IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

CROWN PACKAGING TECHNOLOGY, INC. and CROWN CORK & SEAL USA, INC.,	)	
Plaintiffs,	)	**Civil Action No. 05-608 (KAJ)**
v.	)	
REXAM BEVERAGE CAN CO.	)	**JURY TRIAL DEMANDED**
Defendant.	)	

SECOND AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Plaintiffs Crown Packaging Technology, Inc. ("Crown Technology") and Crown Cork & Seal Company USA, Inc. ("Crown USA") (collectively "Crown") hereby complain and allege against Defendant Rexam Beverage Can Co. ("Rexam") as follows:

THE PARTIES

1. Crown Technology is a Delaware corporation having a principal place of business at 11535 South Central Avenue, Alsip, IL 60803. Crown Technology is a research, development, and engineering company specializing in metal packaging for the beverage and food industry.

2. Crown USA is a Delaware corporation having a principal place of business at One Crown Way, Philadelphia, Pennsylvania 19154. Crown USA is in the business of manufacturing and selling metal beverage can components, including can ends and can bodies.

3. On information and belief, Rexam is a Delaware corporation having a principal place of business at 8770 W. Bryn Mawr Ave., Chicago, Illinois 60631. Rexam is in the business of manufacturing and selling metal beverage can components, including can ends and can bodies.

JURISDICTION AND VENUE

4. This is a civil action for patent infringement arising under the patent laws of the United States, Title 35 of the United States Code. The Court has jurisdiction over the subject matter of this action under 28 U.S.C. §§ 1331, 1338(a), and 2201. Venue is proper in this District under 28 U.S.C. §§ 1391(b) & (c) and 1400(b).

THE PATENTS

5. On February 1, 2005, the United States Patent and Trademark Office duly and legally issued U.S. Patent No. 6,848,875 ("the '875 patent"), entitled "Can End and Method for Fixing Same to a Can Body." The '875 patent is directed to methods of forming a double seam between beverage can bodies and can ends. A copy of the '875 patent is attached hereto as Attachment 1.

6. On August 30, 2005, the United States Patent and Trademark Office duly and legally issued U.S. Patent No. 6,935,826 ("the '826 patent"), entitled "Can End and Method for Fixing Same to a Can Body." The '826 patent is directed to un-seamed can ends adapted to be joined to can bodies in a double seaming process. A copy of the '826 patent is attached hereto as Attachment 2.

7. Crown Technology is the assignee of the '875 and '826 patents.

8. Crown USA is the exclusive licensee of the '875 and '826 patents. At all times relevant, Crown USA has held all substantial rights under the '875 and '826 patents, including without limitation, the exclusive right under the patents to practice the claimed inventions in the United States, to bring suit for infringement of the patents in its own name, to recover any and all damages for past, present, and future infringement of the patents, to enter into any settlement or compromise of any claim arising under the patents, and to sublicense others.

COUNT I (INFRINGEMENT OF U.S. PATENT NO. 6,848,875)

9. The allegations contained in paragraphs 1-8 above are incorporated herein by reference as if set forth in full.

10. Rexam has made, sold and offered to sell, and is now making, selling and offering for sale, can ends known as Rexam ends to the Coca-Cola Company, including its bottling subsidiaries and/or affiliates (together "Coke"), and possibly others in the United States.

11. On information and belief, Rexam has actively induced Coke and possibly others to directly infringe at least claims 14, 16, 30, 32, 44, and 50-52 of the '875 patent by, *inter alia*, supplying Rexam ends to Coke and possibly others for use in carrying out the claimed methods of forming double seams, and on information and belief, by providing training, instruction, and other services to Coke and possibly others in the United States in support of such use.

12. On information and belief, Rexam has contributed to the direct infringement of at least claims 14, 16, 30, 32, 44, and 50-52 of the '875 patent claims by Coke and possibly others, by, *inter alia*, selling Rexam ends for use in carrying out methods in the United States for forming double seams between can bodies and Rexam ends, knowing the same to be especially made and especially adapted for use in a method, the practice of which is an infringement of the patent.

13. On information and belief, Rexam has been aware of the '875 patent since its date of issuance, on February 1, 2005. Rexam has continued to manufacture and sell the Rexam end despite its awareness the '875 patent. Thus, Rexam's infringement of the '875 patent has been, and continues to be, willful and deliberate.

14. Crown Technology and Crown USA have been damaged by Rexam's infringing activities.

15. On information and belief, Rexam will continue its infringing activities unless enjoined by this Court.

COUNT II (INFRINGEMENT OF U.S. PATENT NO. 6,935,826)

16. The allegations contained in paragraphs 1-15 above are incorporated herein by reference as if set forth in full.

17. Rexam has been and are directly infringing at least claim 13 of the '826 patent by making, selling and offering for sale Rexam ends in the United States.

18. On information and belief, Rexam has been aware of the 826 patent and/or the allowed claims of the application leading to the '826 patent since on or about the date of the notice of allowance of that patent, on February 24, 2005. Rexam has continued to manufacture and sell Rexam ends despite its awareness of the patent and the allowed claims. Thus, Rexam's infringement of the '826 patent has been, and continues to be, willful and deliberate.

19. Crown Technology and Crown USA have been damaged by Rexam's infringing activities.

20. On information and belief, Rexam will continue its infringing activities unless enjoined by this Court.

COUNT III (DECLARATORY JUDGMENT OF INFRINGEMENT OF U.S. PATENT NO. 6,935,826)

21. The allegations contained in paragraphs 1-20 above are incorporated herein by reference as if set forth in full.

22. Rexam has sold, is selling, and on information and belief, is planning to continue to sell in the future, Rexam ends to Coke and possibly others in the United States.

23. An actual controversy exists between Crown Technology and Crown USA, on the one hand, and Rexam, on the other hand, as to whether Rexam's continued sale of Rexam ends in the United States infringes at least claim 13 of the '826 patent.

24. Rexam's continued manufacture, use and sale of Rexam ends in the United States will directly infringe at least claim 13 of the '826 patent.

25. Crown Technology and Crown USA have been and will continue to be damaged by Rexam's infringing activities.

REQUEST FOR RELIEF

WHEREFORE, Crown Technology and Crown USA request of this Court enter final judgment:

a. holding that Rexam has infringed the '875 patent under 35 U.S.C. § 271;

b. holding that Rexam has infringed the '826 patent under 35 U.S.C. § 271;

c. awarding damages adequate to compensate Crown for the infringement of the '875 and '826 patents by Rexam, together with prejudgment and post-judgment interest and costs as fixed by the Court as provided by 35 U.S.C. § 284;

d. holding that Rexam's infringement of the '875 and '826 patents has been willful and awarding treble damages pursuant to 35 U.S.C. § 284;

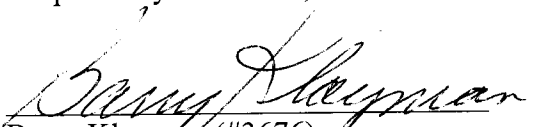
e. permanently enjoining Rexam, and its affiliates, and officers, agents, employees, attorneys, and all other persons in active concert or participation with it, from further infringement of the '875 and '826 patents during its term as provided by 35 U.S.C. § 283;

f. finding that this is an exceptional case and awarding to Crown its reasonable attorneys' fees incurred in prosecuting this action as provided by 35 U.S.C. § 285;

g. declaring that Rexam's continued manufacture, use and sale of Rexam ends in the United States will directly infringe one or more claims of the '826 patent under 35 U.S.C. § 271; and

h Such other and further relief as the Court deems just and proper.

Respectfully submitted,



Dated: October 20, 2005

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EXHIBIT 1

US006848875B2

(12) **United States Patent**
Brifcani et al.

(10) **Patent No.: US 6,848,875 B2**
(45) **Date of Patent: Feb. 1, 2005**

(54) **CAN END AND METHOD FOR FIXING THE SAME TO A CAN BODY**

(75) Inventors: **Mouayed Mamdooh Brifcani**, Oxfordshire (GB); **Peter James Hinton**, Swindon Wiltshire (GB); **Mark Christopher Kysh**, Wantage (GB)

(73) Assignee: **Crown Cork & Seal Technologies Corporation**, Alsip, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 5 days.

(21) Appl. No.: **10/024,862**

(22) Filed: **Dec. 18, 2001**

(65) **Prior Publication Data**

US 2003/0150866 A1 Aug. 14, 2003

Related U.S. Application Data

(63) Continuation of application No. 09/650,664, filed on Aug. 30, 2000, now abandoned, which is a continuation of application No. 09/552,668, filed on Apr. 19, 2000, now abandoned, which is a continuation of application No. 08/945,698, filed as application No. PCT/GB96/00709 on Mar. 25, 1996, now Pat. No. 6,065,634.

(30) **Foreign Application Priority Data**

May 24, 1995 (GB) 9510515

(51) Int. Cl.[7] **B21D 51/32**
(52) U.S. Cl. 413/6; 413/31
(58) Field of Search 413/31, 36, 37, 413/43, 2, 4, 6, 8

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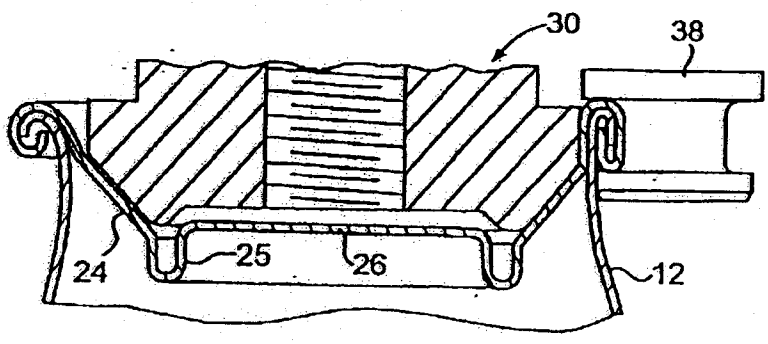
Primary Examiner—Lowell A. Larson
(74) *Attorney, Agent, or Firm*—Woodcock Washburn LLP

(57) **ABSTRACT**

A can end comprising a peripheral cover hook, a chuck wall dependent from a first point on the interior of the cover hook, an outwardly concave annular reinforcing bead extending radially inwards from a second point on the interior of the chuck wall, and a central panel supported by an inner portion of the reinforcing bead, characterized in that, a line connecting the first point and the second point is inclined to an axis perpendicular to the exterior of the central panel at an angle between 30° and 60°.

62 Claims, 4 Drawing Sheets



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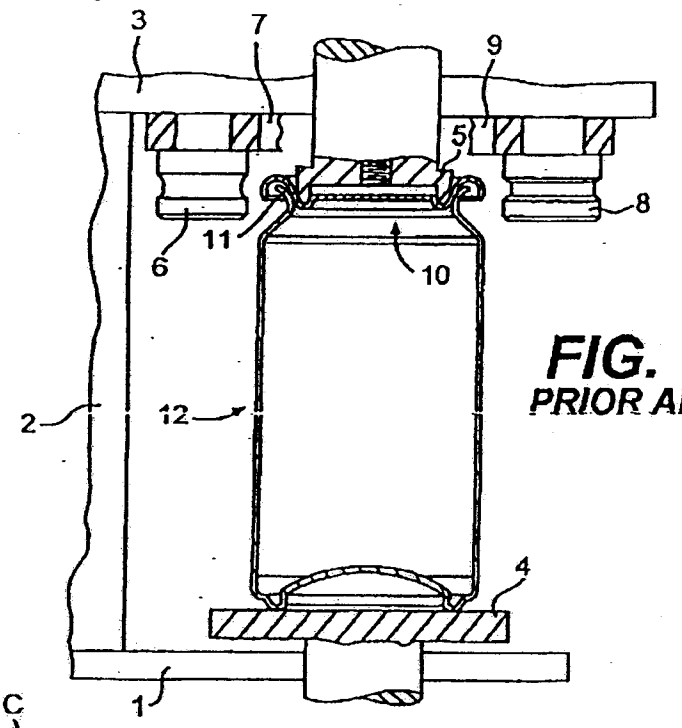


