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Viker et al.

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[54] CAN CLOSURE

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[52] **U.S. Cl.** .... **220/359**; 229/7 R; 222/541
[51] **Int. Cl.** **B65d 41/00**
[58] **Field of Search** .... 220/53, 47, 48, 27, 359; 229/7 R; 222/528, 541

[56] **References Cited**

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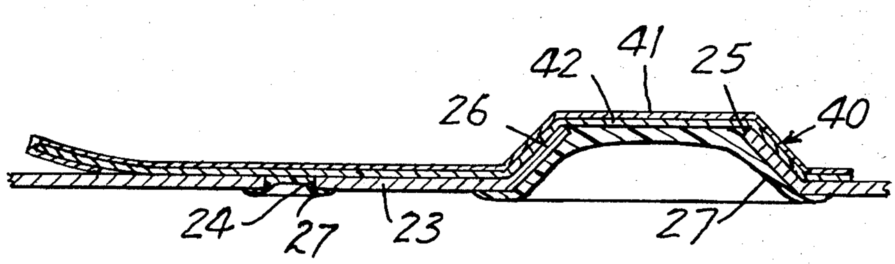
[57] **ABSTRACT**

Cans sealed with removable pressure-sensitive adhesive tape tabs over a pour hole successfully contain carbonated beverages or other pressure-generating liquids if the area around the pour hole and under the tape is slightly elevated, thereby putting the tape in shear rather in peel. Circular can ends may be provided with a circular pour hole, taped and then shaped to impart a frusto-conical area around the pour hole before being crimped over the tubular can body.

