

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MPL BRANDS NV, INC.

Petitioner,

v.

BUZZBALLZ, LLC

Patent Owner.

PTAB Case No. IPR2024-01098

U.S. Patent No. 11,738,904

**DECLARATION OF NATHAN J. DELSON, PH.D., IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 11,738,904**

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Appendix D	U.S. Patent No. 6,234,336 to Neiner
Appendix E	U.S. Patent No. 4,522,779 to Jabarin
Appendix F	U.S. Patent No. 8,468,785 to Thomasset

I. INTRODUCTION

1. My name is Nathan J. Delson. I am a Senior Teaching Professor at the University of California, San Diego (UCSD).

2. I have been engaged by MPL Brands NV, Inc. (“MPL”) as a consultant in connection with MPL’s Petition for *Inter Partes* Review of U.S. Patent No. 11,738,904 (Ex. 1001 (“’904 patent”)).

3. I understand that the ’904 patent has been assigned to BuzzBallz, LLC (“BuzzBallz”). BuzzBallz is also referred to as the “Patent Owner” in this declaration.

4. This declaration is based on the information currently available to me. To the extent that additional information becomes available, I reserve the right to continue my investigation and study, which may include a review of documents and information that may be produced, as well as testimony from depositions that have not yet been taken.

II. QUALIFICATIONS AND EXPERIENCE

A. Education and Experience

5. I obtained my Ph.D. degree in Mechanical Engineering from Massachusetts Institute of Technology (MIT) in 1994.

6. I have worked for 27 years as a faculty teaching mechanical engineering design, first at Yale University and now at the University of California at San Diego.

My current position is Senior Teaching Professor in the Department of Mechanical and Aerospace Engineering. I have performed research in Robotics, Medical Devices, and Design Education. I have also worked for 2 years in the Aerospace Industry for United Technologies. I have consulted in mechanical engineering for companies such as Design Continuum, Sixense, DriveCam, and others. I have received awards from the National Inventors Hall of Fame and for teaching design.

7. I have worked on and supervised a wide range of engineering projects. These projects have included ones with vessels under pressure or vacuum, and containers with seals to contain liquid or gas. I have worked on a project with a component that has a pre-weakened area that was created by a thinning of metal along a line which created a structure that remained intact under certain conditions but then detached under other conditions. I advise on material selection for products which include both metal and plastic components. I teach and supervise projects where Design For Manufacturability (DFM) is a primary consideration and where design decisions are based on reducing the cost of a product while maintaining its functional performance. I also teach Computer Aided Design where the geometric constraints of the parts need to be defined. I am familiar with technology and history of beverage container design and fabrication, and how technology has improved over the years to meet a wide range of needs in the container industry.

8. This experience is directly relevant to the technology described in the patents in suit. The above outline of my experience with mechanical devices and manufacturing is not comprehensive of all of my experience over my years of technical experience. Additional details of my background are set forth in my curriculum vitae, attached to this declaration as Appendix A, which provides a more detailed summary of my education, work experience, publications, and teaching history.

B. Materials Reviewed

9. My opinions expressed in this declaration are based on documents and materials identified in this declaration, including the '904 patent, the prosecution history, the prior art references and background materials discussed in this declaration, and the other references specifically identified in this declaration. I have considered these materials in their entirety, even if only portions are discussed here. The following is an exemplary list of the materials on which I based my opinion.

Exhibit	Description
Ex. 1001	U.S. Patent No. 11,738,904 B2
Ex. 1003	Prosecution History of U.S. Patent No. 11,738,904 B2
Ex. 1004	Prosecution History of U.S. Patent No. 10,604,296 B2
Ex. 1005	Comparison of Original and Amended Specifications
Ex. 1006	Prosecution History of U.S. Patent No. 11,338,955 B2
Ex. 1007	U.S. Patent Publication 2011/0253720 A1 (“Kick”)

Exhibit	Description
Ex. 1008	German Unexamined Patent Publication 102004046423 A1 (“Ackermann”)
Ex. 1009	U.S. Patent No. 4,465,204 (“Kaminski”)
Ex. 1010	U.S. Patent Publication 2008/0044603 A1 (“Hutchinson”)
Ex. 1011	The American Heritage Dictionary

10. I have also relied on my own experience and expertise in mechanical engineering and design technologies.

C. Level of Ordinary Skill in the Art

11. I am not an attorney and offer no legal opinions. I have been informed about certain aspects of the law for purposes of my analyses and opinions.

12. I understand that in analyzing questions of invalidity and infringement, the perspective of a person having ordinary skill in the art (“POSITA”) is often implicated, and the Court may need assistance in determining that level of skill.

13. I understand that the claims and written description of a patent must be understood from the perspective of a POSITA. I have been informed that the following factors may affect the level of skill of a POSITA: (1) the educational level of the inventor; (2) the type of problems encountered in the art; (3) the prior-art solutions to those problems; (4) the pace of innovation; (5) the sophistication of the technology; and (6) the educational level of active workers in the field. A person of ordinary skill in the art is also a person of ordinary creativity in the art.

14. Based on my experience with packaging design technologies, as well as my reading of the '904 patent, it is my opinion that a person of ordinary skill with respect to the subject matter of the '904 patent at the time of the priority date of the '904 patent (which I understand is February 25, 2020) would have at least an associate or a bachelor's degree in mechanical, industrial, or manufacturing engineering and would have at least two to three years of practical experience with designing or manufacturing mechanical products such as food or beverage packaging. Additional level of education can be substituted for work experience and vice versa. This description of a POSITA remains the same if the priority date is determined to be April 19, 2010, which I understand is the filing date of the first patent in the '904 patent family.

15. I am at least a person of ordinary skill in the art and was so on both February 25, 2020 and April, 19 2010. As shown by my qualifications, I am aware of the knowledge and skill possessed by a person of ordinary skill in the art at the time of the priority date of the '904 patent. In performing my analysis, I have applied the standard set forth above.

D. Summary of Opinions

16. I have reviewed and analyzed the '904 patent.

17. Based on my review and analysis, it is my opinion that claims 1-6 of the '904 patent are invalid based on the following grounds:

Ground	Basis	Reference(s)	Challenged Claims
1	§ 102 or 103	Kick	1-6
2	§ 103	Ackermann and Kaminski	1-6
3	§ 103	Ackermann, Kaminski, and Hutchinson	1-6

III. OVERVIEW OF THE TECHNOLOGY

A. Priority Date of the Claims

18. I have been informed that a U.S. patent application may claim the benefit of the filing date of an earlier patent application if the earlier patent application disclosed each limitation of the invention claimed in the later-filed U.S. patent application. I have also been informed that priority is determined on a claim-by-claim basis so that certain claims of a patent may be entitled to the priority date of an earlier-filed patent application even if other claims of the same patent are not entitled to that priority date.

19. I have also been informed that a patented claim is invalid if the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention, or the claimed invention was described in an issued patent or a published

patent application that was effectively filed before the effective filing date of the claimed invention.

20. I understand that the '904 patent claims a priority date of April 19, 2010. I also understand that the application for the '904 patent was filed on August 16, 2022, and that the '904 patent issued on August 29, 2023. (Ex. 1001, front page). I am informed and understand that, due to the introduction of new matter that was added to Application No. 12/762,934 after that application was filed, the effective priority date for the application for the '904 patent is no earlier than February 25, 2020, which is the filing date of the application for the parent patent, U.S. Patent No. 11,338,955.

B. Overview of the Relevant Technology When the '904 Patent Was Filed

21. For decades, containers having an easy-open-end have been manufactured using a metal lid. Such metal lids have been attached to containers to create a variety of food packaging products. Containers with an easy-open lid are and have been especially popular for marketing canned beverages such as beer or soda. As one example, the pop-top lid where a tab is pulled to cause an opening into the container along a weakened or scored portion of the lid is fairly inexpensive to manufacture and purchase, and it is popular among consumers due to its ease of use and because the tab remains connected to the can. Appendix B summarizes a brief

history of innovation related to metal container lids. Decades of innovations in lid design have enhanced the ease of opening containers, reduced material and manufacturing expenses, reduced waste, and mitigated failure modes. The following patents describe just two examples from this extensive history:

- U.S. Patent No. 4,286,728 to Frazee, filed in April 1980 (Appendix C). Frazee described a “tab for easy opening ends” that included flanges to increase longitudinal rigidity of the tab. (Appx. C, Abstract.) This tab could be manufactured with thinner sheet stock to reduce material costs, while still maintaining sufficient rigidity to open a container without bending. (Appx. C, 1:42-59; 2:41-46.)
- U.S. Patent No. 6,234,336 to Neiner, filed in November 1996 (Appendix D). Neiner described a stay-on-tab lid that reduced stress across a scored panel on the lid’s surface, thereby reducing the likelihood of stress-induced fatigue cracking. (Appx. D, Abstract.).

22. When beverage containers have metal bodies, the container bodies are formed from cutting metal and drawing the metal to elongate the metal into a desired shape. Drawing and elongating the metal places restrictions on the types of shapes that can be made. Metal beverage container bodies are typically not cast into a mold in the modern era. Casting metal into a mold is relatively expensive in a mass-produced product due to the requirement to heat the metal until it becomes a molten

liquid, and the need for expensive heat-resistant molds. Thus, it is often difficult to achieve a distinctive design in order to increase the desirability of the metal beverage containers. In contrast, plastic containers are easier to mold into a wide range of shapes, can be mass produced at low cost, and may therefore achieve various designs in order to increase the attractiveness and market value of the container.

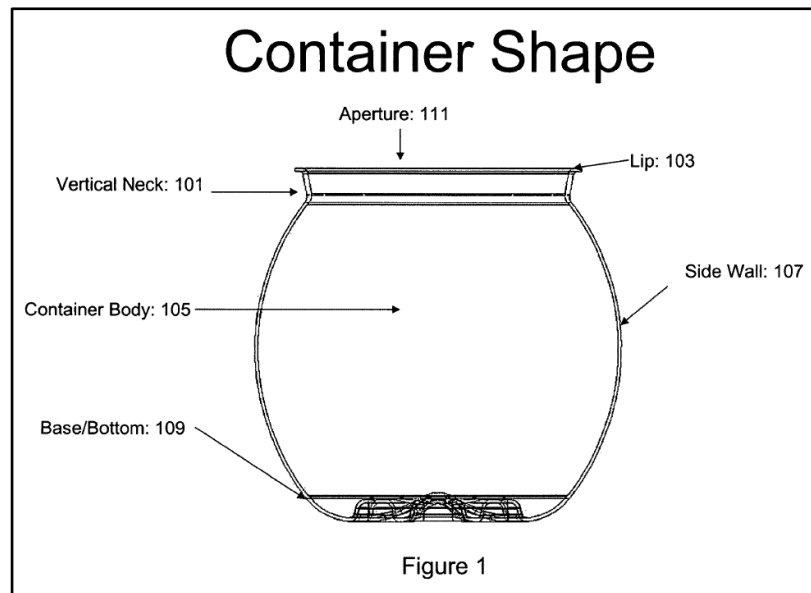
23. Plastic containers for beverages or other food items have been in use for decades. Many of these containers are made from polyethylene terephthalate (PET), and many are produced by blow-molding. The following patents are illustrative snapshots within the history of plastic container innovation:

- U.S. Patent No. 4,522,779 to Jabarin, filed in November 1983, described a process for producing PET containers via blow molding. (Appendix E.)
- U.S. Patent No. 8,468,785 to Thomasset, claiming priority to a European patent application filed in November 2007, described considerations for manufacturing heat-resistant PET containers, for example for hot-filled containers. (Appendix F.)

C. The '904 Patent

24. The '904 patent relates to a container that can store a liquid or a solid. (Ex. 1001, Abstract.) The container has a side wall, a bottom and a lid with a pop top arm. (*Id.*) The pop top arm pivots and cooperates with a weakened area to provide access to the interior of the container body. (*Id.*) A side view of the

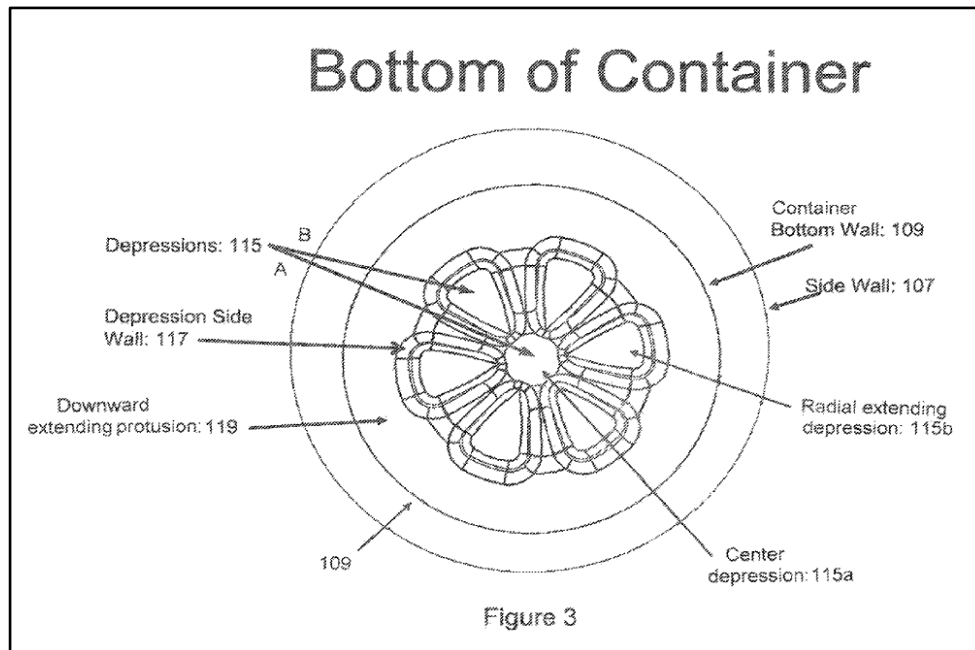
container body 105, with a convex side wall 107, is shown in Figure 1. (*Id.*, 2:22-29.) An aperture 111 extends vertically through the neck 101 to provide access to the liquid/solid in the container body 105, while a lip 103 extends around the vertical neck 101. (*Id.*, 2:35-39.)



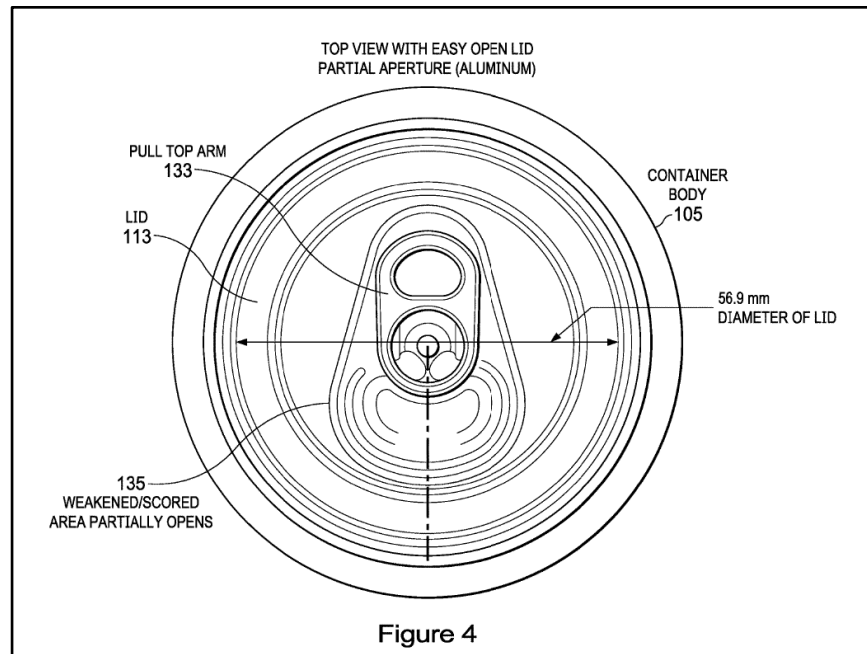
25. The container body may be formed from plastic or synthetic resin such as polyethylene terephthalate (PET) resin, or alternatively, from polyamide resin, polycarbonate resin, polyacetal resin, polybutylene terephthalate resin or other synthetic resin having a sufficient resistance to chemicals. (*Id.*, 2:43-49.)

26. Figure 3 shows a bottom view of the container where the bottom wall 109 has a number of radially extending depressions 115 that increase in width as the radial distance from the center increases. (*Id.*, 3:19-25.) The depression 115 can be defined by a depression side wall 117 which extends around the periphery of the

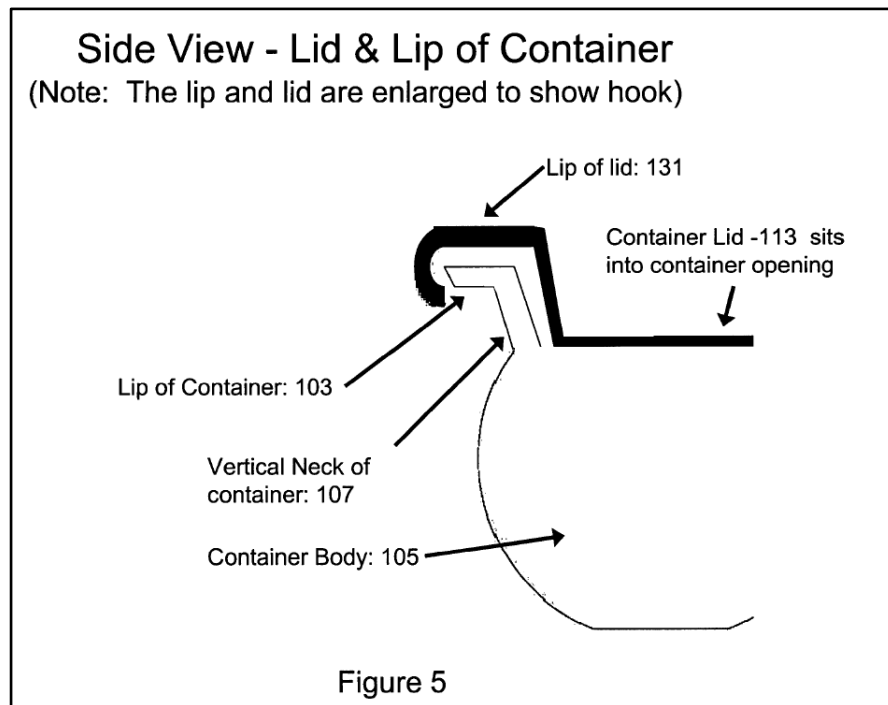
depression 115. The bottom wall 109 may include a downward extending protrusion 119 which may be centered with respect to the depressions 115 and the bottom wall 109. (*Id.*, 3:25-30.)



27. FIG. 4 illustrates a top view of the container. A deformable container lid 113, which can be made of a metal such as steel or aluminum, provides access to the contents of the container. (*Id.*, 3:31-41.) The container lid 113 has a weakened (or scored) area 135 that is deformable to provide an opening when the ‘pull top’ arm 133 is pulled by the user. (*Id.*)



28. FIG. 5 shows a side view of the container lid 103 that extends over the vertical neck 107 and around the lip 131 to provide a substantially watertight seal/airtight seal for the contents of the container body 105. (*Id.*, 3:42-46.)



29. The '904 patent has 6 claims, with claim 1 being the only independent claim.

D. Prosecution History

30. The '904 patent was filed on August 16, 2022, as a Track-1 (expedited) patent application with 5 claims. (Ex. 1003, 1-33.) Applicant canceled claims 1-5 in a preliminary amendment and added 6 new claims. (*Id.*, 41-45.) In an Office Action, dated February 16, 2023, the claims were rejected based on obviousness-type double patenting over claims of parent patents, U.S. Patent Nos. 11,338,955 and 10,604,296. (*Id.*, 117-131.) Claims 6-11 were also rejected as being anticipated by PCT Publication WO 2006/029441 A1 to Wing, *et al.*, and claim 12 was rejected as being obvious over U.S. Design Patent Des. 244,739 to Durand. (*Id.*)

31. In a response filed on May 15, 2023, Applicant filed terminal disclaimers over the parent patents, amended the claims, as below, and made arguments to distinguish claim 1 from the prior art:

wherein the horizontally-extending portion comprises a bottom having a depression formed therein, said depression extending upwardly from an extant of the bottom; ...

wherein a lower portion of the container side wall extends downwardly from the middle portion of the container side wall to the horizontally-extending portion of the container body, said lower portion being greater in diameter along its entirety than the horizontally-extending portion, including the bottom, thereby rendering the container body stemless; ...

wherein an upper portion of the container side wall extends upwardly from the middle portion of the container side wall to the upper edge of the container side wall, said upper portion being greater in diameter along its entirety than the first opening to the interior of said container body; ...

said liquid fills, or nearly fills, the interior of the container body, which interior extends continuously along a height of the entirety of the upper portion of the container wall so as to be interrupted only by the liquid; and

an actual volume of the liquid contained in the container is equal to, or less than, 211.5 mL.

(*Id.*, 231-244.)

32. A Notice of Allowance was issued on July 12, 2023, indicating that the closest reference found, Wing, does not teach the amended limitations. (*Id.*, 249-256.)

E. The Challenged Claims

33. I understand that Petitioner is challenging the validity of claims 1-6 in the '904 patent.

F. Claim Construction

34. I understand that claim terms generally are construed in accordance with the ordinary and customary meaning they would have to a POSITA at the time of the invention in light of the claim language, the specification, and the prosecution history. I understand that dictionaries and other extrinsic evidence may be

considered as well, though such evidence is typically regarded as less significant than the intrinsic record in determining the meaning of the claim language.

35. For all terms of the challenged claims of the '904 patent, I have interpreted them as they would have been understood by a POSITA at the time of the invention.

36. It is my opinion that there are no terms that require construction to address this petition; I do not address terms that may require construction in the district court.

IV. UNPATENTABILITY OF THE '904 PATENT CLAIMS

A. Standards for Invalidity

1. Obviousness

37. I am informed and understand that a patent cannot be properly granted for subject matter that would have been obvious to a person of ordinary skill in the art at the time of the alleged invention, and that a patent claim directed to such obvious subject matter is invalid under 35 U.S.C. § 103. It is also my understanding that in assessing the obviousness of claimed subject matter, one should evaluate obviousness in light of the prior art from the perspective of a person having ordinary skill in the art at the time the alleged invention was made (and not from the perspective of either a layman or a genius in that art). It is my further understanding that the question of obviousness is to be determined based on:

- The scope and content of the prior art;
- The difference or differences between the subject matter of the claim and the prior art (whereby in assessing the possibility of obviousness on should consider the manner in which a patentee and/or a Court has construed the scope of a claim);
- The level of ordinary skill in the art at the time of the alleged invention of the subject matter of the claim; and
- Any relevant objective factors (the “secondary indicia”) indicating nonobviousness, including evidence of any of the following: commercial success of the products or methods covered by the patent claims; a long-felt need for the alleged invention; failed attempts by others to make the alleged invention; copying of the alleged invention by others in the field; unexpected results achieved by the alleged invention; praise of the alleged invention by the alleged infringer or others in the field; the taking of licenses under the patent by others and the nature of those licenses; expressions of surprise by experts and those skilled in the art at the subject matter of the claim; and whether the patentee proceeded contrary to accepted wisdom of the prior art.

B. Ground 1: Kick anticipated or rendered obvious claims 1-6

38. I have reviewed the Kick reference. In my opinion, it teaches or suggests every limitation of claim 1-6 for the reasons explained below.

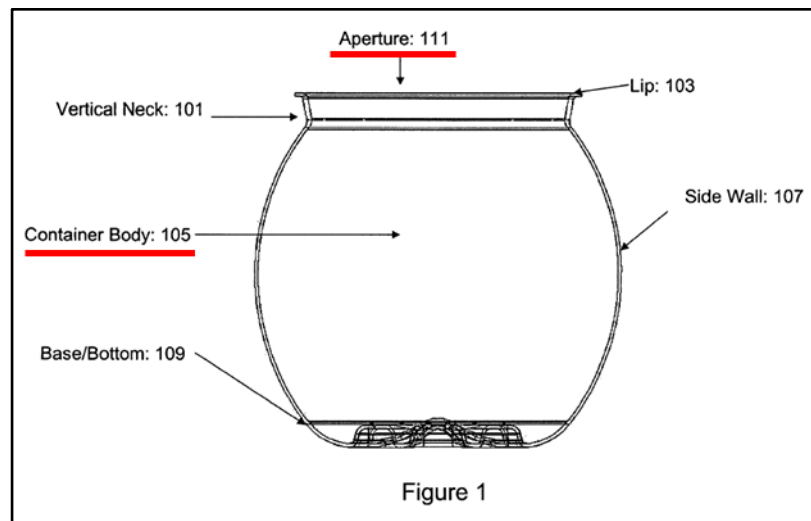
1. Claim 1:

a. Limitation 1[Preamble]: “A container, comprising:”

39. Kick describes designs for containers that can be used to store a liquid or solid. (Ex. 1007 (“Kick”), Abstract; *see also id.*, Figs. 1-9; *id.*, ¶0003 (“A container for storing a liquid . . .”).)

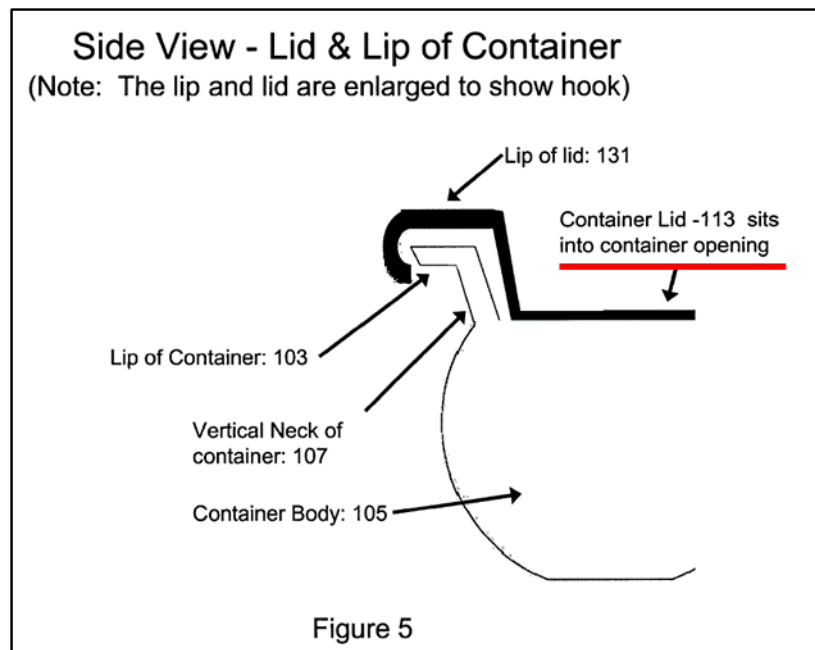
b. Limitation 1[a]: “a container body, said container body defining a first opening to an interior of said container body; and”

40. Kick discloses a container with a “**container body 105** which may include a side wall 107 which may extend radially around a periphery of the container body 105 and may include a convex side wall 107 or a concave side wall (not shown).” (*Id.*, ¶0013.) Kick’s container also has an “aperture 111” that forms a first opening to an interior of the container body. (*Id.*, ¶0016 (“An aperture 111 may extend through the vertical neck 101 in order to provide access to the liquid/solid within the container body 105”); *id.*, Fig. 1.)



(*Id.*, Fig. 1 (annotated)¹.)

41. Kick also teaches an opening into the interior of the container body by its disclosure, in Figure 5, of a lid that “sits into the container opening.”

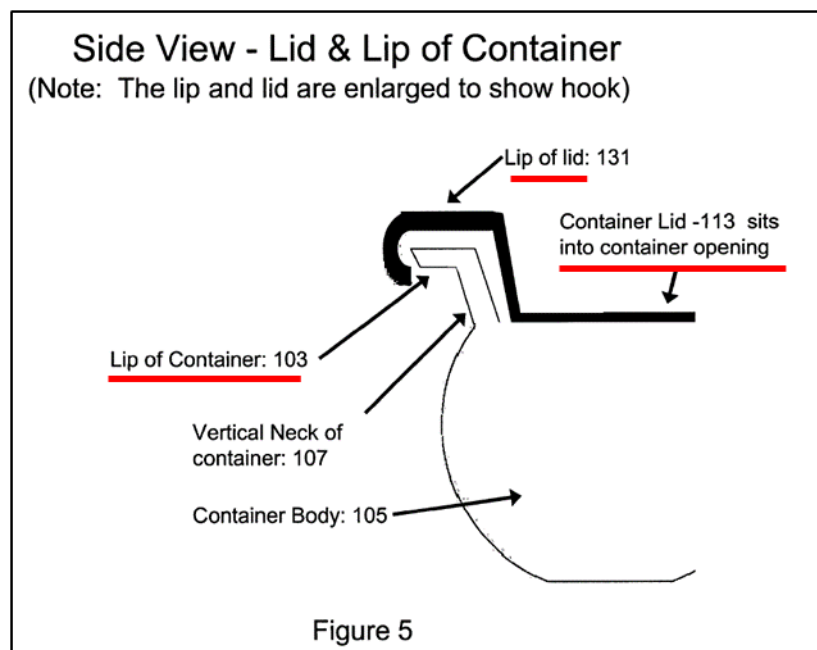


(*Id.*, Fig. 5 (annotated).)

¹ All colored elements in images are added annotations, unless noted otherwise.

c. **Limitation 1[b]: “a lid connected to the container body and covering the first opening to the interior of said container body;”**

42. Kick discloses a metal lid that can be attached at the top of, and used to seal, the container. (*Id.*, Abstract (“A container for storing a liquid or a solid may include a container body having a container side wall and a container bottom and **a container lid.**”). The lid covers the first opening of Kick’s container because, as Kick describes, it “extends over the vertical neck 107 and ... around the lip 131 in order to **provide a substantially watertight seal/airtight seal for the contents of the container body 105.**” (*Id.*, ¶0021; Fig. 5.) The lid is connected to the container body by a lip, extending around the periphery of the container’s neck, to “cooperate with the lid.” (*Id.*, ¶¶0016, 0021.) As a result, the lid would seal contents inside the container. (*Id.*)



(*Id.*, Fig. 5 (annotated).)

d. Limitation 1[c]: “wherein the container body is made out of a resin;”

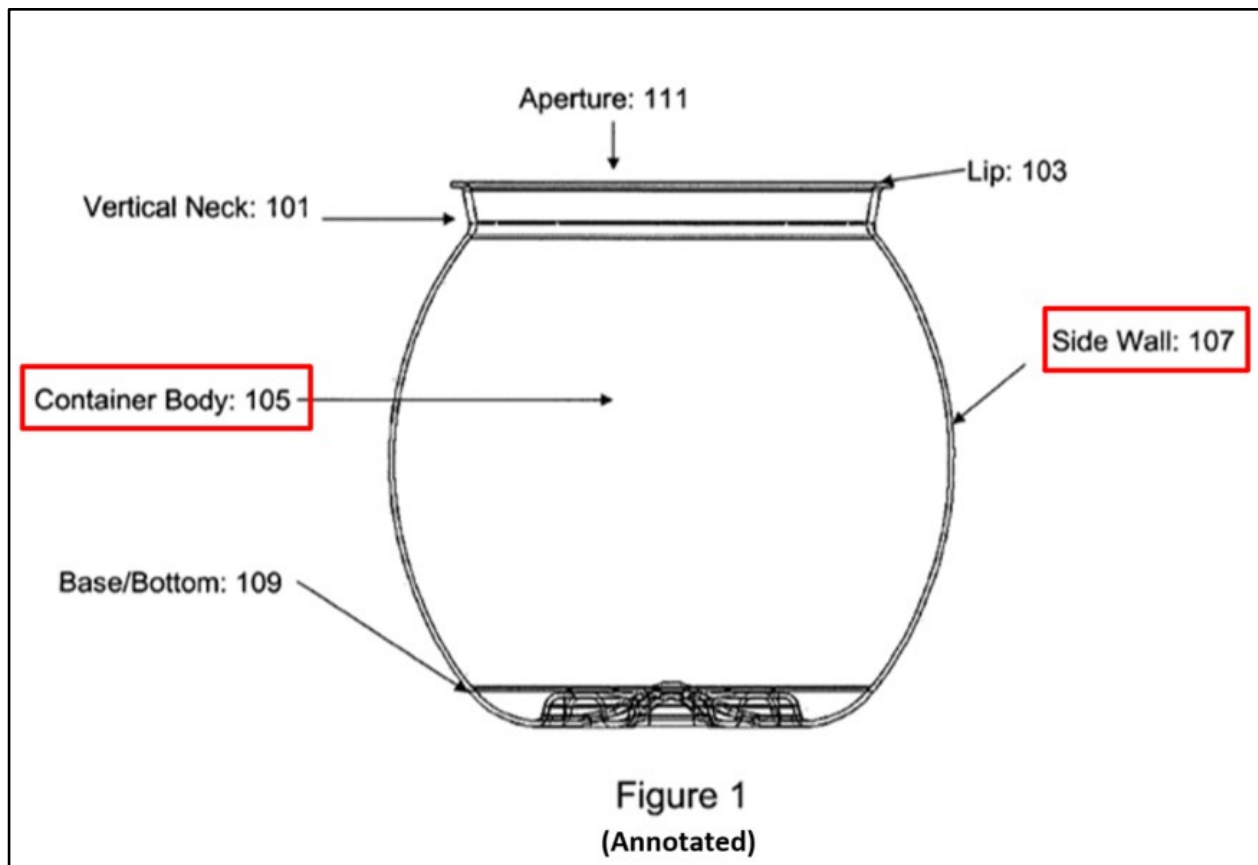
43. Kick teaches that the container’s body can be made out of a resin, such as polyethylene terephthalate (PET) resin. (*Id.*, ¶0015.)

e. Limitation 1[d]: “wherein the lid is made out of a metal;”

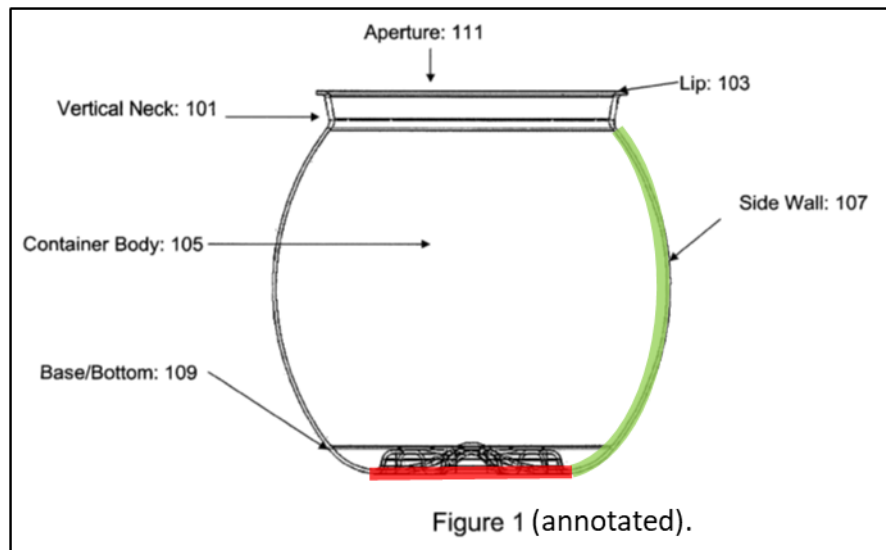
44. Kick teaches that the container lid can be made out of a metal: “The present invention combines the flexibility and desirability of a container body 105 which may be formed from molding plastic or other appropriate material and **a metal lid** to cooperate with the container body.” (*Id.*, ¶0012.)

f. Limitation 1[e]: “wherein the container body comprises a container side wall and a horizontally-extending portion connected to the container side wall;”

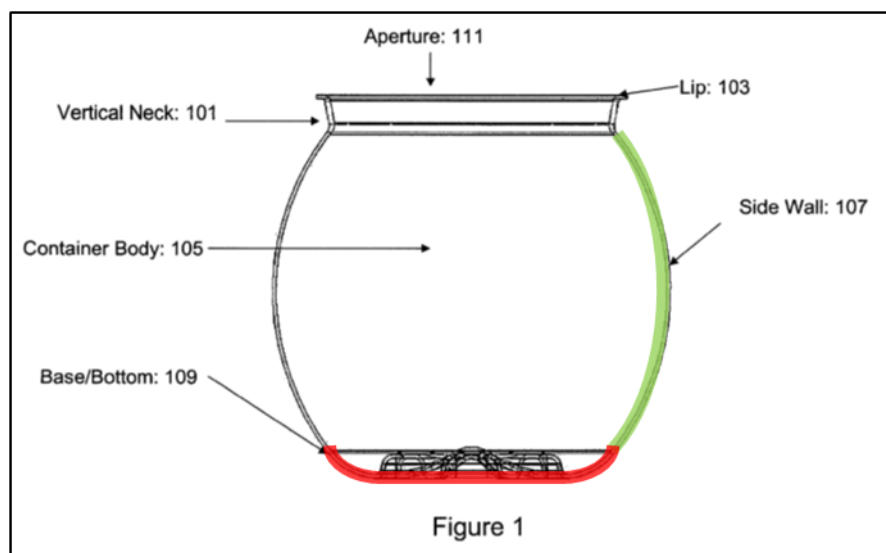
45. Kick describes and depicts a container body that has a container side wall. (Kick, Abstract; ¶[0013]; Figure 1 (annotated below).)



46. Although Kick does not use term “horizontally-extending portion,” Figure 1 illustrated a “base/bottom” of the container. The base/bottom of the container, as shown in Figure 1, taught or suggested a horizontally-extending portion because at least a portion of this base/bottom extended substantially horizontally (that is, across a horizontal space between the container’s side walls), as shown in annotated Figure 1 below. This horizontal portion was connected to the container side wall in Figure 1.



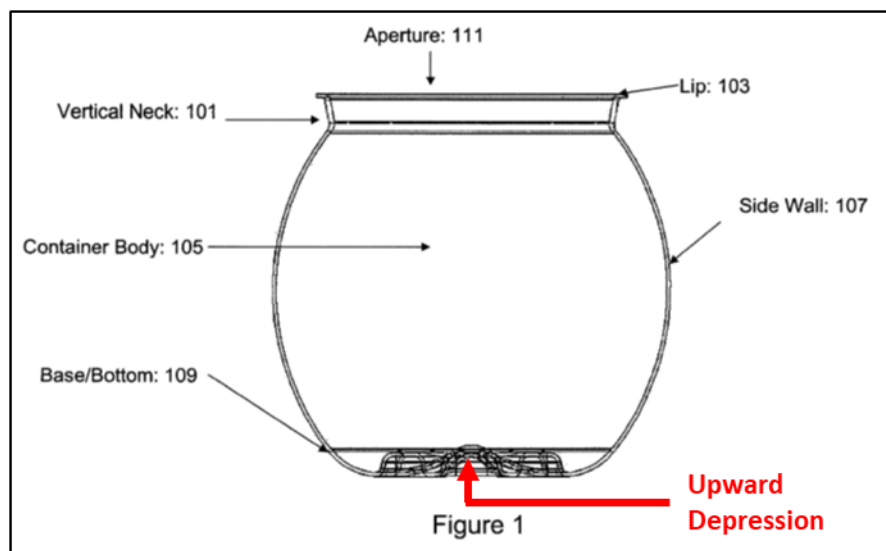
47. Alternatively, if the side wall in Kick is interpreted to extend only to the horizontal line above the “base/bottom 109” in Figure 1, Kick also taught or suggested a **horizontally-extending portion** (see annotated Figure 1 below) that curves upward and connects to the **side wall**, while continuing to extend horizontally between the side walls under this interpretation.



48. Regardless of the interpretation, a POSITA would have found it obvious for the horizontally-extending portion to connect to the side wall in order to form a closed container that can hold a liquid. Connecting the side walls of a container to the horizontally extending portion at the bottom of the container was a well-known and standard design feature of beverage containers.

g. Limitation 1[f]: “wherein the horizontally-extending portion comprises a bottom having a depression formed therein, said depression extending upwardly from an extant of the bottom;”

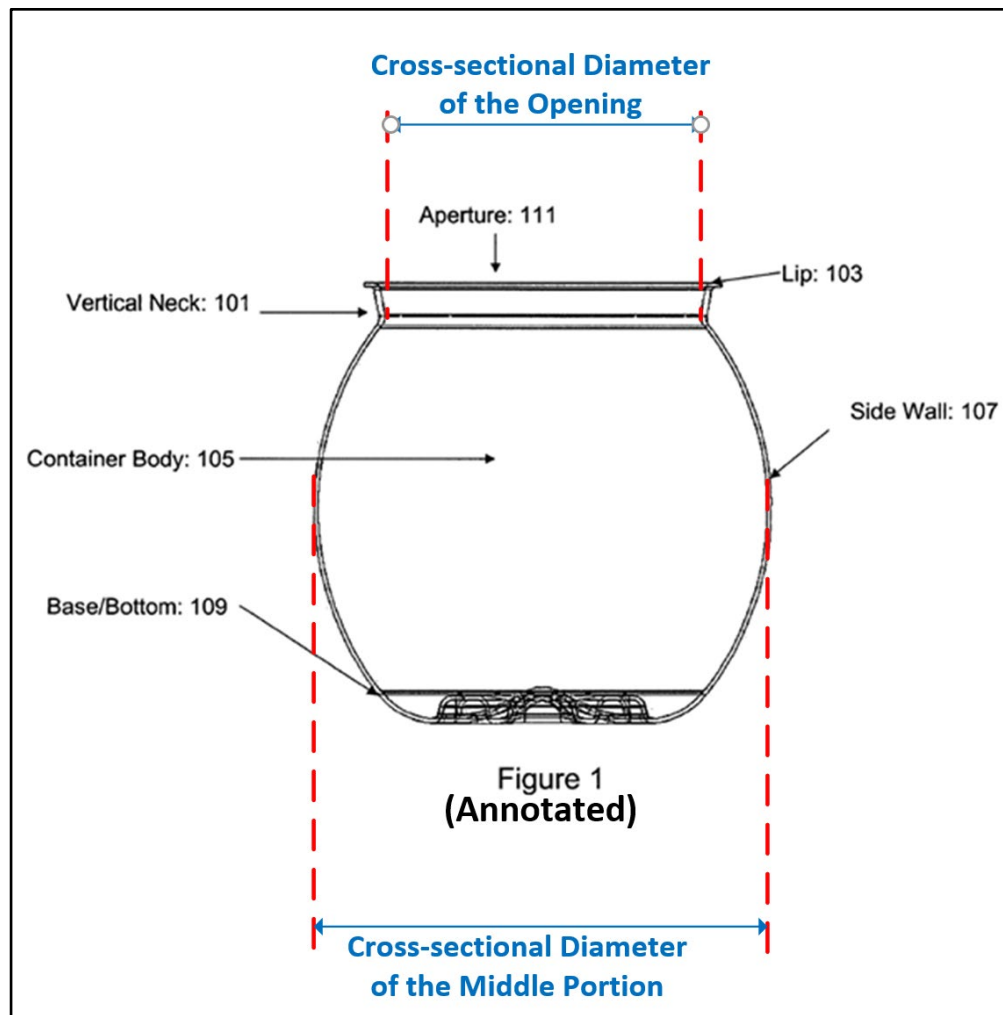
49. As shown in Figure 1 of, the horizontally-extending portion includes a bottom. The bottom has a depression formed therein that extends upwardly from an extant of the bottom, meaning from the lowest portion of the bottom.