FIG. 1
PRIOR ART

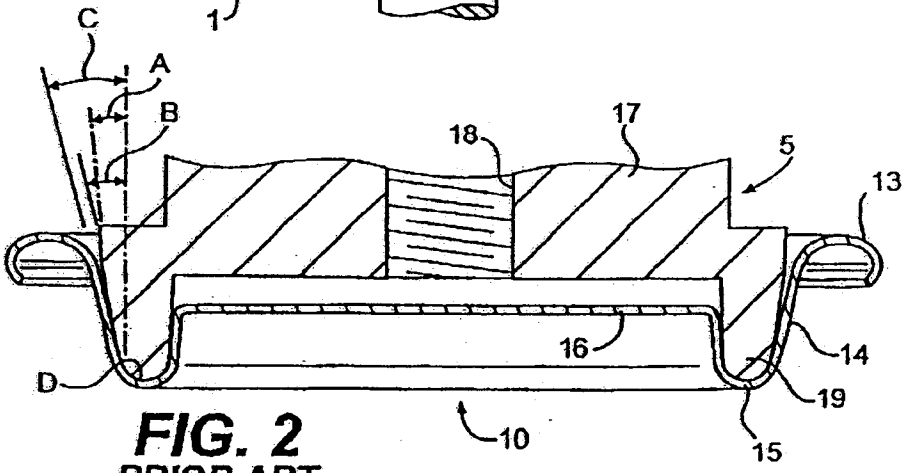


FIG. 2
PRIOR ART

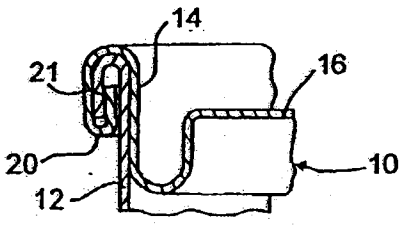


FIG. 3
PRIOR ART

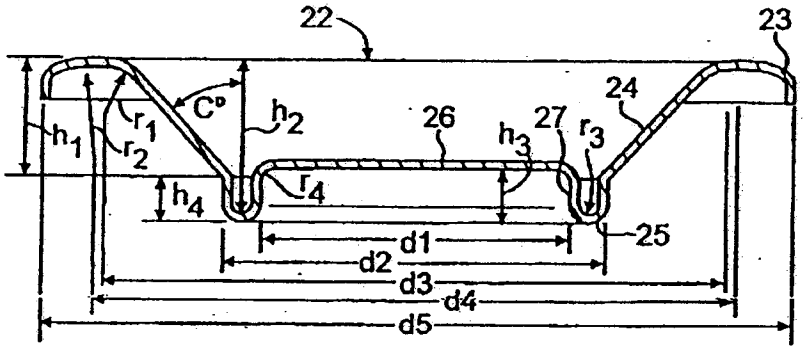
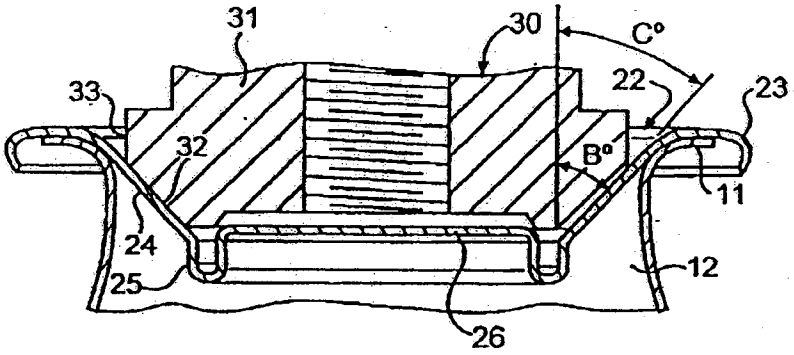

22
23
24
C°
h2
26
h3
27
r3
h1
r1
r2
h4
r4
25
d1
d2
d3
d4
d5

FIG. 4


31
30
C°
33
22
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B°
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26

FIG. 5

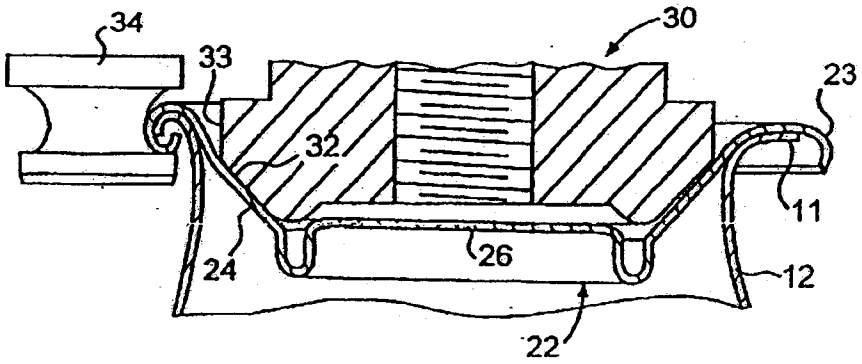

FIG. 6

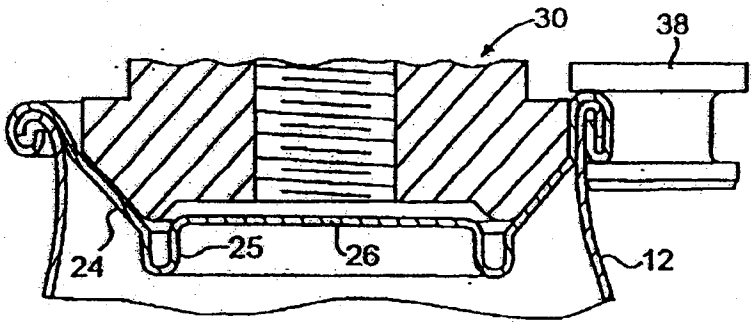

FIG. 7

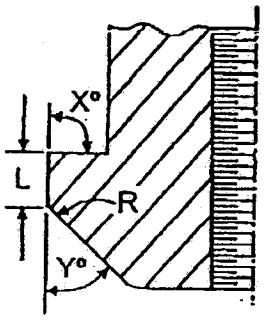

FIG. 8

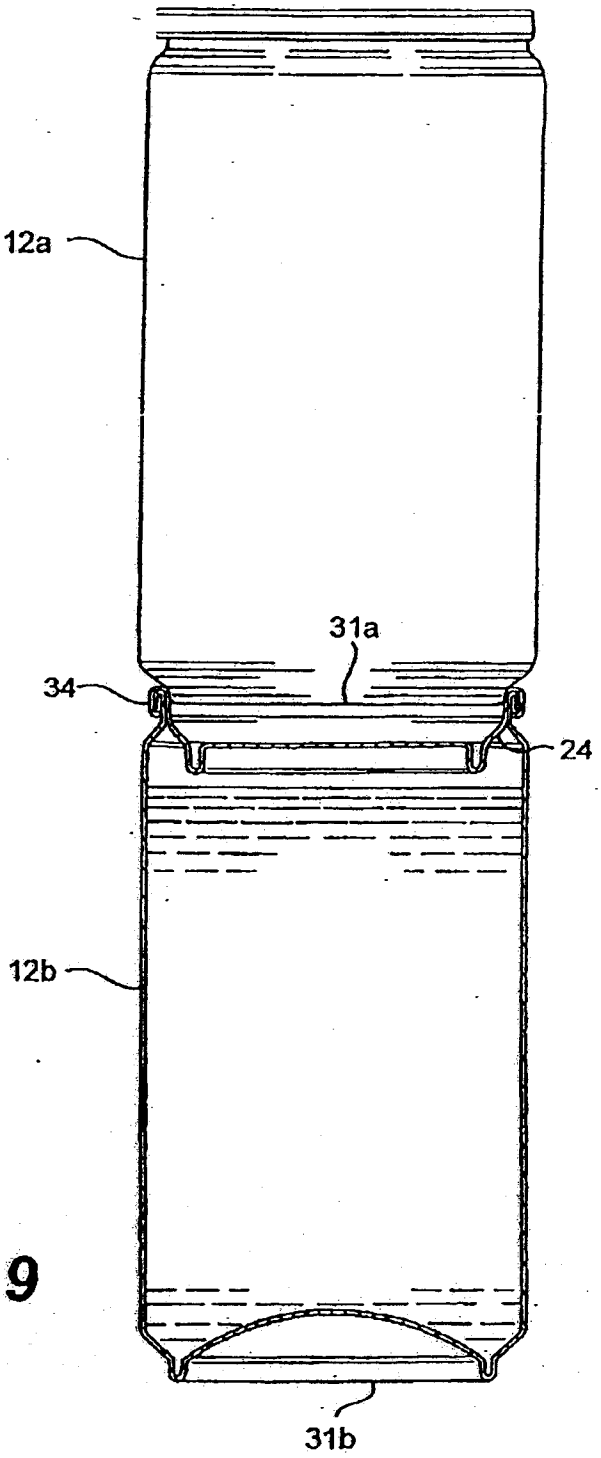

FIG. 9

CAN END AND METHOD FOR FIXING THE SAME TO A CAN BODY

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. patent application Ser. No. 09/650,664, filed Aug. 30, 2000 now abandoned, which is a continuation of U.S. patent application Ser. No. 09/552,668, filed Apr. 19, 2000, now abandoned, which is a continuation of U.S. patent application Ser. No. 08/945,698, filed Nov. 21, 1997, which issued May 23, 2000 as U.S. Pat. No. 6,065,634, which is the U.S. National Phase of PCT/GB96/00709, filed Mar. 25, 1996, which claims priority to UK 9510515.1, filed May 24, 1995.

This invention relates to an end wall for a container and more particularly but not exclusively to an end wall of a can body and a method for fixing the end wall to the can body by means of a double seam.

U.S. Pat. No. 4,093,102 (KRASKA) describes can ends comprising a peripheral cover hook, a chuck wall dependent from the interior of the cover hook, an outwardly concave annular re-inforcing bead extending radially inwards from the chuck wall and a central panel joined to an inner wall of the reinforcing bead by an annular outwardly convex bead. This can end is said to contain an internal pressure of 90 psi by virtue of the inclination or slope of the chuck wall, bead outer wall and bead inner wall to a line perpendicular to the centre panel. The chuck wall slope D° is between 14° and 16°, the outer wall slope E is less than 4° and the inner wall slope C° is between 10 and 16° leading into the outwardly convex bead. We have discovered that improvements in metal usage can be made by increasing the slope of the chuck wall and limiting the width of the anti peaking bead.

U.S. Pat. No. 4,217,843 (KRASKA) describes an alternative design of can end in which the countersink has inner and outer flat walls, and a bottom radius which is less than three times the metal thickness. The can end has a chuck wall extending at an angle of approximately 24° to the vertical. Conversely, the specification of our U.S. Pat. No. 5,046,637 describes a can end in which the chuck wall extends at an angle of between 12° and 20° to the vertical.

The detailed description of our U.S. Pat. No. 4,571,978 describes a method of making a can end suitable for closing a can body containing a beverage such as beer or soft drinks. This can end comprises a peripheral flange or cover hook, a chuck wall dependant from the interior of the cover hook, an outwardly concave reinforcing bead extending radially inwards from the chuck wall from a thickened junction of the chuck wall with the bead, and a central panel supported by an inner portion of the reinforcing bead. Such can ends are usually formed from a prelacquered aluminum alloy such as an aluminum magnesium manganese alloy such as alloy 5182.

The specification of our U.S. Pat. No. 5,582,319 describes a can end suitable for a beverage can and formed from a laminate of aluminum/manganese alloy coated with a film of semi crystalline thermoplastic polyester. This polyester/aluminum alloy laminate permitted manufacture of a can end with a narrow, and therefore strong reinforcing bead in the cheaper aluminum manganese alloy.

Continuing development of a can end using less metal, whilst still permitting stacking of a filled can upon the end of another, this invention provides a can end comprising a peripheral cover hook, a chuck wall dependant from the interior of the chuck wall, an outwardly concave annular reinforcing bead extending radially inwards from the chuck wall, and a central panel supported by an inner portion of the reinforcing bead, characterised in that, the chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle between 30° and 60°, and the concave bead narrower than 1.5 mm (0.060"). Preferably, the angle of the chuck wall to the perpendicular is between 40° and 45°.

In a preferred embodiment of the can end an outer wall of the reinforcing bead is inclined to a line perpendicular to the central panel at an angle between −15° to +150 and the height of the outer wall is up to 2.5 mm.

In one embodiment the reinforcing bead has an inner portion parallel to an outer portion joined by said concave radius.

The ratio of the diameter of the central panel to the diameter of the peripheral curl is preferably 80% or less.

The can end may be made of a laminate of thermoplastic polymer film and a sheet aluminium alloy such as a laminate of a polyethylene teraphthalate film on an aluminium-manganese alloy sheet or ferrous metal typically less than 0.010 (0.25 mm) thick for beverage packaging. A lining compound may be placed in the peripheral cover hook.

In a second aspect this invention provides a method of forming a double seam between a can body and a can end according to any preceding claim, said method comprising the steps of:

placing the curl of the can end on a flange of a can body supported on a base plate, locating a chuck within the chuck wall of the can end to centre the can end on the can body flange, said chuck having a frustoconical drive surface of substantially equal slope to that of the chuck wall of the can end and a cylindrical surface portion extending away from the drive surface within the chuck wall, causing relative motion as between the assembly of can end and can body and a first operation seaming roll to form a first operation seam, and thereafter causing relative motion as between the first operation seam and a second operation roll to complete a double seam, during these seaming operations the chuck wall becoming bent to contact the cylindrical portion of the chuck.

Various embodiments will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic sketch of known apparatus for forming a double seam;

FIG. 2 is an enlarged sectioned side view of a known chuck and can end before seaming;

FIG. 3 is a sectioned view of a fragment of a known double seam;

FIG. 4 is a sectioned side view of a can end according to this invention before edge curling;

FIG. 5 is a sectioned side view of the can end of FIG. 4 on a can body before forming of a double seam;

FIG. 6 is a like view of the can end and body during first operation seaming;

FIG. 7 is a like view of the can end and body during final second operation seaming to create a double seam;

FIG. 8 is a fragmentary section of a chuck detail; and

FIG. 9 is a side view of the cans stacked one on the other.

