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(54) Title: METHOS AND SYSTEM FOR FORMING HIGH - STRENGTH BEVERAGE CAN ENDS OF ALUMINUM MAGNESIUM ALLOY AND SUCH CAN ENDS

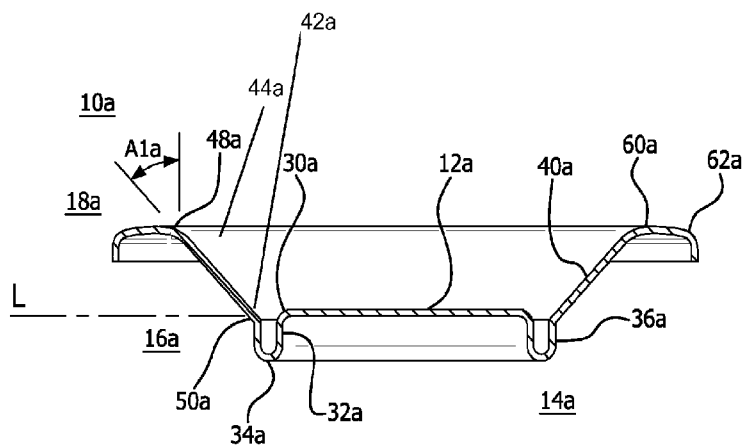


FIG. 2

(57) Abstract: High strength beverage end shells (10a) formed in high speed, commercial production of an aluminum alloy having a specific range of constituents, especially having between 3.0% and 4.5% magnesium.

METHODS AND SYSTEM FOR FORMING HIGH-STRENGTH BEVERAGE CAN ENDS OF ALUMINUM MAGNESIUM ALLOY AND SUCH CAN ENDS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This claims the benefit of U.S. Patent Application Serial No. 61/496,624 filed June 14, 2011, the disclosure of which is hereby incorporated by reference as if set forth in its entirety herein.

[0002] This application relates to metal packaging, and more particular to aluminum beverage can ends and seamed cans.

BACKGROUND

[0003] There are at least three types of light weight or high strength beverage can ends that have been produced in commercial quantities since the 1990's. Each of these high strength end type has, among other things, the attribute of a smaller diameter center panel as a percentage of the seam diameter.

[0004] Crown Cork & Seal first developed its SuperEnd high strength can end, such as that disclosed in United States Patent Number 6,065,634. Later, Metal Container Corporation developed its Lid Of The Future end, such as disclosed in United States Patent Number 7,100,789 and Container Development Corporation Ltd. developed its CDL end, such as disclosed in Figure 13 of United States Patent Number 7,819,275.

[0005] Crown Cork & Seal also identified improvements to the SuperEnd shell provide disclosed in the 6,065,634 patent. United States Patent Number 7,370,774 in Figure 4B and United States Patent Number 7,591,392 in Figures 6 and 7 illustrate, among other things, improved end that includes a weakening feature or a weakened configuration to improve leaking performance of failed ends.

[0006] Most conventional high strength ends are formed of a 5182 alloy having the following maximum limits of constituents:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other		AL
									Each	Total	
5182	0.2	0.35	0.15	0.20-0.50	4.0-5.0	0.10	0.25	0.10	0.05	0.15	Rest

[0007] The source for alloy specifications is the Aluminum Association of Arlington, VA.

[0008] 5182 aluminum is produced in massive quantities to produce the many billions of high strength beverage can ends manufactured and seamed each year throughout the world. Many commercial high strength can ends are made from 0.0082 inch 5182 alloy.

[0009] Several dozen billion beverage can ends are manufactured per year in the United States, and several dozen beverage can ends are manufactured per year in the rest of the world. These vast quantities require vast quantities of aluminum.

[0010] The beverage can industry has specification for various parameters, such as a burst strength requirement of an average of 90 psi and a minimum of 85 psi.

SUMMARY

[0011] High strength beverage end shells formed in high speed, commercial production of an aluminum alloy having a specific range of constituents, especially magnesium within a specific range, are disclosed.

[0012] A method of forming a high strength can end in commercial quantities comprises the steps of (i) providing from a coil a sheet of an aluminum alloy having between 3.0% and 4.5% magnesium; (ii) forming high strength beverage end shells from the aluminum alloy coil in a shell press operating at least at 180 strokes per minute to produce 4140 shells per minute; (iii) whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi. High strength ends include modern, commercially available ends and their variants. Preferably, the aluminum alloy has between 3.5% and 4.5% magnesium.

