkung und eine Verschließkopflippe (212) in Radialrichtung von der Kerbe nach außen.

10. Behälter, der einen Behälterkörper und einen Metallverschluss (201) nach einem der Ansprüche 1 bis 9, der an den Behälterkörper gefalzt ist, umfasst.

Revendications

1. Fermeture en métal (201) destinée à être sertie sur l'extrémité d'un récipient, la fermeture (201) comprenant :

un panneau central (202) défini par une entaille circonférentielle (203) ;
une languette (205) fixée sur le panneau (202) par un rivet (206) formée dans le panneau (202), la languette (205) comportant une partie de talon disposée radialement à l'intérieur du rivet (206), et une partie de nez (207) disposée radialement à l'extérieur du rivet (206) et adjacente à un bord radialement interne de l'entaille (203), de sorte que le soulèvement de la partie de talon entraîne la mise en contact de la partie de nez (207) avec une région du panneau (202) adjacente au bord radialement interne de l'entaille circonférentielle (203), entraînant ainsi la cassure partielle de la fermeture (201) le long de l'entaille (203) ; et
deux bourrelets surélevés allongés espacés (208) formés dans le panneau (202), s'étendant

avec une composante circonférentielle de direction, **caractérisée en ce que** chaque bourrelet surélevé (208) comporte une extrémité se terminant au-dessous de la languette (205), radialement entre le rivet (206) et l'entaille (203), pour permettre le pivotement de la languette (205) autour des deux bourrelets surélevés (208).

2. Fermeture (201) selon la revendication 1, dans laquelle les deux bourrelets surélevés (208) sont sensiblement parallèles à l'entaille circonférentielle (203).

3. Fermeture (201) selon les revendications 1 ou 2, dans laquelle chaque dite extrémité des deux bourrelets surélevés (208) se terminant au-dessous de la languette (205) se termine à une distance angulaire comprise entre 5 degrés et 15 degrés, ou de préférence entre 7 degrés et 13 degrés, d'une ligne A-A définie entre le centre géométrique du rivet et le centre géométrique du panneau central (202).

4. Fermeture (201) selon l'une quelconque des revendications précédentes, dans laquelle chacun des deux bourrelets surélevés (208) a une extension angulaire circonférentielle du début à la fin comprise entre 25 degrés et 35 degrés, ou entre 15 degrés et 25 degrés, ou entre 5 degrés et 15 degrés.

5. Fermeture (201) selon l'une quelconque des revendications précédentes, et comprenant un bourrelet de renforcement à extension circonférentielle (209) dans le panneau (202), adjacent et sensiblement parallèle à l'entaille circonférentielle (203).

6. Fermeture (201) selon la revendication 5, dans laquelle les régions entre le bourrelet de renforcement circonférentiel (209) et les deux bourrelets surélevés (208) sont inclinées sensiblement en continu par rapport au plan du panneau central (202)

7. Fermeture (201) selon les revendications 5 ou 6, dans laquelle chaque dite extrémité des deux bourrelets surélevés (208) se termine dans une région disposée radialement entre le rivet (206) et le bourrelet de renforcement circonférentiel (209).

8. Fermeture (201) selon l'une quelconque des revendications précédentes, et comprenant une ou plusieurs structures en gradin formées dans le panneau central (202).

9. Fermeture (201) selon l'une quelconque des revendications précédentes, et comprenant un fraisage circonférentiel et une paroi de serrage (212) radialement à l'extérieur de l'entaille.

10. Récipient, comprenant un corps de récipient et une fermeture en métal (201) selon l'une quelconque des revendications 1 à 9 sertie sur le corps du récipient.