(*Id.*, Fig. 1; *see also id.*, ¶0004 (“The bottom wall may include a depression, and the bottom wall may include a radial extending depression.”); *id.*, claim 6 (“wherein the bottom wall includes a depression”); *see also id.*, Figs. 2, 3, 7.)

h. Limitation 1[g]: “wherein a cross-sectional diameter of the first opening to the interior of said container body is less than a cross-sectional diameter of a middle portion of said container body;”

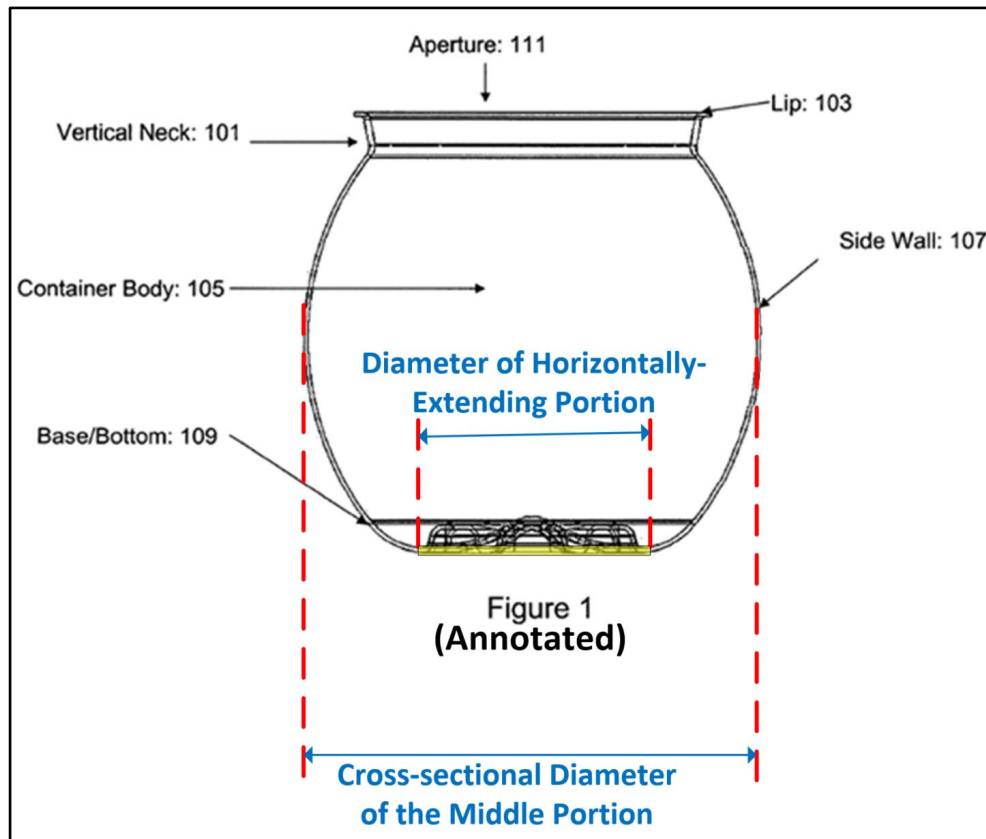
50. This feature is taught by Kick’s Figure 1, in which a middle portion of the container body (annotated in Figure 1 below) is wider than the first opening to the container.

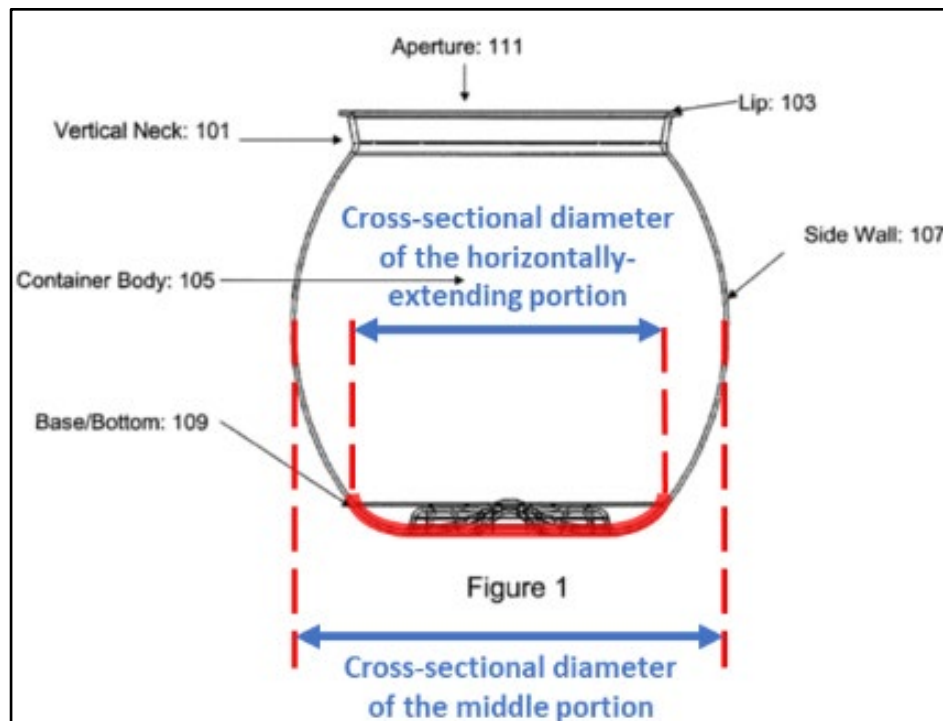


- i. **Limitation 1[h]: “wherein the horizontally-extending portion defines a diameter that is less than the cross-sectional diameter of the middle portion of said container body;”**

51. This feature is taught or rendered obvious by Kick under either interpretation of the side wall and horizontally-extending portion. The base/bottom of Kick’s container had a horizontally-extending portion, as discussed in Limitation 1[e]. This portion defines a diameter at, for example, a point where the side walls transition into the bottom surface on which the container would stand. This diameter

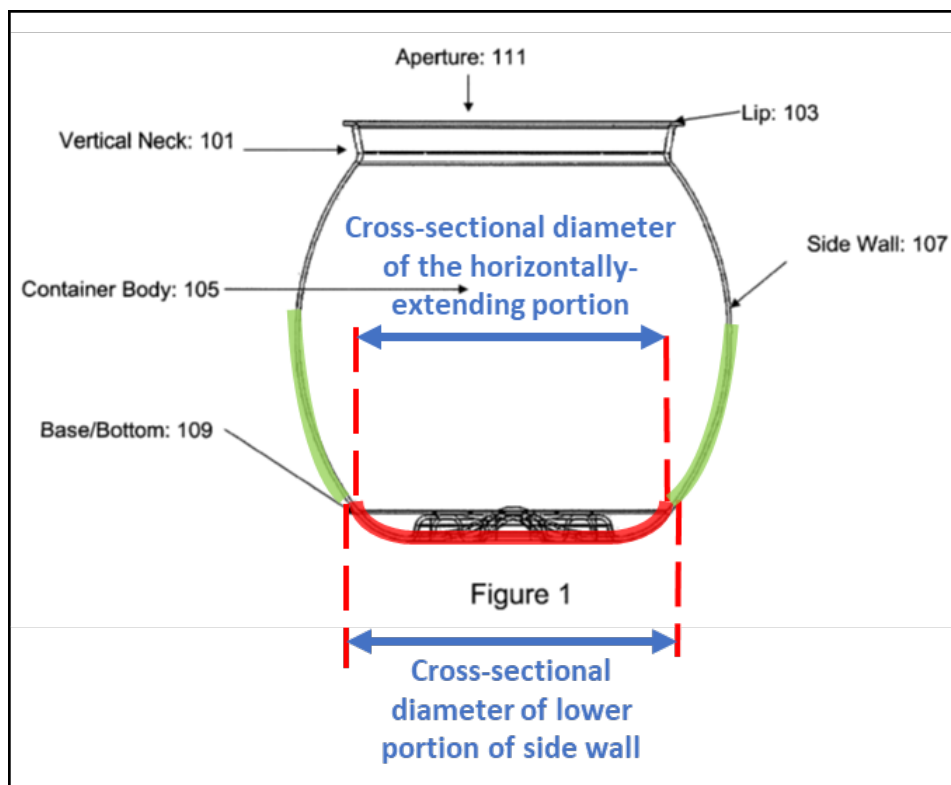
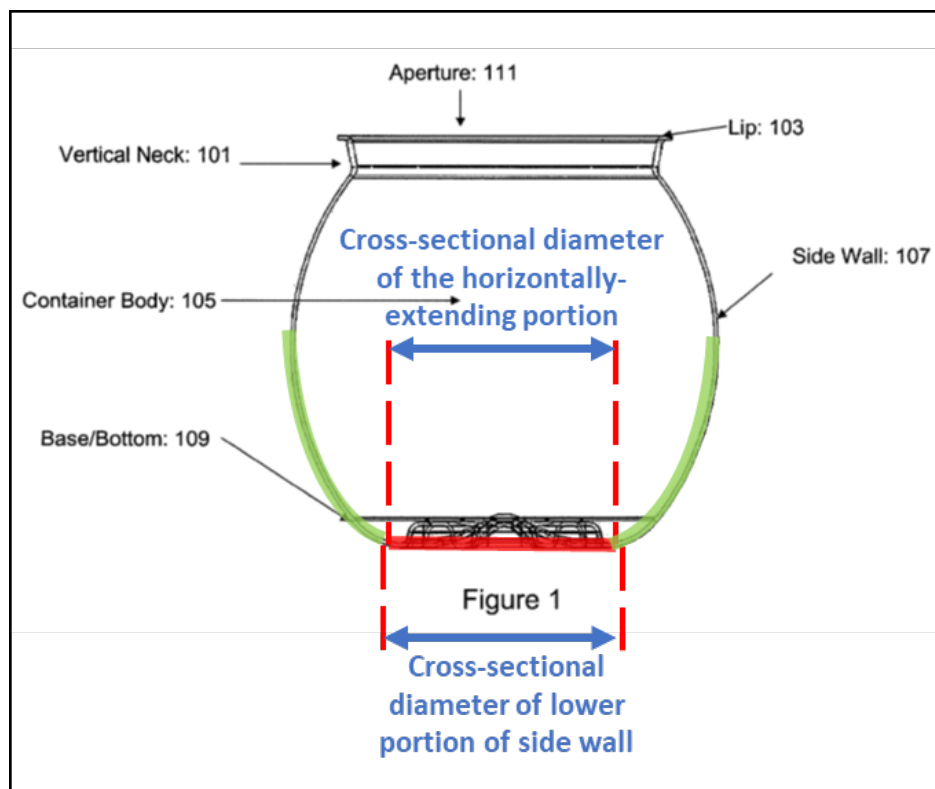
is less than the cross-sectional diameter of the container's middle portion, as shown in the two versions of annotated Figure 1 below (depicting the two interpretations of “horizontally-extending portion” discussed above in Limitation 1[e]).





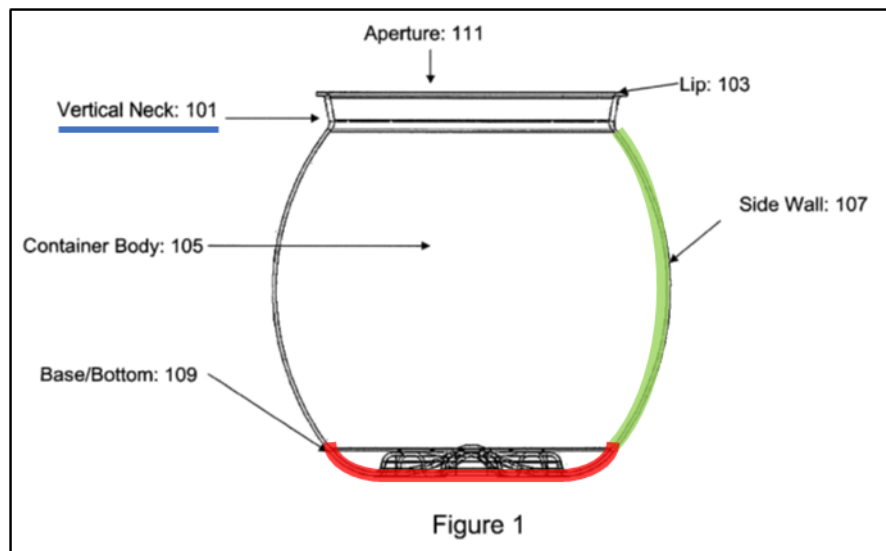
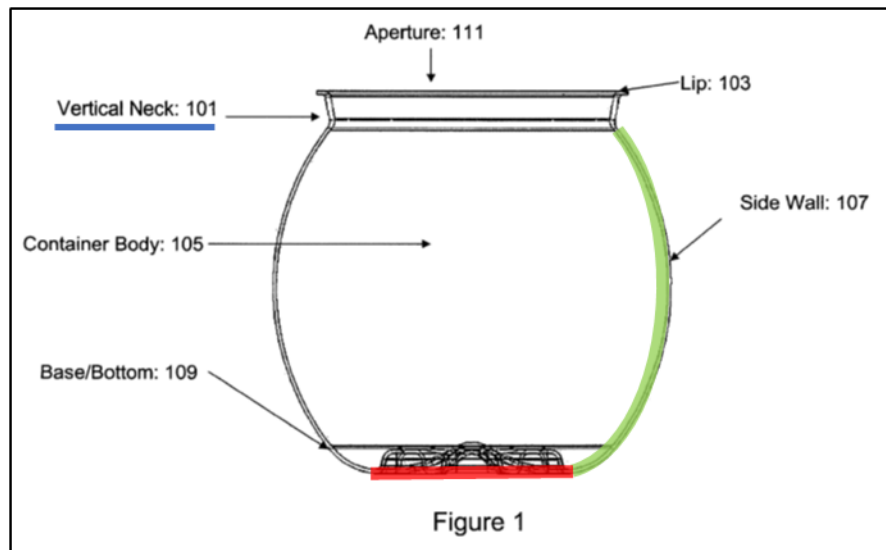
- j. **Limitation 1[i]: “wherein a lower portion of the container side wall extends downwardly from the middle portion of the container side wall to the horizontally-extending portion of the container body, said lower portion being greater in diameter along its entirety than the horizontally-extending portion, including the bottom, thereby rendering the container body stemless;”**

52. Kick’s Figure 1, annotated below, depicts a lower portion of the container side wall that is greater along its entirety than the horizontally-extending portion because, under both interpretations of the “horizontally-extending portion” in Limitation 1[e], the lower portion of the sidewall bends continually down and inward until it connects with the horizontally-extending portion. The container shown in Figure 1 does not have a stem (i.e., “stemless”).



- k. **Limitation 1[j]: “wherein the container body further comprises a circular neck extending from the container side wall so that the container side wall extends between the circular neck and the horizontally-extending portion;”**

53. Kick’s container has a **circular neck** (*see* Figure 1 below) in the form of vertical neck 101 above the container side wall 107. (*Id.*, ¶0014.) Kick explains how the container side wall extended between the vertical neck and the container’s base: “The distal end of the container side wall 107 may be connected to a base/bottom wall 109 in order to seal the first end of the container 105 and **the proximate end of the container side wall 107 may be connected to a substantially vertical neck 101 around the periphery of the container side wall 107.**” (*Id.*, ¶0014, Fig. 1.) Furthermore, under both interpretations of the “horizontally-extending portion” discussed in Limitation 1[e], Kick teaches that the **side wall** extends from the **vertical neck** to the **horizontally extending portion** as shown in the annotated figures below.

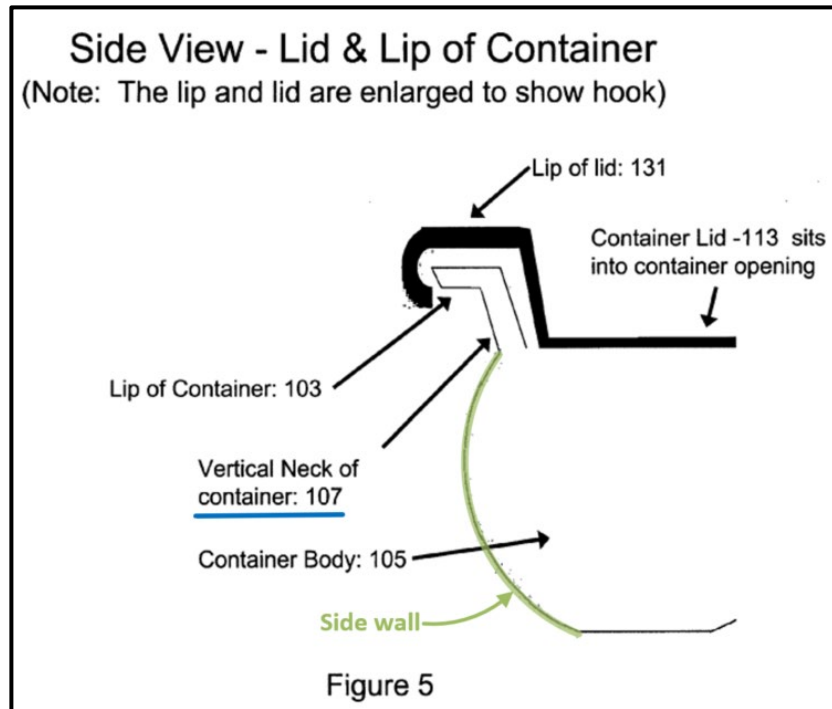


(Kick, Fig. 1; *see also id.*, Figs. 2, 5.)

I. Limitation 1[k]: “wherein an upper edge of said container side wall is adjacent to the circular neck of the container body;”

54. As shown in annotated Figure 1 provided in Limitation 1[j] above, Kick discloses that the upper edge of the container side wall is adjacent to the circular

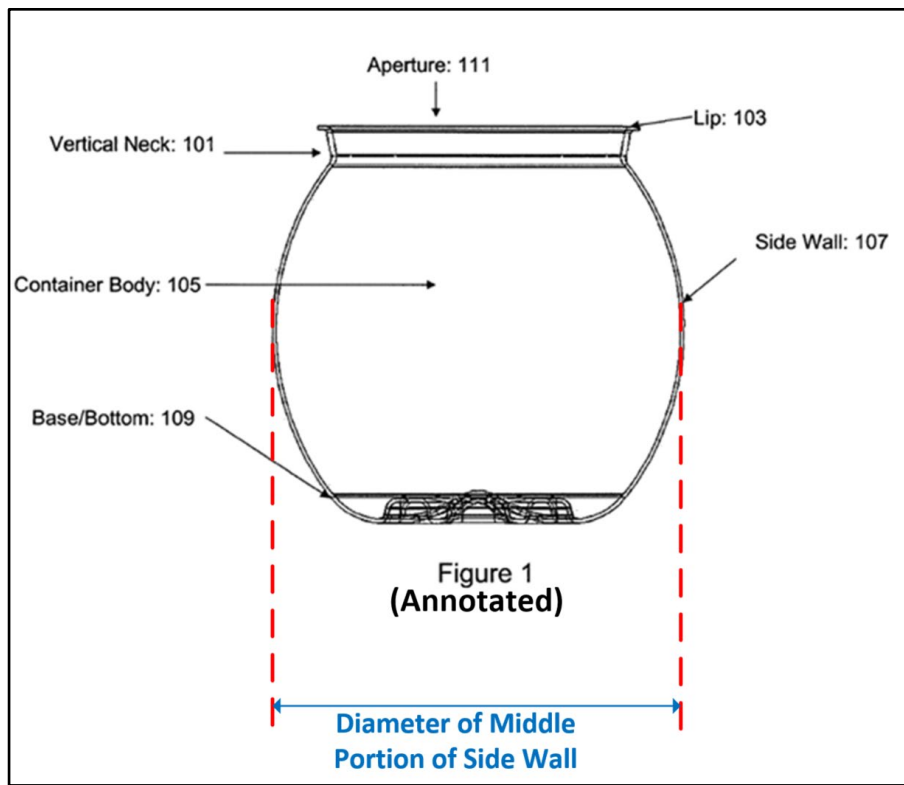
neck. Kick also depicts a close up of the **neck** and **container sidewall** connection in Figure 5.



(*Id.*, Fig. 5.)

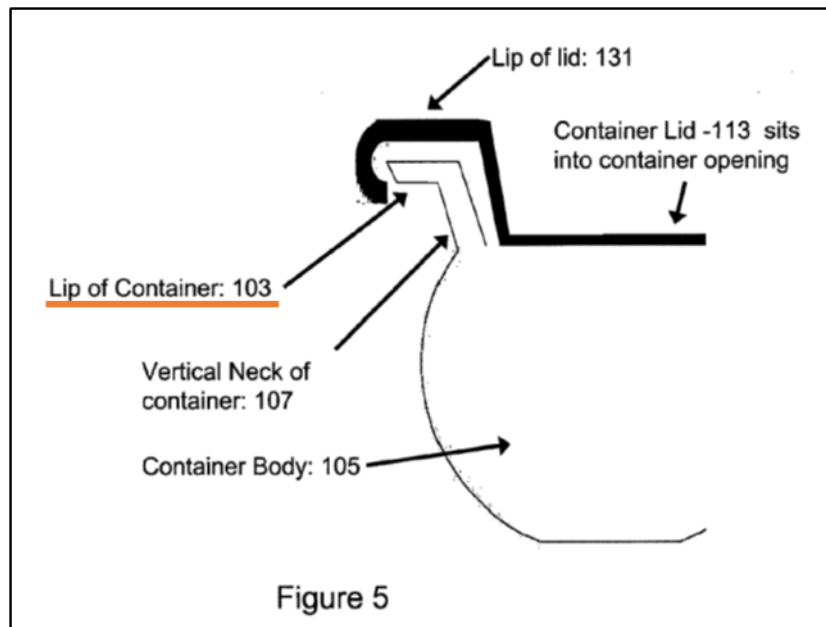
- m. **Limitation 1[l]: “wherein the cross-sectional diameter of the middle portion of said container body is defined by the container side wall;”**

55. Kick teaches this limitation. In Kick’s Figure 1, a curved container side wall 107 defines a cross-sectional diameter at each vertical location along the side wall. Likewise, at a middle portion of the container, the side wall defines the cross-sectional diameter. This is annotated in Figure 1 below.



- n. **Limitation 1[m]: “wherein the container body further comprises a lip at the end of the circular neck opposite the upper edge of said container side wall;”**

56. Kick’s container body has a lip at the upper end of the circular neck. (*Id.*, ¶0014 (“A lip 103 may extend around the periphery of the substantially vertical neck 101 in order to cooperate with the lid 113.”)) This circular neck is on the opposite end of the neck from the upper edge of the container sidewall, as shown in Figure 5. (*Id.*, ¶0016, Fig. 2.)



(*Id.*, Fig. 5; *see also id.*, ¶0021.)

o. Limitation 1[n]: “wherein said circular neck is adjacent to the lip;”

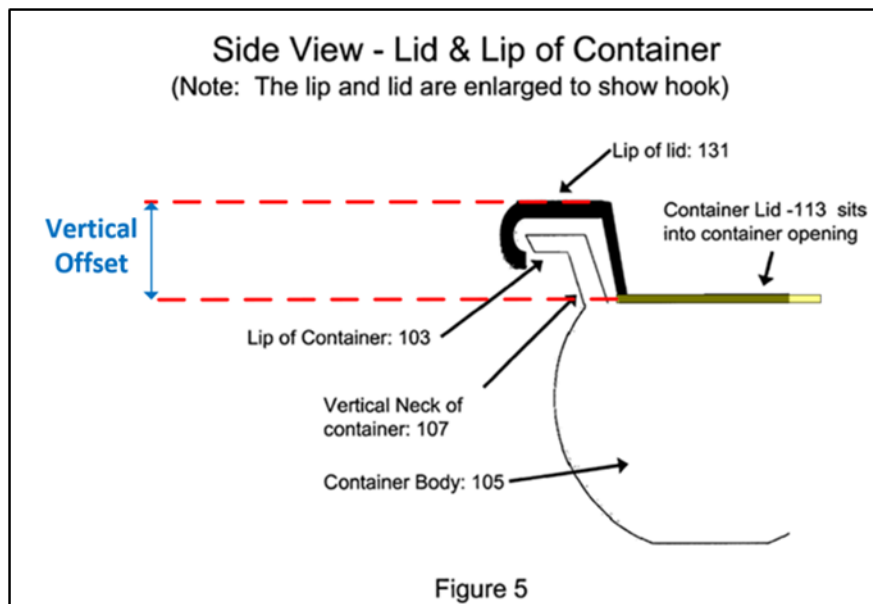
57. As shown in Figure 5 above in limitation 1[m], Kick’s figures depict the circular neck being adjacent to the lip. (*See also id.*, ¶¶0014, 0016, 0021.)

p. Limitation 1[o]: “wherein a first portion of the lid is above the lip of the container body;”

58. Kick discloses a first portion of the lid in the form of a lid section labeled “Lip of lid: 131” in Figure 5. As shown in Figure 5, this first portion of the lid is above the lip of the container in limitation 1[m]. (*See also id.*, ¶0021.)

- q. **Limitation 1[p]: “wherein a second portion of the lid extends horizontally and is vertically offset from the first portion of the lid;”**

59. Kick depicts a second portion of the lid, identified in yellow highlighting in Figure 5 below. As shown in the figure, this second portion of the lid extends horizontally across the top of the container and is vertically offset from the first portion of the lid (*i.e.*, Lip of lid: 131).

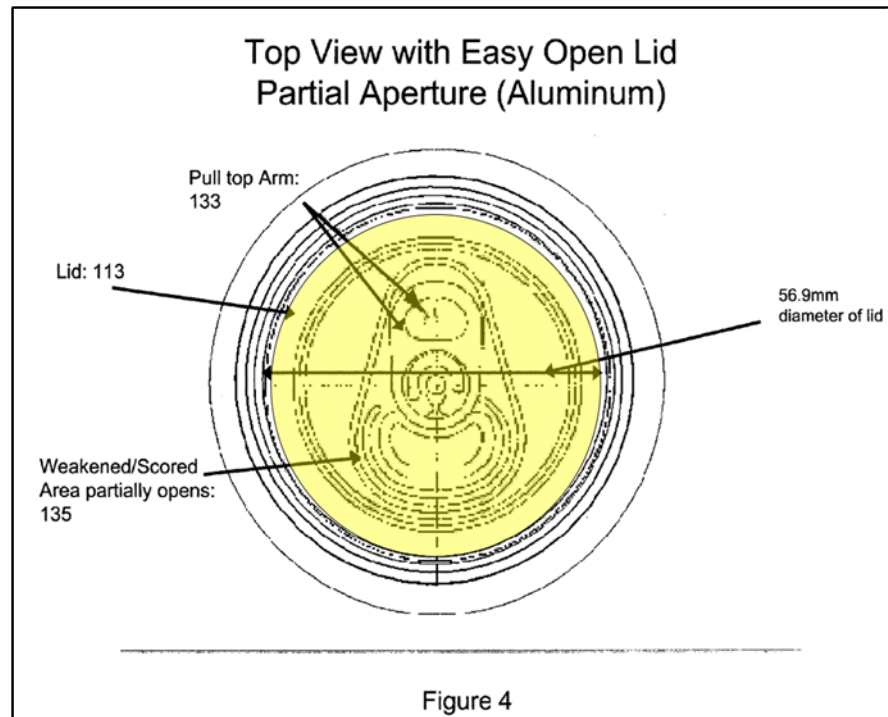


(*Id.*, Fig. 5.)

- r. **Limitation 1[q]: “wherein the second portion of the lid defines a total area across which the second portion of the lid extends horizontally;”**

60. The second portion of Kick’s lid, shown in the yellow highlighted portion of Figure 5 in Limitation 1[o], extends horizontally across the opening of the

container and thereby covered the area above the opening. A top view of the lid, similarly depicting a second portion of the lid, is shown in Figure 4.

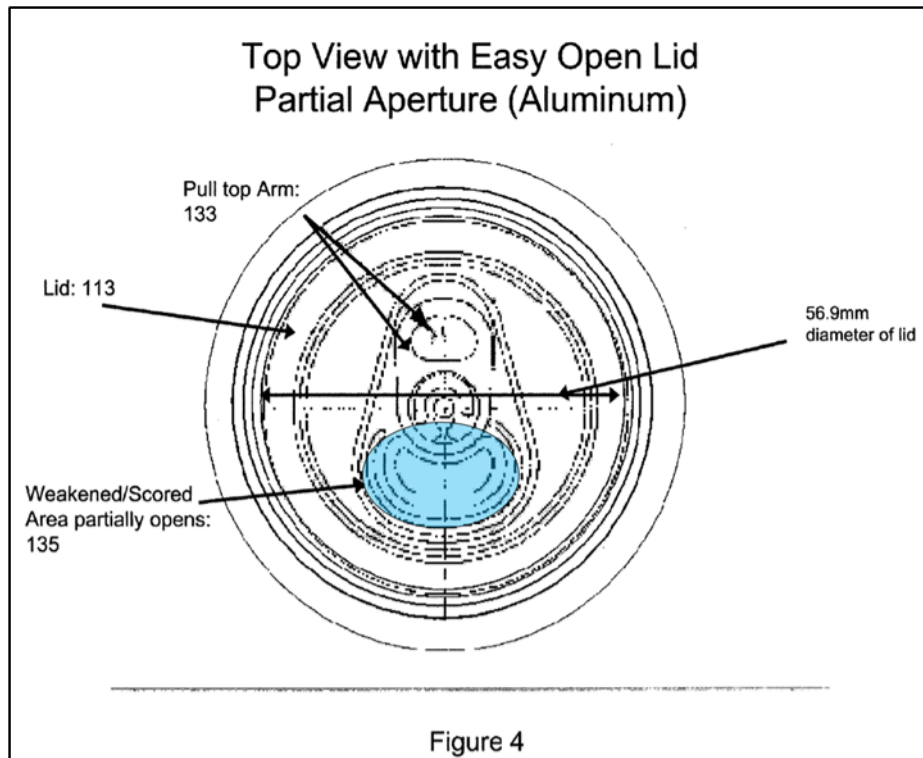


(*Id.*, Fig. 4.)

s. Limitation 1[r]: “wherein the second portion of the lid comprises a weakened or scored area;”

61. Kick teaches and depicts a weakened or scored area (“Weakened/Scored Area partially opens: 135” in Figure 4), within the second portion of the lid. This weakened or scored area functions in conjunction with the tab to provide access to create an opening into the can. (*Id.*, ¶¶0003, 0020.) This weakened or scored area and the pull tab and other features describe in limitation 1[s], 1[t], and 1[u] are nothing more than standard features used in beverage can designs for decades before the earliest possible priority date in 2010 for the ’904

patent in order to provide an easy way to open the container and access the liquid inside.



(*Id.*, Fig. 4; *see also id.*, Fig. 6.)

- t. **Limitation 1[s]: “wherein the weakened or scored area is less than the total area across which the second portion of the lid extends horizontally;”**

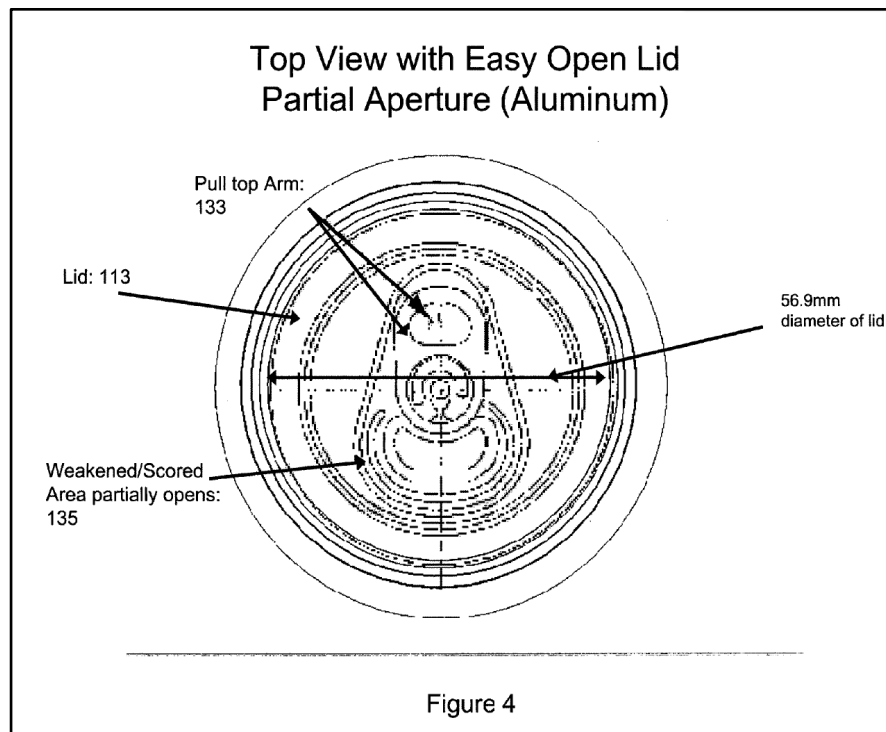
62. Kick discloses that the weakened or scored area was less than the total area across which the second portion of the lid extended horizontally, as shown in Limitation 1[r] above.

u. Limitation 1[t]: “wherein the lid further comprises an arm connected to the second portion of the lid;”

63. Kick discloses “an arm connected to the second portion of the lid” in the form of a tab (“pull top arm 133”) that is used to press on the weakened/scored portion when the tab is lifted. (*Id.*, Abstract, Fig. 4, Fig. 6, ¶¶0003, 0020, 0022, 0026 (at no. 2).)

v. Limitation 1[u]: “wherein the arm is pivotable from a first position, in which the arm extends horizontally and the weakened or scored area is not deformed, to a second position, in which the arm does not extend horizontally and the weakened or scored area is deformed to provide a second opening to the interior of said container body;”

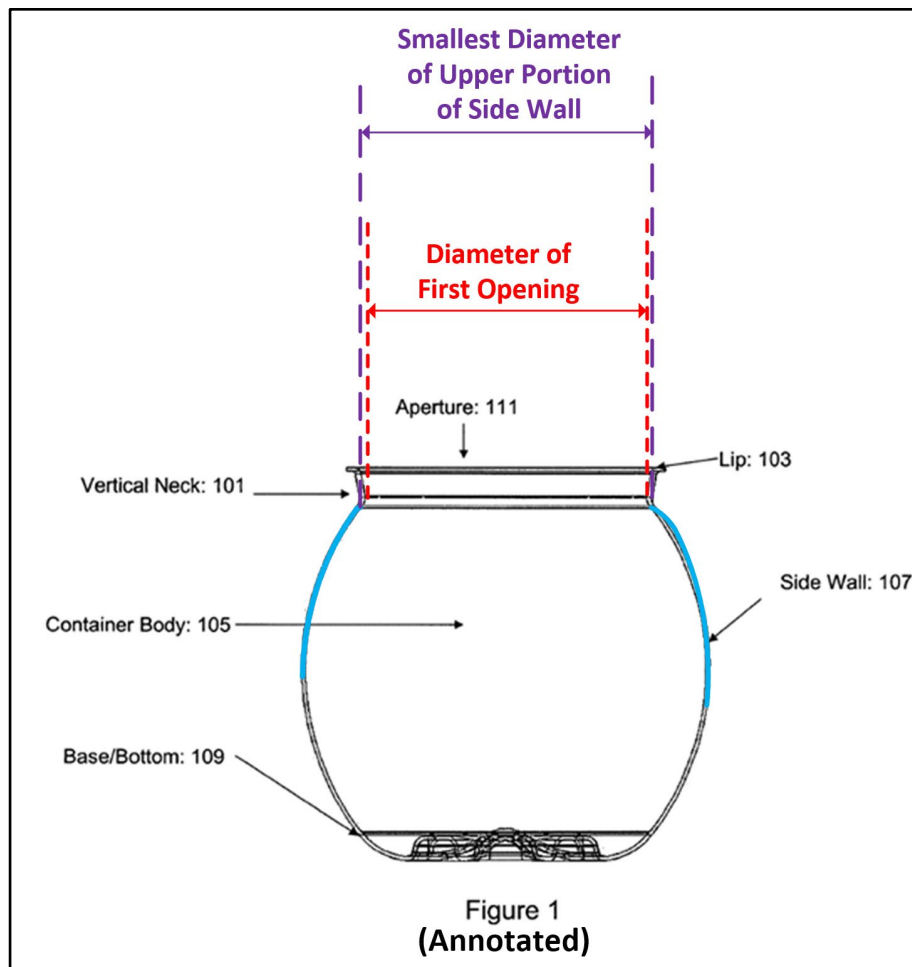
64. Kick describes an arm (a “pop top arm”). (Kick, Abstract.) A first horizontal position of the arm was shown in Figure 4, where the weakened or scored area is not deformed:



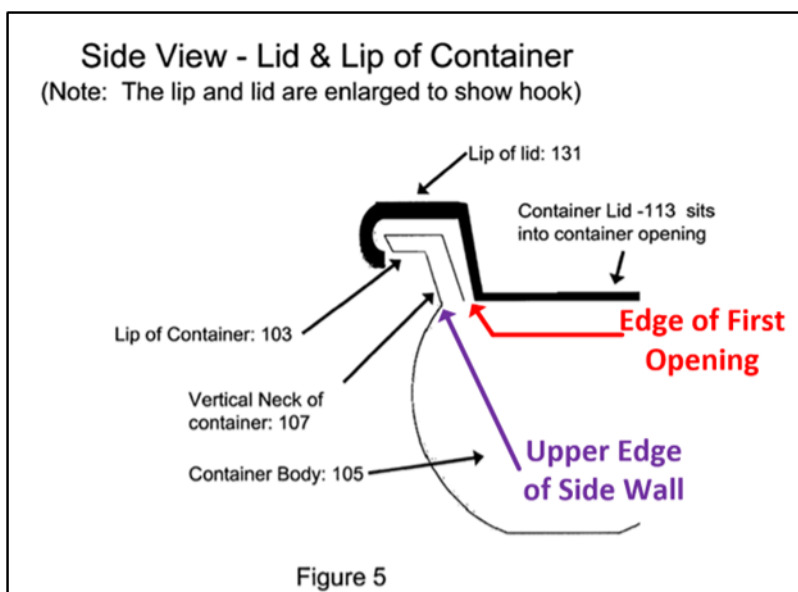
65. Kick explains that the arm would “pivot and cooperate with a weakened area to provide access to the interior of the container body.” (*Id.*, Abstract; *see also* ¶0020 (“a weakened (or scored) area 135...deforms and provides an opening when the ‘pull top’ arm 133 which may include an aperture for a finger of the user and may be pivoted by the user. The weakened/scored area 135 may partially open to provide access to the contents of the container.”).) It would have been obvious that the arm would be in a second, non-horizontal position after the arm has been pivoted to deform the weakened area of the lid. A POSITA also would have understood how this pivoting of the arm would apply a force that would sever the weakened or scored area to create an opening in the lid. This is the standard way in which such tabs functioned for decades before 2010 to open beverage containers.

- w. **Element 1[v]: “wherein an upper portion of the container side wall extends upwardly from the middle portion of the container side wall to the upper edge of the container side wall, said upper portion being greater in diameter along its entirety than the first opening to the interior of said container body;”**

66. This limitation is taught and suggested at least by Kick’s Figure 1. The upper portion of the sidewall (shown in blue in annotated Figure 1 below) extends upwardly and inwardly from the middle portion of the sidewall to its upper edge. As shown in the figure, because the sidewall is continuously bending inward, this upper portion has a diameter that is always greater than the diameter of the first opening. Thus, the smallest diameter of the upper portion of the side wall shown in annotated Figure 1 below is greater than the illustrated diameter of the first opening.



67. Figure 5 further emphasizes the relationship between the diameter of the upper portion of the side wall and the first opening. In Figure 5, annotated below, an edge of the first opening is positioned inside the upper edge of the sidewall, with at least the thickness of the side wall separating the outer diameter of the side wall and the diameter of the first opening. Therefore, even at its smallest diameter (at the edge location), the upper portion of the container's side wall has a larger diameter than does the first opening.



68. While Kick depicts this limitation, it also would have been an obvious design choice to a POSITA. A POSITA would have known that the diameter of the opening to the interior of the container could be smaller than the diameter defined by the upper portion of the sidewall. This is a simple design choice.

x. Limitation 1[w]: “wherein the container contains a liquid; and”

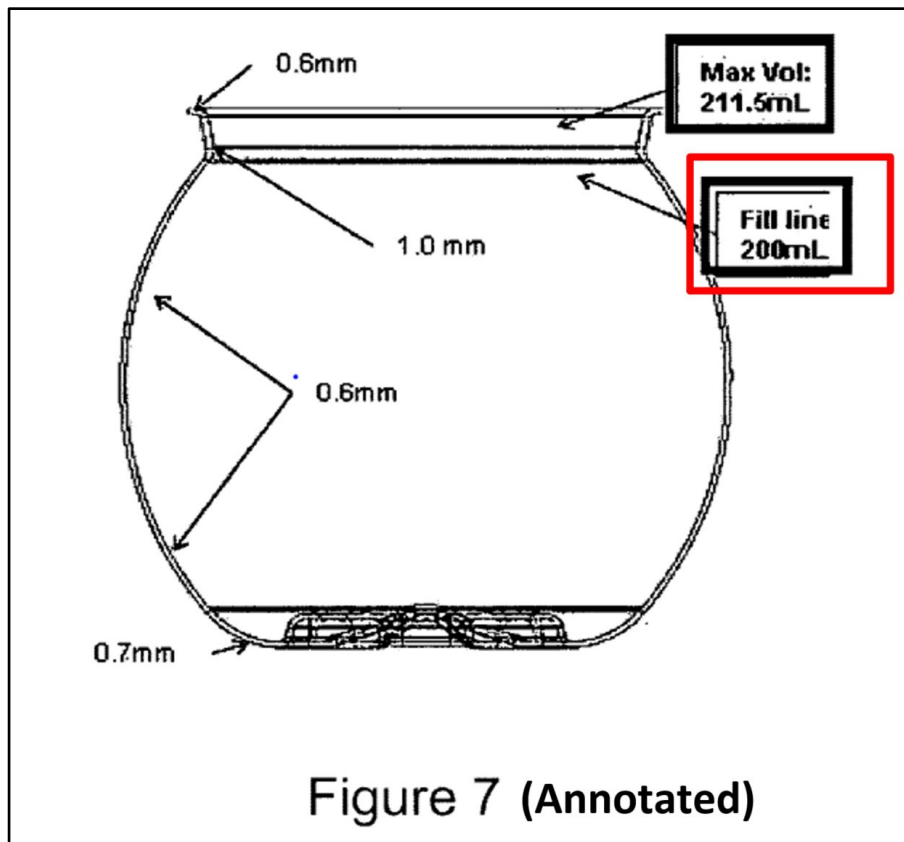
69. Kick teaches that its container can hold a liquid. (*Id.*, Abstract, ¶¶0003, 0013, 0014, 0026.)

y. Limitation 1[x]: “wherein, when the arm of the lid is in the first position and the weakened or scored area is not deformed:”

70. As addressed above in Limitation 1[u], Kick taught the arm (pull tab) being in a first, horizontal position in which it did not deform the weakened or scored area.