6 Claims, 3 Drawing Figures



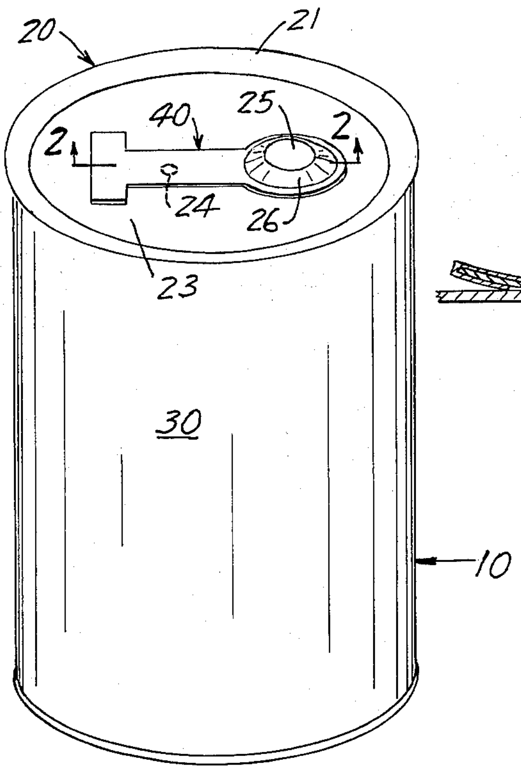


FIG. 1

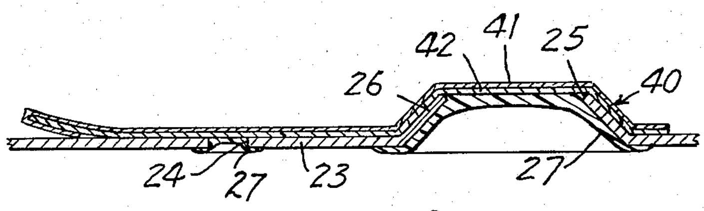


FIG. 2

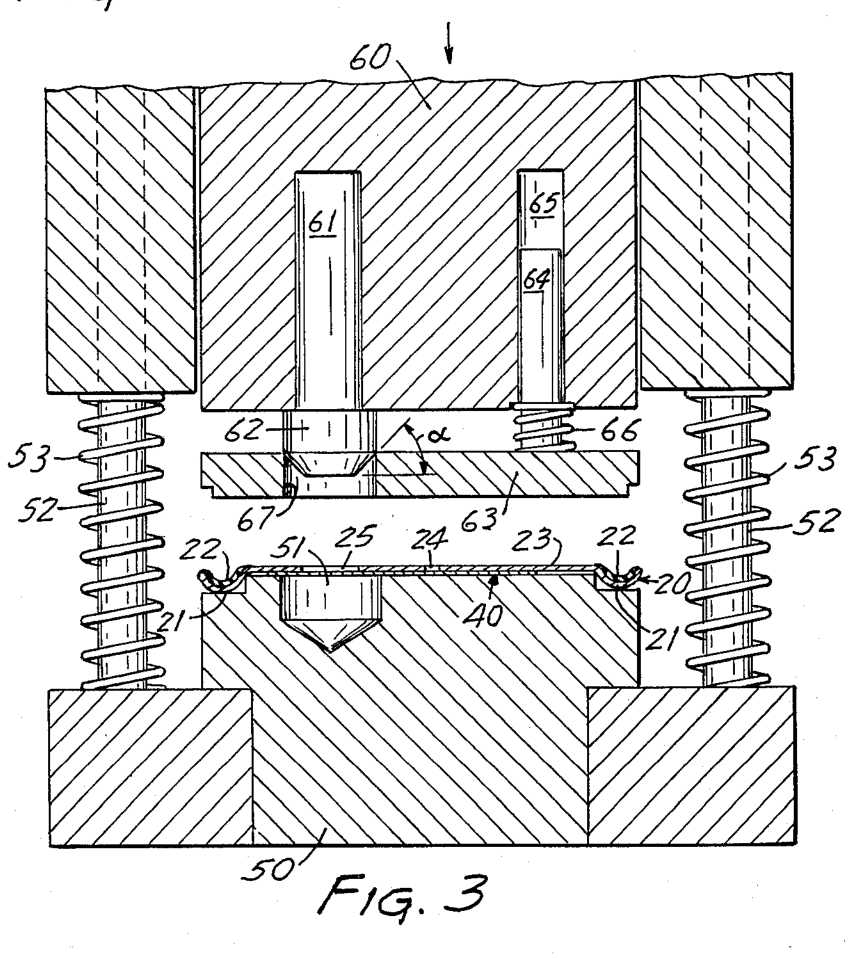


FIG. 3

CAN CLOSURE

BACKGROUND OF THE INVENTION

This invention relates to liquid-containing cans of the type in which a pour hole is covered by a removable pressure-sensitive adhesive tape tab. The invention also relates to end walls useful for the manufacture of such cans and to methods of preparing such end walls.

Over the past several years there has been an increasing use of metal containers for carbonated soft drinks and beer. These containers are opened by lifting and grasping a ring attached to the end wall and removing a portion of the wall along weakened tear lines. Because aluminum is the only commercially available metal which can be formed into a readily openable end wall in this manner, the original "tear-top" cans were made entirely out of aluminum. To make such cans more economical, carbonated beverage manufactures later resorted to fabricating the tubular side wall and one end wall from steel, using openable aluminum for only the other end wall. In some cases an aluminum insert, including a tear strip was incorporated into a steel can end. Although such dual metal cans are satisfactory for the intended use, it is ecologically desirable today for empty cans to be capable of simple recycling; the separation of the aluminum from steel is both inconvenient and expensive. Additionally, several states and cities have banned the use of ring pull cans because the removed tabs are so commonly dropped on the ground or thrown into a body of water, where they decompose only very slowly.

It is known that unpressurized cans containing tomato juice and similar liquids can be provided with a convenient means for opening by pre-punching a hole in one end wall and applying a pressure-sensitive adhesive tape, tab over the hole. When the user desires to open such a container, he grasps the free end of the tape tab and pulls the closure off, exposing the hole in the end wall to permit pouring out the contents of the can. Easy-open containers of this type are shown in U.S. Pat. No. 3,389,827, the disclosure of which is incorporated herein by reference.

Various attempts have been made to adapt the sealing technology of the aforementioned patent to the packaging of gas-containing liquids such as carbonated soft drinks and beer, but these attempts have not proved commercially satisfactory. Typical pressures for various beverages at 38°C. are as follows: orange **1.7** .17 kg/cm^2; strong beer, 3.3 kg/cm^2; root beer, ginger ale, cola and lemon, 4.5 kg/cm^2; club soda, 5.8 kg/cm^2. At room temperature (21°C.), pressures are about 70%, and even under normal refrigeration (e.g., 4°–5°C.), they are about 40%, of the values just cited. Such pressures bulge prior art tape closures upward and gradually peel them from the area immediately circumjacent to the pour hole, and, in a relatively short time, break the seals. Prior to the present time, then, it has been felt that tape closures could not be employed in the sealing of highly pressurized containers.