In FIG. 1, apparatus for forming a double seam comprises a base plate 1, an upright 2 and a top plate 3.

A lifter 4 mounted in the base plate is movable towards and away from a chuck 5 mounted in the top plate. The top plate supports a first operation seaming roll 6 on an arm 7 for pivotable movement towards and away from the chuck. The top plate also supports a second operation seaming roll 8 on

an arm 9 for movement towards and away from the chuck after relative motion as between the first operation roll and can end on the chuck creates a first operation seam.

As shown in FIG. 1 the chuck 5 holds a can end 10 firmly on the flange 11 of a can body 12 against the support provided by the lifter plate 4. Each of the first operation roll 6 and second operation roll 7 are shown clear of chuck before the active seam forming profile of each roll is moved in turn to form the curl of the can end and body flange to a double seam as shown in FIG. 3.

FIG. 2 shows on an enlarged scale the chuck 5 and can end 10. The can end comprises a peripheral curl 13, a chuck wall 14 dependent from the interior of the curl, an outwardly concave anti-peaking bead 15 extending inwards from the chuck wall to support a central panel 16. Typically the chuck wall flares outwardly from the vertical at an angle C about 12° to 15°.

The chuck 5 comprises a body 17 having a threaded bore 18 permitting attachment to the rest of the apparatus (not shown). An annular bead 19 projects from the body 17 of the chuck to define with the end face of the body a cavity to receive the central panel 16 of the can end. The fit of panel 16 in annulus 19 may be slack between panel wall and chuck.

The exterior surface of the projecting bead 19 extends upwards towards the body at a divergent angle B of about 12° to the vertical to join the exterior of the chuck body 17 which tapers off an angle A° of about 4° to a vertical axis perpendicular to the central panel. The outer wall of the chuck 5 engages with the chuck wall at a low position marked "D" within the 12° shaped portion of the chuck bead 15.

As can ends are developed with narrower anti-peaking beads the chuck bead 19 becomes narrower and more likely to fracture. There is also a risk of scuffing of the can end at the drive position D which can leave unacceptable unsightly black marks after pasteurisation.

FIG. 3 shows a sectioned fragment of a typical double seam showing a desirable overlap of body hook 21 and end hook 20 between the can end 10 and can body 12.

FIG. 4 shows a can end, according to the invention, comprising a peripheral cover hook 23, a chuck wall 24 extending axially and inwardly from the interior of the peripheral cover hook, an outwardly concave reinforcing or anti-peaking bead 25 extending radially inwards from the chuck wall, and a central panel 26 supported or an inner portion panel with 27. The panel wall is substantially upright allowing for any metal spring back after pressing. The chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle C, between 20° and 60°; preferably between 40° and 45°. Typically the cross sectional radius of the antipeaking bead is about 0.5 mm.

Preferably the anti-peaking bead 25 is parallel sided, however the outer wall may be inclined to a line perpendicular to the central panel at an angle between −15° to +15° and the height h_4 of the outer wall may be up to 2.5 mm.

This can end is preferably made from a laminate of sheet metal and polymeric coating. Preferably the laminate comprises an aluminium magnesium alloy sheet such as 5182, or aluminium manganese alloy such as 3004 with a layer of polyester film on one side. A polypropylene film may be used on the "other side" if desired.

Typical dimensions of the example of the invention are:

$d5$	overall diameter (as stamped)	65.83 mm
$d4$	PC diameter of seaming panel radius	61.54 mm
$d3$	PC diameter of seaming panel/chuck wall radius	59.91 mm
r_1	seaming panel/chuck wall radius	1.27 mm

-continued

r_2	seaming panel radius	5.56 mm
r_3	concave radius in antipeaking bead	<1.5 mm
d_2	maximum diameter of antipeaking bead	50.00 mm
d_1	minimum diameter of antipeaking bead	47.24 mm
h_2	overall height of can end	6.86 mm
h_1	height to top of antipeaking bead	5.02 mm
h_3	panel depth	2.29 mm
h_4	outer wall height	1.78 mm
c	chuck wall angle to vertical	43°

From these dimensions it can be calculated that the ratio of central panel diameter of 47.24 mm to overall diameter of can end 65.84 is about 0.72 to 1.

For economy the aluminium alloy is in the form of sheet metal less than 0.010" (0.25 mm). A polyester film on the metal sheet is typically 0.0005" (0.0125 mm).

Although this example shows an overall height h_2 at 6.86 mm we have also found that useful can ends may be made with an overall height as little as 6.35 mm (0.25").

FIG. 5 shows the peripheral flange 23 of can end 22 of FIG. 4 resting on the flange 11 of a can body 12 before formation of a double seam as discussed with reference to FIG. 1.

In FIG. 5 a modified chuck 30 comprises a chuck body 31 having a frustoconical drive surface 32 engaging with the chuck wall 24 of the can end 22.

The frustoconical drive surface is inclined outwardly and axially at an angle substantially equal to the angle of inclination C° of between 20° and 60°; in this particular example on chuck angle C of 43° is preferred. The drive surface 32 is a little shorter than the chuck wall 24 of the chuck body. The substantially cylindrical surface portion 33, rising above the drive surface 32, may be inclined at an angle between +4° and −4° to a longitudinal axis of the chuck. As in FIG. 2, this modified chuck 30 has a threaded aperature to permit attachment to the rest of the double seam forming apparatus (not shown).

In contrast to the chuck of FIG. 2 the modified chuck 30 is designed to drive initially on the relatively large chuck wall 32 without entering deeply into the anti-peaking bead 25. Further drive is obtained at the juncture of chuck wall 32 and cylindrical wall 33 as chuck wall of end 24 is deformed during 1st and 2nd operation seaming FIGS. 6 and 7. The chuck 30 shown in FIG. 5 has an annular bead of arcuate cross section but this bead is designed to enter the chuck wall without scratching or scuffing a coating on the can end; not to drive on the concave bead surface as shown in FIG. 2.

It will be understood that first operation seaming is formed using apparatus as described with reference to FIG. 1.

FIG. 6 shows the modified can end and chuck during formation of a first operation seam shown at the left of FIG. 2 as formed by a first operation roll 34 adjacent the interfolded peripheral flange of the can end and flange 11 body 12.

During relative rotation as between the can end 22 and first operation roll 34 the edge between the chuck drive wall 32 and cylindrical wall 33 exerts a pinching force between chuck 30 and roll 34 to deform the chuck wall of the can end as shown.

After completion of the first operation seam the first operation roll is swung away from the first operation seam and a second operation roll 38 is swung inwards to bear upon the first operation seam supported by the chuck 30. Relative rotation as between the second operation roll 38 and first operation seam supported by a chuck wall 30 completes a double seam as shown in FIG. 7 and bring the upper portion 24 of the chuck wall 24 to lie tightly against the can body

neck in a substantially upright attitude as the double seam is tightened by pinch pressure between the second operation roll 38 and chuck 30.

Can ends according to the invention were made from aluminium alloy 5182 and an aluminium alloy 3004/ polymer laminate sold by CarnaudMetalbox under the trade mark ALULITE. Each can end was fixed by a double seam to a drawn and wall ironed (DWI) can body using various chuck angles and chuck wall angle as tabulated in Table 1 which records the pressure inside a can at which the can ends failed:

TABLE 1

	CAN END DATA			PRESSURE IN BAR (PSIG) TO FAILURE FOR VARIOUS SEAMING CHUCK ANGLES B°				
Sample Code	Material Thickness mm	Minimum Diameter D1 mm	CHUCK Wall Angle "C"	23°	10°/23°	4°/23°	23° with D. Seam Ring	10°/23° with D. Seam Ring
A	ALULITE 0.23	52.12 (2.052")	21.13°	5.534 (80.20)	5.734 (83.10)	5.311 (76.97)	6.015 (87.17)	5.875 (85.14)
B	5182 0.244	52.12 (2.052")	21.13°	5.599 (81.15)	5.575 (80.79)	5.381 (77.99)	5.935 (86.01)	5.895 (85.43)
C	5182 0.245	52.12 (2.052")	21.13°	6.004 (87.02)	5.910 (85.65)	5.800 (84.06)	6.224 (90.21)	6.385 (92.54)
D	ALULITE 0.23	51.92 (2.044")	21.13°	5.334 (77.31)	5.229 (75.78)	5.238 (75.91)	5.730 (83.04)	5.404 (78.32)
E	5182 0.224	51.92 (2.044")	21.13°	5.555 (80.50)	5.514 (79.92)	5.354 (77.60)	5.895 (85.43)	5.930 (85.94)
F	5182 0.245	51.92 (2.044")	23°	5.839 (84.63)	5.804 (84.12)	5.699 (82.59)	6.250 (90.58)	6.435 (93.26)
G	ALULITE 0.23	51.92 (2.044")	23°			5.123 (74.25)		
H	5182 0.224	(51.92) (2.044")	23°			5.474 (79.34)		
I	5182 0.245	51.92 (2.044")	23°			5.698 (82.58)		

All pressures on unaged shells in bar (psig). 5182 is an aluminium-magnesium-manganese alloy lacquered. The "ALULITE" used is a laminate of aluminium alloy and polyester film.

The early results given in Table 1 showed that the can end shape was already useful for closing cans containing relatively low pressures. It was also observed that clamping of the double seam with the "D" seam ring resulted in improved pressure retention. Further tests were done using a chuck wall angle and chuck drive surface inclined at nearly 45°: Table 2 shows the improvement observed:

TABLE 2

Sample Code	h_2 mm (inches)	h_3 mm (inches)	h_4 mm (inches)	Chuck Angles B° 43°	43° with seam ring
J	6.86 (0.270)	2.39 (0.094)	2.29 (0.09)	4.89 (70.9)	6.15 (89.1)
K	7.11 (0.280)	2.64 (0.104)	2.54 (0.10)	4.83 (70.0)	5.98 (86.6)
L	7.37 (0.290)	2.90 (0.114)	2.79 (0.11)	4.74 (68.7)	6.44 (93.3)

Table 2 is based on observations made on can ends made of aluminium coated with polymer film (ALULITE) to have a chuck wall length of 5.029 mm (0.198") up the 43° slope.

It will be observed that the container pressures achieved for samples J, K, L, 4.89 bar (70.9 psig), 4.83 bar (70.0 psig) and 4.74 bar (68.7 psig) respectively were much enhanced by clamping the double seam.

In order to provide seam strength without use of a clamping ring, modified chucks were used in which the drive slope angle C° was about 43° and the cylindrical surface 33 was generally +4° and −4°. Results are shown in Table 3.

TABLE 3

	Results			
SAMPLE CODE	MATERIAL	LINING COMPOUND	CHUCK ANGLES DRIVE/ WALL	PRESSURE
c	0.224 5182	with	43°	4.60 (66.7)
g	0.23 Alulite	with	43°/4°	5.45 (79.0)
h	0.224 5182	with	43°/4°	6.46 (93.6)
j	0.23 Alulite	without	43°/4°	5.91 (85.6)
k	0.244 5182	without	43°/4°	6.18 (89.6)
l	0.23 Alulite	without	43°/−4°	5.38 (77.9)
m	0.25 Alulite	without	43°/−4°	6.20 (89.8)
n	0.23 Alulite	without	43°/0°	6.11 (88.5)
o	0.25 Alulite	without	43°/0°	6.62 (95.9)

ALL PRESSURES IN BAR (PSIG)

ALL CODES

Reform Pad Dia. 47.24 mm (1.860") (202 Dia).

6.86 mm (0.270") unit Depth h_2 2.39 mm (0.094") Panel Depth

Table 3 shows Code "0" made from 0.25 mm Alulite to give 6.62 bar (95 psi) Pressure Test Result indicating a can end suitable for pressurised beverages. Further chucks with various land lengths (slope) were tried as shown in Table 4.

TABLE 4

	CHUCK WALL ANGLE			
	43°/0° 1.9 mm LAND SHARP TRANSITION		43°/0° 1.27 MM LAND R. 0.5 MM BLEND	
VARIABLE CODE	NO. D.SEAM RING	WITH D.SEAM RING	NO. D.SEAM RING	WITH D.SEAM RING
7	6.699 (97.08)	7.017 (101.7)	6.779 (98.24)	7.006 (101.54)
8	6.315 (91.52)	6.521 (94.5)	6.293 (91.2)	6.236 (90.37)
9	6.095 (88.33)	6.30 (91.3)	6.238 (90.4)	6.719 (97.38)

ALL PRESSURES IN BAR (PSIG)
CODE

7=0.25 mm Alulite, 47.24 mm (1.860") Reform Pad, 6.86 mm (0.270") h_2 Depth, 2.38 mm (0.094") Panel; h_4 depth=2.29 mm (0.09")

8=0.23 mm Alulite, 47.24 mm (1.860") Reform Pad, 7.11 mm (0.280") h_2 Depth, 2.64 mm (0.104") Panel; h_4 depth=2.54 mm (0.10")

9=0.23 mm Alulite, 47.24 mm (1.860") Reform Pad, 7.37 mm (0.290") h_2 Depth, 2.90 mm (0.114") Panel; h_4 depth=2.79 mm (0.11")

Table 4 shows results of further development to seaming chuck configuration to bring closer the pressure resistance of ring supported and unsupported double seams.