- z. **Limitation 1[y]: “said liquid fills, or nearly fills, the interior of the container body, which interior extends continuously along a height of the entirety of the upper portion of the container wall so as to be interrupted only by the liquid; and”**

71. With respect to a liquid filling, or nearly filling, the interior of the container body, Kick describes a “maximum volume of fluid” for a container filling process. (Kick, ¶0023.) Kick illustrates this in Figure 7 through a “fill line” of 200 mL and a maximum volume of 211.5 mL. (*Id.*, Fig. 7.) Thus, a POSITA would have understood that a liquid could fill or nearly fill the container.



72. Finally, Kick's Figure 7 above shows no obstruction in the upper portion of the container that would interrupt any liquid in the container. The figure depicts the interior of the container extending across the container continuously along the entirety of the upper portion of the container wall.

aa. Limitation 1[z]: “an actual volume of the liquid contained in the container is equal to, or less than, 211.5 mL”

73. Kick discloses a container with a maximum fill volume of 211.5 mL. (*Id.*, Fig. 7, ¶0023.) Thus, Kick teaches that the volume of liquid in the container was equal to or less than 211.5 mL.

74. For all of these reasons Kick teaches or would have rendered obvious to a POSITA claim 1 of the '904 patent.

2. Claim 2: “The container of claim 1, wherein the actual volume of the liquid contained in the container is 200 mL.”

75. Kick teaches filling the container with 200 mL of liquid in Figure 7, which has a “Fill line 200 mL.” (Kick, Fig. 7.)

3. Claim 3: “The container of claim 1, wherein the resin is a polyethylene terephthalate (PET) resin.”

76. Kick discloses that the container body could be made of a polyethylene terephthalate (PET) resin. (*Id.*, ¶0015 (“The **container body 105** according to the present invention **may be made of an appropriate plastic/synthetic resin, typically polyethylene terephthalate (PET) resin.**”).)

4. Claim 4: “The container of claim 1, wherein the container body is formed using a blow molding process.”

77. Kick teaches that its container could be made through “known molding processes, such as **biaxial orientation blow molding process** or **direct blow molding process** or **injection blow molding.**” (*Id.*, ¶0015.)

5. Claim 5: “The container of claim 1, wherein the metal is aluminum.”

78. Kick teaches that the container lid could be made from aluminum. (*Id.*, ¶0020 (“**The container lid 113 may be formed from metal such as steel, aluminum** or other types of metals.”).)

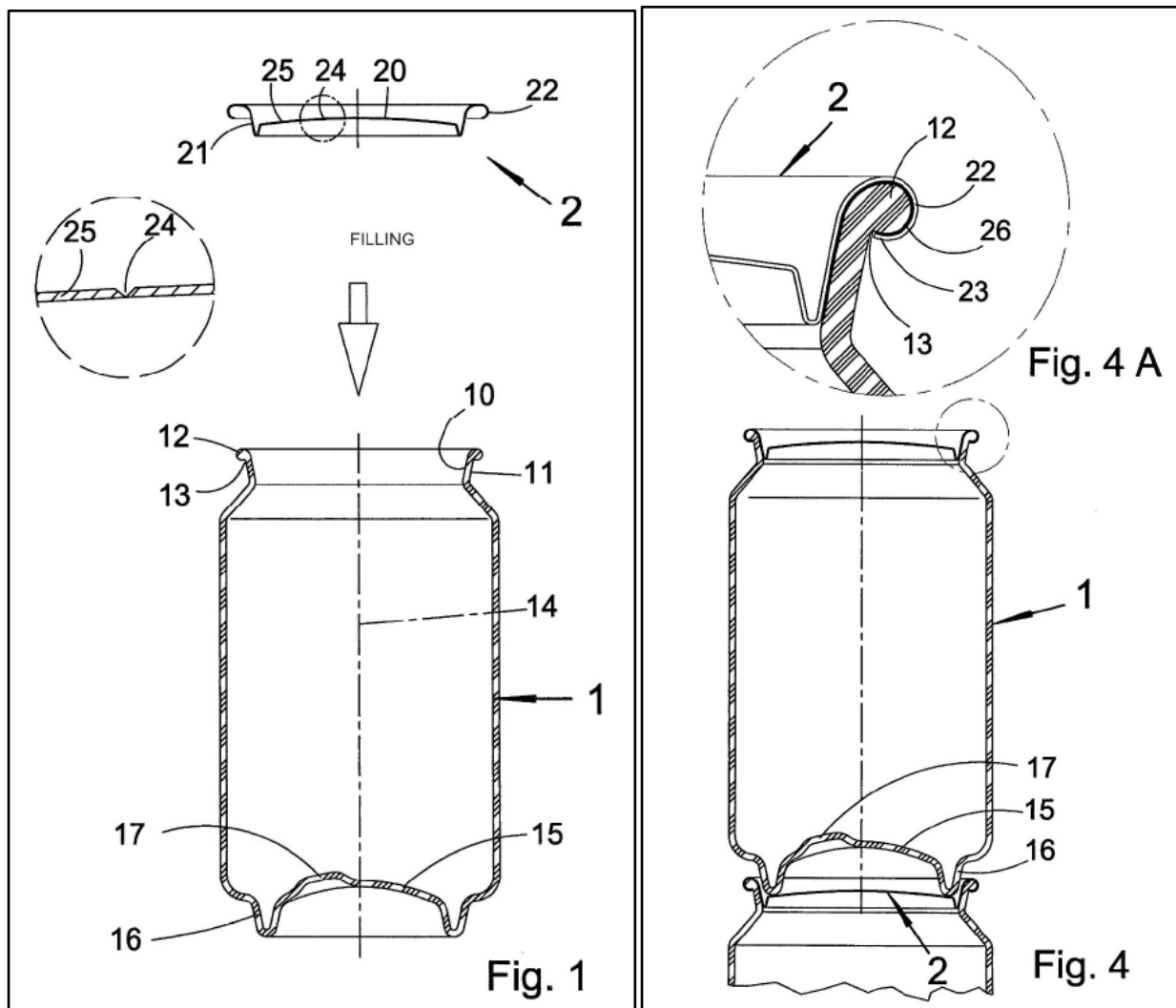
6. Claim 6: “The container of claim 1, wherein the container has a fill line so that, when the container is filled with the liquid up to the fill line, the actual volume of the liquid contained in the container is 200 mL.”

79. Kick teaches that the container has a fill line. (Kick, Fig. 7 (“Fill line 200 mL”).)

80. For these reasons, Kick anticipated or rendered obvious claims 1-6 of the '904 patent.

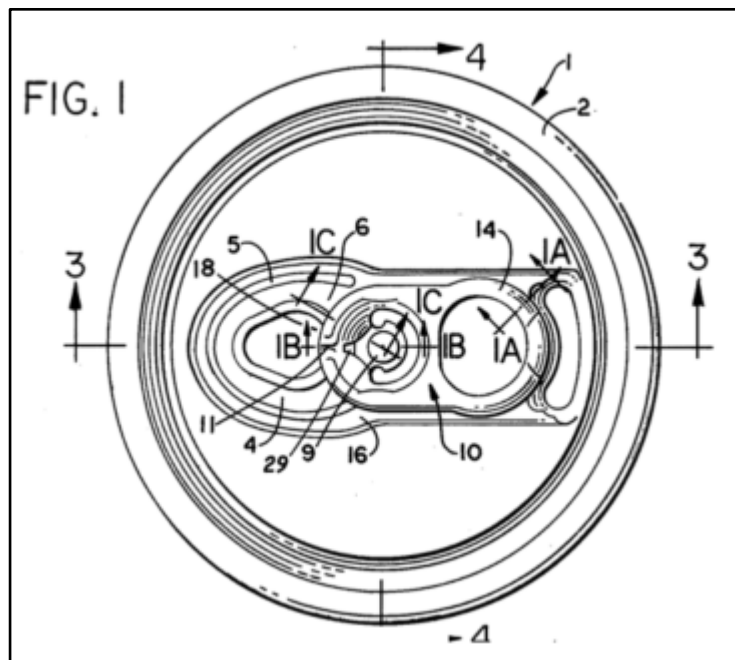
C. Ground 2: Ackermann and Kaminski render claims 1-6 obvious

81. Ackermann describes a beverage container with a plastic body and a metal lid. (Ex. 1008 (“Ackermann”), Abstract; ¶¶0004, 0022, 0027.) Figure 1 shows a side view of the container during filling, while Figures 4 and 4A show the container with an attached lid. (*Id.*, ¶¶0011, 0014, 0015, 0032, 0033.)



(*Id.*, Figs. 1, 4, 4A.)

82. Kaminski describes an “easy open can end;” *i.e.*, lid. (Ex. 1009 (“Kaminski”), Abstract, 2:26.) The lid is manufactured from a “relatively ductile metal, such as aluminum” (*id.*, 3:2-3) and attached to a cylindrical container via a “circumferentially extending raised edge” (*id.*, 2:67-3:1). Figure 1 illustrates a top view of the lid.



(*Id.*, Fig 1.)

1. Motivation to Combine Ackermann and Kaminski with a Reasonable Expectation of Success.

83. In my opinion, the Ackermann-Kaminski combination would have rendered the challenged claims obvious to a POSITA. In the combination, a POSITA would have augmented the container from Ackermann to include commonly known and used lid-opening features from Kaminski. While Ackermann described lids that could be opened via a “tear-away removal opening 25” (Ackermann, ¶0028), Kaminski described a retained-tab lid and explained how this lid configuration was superior to tear-away lids “[f]or ecological and safety reasons.” (Kaminski, 1:14-16.) Partially due to these ecological and safety reasons, the type of pop-top lid was extremely well known and commonly used on beverage

containers for decades prior to 2010, and therefore would have been well known and readily accessible to container designers. Additionally, although Ackermann did not specify the size of its plastic container, it would have been obvious to a POSITA that Ackermann's container could be made in a variety sizes, depending on the intended use. It therefore would have been an obvious design choice to make a container with a volume of less than 211.5 milliliters. A POSITA would have been guided by the teachings of Ackermann and Kaminski and motivated to combine them, which would render the claims obvious.

84. A POSITA would have had a reasonable expectation of success in making the Ackermann-Kaminski combination because it involved simple modifications to the lid of Ackermann's container based on Kaminski's teachings.

85. A POSITA would have found it obvious to make a container that had Ackermann's container body with lid features taught by Kaminski for several reasons.

86. First, the Ackermann-Kaminski combination would have been a simple combination of known elements by known methods, yielding predictable results. Both Ackermann and Kaminski described aluminum lids for beverage containers. (See Ackermann, ¶¶0005, 0027; Kaminski, 2:65-3:4.) A POSITA would have found it obvious to combine features of Ackermann's container and lid with the lid-opening features taught by Kaminski, which provided details about a pull-tab lid for a

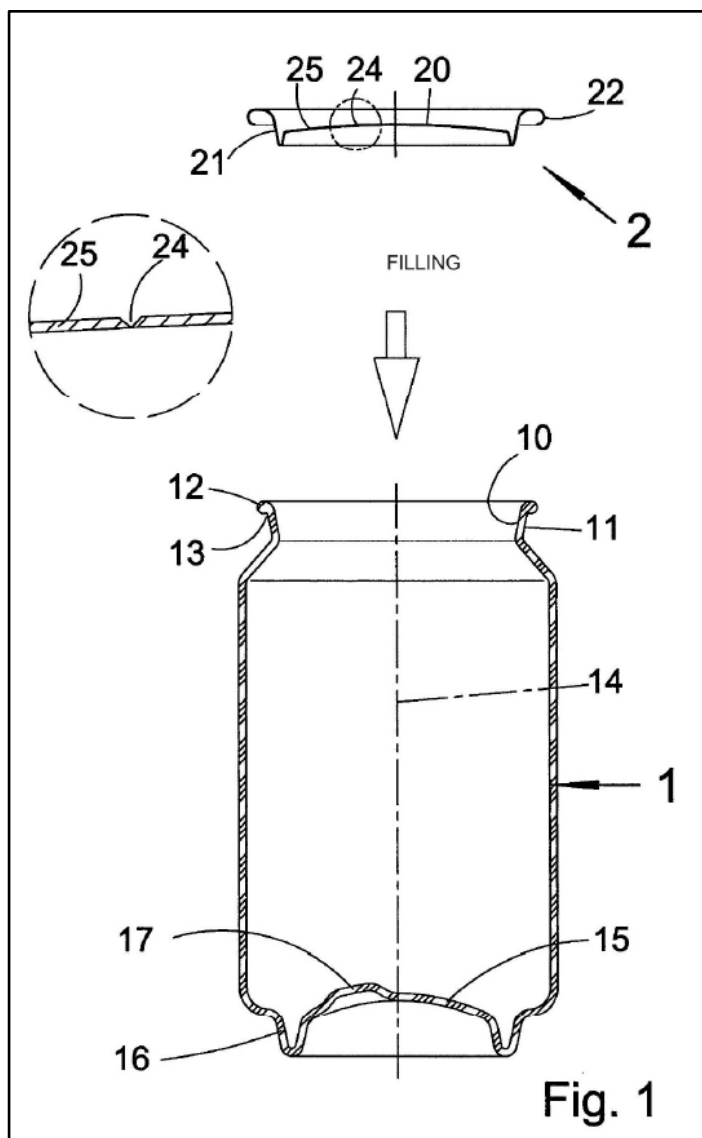
beverage container, to achieve benefits taught by Kaminski. (Kaminski, 1:5-8; 1:14-17 (describing the tab being retained for ecological and safety reasons); 1:27-31 (describing an easy-open lid using less metal).)

87. It also would have been obvious to a POSITA to design the size of the container of the Ackermann-Kaminski combination for the intended use, such as a single serving drink container. A POSITA would have known how to design a container with a volume of that size, and there would be nothing special or unexpected in creating such a container.

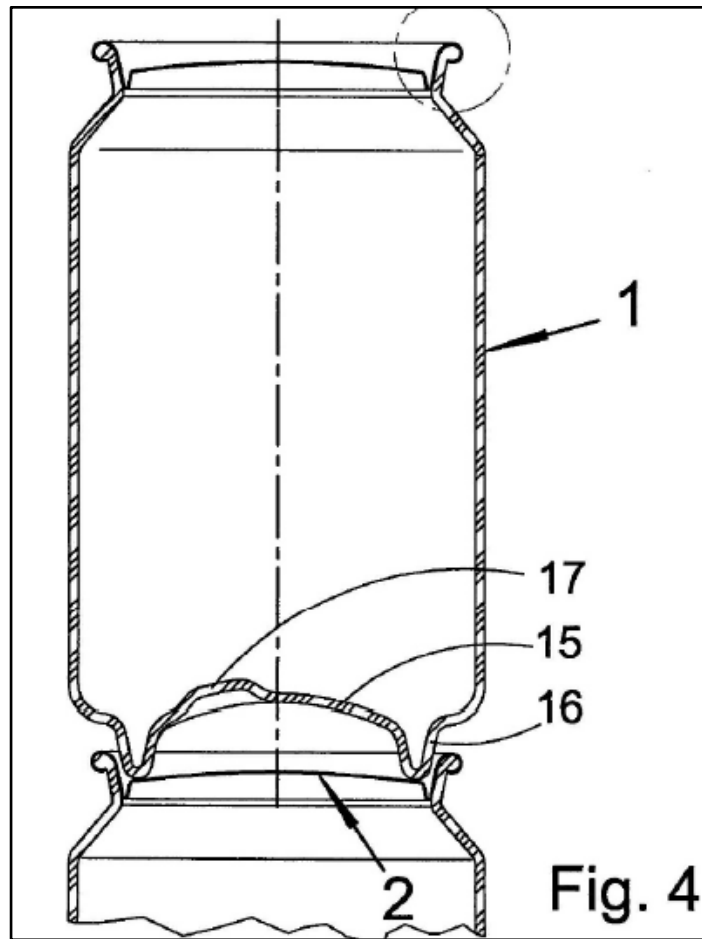
2. Claim 1:

a. Limitation 1[Preamble]: “A container, comprising:”

88. Ackermann discloses a container, in particular a “reusable container, made of plastic.” (Ackermann, Title; Abstract (describing a container “made of plastic, including a lid (2) made of metal for closing a large filling opening (10) of the container (1).”).) Figure 1 of Ackermann illustrates a side view of the container during filling (*id.*, ¶0011), and Figure 4 shows closed and stacked containers (*id.*, ¶0015).



(*Id.*, Fig. 1.)



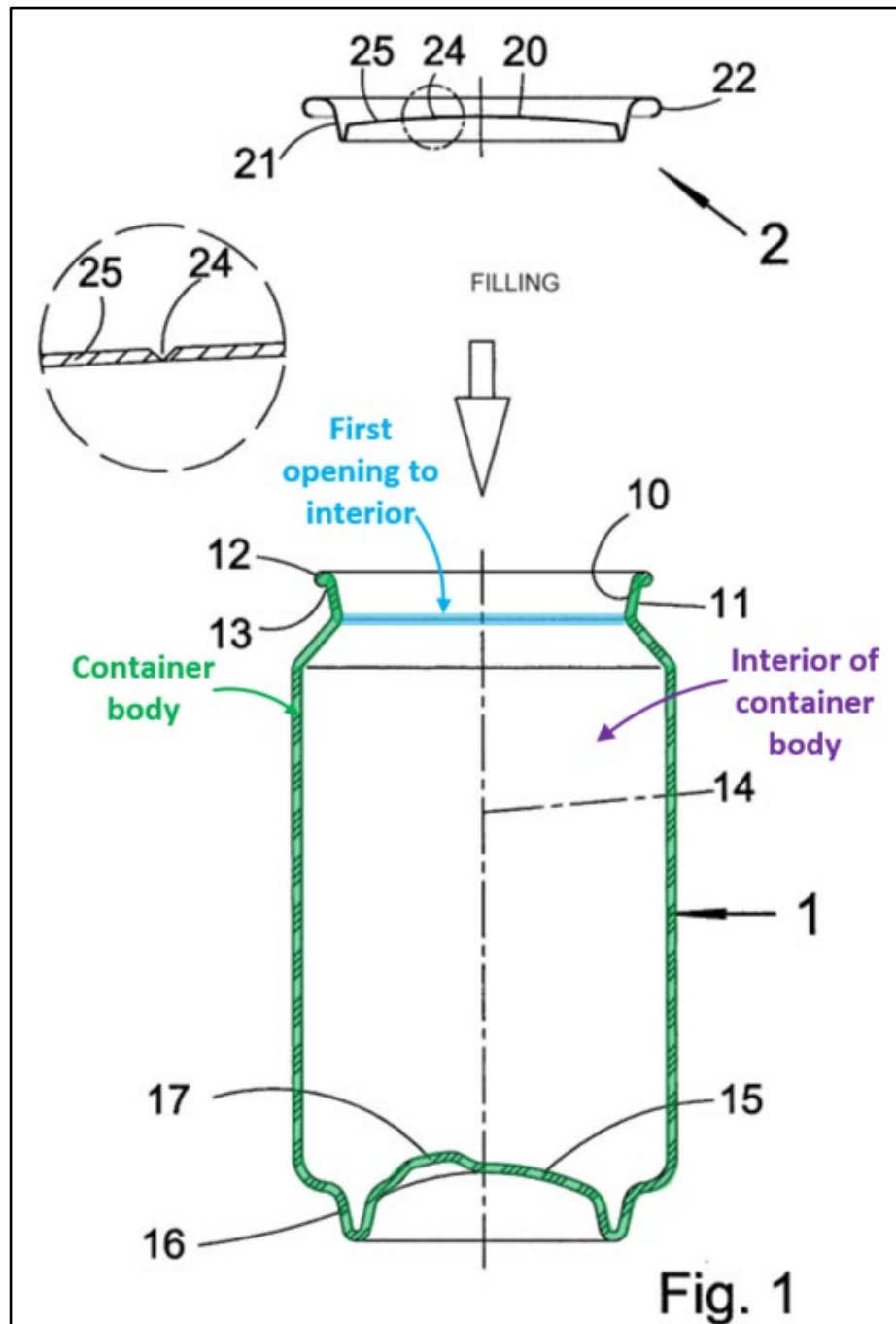
(*Id.*, Fig. 4.)

- b. Limitation 1[a]: “a container body, said container body defining a first opening to an interior of said container body; and”**

89. Ackermann discloses a “container body” that is defined in part by vertical side walls and a bottom of the container. (*See id.*, Fig. 1; *see also id.*, ¶0033 (referring to a “container body”).)

90. The container has a first opening to an interior of the container body in the form of “container opening or filling opening 10.” (*Id.*, ¶0022; *see also* ¶0033

(referring to an interior of the container).) Figure 1 is annotated below to show the container body and first opening to the interior of the container.

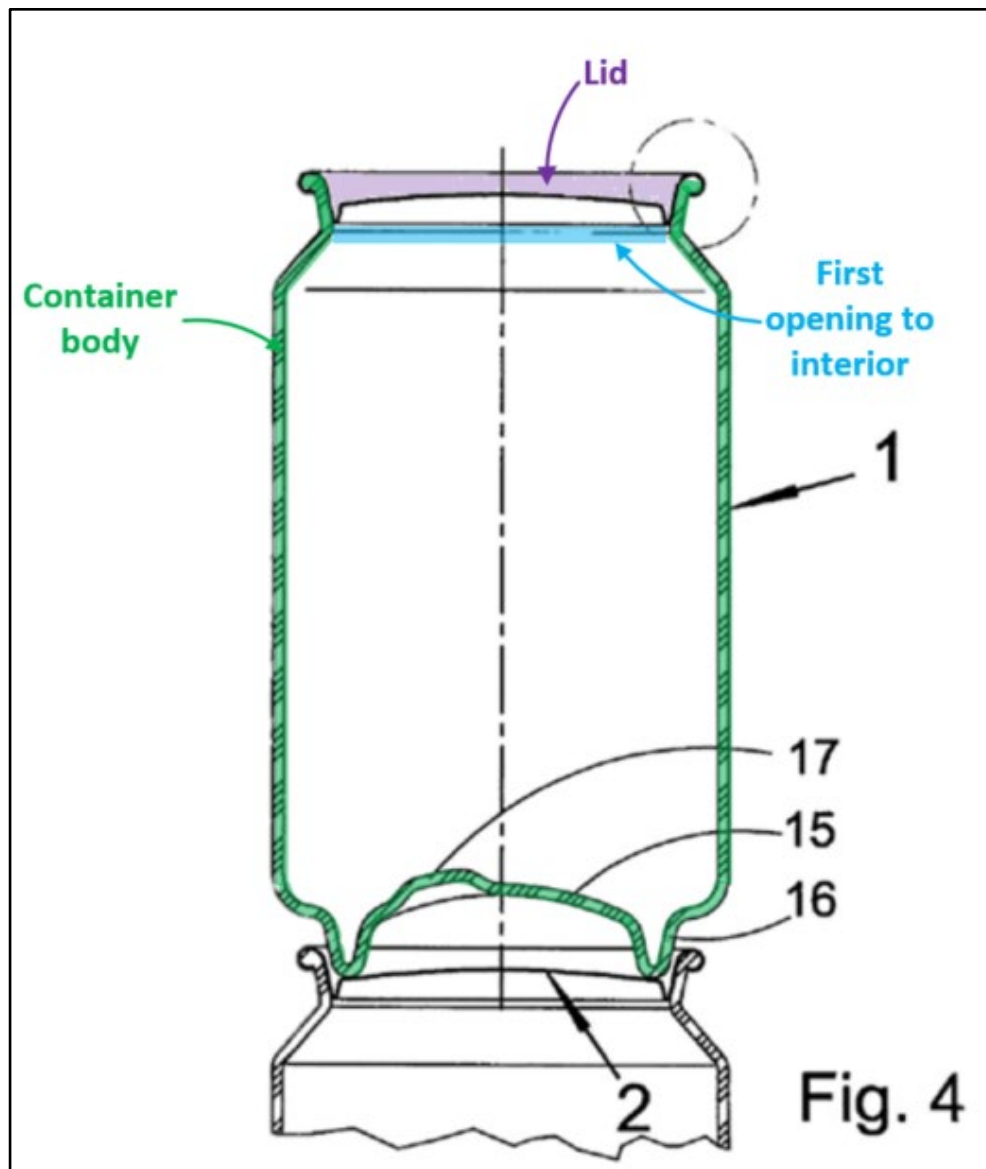


(*Id.*, Fig. 1.)

c. Limitation 1[b]: “a lid connected to the container body and covering the first opening to the interior of said container body;”

91. Ackermann discloses a “lid” in the form of “lid 2,” which can be made out of aluminum or tinplate. (*Id.*, ¶0027.) The lid can be connected to the container body by engaging around a toroidal ridge on the container body. (*Id.*, ¶0004, ¶0033.)

92. The lid 2 of Ackermann covers the first opening to the interior of said container body because it is used to close and seal the container. (*See id.*, ¶0027; *see also* Fig. 4, as annotated below.)



(*Id.*, Fig. 4.)

d. Limitation 1[c]: “wherein the container body is made out of a resin;”

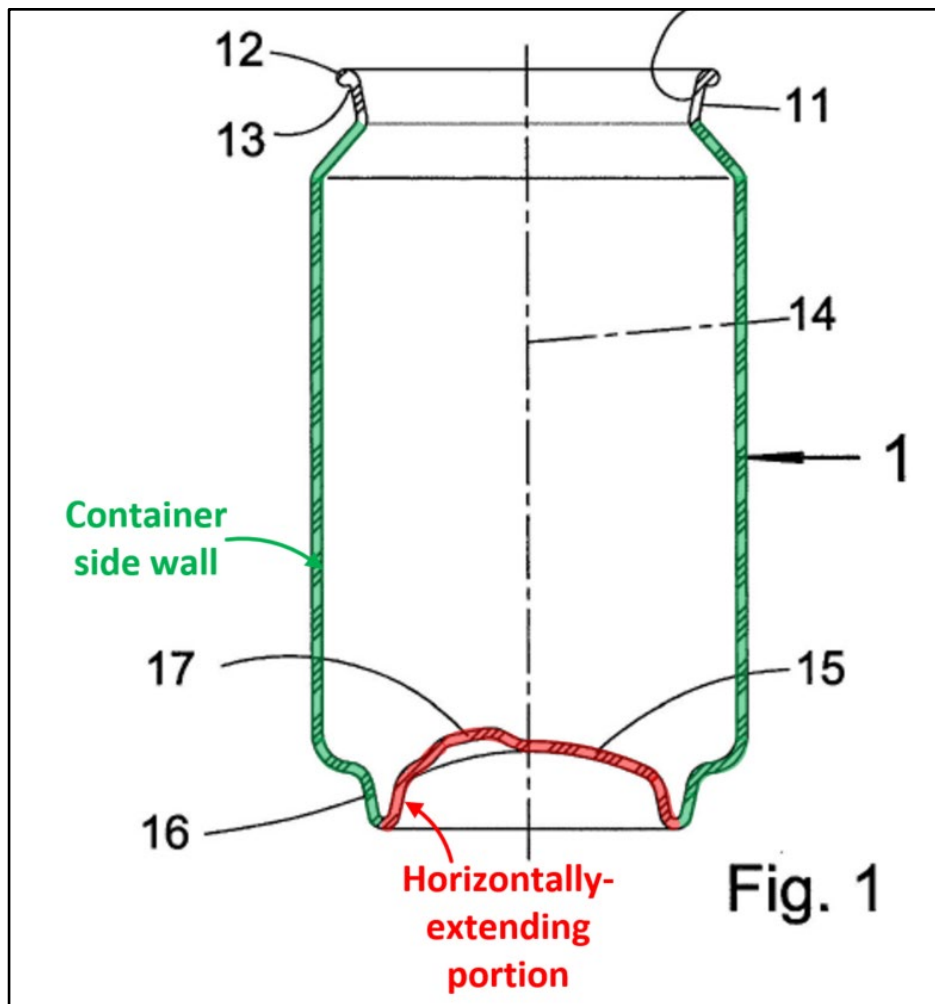
93. The container 1 of Ackermann is made out of a plastic such as polyethylene terephthalate (PET). (Ackermann, ¶0022.) PET is a type of resin. (See Ex. 1011.)

e. Limitation 1[d]: “wherein the lid is made out of a metal;”

94. Ackermann teaches that the lid is made out of a metal such as “aluminum or tinplate.” (Ackermann, ¶0027.) Kaminski also teaches a metal lid. (Kaminski, 3:1-4.)

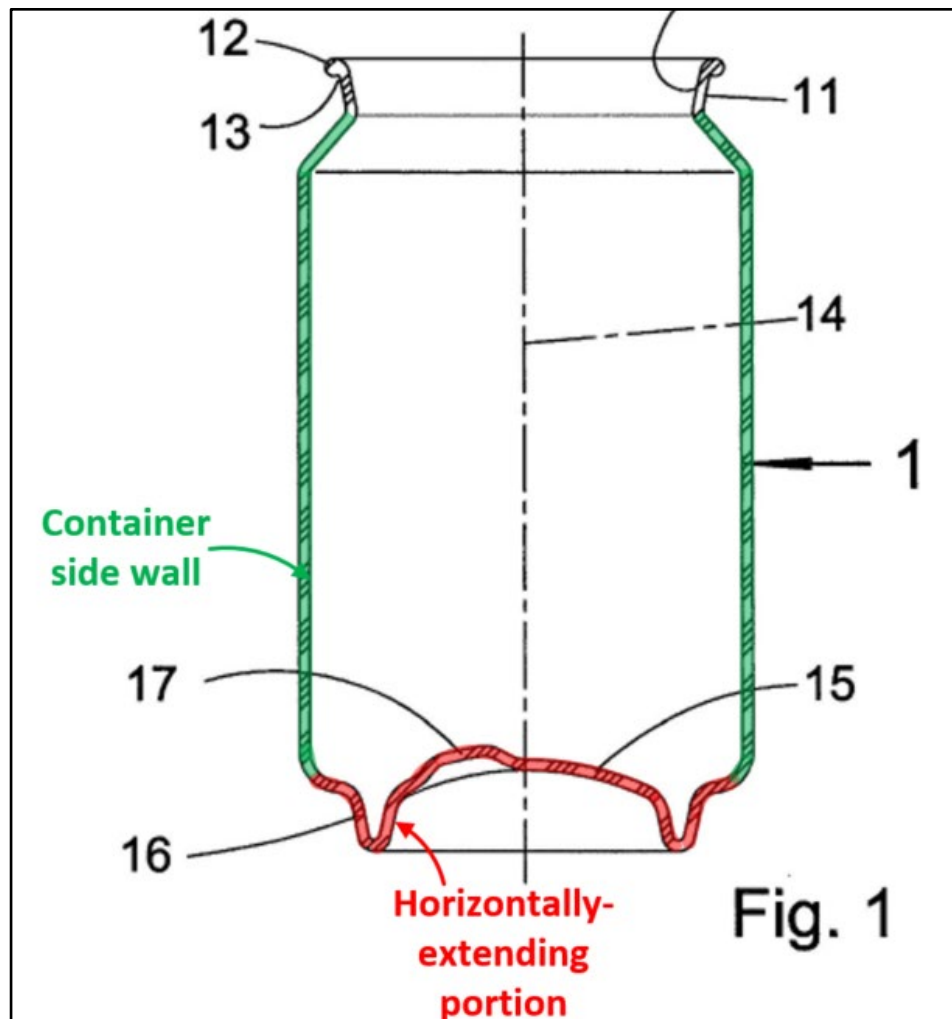
f. Limitation 1[e]: “wherein the container body comprises a container side wall and a horizontally-extending portion connected to the container side wall;”

95. Ackermann discloses a “container side wall” in the form of the vertical side walls and adjacent portions of the container 1, as annotated in green in Figure 1 below. Furthermore, container 1 includes a “horizontally-extending portion connected to the container side wall” in the form of a container base 15 (Ackermann, ¶0026), which extends across a horizontal space between the side walls as annotated in red in Fig. 1 below.



(*Id.*, Fig. 1 (cropped).)

96. Although the annotated figure above shows the horizontally-extending portion including and extending between the lowest points of the container, the lower portion of the container extends further out horizontally, so the side wall and horizontally-extending portion can also be depicted as shown in the figure below.

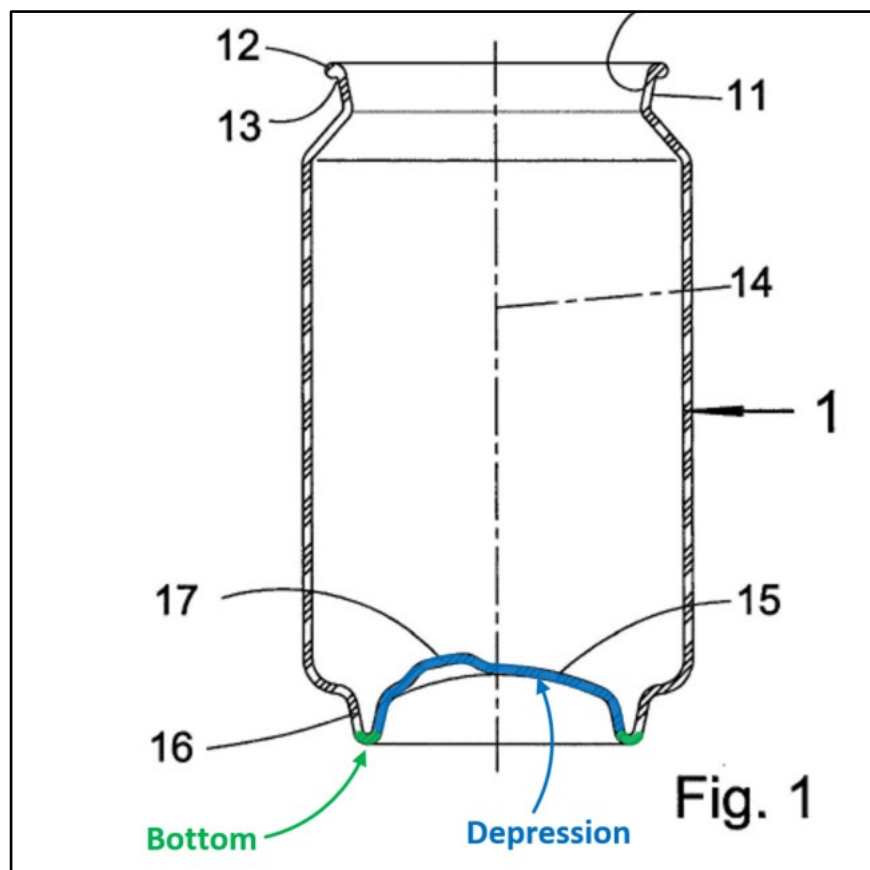


(*Id.*, Fig. 1 (cropped).)

97. Regardless of the dividing point between the sidewall and the horizontally-extending portion, it would have been obvious to a POSITA to connect the side wall to the horizontally extending portion to form a sealed container for liquids.

- g. **Limitation 1[f]: “wherein the horizontally-extending portion comprises a bottom having a depression formed therein, said depression extending upwardly from an extant of the bottom;”**

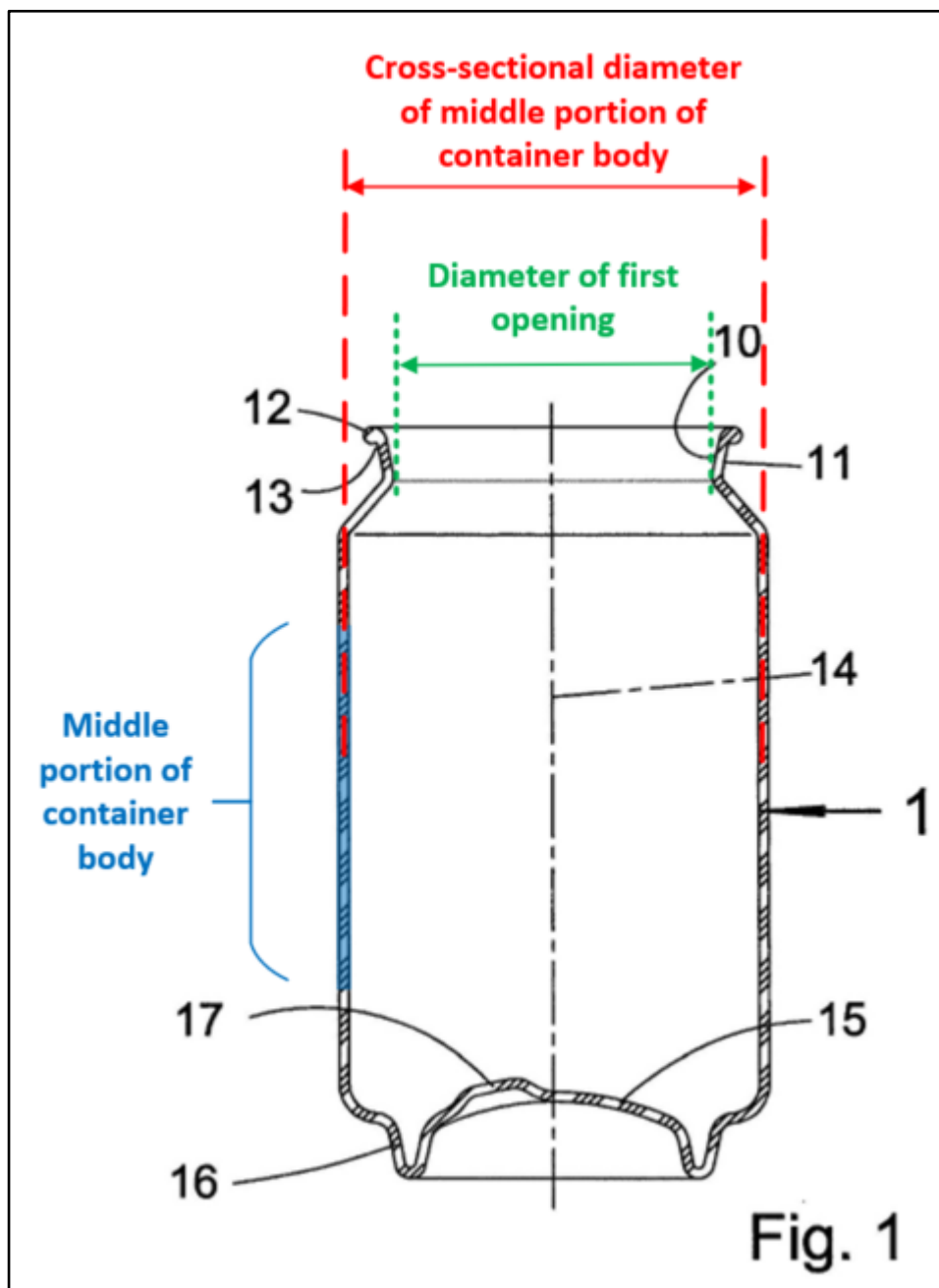
98. Regardless of the interpretation of the section of Ackermann’s container that represents the claimed “horizontally-extending portion” (as discussed in Limitation 1[e]), this portion of Ackermann comprises a bottom in the form of an annular surface on which the container stands, shown in annotated Figure 1 below. Figure 1 further illustrates a depression formed in the bottom and extending upwardly from the bottom.



(*Id.*, Fig. 1 (cropped).)

h. Limitation 1[g]: “wherein a cross-sectional diameter of the first opening to the interior of said container body is less than a cross-sectional diameter of a middle portion of said container body;”

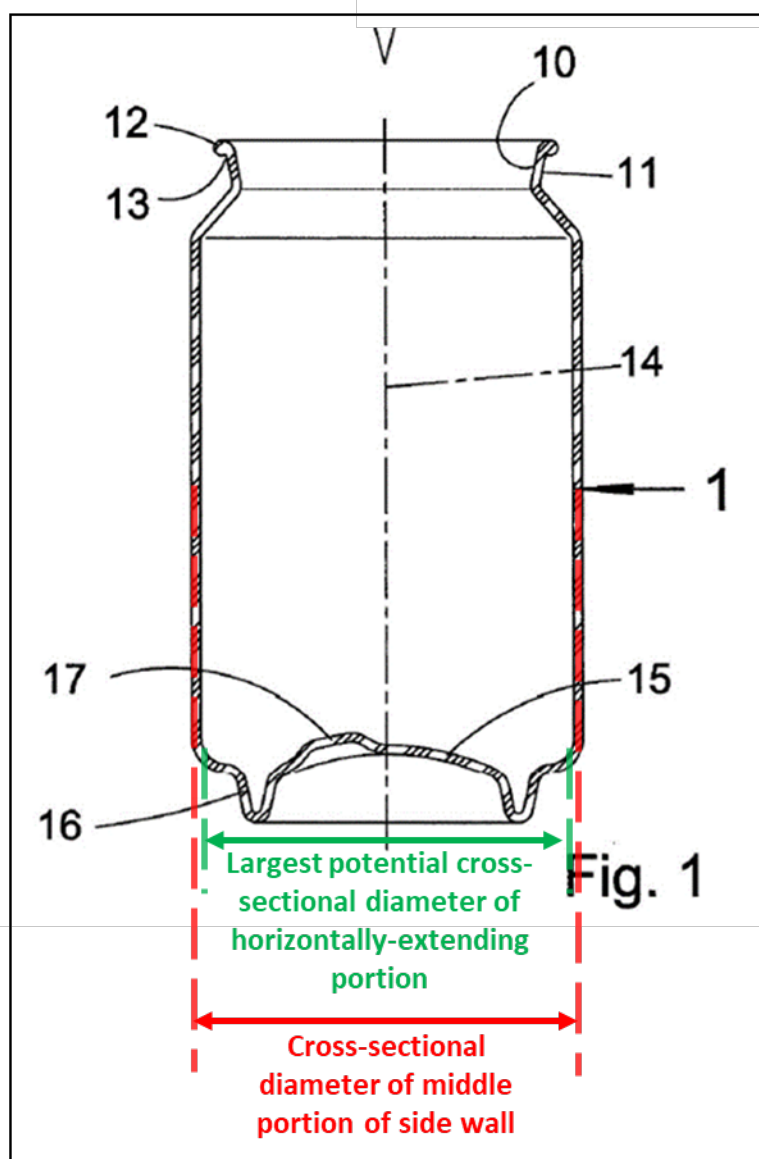
99. Ackermann discloses this feature and would have rendered this feature obvious. As annotated in Figure 1 below, Ackermann’s container body has a **middle portion**. The container also had a **cross-sectional diameter of the first opening** and a larger **cross-sectional diameter of the middle portion**. Thus, Ackermann teaches this limitation. This limitation also would have been obvious because it is a simple design choice to configure the container such that the cross-sectional diameter of the first opening is less than the cross-sectional diameter of the middle portion of the container body.