SUMMARY

The present invention provides a closed liquid-filled hollow container which is economical to manufacture, utilizes the simple and easily operated pressure-sensitive adhesive tab of the type shown in U.S. Pat. No. 3,389,827, can be fabricated entirely from steel, and resists high internal pressures for an extended period of time.

In accordance with the invention, the area of the can wall immediately circumjacent to the pour hole is so contoured that it tapers outward, and the hole is thus located in a plane displaced outward with respect to the rest of the end wall. When the can is filled with a pressure-generating liquid, the portion of the tape covering the hole bulges outward, as in previous constructions. Because of the contour of the can wall circumjacent to the hole, however, the forces acting on the tape tend to place the adhesive in shear (i.e., the forces are exerted parallel to the tape backing) instead of in peel (i.e., where the forces are exerted at right angles to the tape backing). Since the shear force required to loosen the tape greatly exceeds the peel force required to loosen it, the container can be subjected to substantially higher internal pressure without seal failure than is possible when the hole is located in the same plane as the remainder of the wall.

In fabricating containers of the invention, it has been found convenient to employ a subassembly comprising a preformed circular end piece which is a modification of the conventional type, having a depressed center end wall with a died-out pour hole and a circumferential lip for clamping over and sealing to one end of tubular metal can body. The modification is conveniently made by applying to the depressed center portion of the end piece a strip of normally tacky and pressure-sensitive adhesive tape so that it overlies the pour hole and is sealed to the circumjacent surface, supporting the taped side of the end piece in an area adjacent to but spaced slightly outward from the pour hole, and firmly gripping the end piece in this area. The area of the end wall immediately circumjacent to the pour hole is then tapered outward by forcing a blunt punch into the pour hole from the side of the end piece which has not been taped. Where the pour hole is circular, the punch normally will have a head with a circular cross section in a plane taken at right angles to the axis of the punch. The distal end of the head then has a diameter smaller than that of the pour hole and the remainder of the head has a diameter larger than that of the pour hole; the head may be beveled, tapered, chamfered, or curved in order to achieve this shape. As the head is forced into the pour hole, it imparts an open-topped outwardly tapered configuration to the taped side of the end piece, simultaneously stretching the tape and leaving it firmly adhered.

BRIEF DESCRIPTION OF THE DRAWING

Understanding of the invention will be further facilitated by reference to the accompanying drawing, in which like numbers refers to like parts in the several views and in which:

FIG. **1** is a perspective view of a can made in accordance with the present invention;

FIG. **2** is a cross section of the end wall of the can shown in FIG. **1**, taken along section line **2—2** and looking in the direction of the arrows; and

FIG. **3** is a cross sectional view of a forming press suitable for imparting a frusto-conical configuration to the end wall of a can in the area immediately circumjacent to the pour hole.

DESCRIPTION OF PRESENTLY PREFERRED EMBODIMENTS

In evaluating the effectiveness of can end walls made in accordance with the invention to resist pressure, it has been found convenient to employ a water-tight chamber equipped with an electric heating element and having temperature controls in the base. The chamber is provided with a top having several 68.3-mm holes designed to accommodate can lids for pressure testing. A lid hinged to the chamber contains several 68.3-mm holes corresponding to those in the top of the chamber. Can end walls to be tested are mounted over the holes in the top, after which the cover is bolted to the chamber. To perform a test, the water is heated to the desired test temperature, the desired air pressure supplied to the base of the chamber, and an electric timer mounted above each test lid started; the timer is connected to a pressure-activated switch, which in turn is connected to the lid. The switch is closed, and the timer thereby stopped, when the tape closure is sufficiently loosened to permit escape of the pressure in the chamber, thus marking the end of the test.