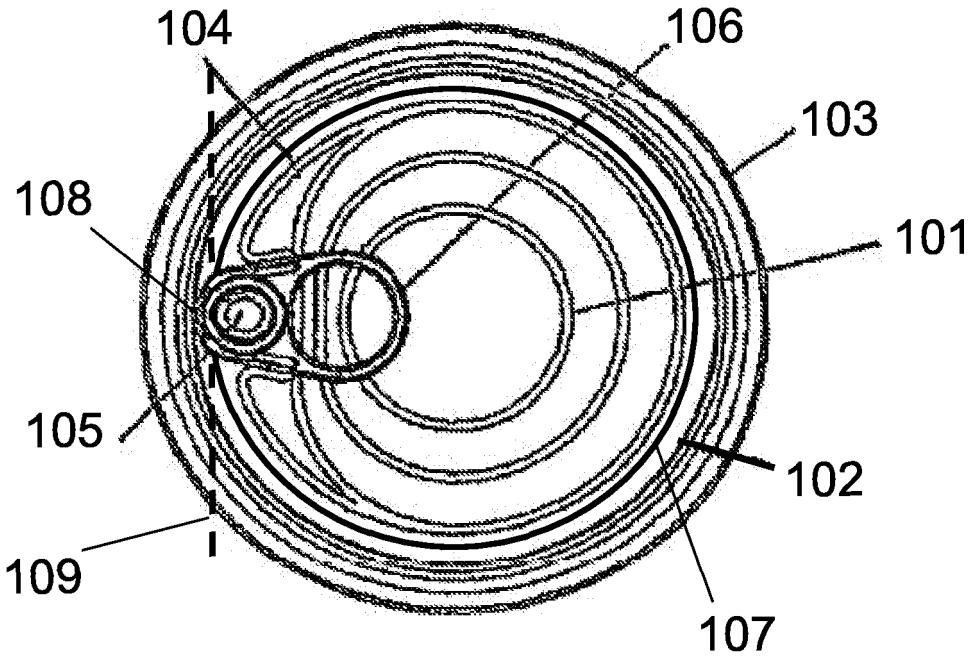

Figure 1 (prior art)