(*Id.*, Fig. 1 (cropped).)

i. Limitation 1[h]: “wherein the horizontally-extending portion defines a diameter that is less than the cross-sectional diameter of the middle portion of said container body;”

100. Regardless of the interpretation of the section of Ackermann’s container that represents the claimed “horizontally-extending portion” (as discussed in Limitation 1[e]), Ackermann teaches this limitation because the middle portion of the side wall has a greater cross-sectional diameter than the largest possible diameter of the horizontally-extending portion because the horizontally-extending portion does not include any portion of the vertical sidewall. The figure below illustrates how the diameter of the middle portion of the sidewall is greater than the largest potential diameter for the horizontally extending portion.

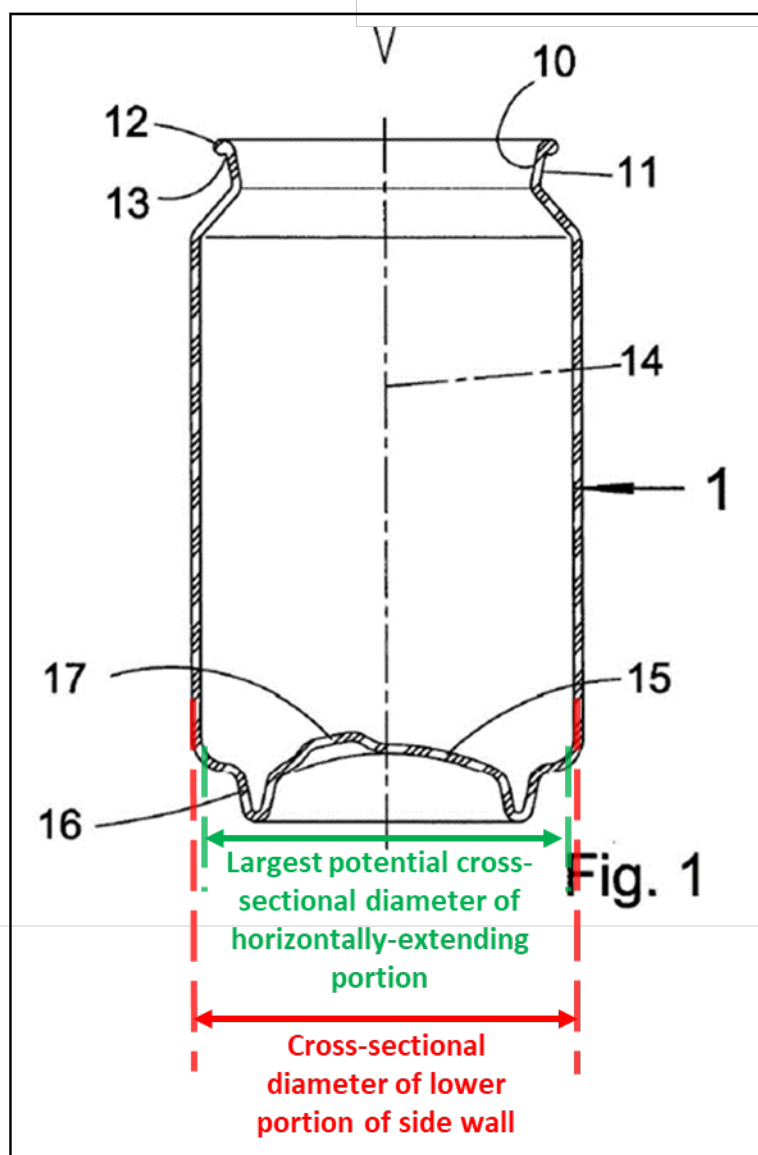


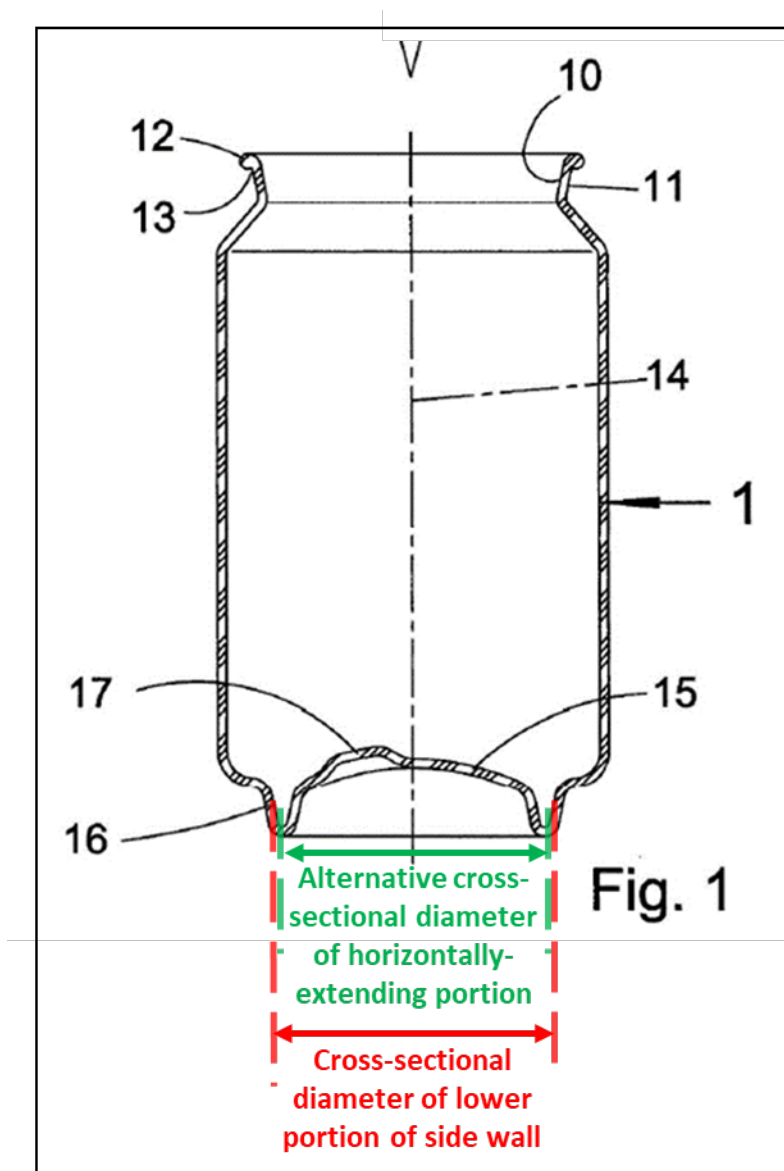
(*Id.*, Fig. 1 (cropped).)

- j. **Limitation 1[i]: “wherein a lower portion of the container side wall extends downwardly from the middle portion of the container side wall to the horizontally-extending portion of the container body, said lower portion being greater in diameter along its entirety than the horizontally-extending portion, including the bottom, thereby rendering the container body stemless;”**

101. Regardless of the dividing point between the side wall and the horizontally extending portion, Ackermann teaches that the lower portion of the sidewall has a greater diameter than the horizontally-extending portion because the side wall and bottom of the container only extend inwardly with a shrinking diameter. They never extend outwardly such that the horizontally-extending portion could have a greater diameter than the lower portion of the sidewall. This is shown in the figures below, each showing a different dividing point between the side wall and the horizontally-extending portion.

102. First, as shown in annotated Figure 1 below, Ackermann’s container had a lower portion of the container side wall (see yellow annotation below), which extended downwardly from the **middle portion of the container wall** to the **horizontally-extending portion**. One interpretation of the lower portion of the container side wall is shown below, with a first interpretation of the section of the container’s base that represents the horizontally-extending portion.





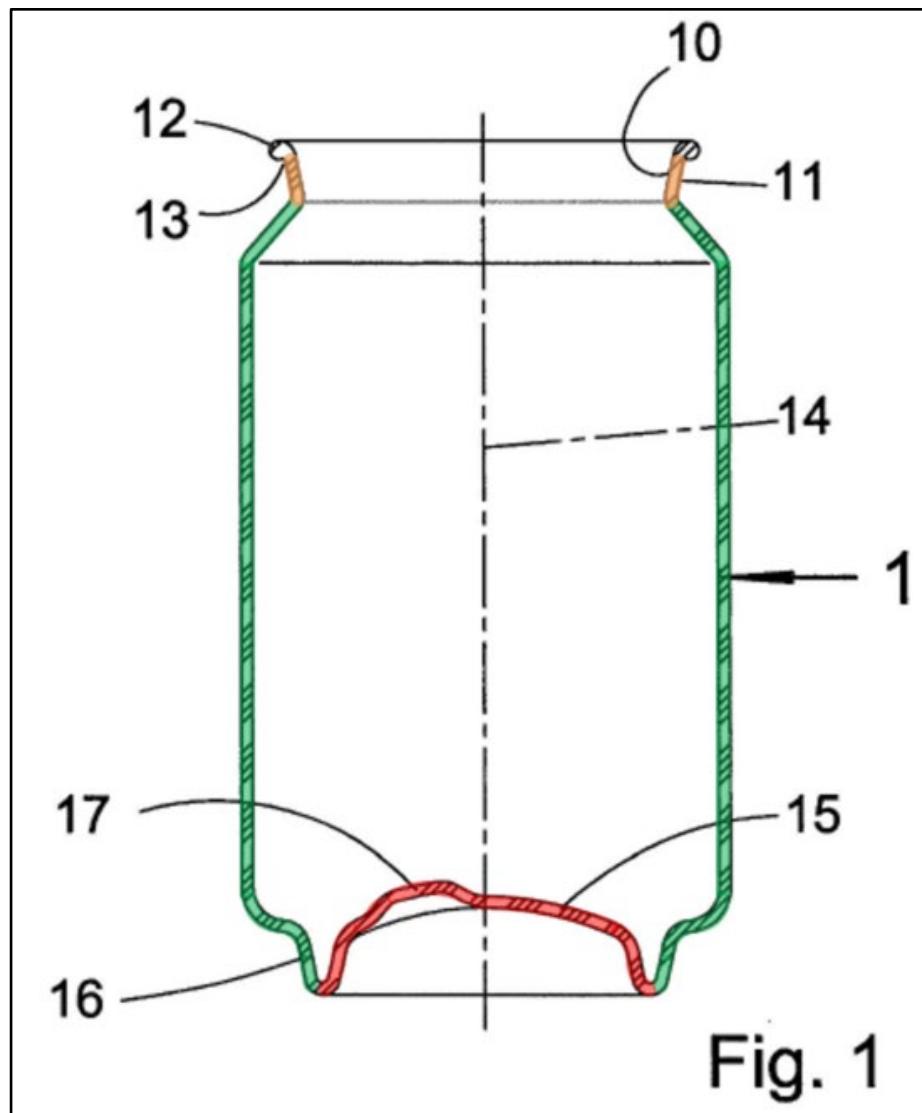
(*Id.*, Fig. 1 (cropped).)

103. Finally, Ackermann's container satisfies this limitation because it is stemless.

- k. **Limitation 1[j]: “wherein the container body further comprises a circular neck extending from the container side wall so that the container side wall extends between the circular neck and the horizontally-extending portion;”**

104. Ackermann discloses a circular neck in the form of “annular wall 11.”
(Ackermann, ¶0022; Figure 1.)

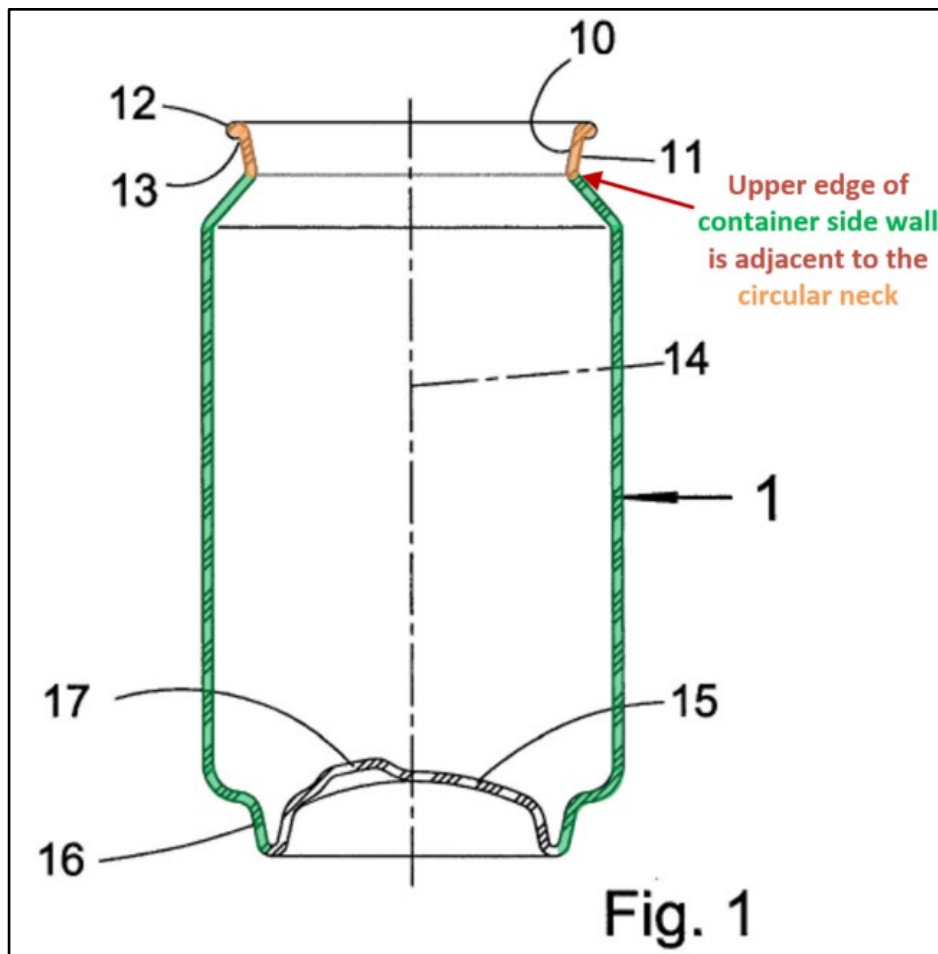
105. As shown in annotated Figure 1 below, the **annular wall (circular neck)** extends from the **container side wall**, such that the container side wall extends between the circular neck and the **horizontally-extending portion**, according to any interpretation of the horizontally-extending portion in Limitation 1[e].



(*Id.*, Fig. 1 (cropped).)

- I. **Limitation 1[k]: “wherein an upper edge of said container side wall is adjacent to the circular neck of the container body;”**

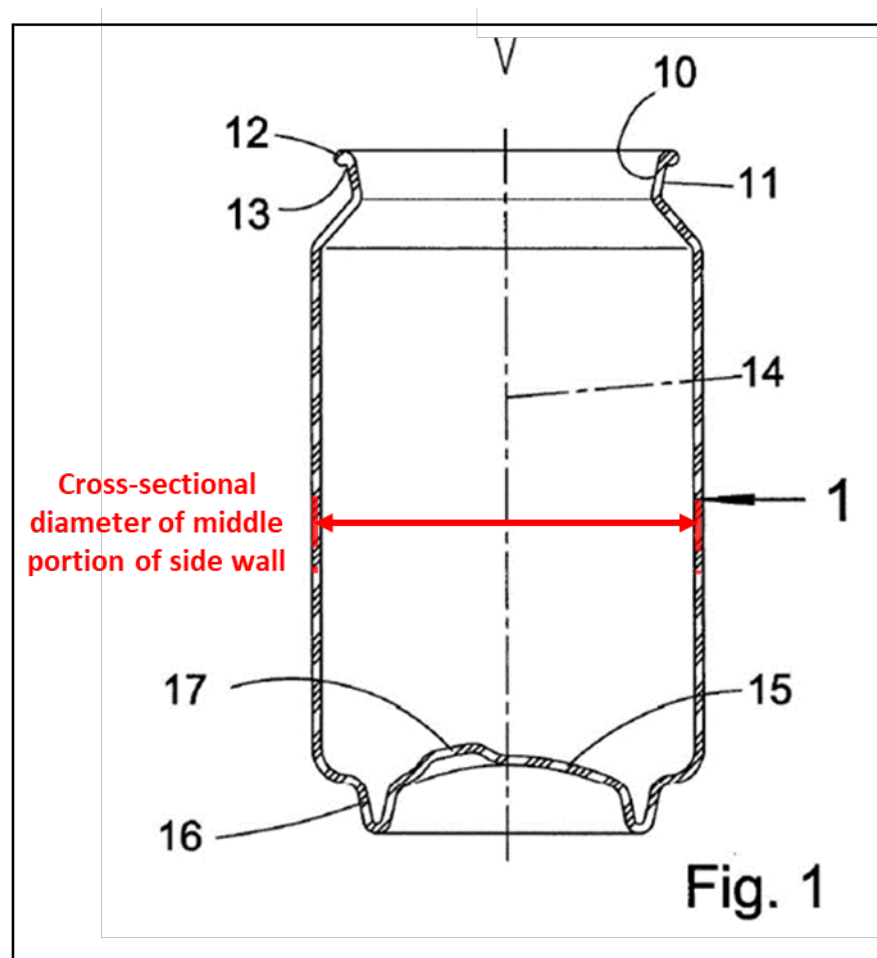
106. In Figure 1, Ackermann illustrates that the upper edge of the container side wall (*see* Limitation 1[j]) is adjacent to the annular wall (circular neck of the container body). (*Id.*, Fig. 1.)



(*Id.*, Fig. 1 (cropped).)

- m. **Limitation 1[l]: “wherein the cross-sectional diameter of the middle portion of said container body is defined by the container side wall;”**

107. Ackermann’s Figure 1 illustrates the middle portion of the container body as defined by the container side wall, and the container side wall defines a cross-sectional diameter, as shown in the annotated figure below.

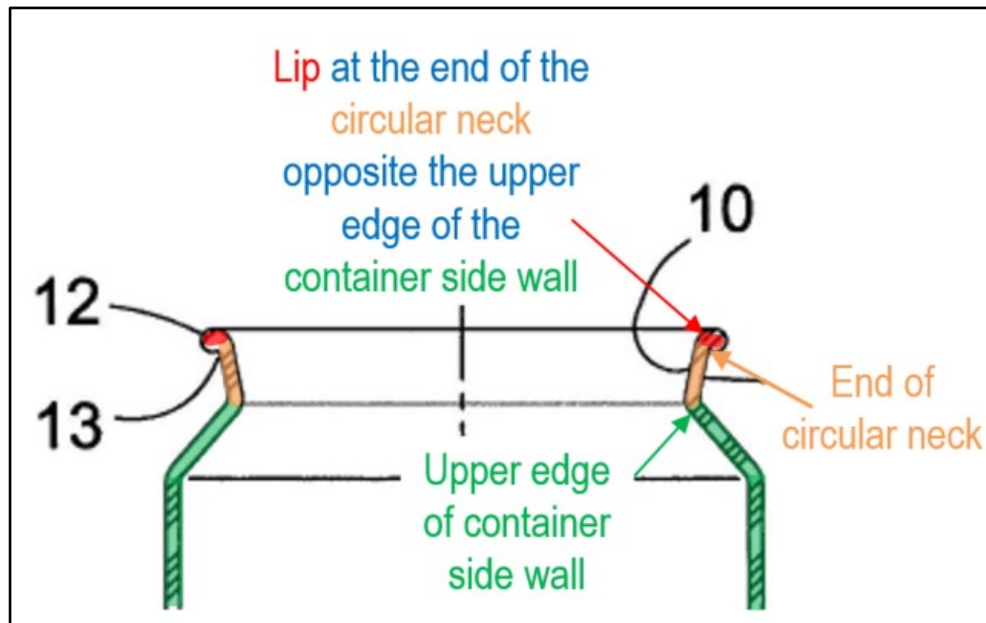


(*Id.*, Fig. 1 (cropped).)

- n. **Limitation 1[m]: “wherein the container body further comprises a lip at the end of the circular neck opposite the upper edge of said container side wall;”**

108. Ackermann discloses a lip at the end of the circular neck, in the form of a “protruding ridge 12” that “projects beyond the contour of the annular wall 11 in order to form an undercut groove 13.” (*Id.*, ¶0023; Figure 1.) The ridge 12 is used for closing the container, as a rolled wall of a lid would engage around the ridge. (*Id.*, ¶0027.)

109. As shown in Ackermann's Figure 1, annotated below, the lip (protruding ridge 12) is at the end of (i.e., the top of) the circular neck (annular wall 11), opposite the upper edge of the container side wall.



(*Id.*, Fig. 1 (cropped).)

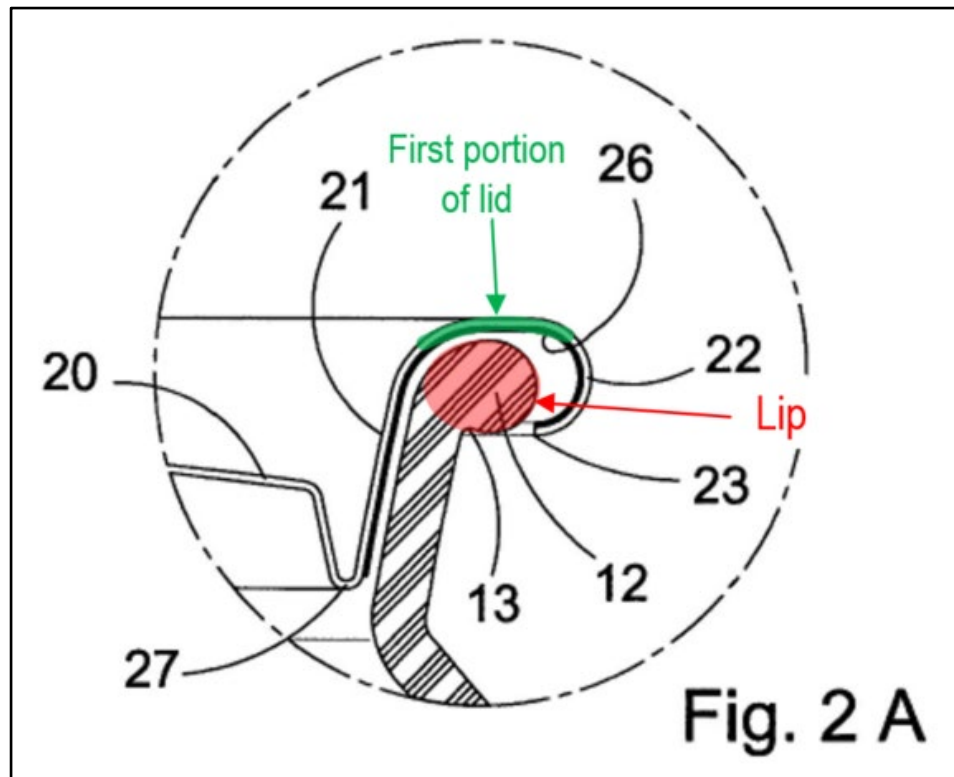
- o. Limitation 1[n]: “wherein said circular neck is adjacent to the lip;”**

110. The annotations to Figure 1 in Limitation 1[m] show that the circular neck of Ackermann is adjacent to the lip.

- p. Limitation 1[o]: “wherein a first portion of the lid is above the lip of the container body;”**

111. Ackermann discloses this feature in its Figure 2A, which shows an “enlarged detail” of “the container during mounting of the lid.” (*Id.*, ¶¶0012, 0013.)

As depicted in Figure 2A and annotated below, a first portion of the lid is above the lip of the container body.

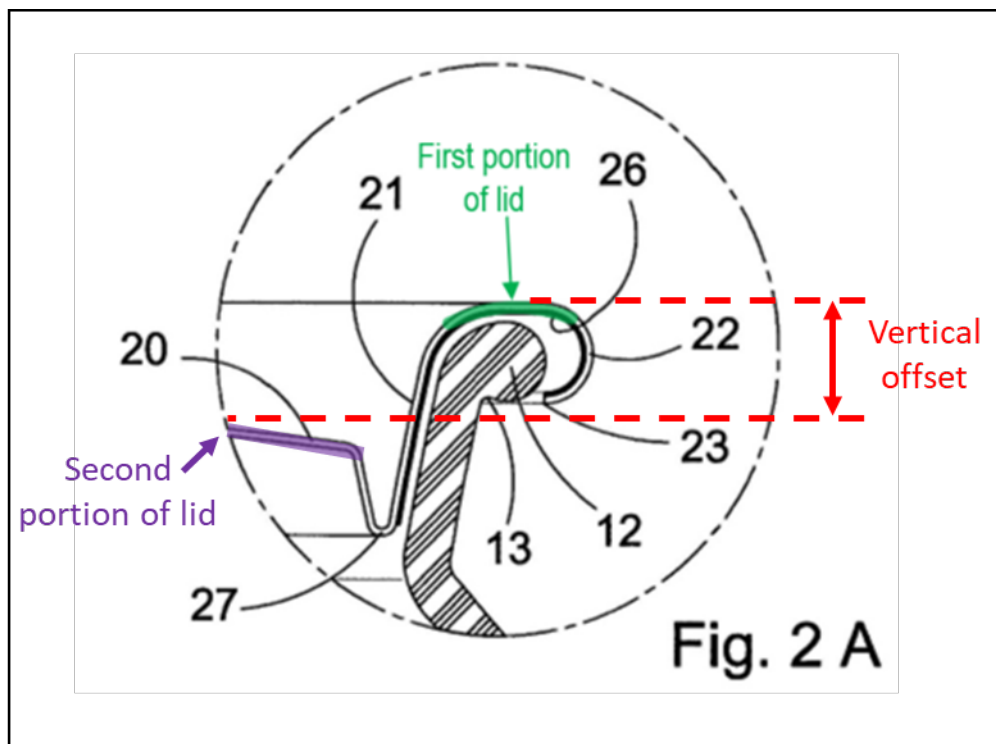


(*Id.*, Fig. 2A.)

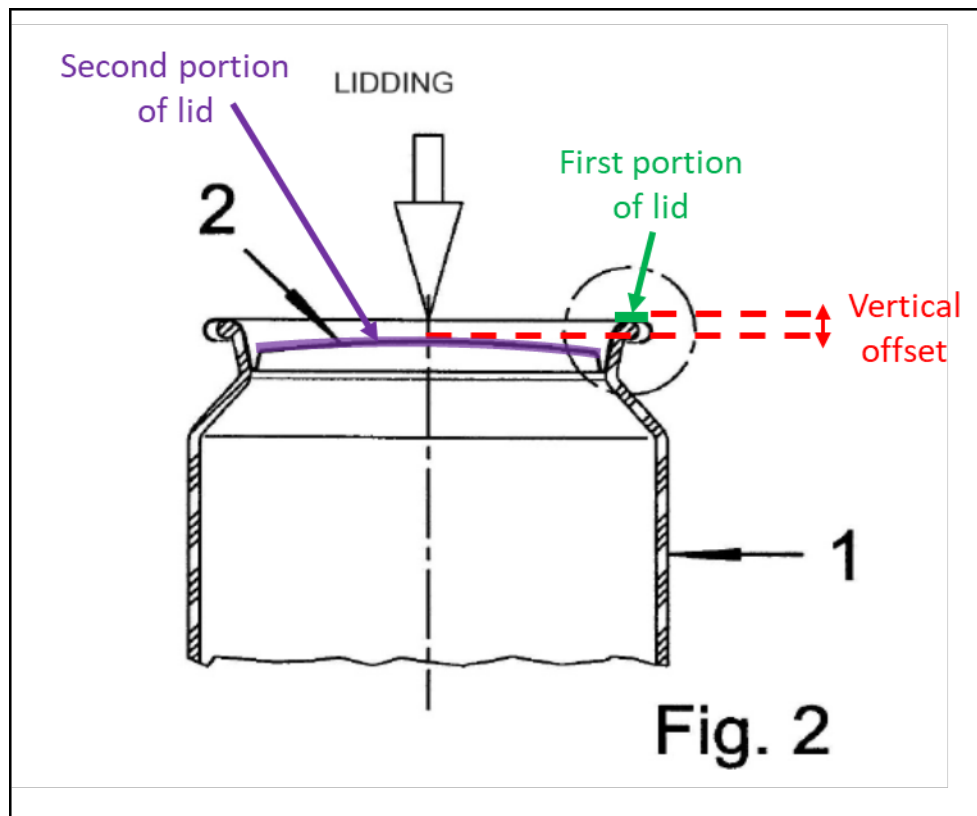
- q. **Limitation 1[p]: “wherein a second portion of the lid extends horizontally and is vertically offset from the first portion of the lid;”**

112. Figures 2 and 2A of Ackermann illustrate this feature. These figures are annotated below to show how a central region of the lid – forming a second portion of the lid – extends horizontally when the lid is attached to the container; that is, spanning across a horizontal space between the container’s side walls. This

central region of the lid is vertically offset from (i.e., below) the first portion of the lid.



(*Id.*, Fig. 2A.)

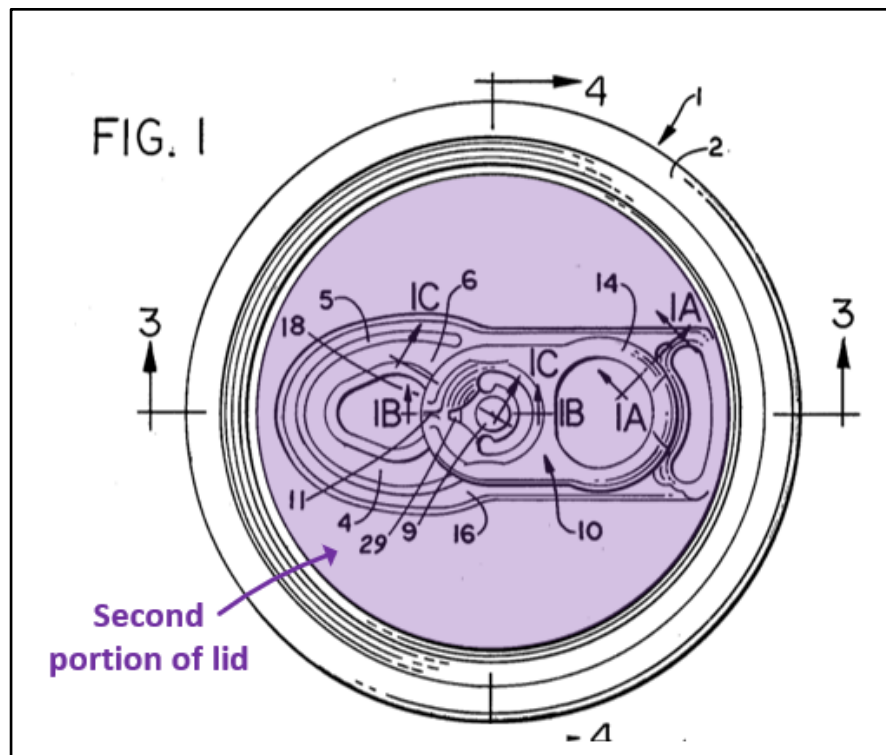


(*Id.*, Fig. 2.)

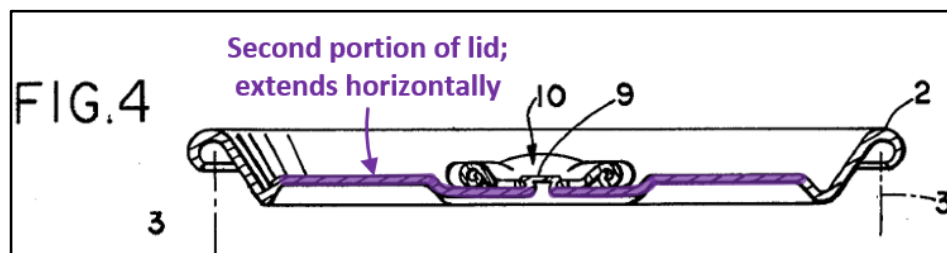
- r. **Limitation 1[q]: “wherein the second portion of the lid defines a total area across which the second portion of the lid extends horizontally;”**

113. Annotated Figure 2 of Ackermann above illustrates that the second portion of the lid (purple) defines a total area across which the second portion of the lid extends horizontally.

114. Kaminski’s lid, analogously, has a second portion that extends horizontally, as shown in purple in annotated Figures 1 and 4 below.



(Kaminski, Fig. 1.)



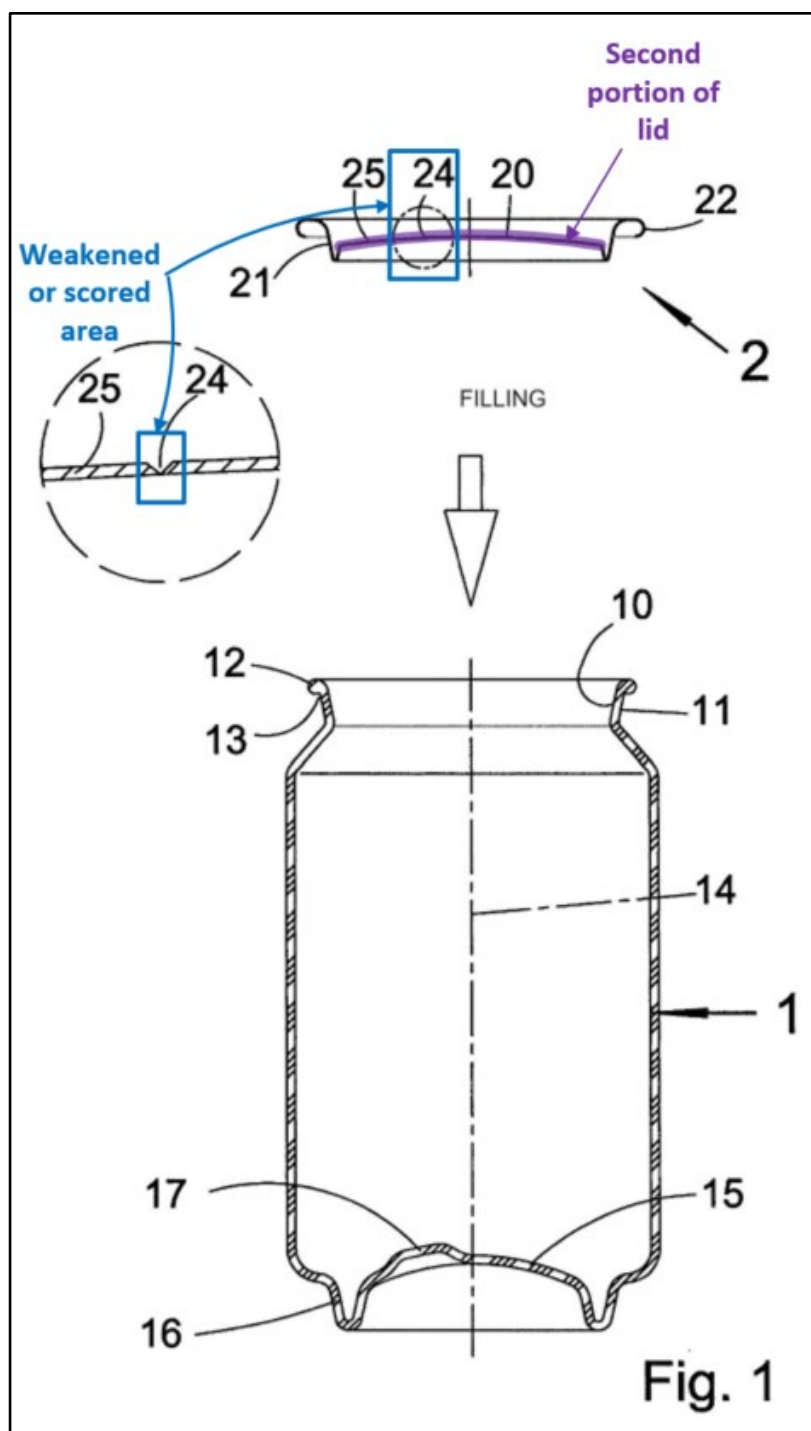
(*Id.*, Fig. 1.)

115. Like Ackermann's lid, the second portion of Kaminski's lid has a total area that represents the area of the portions of the lid shown in purple above.

- s. **Limitation 1[r]: "wherein the second portion of the lid comprises a weakened or scored area;"**

116. Ackermann and Kaminski both disclose this feature.

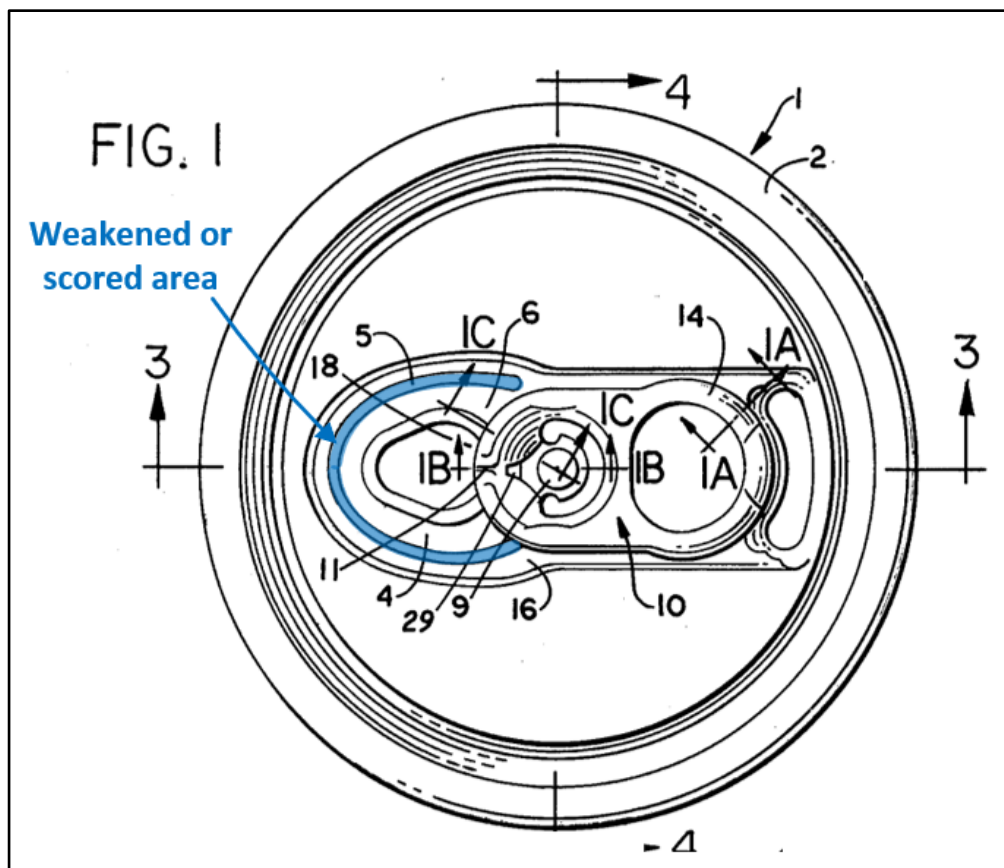
117. Ackermann explains that its lid 2 can include a weakened or scored area in the form of a “**weakening notch 24** around a tear-away removal opening 25.” (Ackermann, ¶0028.) The weakening notch 24 is illustrated in Fig. 1, as annotated below.



(Ackermann, Fig. 1.)

118. Kaminski also discloses a lid with a weakened or scored area. Kaminski's lid is "of generally circular shape including a circumferentially

extending raised edge 2 for attaching can end 1 to a suitable cylindrical beverage can 3.” (Kaminski, 2:65-3:4.) The second portion of Kaminski’s lid has a weakened or scored area in the form of a “score or tear line 5.” (*Id.*, 3:7-10; Fig. 1.) Raising a pull tab 10 on the lid would “initiate[] a tear along the score line 5” (*id.*, 3:49-51), causing “the score line 5...to tear therearound” (*id.*, 3:56-58).



(*Id.*, Fig. 1.)