[0013] The ends may be configured such that the aged seamed ends satisfy a burst pressure specification of a minimum of at least 85 psi, especially wherein the burst pressure specification requires substantially all the aged seams end to satisfy the minimum burst pressure requirement and/or satisfaction of the burst pressure specification requires commercial acceptance by a beverage company.

[0014] Preferably, the structure of the shell includes a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical. Also, the structure of the shell preferably includes a countersink bead extending between the center panel and the inclined wall. The inclined wall is a multipart wall that extends between the countersink bead and the peripheral curl.

[0015] The inclined wall preferably includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at an innermost point of

the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.

[0016] The inclined wall angle may be measured between the first point and the second point, such that a lower wall angle measured between the second point and the juncture is at least 28 degrees, preferably the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 32 degrees and approximately 55 degrees, and more preferably the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

[0017] The lower wall angle measured between the second point and the juncture preferably is at least 33 degrees. This inclined wall angle preferably is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

[0018] The present invention encompasses a system for manufacturing beverage end shells in commercial quantities from a coil of aluminum alloy sheet, comprising (i) a shell press operating at least at 180 strokes per minute producing at least 4140 beverage end shells per minute; (ii) each shell: including a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical; and is formed of an aluminum alloy having between 3.0% and 4.5% magnesium; (iii) whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi. Preferably, the aluminum alloy has between 3.5% and 4.5% magnesium.

[0019] The structure preferably includes a countersink bead extending between the center panel and the inclined wall. And the inclined wall may be a multipart wall that extends between the countersink bead and the peripheral curl. Thus, the inclined wall includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at an innermost point of the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.

[0020] The inclined wall angle may be measured between the first point and the second point such that it is at least 28 degrees. Preferably, the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between

approximately 32 degrees and approximately 55 degrees. More preferably, the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

[0021] The lower wall angle measured between the second point and the juncture such preferably is at least 33 degrees. Using this measurement, the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

[0022] The present invention also encompasses plural beverage can end shells formed in a commercial shell press operating at least at 180 strokes per minute and at least 4140 shells per minute. Each one of the plural shells comprises (i) a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical; (ii) the shell formed of an aluminum alloy having between 3.0% and 4.5% magnesium; (iii) whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi. Preferably, the aluminum alloy has between 3.5% and 4.5% magnesium. The structure of the end shells preferably includes a countersink bead extending between the center panel and the inclined wall.

[0023] The inclined wall may be a multipart wall that extends between the countersink bead and the peripheral curl. The inclined wall thus includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at an innermost point of the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.

[0024] The inclined wall angle may be measured between the first point and the second point. A lower wall angle may be measured between the second point and the juncture such that it is at least 28 degrees. Preferably the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 32 degrees and approximately 55 degrees. More preferably the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

[0025] The lower wall angle measured between the second point and the juncture may be at least 33 degrees. Thus, the inclined wall angle preferably is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

BRIEF DESCRIPTION OF THE FIGURES

[0026] Figure 1 is a flow chart showing the shell making processes; and

[0027] Figure 2 is a cross sectional diagram of an example high strength end shell.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] In addition to 5182 aluminum, 5042 aluminum alloy is also widely manufactured. 5042 aluminum has the following constituents:

	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other		AL
									Each	Total	
5042	0.2	0.35	0.15	0.20- 0.50	3.0-4.0	0.10	0.25	0.10	0.05	0.15	Rest

[0029] The inventor has demonstrated that SuperEnd end shells can be made from 5042 alloy, even though the end shells would like end shells made from 0.0082 inch thick 5042 alloy have an average buckle pressure of only about 85 psi when aging is simulated by heating the seamed ends at 90 degrees C for 30 minutes. Buckle strength was determined by seaming aged ends onto cans, then pressurizing the can incrementally. A gauge records the pressure at the point of failure.

[0030] The inventor surmises that for commercial SuperEnd ends and other high strength ends, an alloy having a range of constituents that overlaps some of the ranges of 5042 alloy and 5182 alloy constituents would be preferred.

[0031] Even just a few years ago, it would not have been feasible to customize aluminum alloy between industry standard 5182 and 5042 in sufficient quantities because of high cost and inconsistent properties, but the capability of mills to produce consistent product of a customized chemistry at high capacity has improved.