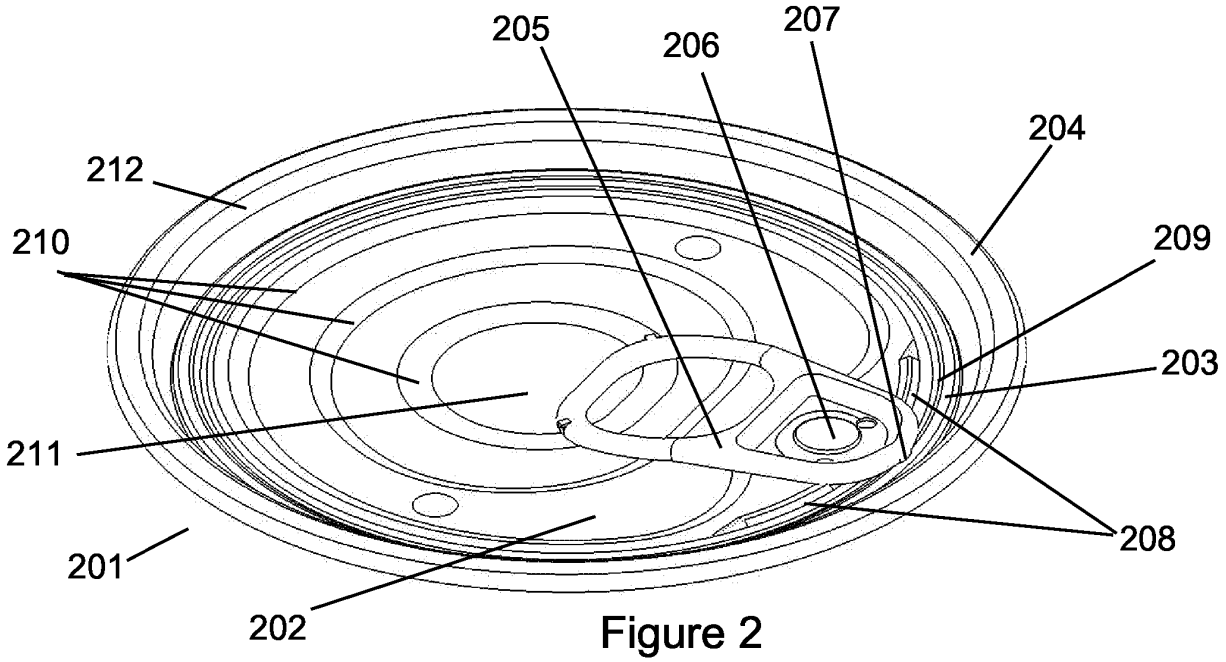

Figure 2

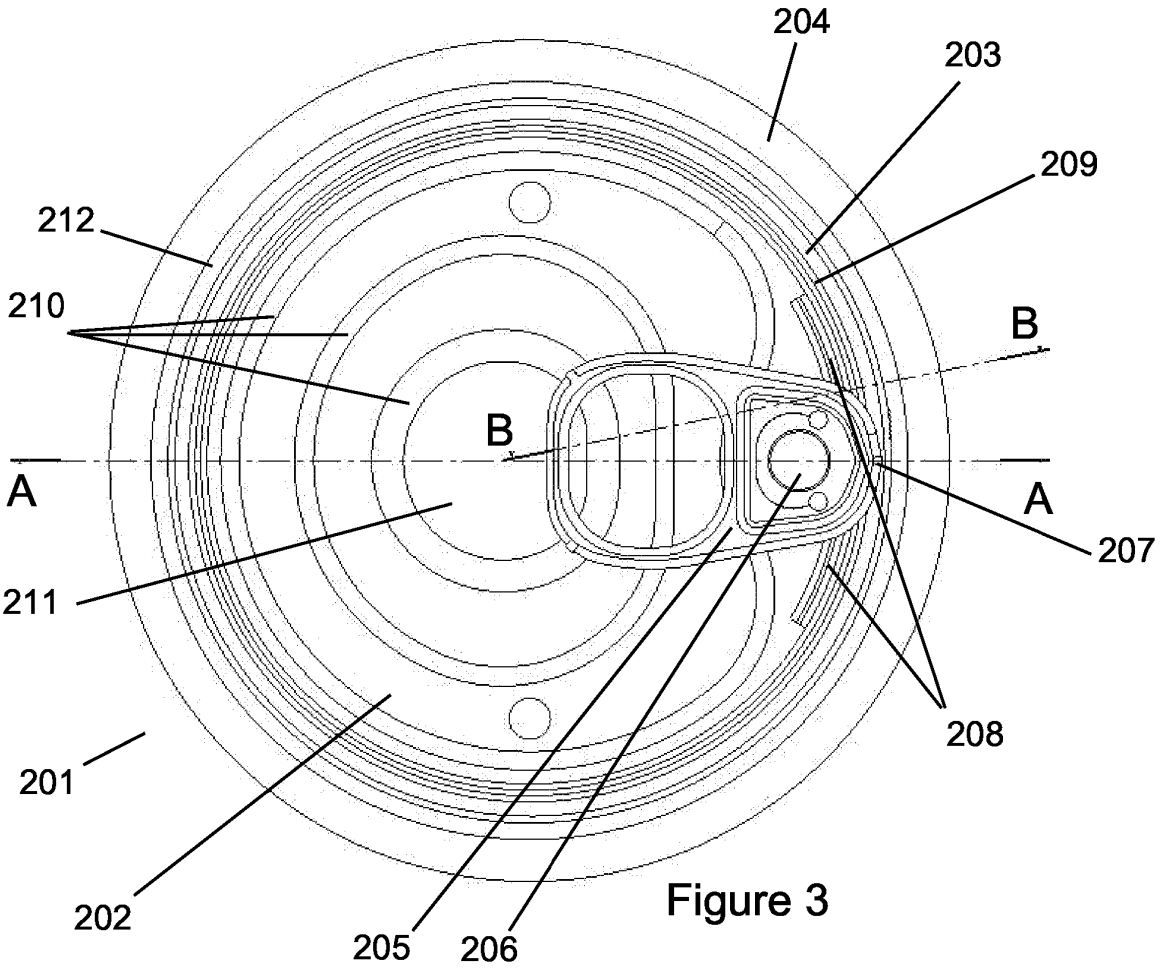