119. A POSITA would have found it obvious to modify the lid of Ackermann’s disclosure to include features of the lid from Kaminski. For example, it would have been obvious to modify Ackermann’s lid to include the score line and

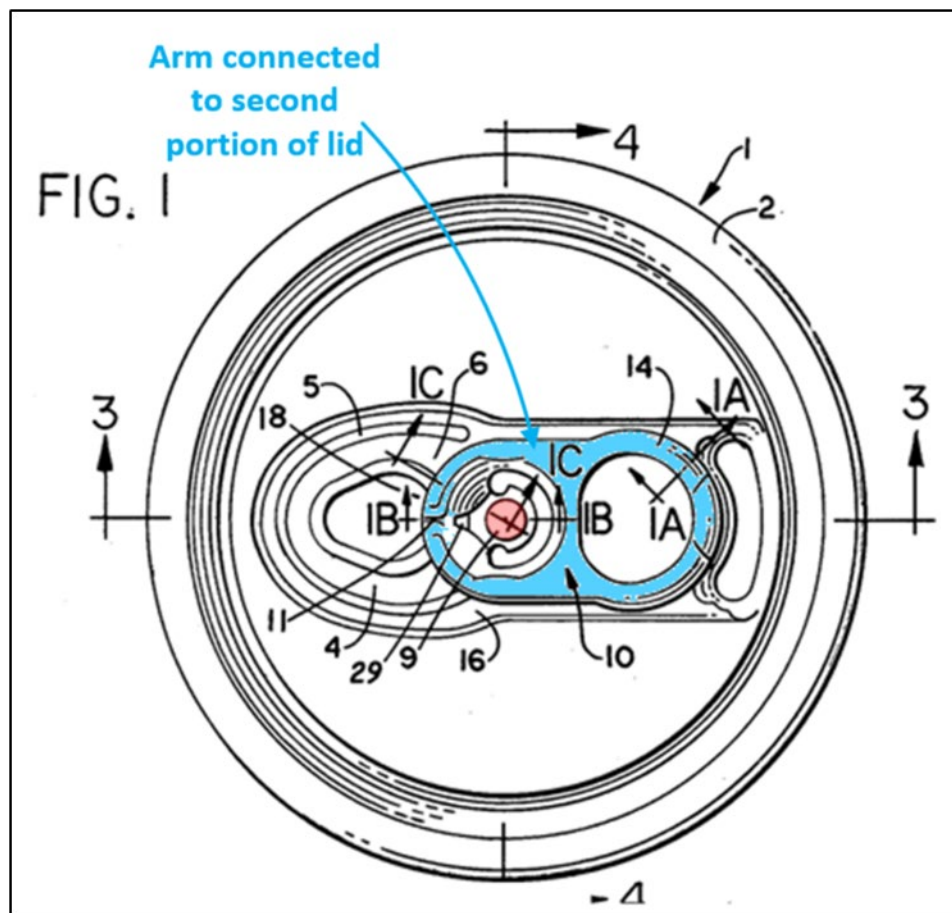
pull tab of Kaminski as a mechanism to open the container, because such modifications would have been a simple substitution of one known element for another to obtain predictable results. Pull-tab or pop-top lids like those disclosed by Kaminski had been in widespread use for decades before the priority date of the '904 patent, and a POSITA would have known how to configure such lids. A POSITA also would have been motivated to replace Ackermann's weakening notch and tear-away removal opening with Kaminski's score line and pull tab because, as explained by Kaminski, retaining the tab to the container has ecological and safety benefits (Kaminski, 1:5-8; 1:14-17), and is easy to open (*id.*, 1:27-31).

t. Limitation 1[s]: “wherein the weakened or scored area is less than the total area across which the second portion of the lid extends horizontally;”

120. As shown in Figure 1, Kaminski discloses this feature. The annotated figures in Limitations 1[q] and 1[r] demonstrate that the weakened or scored area is less than the total area across which the second portion of the lid extends horizontally. Again, this is a standard feature of pop-top cans with a lid similar to the design in Kaminski, and this feature was well known and widely used in beverage cans for decades prior to the earliest possible priority date for the '904 patent because it provides easy access to the liquid in the container while still limiting the exposure of the liquid to spills or contamination, as would be the case if the entire surface of the lid were opened or removed.

u. Limitation 1[t]: “wherein the lid further comprises an arm connected to the second portion of the lid;”

121. Kaminski’s lid further includes an **arm** in the form of “pull tab 10,” labeled in annotated Figure 1 below. (Kaminski, 3:17-20; 3:49-52.) A rivet 9 (marked in red below) connects the pull tab 10 to the lid at a location within the second portion of the lid. (*Id.*, 3:13-17.)

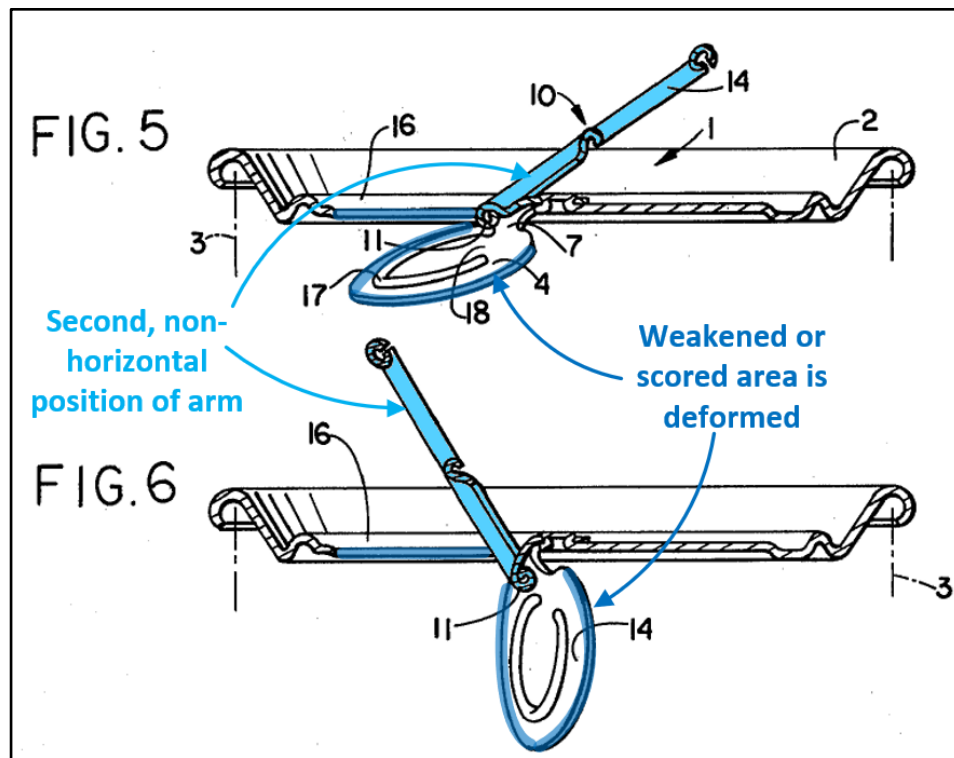


(*Id.*, Fig. 1.)

- v. **Limitation 1[u]: “wherein the arm is pivotable from a first position, in which the arm extends horizontally and the weakened or scored area is not deformed, to a second position, in which the arm does not extend horizontally and the weakened or scored area is deformed to provide a second opening to the interior of said container body;”**

122. This is yet another claim limitation that describes a standard, well-known feature of pop-top beverage lids that have existed for decades, where a tab is lifted to puncture the lid along the weakened or scored area to create an opening in the lid. Kaminski also disclosed this limitation. Kaminski’s pull tab is pivotable, as illustrated in Figures 1, 3, and 5-6. First, Figures 1 and 3, annotated below, respectively depict a top and side view of a first position in which the pull tab extends horizontally – that is, approximately parallel to the plane of the lid. In this position, the score or tear line 5 (i.e., weakened or scored area) is not deformed.

123. Then, in Figure 5, Kaminski illustrates how “when the pull tab 10 is raised” – pivoted to a second position in which it did not extend horizontally – “the nose portion 11 thereof initiates a tear along the score line 5” – deforming the score line and forming an opening in the lid. (*Id.*, 3:49-52.)



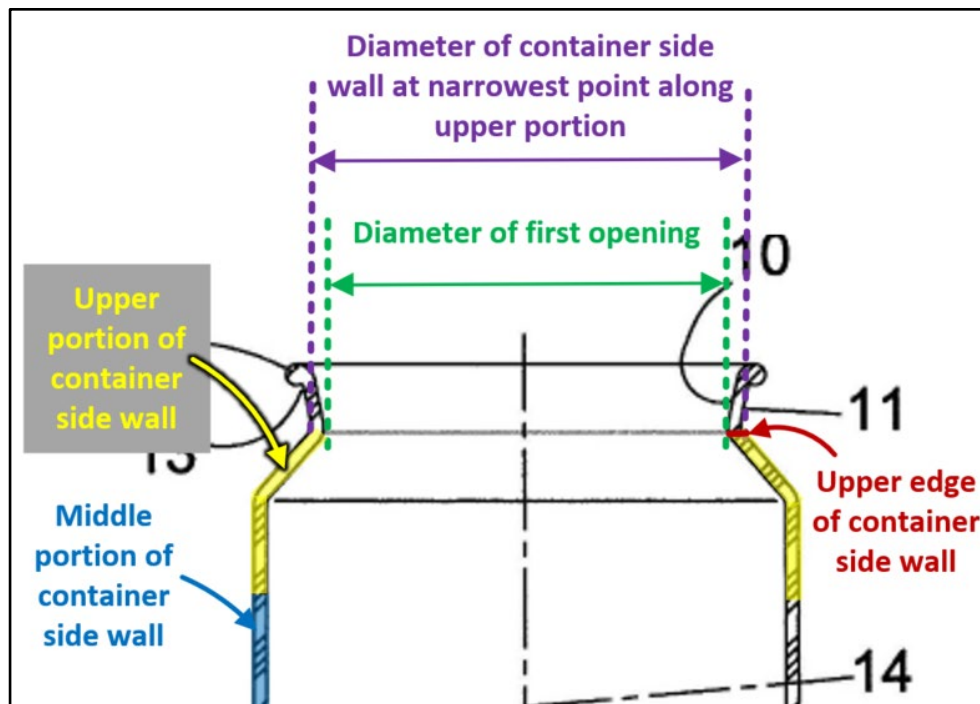
(*Id.*, Figs. 5 and 6.)

124. When combined with the container of Ackermann, the opening formed in Kaminski's lid would have been a second opening to the interior of the container body.

125. As discussed above, a POSITA would have found it obvious to modify the lid of Ackermann's disclosure to include features of the lid of Kaminski's disclosure because such modifications would have been a simple substitution of one known element for another to obtain predictable results and would have offered the improvements and benefits taught by Kaminski. (*See* Limitation 1[r].)

- w. **Limitation 1[v]: “wherein an upper portion of the container side wall extends upwardly from the middle portion of the container side wall to the upper edge of the container side wall, said upper portion being greater in diameter along its entirety than the first opening to the interior of said container body;”**

126. Ackermann discloses this feature. As shown in annotated Figure 1 below, the container body has an upper portion of the container side wall (*e.g.*, a section identified in yellow, although this section could represent a greater or smaller portion of the container side wall), and this upper portion extends upwardly from the middle portion of the wall. An upper edge of the container side wall can be defined, for example, at a point where the container side wall connects to the annular wall 11. (Ackermann, ¶¶0023, 0025.) Accordingly, as shown, the upper portion of the container side wall extends to the upper edge of the container side wall.



(*Id.*, Fig. 1 (cropped).)

127. As also shown in the annotated figure above, the upper portion of the container side wall is greater in diameter along its entirety than the first opening because the portion of the side wall with the narrowest diameter – the upper edge of the side wall – is the portion where the opening to the interior of the container body is defined. The diameter of the side wall at this point includes the diameter of the opening to the interior plus the thickness of the container side walls, and therefore is necessarily larger than the diameter of the opening. The container side walls have an even greater diameter at every other point along the upper portion of the wall.

x. Limitation 1[w]: “wherein the container contains a liquid; and”

128. Ackermann discloses that the container is a beverage container, and therefore would contain a liquid. For example, Ackermann describes its container being configured “[f]or carbonated beverages” (*id.*, ¶0005) and describes considerations “for beverage cans” (*id.*, ¶¶0029 and 0031).

y. Limitation 1[x]: “wherein, when the arm of the lid is in the first position and the weakened or scored area is not deformed;”

129. This limitation is disclosed in Kaminski and would be obvious based on the Ackermann-Kaminski combination.

130. As addressed above with respect to Limitation 1[b], Ackermann’s container has a lid. As addressed with respect to Limitations 1[r] and 1[t], Kaminski describes a lid configuration with an arm and a weakened or scored area, which would have been obvious to combine with Ackermann for the reasons discussed above. Kaminski depicts in Figures 1 and 3 that when the arm of the lid is in the first position (i.e., prior to the tab being pulled upward), the weakened or scored area is not deformed, as described with respect to Limitation 1[u]. (Kaminski, Figs. 1 and 3.)

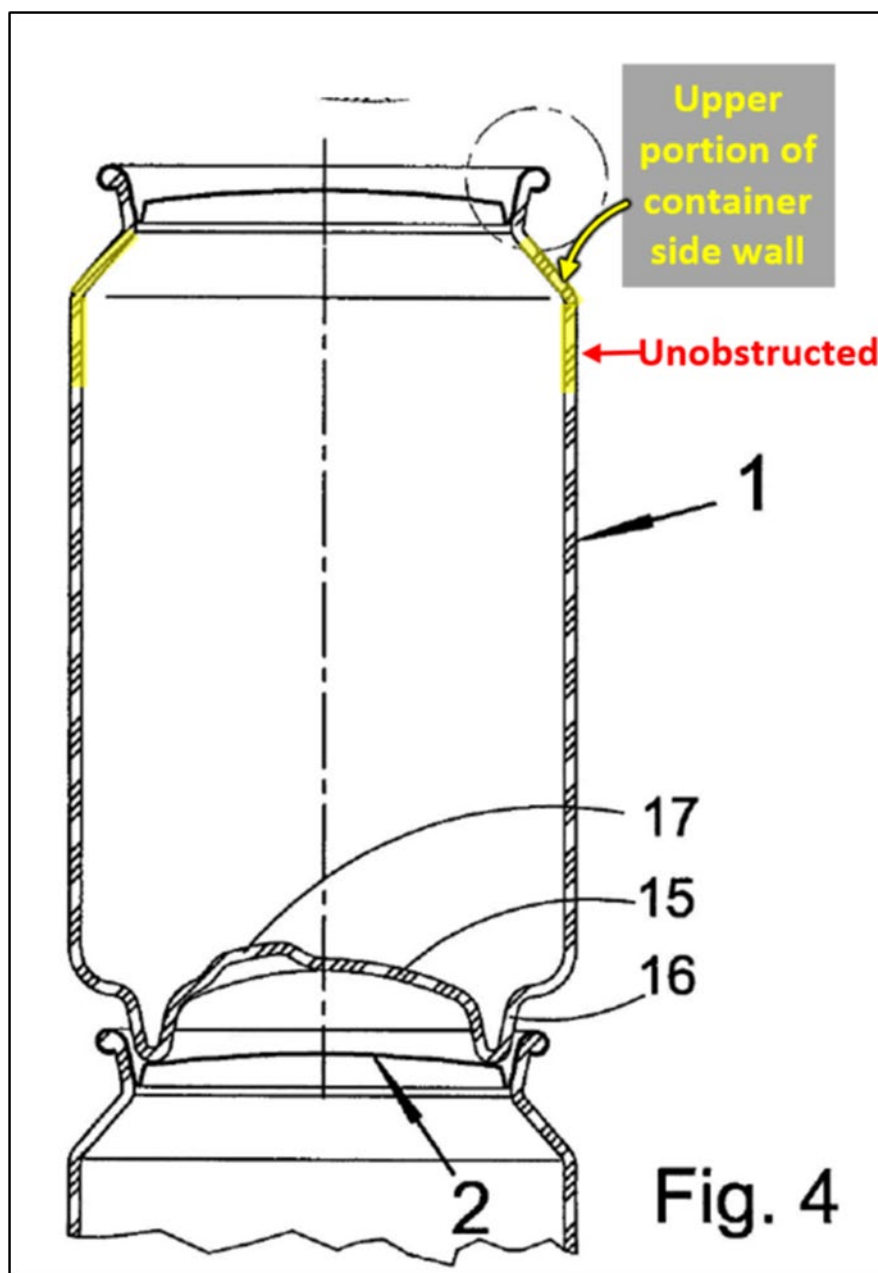
131. Furthermore, it would have been obvious to a POSITA that the liquid fills the container of the Ackermann-Kaminski combination when the arm of the lid

is in the first position and the weakened or scored area is not deformed, since the container would be closed under these conditions and Ackermann described filling prior to closing the container. (Ackermann, ¶0033.)

- z. Limitation 1[y]: “said liquid fills, or nearly fills, the interior of the container body, which interior extends continuously along a height of the entirety of the upper portion of the container wall so as to be interrupted only by the liquid; and”**

132. Ackermann describes the container being filled with liquid. (Ackermann, ¶0006.) When the container is a beverage container, a POSITA would have understood that “filling” the container would result in a liquid filling or nearly filling the container. It would be wasteful and impractical to make a container far larger than needed and then only partially fill the container. Therefore, it would have been obvious to a POSITA to make a container with a slightly larger interior volume than the amount of liquid that the container is intended to hold.

133. Ackermann also depicts that there are no obstructions between the upper portions of the container wall, as shown in annotated Figure 4 below. As a result, the interior of the disclosed container would extend continuously along a height of the entirety of the upper portion of the container wall so as to be interrupted only by the liquid, and the liquid could “fill” or “nearly fill” this interior.



(Ackermann, Fig. 4.)

134. Furthermore, it would have been obvious to a POSITA to have the liquid fill the container of the Ackermann-Kaminski combination when the arm of the lid is in the first position and the weakened or scored area is not deformed

because the container would be closed under these conditions and Ackermann described filling prior to closing the container. (*Id.*, ¶0033.)

aa. Limitation 1[z]: “an actual volume of the liquid contained in the container is equal to, or less than, 211.5 mL.”

135. Ackermann does not explicitly describe a volume of its container. However, configuring a beverage container with a volume that is less than 211.5 mL would have been an obvious design choice to a POSITA, who would be guided by the intended use of the container and the amount of liquid that it was intended to contain. Liquid containers with a volume less than 211.5 mL, such as single serving juice containers, were well known in the beverage container industry long before the earliest possible priority date for the '904 patent.

136. As an example, U.S. Patent Publication No. 2008/0044603 (“Hutchinson”, Ex. 1010) describes a “[p]lastic multi-piece container[] for storing beverages and other foodstuff,” which could be made of PET. (Hutchinson, Abstract, ¶0247.) Hutchinson explains that its container could have a volume of approximately 200 milliliters, which is less than 211.5 mL. (*See id.*, ¶0241 (“[T]he capacity of the formed container is **approximately 200 ml.**”))

137. Making a container of this size through the combination of the teachings of Ackermann and Kaminski would have yielded predictable results, and

therefore would have been obvious, for the container to contain a volume of liquid that is equal to or less than 211.5mL based on the knowledge of a POSITA.

3. Claim 2: “The container of claim 1, wherein the actual volume of the liquid contained in the container is 200 mL.”

138. A container with a liquid volume of 200 mL would have been an obvious design choice to a POSITA for the reasons discussed with respect to Limitation 1[z].

4. Claim 3: “The container of claim 1, wherein the resin is a polyethylene terephthalate (PET) resin.”

139. As discussed with respect to Limitation 1[c], Ackermann discloses a container made out of polyethylene terephthalate (PET). (Ackermann, ¶0022.)

5. Claim 4: “The container of claim 1, wherein the container body is formed using a blow molding process.”

140. I understand that claim 4 is a product-by-process claim given that it is directed to a product (a container) that is made through a process (blow molding). I further understand that such a claim is obvious when the prior art teaches the product, even if the product is formed by a different process than recited in claim 4. Since the prior art renders the container of claim 1 obvious, claim 4 is also rendered obvious in view of Ackermann and Kaminski.

141. I also note that the '904 patent's specification does not attach significance to the blow molding process for forming the container body, but states

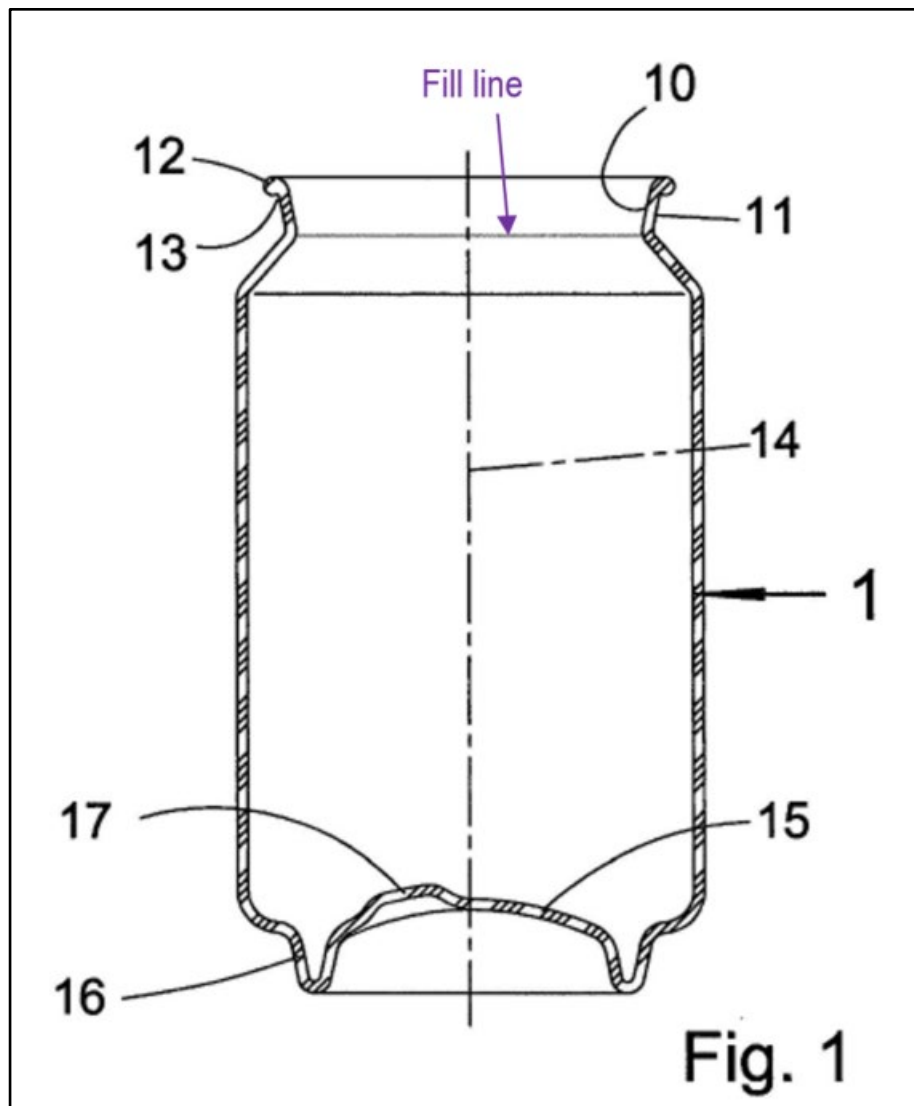
that any one of several known alternatives may be used. ('904 patent, 2:49-52, 3:15-18). This is not surprising given that by February 25, 2020, or even April 19, 2010, blow molding was well known to POSITA's as a manufacturing method for mass producing plastic containers, including PET beverage containers. Because blow molding was a well-known manufacturing technique to POSITAs, it would have been obvious to make the container of claim 1 using a blow molding process.

6. Claim 5: “The container of claim 1, wherein the metal is aluminum.”

142. Ackermann describes a lid made out of aluminum. (Ackermann, ¶0027.) Kaminski does the same. (Kaminski, 3:1-4.)

7. Claim 6: “The container of claim 1, wherein the container has a fill line so that, when the container is filled with the liquid up to the fill line, the actual volume of the liquid contained in the container is 200 mL.”

143. Claim 6 would have been obvious to a POSITA based on Ackermann. Although Ackermann did not explicitly identify a fill line or the volume of the liquid that can be contained in the container, Figure 1 suggests a fill line in the container, as annotated below:



(Ackermann, Fig. 1 (cropped).)

144. To the extent a fill line is not obvious based on Ackermann alone, first, as discussed in regard to limitation 1[z] and claim 2, a container that holds a liquid volume of 200 mL would have been obvious to a POSITA. And if the container was to hold 200 mL of liquid, it would have been obvious to a POSITA to have a fill line of 200 mL. Having a fill line on containers is not a new idea disclosed in the '904

patent. Fill lines on containers have been around for a long time and were well known to POSITAs. Including a fill line on the container for the intended volume can help provide consistency in manufacturing, provide an easy check on the size of the container and/or volume of liquid in the container, and would have helped ensure that the actual volume of the liquid in the container is 200 milliliters. Therefore, a POSITA would have been motivated to include this well-known feature on the beverage container.

D. Ground 3: Claims 1-6 are obvious under 35 U.S.C. § 103 over Ackermann, Kaminski, and Hutchinson

1. Summary of Hutchinson

145. Hutchinson is directed to a plastic beverage or food container. (Ex. 1010 (“Hutchinson”), Abstract). The plastic container can be manufactured through a variety of methods. (*Id.*, ¶[0006] (describing containers made by “blow molding, extrusion blow molding (EBM), stretch blow molding (SBM), injection stretch blow molding (ISBM), and/or combinations thereof.”)) Additionally, Hutchinson’s plastic containers can hold various volumes, including one container with a volume of approximately 200 milliliters. (*Id.*, ¶[0241]).

2. The Combination of Ackermann, Kaminski, and Hutchinson:

146. As discussed above, a POSITA would have found it obvious, and would have been motivated, to combine the teachings of Ackermann’s container and

Kaminski's lid for the reasons stated. The combination of Ackermann-Kaminski with the teachings of Hutchinson regarding the container size would have also been obvious to a POSITA. Ackermann did not identify possible volumes that would be suitable for a beverage container, but Hutchinson did. (*Id.*, Abstract, ¶[0241].) In the absence of Ackermann's explicit disclosure, a POSITA would have been motivated to look to other references for beverage containers, such as Hutchinson, to identify suitable sizes for beverage containers. This Ackermann-Kaminski-Hutchinson combination would have been a simple combination of known elements by known methods and would have yielded predictable results, and therefore would have been obvious to a POSITA.

3. The Ackermann-Kaminski-Hutchinson combination renders claims 1-6 of the '904 patent obvious

147. For the reasons explained below, it is my opinion that the combination of Ackermann, Kaminski, and Hutchinson renders claims 1-6 of the '904 patent obvious.

a. Limitation 1[Preamble] through Limitation 1[y]

148. For the reasons stated above, limitations 1[Preamble] through 1[y] would have been obvious to a POSITA in view of the combination of Ackermann and Kaminski, and those limitations would be obvious for the same reasons in view of Ackermann, Kaminski, and Hutchinson.

b. Limitation 1[z]: “an actual volume of the liquid contained in the container is equal to, or less than, 211.5 mL.”

149. In addition to the reasons described above for this limitation in regard to the combination of Ackermann and Kaminski, limitation [1.z] would have been obvious in view of Ackermann, Kaminski, and Hutchinson. Ackermann does not explicitly specify the size of its container. Since Ackermann does not place any restrictions on a container’s size, a POSITA would have recognized that a container for beverages could have been made within a range of practical sizes. Hutchinson explains that a suitable size for a plastic beverage container is approximately 200 mL, which is less than 211.5 mL as recited in the claim. (Hutchinson, ¶[0241].) Based on Hutchinson’s teaching, a POSITA would have been motivated to create a container based on Ackermann’s disclosure that had a volume of 200 mL because Hutchinson teaches this as a suitable volume for plastic beverage containers.

150. Claim 1 would therefore have been obvious to a POSITA in view of Ackermann, Kaminski, and Hutchinson.

c. Claim 2: “The container of claim 1, wherein the actual volume of the liquid contained in the container is 200 mL.”

151. In addition to the reasons described above in regard to the combination of Ackermann and Kaminski, this limitation and claim also would have been obvious

to a POSITA in view of the combination of Ackermann, Kaminski, and Hutchinson for the reasons set forth in Limitation 1[z].

d. Claim 3: “The container of claim 1, wherein the resin is a polyethylene terephthalate (PET) resin.”

152. In addition to the reasons described above in regard to the combination of Ackermann and Kaminski, this limitation and claim also would have been obvious to a POSITA in view of Ackermann, Kaminski, and Hutchinson. As discussed in Ground 2, Ackermann discloses a container body that is made out of a PET resin. (Ackermann, ¶[0022].) Hutchinson also taught that the container can be made of a PET resin. (Hutchinson, ¶[0014].)

e. Claim 4: “The container of claim 1, wherein the container body is formed using a blow molding process.”

153. As discussed in Ground 2, I understand that Claim 4 is a product-by-process claim. In addition to the reasons for obvious of Claim 4 discussed above, Hutchinson a blow molding process as a method that is used to manufacture its plastic container. (Hutchinson, ¶¶[0023], [0101].)

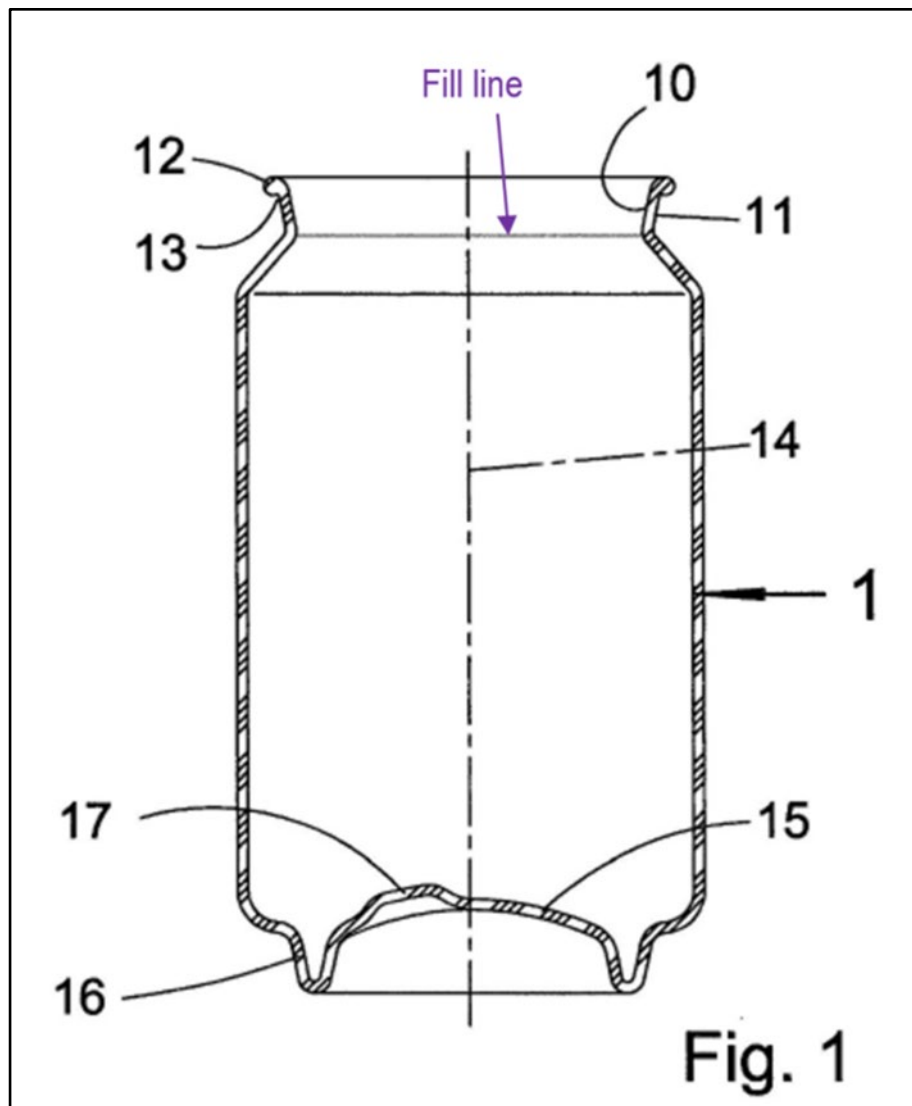
f. Claim 5: “The container of claim 1, wherein the metal is aluminum.”

154. As discussed in Ground 2, both Ackermann and Kaminski describe a container lid made out of aluminum. (Ackermann, ¶[0027]; Kaminski, 3:1-3.)

- g. Claim 6: “The container of claim 1, wherein the container has a fill line so that, when the container is filled with the liquid up to the fill line, the actual volume of the liquid contained in the container is 200 mL.”**

155. Claim 6 would have been obvious in view of Ackermann, Kaminski, and Hutchinson for several reasons.

156. First, Figure 1 of Ackermann has a line near the top of the container, as annotated below. Although Ackermann did not explicitly describe a fill line or the volume of the liquid that can be contained in the container, this line in Figure 1 suggests a **fill line**:



(Ackermann, Fig. 1 (cropped).)

157. Second, a container that holds a liquid volume of 200 mL would have been obvious to a POSITA based on the Ackermann-Kaminski-Hutchinson combination, for the reasons discussed in regard to limitation 1[z] and claim 2. If the container was to hold a certain volume of liquid, a POSITA would have found it obvious for the container to have a fill line because a fill line would have helped to

provide consistency of beverage manufacturing for beverages contained in the combined container. For example, a fill line would help ensure that each container was filled to the correct liquid volume.

158. For the foregoing reasons, claims 1-6 would have been obvious to a POSITA in view of the Ackermann, Kaminski, Hutchinson combination.

V. CONCLUSION

159. Based on the foregoing analysis, it is my opinion that claims 1-6 of the '904 patent are invalid due to anticipation and/or obviousness.

DECLARATION OF NATHAN J. DELSON, PH.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,932,904

I hereby declare that all the statements made in this declaration are based on my own true knowledge, that all statements made on information and belief are believed to be true, and that all statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under the penalty of perjury under the laws of the United States that all statements made in this declaration are true and correct.

Dated this 17 day of July, 2024



Nathan J. Delson, Ph.D.

APPENDIX A

Nathan J. Delson

UC San Diego
9500 Gilman Ave
La Jolla, CA 92093-0411

Email: ndelson@ucsd.edu

INTERESTS Mechanical Design, Mechatronics, Robotics, Biomedical Devices, and Design Education.

EDUCATION

6/90-5/94 **Ph.D. in Mechanical Engineering**, Massachusetts Institute of Technology. Minor in Biomechanics. Thesis: "Robot Programming by Human Demonstration".

9/88 - 6/90 **Master of Science**, Massachusetts Institute of Technology. Thesis: "Design of Bracing End-Effectors for Dynamic Advantage with Application to Robotic Grinding".

9/81-6/86 **Bachelor of Science in Mechanical Engineering**
University of California at San Diego. Cum Laude.

ACADEMICS

7/20 – present **Senior Teaching Professor** Dept. of Mechanical and Aerospace Engineering, UC San Diego.

1/08 – 6/20 **Associate Teaching Professor** Dept. of Mechanical and Aerospace Engineering, UC San Diego.

1/16 – 6/19 **Inaugural Faculty Director** of EnVision: The Arts and Engineering Maker Studio.
Jacobs School of Engineering, UC San Diego.

7/99 – 12/07 **Academic Coord. and Director of the Mechanical Engineering Design Center**
Dept. of Mechanical and Aerospace Engineering, UC San Diego.

7/96 - 6/99 **Director of the Mechanical Engineering Design Studio**, Yale University Dept. of Mechanical Engineering.

7/95 – 6/99 **Lecturer**, Yale University, Dept. of Mechanical Engineering. Instruct design courses, and supervise senior and master level projects.

INDUSTRY

2016 – present **Co-founder of eGrove Education, Inc.** Developer of Educational Software.

1994 – present **Consultant**: Design Continuum, Sixense, Drivecam, and others.

6/96 – 1/08 **Co-founder of Coactive Drive Corporation.** Design of electromechanical actuator that was patented and licensed in the industry.

7/93 - 8/93 **Visiting Engineer**, Daikin Industries, LTD. Osaka, Japan.

6/92 - 6/94 **Co-founder of Sensor Lab Partnership** that developed a science education kit for hands-on physics and biomechanics educational experiments.

7/86 - 6/88 **Associate Structural Analysis Engineer**, United Technologies, Advanced Systems Division, San Diego CA. Structural analysis and design for manufacturability.

AWARDS

2015-16 **Best Teaching Award**, MAE Dept., Jacob School of Engineering Dean's Office

2015 **Chair's Award**, Engineering Design Graphics Division ASEE

2014 **Outstanding Teaching Award**, Warren College UC San Diego

2009-10 **Best Teaching Award**, MAE Dept., Jacob School of Engineering Dean's Office

7/05 **Best Paper Finalist**, 12th International Conference on Advanced Robotics

9/99 **Collegiate Inventors Competition Winner of Two Adviser Awards**, National Inventors Hall of Fame.

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APPENDIX B

A Clino-cladistic Look at Pull & Push Tab Patents ca.1950-1980

William D. Schroeder, M.S., R.P.A., PhD candidate—University of Montana; Cultural Heritage and Applied Anthropology

Abstract

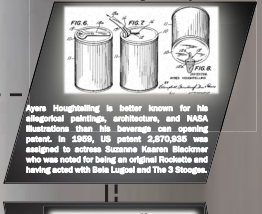
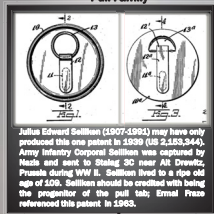
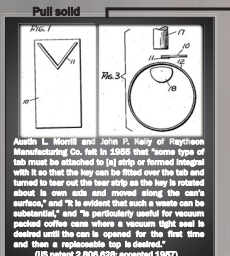
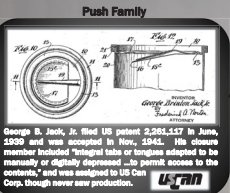
Pull tabs revolutionized the way beverage cans and food containers were opened and their contents removed. Ermal Frazee is credited with this, yet he was not alone in the invention nor was he technically the first. Until recently, pull tabs were not considered diagnostic in Historical Archaeology because they had not yet met the 50-year-old threshold. As of 2015, ring pull tabs entered the historic era, yet relatively little is known about these artifacts. In order to place these artifacts in *terminus ante* and post *quem* timeframes for historical archaeologists who have located and will more frequently encounter these items of disposable material culture, a database with hyperlinks has been built to provide an archival reference. There are hundreds of patented variations and manufacturing methods in the United States Patent and Trademark Office filed and accepted between ca.1950 and 1980 yet really only two gen—pull and push, and four species—"snap top," ring pull, stay-tab, and push button. Taking a cue from biology, the inventions were arranged by family based on the first instance of a morphological characteristic (clade) and by progenitors (inventors) then put in numerical/chronological order based on their patent or design filing and/or acceptance dates (cline) thereby generating a genealogy or family tree thereby charting their evolution. Not all patents or designs saw nationwide production or distribution; some never saw production. Not all patents, designs, or innovations are represented here. And, one should keep in mind the "time lag" between a patent's filing, patent pending production, and its official acceptance. Products also had a use life and disposal period that often extended past its manufactured date range. Functional ease, compatibility with can manufacturing machinery, reduction of harm, and externalities also influenced the food and beverage container industry to "build a better mousetrap." Then there's "Sister Frange"....

1950

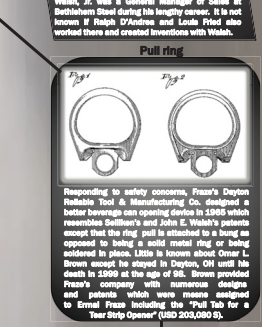
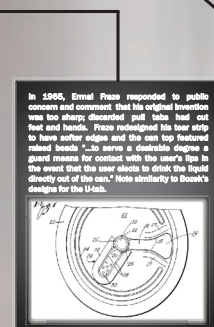
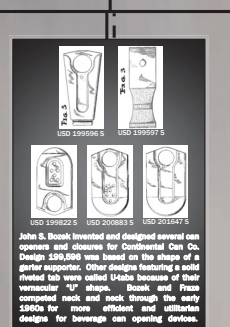
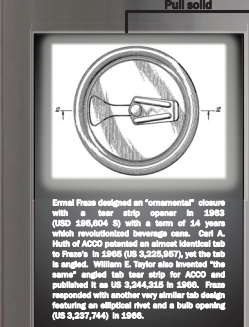
Keymark brand steps were first used to provide a convenient means of opening sealed tin-plated steel food containers in 1908. Over 100 tin manufacturers incorporated as the American Can Co. (ACC) in 1914. Elmer Norton—a chemist since 1888—remained the Norton Tin Can and Plate Company and founded Continental Can Co. in 1924. The second major can manufacturer in the US, National Can Co., founded in 1929, became the third largest. The US Government used the American Can Co. in 1935 during the Tin Can Trust restrained trade and antitrust proceedings and so should be "discredited". All three restructured, renamed, and re-branded several times. All three declined means of opening can ends more reliably, easier, and safer.

Ernest "Emil" Olson Frazee founded the Dayton Reliable Tool and Manufacturing Co. in 1949. Legend has it that Frazee invented the pull tab out of frustration and assembly while on a camping trip in 1950. There had to be an easier way to open a beverage can than with a church-key opener.

Over 70% of US beer producers adopted Frazee's can by 1965. John B. Bosak and John Heschbert of the Continental Can Co., William E. Taylor of the American Can Co., and Daniel Cudde of Reynolds Aluminum Co. improved on Frazee's patents and were the subsequent competitors in opening device designs. An competitor from the tin shop of Iron City Beer produced in 1963 featuring the first "stay-open can" manufactured by the Aluminum Company of America (ALCOA, Inc.) is held in the Weitz State University archives along with bench drawings and other Ermal Frazee memorabilia.



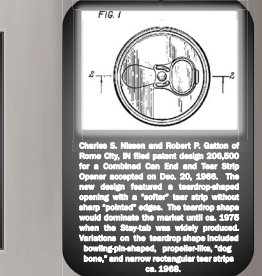
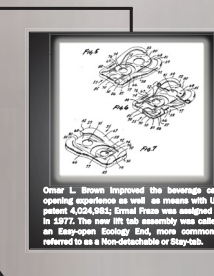
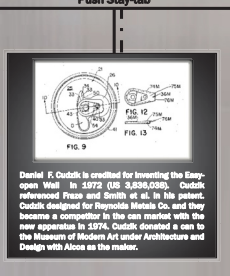
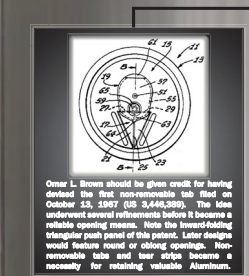
1960



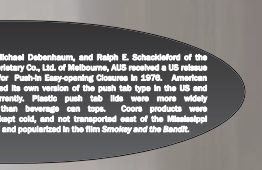
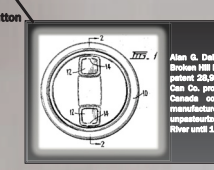
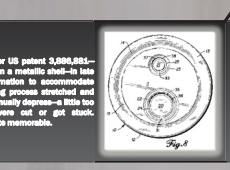
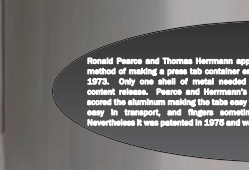
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1965

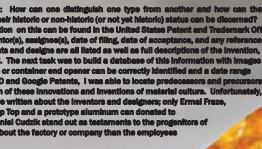
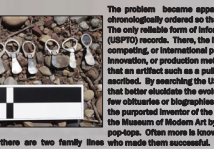
1970



1975



1980



In the summer of 2016, I was selected as the Summer Resources Intern at the Grand Teton National Park. My assignment was to locate trace evidence of items of the century Mormon and non-Mormon heritages and artifacts near the historic towns of Mormon Row and Kelly, WY within the park's boundaries. I was also tasked with locating previously unidentified irrigation network features that served the historic communities. While attempting to locate an irrigation ditch, I happened upon an area near Kelly, WY which was used for generations as the "town dump." Historic-era refuse before the Great Ventside Slide of 1928 and Flood event of 1927 was washed away from the landscape. Large scar marks from the flood created points where refuse was later deposited until the 1950s when Park clean-up crews took place. The resultant archaeological concentrations include a small community's disposable material culture from ca.1890 to 1980 and contains numerous food and beverage cans, bottles, and other artifacts close to the surface. Having already devised a "key code" for handy field reference of beverage can pull tab types, I was delighted to find a nearly complete series of the most commonly and widely produced "snap top" and ring pull tab types.