In the drawings, can **10** comprises generally circular upper end **20** and tubular body **30.** (Can **10,** of course, has a generally circular lower end which is not visible). End **20** comprises a circumferential lip **21,** having a resin coating **22** at its inner aspect; lip **21** fits down over the upper end of can body **30** and is crimped in position, resin **22** sealing the joint against leakage. The central portion of end wall **23** is depressed slightly with respect to lip **21,** a common arrangement in can manufacture. Located in end wall **23** adjacent lip **21** is pour hole **25,** which, if circular, typically has a diameter of 10–15 mm; slightly radially inward therefrom is located vent hole **24,** which typically has a diameter of 1½ – 3 mm. In the area **26** circumjacent to pour hole **25,** end wall **23** is so contoured that it tapers upward, leaving pour hole **25** situated in a plane spaced slightly (e.g., 2–4 mm) above the remainder of end wall **23.** To minimize damage, especially in stacking or handling, pour hole **25** is preferably located in a plane which is slightly lower than the upper portion of lip **21.** The difference in elevation between the pour hole **25** and can end wall **23** in the formed end **20** should usually be, for a 12.7-mm pour hole, on the order of 2½ – 3 mm, and the angle of the sides to the base should generally exceed 20° to insure placing the tape closure in a shear mode adequate to resist failure under anticipated conditions of use.

Overlying pour hole **25** and vent hole **24** is sealing tab **40,** the construction of which is shown best in the cross-sectional view of FIG. **2.** Tab **40** comprises stretchable backing **41,** advantageously formed of a strong oriented synthetic polymeric film which is 25–250 microns thick, although metal foil or reinforced fibrous sheet material can probably be employed in some circumstances. It is important, however, that the backing of the sealing tab be relatively impermeable to water vapor, carbon dioxide and oxygen. Water vapor transmission, for example, should not exceed 1.7–1.8 gms/100 in^2/24 hr/mil at 23°C. when measured in accordance with ASTM Test E96. Carbon dioxide should have a permeability rate which does not exceed 15–25 cc/100 in^2/24 hr/atmosphere at 25°C., and oxygen permeability should not exceed about 30–40% of this figure; see ASTM Test D 1434. It is also important for the film to be capable of elongating 10–200% at break so that the tab can be stretched to conform to the convex area around the pour hole. To insure continued smooth conformance, the stretched backing should not, after withdrawing the stretching force, retract more than 30% of the incremental amount stretched; in fact, a backing which possesses "dead stretch" (i.e., no retraction) is preferred.

In order to minimize any difference in appearance between tab **40** and end wall **23,** it is often desirable to impart a metallic appearance to sealing tab **40**; this can be accomplished by laminating a metal foil or a thin transparent polymeric film, aluminum vapor coated on its lower surface, over the top of backing **41.** If desired, backing **41** may be provided with a thin coating of vapor-deposited aluminum on its exposed surface. Coated over the lower surface of backing **41** is a layer of firmly adherently bonded normally tacky and pressure-sensitive adhesive **32.** The distal end of tab **40** is made easier to grasp initially by covering a portion of the adhesive with a small piece of film or paper. The nature of the adhesive layer should be such that the force required to peel it from steel (U.S. Federal Standard No, 147) should be in the range of 0.9–2.8 kg/cm width to insure adequate adhesion and yet permit removal of the tab with a reasonable amount of effort. The backing must, of course, be strong enough not to tear during removal.

In order to minimize corrosion of the raw edge of end wall **23** which immediately surrounds vent hole **24** and pour hole **25,** it is generally preferred to apply a light coating of a protective polymeric material **27** after sealing tab **40** has been adhered in place; this protective coating also covers the exposed surface of pressure-sensitive adhesive **42,** obviating any possibility that the can contents may be contaminated with undesirable flavors leached from the adhesive. In carrying out the pressure test described above, it has been found that more consistent results are obtained if coating **27** is eliminated; in the actual packaging of carbonated liquids, however, coating **27** is normally included.