Table 4 identifies parameters for length of generally vertical cylindrical surface 33 on the seaming chuck 30, and also identifies a positional relationship between the chuck wall 24 of the end and the finished double seam. It will be understood from FIG. 7 shows that the forces generated by thermal processing or carbonated products are directed towards and resisted by the strongest portions of the completed double seam.

Table 5 shows results obtained from a typical seam chuck designed to give double seam in accordance with parameters and relationships identified in Table 4. Typically:—As shown in FIG. 8 the chuck comprises a cylindrical land of length 'l' typically 1.9 mm (0.075") and frustoconical drive surface 32 inclined at an angle Y°, typically 43°, to the cylindrical to which it is joined by a radius R typically 0.5 mm (0.020"). Angle "X" is typically 90°.

TABLE 5

		DIMENSIONS mm		PRESSURE	
CODE	GAUGE	h_2	h_3	bar	(psi)
20	.23 mm	7.37 (.290")	2.36 (.093")	6.383	(92.6)
21	.23 mm	7.37 (.290")	2.36 (.093") with compound	6.402	(92.8)
26	.23 mm	6.87 (.2705")	2.37 (.0935")	6.144	(89.88)
27	.23 mm	6.87 (.2705")	2.37 (.0934") with compound	6.071	(88.0)
28	.23 mm	7.37 (.290")	2.36 (.093")	6.414	(93.0)
29	.23 mm	7.37 (.290")	2.84 (.112")	6.725	(97.5)
30	.23 mm	6.86 (.270")	2.37 (.0935")	6.062	(87.9)
31	.23 mm	6.86 (.270")	2.37 (.0935")	6.013	(87.2)
34	.25 mm	7.37 (.290")	2.87 (.113")	7.787	(112.9)
36	.25 mm	7.32 (.288")	2.34 (.092")	7.293	(105.8)
37	.25 mm	7.32 (.288")	2.34 (.092") with compound	7.402	(107.3)
38	.25 mm	6.87 (.2705")	2.41 (.095")	7.077	(102.6)
516	.25 mm	6.35 (.250")	2.34 (.092") with compound	6.937	(100.6)

All variables made from Alulite, 10 Cans per variable.

The can ends may be economically made of thinner metal if pressure retention requirements permit because these can ends have a relatively small centre panel in a stiffer annulus.

FIG. 9 shows a can 12*a*, closed according to this invention, stacked upon a like can 12*b* shown sectioned so that stacking of the upper can on the lower can end is achieved by a stand bead 31*a* of the upper can fits inside the chuck wall 24 of the lower can end with the weight of the upper can resting on the double seam 34 of the lower can end.

The clearance between the bottom of the upper can body and lower can end may be used to accommodate ring pull features (not shown) in the can end or promotional matter such as an coiled straw or indicia.

Using the experimental data presented above, a computer programme was set up to estimate the resistance to deformation available to our can ends when joined to containers containing pressurised beverage. The last two entries on the table relate to a known 206 diameter beverage can end and an estimate of what we think the KRASKA patent teaches.

TABLE 6

END SIZE Bead OD:ID	OVERALL DIA mm	PANEL DIA d_1 mm	RATIO OVERALL DIA: PANEL DIA	CHUCK WALL ANGLE ° C.	CHUCK WALL LENGTH L mm	RE-INPORCING RAD r_3 mm	INNER WALL HEIGHT h_3 mm	OUTER WALL HEIGHT h_4 mm	PREDICTED CUT EDGE Ø (*DENOTES ACTUAL)	ACTUAL THICK-NESS TO CONTAIN PSI
206-204	64.39 (2.535")	49.49 (1.9485")	1.3010	33.07°	4.22 (0.166")	0.52 (0.204")	2.34 (0.092")	1.78 (0.070")	75.239 (2.9618")	0.255
206-202	64.39 (2.535")	47.33 (1.8634")	1.3604	42.69°	4.95 (0.195")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	74.272 (2.9241")*	0.255
206-200	64.39 (2.535")	45.07 (1.7744")	1.4287	50.053°	5.82 (0.229")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.13 (2.9021")	0.255
204-202	62.18 (2.448")	47.33 (1.8634")	1.3137	29.78°	3.96 (0.156")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.767 (2.9042")	0.24

TABLE 6-continued

END SIZE Bead OD:ID	OVERALL DIA mm	PANEL DIA d_1 mm	RATIO OVERALL DIA: PANEL DIA	CHUCK WALL ANGLE ° C	CHUCK WALL LENGTH L mm	RE-INFORCING RAD r_3 mm	INNER WALL HEIGHT h_3 mm	OUTER WALL HEIGHT h_4 mm	PREDICTED CUT EDGE Ø (*DENOTES ACTUAL)	ACTUAL THICK-NESS TO CONTAIN PSI
204-200	62.18 (2.448")	45.07 (1.7744")	1.3796	40.786°	4.70 (0.185")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	72.913 (2.8705")	0.24
202-200	71.98 (2.834")	45.07 (1.7744")	1.597	30.266°	4.09 (0.161")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	71.984 (2.834")	0.225
206 std	64.69 (2.547")	51.92 (2.044")	1.2461	15.488°	4.39 (0.173")	0.56 (0.022")	2.03 (0.080")	—	76.454 (3.010")*	0.28
KRASKA ESTIMATE	64.39 (eg 2.535")	—	—	15°	2.54 (0.100")	0.81 (0.032")	1.65 (0.065")	2.29 (0.090")	78.080 (3.074")	0.292 (0.0115")

All experiments modelled on a notional aluminium alloy of yield strength 310 mpa 0.25 mm thick. The standard was also 310 mpa BUT 0.275 mm thick.

What is claimed is:

1. A method of forming a double seam between a can body and a can end, said method comprising the steps of:

a) providing a can end having a circumferentially extending peripheral curl and a wall extending circumferentially and radially inward from said curl and an annular reinforcing bead extending radially inward from said wall, said reinforcing bead having an interior surface, said peripheral curl comprising a seaming panel and a radiused portion extending from said seaming panel to said wall, said wall inclined between about 20° and about 60° with respect to an axial centerline of said can end;

b) placing said curl of said can end into contact with a circumferentially extending flange of a can body;

c) providing a rotatable chuck having first and second circumferentially extending walls, said first and second walls forming a juncture therebetween; bringing said chuck into engagement with said can end so that said juncture of said first and second walls of said chuck contacts said inclined wall of said can end;

d) rotating said chuck;

e) performing a first seaming operation by placing a first seaming roll into contact with said can end curl while rotating said can end so as to partially deform said curl and said can body flange into a partial seam, said rotation of said can end during said first seaming operation driven by said rotating chuck through driving contact between said juncture of said first and second walls of said chuck and said inclined wall of said can end without driving contact between said chuck and said can end bead interior surface;

f) performing a second seaming operation by placing a second seaming roll into contact with said partially deformed can end curl so as to further deform said curl and said can body flange so as to further form said seam.

2. The method according to claim 1, wherein said first and second seaming operations reform said can end inclined wall by bending a first portion of said inclined wall upward by an angle of at least about 16°.

3. The method according to claim 1, wherein as a result of said first and second seaming operations said can end inclined wall is reformed so that a first portion of said wall is oriented substantially cylindrically.

4. The method according to claim 1, wherein prior to performing said first seaming operation said wall of said can end is inclined between about 30° and about 50° with respect to said axial centerline of said can end.

5. The method according to claim 4, wherein as a result of said first and second seaming operations said can end inclined wall is reformed so that a first portion of said wall is oriented substantially cylindrically.

6. The method according to claim 4, wherein said first and second seaming operations reform said can end inclined wall by bending a first portion of said inclined wall upward by an angle of at least about 26°.

7. The method according to claim 1, wherein prior to performing said first seaming operation said wall of said can end is inclined between about 40° and about 45° with respect to an axial centerline of said can end.

8. The method according to claim 7, wherein as a result of said first and second seaming operations said can end inclined wall is reformed so that a first portion of said wall is oriented substantially cylindrically.

9. The method according to claim 7, wherein said first and second seaming operations reform said can end inclined wall by bending a first portion of said inclined wall upward by an angle of at least about 36°.

10. The method according to claim 1, wherein said first circumferentially extending wall of said chuck is oriented so as to be substantially cylindrical.

11. The method according to claim 10, wherein said substantially cylindrical first wall of said chuck is oriented so as to be inclined with respect to an axial centerline of said chuck by no more than about 4°.

12. The method according to claim 1, wherein the distance from the lowermost point on said annular bead to the uppermost point on said curl defines a height of said can end, and wherein as a result of said first and second seaming operations said can end inclined wall is reformed so that a first portion of said wall is bent upwardly so as to substantially increase said height of said can end.

13. The method according to claim 1, wherein said chuck second wall is inclined with respect to an axial centerline of said chuck that substantially matches said inclination of said can end wall, and wherein said rotation of said can end during said first seaming operation is aided by driving contact between said second wall of said chuck and said inclined wall of said can end.

14. A method of forming a double seam between a can body and a can end intended for use in packaging a carbonated beverage, said method comprising the steps of:

a) providing a can end having (i) a circumferentially extending peripheral cover hook, said peripheral cover hook comprising a seaming panel to be formed into a portion of said double seam during a seaming operation, (ii) an annular reinforcing bead, and (iii) a circumferentially extending wall extending from said

seaming panel to said reinforcing bead, said wall comprising first and second wall portions, said first wall portion to be formed into another portion of said double seam during said seaming operation, said first wall portion extending from said seaming panel to a first location on said wall and comprising a radiused portion extending from said seaming panel, said second wall portion extending from said first wall portion at said first wall location to a second location on said wall that forms a transition with said reinforcing bead, whereby said first and second locations form end points of said second wall portion, and wherein a straight line extending between said first and second locations on said wall is inclined between about 20° and about 60° with respect to an axial centerline of said can end;

b) placing said cover hook of said can end into contact with a circumferentially extending flange of a can body;

c) providing a rotatable chuck comprising a first circumferentially extending wall, said chuck first wall being substantially cylindrical;

d) bringing said chuck into engagement with said can end; and

e) performing said seaming operation by placing one or more seaming rolls into contact with said peripheral cover hook of said can end while said can end rotates so as to deform said seaming panel of said cover hook and said first wall portion and said can body flange into said double seam, said seaming operation deforming said first wall portion such that at least a portion of said first wall portion after seaming is substantially cylindrical, said first location on said wall after said seaming operation forming the transition from said substantially cylindrical wall portion to said second wall portion, said line between said first and second locations on said wall remaining inclined between about 20° and about 60° with respect to said axial centerline after completion of said seaming operation.

15. The method according to claim 14, wherein during said seaming operation at least a portion of said can end wall first portion is reformed by bending upward by an angle of at least about 16°.

16. The method according to claim 14, wherein said line between said first and second locations on said wall of said can end is inclined between about 30° and about 50° with respect to an axial centerline of said can end prior to performing said seaming operation.

17. The method according to claim 16, wherein during said seaming operation at least a portion of said can end wall first portion is reformed by bending upward by an angle of at least about 26°.

18. The method according to claim 14, wherein said line between said first and second locations on said second wall of said can end is inclined between about 40° and about 45° with respect to an axial centerline of said can end.

19. The method according to claim 18, wherein during said seaming operation at least a portion of said can end wall first portion is reformed by bending upward by an angle of at least about 36°.

20. The method according to claim 14, wherein said substantially cylindrical first wall of said chuck is oriented so as to be inclined with respect to an axial centerline of said chuck by no more than about 4°.

21. The method according to claim 14, wherein the distance from the lowermost point on said annular bead to the uppermost point on said cover hook defines a height of said can end, and wherein as a result of said seaming operation at least a portion of said can end first wall portion is bent upwardly into said substantially cylindrical orientation so as to substantially increase said height of said can end.

22. The method according to claim 14, wherein

f) said annular bead has an interior surface thereof;

g) said chuck further comprises a second wall, said first and second walls of said chuck form a juncture therebetween;

h) said seaming operation comprises (i) performing a first seaming operation by placing a first seaming roll into contact with said can end cover hook while said can end is rotated so as to partially deform said cover hook and said first wall portion and said can body flange into a partial seam, and (ii) performing a second seaming operation by placing a second seaming roll into contact with said partially deformed can end cover hook so as to further deform said cover hook and said first portion and said can body flange so as to further form said seam;

i) said rotation of said can end during said first seaming operation is accomplished by imparting driving contact between said juncture of said first and second walls of said chuck and said wall of said can end but without imparting driving contact between said chuck and said can end bead interior surface.

23. The method according to claim 14, further comprising the step of filling the can body with a carbonated beverage prior to performing said seaming operation.