In evolutionary biological terms, there are two family lines based on morphological characteristics, i.e. clades: Pull and Push. There are four "species": Pull solid, Pull ring, Push button and Push Stay-tab. (And then there's "Frange.") Their changes over time or historical trajectories might be said to constitute cline. I have arranged the evolution of beverage can opening means as if a genealogical family tree. There are hundreds of "patent children" that are not represented here; only the first patent (parent) for a particular "species" of opening type.

The problem became apparent: How can one distinguish one type from another and how can they be chronologically ordered so that their historic or non-historic status can be discerned? The only reliable form of information on this can be found in the United States Patent and Trademark Office (USPTO) records. There, the inventor(s), assignee(s), date of filing, date of acceptance, and any references, competing, or international patents and designs are all listed as well as full descriptions of the invention, innovation, or production method. The next task was to build a database of this information with images so that an artifact such as a pull tab or container opener can be correctly identified and its date range ascertained. By researching the USPTO and Google Patents, I was able to locate predecessors and precursors that better elucidate the evolution of these inventions and inventors of material culture. Unfortunately, few obituaries or biographies were written about the inventors and designers: only Ermal Frazee, the purported inventor of the Stay-Top and a prototype aluminum can donated to the Museum of Modern Art by Daniel Cudde stand out as testaments to the progenitors of pop-top. Often more is known about the history of company than the employees who made them successful.

EX-1002 IPR2024-01098

APPENDIX C

[54] TAB AND ECOLOGY END

[75] Inventors: Ermal C. Fraze, 355 W. Stroop Rd.,
Dayton, Ohio 45429; Omar L.
Brown, Dayton, Ohio

[73] Assignee: Ermal C. Fraze, Dayton, Ohio

[21] Appl. No.: 139,248

[22] Filed: Apr. 11, 1980

[51] Int. Cl.³ B65D 17/34

[52] U.S. Cl. 220/270

[58] Field of Search 220/269, 1, 273

[56] References Cited

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4,015,744 4/1977 Brown 220/269

4,024,981	5/1977	Brown	220/269
4,030,631	6/1977	Brown	220/269
4,084,410	4/1977	Brown	220/269
4,183,445	1/1980	La Cross	220/269

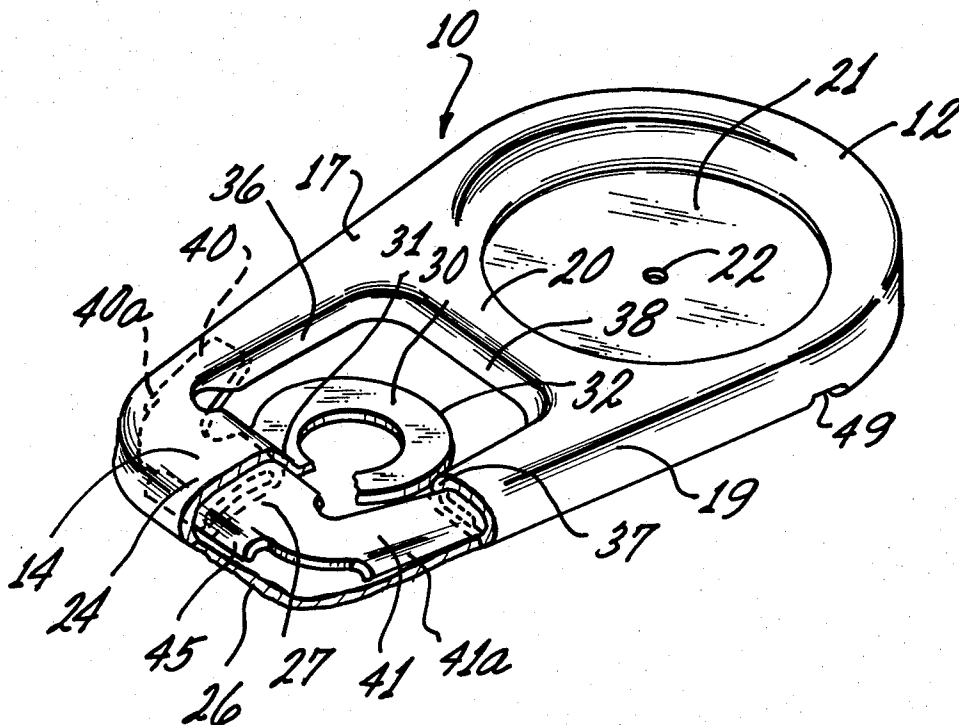
Primary Examiner—George T. Hall

Attorney, Agent, or Firm—Smyth, Pavitt, Siegemund & Martella

[57] ABSTRACT

A tab for easy opening ends including a lifting end and an opening end and spaced side legs is improved by the use of finger means extending from the opening end towards the lifting end, the finger means including flanges which stiffen the finger. The lifting end is formed of a smooth unbroken curl of sheet material.

14 Claims, 6 Drawing Figures



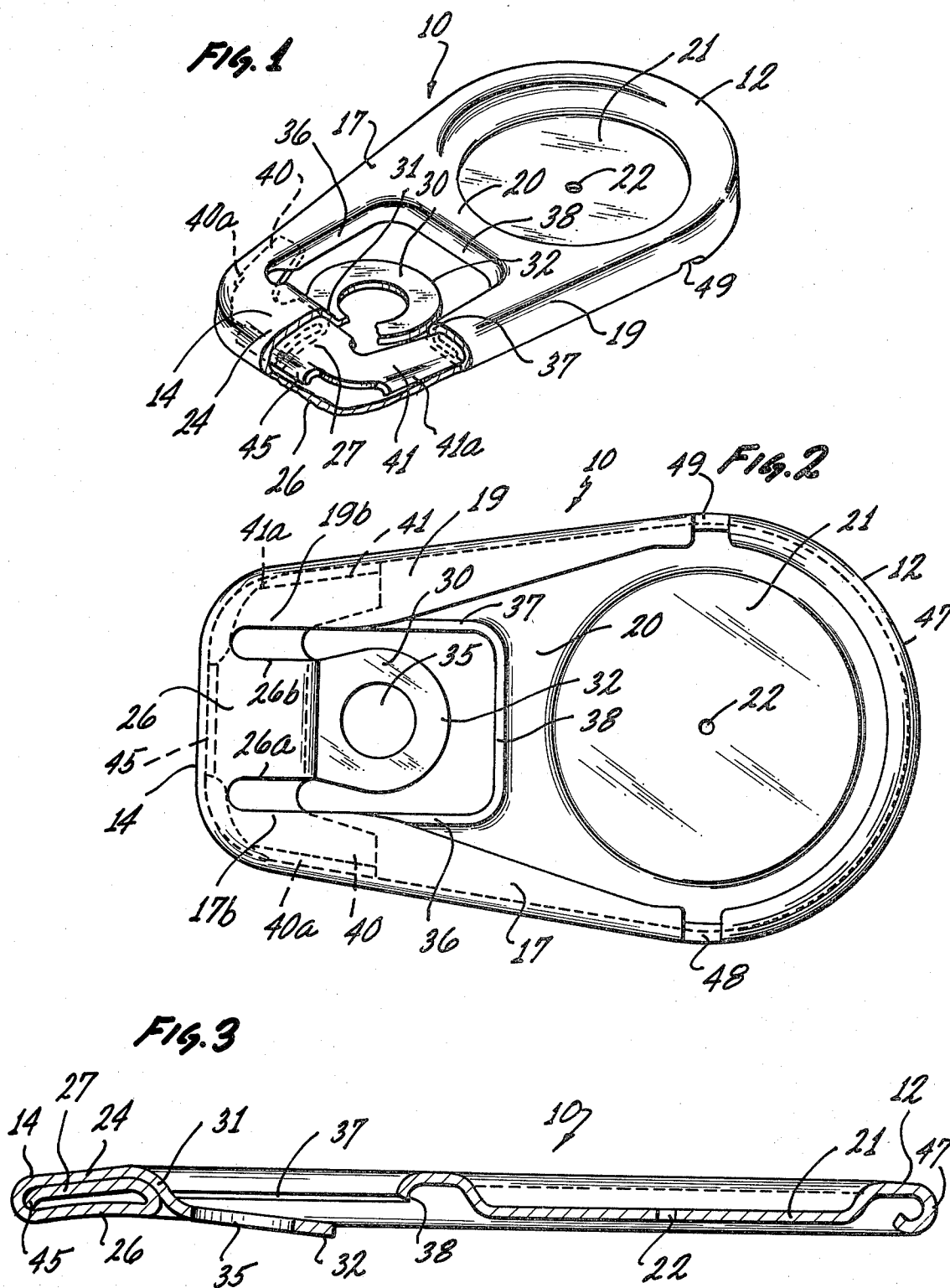


Fig. 4

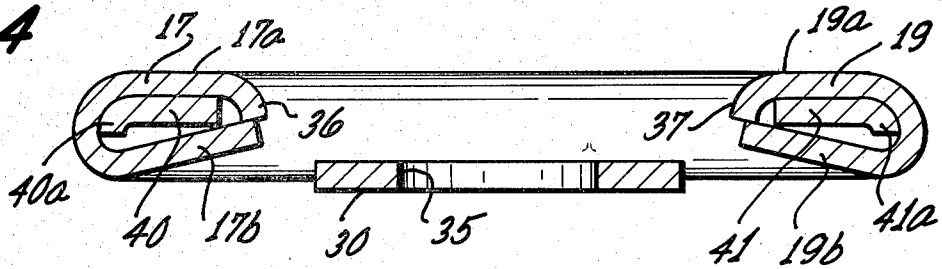


Fig. 5

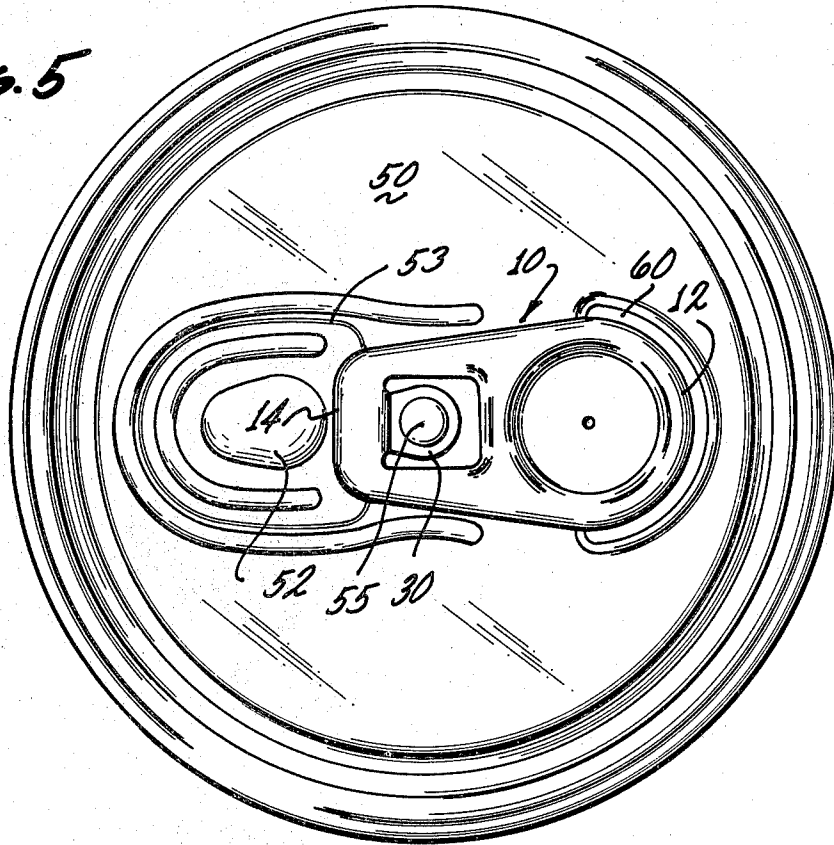
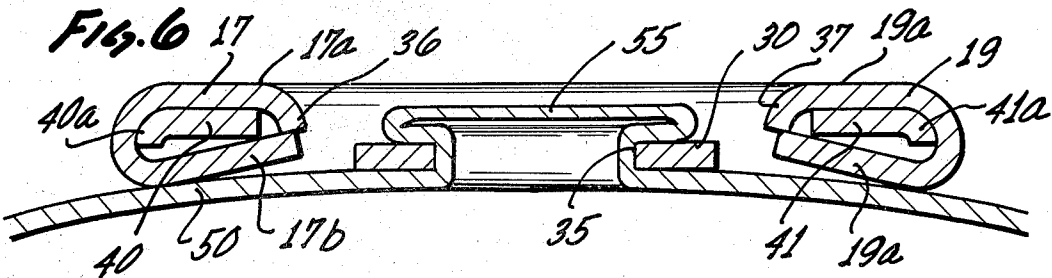


Fig. 6



TAB AND ECOLOGY END

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to easy-opening can ends and more particularly to an improved tab of increased longitudinal strength for use as a retained tab on an improved ecology-type can end.

2. The Prior Art

It is known in the art to provide container end wall structures which include a retained tab and a retained tear strip so that in use, no container component is separated to form litter. These type containers and end structures have been referred to as ecology ends.

Typical of one form of ecology ends are those shown and described in U.S. Pat. Nos. 4,024,981 and 4,084,410 of May 24, 1977, respectively and Apr. 10, 1979, assigned to the same assignee.

U.S. Pat. No. 4,024,981 describes an improved longitudinally rigid tab and an improved end structure wherein the tab initially acts as a class 2 lever to initiate fracture of the portion of the scoreline immediately in front of the rivet. Thereafter the tab operates as a class 1 lever to complete fracture of the scoreline and to push the retained pour panel downwardly, the panel being retained on the end wall.

U.S. Pat. No. 4,084,410 relates to a tab with increased resistance to removal by bending of the tab through the provision of a plurality of bending regions.

Regardless of the details of the structure of the tab, those tabs intended to be used in ecology-type ends require substantial longitudinal rigidity especially if the tab is intended to function as a class 2 and then a class 1 lever in an opening sequence.

In the tabs described in the above patents, longitudinal rigidity was achieved by curling the side legs of the tab to provide a double thickness of metal extending essentially from the front to the rear of the tab. Additionally the front end of the tab is formed of multiple layers of sheet material, preferably of one piece.

Initially, tabs as described were manufactured from aluminum alloy sheet stock of 0.018 inch thickness, and operated satisfactorily. Such tabs included an intermediate web of material at the front end of the tab, the web including space finger elements extending rearwardly and disposed within the folds of the side legs and terminating approximately at the forward end of the aperture in the flap and through which the rivet extends to attach the tab to the end wall. This structure was found to be of sufficient longitudinal strength when the tab was fabricated of sheet stock of 0.018 inch thickness. The price of aluminum has, however, increased significantly and thus, there has been a tendency to use thinner stock, i.e. 0.016 inch thick material, in the fabrication of tabs. The result has been that under certain circumstances there have been tab failures where the tabs have been fabricated of lighter stock in order to save in material costs.

For example, some beverages are packed under substantial pressure or exposed to substantial pressure during the packing operation. In such cases the scoreline normally includes a relatively high residual, i.e. the dimension of the unscored metal beneath the score area is comparatively high. The result was that in some instances, tabs of the lighter stock, i.e. 0.016 inch material, failed by bending in a zone in front of the rivet and to the rear of the front of the tab. The observed mode of

failure appeared to be the pulling of the fingers out from under the curls along the side legs, or actual bending of the side legs, or both. In other instances tab failure appeared to result from the fact that the tab was misaligned, i.e. rotated about the rivet with the result that a portion of the nose of the tab was over the end wall rather than being over the pour panel, with the result that tabs of the thinner stock exhibited a tending to fail by bending, as described.

It has also been noted, in some instances that the scoreline in front of the rivet was prematurely rupturing under certain circumstances. More particularly, the tab is attached to the end wall by a rivet which passes through an aperture in the ear of the tab, the ear being located to the rear of the nose or opening end of the tab, and the scoreline including a portion immediately in front of the rivet. In some instances the end wall of the packed container is slightly bulged due to pressure developed during packing or because of the internal pressure of the container, or both.

In such cases, it is believed that the entire tab is raised a very small distance above the end wall, i.e. there is a small vertical clearance between the underside of the tab and the end wall. Normally such a clearance presents no problem, except it has been observed in some instances that there was premature fracture of the portion of the scoreline to the front of the rivet. It is believed that such premature fractures, when they occur, are caused by the normal vibration of the stacked containers during shipping.

It is believed that the vibration is transmitted to the tab and through the tab ear to the rivet with the result that the portion of the end wall around the rivet is stressed through the vibration, in a vertical direction, of the tab, the latter being free to move up and down because of the small clearance between the underside of the tab and the end wall.

SUMMARY OF THE INVENTION

The improved tab and end structure of the present invention are achieved by substantially increasing the longitudinal rigidity of the tab to such an extent that even if fabricated of thinner sheet stock, the tab has sufficient longitudinal rigidity to overcome substantially failure by bending. The improved tab also is structured such that the tab may be mounted on the end wall so as to contact the end wall so that forces created by vibration are transmitted over the entire tab and to the underlying end wall rather than through the ear of the tab and to the rivet.

To this end, the fingers have been increased in length to extend rearwardly from the opening end to approximately the midpoint of the rivet opening in the ear. The fingers are also provided with flanges, extending downwardly, and which operate to increase the strength of the fingers and thus the tab in a longitudinal direction. Increase longitudinal strength is also provided by providing flange means on at least a portion of the upper layer of the side legs so that in that portion, the fingers are clamped between the layers forming the side legs.

Further, the tab ear may be oriented with respect to the body of the tab so as to be angled in a downward direction prior to assembly of the tab to a container end wall. In this way, once assembly to the end wall by the rivet, the tab is in contact with the end wall so that forces transmitted to the tab, i.e. as the result of vibration in handling and shipping of the packed containers,

is transmitted through the tab to the end wall rather than through the tab ear to the rivet for localized stressing of the end wall and possible rupture of the portion of the scoreline in front of the rivet.

As will be apparent from the following detailed description, a much improved tab and container end structure are disclosed, both with reference to a preferred form of the structure, it being understood that the configuration of the tab and its appearance may vary from that described, and yet may include the features and advantages of the present invention which may be best understood by reference to the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in perspective, with portions thereof broken away, illustrating the tab structure of the present invention;

FIG. 2 is a plan view of the underside, i.e. what is sometimes called the non-public side of the tab of the present invention;

FIG. 3 is a view partly in section and partly in elevation taken along a line extending longitudinally through the center of the tab of this invention, which for purposes of illustration is of a slightly larger scale than is illustrated in FIG. 2;

FIG. 4 is a sectional view of the tab of this invention taken transversely of the tab approximately midway through the rivet hole;

FIG. 5 is a plan view of a container end wall having mounted thereon a tab in accordance with this invention; and

FIG. 6 is a sectional view, similar to FIG. 4, but illustrating the tab of this invention mounted on the end wall as shown in FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings which illustrate a preferred form of the structural features of the present invention, FIGS. 1 and 2 show a tab 10 which may be formed of sheet material, for example, aluminum alloy sheet of a thickness of about 0.0016 inch or more, in the usual fashion through a progressive die set which performs a series of operations on tab sheet stock. The tab 10, which may be formed of a single sheet of material, includes a lifting end 12 at the rear end thereof and an opening end 14 at the front end thereof.

Extending from the opening end to the lifting end of the tab are spaced longitudinally extending side legs 17 and 19 each of which may be formed of a curled double layer of sheet material, as illustrated. Extending between the legs 17 and 19 and towards the rear of the tab is an upper web of sheet material 20 including a depression 21 therein, the web and depression constituting a substantial portion of the upper surface of the tab. As shown there is an indexing aperture 22 used as a pilot during progressive die formation of the tab.

As illustrated in FIGS. 1-3, the opening end 14 of the tab may be formed of multiple layers of sheet material, as illustrated, including an upper layer 24, a lower layer 26 and an intermediate layer 27. Immediately to the rear of the opening end of the tab is an ear 30 which is formed as a continuation of the upper layer 24 but which extends rearwardly and downwardly through a bend area 31. The rear end 32 of the ear extends below the front end of the tab, in the unmounted condition of

the tab, as seen in FIG. 3 for reasons which will be explained. The ear is provided with an aperture 35 through which a rivet may pass for fastening the tab to an end wall.

In the form illustrated, the lower-most layer 26 has a width corresponding approximately to the width of the ear 30 in the bend area 31 and includes sides 26a and 26b which are spaced from the opposing portions lower curls 17a and 19a, respectively, at the forward end of the tab as seen in FIG. 2. Moreover, the ear 30 is spaced from each of the side legs 17 and 19 which, in the area adjacent the ear, each includes a downwardly extending flange 36 and 37 which is continuous with a flange 38 located to the rear of the ear and which forms a part of the upper web 20 of sheet material. These flanges provide strength in addition to providing a smooth contour to reduce the possibility of finger laceration.

The center layer 27 of the front end of the tab, as seen in FIGS. 1 and 2, extends the width of the front end of the tab and includes two fingers 40 and 41 extending towards the rear of the tab and terminating at approximately the centerline of the rivet aperture 35. In the form shown, the free ends of the fingers are slightly narrower than the remaining portion such that the width dimension of the finger gradually increases from the rear to the forward end. The forward end of the center layer 27 includes a downwardly forward flange 45 which extends along the sides 40a and 41a of each of the fingers 40 and 41, respectively to form a downwardly extending flange extending longitudinally along a substantial portion of the length of each finger. The longitudinally extending and downwardly depending flanges operate to increase longitudinal rigidity of the tab.

As seen in FIGS. 2 and 3, the rear end of the tab includes a smooth outer peripheral surface forward by the curl 47 which, as shown, substantially prevents contact with the free edge of metal. In fact, except for segments 48 and 49 which are used to hold the tab blank in the progressive strip during manufacture, substantially the entire outer peripheral surface of the tab is smooth and unbroken. Segments 48 and 49 each include a small segment which is folded under the follow the outer curl contour and the rip-off point is space inwardly away from the outer side surface such that in plain view it is difficult to see the rip-off section. Since this type of tab is not a pull-ring type, but one in which the finger is inserted under the rear end in an opening sequence, a smooth rear configuration has practical advantages.

As seen in FIGS. 2 and 4, each of the side legs 17 and 19 is curled to form a multiple layer leg, the upper layer 17a and 19a of which are essentially flat and coplanar with the web 20. The lower layers 17b and 19b, respectively are angled upwardly, as seen in FIG. 4, the width dimension of the legs in the vicinity of the fingers is greater than that of the respective finger such that layers substantially enclose the corresponding finger therebetween.

As shown, the inner surface 36 and 37 of the upper surface 17a and 19a of each of the legs is downwardly flanged to contact the respective lower layer 17b and 19b inwardly of the inner edge of the corresponding finger. In this way, the tendency to pull the finger out of the legs is substantially reduced. Further, the flanges 40a and 41a, respectively, on the fingers 40 and 41 and the flanges 36 and 37 respectively on the upper surface of the legs 17 and 19, tend to increase the longitudinal

strength of the tab forward of the rear end 32 of the ear 30 as compared to a structure absent such flanges and of the same stock thickness.

FIG. 4 also illustrates the relative position of the ear of the tab with respect to the under surface of the tab after formation of the tab and prior to assembly to a container end wall.

To understand better the substantial improvement represented by the present invention, reference is made to FIG. 5 illustrating the tab 10 of the present invention mounted on a container end wall 50. Where applicable, the same reference numbers have been used for the parts already described. The end wall includes a pour panel 52 formed by a scoreline 53 a portion of which passes between the front end 14 of the tab and immediately in front of the rivet 55 which passes through the tab ear 30 to secure the tab to the end wall. For the remaining details of the end wall structure, reference is made to the patents previously mentioned.

In a normal opening sequence, a finger is inserted between the finger well 60 and the rear end 12 of the tab to lift the rear end. One can easily appreciate the advantage of having a tab with a smooth clean contour. Since the initial pop of the portion of the scoreline to the front of the rivet is by a class 2 lever action, lifting of the rear end of the tab causes the ear 30 to lift on the rivet, and the portion of the end wall around the rivet while the nose or front end of the tab contacts the pour panel. After the initial pop, the tab acts as a class 1 lever to break out the scoreline and push the pour panel downwardly. Thereafter the tab is normally pushed flat against the end wall.

As will be apparent, the initial pop phase of the opening sequence creates a significant stress on the tab which should remain longitudinally rigid throughout the opening sequence, especially the initial pop phase. What has been observed, especially with the prior art tabs formed of thinner sheet stock, is an occasional bending of the tab during the initial pop phase. If it occurs, the bending normally is across the width of the tab and in a band generally in the bend area 31 of the ear, and includes bending of the legs.

In some cases the tab, though initially properly secured on the end wall, may through handling in shipping and the like be rotated slightly so that the opening end of the tab overlies a portion of the end wall laterally of the pour panel, even though the end wall may be provided with dimples and the like to maintain proper tab alignment. Normally, the consumer does not align the tab, but attempts to open the container by the usual manipulation. In this circumstance what has been observed is an occasional bending of the prior art tab, as described, and in some instances the fingers of the prior art tabs have been pulled out of the curl.

The tab of the present invention, which is significantly more rigid longitudinally as compared to the prior art tabs described, substantially reduces failure by bending. Also, even if the tab is misaligned, the fingers are not pulled out of the curl, especially where the heavier grade of tab stock is used. Overall, the longitudinal rigidity has been increased through the use of flanges and extension of the finger length.

In addition the improved tab substantially reduces premature damage and even rupture of the scoreline in front of the rivet. Since most container end walls are bulged slightly (exaggerated in FIG. 6 for illustration purposes) the prior art tabs when assembled to the end wall were spaced a small distance above the wall. It is

believed that vibration caused a stress to be transmitted through the tab, the tab ear to the rivet which stressed the metal around the rivet and the portion of the scoreline in front of the rivet. What was detected, on occasion, were hairline cracks in the scoreline with the result that the container contents lost all or some of the pressure i.e. became "flat" or actually leaked.

By this invention, such a problem is substantially reduced by positioning the tab ear below the underside of the tab body, as seen in FIGS. 3 and 4, during tab manufacture. Thus, as the tab is secured to the end wall, as seen in FIG. 6, the underside of the tab is pulled tight against the end wall i.e. the clearance is eliminated, and downward stresses are transmitted to the end wall rather than to the rivet and the scoreline.

Accordingly, it will be seen that the structural features of the present invention have substantially improved the longitudinal rigidity of the tab, so much so that lighter tab stock may be used. Moreover, the tendency toward preventing fracture of the scoreline has been substantially reduced.

While the tab shown illustrates the preferred structural features of the present invention, it is understood that the shape and configuration of the tab may vary considerably. Thus, the panel 21 may be punched out or the rear end of the tab may be made boxier with rounded corners to provide a tab with a straight rather than curved section along the rear end. The portion of the tab to the rear of the web may be contoured to permit easy insertion of the finger.

Accordingly, various modifications may be made, as will be apparent from the above, without departing from the invention as set forth in the appended claims:

What is claimed is:

1. In a tab for use with an easy opening end structure wherein said tab is formed of metal sheet material, and which includes a lifting end and an opening end with an ear therebetween, the ear including an aperture through which a rivet may extend for attachment of said tab to an end wall, spaced side legs formed of a curled double layer of sheet material and extending between the opening end and at least to the rear of said ear, and wherein said opening end is formed of multiple layers of sheet material, the improvement comprising:

one of the multiple layers forming the opening end of said tab including finger means extending towards the lifting end of said tab and positioned within the double layer of said spaced side legs, and said finger means including flange means extending lengthwise thereof to form ribs stiffing said tab along its length.

2. A tab as set forth in claim 1 wherein said flange means extends lengthwise at least as far as the aperture in said ear.

3. A tab as set forth in claim 1 wherein said flange means is located on the portion of said finger means located within the curl of said double layer,

one layer of the double layer forming the upper surface of said tab, and

said flange means being disposed to face away from the upper surface of said tab.

4. A tab as set forth in claim 1 wherein the double layer of said side legs includes an upper layer forming the top surface of the tab and a lower layer therebeneath, and

the lower layer overlying said finger to prevent said finger from being pulled out of said double layer during manipulation of said tab.

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5. A tab as set forth in claim 1 wherein the finger is so dimensioned with respect to the lowermost layer of said curl that the lowermost layer substantially completely covers the tip end of said finger to prevent movement of said finger relative to said side leg during normal use of said tab in an opening sequence.

6. A tab as set forth in claim 1 wherein the lowermost layer of said side legs overlies the lateral inside edge of said finger means to retain said finger means within said curl.

7. A tab as set forth in claim 1 wherein said tab is formed of a single piece of sheet material.

8. A tab as set forth in claim 1 wherein the opening end of said tab includes a triple layer of sheet material, and

said finger means being integral with the intermediate layer of said triple layer.

9. A tab as set forth in claim 1 wherein the opening end of said tab includes a triple layer of sheet material, and

said ear being integral with one of said triple layers and including a bend area to position said ear at an angle relative to the plane of the side legs.

10. A tab as set forth in claim 1 wherein said side legs include a continuous outer curled surface and a lower layer which is interrupted at a region to the rear of the rear curl of said ear.

11. A tab as set forth in claim 1 wherein said side legs include portions spaced from said ear, and

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the upper layer of said side legs spaced from said ear including flange means for providing strength.

12. A tab as set forth in claim 11 wherein the flange means on said finger means and the flange means on said side legs extend in the same direction.

13. A tab as set forth in claim 11 wherein the flange means on said side legs contacts at least a portion of the lower layer of said side legs and in said portion encloses the corresponding finger means.

14. In an easy opening end wall of the ecology type for use with a container wherein the end wall includes a retained tab and a retained pour panel and wherein the tab initially functions as a class 2 lever initially to pop a portion of the scoreline and as a class 1 lever to complete fracture of the scoreline, an improved tab comprising:

a body member having an opening end and a lifting end,

the opening end being formed of multiple layers of sheet material,

legs formed of curled sheet material extending from said opening end to said lifting end,

one of the multiple layers of the opening end including finger means received and secured within a portion of the corresponding leg, and

the lifting end of said tab which is contacted by the user's finger in an opening sequence being formed of a smooth unbroken curl of sheet material.

* * * * *

APPENDIX D



US006234336B1

(12) **United States Patent**
Neiner

(10) **Patent No.:** **US 6,234,336 B1**
(45) **Date of Patent:** ***May 22, 2001**

(54) **STAY-ON-TAB CONTAINER CLOSURE
HAVING TEAR PANEL WITH NO CONTOUR
FEATURES ON THE UPPER SURFACE**

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(US)**

(73) **Assignee:** **Metal Container Corporation, St.
Louis, MO (US)**

(*) **Notice:** This patent issued on a continued pros-
ecution application filed under 37 CFR
1.53(d), and is subject to the twenty year
patent term provisions of 35 U.S.C.
154(a)(2).

Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **08/742,970**
(22) **Filed:** **Nov. 1, 1996**
(51) **Int. Cl.⁷** **B65D 17/34**
(52) **U.S. Cl.** **220/269; 220/906**
(58) **Field of Search** **200/269, 270,
200/906**

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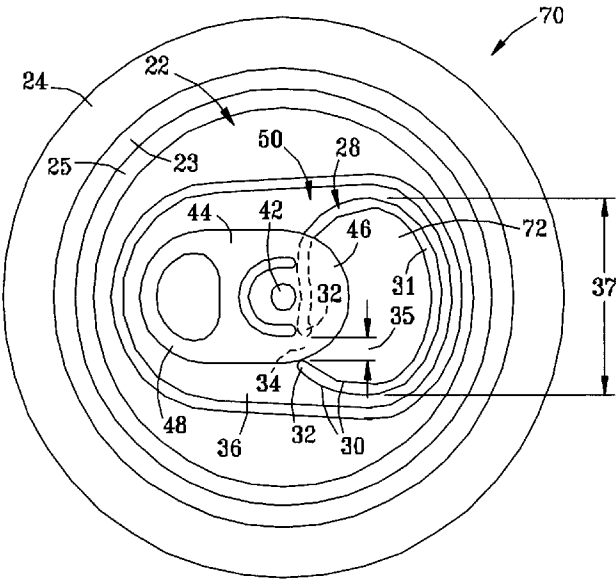
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Primary Examiner—Allan N. Shoap
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(74) *Attorney, Agent, or Firm*—Carr & Storm, L.L.P.

(57) **ABSTRACT**

A stay-on-tab container closure suitable for use on beverage
cans and the like, said closure including an center panel with
an downwardly displaceable tear panel, which, in one
aspect, has a smooth upper surface having no visually
perceptible contour features, and which, in another aspect,
has low-relief contour features on its upper surface. Closures
according to the invention have reduced stresses across the
score defining the tear panel, thereby reducing the likelihood
of stress-induced fatigue cracking which can lead to score
failure when the container closure is joined to a can body
and the resulting can is internally pressurized.

7 Claims, 5 Drawing Sheets



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FIG. 1
(PRIOR ART)

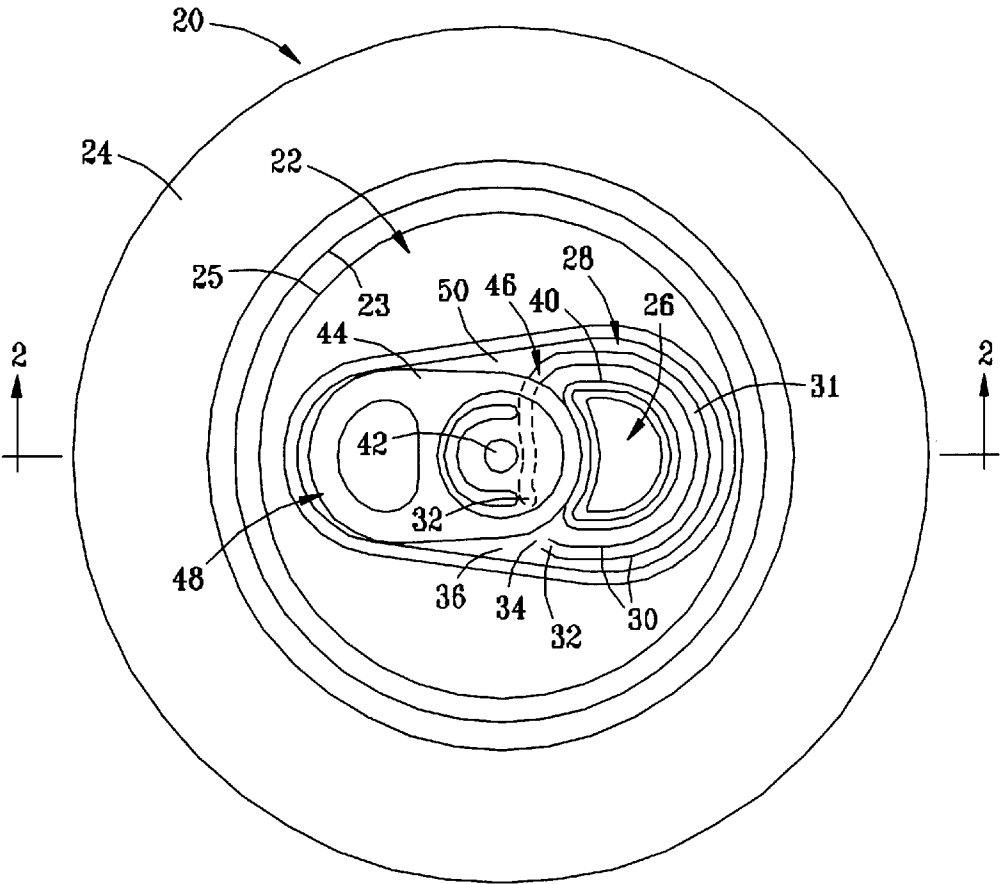


FIG. 2
(PRIOR ART)

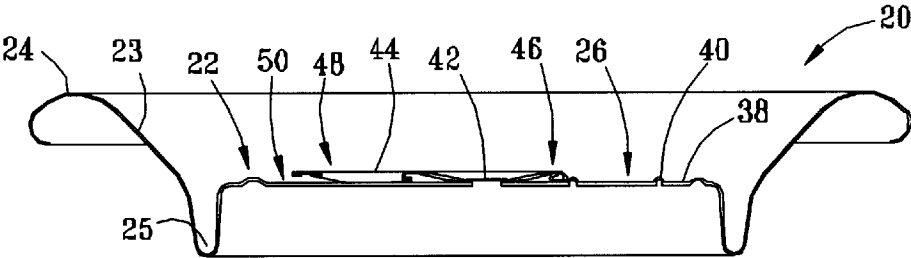


FIG. 5A

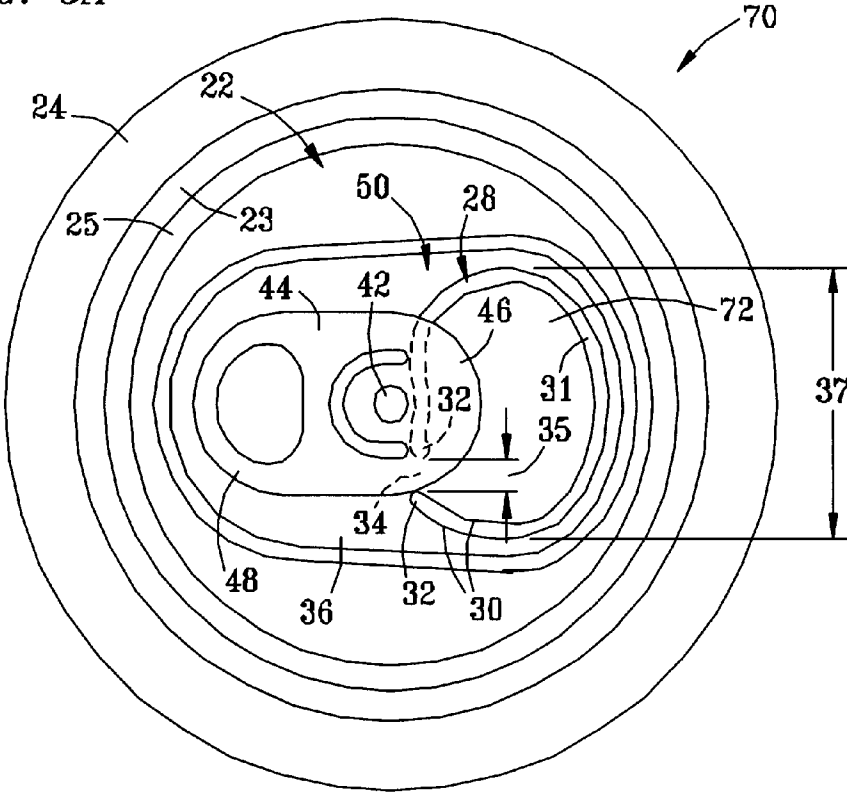


FIG. 5B

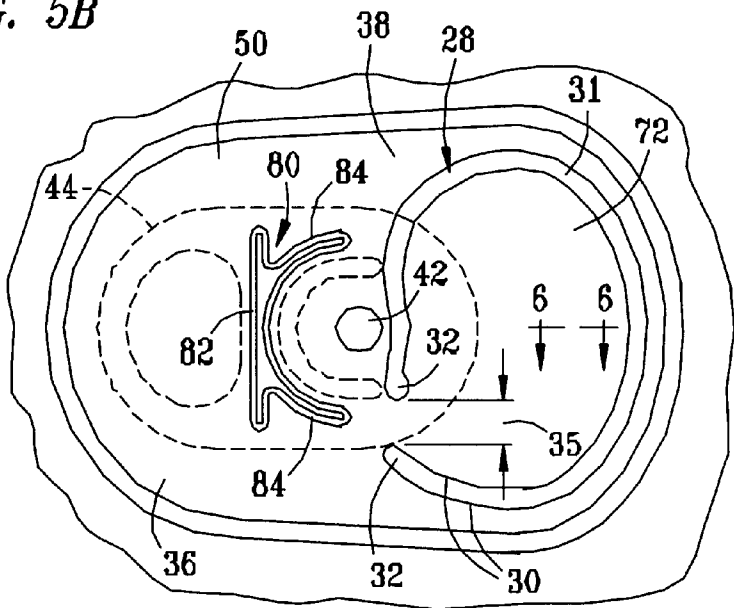


FIG. 6

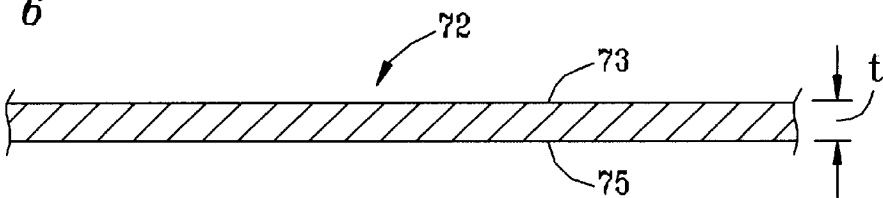


FIG. 7

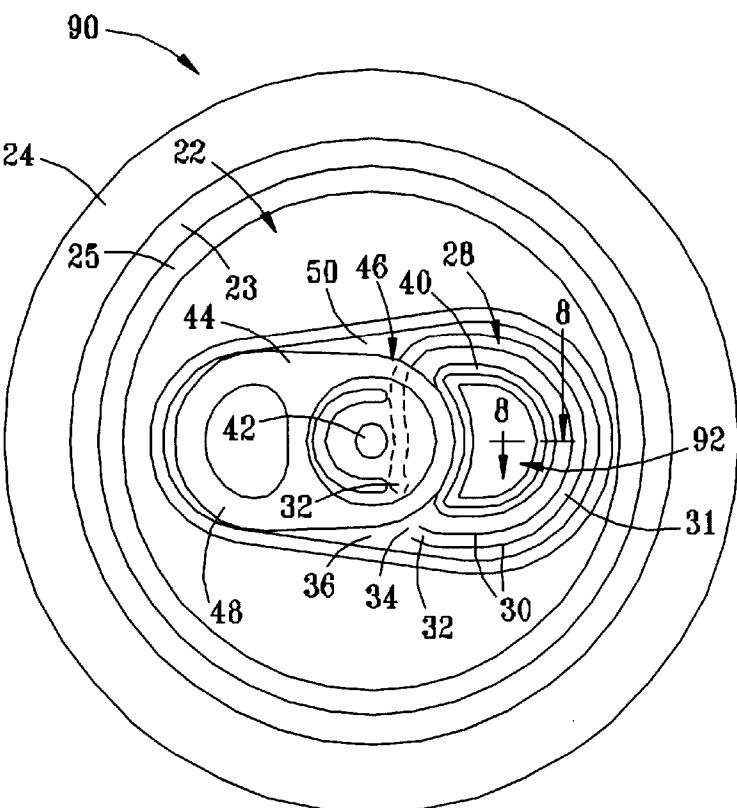


FIG. 8

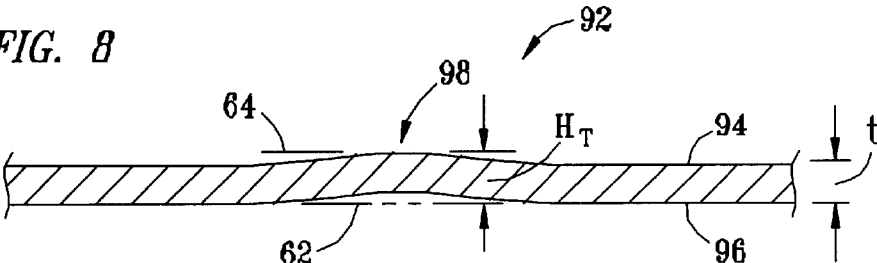


FIG. 9A

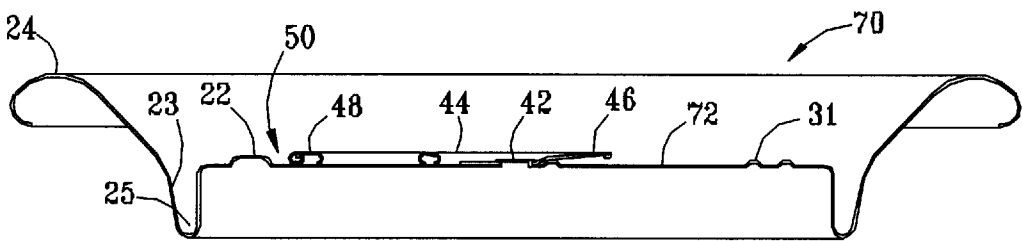


FIG. 9B

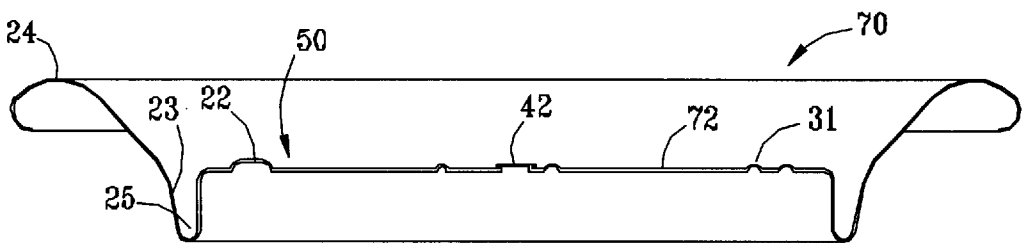
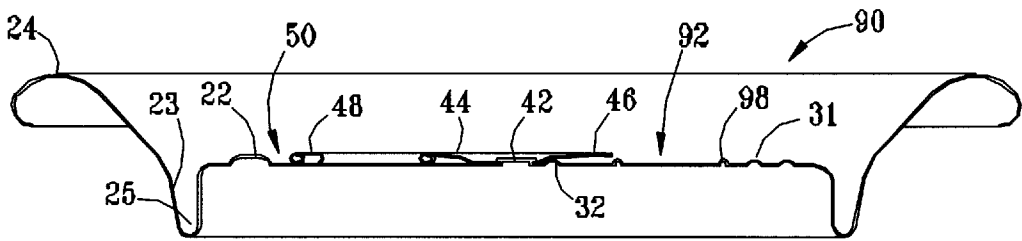


FIG. 10



**STAY-ON-TAB CONTAINER CLOSURE
HAVING TEAR PANEL WITH NO CONTOUR
FEATURES ON THE UPPER SURFACE**

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to closures of the type used for metal beverage containers and, more particularly, to stay-on-tab closures in which an attached tab is lifted to partially sever and displace a tear panel to create an opening for dispensing the contents of the container. In one aspect, the current invention relates to a stay-on-tab closure having a tear panel with low-relief contour features on the upper surface.