Turning now to FIG. **3,** the method of forming can end **20** in accordance with the invention will be discussed. Vent hole **24** and pour hole **25** are die-cut from the end wall **23** of an end **20,** sealing tab **40** applied thereover, and a protective coating **27** of lacquer or the like applied to protect the raw edges. End **20** is then inverted and placed atop a circular support table **50,** the diameter of which is the same as the diameter of end wall **23.** In the upper surface of table **50** is a generally cylindrical cavity **51,** the diameter of which is somewhat greater than the diameter of pour hole **25.** Can end **20** is so positioned that pour hole **25** is centered over cavity **51.**

Connected to table **50** by means of supporting member **52** is press head **60,** coil springs **53** surrounding member **52** to maintain the press in normally open position. Punch **61,** at the lower end of which is chamfered head **62,** is seated in press head **60.** The location of head **62** may be controlled by the insertion of shims (not shown) between the lower surface of press head **60** and the upper surface of head **62.** Suspended somewhat below the lower surface of press head **60** is forming ring **63,** supported by three guide pins **64,** only one of which is shown in the drawing. Guide pin **64** slides in channel **65,** spring **66** surrounding the exposed portion of guide pin **64** and holding forming ring **63** a fixed distance beneath the lower surface of press body **60.** Positioned in axially aligned relationship with respect to punch **61** is hole **67,** the diameter of which is slightly greater than the greatest diameter of head **62.**

After can end **20** is positioned on the upper surface of table **50,** press head **60** is lowered, bringing draw ring **63** into snug contact with end wall **23** everywhere except in the portion of end wall **23** immediately circumjacent to pour hole **25.** As head **60** is further lowered, punch head **62** contacts the portion of end wall **23** which defines pour hole **25** and gradually forces it into a frusto-conical shape, the configuration of which is dictated by the angle, α, of the chamfered portion of head **62.**

In many situations it may be preferable to employ a pour hole which is other than circular, e.g., an elliptical hole which takes the place of both pour hole **25** and vent hole **24.** The same principles of tapering the area circumjacent such a hole apply, but the resultant shape is not a frustum in the strict geometric sense. As used herein, however, the terms "frustum", "frusto-conical", etc., are intended to be liberally construed so as to embrace such shapes. Similarly, where the term "diameter" is employed, it is not intended that a circular cross-section is necessarily connoted thereby.

For some purposes, pour hole **25** need not be a single large hole but may be a plurality of closely spaced smaller holes. In this event, all the holes should be located in the plane which is spaced farthest from the upper surface of end wall **23.** Likewise, although holes which have the shape of a circle or regular polygon are simple and economical, teardrop, oval, or other shapes may be employed. Where the hole is non-circular, however, it is desirable to use tape which has dead stretch, or at least very little elastic memory.

Understanding of the invention will be further facilitated by reference to the following illustrative but non-limiting examples, in which all parts are by weight unless otherwise noted.

EXAMPLE 1

Biaxially oriented polyethylene terephthalate film approximately 90 microns thick was provided on one face with a thin vapor coating of aluminum to impart a metallic appearance. The opposite face was then coated with a thin primer layer of a styrene-butadiene-styrene block copolymer in which each of the two polystyrene blocks had a molecular weight of about 15,000 and the polybutadiene block had a molecular weight of about 70,000. (A suitable copolymer of this type is available from Shell Chemical Company under the registered trademark "Kraton" 1101.) The coating was then exposed to a corona discharge to bond it firmly to the film backing. Over the primed face was applied a 30% toluene solution containing 100 parts of the same block copolymer and 95 parts of a polyterpene resin containing alpha-pinene and having a ring-and-ball softening point (ASTMM Test E28–58T) of 135°C. (A suitable polyterpene resin is available from Pennsylvania Industrial Chemical Corporation under the registered trademark designation "Piccolyte" α135.) The coated solution was then oven dried to leave a pressure-sensitive adhesive coating weighing approximately 6 mgm/cm^2. The sheet material was then wound into roll form, a silicone-coated paper release liner being interposed between adjacent convolutions in the roll.

From the linered pressure-sensitive sheet material described in the preceding paragraph a tab similar in shape to tab **40** in FIG. **1** was died. The overall length of the tab was just over 50 mm, the distal gripping portion being 25 mm wide and 10 mm deep, the central portion 12½ mm wide × 18 mm long, and the circular end 22 mm in diameter. A strip of paper was then applied to the pressure-sensitive adhesive coating of the gripping portion.