Figure 3

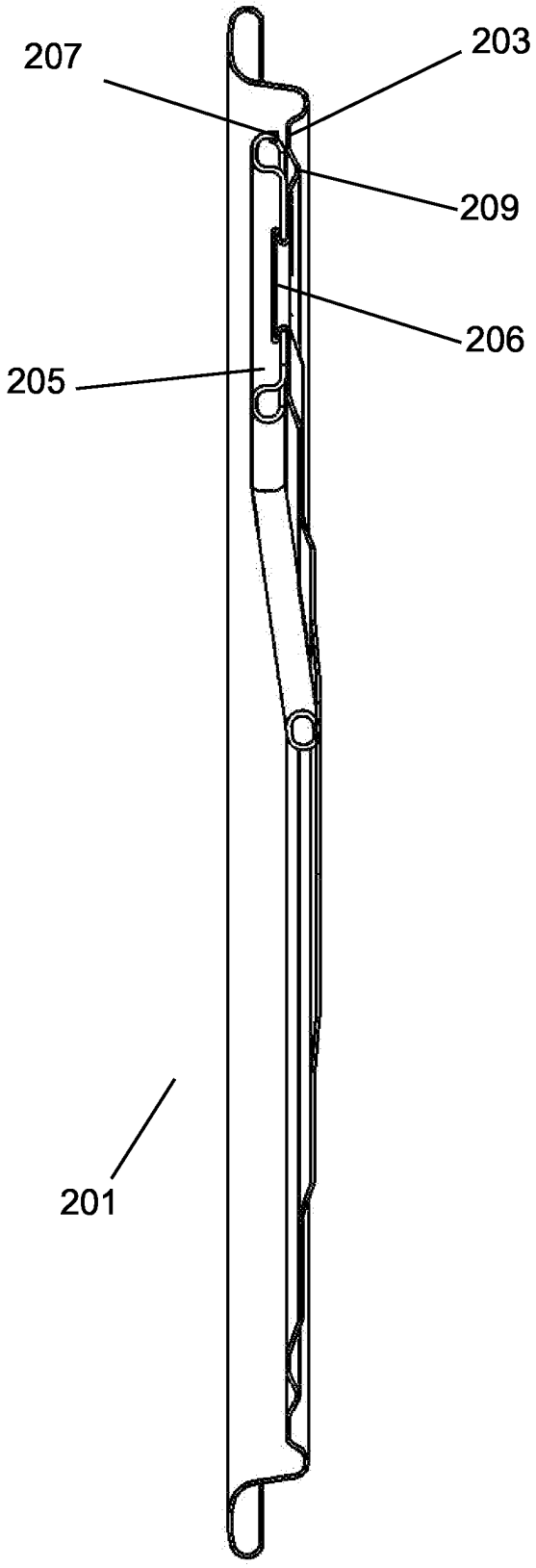

Figure 4a

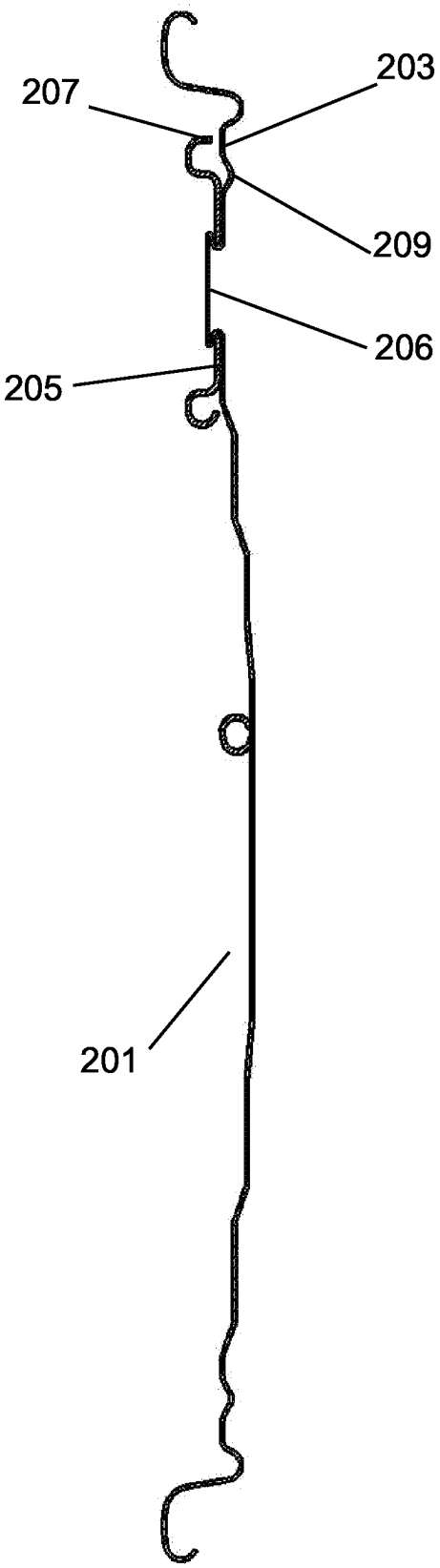