BACKGROUND OF THE INVENTION

It is well known to use closures, also referred to as “ends” or “lids,” for sealing metal beverage containers of the type used for packaging beer, carbonated soft drinks, juice, tea, water, and other liquids or fluids. These closures are typically formed of an aluminum alloy or steel, although other materials such as metal-plastic laminates or composites can also be used. A common type of closure, often referred to as a “stay-on-tab” closure, incorporates an attached tab which is lifted to partially sever and displace a tear panel defined by a frangible curvilinear score line. The downward displacement of the tear panel creates an opening for dispensing the contents of the container without the use of a separate opening tool. Both the tear panel and the tab remain attached to the closure after opening.

Conventional stay-on-tab closures typically include a center panel having a generally planar or slightly upwardly domed surface. A tear panel is defined by a curvilinear, but non-closed, frangible score line formed on the center panel which defines the general periphery of the tear panel but leaves a narrow integral hinge connecting the tear panel to the remainder of the center panel. An opening tab is secured to the center panel of the closure by a rivet or other such fastener hingedly connected to the tab. When one tab end is lifted upward, the tab applies forces to the tear panel and center panel to rupture the score line and displace the tear panel down into the associated container to form an opening through which the container contents can be dispensed. The non-closed portion of the score line forms a hinge which retains the tear panel with the closure. Similarly, the tab remains attached to the closure by its hinged connection to the rivet.

To facilitate the easy bending of the tear panel into the container during opening, conventional stay-on-tab closures connect the tear panel to the center panel using a narrow hinge, i.e., a hinge having a width less than about 25% of the maximum width of the tear panel. Unconventional container closures having displaceable panels and permanently affixed tabs are also known, such as described in U.S. Pat. No. 5,405,039 to Komura, and such closures may be referred to by some as “stay-on-tab” closures. The displaceable panels in such unconventional closures, however, are connected to the center panel by a hinge having a width significantly greater than 25% of the maximum width of the displaceable panel. For example, one closure in the previously mentioned Komura '039 patent provides a displaceable panel comprising approximately one-half of the top of the lid and a hinge having a width of approximately 100% of the maximum width of the displaceable panel. Because the forces relating to the opening and bending of such unconventional closures are significantly different than for conventional stay-on-tab closures, all further references to “stay-on-tab” closures in

this application refer to closures having a hinge width less than about 25% of the maximum width of the tear panel.

All stay-on-tab container closures heretofore known include high-relief “contour features” formed in the tear panel and projecting substantially above the nearby generally planar surface of the tear panel. For the purposes of this application, a contour feature is considered to have “high relief” when the “total height”, or H_T , of the feature is not less than about 2 times the thickness of the sheet material used to form the lid. The total height, H_T , of a contour feature is the vertical distance from the highest point on the upper surface of the contour feature to the level of the underside of the surrounding generally planar tear panel material. One contour feature commonly used on tear panels is a raised curvilinear ridge generally referred to as a “bead.” It is known to use high-relief beads having a variety of configurations, when viewed from above, including a non-closed curve resembling the letter “C” (sometimes called a “C-bead”), a closed curve having one straight side resembling the letter “D” (sometimes called a “D-bead”), a closed curve of circular or oval shape, or an irregular closed or non-closed shape. For example, closures are known which are formed from sheet material having a thickness of about 0.0093 inches and having a high-relief bead on the tear panel with a total height, H_T , in the range of about 0.0200 to 0.0230 inches, as are closures formed from sheet material having a thickness of about 0.0090 inches and having a high-relief bead on the tear panel with a total height, H_T , of about 0.0180 inches. It must be noted that although beads are among the most common high-relief contour features found on tear panels, other high-relief contour features are also known, including ridges, panels, embossments, and various combinations of these features.

It was heretofore believed necessary to incorporate high-relief contour features on the tear panel of stay-on-tab container closures for one or more of the following reasons: 1) to serve as lateral stiffening or reinforcing structures on the tear panel so that the panel will not bow excessively or buckle during the opening operation, which can cause “nose failure” and “tuck-under” type failures; 2) to selectively distribute the forces of the opening tab across the tear panel to propagate the fracturing of the score line completely around the tear panel so the panel will not experience an “partial opening” type failure; and 3) to gather in the “slack metal” on the tear panel which results from the widening of the panel during formation of the score lines, thereby maintaining tension in the tear panel, the lack of which can also cause nose failure, tuck-under type failure, or partial opening type failure. A “nose failure” occurs when excessive bowing or buckling of the tear panel due to insufficient stiffness or insufficient tension allows the tab end to slip along the surface of the tear panel without rupturing the score line at all. A “tuck-under” type failure, also known as a “non-turn-under” type failure, occurs when the same factors cause the tab to only partially rupture the score line and not displace the tear panel far enough into the container to provide a useable opening. A “partial opening” type failure, also known as an “insufficient angle” type failure occurs when the score line fully ruptures, but bowing of the tear panel or inadequate distribution of tab forces prevents the tab from displacing the tear panel through a sufficient angle into the container to avoid obstructing the opening.

The operational problems described above are known for stay-on-tab container closures having “standard-size” openings, that is, openings defined by tear panels having an area of approximately 0.40 square inches, and the use of a high-relief bead or some other type of high-relief contour

feature on the tear panel was heretofore believed necessary to overcome such problems. It was heretofore further believed that such operational problems are exacerbated on container closures incorporating so-called "large-size" openings, that is, openings defined by tear panels having an area of approximately 0.59 square inches or larger, and thus that the use of a high-relief bead or other contour feature on the tear panel was of increased necessity. See, for example, European Patent Application No. EP 0 704 382 A2.

Another factor affecting the performance of container closures is the gauge, or thickness, of the material used to form the closures. At one time, stay-on-tab container closures were manufactured using sheet metal "stock" having a thickness of at approximately 0.0100 inches or greater. In order to conserve materials and decrease costs, however, stay-on-tab container closures are now being manufactured from metal stock having a thickness in the range of approximately 0.0091 inches to 0.0085 inches, and the thickness is anticipated to continue decreasing in the future. As the thickness of the sheet material used to make the container closures decreases, the operational behavior of the tear panel and its interaction with the tab also changes. Thus, container closure designs that function adequately for lids having a thickness of over 0.010 inches cannot be assumed to function identically for lids having a lesser thickness.

In fact, it has been discovered in connection with the development of the current invention that beverage containers using stay-on-tab container closures having a thickness of about 0.0091 inches or less and provided with high-relief contour features on the tear panels, as was heretofore thought necessary for proper opening function, experience an unacceptably high rate of score failure when the containers are internally pressurized to relatively high pressures, such as those normally encountered in a beverage pasteurizer or from handling during shipping. It should be noted that the absolute failure rate for such closures is very small, but due to the astronomical number of closures produced (tens of billions per year), a small change in the failure rate is of economic significance. Further, it has been determined that this score failure rate is highest on container closures having large-size openings, which are a growing segment of the closure market, adding to the economic significance. It has been determined in connection with the development of the current invention that the increased score failure rate is at least partially attributable to fatigue cracking of the container closure material along the score line. It is believed that the fatigue cracking is caused by excessive stress across the score line.

A need therefore exists, for a stay-on-tab container closure formed from sheet stock having a thickness, preferably of about 0.0091 inches or less, having conventional tear panel function and operation characteristics, and having reduced lateral stress across the score line to provide improved resistance to stress-induced cracking of the score line.

A need further exists for a stay-on-tab container closure having a large-size opening with an area of 0.59 square inches or greater, the container closure being formed from sheet stock having a thickness, preferably of about 0.0091 inches or less, having conventional tear panel function and operation characteristics, and having reduced lateral stress across the score line to provide improved resistance to stress-induced cracking of the score line.

SUMMARY OF THE INVENTION

For purposes of clarity and consistency some of the terms used in the specification and the claims hereof will now be

defined. Directional terms such as "up," "down," "high," "low," "upper," "lower," "top," "bottom," "side," "horizontal" and "vertical" refer to container closures as though they were disposed in operational relationship with an upright, level container body resting on a flat horizontal surface. Directional terms such as "in," "out," "inward" and "outward," relate to the interior of a can formed with a container closure.

It is an object of the current invention to provide a stay-on-tab container closure formed from sheet material having a thickness, preferably of about 0.0091 inches or less, having conventional tear panel function and operation characteristics, and having reduced lateral stress across the score line to provide improved resistance to stress-induced cracking of the score line.

It is a further object of the current invention to provide a stay-on-tab container closure having an opening defined by a tear panel having an area of approximately 0.59 square inches or greater, the closure being formed from sheet stock having a thickness, preferably of about 0.0091 inches or less, having conventional tear panel function and operation characteristics, and having reduced lateral stress across the score line to provide improved resistance to stress-induced cracking of the score line.

The above and other objects are realized by providing a stay-on-tab container closure comprising a generally circular center panel having upper and lower surfaces and being formed from a sheet material having a thickness. A frangible curvilinear score is formed on the upper surface of the center panel defining a displaceable tear panel, a hinge, and a fixed portion on the center panel. The tear panel has upper and lower surfaces and the upper surface of the tear panel is smooth, that is, it has no visually perceptible contour features. In a preferred embodiment, the sheet material has a thickness of 0.0091 inches or less. In a more preferred embodiment, supplemental contour features are provided on the fixed portion of the center panel. In a still more preferred embodiment, the area of the tear panel is 0.59 square inches or greater.

In another aspect of the current invention, a stay-on-tab container closure is provided comprising a generally circular center panel having upper and lower surfaces and being formed from a sheet material having a thickness. A frangible curvilinear score is formed on the upper surface of the center panel defining a displaceable tear panel, a hinge, and a fixed portion on the center panel. The tear panel has upper and lower surfaces and the upper surface of the tear panel has contour features projecting upward to a total height not greater than about 1.6 times the thickness of the sheet material. In a preferred embodiment of this aspect, the sheet material has a thickness of 0.0091 inches or less. In a more preferred embodiment of this aspect, the upper surface of the tear panel has contour features projecting upward to a total height not greater than 1.25 times the thickness of the sheet material. In a still more preferred embodiment of this aspect, the upper surface of the tear panel has contour features projecting upward to a total height not greater than 1.1 times the thickness of the sheet material. In still other embodiments of this aspect, supplemental contour features are provided on the fixed portion of the center panel. In yet another embodiment of this aspect, the area of the tear panel is 0.59 square inches or greater.

In yet another aspect of the current invention, a method for producing container closures is provided, comprising the steps of:

- a) cutting a lid blank from a sheet of material;
- b) forming a lid shell having a featureless center panel;
- c) moving the lid shell to a conversion press having a plurality of stations;
- d) forming, at one said station of said conversion press, a score on the center panel, said score defining a tear panel, a hinge, and a fixed portion, but not forming any visually perceptible contour features on said tear panel at the same said station; and
- e) forming, at another of said stations of said conversion press, a recessed panel encompassing said score, hinge, and tear panel, but not forming any visually perceptible contour features on said tear panel at the same said other station.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a PRIOR ART stay-on-tab container closure;

FIG. 2 is cross-sectional view of the PRIOR ART closure of FIG. 1 taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged plan view of the score and tear panel of the PRIOR ART closure of FIG. 1;

FIG. 4 is an enlarged cross-sectional view of the high-relief contour feature of the PRIOR ART closure of FIG. 1 taken along line 4—4 in FIG. 3;

FIG. 5A is a plan view of a container closure according to one aspect of the current invention;

FIG. 5B is a partial plan view of the closure of FIG. 5A with the opening tab shown in phantom to show the underlying panel;

FIG. 6 is an enlarged cross-sectional view of the tear panel of the closure of FIG. 5A taken along line 6—6 in FIG. 5B;

FIG. 7 is a plan view of a container closure according to a second aspect of the current invention; and

FIG. 8 is an enlarged cross-sectional view of the low-relief contour feature of the closure of FIG. 7 taken along line 8—8 in FIG. 7;

FIG. 9a is a cross-sectional view of the container closure of FIG. 5a;

FIG. 9b is a cross sectional view of the container closure of FIG. 5b;

FIG. 10 is a cross sectional view of the container closure of FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings in detail, and in particular to FIGS. 1—4, a PRIOR ART container closure 20 is shown for comparison to the current invention. PRIOR ART container closure 20 is typical of conventional stay-on-tab container closures suitable for use on beverage cans and the like. As best seen in FIGS. 1 and 2, PRIOR ART container closure 20 comprises a generally circular center panel 22 defined by an upstanding annular chuck wall 23 which is disposed within a peripheral flange 24 and countersink 25. Center panel 22 has a tear panel 26 defined by a score 28 which forms a curvilinear pattern when viewed from above. In the closure shown, score 28 forms a generally oval pattern, however, other score line pattern shapes are known. Score 28 typically comprises two score grooves 30 disposed

generally adjacent to one another and formed in the upper surface 38 of center panel 22 by pressing or stamping. Score 28 has a curving bend or “bight” portion 31 and two end portions 32 which are disposed adjacent to one another at the ends of the bight portion 31 and define therebetween a hinge portion 34 which permanently attaches tear panel 26 to a fixed portion 36 of center panel 22. The hinge portion 34 has a hinge width 35 measured between the two end portions 32. Tear panel portion 26 has a high-relief contour feature 40 which projects above upper surface 38 of tear panel 26. In the PRIOR ART closure shown, contour feature 40 takes the shape, when viewed from above, of an uppercase letter “D”, and therefore may also be referred to as a “D-bead”, however, contour features of many other configurations are known. PRIOR ART container closure 20 further comprises a rivet 42 disposed on the fixed portion 36 of center panel 22 proximate hinge portion 34 and an opening tab 44 secured to center panel 22 by rivet 42. Opening tab 44 has a forward portion 46 overlying tear panel 26 and a rear portion 48 overlying fixed panel portion 36. In most cases, score 28, tear panel 26, rivet 42 and opening tab 44 are disposed together in a recessed area 50 formed on center panel 22 as shown in FIG. 1. Recess 50, while preferred, is not required.

Referring now to FIGS. 3 and 4, enlarged views of the tear panel 26 of PRIOR ART closure 20 are shown. Note that in these FIGS., opening tab 40 is not shown for purposes of illustration. In the PRIOR ART tear panel 26 shown, contour feature 40 is a “D-bead” having a generally curvilinear profile, viewed in cross section, and having an outer slope 52, an inner slope 54, and an apex line 56, which is the uppermost projection of the D-bead 40 above the generally planar portions 58, 60, of tear panel 26. Other contour features are known in the art, including beads having various configurations, when viewed from above, beads having various other profiles, such as semicircular, when viewed in cross section, and other contour features such as embossments and panels.

Referring still to FIGS. 3 and 4, the D-bead contour feature 40 of PRIOR ART container closure 20 is, like all of the contour features of PRIOR ART stay-on-tab closures, a “high relief” contour feature because the total height, H_T , of contour feature 40 is not less than about 2 times the thickness, t , of the sheet material used for forming the closure. Referring now to FIG. 4, the total height, H_T , of contour feature 40 is the distance between a first line 62, which constitutes an extension of the lower surface 39 of the generally planar areas 58 and 60 adjacent to contour feature 40, and a second line 64, which is generally parallel to first line 62 and passing through the uppermost point of the upper surface 38 of contour feature 40 (i.e., the apex line 56). For example, if PRIOR ART closure 20 is formed from metal stock having a thickness, t , of approximately 0.0091 inches, then the total height, H_T , of heretofore known high-relief contour features is 0.0182 inches or greater.

As previously discussed, container closures having high-relief contour features on the tear panel, which were heretofore thought necessary, experience high rates of score failures when made from metal stock having a thickness of about 0.0091 inches or less, and especially when the closures incorporate large-size openings. It is believed that the formation of the high-relief contour features on the tear panel creates stresses running laterally across the score line having a magnitude that makes the score line region susceptible to fatigue cracking after the closure is incorporated into a container and subjected to the additional stresses from the pressurized contents of the completed container.

The current invention provides a stay-on-tab container closure formed from sheet material having a thickness,

preferably of about 0.0091 inches or less, and having, in a first aspect, a tear panel with a smooth upper surface, that is, with no visually perceptible contour features. In an alternative aspect, the invention provides a closure having a tear panel with low-relief contour features. In both aspects of the invention, lateral stresses across the score line are reduced, thus providing improved resistance to stress-induced cracking of the score line and reduced score failure rates. The current invention has the further unexpected benefit of exhibiting conventional opening characteristics, e.g., the current invention does not experience operating problems such as nose failures, tuck-under failures, and partial opening type failures at rates significantly different than for comparable closures having the previously believed necessary high-relief contour features. The unexpected benefit of the current invention further extends to use on closures having large-size openings.

Referring generally now to FIGS. 5A, 5B, and 6, a container closure 70 according to a first aspect of the invention is shown. Closure 70 is formed from sheet material having a thickness, preferably of approximately 0.0091 inches or less. Referring first to FIG. 5A, closure 70 comprises a generally circular center panel 22, and can include an annular chuck wall 23, a peripheral flange 24, a countersink 25, and a recessed panel 50 similar to the PRIOR ART closure previously discussed and illustrated in FIGS. 1 and 2. Alternatively, center panel 22 can be connected to other peripheral annular structures (not shown) as is known in the art to adapt the closure to the specific geometry of the associated container. Center panel 22 of closure 70 has a curvilinear score 28 defining a tear panel 72, a hinge 34, and a fixed portion 36. In the embodiment shown, score 28 comprises two separate score grooves 30 disposed generally adjacent to one another and formed in the upper surface 38 of center panel 22 by pressing or stamping. While this configuration of score 28 is preferred, a score having a single groove or larger number of grooves is within the scope of the current invention. Score 28 has a curving bight portion 31 and two end portions 32 which are disposed adjacent to one another at the ends of the bight portion 31 and define therebetween the hinge portion 34 which permanently attaches tear panel 72 to the fixed portion 36 of center panel 22. The hinge portion 34 has a hinge width 35 measured between the score end portions 32. Hinge width 35 is less than 25% of the maximum width (shown as 37) of the tear panel 72. In the embodiment shown in FIG. 5A, closure 70 is of the "large-size" type, because the tear panel 72 has an area greater than 0.59 square inches. It will be readily apparent, however, that the current invention is also applicable to container closures of the "standard-size" opening type. As best seen in FIG. 6, the tear panel 72 of closure 70 has upper and lower surfaces 73, 75, respectively. Still referring to FIG. 6, the upper surface 73 of tear panel 72 is smooth, that is, it has no visibly perceptible contour features projecting upward from the upper surface 73. For the purposes of this application, "visually perceptible" contour features are features projecting upwards which can be perceived by an ordinary person using the unaided eye. Lettering or other indicia incised into the upper surface 73 of tear panel 72 could be visually perceptible, but would not constitute a contour feature because they do not project upwards. It should be noted that since the upper surface 73 of tear panel 72 is smooth, the cross section shown in FIG. 6 would apply to all regions of tear panel 72.

Referring again to FIGS. 5A and 5B, container closure 70 further comprises a rivet 42 disposed on the fixed portion 36 of center panel 22 proximate hinge portion 34 and an

opening tab 44 secured to center panel 22 by rivet 42. Opening tab 44 has a forward portion 46 overlying tear panel 72 and a rear portion 48 overlying fixed panel portion 36. In some cases, score 28, tear panel 72, rivet 42 and opening tab 44 may be disposed together in a recessed area 50 formed on center panel 22 as shown in FIGS. 5A and 5B, however, recess 50 is not required. The operation of closure 70 is similar to the operation of previous stay-on-tab closures: Lifting the rear portion 48 of opening tab 44 causes the tab to exert forces on tear panel 72 and fixed portion 36 of the center panel 22 to rupture score 28 and displace tear panel 72 downward into the associated container (not shown) to form an opening for dispensing the contents of the container. These opening procedures apply to closures with standard-size openings and to containers with large-size openings.

Referring now to FIG. 5B, which shows opening tab 44 in phantom to reveal underlying structures on the center panel 22, in a more preferred embodiment of the current invention, supplemental contour feature 80 is provided on fixed portion 36 of center panel 22 proximate rivet 42. Supplemental contour feature 80, while preferred, is not required. Supplemental contour feature 80 further stiffens and reinforces the center panel 22 to improve opening performance of the closure 70 without introducing lateral stresses across the score 28 which can lead to increased score failure rates. Supplemental contour feature 80 can therefore be of either "high-relief" or "low-relief" type, when viewed in cross section. In the embodiment shown in FIG. 5B, the supplemental contour feature 80 has a configuration, when viewed from above, of a "picnic table" having a generally straight "top" feature 82, which is spaced apart from rivet 42, and two curvilinear "leg" features 84, which are attached to top feature 82 and curve around rivet 42 at a generally constant radius. It will be appreciated that many other configurations for the supplemental contour feature 80 are within the scope of the current invention.

Referring now to FIGS. 7 and 8, a container closure 90 according to a second aspect of the current invention is shown. Closure 90 comprises many of the same structures found in the closures previously discussed, as shown by their like-numbering in FIG. 7. The tear panel 92 of closure 90, however, has upper and lower surfaces 94, 96, respectively, and low-relief contour features 98 formed on upper surface 94. As best seen in FIG. 8, when viewed in cross section, the low-relief contour features 98 of tear panel 92 have a total height, H_T , that is not greater than about 1.6 times the thickness, t , of the sheet material used for forming the closure. For example, for a closure in which the thickness, t , of the stock metal is approximately 0.0091 inches, the total height, H_T , of low-relief contour features 98 on tear panel 92 will be less than about 0.0146 inches.

Referring now to FIGS. 9a, 9b, and 10, which show cross sectional views of FIGS. 5a, 5b, and 7, respectively. These views show that recessed area 50 of the container closure according to the present invention is recessed below, or at a lower elevation relative to, center panel 22.

Container closures according to the current invention exhibit normal operating performance during opening, both for closures with standard-size openings and for closures with large-size openings. The low-relief contour features 98 of upper surface 94 of the tear panel 92 of the current invention does not cause an increase in operational problems such as nose failure, tuck-under type failure, or partial opening type failure as was heretofore predicted in the art. Further, because formation of the low-relief contour features 98 of the tear panel 92 gathers in the metal of the tear panel to a lesser extent than formation of the high-relief contour

features on the tear panel of previously known closures, the closures of the current invention have less stress running laterally across the score area. This relative stress reduction across the score area provides closures according to the current invention with a significant improvement in resistance to fatigue cracking relative to previously known closures. In addition, the low-relief contour features **98** do provide a visually perceptible contour feature on the tear panel **92**, which may be desirable for providing alignment or for aesthetic purposes.

In a more preferred embodiment of this aspect, low-relief contour features **98** have a total height, H_T , that is not greater than about 1.25 times the thickness, t , of the sheet material used for forming the closure. In a still more preferred embodiment of this aspect, low-relief contour features **98** have a total height, H_T , that is not greater than about 1.10 times the thickness, t , of the sheet material used for forming the closure. In each of the preferred embodiments, even less metal of the tear panel **92** is gathered in by the low-relief contour features **98**, to further reduce the tension in the metal, however, a visually perceptible contour feature is provided suitable for the purposes described above.

Closures according to the current invention having no contour features on the tear panel, such as closure **70** shown in FIG. **5**, have further advantages over the known art. Since no contour features need be formed on the tear panel **72**, the tooling required to produce the closures is simplified. In addition, the smooth flat upper surface of the tear panel **72** provides additional area on the closure **70** suitable for incising indicia as may be required by governmental regulations or business purposes.

Yet another aspect of the current invention provides a method for producing container closures having improved fatigue crack resistance, the method comprising the steps of:

- a) cutting a closure blank from a sheet material having a thickness;
- b) forming a closure shell having a featureless center panel;
- c) moving the closure shell to a conversion press having a plurality of stations;
- d) forming on said closure shell, at one of said stations of said conversion press, a score on the center panel, said score defining a tear panel, a hinge, and a fixed portion, but not forming any visually perceptible contour features on said tear panel at the same said station; and
- e) forming on said closure shell, at another of said stations of said conversion press, a recessed panel encompassing said score, hinge, and tear panel, but not forming any visually perceptible contour features on said tear panel at the same said other station.

The details of each step of this aspect of the current invention are well known to those in the art. In addition, it will be readily appreciated, for example, that additional operations known in the art may be performed at conversion press stations preceding and subsequent to the two stages described in steps d) and e) above. It is the unique combination of steps described above which provides the unexpected benefit of increased fatigue crack resistance, especially for closures formed from sheet material having a thickness of about 0.0091 inches or less, and more especially for such closures having large size openings.

While the preferred embodiment of the invention has been disclosed with reference to particular aspects of container closures and the functioning thereof, it is to be understood that many changes in detail may be made as a matter of engineering choices without departing from the spirit and scope of the invention, as defined by the appended claims.

I claim:

1. A stay-on-tab container closure comprising:

- (a) a circular center panel formed from a sheet material having a thickness;
said center panel having upper and lower surfaces;
- (b) a recessed area formed on said center panel at a lower elevation than the remaining portions of said center panel;
- (c) a frangible score formed on said upper surface of said center panel and disposed within said recessed area;
said score, when viewed from above, having a curvilinear bight portion and two end portions disposed at the ends of said bight portion in spaced-apart relation to one another;
said bight portion defining most of the periphery of a downwardly displaceable tear panel;
said end portions defining therebetween a hinge portion which permanently attaches said tear panel to a fixed portion of said center panel;
- (d) said tear panel being flat and without axial curvature and having upper and lower surfaces;
said surfaces of said tear panel being smooth and without visually perceptible contour features;
- (e) a rivet disposed on said fixed portion of said center panel within said recessed area proximate said hinge portion; and
- (f) an opening tab hingedly secured to said rivet, said opening tab having a forward portion overlying said tear panel, said forward portion having a forward edge smoothly curving about said rivet.

2. A stay-on-tab container closure according to claim 1, wherein said thickness of said sheet material is not more than about 0.0091 inches.

3. A stay-on-tab container closure according to claim 1, wherein said tear panel has an area of at least about 0.59 square inches.

4. A stay-on-tab container closure according to claim 3, wherein said sheet material is formed from a substance selected from the group consisting of aluminum and aluminum alloys.

5. A stay-on-tab container closure according to claim 2, further comprising supplemental contour features formed on said fixed portion of said center panel proximate said rivet.

6. A stay-on-tab container closure according to claim 5, wherein said supplemental contour features comprise a raised bead having a first straight portion spaced apart from said rivet and two curvilinear portions joined to said straight portion and disposed along a curved path about said rivet at a fixed distance from said rivet.

7. A stay-on-tab container closure according to claim 1, wherein said sheet material is formed from a substance selected from the group consisting of aluminum and aluminum alloys.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,234,336 B1
DATED : May 22, 2001
INVENTOR(S) : Neiner

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

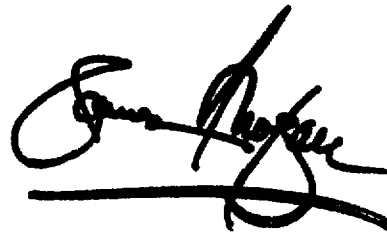
Column 5,

Line 37, delete "SB" insert --5B --

Signed and Sealed this

Nineteenth Day of February, 2002

Attest:

A handwritten signature in black ink, appearing to read "James E. Rogan", with a long horizontal flourish extending from the bottom of the signature.

Attesting Officer

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

APPENDIX E

United States Patent [19]
Jabarin

[11] **Patent Number:** **4,522,779**
[45] **Date of Patent:** **Jun. 11, 1985**

[54] **METHOD FOR PRODUCTION OF
POLY(ETHYLENE TEREPHTHALATE)
ARTICLES**

57-53326 3/1982 Japan 264/529
2108899 5/1983 United Kingdom 264/530

[75] **Inventor:** Saleh A. Jabarin, Holland, Ohio
[73] **Assignee:** Owens-Illinois, Inc., Toledo, Ohio

Primary Examiner—Jan Silbaugh
Attorney, Agent, or Firm—Thomas L. Farquer; M. E.
Click

[21] **Appl. No.:** 555,759

[57] **ABSTRACT**

[22] **Filed:** Nov. 28, 1983

[51] **Int. Cl.³** B29C 17/07

[52] **U.S. Cl.** 264/530; 264/535

[58] **Field of Search** 264/523, 529, 530, 532,
264/535; 425/530

Improved plastic containers and process for their production are disclosed. In one embodiment, containers are blow molded in a first hot blow mold, then reblown to a larger size in a second cold mold of larger volume than the first hot mold. Such containers have improved physical properties, particularly very high hoop yield stresses. In a second embodiment, containers are blow molded in a hot blow mold, then reblown to a larger size in a second hot blow mold. Such containers show high resistance to shrinkage and gross deformation in shape upon exposure to high temperatures.

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,108,937 8/1978 Martinen et al. 264/529
4,385,089 5/1983 Bonnebat et al. 264/529

FOREIGN PATENT DOCUMENTS

56-105935 8/1981 Japan 264/530

8 Claims, No Drawings

METHOD FOR PRODUCTION OF POLY(ETHYLENE TEREPHTHALATE) ARTICLES

BACKGROUND OF THE INVENTION

This invention relates to improved methods of making hollow, biaxially oriented, heat-set partially crystalline articles. In another aspect, it relates to biaxially oriented, heat-set hollow poly(ethylene terephthalate) containers having excellent mechanical properties and low permeabilities to carbon dioxide and oxygen gas. The containers according to the present invention exhibit excellent gas barrier properties, that is low gas permeabilities, and significant mechanical property improvement in hoop yield strength, thermal stability and creep-resistant over prior containers.

In order to improve several physical properties of hollow articles such as containers made from poly(ethylene terephthalate), it has been suggested that biaxially oriented poly(ethylene terephthalate) hollow articles, made by orientation blow molding from a preform or parison under conditions to provide biaxial orientation and concomitant crystallization, be further heat-treated at higher temperatures than the orientation blowing temperature to further increase the density by increasing the crystallinity of the hollow article. Such increasing of the density or crystallinity by heating after shaping under orientation conditions is commonly known as heat-setting.

Wyeth et al. in U.S. Pat. No. 3,733,309 suggests such a process. However, the heat-setting process is mentioned only in passing and no specific examples including heat-setting are present in the patent. Of course, the extra step would ordinarily add considerable expense to the bottle making process. Such heat-setting processes typically take many minutes per container and are thus not well-suited to commercial speed container manufacture.

Collins in U.S. Pat. No. 4,039,641 discloses heat-setting containers of an organic crystallizable synthetic thermoplastic polymeric material. Among such materials disclosed are high density polyethylene, polypropylene homopolymers and copolymers and polyesters such as poly(ethylene terephthalate) and poly(butylene terephthalate), including polyesters such as ethylene terephthalate/isophthalate copolymers. In a preferred embodiment, heat-setting is accomplished by blowing the plastic parison in a heated blow-mold, preheated to the heat-setting temperature.

It is stated in the Collins patent that the heat-setting temperature used is that normally encountered in heat-setting of oriented films or fibers made from the given plastic material. It is not stated, however, what heat-setting temperatures are "normal" for making oriented films or fibers from poly(ethylene terephthalate).

It is also disclosed in Collins that after heat-setting, the container should be cooled down to a temperature, for instance, below about 60° C. In one example of Collins, the heat-setting temperature of the mold is 200° C. and in the other, it is 140° C.

In Japanese Patent Application No. 146,175, laid open Nov. 15, 1980, containers are stretch blow-molded under conditions to biaxially orient the polyester molecules. It is explained that as a result of the stretch blow-molding, the residual strain was large and that when heated subsequent to the molding, the residual strain was released, causing deformation of the container. To solve this problem, the reference recommends heat-set-

ting the containers after blow-molding. It is also recommended that the heat-setting temperature in unstretched areas such as the neck be held to 95°-125° C. so that hazing will not occur in these areas. Other areas are heat-set at a higher temperature. It is recommended that the heat-setting of the highly strained areas of the container be in the range from 125° C. to 235° C.

In Japanese Patent Application No. 77,672, laid open June 21, 1979, is similar except that it is not taught to heat-set unoriented parts at a lower temperature than other parts. The highest temperature disclosed for heat-setting is 130° C. and in the only specific example, the oriented blow-molded container is heat-set by contacting with the hot blow-mold kept at 130° C. and then lowering the mold temperature to 100° C. to prevent container deformation when the container is discharged from the mold. In this reference, it is stated that hazing occurs when higher heat-setting mold temperatures are used.

In Japanese Patent Application No. 21,463, laid open Feb. 17, 1979, a blown poly(ethylene terephthalate) container was heat-set by heating the container to 140° C. while still within the blow-mold.

In Japanese Patent Application No. 78,267, laid open June 11, 1978, there is disclosed stretch blow-molding a thermoplastic resin, in the example specifically poly(ethylene terephthalate) to make a hollow article, and while the article is still in the mold to introduce hot gases for the purposes of heat-setting. In the example, the hot gas is at 180° C. The example does not disclose cooling the heat-set article before removal from the mold, but the description of the drawing does describe this as an alternative treatment, using normal temperature compressed gas to cool the molded piece.

In Japanese Patent Application No. 66,968, laid open May 29, 1979, methods of reducing residual strain in biaxially oriented blown containers are disclosed. The methods are applied to unidentified, saturated polyester resins. In all of the methods, the container is heated after being formed by biaxial orientation blow-molding by one method or another. After the heat treatment the container is cooled, but the temperature to which the container is cooled is not disclosed. The heating step apparently includes heating the neck portion of the container, since in one method the heating is by passing steam through channels which include channels next to the neck, and in another method heating is carried out by high temperature pressurization of the interior of the container, which of course includes the neck.

In Japanese Patent Application No. 78,268, laid open June 11, 1978, a stretch blow-molded hollow body, including those made from poly(ethylene terephthalate) is heat-set by introducing hot gas under pressure into the interior of the container while in the mold. After the heat-setting, normal temperature gas can be optionally blown into the article to cool the article before removal from the mold, or the heat-set body can simply be exhausted to atmospheric. In an example, the heated gas for heat-setting is at 200° C. In the specific example, no cooling before removal from the mold was disclosed. Again, the heating includes heating of the neck portion of the bottle.

In Japanese Patent Application No. 41,973, laid open Apr. 3, 1979, it is disclosed to heat-set stretch blow molded containers, including those made from poly(ethylene terephthalate) by heating the blown containers at a high temperature and then rapidly cooling them

to room temperature. Heat treatment can be within the mold while under pressure and the heating can be by means of a hot mold. It is disclosed that the heat treatment should be such that the density of the container following the heat treatment is no greater than 1.40 gms./cc. In the example given, steam at 179° C. is used for heating the mold in the heating step.

U.S. Pat. No. 2,823,421 to Scarlett discloses heat-setting of poly(ethylene terephthalate) films using heat-setting temperatures of 150°–250° C. after orientation stretching. This patent does not state, however, what “normal” polyester film heat-setting temperatures are. It does disclose that for a film stretched three times in each direction that a heat-setting temperature of 200° C. is preferred by Scarlett.

German Patent No. 2,540,930 discloses heat-setting of hollow articles. The blank or parison is blow-molded at 70°–140° C. and then cooled in the mold to below 70° C. Thereafter, the container can be reheated to the heat-setting temperature in the same mold or in a different mold. The heat-setting temperature is said to be 140° C. or higher. In the disclosed process, the entire container including the neck is heated in the heat-setting step to the same temperature and the neck of the container crystallizes to an opaque state.

In the Brady et al. patent, U.S. Pat. No. 4,233,022, a container oriented by blow-molding of polyester at 75°–100° C. is heat-set. Heat-setting is accomplished in a hot mold at a suitable heat-setting temperature; examples of such temperatures are given as 150° to 220° C. The patent features controlling different zones of the container at different temperatures, so that all the side-wall of the container is at the maximum heat-setting temperatures being used, but the finish or neck, for instance, is actually cooled to prevent crystallization thereof. In this patent after the heat-setting step, it is stated that the container is cooled to a self-sustaining condition.

Accordingly, a need exists for a process for the production, at commercially acceptable speeds, of biaxially oriented, heat-set polyester, particularly poly(ethylene terephthalate), containers which exhibit low gas permeability, high mechanical strength including creep-resistance, thermal stability and high hoop yield strengths.

SUMMARY OF THE INVENTION

The present invention relates to a process for forming biaxially oriented heat-set, polyester containers having excellent gas barrier and mechanical properties.

In one embodiment of the invention, a polyester parison is heated to the orientation temperature, expanded by internal pressurization to biaxially orient the parison in a first hot heat-setting blow-mold, which mold has heated walls and thusly the container is heat-set to induce crystallization therein within the first mold. The biaxially oriented heat-set container is then transferred, under reduced but substantial enough internal pressure to prevent shrinkage, to a second cold mold which is larger in volume than the first hot heat-setting mold and is itself not a hot heat-setting mold but rather a cold walled mold wherein the container derived from the first hot heat-setting mold is again expanded under internal pressure to further biaxially orient the previously biaxially oriented, heat-set container without further heat-setting. The container is subsequently removed from the second cold mold and cooled to room temperature in ambient air. Such containers show excellent

barrier properties as well as good thermal stability, creep-resistance and hoop yield strength.