A conventional 68.3-mm diameter depressed-center beverage can end was punched as shown in FIG. **1** so that it had a pour hole approximately 9.5 mm in diameter and a vent hole approximately 1.6 mm in diameter. Over the outer surface of the can end was then applied the tab described in the preceding paragraph, the resulting laminate being subjected to a pressure of approximately 40 kg/cm^2 at 50°C. (Adhesion may be further increased by utilizing higher temperatures, higher pressures, or both. For many end uses, however, application may be made at room temperature and pressures as low as 6 kg/cm^2.) Over the lower surface of the can lid, in the areas immediately adjacent to the edges of the pour hole and the vent hole, was applied a 25% toluene solution of a protective rubber-resin coating. The solid material consisted of 100 parts of the block copolymer used in the primer coating (described earlier in this example) and 180 parts of a non-oxidizing white hydrocarbon copolymer of 65% m- and p-vinyl toluene and 35% alpha-methyl styrene. (A suitable hydrocarbon copolymer of this type, having an ASTM E28–58T ball-and-ring softening point of 92°C., is available from Pennsylvania Industrial Chemical Corporation under the registered trademark "Piccotex" LC.) The solvent was evaporated and the taped, edge-sealed can end placed in a 65°C. oven for 4 hours to enhance adhesion of the tab; longer times, higher temperatures, or both, improve adhesion still more.

The taped lid, prepared as just described, was shaped on an apparatus similar to that shown in FIG. **3,** as described earlier, so as to impact a frustum-like configuration to the pour hole and the immediately surrounding area. The pour hole opening was enlarged to a diameter of about 11 mm, and the height of the frustum was about 2.2 mm above the remaining area of the can end. The sides of the frustum lay at an angle of about 30° to the remainder of the can lid, the base blending into the can end in a smooth curve.

When the sealed lid was mounted on the end of a can containing pressurized liquid, it functioned extremely effectively but could be removed easily.

Tabulated below are examples showing the effect of several variables on the performance of products made in accordance with the invention. None of these examples included a protective edge sealing coat; otherwise, all are made in substantially the same way as Example 1.

For convenience, the following abbreviations are employed in the table:

PET	Biaxially oriented polyethylene terephthalate film
IPP	Biaxially oriented isotactic polypropylene film

-Continued

ASA	Elastomeric film of 23:48:28 acrylonitrile:styrene:butyl acrylate polymer, having a density of 1.07 and a melt index at 200°C./21.6 kgf of 8–12 g/mm, per ASTM Test No. 1238. Resin of this type is available from BASF under the trade designation "Luran", and film is sold by Richman Chemical Company as "Richform" ASA.
SBS	Adhesive blend of 100 parts of the block copolymer of Example 1 and 90 parts of α-pinene resin having a ball-and-ring softening point of 135°C., coated from 40% solution in toluene
Crude	Adhesive blend of 100 parts crude rubber smoked sheets, 19 parts phenol-formaldehyde resin, 19 parts wood rosin and 65 parts poly-β-terpene.
VOAC:2EHA:-VA:EA	Adhesive based on vinyl acetate:2-ethylhexyl acrylate:vinyl alcohol:acrylic acid polymer (e.g., available from Monsanto under the registered trademark "Gelva" MP5-276), crosslinked with polycarbodiimide
VA:EA:2EHA:AA	Adhesive based on 27:19:51:3 vinyl acetate: ethyl acrylate:2-ethylhexyl acrylate:acrylic acid polymer (e.g., available from Ashland Chemical Company under the registered trademark "Aeroset" 1044), crosslinked with p-toluene sulfonic acid-catalyzed melamine resin
IOA:EA:AA	50:40:10 iso-octyl acrylate:ethyl acrylate:acrylic acid terpolymer
Polyamide	Polyamide resin having a ball-and-ring softening point of 140°C., a tensile strength of 50 kg/cm² at 24°C. and 350 kg/cm² at −29°C., and a Shore "A" hardness (ASTM Test D 1707-61) of 85, available from General Mills under the registered trademark designation "Versalon" 1140
PEPU	Highly crystalline thermoplastic polyester polyurethane resin which, in non-crystalline state, has a tack retention of 2 hours; stress-strain values are 64 kg/cm² at 40% elongation and 350 kg/cm² at 700% to break. (Suitable resins, disclosed in U.S. Patent No. 2,871,218, are available from B.F. Goodrich under the registered trademark "Estane" 5712)
SPE	Soluble polyester formed by co-reacting isophthalic acid, terephthalic acid and ethylene glycol

convex. Both of the latter slopes are effective to a degree but tend to be more prone to failure of the seal because of peel forces. It has been found that the greater the angle of slope with respect to the flat portion of the lid, the greater the capacity of the closure to transmit pressure to the shear mode and hence resist failure by peeling. Slopes greater than 45° are hard to attain on conventional steel but can be achieved with other metals; such slopes, however, require an extremely compliant, albeit strong, sealing tab; thus, although a 90° slope is theoretically ideal, it is generally quite impractical to attain.