[0032] The perceived lack of uniformity in any material other than 5182 or like standardized, mass produced material created a disincentive to switching to new materials for commercial high strength beverage can ends because essentially all ends must meet minimum specifications for carbonated soft drink, beer, or other beverage uses. If a minimum buckle strength would be specified, as is typically required by commercial specifications of beverage companies, then the aluminum sheet must be sufficiently thick such that the worst or weakest coils of aluminum satisfy the buckle strength requirement.

Accordingly, even up to several years ago, many believed that the lack of uniformity in customized aluminum alloy made its use infeasible for beverage can ends.

[0033] Further, many believed that switching from 5182 to a weaker material was unwise because 5182 alloy had the best combination of strength and ductility. 5182 alloy has proven to be sufficiently brittle such that the score about the tear panel would consistently propagate all the way around the tear panel. In other words, brittle material was a benefit to the opening process. Sufficiently brittleness to enhance opening has become even more important as the beverage industry has converged on large opening, oval ends, which inherently are more difficult to open compared with smaller, round opening ends.

[0034] An aluminum alloy that the inventor surmises provides an optimum combination of ductility (that is, brittleness) for good score propagation, strength for burst pressure resistance, and cost by reducing the amount of magnesium and other elements that promote strength is provided by an aluminum alloy provided below:

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other		AL
								Each	Total	
0.2	0.35	0.15	0.20-0.50	3.0-4.5	0.10	0.25	0.1	0.05	0.15	Rest

[0035] Preferably, the magnesium content would be approximately 4.0 percent.

[0036] A system 110 includes a conventional shell press 120 that includes multiple (conventional) tools for forming multiple shells 140 per stroke. Most commercial shell press machines operate at least at 180 strokes per minute and have a minimum of 23 or 24 tools such that each stroke produces shells at a rate of at least 4140 shells per minute. Shell press 120 may be any commercial press, such as produced by Stolle Machinery, Inc.

[0037] A coil 101 of an aluminum alloy sheet having between 3.0% and 4.5% magnesium, and preferably having the chemistry provided above, is fed into shell press 120 to produce high strength end shells at a commercial rate.

[0038] Shells 140 are conveyed to a conventional conversion press, such as produced by Minter Machine Company, where a tab is applied.

[0039] A high strength can end formed by system 110 of an aluminum alloy having between 3.0% and 4.5% magnesium, more preferably having between 3.5% and 4.5% magnesium preferably having the chemistry provided above, are provided. A first example of a high strength can end is a SuperEnd can end shell 10a, as provided by Crown Cork &

Seal Company and shown in Figure 2. End shell 10a, a center panel 12a, a countersink bead 14a, an inclined wall 16a, and a peripheral curl 18a. Center panel 12a merges into inner wall 30a of the countersink bead 14a at a transition 30a. An arcuate bottom 34a extends downwardly from a lower portion of inner wall 30a. An outer wall 36a of bead 14a extends upwardly from an outermost portion of bottom 34a.

[0040] Wall 16a includes a lower wall 42a and an upper wall 44a. As shown in the figure, lower wall 42a extends from an uppermost portion of bead outer wall 34a and joins upper wall 44a at a juncture 46a.

[0041] Peripheral curl 18a includes a seaming panel 60a and a cover hook 62a. A first point 48a is defined at the junction of the uppermost end of upper wall 44a with the innermost end of seaming panel 60a or peripheral curl 18a. A second point 50a is defined where a horizontal line L is extended from the plane of center panel 12a to intersect with wall 16a. For measuring other high strength end shells, the first point, juncture (if any), and second point may be defined as described above.

CLAIMS

1. A method of forming a high strength can end in commercial quantities, comprising the steps of:
 - a. providing from a coil a sheet of an aluminum alloy having between 3.0% and 4.5% magnesium;
 - b. forming high strength beverage end shells from the aluminum alloy coil in a shell press operating at least at 180 strokes per minute to produce 4140 shells per minute;
 - c. whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi.
2. The method of claim 1 further wherein the aluminum alloy has between 3.5% and 4.5% magnesium.
3. The method of claim 2 wherein the ends are configured such that the aged seamed ends satisfy a burst pressure specification of a minimum of at least 85 psi.
4. The method of claim 3 wherein the burst pressure specification requires substantially all the aged seams end to satisfy the minimum burst pressure requirement.
5. The method of claim 4 wherein satisfaction of the burst pressure specification requires commercial acceptance by a beverage company.
6. The method of claim 5 wherein the shell includes a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical.
7. The method of claim 6 wherein the shell further includes a countersink bead extending between the center panel and the inclined wall.
8. The method of claim 7 wherein the inclined wall is a multipart wall that extends between the countersink bead and the peripheral curl.
9. The method of claim 8 wherein the inclined wall includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at

an innermost point of the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.