Figure 4b

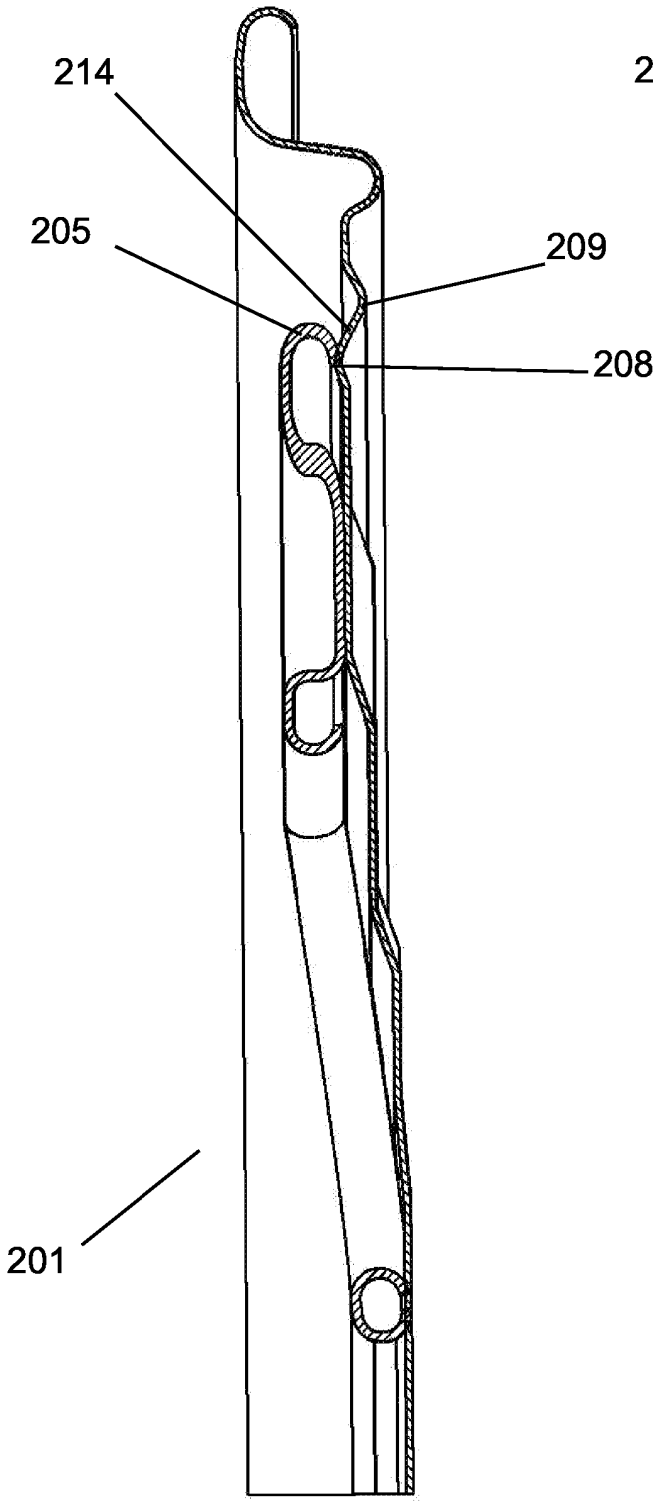

Figure 5a