It is not feasible to provide an exhaustive list of the various components, which might be employed in practicing the invention. It has been demonstrated, however, that various polymeric films and laminates can be used as backings for the closures, and that any primer must take account of both the backing and the subsequently applied adhesive. Although normally tacky and pressure-sensitive adhesives possess many advantages, hot melt adhesives, especially those which become tacky when heated and remain tacky for some time thereafter, are also useful. Presumably highly elastic thermoset resins could also be employed.

It will likewise be appreciated that while the major utility of structures formed in accordance with the invention resides in the packaging of pressure-generating liquid, such structures also find application in the packaging of particulate or non-pressure generating liquid material, the slightly elevated area surrounding the pour hole facilitating removal of the contents in a simple and convenient manner.

What is claimed is as follows:

1. In a closed hollow container wherein a pour hole

Examples 2–10

	Film Backing					Effectiveness	
Example	Composition	Thickness, microns	Primer	Adhesive	Test Temp. °C.	Pressure kg/cm²	Time to fail, min.*
Control	PET	90	SPE	SBS	38	3.5	4,332
2	"	"	"	"	"	"	10,000
Control	"	"	"	"	"	5.25	25–30
3	"	"	"	"	"	"	1,400
Control	"	"	"	"	60	6.3	9–12
4	"	"	"	"	"	"	112
Control	PET, aluminum vapor-coated	50	"	IOA:EA:AA, peroxide—crosslinked	38	3.5	80
5	"	"	"	"	"	"	181
Control	IPP	"	Atactic polypropylene	Crude	"	"	2–3
6	"	"	"	"	"	"	311
Control	"	"	"	Polyamide	43	"	15.7
7	"	"	"	"	"	"	98.6
Control	"	"	"	VOAC:2EHA	"	"	2.5
8	IPP	50	"	VOAC:2EHA	43	3.5	12.0
Control	"	"	"	VA:EA:2EHA:AA	"	"	4.4
9	"	"	"	"	"	"	15.3
Control	ASA	150	Polyamide	PEPU	"	2.8	76.5
10	"	"	"	"	"	"	1,820

*Test ended after 10,000 minutes, whether or not failure had occurred.

Those skilled in the art will readily recognize that practice of the invention is susceptible of many variations without departure from the spirit of what has been disclosed. For example, the dimensions recited are not intended to be narrowly applied. It has been found, however, that it is preferable for the slope of the tapered area to be linear rather than either concave or

in the container wall is protectively covered by a tape removably adhered to the outer surface of the wall in the area immediately circumjacent to the pour hole,

the improvement which comprises contouring said area so that the wall uniformly tapers outward and the hole is thus located in a plane displaced outward with respect to the portion of the wall peripherally adjoining said area, the tape being adhered to the tapered portion of the wall,

whereby, without causing the tape to loosen, the container can be subjected to substantially higher internal pressure than is possible when the hole is located in the same plane as the immediately circumjacent area.

2. The invention of claim 1 wherein the container is a cylindrical metal can having circular ends, the pour hole being located in one of said ends.

3. The invention of claim 2 wherein said one end is recessed, the height of the tapered area not exceeding the distance said one end is recessed.

4. The invention of claim 3 wherein the can contains a carbonated beverage.

5. The invention of claim 3 wherein the shape of the tapered area is that of a frustum.

6. A subassembly for use in fabricating the can of claim 2, comprising a pre-formed circular end piece having a depressed center end wall and a circumferential lip for clamping over and sealing to one end of an annular metal can body, said end wall having a portion which is displaced upward therefrom, a pour hole being located at the top of the upwardly displaced portion, with a strip of tape protectively covering said pour hole and sealed to the upwardly displaced side of the end wall in the area immediately circumjacent to the pour hole.

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