24. The method according to claim 14, wherein said chuck further comprises a second chuck wall depending from said substantially cylindrical first chuck wall, said second chuck wall not being substantially cylindrical whereby said first and second chuck walls form a juncture therebetween, and wherein the step of bringing said chuck into engagement with said can end comprises bringing said chuck wall juncture into engagement with said can end wall proximate said first location on said can end wall.

25. The method according to claim 24, wherein the step of performing said seaming operation further comprises bending said first wall portion of said can end upwardly around said chuck wall juncture so as to permanently deform said first wall portion.

26. The method according to claim 14, wherein said wall of said can end is substantially frustoconical prior to performing said seaming operation.

27. The method according to claim 14, wherein said first and second portions of said wall of said can end lie along a substantially straight line prior to performing said seaming operation.

28. The method according to claim 14, wherein said line between the first and second locations on said second wall remains inclined between about 30° and about 50° after seaming.

29. The method according to claim 14, wherein said line between the first and second locations on said second wall remains inclined between about 40° and about 45° after seaming.

30. The method according to claim 14, wherein, in said step c) of performing the seaming operation, rotation of said can end is achieved without imparting driving contact between said chuck and a bottom interior surface of said reinforcing bead.

31. The method according to claim 14, wherein said chuck further comprises a second chuck wall depending from said substantially cylindrical first chuck wall, said second chuck wall being substantially frustoconical.

32. A method of forming a double seam between a can body and a can end intended for use in packaging a carbonated beverage, said method comprising the steps of:

a) providing a can end having (i) a circumferentially extending peripheral cover hook, said peripheral cover hook comprising a seaming panel to be formed into a portion of said double seam during a seaming operation and (ii) a circumferentially extending wall comprising first and second portion, said first wall portion to be formed into another portion of said double seam during said seaming operation, said first wall portion extending from said seaming panel to a first location on said wall and comprising a radiused portion extending from said seaming panel, said second wall portion extending from said first wall portion at said first wall location on said wall to a second location on said wall, whereby said first and second locations form end points of said second wall portion, said second wall location being the lowermost point of said wall, and wherein a straight line extending between said first and second locations on said wall is inclined between about 20° and about 60° with respect to an axial centerline of said can end;

b) placing said cover hook of said can end into contact with a circumferentially extending flange of a can body;

c) providing a rotatable chuck comprising a first circumferentially extending wall, said first chuck wall being substantially cylindrical;

d) bringing said chuck into engagement with said can end; and

e) performing said seaming operation by placing one or more seaming rolls into contact with said peripheral cover hook of said can end so as to deform said seaming panel of said cover hook and said first wall portion and said can body flange into said double seam, said first portion of said can end wall being pressed against said chuck first wall so that at least a portion of said first portion of said can end wall is bent upward through an angle of at least about 16°, said first location on said wall after said seaming operation forming the transition from said double seam to said second wall portion, said line between said first and second locations remaining inclined between about 20° and about 60° with respect to said axial centerline.

33. The method according to claim 32, wherein said line between said first and second locations on said wall of said can end is inclined between about 30° and about 50° with respect to said axial centerline of said can end prior to performing said seaming operation.

34. The method according to claim 33, wherein during said seaming operation at least a portion of said can end wall first portion is reformed by bending upward by an angle of at least about 26°.

35. The method according to claim 33, wherein said line between the first and second locations on said second wall portion remains inclined between about 30° and about 50° after seaming.

36. The method according to claim 32, wherein said line between said first and second locations on said wall of said can end is inclined between about 40° and about 45° with respect to said axial centerline of said can end prior to performing said seaming operation.

37. The method according to claim 36, wherein during said seaming operation at least a portion of said can end wall first portion is reformed by bending upward by an angle of at least about 36°.

38. The method according to claim 36, wherein said line between the first and second locations on said second wall portion remains inclined between about 40° and about 45° after seaming.

39. The method according to claim 32, wherein the can end further comprises a reinforcing bead extending radially inward from said second portion of said wall at said second wall location, the distance from a lowermost point on said annular bead to the uppermost point on said cover hook defines a height of said can end, and wherein said upward bending of said first portion of can end wall during said seaming operation substantially increases said height of said can end.

40. The method according to claim 32, wherein

f) said can end comprises an annular reinforcing bead extending radially inward from said wall, said annular bead having an interior surface thereof;

g) said chuck further comprises a second wall, said first and second walls of said chuck form a juncture therebetween;

h) said seaming operation comprises (i) performing a first seaming operation by placing a first seaming roll into contact with said can end peripheral cover hook while said can end is rotated so as to partially deform said cover hook and said first wall portion and said can body flange into a partial seam, and (ii) performing a second seaming operation by placing a second seaming roll into contact with said partially deformed can end cover hook so as to further deform said cover hook and said first wall portion and said can body flange so as to further form said seam;

i) said rotation of said can end during said first seaming operation is accomplished by imparting driving contact between said juncture of said first and second walls of said chuck and said wall of said can end but without imparting driving contact between said chuck and said can end bead interior surface.

41. The method according to claim 32, further comprising the step of filling the can body with a carbonated beverage prior to performing said seaming operation.

42. The method according to claim 32, wherein said chuck further comprises a second chuck wall depending from said substantially cylindrical first chuck wall, said second chuck wall not being substantially cylindrical whereby said first and second chuck walls form a juncture therebetween, and wherein the step of bringing said chuck into engagement with said can end comprises bringing said chuck wall juncture into engagement with said can end wall proximate said second location on said can end wall.

43. The method according to claim 42, wherein said bending of said first wall portion during said seaming operation comprises bending said first wall portion upwardly around said chuck wall juncture.

44. The method according to claim 42, wherein said end includes an annular reinforcing bead extending from said second wall portion and, in said step e) of performing the seaming operation, rotation of said can end is achieved without imparting driving contact between said chuck and a bottom interior surface of said reinforcing bead.

45. The method according to claim 32, wherein the can end includes a reinforcing bead extending radially inward from said lowermost point of said second portion of the wall.

46. The method according to claim 32, wherein said wall of said can end is substantially frustoconical prior to performing said seaming operation.

47. The method according to claim 32, wherein said first and second portions of said wall of said can end lie along a substantially straight line prior to performing said seaming operation.

48. The method according to claim 32, wherein after said seaming operation said first and second portions of said can end wall intersect at an obtuse angle.

49. The method according to claim 32, wherein said chuck further comprises a second chuck wall depending from said substantially cylindrical first chuck wall, said second chuck wall being substantially frustoconical.

50. A method of forming a double seam between a can body and a can end intended for use in packaging a carbonated beverage, said method comprising the steps of:

a) providing a can end having (i) a circumferentially extending peripheral cover hook, said peripheral cover hook comprising a seaming panel to be formed into a portion of said double seam during a seaming operation, (ii) an annular reinforcing bead, and (iii) a circumferentially extending wall extending from said seaming panel to said reinforcing bead, said wall and said reinforcing bead forming a transition therebetween;

b) placing said cover hook of said can end into contact with a circumferentially extending flange of a can body;

c) providing a rotatable chuck comprising first and second circumferentially extending walls, said second chuck wall depending from said first chuck wall so as to form a juncture therebetween;

d) bringing said chuck into engagement with said can end; and

e) performing said seaming operation by placing one or more seaming rolls into contact with said peripheral cover hook of said can end while said can end rotates so as to deform said seaming panel of said cover hook and to bend a portion of said can end wall upwardly around said juncture of said chuck walls at a first location on said can end wall, a straight line extending from said first location on said can end wall to said transition between said can end wall and said reinforcing bead inclined between about 20° and about 60° with respect to said axial centerline both before and after said seaming operation.

51. The method according to claim 50 wherein at least a portion of said portion of said can end wall bent upwardly during said seaming operation is bent upward through an angle of at least about 16°.

52. The method according to claim 50, wherein said line extending from said first location to said transition is inclined between about 30° and about 50° with respect to said axial centerline of said can end both before and after performing said seaming operation.

53. The method according to claim 52, wherein at least a portion of said portion of said can end wall bent upwardly during said seaming operation is bent upward through an angle of at least about 26°.

54. The method according to claim 50, wherein said line extending from said first location to said transition is inclined between about 40° and about 45° with respect to said axial centerline of said can end both before and after performing said seaming operation.

55. The method according to claim 54, wherein at least a portion of said portion of said can end wall bent upwardly during said seaming operation is bent upward through an angle of at least about 36°.

56. The method according to claim 50, wherein at least a portion of said portion of said can end wall bent upwardly during said seaming operation is bent upward into a substantially cylindrical configuration.

57. The method according to claim 50, wherein said wall of said can end is substantially frustoconical prior to performing said seaming operation.

58. The method according to claim 50, wherein said first wall of said chuck is oriented so as to be inclined with respect to an axial centerline of said chuck by no more than about 4°.

59. The method according to claim 50, wherein said first wall of said chuck is substantially cylindrical.

60. The method according to claim 59, wherein said said second chuck wall being substantially frustoconical.

61. The method according to claim 50, wherein the distance from a lowermost point on said annular bead to the uppermost point on said cover hook defines a height of said can end, and said seaming operation increases said height of said can end.

62. The method according to claim 50, wherein

f) said annular bead has an interior surface thereof;

g) said seaming operation comprises (i) performing a first seaming operation by placing a first seaming roll into contact with said can end curl while said can end is rotated so as to partially deform said cover hook and a first portion of said can end wall and said can body flange into a partial seam, and (ii) performing a second seaming operation by placing a second seaming roll into contact with said partially deformed can end cover hook so as to further deform said cover hook and said can end wall first portion and said can body flange so as to further form said seam;

h) said rotation of said can end during said first seaming operation is accomplished without imparting driving contact between said chuck and said can end bead interior surface.

* * * * *

EXHIBIT 2

US006935826B2

(12) **United States Patent**
Brifcani et al.

(10) **Patent No.: US 6,935,826 B2**
(45) **Date of Patent: Aug. 30, 2005**

(54) **CAN END AND METHOD FOR FIXING THE SAME TO A CAN BODY**

(75) Inventors: **Mouayed Mamdooh Brifcani**, Oxfordshire (GB); **Peter James Hinton**, Swindon (GB); **Mark Christopher Kysh**, Wantage (GB)

(73) Assignee: **Crown Cork & Seal Technologies Corporation**, Alsip, IL (US)

(*) Notice: 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.: **10/417,980**

(22) Filed: **Apr. 17, 2003**

(65) **Prior Publication Data**

US 2003/0202862 A1 Oct. 30, 2003

Related U.S. Application Data

(63) Continuation of application No. 10/024,862, filed on Dec. 18, 2001, now Pat. No. 6,848,875, which is a continuation of application No. 09/650,664, filed on Aug. 30, 2000, now abandoned, which is a continuation of application No. 09/552,668, filed on Apr. 19, 2000, now abandoned, which is a continuation of application No. 08/945,698, filed as application No. PCT/GB96/00709 on Mar. 25, 1996, now Pat. No. 6,065,634.

(30) **Foreign Application Priority Data**

May 24, 1995 (GB) 9510515

(51) **Int. Cl.**[7] **B21D 51/32**; B21D 51/44

(52) **U.S. Cl.** **413/31**; 220/619; 220/620; 220/623; 220/906

(58) **Field of Search** 413/2, 4, 8, 31, 413/27, 36, 37, 43; 220/268, 269, 270, 619, 620, 623, 621, 617, 62.22, 62.12, 906

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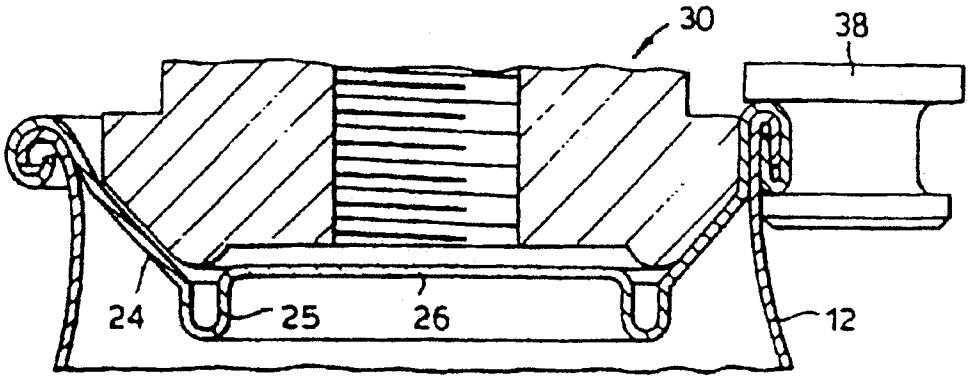
(57) **ABSTRACT**

A can end includes a peripheral cover hook a chuck wall dependent from the interior of the cover hook, an outwardly concave annular reinforcing bead extending radially inwards from the chuck wall, and a central panel supported by an inner portion of the reinforcing bead, characterized in that, the chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle between 20° and 60°, and the concave cross-sectional radius of the reinforcing bead is less than 0.75 mm.