In another embodiment of the invention, a polyester parison is heated to the orientation temperature, inserted in a first hot heat-setting mold and expanded under internal pressure to biaxially orient the parison to produce a fully formed container, which is heat-set to induce crystallization under internal pressure in the hot heat-setting mold. The heat-set container is removed from the first hot heat-setting mold under reduced but substantial enough internal pressure to prevent shrinkage and transferred to a second, larger internal volume hot heat-setting mold which is also heated to provide hot mold walls wherein the fully formed container, derived from the first hot heat-setting mold, is again biaxially stretched by expansion under internal pressure and also heat-set by forcing the container wall against the hot walls of the second hot heat-setting mold. The second mold is larger in internal volume than the first hot heat-setting blow-mold in internal volume. Subsequently, the twice biaxially oriented, twice heat-set container is cooled to room temperature. The container produced by this embodiment of the invention has excellent barrier properties as well as excellent mechanical properties and thermal stability.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the first embodiment of the present invention, a process and resulting container is disclosed for forming biaxially oriented, heat-set, i.e. partially crystalline, polyester containers having excellent gas barrier and mechanical properties. The first embodiment of the invention includes the following steps:

a polyester parison is heated to a temperature in the orientation temperature range;

the parison at orientation temperature is expanded by internal pressurization within a hot heat-setting blow-mold, which mold has heated walls, to biaxially orient and partially crystallize by heat-setting at least the wall portions of the container, formed by expansion of the parison, within the first hot heat-setting mold;

the biaxially oriented, partially crystallized, heat-set container formed in the first heat-setting mold is transferred under reduced yet substantial internal pressurization to a second cold mold, such reduced pressure being substantial enough positive pressure to prevent shrinkage of the container and simultaneously prevent premature ballooning of the hot container walls;

the second cold mold, which is larger than the first hot heat-setting mold is closed about the container derived from the first hot heat-setting mold, and the container is again inflated under internal pressurization to further biaxially orient the previously biaxially oriented, heat-set container. The second cold mold is a relatively colder mold than the first hot heat-setting mold and maintained at a lower temperature so as to prevent any significant additional heat-setting from taking place in the second cold mold; and

subsequent to the second blow molding step in the second, cold mold, the larger finished container, formed in the second cold mold, is removed from the cold mold and allowed to further cool to room temperature for filling or storage.

Such containers formed by the first embodiment of the invention disclosed above show excellent gas barrier properties with respect to the retention of carbon dioxide and the exclusion of oxygen from the internal

spaces of the package. Also, containers so prepared show very high hoop yield stresses and thus superior resistance to sidewall deformation when used to package pressurized fluids. The characteristic of barrier properties are particularly important for oxygen sensitive foods and wines while high hoop yield stresses are needed for pressurized contents like soda and beer. Such containers also show excellent mechanical properties.

While the first embodiment of the invention disclosed immediately above is disclosed as relating to polyester parisons and the containers formed therefrom, the preferred embodiment of the invention relates to poly(ethylene terephthalate). Particularly preferred are poly(ethylene terephthalate) polymers having an inherent viscosity of at least 0.6 wherein the polymer contains at least 97% repeating units of ethylene terephthalate with the remainder being minor amounts of ester-forming components. Also useful are copolymers of ethylene terephthalate with up to about 10 mole percent of the copolymer being prepared from the monomer unit selected from butane-1,4-diol; diethylene glycol; propane-1,3-diol, poly(tetramethylene glycol); poly(ethylene glycol); poly(propylene glycol); 1,4-hydroxymethylcyclohexane and the like, substituted for the glycol moiety in the preparation of the copolymer, or isophthalic; naphthalene 1,4- or 2,6-dicarboxylic; adipic; sebacic; decane-1,10-dicarboxylic acids, and the like, substituted for the acid moiety (terephthalic acid) in the preparation of the copolymer.

Of course, the poly(ethylene terephthalate) polymer can include various additives that do not adversely affect the polymer or the processing according to the invention. For instance, some such additives are stabilizers, e.g., antioxidants or ultraviolet light screening agents, extrusion aids, additives designed to make the polymer more degradable, antistatic agents and dyes or pigments. Moreover, conventional cross-linking or branching agents can be included in small amounts in order to increase the melt strength of the preferred poly(ethylene terephthalate).

The invention is preferably practiced with conventional injection molded polyester parisons. Such parisons are generally elongate tubes of cylindrical cross-section which have an open upper threaded finish which accepts a closure; a cylindrical elongate main body portion; and a closed hemispherical bottom portion. The parison when expanded results in a narrow neck container having a generally cylindrical main body portion and a closed hemispherical bottom portion. Such parisons and final container shapes are preferred but other geometrical configurations may be selected within the scope of the present invention.

In the preferred mode of practicing the first embodiment of the present invention, the first hot heat-setting mold is maintained at a temperature of between 100°-250° C., which is a temperature sufficient to induce substantial crystallization in the formed container as it is being heat-set within the mold after biaxial stretching upon inflation. The time of residence of the biaxially oriented container, once its walls are in contact with the mold, is less than five minutes. It has been discovered according to the present process that time periods of from one to ten seconds are sufficient to induce substantial crystallization when coupled with the second expansion and concomitant biaxial orientation in a second, larger, cold mold to produce the superior containers according to the present process. In the

preferred embodiment, the mold volume of the first hot heat-setting mold is 70% of the volume of the second cold mold, i.e. the second mold is preferably about 1.4 times larger in total internal volume than the first mold.

The hot heat-setting mold equipment, parison handling, container transfer and cold mold equipment are all of conventional design and are not part of the invention.

Preferably, the parisons are injection molded and are preheated to the orientation range by conventional parison preheaters available in the market place.

Typically, a transfer time between the two molds is between three and fifteen seconds. Similarly, the reduced pressure needed for such transfer operation is between 20 and 24 psi.

As indicated above, the second cold mold has a volume about 1.4 times the volume of the first hot heat-setting mold in the preferred embodiment. However, generally speaking, according to the present process, the mold need only be slightly larger than the first hot heat-setting mold to achieve advantageous features of the present invention over conventional containers. However, as indicated above, preferably the first hot heat-setting mold is about 70% of the internal volume of the second cold mold and of the same general internal shape.

The second cold mold is typically operated at less than 100° C. so no significant additional heat-setting occurs and most preferably, according to the present invention, at a temperature of less than 25° C. for such reasons.

This first embodiment of the present invention is particularly advantageous for the production of small poly(ethylene terephthalate) containers. It is particularly well-suited for producing containers on the order of one half-liter in container internal volume, for use in high carbonation beverages like soft drinks and beer. The containers, according to the first embodiment of the present invention, are also particularly advantageous for the packaging of gas-sensitive contents like wine, cosmetics and foodstuffs, wherein a high gas barrier for the retention of internal packaging gases and the exclusion of external oxygen is necessary.

In the second embodiment of the present invention, a process and resulting container is disclosed for forming biaxially oriented, heat-set, i.e. partially crystalline, polyester containers having improved properties. The second embodiment of the invention includes the following steps:

heating a polyester parison to the orientation temperature range;

insertion of the hot parison into a first hot heat-setting mold and enclosing the mold thereupon;

expansion of the preheated parison enclosed in the first hot heat-setting mold by internal pressurization to biaxially orient the parison by inflation to produce a fully formed container which is heat-set by the internal pressurization of the parison forcing the walls of the container into close contact with the hot heat-setting mold walls;

the thusly heat-set container is subsequently removed under reduced yet substantial enough internal pressurization to prevent shrinkage, from the first hot heat-setting mold and transferred under such pressure to a second, larger hot heat-setting mold;

the formed container derived from the first hot heat-setting mold is again inflated to induce biaxial orientation while enclosed within the larger second hot heat-

setting mold and maintained in close contact with the hot walls of the second larger hot heat-setting mold, by the internal pressurization, to again heat-set the container in the second hot heat-setting mold; and

subsequently, the twice biaxially oriented, twice heat-set container is cooled to room temperature by removing the doubly oriented, doubly heat-set container from the second larger hot heat-setting mold under significant positive pressure and allowing the container to cool (a) externally, or (b) immediately transferring the doubly biaxially oriented, doubly heat-set container to a third cold mold which has approximately the same volume as the second hot heat-setting mold wherein it is cooled by contact with cold mold walls to a temperature of less than 100° C. and preferably a temperature of 25° or less, or in a third embodiment, (c) the doubly oriented, doubly heat-set container may be cooled in the second hot heat-setting mold itself by cooling the mold with a conventional heat transfer mechanism, for example, internal channeling for the passage of cold fluids through the mold.

In the preferred embodiment of practicing the second embodiment of the invention, the temperature of the first hot heat-setting mold is between 100°–250° C. and the residence time of the blown biaxially oriented container in the first mold is less than five minutes, preferably

stantially less than 10 minutes and of the preferred process between one and five seconds.

The second embodiment of the invention is the most preferred process for forming highly thermally stable mechanically superior partially crystalline containers for pasturized foods like beer and foodstuffs. The first embodiment of the process is most preferred for forming containers which have high barrier properties, good mechanical properties and particularly high hoop yield stresses. The first embodiment is also particularly useful for containers for carbonated beverage packaging and oxygen sensitive food and cosmetics packaging.

All documents referred to herein are incorporated by reference.

The following Tables illustrate the superior properties of the containers formed according to the present invention as compared to conventional containers fabricated from PET, wherein PET represents poly(ethylene terephthalate) and where the containers are conventionally shaped narrow neck, cylindrical sidewalled containers having hemispherical bottoms.

Table I illustrates the improved characteristics of containers formed according to the first embodiment of the invention utilizing a first hot mold to induce heat-setting and a second larger internal volume cold mold to prevent additional heat-setting.

TABLE I

Physical Property ↓	Container Type →	Unheat-set biaxially oriented container of PET at Full size		Biaxially oriented singly heat-set container of PET at Full size		Biaxially oriented singly heat-set container of PET at 0.7× Full size		Biaxially oriented singly heat-set hot mold, biaxially oriented, cold mold at Full size	
		Axial	Hoop	Axial	Hoop	Axial	Hoop	Axial	Hoop
Modulus (psi × 10 ³)	Avg.	404	955	443	799	513	790	482	978
	std. dev.	9	65	20	47	27	93	17	65
Yield Stress (psi × 10 ³)	Avg.	12.7	33.5	14.1	31.5	16.4	22.3	13.8	40.8
	std. dev.	0.5	2.8	0.5	1.7	0.8	1.6	0.2	1.7
Yield Strain (percent)	Avg.	6.3	5.6	5.9	6.0	6.3	6.0	6.1	6.0
	std. dev.	0.4	0.4	0.2	—	0.1	—	0.2	—
Ultimate Strength (psi × 10 ³)	Avg.	16.3	35.0	11.5	44.8	14.4	37.6	14.4	46.1
	std. dev.	1.0	1.7	0.2	1.7	1.1	1.6	0.8	2.8
Ultimate Elongation	Avg.	78	10	42	17	46	22	38	13
	std. dev.	8	1	9	4	8	2	10	1
Density									
Position 1		1.3599		1.3920		1.3950		1.3894	
Position 2		1.3590		1.3960		1.3970		1.3931	

bly 1–10 seconds. The volume of the first hot heat-setting mold is approximately, in the most preferred embodiment, 70% of the volume of the second hot heat-setting mold such that the second hot heat-setting mold is approximately 1.4 times larger in total internal volume than the first hot heat-setting mold.

The formed container which is removed from the first hot heat-setting mold and transferred under significant positive pressure to the second larger hot heat-setting mold is most preferably transferred at between 20–24 psi pressure as set forth in the first embodiment of the invention.

The second larger internal volume hot heat-setting mold is, as disclosed above, in the most preferred embodiment about 1.4 times larger in total internal volume than the first hot heat-setting mold. While this is the most preferable volume ratio for the two hot heat-setting molds, a lesser volume differential may be used if desired and still achieve advantages relative to conventional containers. Typically, the second hot heat-setting mold is run at the same temperature as the first, i.e., 100°–250° C. The time of residence of the container in the second hot heat-setting mold after expansion is sub-

As defined in Table I, position 1 is a sample of material taken from a position four inches from the top of the container while position two samples are taken from a position six inches from the top of the container.

The data illustrated in Table I was generated using PET parisons of 22 gram weight suited for forming one-half liter internal volume containers.

The half-liter beverage parison used has an overall length of 3.970 inches. The outer diameter of the body portion of the parison just below the finish region is 0.760 inch. There is a 0° 28 minute inward taper along the parison length resulting in a 0.728 inch outer diameter at the hemi-bottom end of the parison. The wall thickness is maintained at 0.134 inch throughout the body of the parison. The inside diameters in this regions are 0.626 inch at the finish end and 0.594 inch at the bottom end. The finish is a conventional beverage container finish. Three types of containers were prepared from parisons identical to the PET parisons used with the inventive process for comparison with the improved containers according to the first embodiment of the invention, they are:

(1) A conventional blow molded PET container formed by blow molding the parison at orientation temperature in a cold mold at a final size of one-half liter so as to induce biaxial orientation;

(2) A container blow molded as above under conditions to biaxially orient the containers and simultaneously heat-set by contacting the container walls with a hot mold to induce heat-setting and concomitant increase in crystallinity and density, the size of the final containers being one-half liter;

(3) A container blow molded as above under conditions to biaxially orient the containers and simultaneously heat-set by contacting the container walls with a hot mold to induce heat-setting and thus partial crystallization except that the mold volume is 0.7 of the size of a one-half liter mold used for the containers of (1), (2) and (4) below; and

(4) A container of full one-half liter size manufactured as defined above according to the first embodiment of the invention and particularly with the first hot mold temperature at 230° C., time of residence after expansion in the first hot mold 1.3 seconds, transfer time between molds 8 seconds, transfer pressure in container of 22 psi, temperature of second cold mold at 25° C. and time of residence in second mold after completion of expansion at 1.3 seconds.

For containers (2) and (3), the heat-setting temperature was 225° C., the crystallization time after completion of inflation is 1.3 seconds.

As Table I clearly illustrates that containers fabricated according to the first embodiment of the invention are superior in overall mechanical properties and accordingly barrier properties to the other containers of the test.

Of particular importance is the recognition that the containers of this invention show an average hoop yield stress significantly higher than any of the other conventionally formed containers. As pointed out above, hoop yield stress is a critical property as it relates to the ability of small containers to hold highly pressurized food products, like carbonated soft drinks.

Note also that containers according to the present invention are also significantly higher in ultimate strengths than are either the unheat-set biaxially oriented containers at full size or the biaxially oriented singly head-set containers of 0.7 full size.

With respect to the physical properties described in Table I, such properties are defined herein as follows.

Modulus is the measure of the stiffness of the containers, as defined by ASTM standard D-638.

Yield stress is defined as the resistance to creep under heat and/or pressure of a container wall portion, as defined by ASTM standard D-638.

Yield strain is defined as the percent of elongation to which a section of containers may be subjected and then not return 100% to its original dimensions by elastic recovery, as defined by ASTM standard D-638.

Ultimate strength is a measure of the internal pressurization which a container can tolerate prior to irrevocable rupture, as defined in ASTM standard D-638.

Ultimate elongation is a measure of impact strength of the material, as defined in ASTM standard D-638.

To further define the manufacture condition of the containers represented in Table I, the extension ratios for the parisons blown in the 0.7×half-liter size mold were an average hoop extension of 3.99X and an average axial extension of 2.36X. For the overall extension of the parison from the preblown parison shape to the final shape when blown into a one-half liter mold the average hoop extension ratio was 4.69X and the average axial extension was 2.43X.

For the container according to the first embodiment of the invention which are twice expanded, i.e., once in the first hot mold and a second time in the cold mold, the cylindrical sidewall portion has a volume expansion of 1.37X; a hoop extension of 1.17X and an axial extension of 1.0X. The hemispherical bottom portion has a volume expansion of 1.53X; a hoop extension of 1.15X and an axial extension of 1.15X. The overall extension is a volume extension of 1.43X; a hoop extension of 1.17X and an axial extension of 1.02X.

Table II illustrates the improved resistance to shrinkage and to gross deformations in shape upon exposure to elevated temperature of containers prepared according to the second embodiment of the invention. In hot filled foods, like catsup or soy sauce, and pasteurized foods, like beer, it is critical that plastic containers not only have good barrier properties and mechanical strength but also resist shrinkage and gross deformation upon exposure to elevated hot filling and pasturization temperatures.

Table II compares unheat-set biaxially oriented containers blown against cold mold walls in a full size one-half liter mold and biaxially oriented heat-set in a hot mold of full one-half liter size with containers prepared by both the first and second embodiments of the present invention.

TABLE II

Physical Property ↓	Container Type →	Unheat-set biaxially oriented container of PET	Biaxially oriented, singly heat-set container of PET	Biaxially oriented, heat-set hot mold, biaxially oriented, cold mold	Biaxially oriented heat-set hot mold, biaxially oriented heat-set hot mold
Volume Reduction after Exposure for 5 minutes at 90° C. (percent change)		16.4	1.4	8.9	0.9
Gross Deformation in Shape Production Conditions		yes	no	no	no
Temperature Mold One (°C.)		25	230	230	230
Time in Mold One (second)		1.3	1.3	1.3	1.3
Temperature Mold Two (°C.)		—	—	25	240
Time in Mold Two (seconds)		—	—	1.3	3-4

As illustrated by the data, containers prepared by the dual hot mold, a second embodiment of the invention are superior to all other tested containers in both (1) resistance to shrinkage (shrinkage less than one percent) and (2) showing no gross deformation.

Additionally, the biaxially oriented, heat-set hot mold and subsequently biaxially oriented and heat-set again in hot mold containers described also have superior mechanical properties. The containers show a yield stress of 16,900 psi $\pm$ 500 psi axial and of 36,000 psi $\pm$ 1,800 psi hoop. Thus, the containers of the second embodiment show superior yield stress number than even singly heat-set containers. This is highly unexpected since it is generally known in films that any heat-setting step will lower the yield stress of the film article. I have discovered that not only do properties related to shrinkage improve with double heat-setting in a larger mold but so does the important mechanical property of yield stress.

Conventionally prepared biaxially oriented unheat-set containers show large shrinkage as well as gross structural deformation. Containers prepared by the first, i.e., hot mold, cold mold, embodiment of the invention, show good resistance to gross deformation but shrink in overall dimension to a large extent. Biaxially oriented containers which are singly heat-set show resistance to deformation but still are substantially more prone to shrinkage than are the containers of the second embodiment of the invention.

Accordingly, containers according to the first embodiment of the invention are excellent for the retention of pressurized food products due to good barrier properties and high mechanical properties particularly high hoop yield stress. Containers according to the second embodiment are also excellent in respect of barrier properties and mechanical properties but also show excellent resistance to shrinkage and gross deformation at elevated food packaging and processing temperatures.

Accordingly, what is claimed is:

1. A process for fabricating a partially crystalline, biaxially oriented hollow plastic container article comprising:

- (1) enclosing a plastic parison which is at a temperature within its molecular orientation temperature range within a first blow which first blow mold is at a temperature sufficient to induce crystallization into said plastic upon contact of said plastic with said blow mold;
- (2) expanding said plastic parison within said first blow mold by internal pressurization while still within the molecular orientation temperature range to induce biaxially orienting in said plastic and force said plastic parison into intimate contact and conformance with said first blow mold to form a biaxially oriented container and by such internal pressurization maintaining contact between said first mold and said biaxially oriented container for a time sufficient to induce partial crystallization into said biaxially oriented container;
- (3) transferring said partially crystallized, biaxially oriented container from said first blow mold to a second blow mold, said transfer occurring with sufficient internal pressurization of said partially crystallized biaxially oriented container to prevent significant shrinkage during said transfer;
- (4) enclosing said partially crystalline biaxially oriented container in said second blow mold, which said second blow mold is (a) at a temperature

which is not sufficient to induce significant crystallization in said plastic of said container and (b) which is larger in internal volume than said first blow mold;

- (5) expanding by internal pressurization said partially crystalline biaxially oriented container within said second blow mold into intimate contact and conformance with said second blow mold to form a larger container and again biaxially orient the material of said partially crystallized biaxially oriented container derived from said first blow mold; and
 - (6) subsequently removing the resultant container from said second blow mold and reducing the internal pressure to ambient pressure.
2. The process defined in claim 1 wherein said plastic is poly(ethylene terephthalate) and said first blow mold is at a temperature between 100° C. and 250° C. and said second blow mold is at a temperature of about 100° C. or less.
3. The process defined in claim 1 wherein said plastic is maintained in contact with said first blow mold for a time between 1 second and 5 minutes.
4. The process defined in claim 1 wherein the internal volume of said first blow mold is about 0.7 times the internal volume of said second blow mold.
5. A process for fabricating a partially crystalline, biaxially oriented hollow plastic container article comprising:
- (1) enclosing a plastic parison which is at a temperature within the molecular orientation temperature range in a first blow mold, which first blow mold is at a temperature sufficient to induce crystallization into said plastic upon contact of said plastic with said blow mold;
 - (2) expanding by internal pressurization said plastic parison within said first blow mold while still within the molecular orientation temperature range to induce biaxial orientation into said plastic and force said plastic parison into intimate contact and conformance with said first blow mold to form a biaxially oriented container and by such internal pressurization, maintaining contact between said biaxially oriented container and said first blow mold for a time sufficient to induce partial crystallization into said biaxially oriented container;
 - (3) transferring said partially crystallized, biaxially oriented container from said first blow mold to a second blow mold, said transfer occurring with sufficient internal pressurization of said partially crystallized biaxially oriented container to prevent significant shrinkage during said transfer;
 - (4) enclosing said partially crystallized biaxially oriented container in said second blow mold, which second blow mold is (a) at a temperature sufficient to induce additional crystallization into said partially crystalline biaxially oriented container upon contact with said second blow mold and (b) which is larger in internal volume than said first blow mold;
 - (5) expanding by internal pressurization said biaxially oriented partially crystallized container within said second blow mold into intimate contact and conformance with said second blow mold to form a larger container and to again biaxially orient and partially crystallize the biaxially oriented and partially crystallized container derived from said first blow mold; and

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(6) subsequently removing the resulting container from said second blow mold and reducing the pressure to ambient pressure.

6. The process defined in claim 1 wherein said plastic is poly(ethylene terephthalate) and said first and second blow molds are each at a temperature between 100° C. and 250° C.

7. The process defined in claim 1 wherein said plastic

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is maintained in contact with said first and second blow molds for a time between 1 second and 5 minutes.

8. The process defined in claim 1 wherein said first blow mold is about 0.7 times the internal volume of said second blow mold.

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APPENDIX F



US008468785B2

(12) **United States Patent**
Thomasset

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(54) **CONTAINER FOR HOT-FILLING**

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See application file for complete search history.

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(57) **ABSTRACT**

The invention relates to a process for manufacturing and hot-filling a PET container comprising the following steps:

- providing a PET preform capable of being blow molded;
- blow molding the preform in the cavity of a mold so as to form a container;
- removing the container from the mold cavity;
- filling the container with a liquid, the temperature of which is above 80° C.;
- sealing the container in a leaktight fashion;
- sterilizing and cooling the container; and
- shrinking the container,

characterized in that:

- in step a) a PET preform composed of a copolymer based on terephthalic acid is used;
- in step a), at least one part of the preform is at a temperature greater than or equal to 110° C.;
- the temperature of the mold used in step b) is less than or equal to 65° C.; and
- during step g) the container is heated for a duration between 1 and 5 seconds at a temperature between 600 and 1000° C. in at least one part of the container so as to create a shrinkage and a reduction in the volume of the container.

The invention also relates to a container obtained using the process described above.

3 Claims, No Drawings

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CONTAINER FOR HOT-FILLING

This application is the U.S. national phase of International Application No. PCT/IB2008/054797 filed 17 Nov. 2008, which designated the U.S. and claims priority to EP Application No. 07121609.7 filed 27 Nov. 2007, the entire contents of each of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to a hot-filled polyethylene terephthalate (PET) container, and also to the process for filling said container. The process applies, in particular, to the packaging of a product at above 80° C. in a PET bottle that has not been manufactured with blow-molding processes that are referred to as "Heat Resistant" and that are more commonly denoted by the letters HR.

PRIOR ART

Polyethylene terephthalate (PET) bottles are used in many fields owing to their excellent properties of resistance, lightness, transparency and organolepticity. These bottles are manufactured at a high production rate by biaxially stretching a preform in a mold.

In the present text, the expression "hot-filling" should be understood to mean a filling where the temperature of the liquid is above ambient temperature, in general above 80° C.

The expression "cold-filling" is understood to mean ambient temperature or a temperature below ambient temperature.

The manufacture of PET bottles for cold-filled bottles resorts to the process of blow molding a preform in the cavity of a mold. The preform manufactured by injection molding resembles a tube, one end of which is plugged and the other end of which forms a neck. After heating this preform via infrared radiation up to 95/120° C., the amorphous PET is softened and undergoes a deformation by blow molding in the cavity of a mold. During the blow-molding phase, the preform is deformed biaxially due to the combined action of a stretching rod and due to the air introduced under pressure into the preform and that causes inflation. The molds are water-cooled in order to dissipate the heat of the PET by contact, which has the effect of setting the geometry of the bottle. The bottles obtained are said to be biaxially oriented since during their manufacture they have undergone biaxial stretching. The macromolecular chains thus oriented lead to excellent mechanical and optical properties at ambient temperature. The drawback of this biaxial orientation results from its reversible nature and the material seeks to return to its initial state as soon as the temperature increases; a phenomenon known as shape memory.

Thus, although these bottles offer many advantages, they have the drawback of deforming when their temperature is above 60° C. Filling these bottles with a product at a high temperature 85/95° C. causes such deformations that said bottles become unfit for use. Several processes for remedying the aforementioned drawback and allowing PET bottles to be hot-filled have been described in the prior art.

The most common solution for allowing a PET bottle to be filled with a hot liquid consists in jointly using a process known as a "Heat Resistant" bottle blow-molding process, and also a specific bottle design.

The processes known as "Heat Resistant" processes, and more commonly denoted by the letters HR, make it possible to improve the heat resistance of the bottles. Thus, there is a first HR process, referred to as a one-part process, which allows filling temperatures of 80 to 88° C. to be achieved. A

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second HR process, referred to as a two-part process, allows liquids to be packaged at temperatures of 88 to 95° C.

In the same way as HR bottle manufacturing processes, it is necessary to resort to different bottle designs. During packaging, the bottles must withstand the vacuum generated by the cooling of the liquid when said bottle has been stoppered at high temperature. The cooling causes a double contraction, that of the liquid and that of the air trapped in the bottle. Thus, hot-filled bottles comprise compensating panels that make it possible to absorb the variation in volume, and more rigid parts that prevent an uncontrolled deformation of the bottle. These designs require greater wall thicknesses and result in bottles for which the weight may range up to two times the weight of a cold-filled bottle.

The HR processes used to make bottles that are designed to be hot-filled also resort to the blow molding of a preform in the cavity of a mold, but with more sophisticated and more complex operating parameters. Specifically, the preform is heated at a higher temperature than in the case of blow molding a cold-filled container. The high blow-molding temperature makes it possible to minimize the shape memory of the PET and to relax some of the stresses due to the blow molding. In the case of the one-part HR process, the bottle is subjected to a heat treatment when it comes into contact with the walls of the mold. The high temperature of the walls of the mold has the effect of increasing the crystallization of the biaxially oriented PET chains and thus improving its temperature resistance. A circulation of air inside the bottle makes it possible to discharge the heat from the PET and thus solidify the walls of the bottle before the removal of the mold. In the case of the two-part HR process, the process makes it possible to attain a higher heat resistance but at the cost of a succession of more complex steps. Specifically, the first step consists in blow molding a preform, the volume of which is much greater than that of the bottle; this preform, having a high degree of crystallization, is then shrunk by heating beyond the glass transition; the shrunken preform is finally blow molded in the cavity of a mold corresponding to the dimensions of the bottle to be manufactured. The bottle has a high degree of crystallization, which allows filling at temperatures between 88 and 95° C.

However, the bottles that have undergone a heat treatment in order to allow the packaging of a liquid at high temperature have several drawbacks.

A first drawback is linked to the reduction in the bottle production rate because the heat-setting process slows down the blow-molding cycle. The HR processes are more complex than the conventional blow-molding process and consequently more costly to set up and to use.

A second drawback is linked to the weight and consequently to the cost of these bottles. As has been explained previously, the addition of material makes it possible to withstand the vacuum that is created in the container and the high filling temperature. However, the current solution uses an excess of material, which is not strictly necessary for good preservation of the product. Furthermore, the compensating panels detract from the appearance of the container, making it less attractive to the consumer.

Patent Application FR2887238 proposes to partly overcome the aforementioned drawbacks by producing thin-walled bottles suitable for hot-filling. These bottles are manufactured using a one- or two-part HR blow-molding process as explained previously and consequently have properties that allow hot-filling without shrinkage of the container. The bottles proposed in Application FR2887238 have many advantages since they do not comprise shrinkage panels, and have a reduced weight compared to the containers used by a

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person skilled in the art, this weight being substantially equivalent to that of the containers used to hold mineral water, at equal capacity. The container is of cylindrical shape, optionally with grooves to stiffen the body, with a light base like that of the containers for still mineral water, but reinforced. This container is hot-filled on a filler of known type, the liquid being brought to and maintained at a temperature of 60 to 95° C. depending on the targeted applications. After stoppering at high temperature and cooling, a vacuum is created in the bottle, which creates a significant deformation of the body of the bottle. The process, according to Application FR2887238, consists in reducing the volume of the bottle by causing a heat shrinkage of the walls of the bottle when the temperature of the liquid is below a transition of around 40 to 50° C. Despite the many advantages that it provides, Patent Application FR2887238 has several drawbacks.

A first drawback is linked to the method of manufacturing these bottles which requires a one- or two-part HR blow-molding process in order to render the container sufficiently temperature resistant. As has been explained previously, these manufacturing processes are complex and consequently more difficult to exploit. This has a repercussion on the cost of the containers produced.

The second drawback of the process proposed lies in the difficulty in shrinking the volume of the container by heating, bearing in mind that said container was manufactured by using a HR blow-molding process that makes it more temperature resistant.

General Presentation of the Invention

The invention proposes to overcome the aforementioned drawbacks by means of a novel container manufactured and hot-filled according to a novel process.

According to the invention, the PET container for hot-filling is manufactured using a conventional blow-molding process, that is to say a process commonly used for producing cold-filled containers. According to the invention, the container is blow molded in a "cold" mold, unlike the "Heat Resistant" or "HR" blow-molding processes that consist in blow molding the container in a mold at high temperature.

The filling process comprises an additional step compared to the hot-filling commonly used. This step consists in shrinking the walls of the container using a high-intensity heat source.

The container is differentiated from hot-filled containers by its geometry without compensating panels, by its base of petaloid or star type, by its low weight, by its low average density and by the spatial distribution of its density.

The invention makes it possible, in particular, to manufacture a low-weight container, the hot-fillability of which is not provided by a HR blow-molding process but by the unexpected combination of several factors including the geometry of the container, the composition of the container and the manufacturing and filling process.

The weight of the container according to the invention is substantially equivalent to that of a container, e.g. a bottle, intended to contain a cold-filled liquid.

It should be noted, furthermore, that the container according to the invention is designed to withstand the pressure and not the vacuum as is proposed in the prior art. Advantageously, the base of the container is designed to withstand a positive pressure in the container.

The invention also comprises a process of hot-filling a container, such as a PET bottle, which has not been manufactured using a HR process and of which the hot-fillability results from the combination of the design of the bottle and its method of manufacture. The filling process additionally com-

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prises a step of shrinkage of the container, under the effect of an intense heat source, when the hot-filled liquid is completely or partly cooled.

DETAILED PRESENTATION OF THE INVENTION

The invention will be better understood below by means of an example that describes the manufacture of a hot-filled PET bottle which is manufactured from a preform according to a conventional blow-molding process that is not a HR process. The bottle has a high temperature resistance due to an unexpected synergy between the geometry of the bottle, the manufacturing and filling process and the resin used.

Unlike the solutions of the prior art which propose to increase the crystallinity of PET containers in order to improve their temperature resistance, the invention proposes the use of a container for which the lower degree of crystallization alone does not enable it to withstand the filling temperature. The heat resistance of the container results from the combined action of the degree of crystallization, of the geometry of the container and of the blow-molding and filling process. The invention is of great interest since it makes it possible to avoid the one- or two-part HR manufacturing processes used to increase the degree of crystallization of the container. These processes comprise complex steps that slow down the rate of production and that have a great impact on the cost of the containers produced.

As indicated above, the detailed example of the invention describes PET bottles, but it goes without saying that the invention is not limited to this type of object. Other types of containers, e.g. made of PET or similar resins, also form the subject of the invention. The bottle comprises a neck, a generally cylindrical body and a base. The weight of the bottle is similar to that of a bottle for mineral water or a carbonated drink, at equivalent capacity.

The neck is of reduced thickness compared to the necks of bottles manufactured using a HR process. For example, the neck of a bottle for a carbonated drink is particularly suitable.

The body of the bottle is generally of cylindrical shape, of small thickness and may comprise ribs that provide the rigidity. The bottle does not comprise the characteristic elements of hot-filled PET bottles, such as panels, band, bulb at the shoulder. According to one preferred embodiment of the invention, the cylindrical body comprises, however, a contracting zone intended to eliminate the vacuum in the bottle after partial or complete cooling of the liquid. The contracting zone is preferably localized. The filling process comprises a step of intense heating of said contracting zone, which has the effect of eliminating the vacuum in the bottle. Under the effect of the heat, the contracting zone shrinks and creates a reduction in the volume of the bottle.

Advantageously, the bottle comprises a base endowed with specific characteristics. Unlike what is proposed in the prior art, only the bases having a high pressure resistance may be used. Surprisingly, the bases of petaloid type used for the containers of carbonated drinks are barely deformed under the effect of the temperature. The bases of star type that are sufficiently pressure resistant may also be suitable.

The bottles are manufactured using a conventional blow-molding process without a post-stretching crystallization step in the cavity of the mold. A specific control of the blow-molding process is however necessary in order to obtain a bottle that is not deformed under the effect of the filling temperature.

This process comprises a first step that consists in heating a preform to the maximum permissible temperature, close to

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the crystallization. Advantageously, the preform is heated at a temperature above 110° C. The PET grades known to a person skilled in the art for producing bottles known as "heat set" bottles are used. These grades are generally high molecular weight products or copolymers of PET. The PET copolymers obtained from terephthalic and isophthalic acids are particularly suitable.

The preform is stretched and blow molded in the cavity of a mold of suitable geometry, the walls of which are cooled in order to dissipate the heat transmitted by contact, which has the effect of setting the walls of the bottle. Unlike the HR process where the mold is heated at a temperature generally between 115 and 140° C. in order to increase the crystallinity of the side walls of the bottle, the invention makes it possible to use the conventional blow-molding process that consists in using molds that are cooled or at the very most tempered at a temperature below the glass transition temperature of PET (around 65° C.). The part of the mold that forms the base of the bottle is advantageously cooled at a temperature below 20° C.

Astonishingly, it has been found that the colder the part of the mold that forms the base, the lower the deformation of the base of the bottle under the effect of the temperature. This surprising result goes against the current process which consists in increasing the temperature of the mold in order to increase the crystallization and relax the stresses of the polymer chains.

The bottles are produced at a high production rate in a similar manner to the bottles intended to contain mineral water or carbonated drinks.

Multilayer PET bottles manufactured and filled according to the process described in the invention are advantageously used to contain oxygen-sensitive and hot-filled products such as fruit juice. The bottles are manufactured from a multilayer preform blown in a mold, the temperature of which is below 65° C. The geometry of the bottle is similar to that of a single-layer bottle described in the invention. The bottle does not comprise the characteristic elements of hot-filled PET bottles, such as panels, band, bulb at the shoulder. According to one preferred embodiment of the invention, the cylindrical body comprises, however, a contracting zone intended to eliminate the vacuum in the bottle after partial or complete cooling of the liquid.

The hot-filling of single-layer or multilayer bottles may be carried out rapidly after blow molding the bottles, or after a variable period of time. An immediate filling is advantageous since the dry bottles have a better thermal stability. However, for logistical reasons, the bottles are generally filled after a relatively long storage time during which an equilibrium is produced between the moisture in the air and that in the walls of the bottle. This uptake of water slightly reduces the heat resistance of the bottle.

The filling of the bottle is differentiated from hot-fillings by the step of shrinking the contracting zone, a step that makes it possible to eliminate the vacuum created in the bottle after cooling.

The filling is generally carried out by gravity, the hot liquid flowing directly into the container. Depending on the products, the filling temperature is between 80 and 95° C.

When the hot liquid flows into the bottle, the wall of the container is rapidly heated without however deformations of the bottle being able to be observed. The container is then hermetically sealed using a stopper. The increase in the temperature of the air trapped in the head space has the effect of creating a slight pressure in the bottle after sealing.

Since the base has been designed to withstand the pressure, it does not deform despite the high temperature of the liquid

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in the bottle. The walls of the container are sterilized via the temperature of the product for a duration of around 3 minutes. The sterilization operation comprises an upturning of the bottle to ensure the sterilization of the inside face of the stopper and of the neck.

Next, the bottle is cooled rapidly by spraying cold water onto its outer wall. On cooling, the liquid and the head space contained in the container contract, creating a vacuum in the bottle. Under the effect of the negative pressure, the side walls of the bottle of thin thickness deform by "collapsing". It is advantageous to provide, in the design of the bottle, flexible zones that deform by collapsing under the effect of the negative pressure, and more rigid zones that do not deform. The deformation of the bottle is thus localized in one defined zone. It has been found that the flexible zone advantageously forms a cylindrical geometry of oval or circular cross section.

When the temperature of the liquid contained in the bottle has reached a temperature below 50° C., the bottle is heated at a high temperature at the contracting zone. The heating of the contracting zone has the effect of reducing the volume of the bottle by shrinking the contracting zone. The reduction in volume of the bottle created by the shrinkage compensates for the variation in volume of the liquid and cancels the vacuum inside the container.

Unlike what is proposed in the prior art, this heating is difficult to carry out by radiation since the supply of energy is not rapid enough to prevent a significant reheating of the liquid.

The shrinkage step requires an intense energy supply over a very brief duration. It has been found that the bottle could be heated by flame treatment, which causes a rapid and reproducible shrinkage of the contracting zone. As the wall of the bottle is in contact with a cold liquid on its inner face, the outer face may be brought into direct contact with a very high temperature flame for a very short time. Heating by hot air may also be used.

Compared to what is proposed in the prior art, it has been found that the bottle must be heated symmetrically, otherwise the bottle loses its verticality and the final geometry is not reproducible. Preferably, during the shrinkage step, the bottle is rotated in front of two heat sources that are positioned symmetrically with respect to the axis of rotation. Advantageously, the distance between the wall of the bottle and the heat source is constant.

Before the shrinkage step, the geometry of the contracting zone advantageously forms a homogeneous convex surface around the circumference of the bottle. The convex surface has several advantages with respect to a cylindrical, conical or concave surface. It has been found that the shrinkage of a convex surface stabilizes the shrinkage process and enables a high reproducibility of the final geometry of the bottle. When the contracting zone is not convex, great variations in the perpendicularity between the axis of the neck and the base of the bottle are sometimes observed.

The invention proposes the use of a container for which the lower degree of crystallization alone does not enable it to withstand the filling temperature. The heat resistance of the container results from the combined action of the degree of crystallization, of the geometry of the container and of the blow-molding and filling process. The bottle comprises a contracting zone having a degree of crystallization 2% greater than any other part of the bottle except for the neck when the latter is crystallized. The bottle therefore has a denser or more crystalline zone in the contracting zone. This zone is generally spread over the circumference of the bottle, thus forming a ring of higher density in the side wall of the bottle.

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The invention was described previously for a bottle comprising an uncrystallized neck. Many processes are known by a person skilled in the art for improving the thermal stability of the necks when filling at a high temperature in order to prevent the latter from deforming. The processes used to obtain them may be easily combined with the present invention. However, against all expectations, it has been found that lighter neck geometries commonly used for the packaging of carbonated drinks could be used successfully in the context of the present invention.

The bottle obtained by the manufacturing and hot-filling process is distinguished from known bottles for hot-filling by:

- a low weight;
- the absence of compensating panels;
- a pressure-resistant base;
- a neck which may be of reduced weight;
- a contracting zone that forms a more crystalline ring; and
- a positive internal pressure after filling.

The positive internal pressure after filling has many advantages, in particular for the storage of the bottles. This is because, despite their low weight, these bottles have a high resistance to vertical compression due to the positive pressure in the container. The stacking height of the bottles is consequently increased. The positive pressure in the bottle after filling is also manifested during the opening of the bottle by the consumer. The bottles described in the prior art are under vacuum after filling and see their level decrease during opening whereas the bottle obtained according to the invention sees its level remain constant or increase slightly during opening.

Example

The bottle had a weight of 24 g for a capacity of 500 ml. The base was of petaloid type, the body had an upper cylindrical zone of small thickness, and a lower convex contracting zone. This bottle was obtained by blow molding a preform heated at 100° C. in a mold at 12° C. A PET copolymer based on terephthalic and isophthalic acids was used to mold the preforms (Cleartuf P85HF from M&G Polimeri Italia). The bottle was stored for 3 days before filling. The bottle was rinsed and filled at 85° C. according to the filling procedure used in the profession. After cooling the bottle, the upper zone was deformed under the effect of the vacuum in the bottle. The deformation of the upper zone created a reduction in the

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volume of the bottle substantially equal to 3.5%. The convex contracting zone was then heated by flame treatment for 1 to 5 s and advantageously for 3 s. During the shrinkage step, the bottle was rotated in front of two diametrically opposed flame treatment stations. After shrinkage, the vacuum in the bottle was eliminated; the upper zone regained its initial geometry and the initially convex contracting zone formed a cylindrical surface. The bottle comprised a contracting zone having a degree of crystallization greater than 34% whereas the degree of crystallization of the other parts of the bottle was less than or equal to 32%. The bottle therefore had a denser or more crystalline zone in the contracting zone. This zone was generally spread over the circumference of the bottle thus forming a ring of higher density in the side wall of the bottle.

The invention claimed is:

1. A process for manufacturing and hot-filling a PET container comprising the following steps:

- a) providing a PET preform capable of being blow molded according to a conventional process which is not a heat resistant process,
- b) blow molding the preform in a cavity of a mold so as to form a container;
- c) removing the container from the mold cavity;
- d) filling the container with a liquid, the temperature of which is above 80° C.;
- e) sealing the container in a leaktight fashion;
- f) sterilizing and cooling the container; and
- g) shrinking the container,

wherein:

- in step a) a PET preform composed of a copolymer based on terephthalic acid is used;
- in step a), at least one part of the preform is at a temperature greater than or equal to 110° C.;
- the temperature of the mold used in step b) is less than or equal to 65° C.; and
- during step g) the container is heated for a duration between 1 and 5 seconds at a temperature between 600 and 1000° C. in at least one part of the container so as to create a shrinkage and a reduction in the volume of the container.

2. The process as claimed in claim 1, wherein a bottom of the mold is maintained at a temperature below 20° C.

3. The process as claimed in claim 2, wherein the bottom of the mold is maintained at a temperature between 1 and 15° C.

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