10. The method of claim 9 wherein the inclined wall angle is measured between the first point and the second point.
11. The method of claim 10 wherein a lower wall angle measured between the second point and the juncture is at least 28 degrees.
12. The method of claim 11 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 32 degrees and approximately 55 degrees.
13. The method of claim 11 wherein the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.
14. The method claim 10 wherein a lower wall angle measured between the second point and the juncture is at least 33 degrees
15. The method of claim 14 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.
16. A system for manufacturing beverage end shells in commercial quantities from a coil of aluminum alloy sheet, comprising:
 - a. a shell press operating at least at 180 strokes per minute producing at least 4140 beverage end shells per minute;
 - b. each shell:
 - i. including a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical; and
 - ii. is formed of an aluminum alloy having between 3.0% and 4.5% magnesium;

- c. whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi.
- 17. The system of claim 16 further wherein the aluminum alloy has between 3.5% and 4.5% magnesium.
 - 18. The system of claim 17 further comprising a countersink bead extending between the center panel and the inclined wall.
 - 19. The system of claim 18 wherein the inclined wall is a multipart wall that extends between the countersink bead and the peripheral curl.
 - 20. The system of claim 19 wherein the inclined wall includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at an innermost point of the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.
 - 21. The system of claim 20 wherein the inclined wall angle is measured between the first point and the second point.
 - 22. The system of claim 21 wherein a lower wall angle measured between the second point and the juncture is at least 28 degrees.
 - 23. The system of claim 22 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 32 degrees and approximately 55 degrees.
 - 24. The system of claim 22 wherein the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.
 - 25. The system of claim 21 wherein a lower wall angle measured between the second point and the juncture is at least 33 degrees

26. The system of claim 25 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.
27. Plural beverage can end shells formed in a commercial shell press operating at least at 180 strokes per minute and at least 4140 shells per minute, each one of the plural shells comprising:
 - a center panel, a cover hook, and an inclined wall located between the center panel and a peripheral curl, the inclined wall is inclined at an inclined wall angle of at least 20 degrees from vertical;
 - the shell formed of an aluminum alloy having between 3.0% and 4.5% magnesium;
 - whereby, when the seamed can ends are fully aged, the aged ends satisfy a burst pressure specification of a minimum of at least 80 psi and an average of at least 90 psi.
28. The shells of claim 27 further wherein the aluminum alloy has between 3.5% and 4.5% magnesium.
29. The shells of claim 28 further comprising a countersink bead extending between the center panel and the inclined wall.
30. The shells of claim 29 wherein the inclined wall is a multipart wall that extends between the countersink bead and the peripheral curl.
31. The shells of claim 30 wherein the inclined wall includes an upper portion and a lower portion that are joined at a juncture, the upper portion is defined between a first point at an innermost point of the peripheral curl and the juncture, and the lower portion is defined between the juncture and a second point that is defined by an intersection of a horizontal projection from the plane of the center panel with the inclined wall or outer wall of the countersink bead.
32. The shells of claim 31 wherein the inclined wall angle is measured between the first point and the second point.
33. The shells of claim 32 wherein a lower wall angle measured between the second point and the juncture is at least 28 degrees.

34. The shells of claim 33 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 32 degrees and approximately 55 degrees.
35. The shells of claim 34 wherein the inclined wall angle is between approximately 25 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.
36. The shells of claim 31 wherein a lower wall angle measured between the second point and the juncture is at least 33 degrees
37. The shells of claim 36 wherein the inclined wall angle is between approximately 23 degrees and approximately 60 degrees and the lower wall angle is between approximately 34 degrees and approximately 53 degrees.