14 Claims, 4 Drawing Sheets



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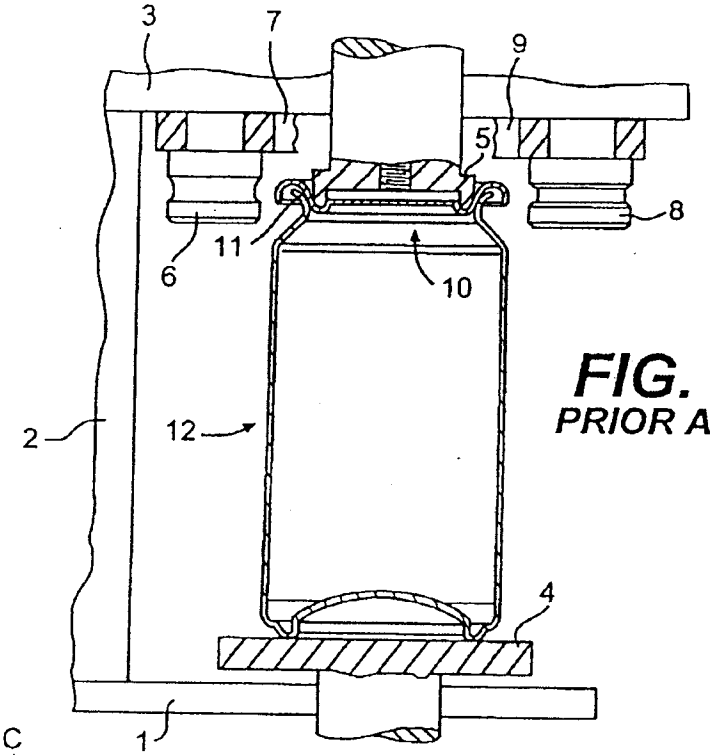


FIG. 1
PRIOR ART

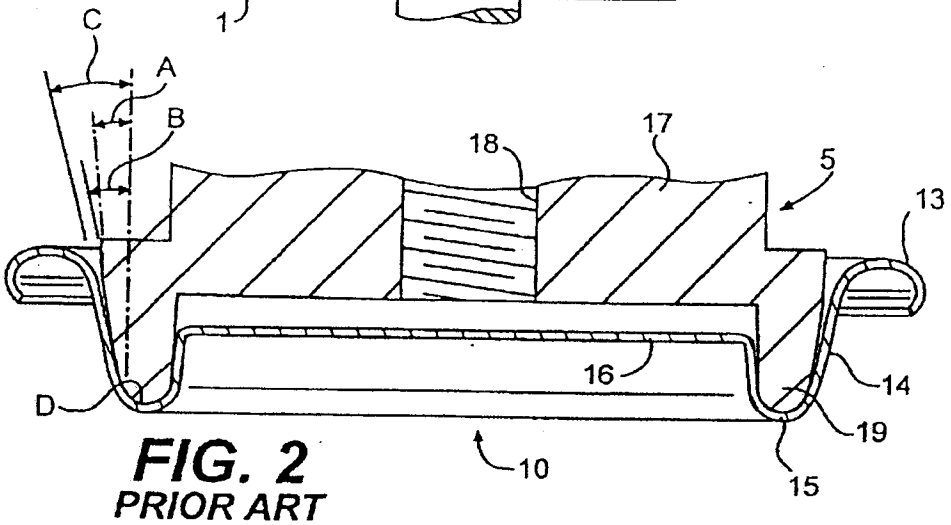


FIG. 2
PRIOR ART

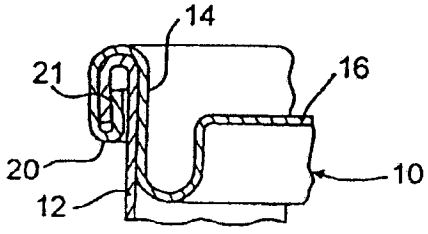


FIG. 3
PRIOR ART

Fig.4.

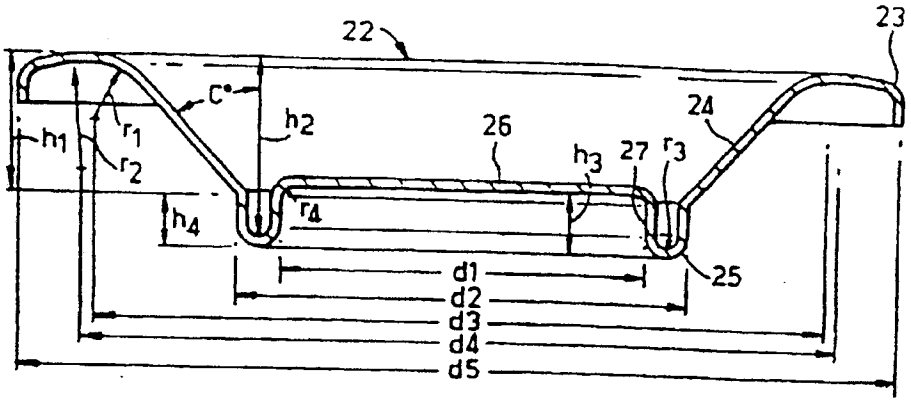

22
23
C°
h1
r1
r2
h2
26
24
h3
27
r3
h4
r4
25
d1
d2
d3
d4
d5

Fig.5.

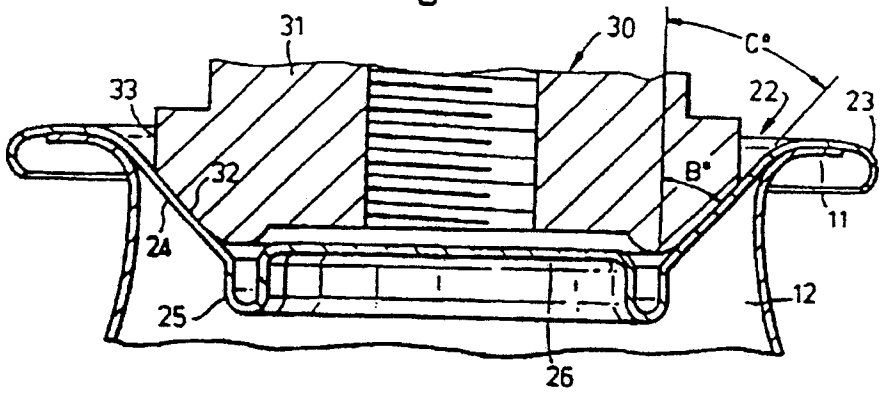

31
30
C°
33
22
23
32
B°
24
11
25
12
26

Fig.6.

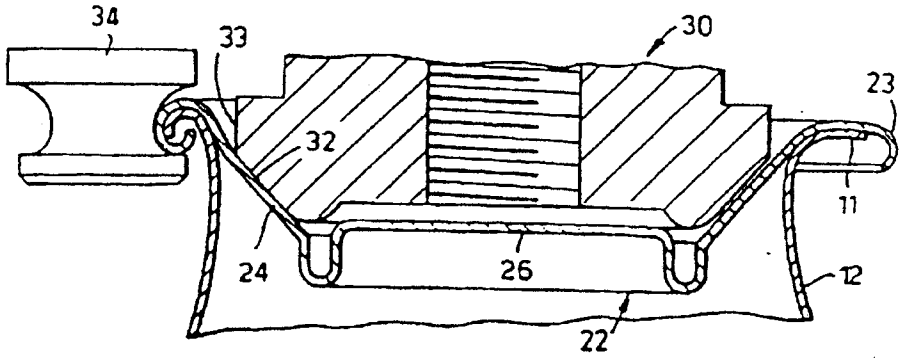


Fig.7.

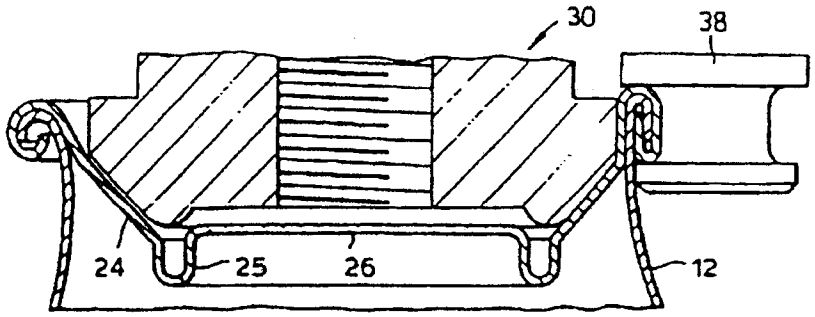


Fig.8.

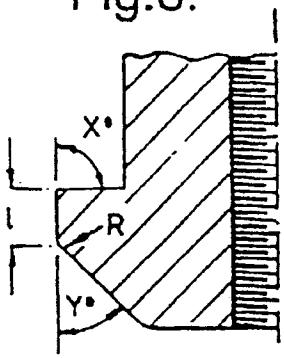
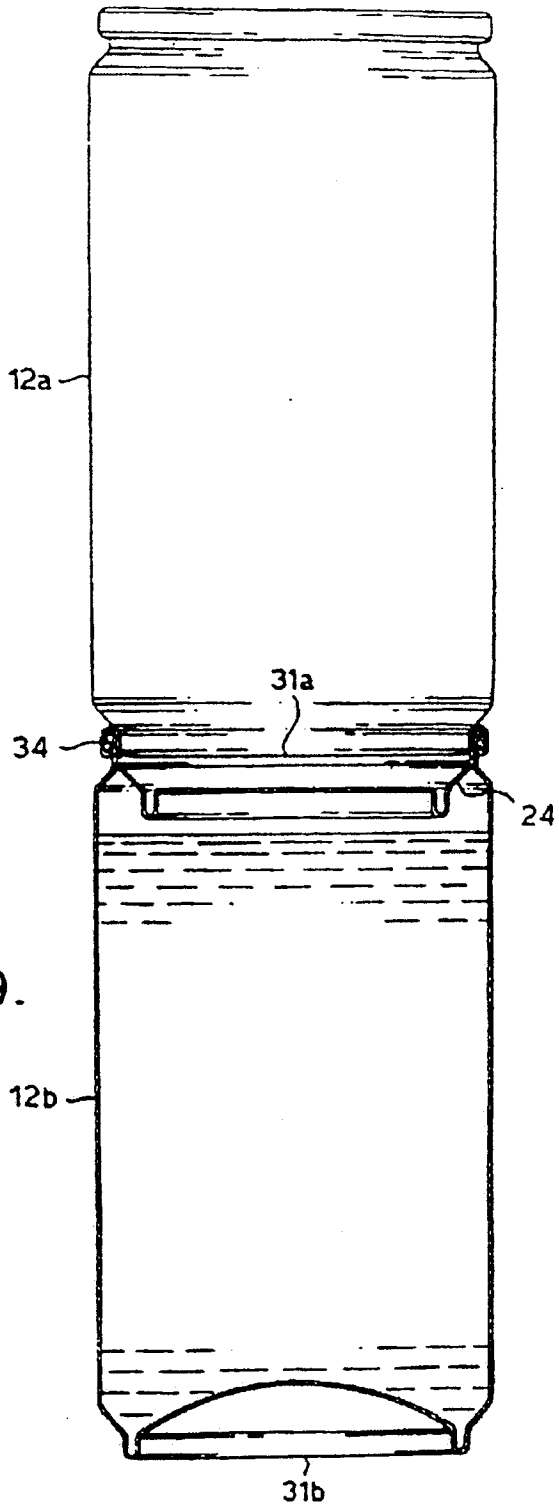


Fig.9.



CAN END AND METHOD FOR FIXING THE SAME TO A CAN BODY

This is a continuation of U.S. patent application Ser. No. 10/024,862, which issued Feb. 1, 2005 as U.S. Pat. No. 6,848,875, filed Dec. 18, 2001, which is a continuation of U.S. patent application Ser. No. 09/650,664, filed Aug. 30, 2000, now abandoned which is a continuation of U.S. patent application Ser. No. 09/552,668, filed Apr. 19, 2000, now abandoned, which is a continuation of U.S. patent application Ser. No. 08/945,698, filed Nov. 21, 1997, which issued May 23, 2000 as U.S. Pat. No. 6,065,634, which is the U.S. National Phase of PCT/GB96/00709, filed Mar. 25, 1996, which claims priority to UK 9510515.1, filed May 24, 1995.

BACKGROUND OF THE INVENTION

This invention relates to an end wall for a container and more particularly but not exclusively to an end wall of a can body and a method for fixing the end wall to the can body by means of a double seam.

U.S. Pat. No. 4,093,102 (KRASKA) describes can ends comprising a peripheral cover hook, a chuck wall dependent from the interior of the cover hook, an outwardly concave annular reinforcing bead extending radially inwards from the chuck wall and a central panel joined to an inner wall of the reinforcing bead by an annular outwardly convex bead. This can end is said to contain an internal pressure of 90 psi by virtue of the inclination or slope of the chuck wall, bead outer wall and bead inner wall to a line perpendicular to the centre panel. The chuck wall slope D° is between 14° and 16°, the outer wall slope E is less than 4° and the inner wall slope C° is between 10 and 16° leading into the outwardly convex bead. We have discovered that improvements in metal usage can be made by increasing the slope of the chuck wall and limiting the width of the anti peaking bead.