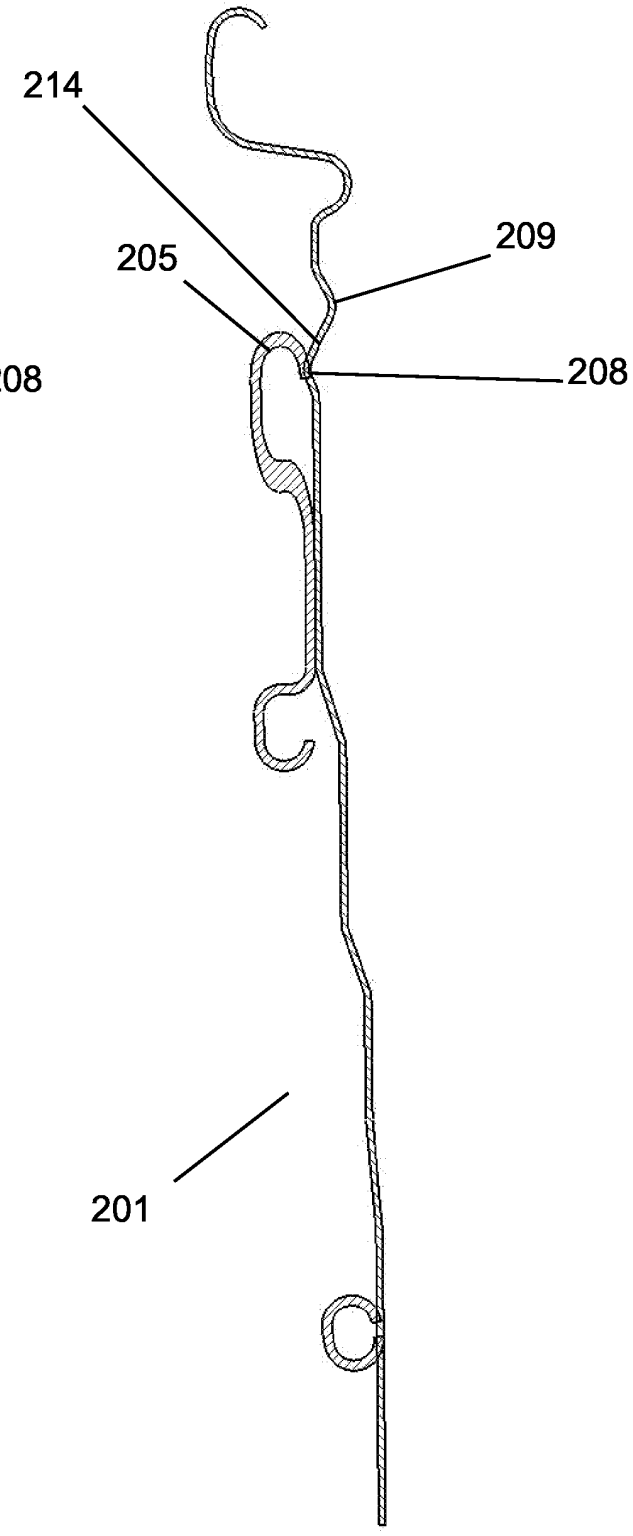

Figure 5b

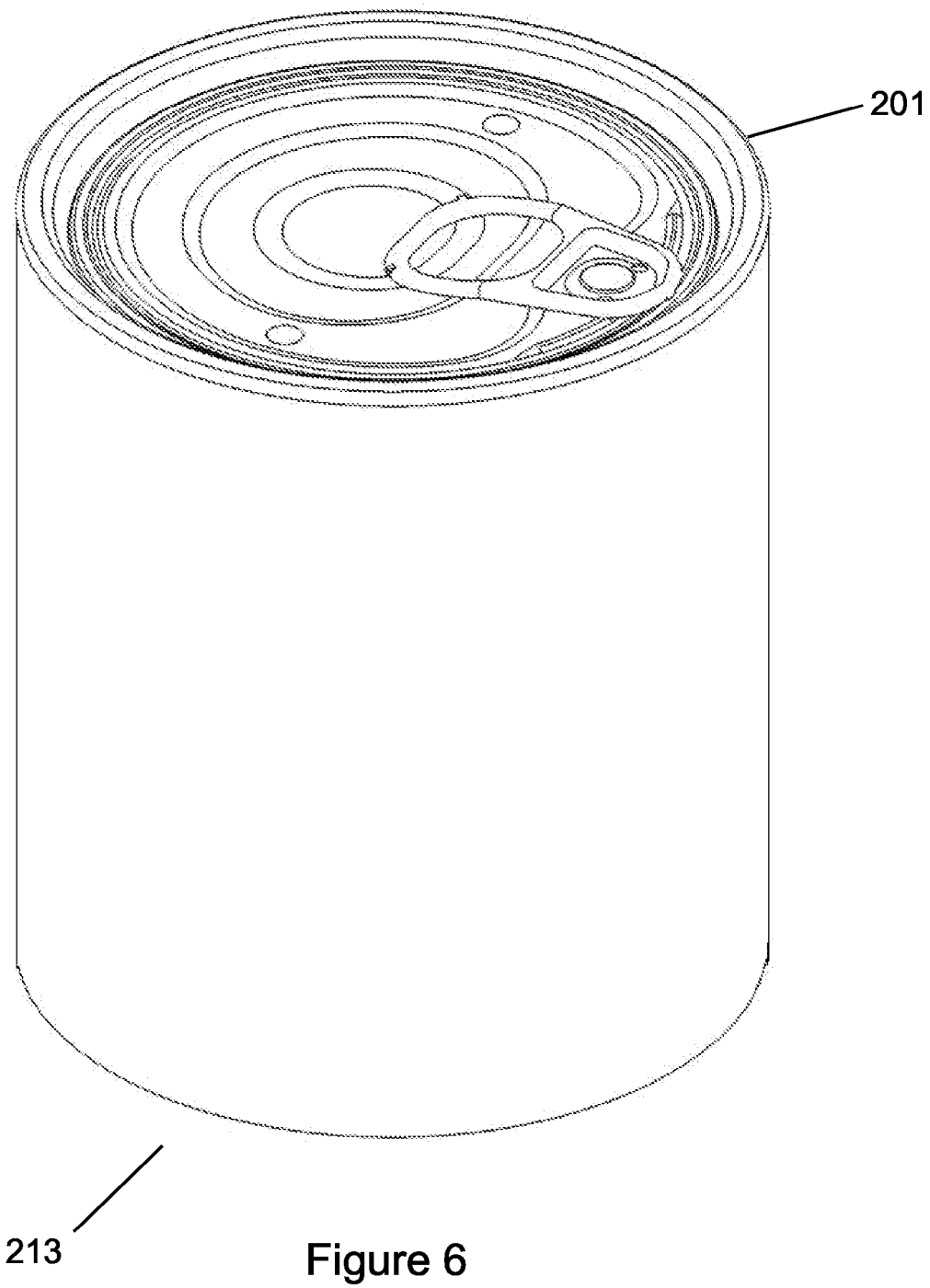

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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