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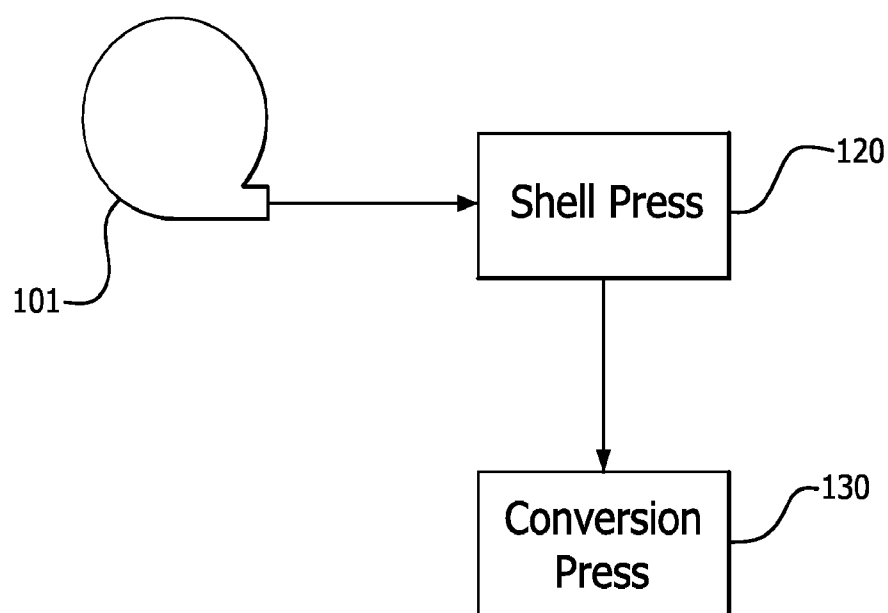


FIG. 1

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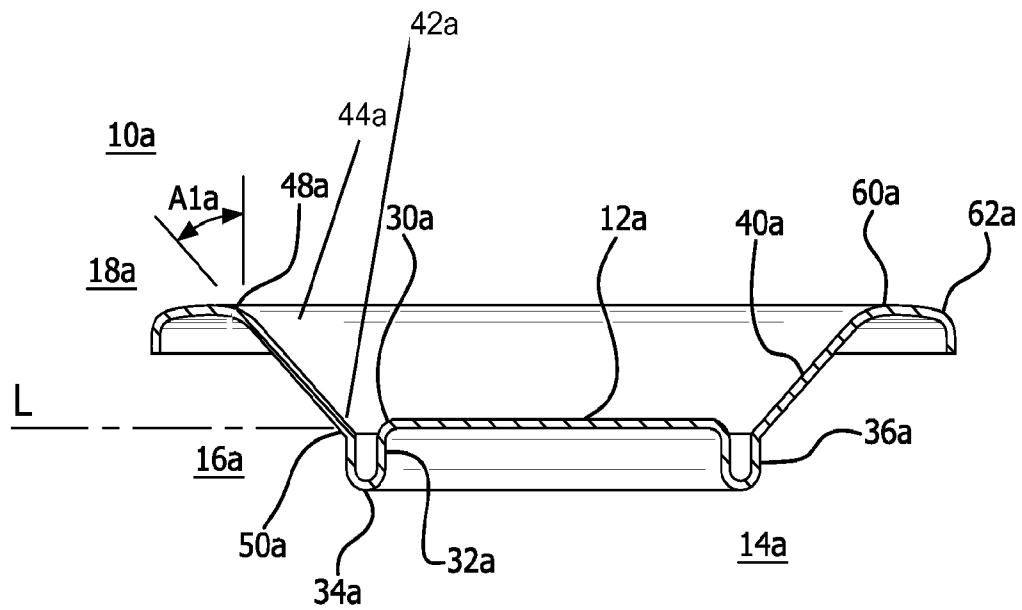


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/042167

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21D51/44
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21D B65D

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	the whole document	16-26
X	WO 01/41948 A2 (METAL CONTAINER CORP INC [US]) 14 June 2001 (2001-06-14)	1-15, 27-35
Y	abstract; figures 1-5 page 1, line 21 - line 22 page 6, line 9 - line 14	16-26
X	US 2003/121920 A1 (ZONKER HARRY R [US] ET AL) 3 July 2003 (2003-07-03)	1-11, 27-33
Y	abstract; figures 4,5,7	16-22
A	paragraph [0009] - paragraph [0011]	12-15, 23-26, 34-37
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

31 July 2012

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/042167

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Y	abstract; figures 1-3	16-26
A	column 7, line 39 - line 44	12-15, 34-37
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Information on patent family members

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