U.S. Pat. No. 4,217,843 (KRASKA) describes an alternative design of can end in which the countersink has inner and outer flat walls, and a bottom radius which is less than three times the metal thickness. The can end has a chuck wall extending at an angle of approximately 24° to the vertical. Conversely, the specification of our U.S. Pat. No. 5,046,637 describes a can end in which the chuck wall extends at an angle of between 12° and 20° to the vertical.

The detailed description of our U.S. Pat. No. 4,571,978 describes a method of making a can end suitable for closing a can body containing a beverage such as beer or soft drinks. This can end comprises a peripheral flange or cover hook, a chuck wall dependant from the interior of the cover hook, an outwardly concave reinforcing bead extending radially inwards from the chuck wall from a thickened junction of the chuck wall with the bead, and a central panel supported by an inner portion of the reinforcing bead. Such can ends are usually formed from a prelacquered aluminum alloy such as an aluminum magnesium manganese alloy such as alloy 5182.

The specification of our U.S. Pat. No. 5,582,319 describes a can end suitable for a beverage can and formed from a laminate of aluminum/manganese alloy coated with a film of semi crystalline thermoplastic polyester. This polyester/aluminum alloy laminate permitted manufacture of a can end with a narrow, and therefore strong reinforcing bead in the cheaper aluminum manganese alloy.

These known can ends are held during double seaming by an annular flange of chuck, the flange being of a width and height to enter the anti-peaking bead. There is a risk of scuffing if this narrow annulus slips. Furthermore a narrow annular flange of the chuck is susceptible to damage.

Continuing development of a can end using less metal, whilst still permitting stacking of a filled can upon the end of another, this invention provides a can end comprising a peripheral cover hook, a chuck wall dependant from the interior of the chuck wall, an outwardly concave annular reinforcing bead extending radially inwards from the chuck wall, and a central panel supported by an inner portion of the reinforcing bead, characterized in that, the chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle between 30° and 60°, and the concave bead narrower than 1.5 mm (0.060"). Preferably, the angle of the chuck wall to the perpendicular is between 40° and 45°.

In a preferred embodiment of the can end an outer wall of the reinforcing bead is inclined to a line perpendicular to the central panel at an angle between −15° to +15° and the height of the outer wall is up to 2.5 mm.

In one embodiment the reinforcing bead has an inner portion parallel to an outer portion joined by said concave radius.

The ratio of the diameter of the central panel to the diameter of the peripheral curl is preferably 80% or less.

The can end may be made of a laminate of thermoplastic polymer film and a sheet aluminum alloy such as a laminate of a polyethylene terephthalate film on an aluminum-manganese alloy sheet or ferrous metal typically less than 0.010 (0.25 mm) thick for beverage packaging. A lining compound may be placed in the peripheral cover hook.

In a second aspect this invention provides a method of forming a double seam between a can body and a can end according to any preceding claim, said method comprising the steps of:

placing the curl of the can end on a flange of a can body supported on a base plate, locating a chuck within the chuck wall of the can end to centre the can end on the can body flange, said chuck having a frustoconical drive surface of substantially equal slope to that of the chuck wall of the can end and a cylindrical surface portion extending away from the drive surface within the chuck wall, causing relative motion as between the assembly of can end and can body and a first operation seaming roll to form a first operation seam, and thereafter causing relative motion as between the first operation seam and a second operation roll to complete a double seam, during these seaming operations the chuck wall becoming bent to contact the cylindrical portion of the chuck.

BRIEF DESCRIPTION OF THE FIGURES

Various embodiments will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic sketch of known apparatus for forming a double seam;

FIG. 2 is an enlarged sectioned side view of a known chuck and can end before seaming;

FIG. 3 is a sectioned view of a fragment of a known double seam;

FIG. 4 is a sectioned side view of a can end according to this invention before edge curling;

FIG. 5 is a sectioned side view of the can end of FIG. 4 on a can body before forming of a double seam;

FIG. 6 is a like view of the can end and body during first operation seaming;

FIG. 7 is a like view of the can end and body during final second operation seaming to create a double seam;

FIG. 8 is a fragmentary section of a chuck detail; and

FIG. 9 is a side view of the cans stacked one on the other.

DETAILED DESCRIPTION

In FIG. 1, apparatus for forming a double seam comprises a base plate 1, an upright 2 and a top plate 3.

A lifter 4 mounted in the base plate is movable towards and away from a chuck 5 mounted in the top plate. The top plate supports a first operation seaming roll 6 on an arm 7 for pivotable movement towards and away from the chuck. The top plate also supports a second operation seaming roll 8 on an arm 9 for movement towards and away from the chuck after relative motion as between the first operation roll and can end on the chuck creates a first operation seam.

As shown in FIG. 1 the chuck 5 holds a can end 10 firmly on the flange 11 of a can body 12 against the support provided by the lifter plate 4. Each of the first operation roll 6 and second operation roll 8 are shown clear of chuck before the active seam forming profile of each roll is moved in turn to form the curl of the can end and body flange to a double seam as shown in FIG. 3.

FIG. 2 shows on an enlarged scale the chuck 5 and can end 10. The can end comprises a peripheral curl 13, a chuck wall 14 dependent from the interior of the curl, an outwardly concave anti-peaking bead 15 extending inwards from the chuck wall to support a central panel 16. Typically the chuck wall flares outwardly from the vertical at an angle C about 12° to 15°.

The chuck 5 comprises a body 17 having a threaded bore 18 permitting attachment to the rest of the apparatus (not shown). An annular bead 19 projects from the body 17 of the chuck to define with the end face of the body a cavity to receive the central panel 16 of the can end. The fit of panel 16 in annulus 19 may be slack between panel wall and chuck.

The exterior surface of the projecting bead 19 extends upwards towards the body at a divergent angle B of about 12° to the vertical to join the exterior of the chuck body 17 which tapers off an angle A° of about 4° to a vertical axis perpendicular to the central panel. The outer wall of the chuck 5 engages with the chuck wall at a low position marked "D" within the 12° shaped portion of the chuck bead 15.

As can ends are developed with narrower anti-peaking beads the chuck bead 19 becomes narrower and more likely to fracture. There is also a risk of scuffing of the can end at the drive position D which can leave unacceptable unsightly black marks after pasteurization.

FIG. 3 shows a sectioned fragment of a typical double seam showing a desirable overlap of body hook 21 and end hook 20 between the can end 10 and can body 12.

FIG. 4 shows a can end, according to the invention, comprising a peripheral cover hook 23, a chuck wall 24 extending axially and inwardly from the interior of the peripheral cover hook, an outwardly concave reinforcing or anti-peaking bead 25 extending radially inwards from the chuck wall, and a central panel 26 supported or an inner portion panel with 27. The panel wall is substantially upright allowing for any metal spring back after pressing. The chuck wall is inclined to an axis perpendicular to the exterior of the central panel at an angle C_1 between 20° and 60°; preferably between 40° and 45°. Typically the cross sectional radius of the antipeaking bead is about 0.5 mm.

Preferably the anti-peaking bead 25 is parallel sided, however the outer wall may be inclined to a line perpendicular to the central panel at an angle between -15° to +15° and the height h_4 of the outer wall may be up to 2.5 mm.

This can end is preferably made from a laminate of sheet metal and polymeric coating. Preferably the laminate comprises an aluminum magnesium alloy sheet such as 5182, or aluminum manganese alloy such as 3004 with a layer of polyester film on one side. A polypropylene film may be used on the "other side" if desired.

Typical dimensions of the example of the invention are:

d5	overall diameter (as stamped)	65.83 mm
d4	PC diameter of seaming panel radius	61.54 mm
d3	PC diameter of seaming panel/chuck wall radius	59.91 mm
r_1	seaming panel/chuck wall radius	1.27 mm
r_2	seaming panel radius	5.56 mm
r_3	concave radius in antipeaking bead	<1.5 mm
d_2	maximum diameter of antipeaking bead	50.00 mm
d_1	minimum diameter of antipeaking bead	47.24 mm
h_2	overall height of can end	6.86 mm
h_1	height to top of antipeaking bead	5.02 mm
h_3	panel depth	2.29 mm
h_4	outer wall height	1.78 mm
c	chuck wall angle to vertical	43°

From these dimensions it can be calculated that the ratio of central panel diameter of 47.24 mm to overall diameter of can end 65.84 is about 0.72 to 1.

For economy the aluminum alloy is in the form of sheet metal less than 0.010" (0.25 mm). A polyester film on the metal sheet is typically 0.0005" (0.0125 mm).

Although this example shows an overall height h_2 at 6.86 mm we have also found that useful can ends may be made with an overall height as little as 6.35 mm (0.25").

FIG. 5 shows the peripheral flange 23 of can end 22 of FIG. 4 resting on the flange 11 of a can body 12 before formation of a double seam as discussed with reference to FIG. 1.

In FIG. 5 a modified chuck 30 comprises a chuck body 31 having a frustoconical drive surface 32 engaging with the chuck wall 24 of the can end 22.

The frustoconical drive surface is inclined outwardly and axially at an angle substantially equal to the angle of inclination C° of between 20° and 60°; in this particular example on chuck angle C of 43° is preferred. The drive surface 32 is a little shorter than the chuck wall 24 of the chuck body. The substantially cylindrical surface portion 33, rising above the drive surface 32, may be inclined at an angle between +4° and -4° to a longitudinal axis of the chuck. As in FIG. 2, this modified chuck 30 has a threaded aperture to permit attachment to the rest of the double seam forming apparatus (not shown).

In contrast to the chuck of FIG. 2 the modified chuck 30 is designed to drive initially on the relatively large chuck wall 32 without entering deeply into the anti-peaking bead 25. Further drive is obtained at the juncture of chuck wall 32 and cylindrical wall 33 as chuck wall of end 24 is deformed during 1st and 2nd operation seaming FIGS. 6 and 7. The chuck 30 shown in FIG. 5 has an annular bead of arcuate cross section but this bead is designed to enter the chuck

wall without scratching or scuffing a coating on the can end; not to drive on the concave bead surface as shown in FIG. 2.

It will be understood that first operation seaming is formed using apparatus as described with reference to FIG. 1.

FIG. 6 shows the modified can end and chuck during formation of a first operation seam shown at the left of FIG. 2 as formed by a first operation roll 34 adjacent the inter-folded peripheral flange of the can end and flange 11 body 12.

During relative rotation as between the can end 22 and first operation roll 34 the edge between the chuck drive wall 32 and cylindrical wall 33 exerts a pinching force between chuck 30 and roll 34 to deform the chuck wall of the can end as shown.

After completion of the first operation seam the first operation roll is swung away from the first operation seam and a second operation roll 38 is swung inwards to bear upon the first operation seam supported by the chuck 30. Relative rotation as between the second operation roll 38 and first operation seam supported by a chuck wall 30 completes a double seam as shown in FIG. 7 and bring the upper portion 24 of the chuck wall 24 to lie tightly against the can body neck in a substantially upright attitude as the double seam is tightened by pinch pressure between the second operation roll 38 and chuck 30.

Can ends according to the invention were made from aluminum alloy 5182 and an aluminum alloy 3004/polymer laminate sold by CarnaudMetalbox under the trade mark ALULITE. Each can end was fixed by a double seam to a drawn and wall ironed (DWI) can body using various chuck angles and chuck wall angle as tabulated in Table 1 which records the pressure inside a can at which the can ends failed:—

The early results given in Table 1 showed that the can end shape was already useful for closing cans containing relatively low pressures. It was also observed that clamping of the double seam with the "D" seam ring resulted in improved pressure retention. Further tests were done using a chuck wall angle and chuck drive surface inclined at nearly 45°: Table 2 shows the improvement observed:—

TABLE 2

Sample Code	h_2 mm (inches)	h_3 mm (inches)	h_4 mm (inches)	Chuck Angles B° 43°	43° with seam ring
J	6.86 (0.270)	2.39 (0.094)	2.29 (0.09)	4.89 (70.9)	6.15 (89.1)
K	7.11 (0.280)	2.64 (0.104)	2.54 (0.10)	4.83 (70.0)	5.98 (86.6)
L	7.37 (0.290)	2.90 (0.114)	2.79 (0.11)	4.74 (68.7)	6.44 (93.3)

Table 2 is based on observations made on can ends made of aluminum coated with polymer film (ALULITE) to have a chuck wall length of 5.029 mm (0.198") up the 43° slope.

It will be observed that the container pressures achieved for samples J, K, L, 4.89 bar (70.9 psig), 4.83 bar (70.0 psig) and 4.74 bar (68.7 psig) respectively were much enhanced by clamping the double seam.

In order to provide seam strength without use of a clamping ring, modified chucks were used in which the drive slope angle C° was about 43° and the cylindrical surface 33 was generally +4° and −4°. Results are shown in Table 3.

TABLE 1

	CAN END DATA			PRESSURE IN BAR (PSIG) TO FAILURE FOR VARIOUS SEAMING CHUCK ANGLES B°				
Sample Code	Material Thickness mm	Minimum Diameter D1 mm	CHUCK Wall Angle "C"	23°	10°/23°	4°/23°	23° with D. Seam Ring	10°/23° with D. Seam Ring
A	ALULITE 0.23	52.12 (2.052")	21.13°	5.534 (80.20)	5.734 (83.10)	5.311 (76.97)	6.015 (87.17)	5.875 (85.14)
B	5182 0.244	52.12 (2.052")	21.13°	5.599 (81.15)	5.575 (80.79)	5.381 (77.99)	5.935 (86.01)	5.895 (85.43)
C	5182 0.245	52.12 (2.052")	21.13°	6.004 (87.02)	5.910 (85.65)	5.800 (84.06)	6.224 (90.21)	6.385 (92.54)
D	ALULITE 0.23	51.92 (2.044")	21.13°	5.334 (77.31)	5.229 (75.78)	5.238 (75.91)	5.730 (83.04)	5.404 (78.32)
E	5182 0.224	51.92 (2.044")	21.13°	5.555 (80.50)	5.514 (79.92)	5.354 (77.60)	5.895 (85.43)	5.930 (85.94)
F	5182 0.245	51.92 (2.044")	23°	5.839 (84.63)	5.804 (84.12)	5.699 (82.59)	6.250 (90.58)	6.435 (93.26)
G	ALULITE 0.23	51.92 (2.044")	23°			5.123 (74.25)		
H	5182 0.224	(51.92) (2.044")	23°			5.474 (79.34)		
I	5182 0.245	51.92 (2.044")	23°			5.698 (82.58)		

All pressures on unaged shells in bar (psig). 5182 is an aluminum-magnesium-manganese alloy lacquered. The "ALULITE" used is a laminate of aluminum alloy and polyester film.

TABLE 3

SAMPLE CODE	MATERIAL	LINING COMPOUND	CHUCK ANGLES DRIVE/ WALL	PRESSURE
		Results		
c	0.224 5182	with	43°	4.60 (66.7)
g	0.23 Alulite	with	43°/4°	5.45 (79.0)
h	0.224 5182	with	43°/4°	6.46 (93.6)
j	0.23 Alulite	without	43°/4°	5.91 (85.6)
k	0.244 5182	without	43°/4°	6.18 (89.6)
l	0.23 Alulite	without	43°/-4°	5.38 (77.9)
m	0.25 Alulite	without	43°/-4°	6.20 (89.8)
n	0.23 Alulite	without	43°/0°	6.11 (88.5)
o	0.25 Alulite	without	43°/0°	6.62 (95.9)

ALL PRESSURES IN BAR (PSIG)
ALL CODES
Reform Pad Dia. 47.24 mm (1.860") (202 Dia).
6.86 mm (0.270") unit Depth h_2 2.39 mm (0.094") Panel Depth

Table 3 shows Code "O" made from 0.25 mm Alulite to give 6.62 bar (95 psi) Pressure Test Result indicating a can end suitable for pressurized beverages. Further chucks with various land lengths (slope) were tried as shown in Table 4.

TABLE 4

VARIABLE CODE	43°/0° 1.9 mm LAND SHARP TRANSITION NO. D. SEAM RING	43°/0° 1.9 mm LAND SHARP TRANSITION WITH D. SEAM RING	43°/0° 1.27 MM LAND R 0.5 MM BLEND NO. D. SEAM RING	43°/0° 1.27 MM LAND R 0.5 MM BLEND WITH D. SEAM RING
	CHUCK WALL ANGLE			
7	6.699 (97.08)	7.017 (101.7)	6.779 (98.24)	7.006 (101.54)
8	6.315 (91.52)	6.521 (94.5)	6.293 (91.2)	6.236 (90.37)
9	6.095 (88.33)	6.30 (91.3)	6.238 (90.4)	6.719 (97.38)

ALL PRESSURES IN BAR (PSIG) CODE
7 = 0.25 mm Alulite, 47.24 mm (1.860") Reform Pad, 6.86 mm (0.270") h_2 Depth, 2.38 mm (0.094") Panel; h_4 depth = 2.29 mm (0.09")
8 = 0.23 mm Alulite, 47.24 mm (1.860") Reform Pad, 7.11 mm (0.280") h_2 Depth, 2.64 mm (0.104") Panel; h_4 depth = 2.54 mm (0.10")
9 = 0.23 mm Alulite, 47.24 mm (1.860") Reform Pad, 7.37 mm (0.290") h_2 Depth, 2.90 mm (0.114") Panel; h_4 depth = 2.79 mm (0.11")

Table 4 shows results of further development to seaming chuck configuration to bring closer the pressure resistance of ring supported and unsupported double seams.

Table 4 identifies parameters for length of generally vertical cylindrical surface 33 on the seaming chuck 30, and also identifies a positional relationship between the chuck wall 24 of the end and the finished double seam. It will be understood from FIG. 7 shows that the forces generated by thermal processing or carbonated products are directed towards and resisted by the strongest portions of the completed double seam.

Table 5 shows results obtained from a typical seam chuck designed to give double seam in accordance with parameters and relationships identified in Table 4. Typically:—As shown in FIG. 8 the chuck comprises a cylindrical land of length '1' typically 1.9 mm (0.075") and frustoconical drive surface 32 inclined at an angle Y°, typically 43°, to the cylindrical to which it is joined by a radius R typically 0.5 mm (0.020"). Angle "X" is typically 90°.

TABLE 5

CODE	GAUGE	DIMENSIONS mm h_2	DIMENSIONS mm h_3	PRESSURE bar	PRESSURE (psi)
20	.23 mm	7.37 (.290")	2.36 (.093")	6.383	(92.6)
21	.23 mm	7.37 (.290")	2.36 (.093") with compound	6.402	(92.8)
26	.23 mm	6.87 (.2705")	2.37 (.0935")	6.144	(89.88)
27	.23 mm	6.87 (.2705")	2.37 (.0934") with compound	6.071	(88.0)
28	.23 mm	7.37 (.290")	2.36 (.093")	6.414	(93.0)
29	.23 mm	7.37 (.290")	2.84 (.112")	6.725	(97.5)
30	.23 mm	6.86 (.270")	2.37 (.0935")	6.062	(87.9)
31	.23 mm	6.86 (.270")	2.37 (.0935")	6.013	(87.2)
34	.25 mm	7.37 (.290")	2.87 (.113")	7.787	(112.9)
36	.25 mm	7.32 (.288")	2.34 (.092")	7.293	(105.8)
37	.25 mm	7.32 (.288")	2.34 (.092") with compound	7.402	(107.3)
38	.25 mm	6.87 (.2705")	2.41 (.095")	7.077	(102.6)
516	.25 mm	6.35 (.250")	2.34 (.092") with compound	6.937	(100.6)

All variables made from Alulite, 10 Cans per variable.

The can ends may be economically made of thinner metal if pressure retention requirements permit because these can ends have a relatively small centre panel in a stiffer annulus.

FIG. 9 shows a can 12*a*, closed according to this invention, stacked upon a like can 12*b* shown sectioned so that stacking of the upper can on the lower can end is achieved by a stand bead 31*a* of the upper can fits inside the chuck wall 24 of the lower can end with the weight of the upper can resting on the double seam 34 of the lower can end.

The clearance between the bottom of the upper can body and lower can end may be used to accommodate ring pull features (not shown) in the can end or promotional matter such as an coiled straw or indicia.

Using the experimental data presented above, a computer program was set up to estimate the resistance to deformation available to our can ends when joined to containers containing pressurized beverage. The last two entries on the table relate to a known 206 diameter beverage can end and an estimate of what we think the KRASKA patent teaches.

TABLE 6

END SIZE Bead OD:ID	OVERALL DIA mm	PANEL DIA d_1 mm	RATIO OVERALL DIA: PANEL DIA	CHUCK WALL ANGLE C°	CHUCK WALL LENGTH L mm	RE-ENFORC-ING RAD r_3 mm	INNER WALL HEIGHT h_3 mm	OUTER WALL HEIGHT h_4 mm	PREDICTED CUT EDGE Ø (*DENOTES ACTUAL)	ACTUAL THICK-NESS TO CONTAIN PSI
206–204	64.39 (2.535")	49.49 (1.9485")	1.3010	33.07°	4.22 (0.166")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	75.230 (2.9618")	0.255
206–202	64.39 (2.535")	47.33 (1.8634")	1.3604	42.69°	4.95 (0.195")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	74.272 (2.9241")*	0.255
206–200	64.39 (2.535")	45.07 (1.7744")	1.4287	50.053°	5.82 (0.229")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.713 (2.9021")	0.255
204–202	62.18 (2.448")	47.33 (1.8634")	1.3137	29.78°	3.96 (0.156")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	73.767 (2.9042")	0.24
204–200	62.18 (2.448")	45.07 (1.7744")	1.3796	40.786°	4.70 (0.185")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	72.911 (2.8705")	0.24
202–200	71.98 (2.834")	45.07 (1.7744")	1.597	30.266°	4.09 (0.161")	0.52 (0.0204")	2.34 (0.092")	1.78 (0.070")	71.984 (2.834")	0.225
206 std	64.69 (2.547")	51.92 (2.044")	1.2461	15.488°	4.39 (0.173")	0.56 (0.022")	2.03 (0.080")	—	76.454 (3.010")*	0.28
KRASKA estimate	64.39 (eg 2.535")	—	—	15°	2.54 (0.100")	0.81 (0.032")	1.65 (0.065")	2.29 (0.090")	78.080 (3.074")	0.292 (0.0115")

All experiments modeled on a notional aluminum alloy of yield strength 310 mpa 0.25 mm thick. The standard was also 310 mpa BUT 0.275 mm thick.

What is claimed is:

1. A metal can end adapted to be joined to a can body for packaging beverages under pressure, said can end comprising;

a peripheral cover hook adapted to be seamed onto a can body so as to form a joint therewith;

a wall extending inwardly and downwardly from the cover hook;

an outwardly concave annular reinforcing bead extending inwardly and downwardly from the wall; and

a central panel supported by and extending inwardly from the reinforcing bead;

wherein, prior to being joined to said can body: (i) the location at which said wall extends from said peripheral cover hook defines a first point, (ii) the location at which said reinforcing bead extends from said wall defines a second point, and (iii) a line extending between the first point and the second point is inclined to an axis perpendicular to the exterior of the central panel at an angle of between 30° and 60°.

2. The can end of claim 1, wherein a base of the concave reinforcing bead is arcuate in cross-section and has a cross-sectional radius of less than 0.75 mm.

3. The can end of claim 1, wherein the base of the concave reinforcing bead is approximately semi-circular in cross section.

4. The can end of claim 1, wherein the reinforcing bead comprises an outer wall that is inclined to said axis at an angle between −15° and +15°.

5. The can end of claim 1, wherein the reinforcing bead has inner and outer walls, a lower portion of the outer wall spaced apart from a lower portion of the inner wall by less than 1.5 mm.

6. The can end of claim 1, wherein the reinforcing bead has an outer wall and an inner wall that is parallel to the outer wall, said inner wall and said outer wall being joined by a concave radius.

7. The can end of claim 1, wherein the wall extends between said first and second points along an essentially straight line.

8. The can end of claim 7, wherein the line extending between the first point and the second point is inclined to said axis at an angle between 40° and 45°.

9. The can end of claim 1, wherein the ratio of the diameter of the central panel to the diameter of the peripheral cover hook is 80% or less.

10. The can end of claim 1, wherein the can end is made of a laminate of thermoplastic polymer film and a sheet aluminium alloy.

11. The can end of claim 1, wherein the can end is made of tinplate.

12. The can end of claim 1, wherein the can end is made of electrochrome coated steel.

13. A metal can end for use in packaging beverages under pressure and adapted to be joined to a can body by a seaming process so as to form a double seam therewith using a rotatable chuck comprising first and second circumferentially extending walls, said first and second chuck walls forming a juncture therebetween, said can end comprising;

a peripheral cover hook, said peripheral cover hook comprising a seaming panel adapted to be formed into a portion of said double seam during said seaming operation;

a central panel;

a wall extending inwardly and downwardly from said cover hook, a first portion of said wall extending from said cover hook to a first point on said wall, said first wall portion adapted to be deformed during said seaming operation so as to be bent upwardly around said juncture of said chuck walls at said first point on said wall, a second portion of said wall extending from said first point to a second point forming a lowermost end of said wall, a line extending between said first and second points being inclined to an axis perpendicular to said central panel at an angle of between 30° and 60°.

14. The end according to claim 13, further comprising an annular reinforcing bead connected to said wall at said second point, said annular reinforcing bead connecting said wall to said central panel.

* * * * *

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this date, he caused a copy of the foregoing document to be filed electronically with the Clerk of Court using CM/ECF and that a copy was served on the person(s) listed below in the manner stated:

Via E-Filing and Hand Delivery

Frederick L. Cottrell, III, Esquire
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Dated: October 20, 2005

Barry M. Klayman, Esquire (#3676)