# United States Patent

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[72] Inventors **Robert R. Fritz**
Santa Ana, Calif.;
**George R. Ingram, Houston, Tex.;**
**Lawrence D. Barr, Eloy, Ariz.**



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[73] Assignee **Esso Research and Engineering Company**
**a corporation of Delaware**
**Continuation-in-part of application Ser. No. 623,448, Mar. 15, 1967, now abandoned.**


[54] **THERMOPLASTIC CONTAINER**
**2 Claims, 4 Drawing Figs.**


[52] **U.S. Cl.** ..... **220/67,** 220/72
[51] **Int. Cl.** ..... **B65d 7/42**
[50] **Field of Search** ..... 220/72, 83, 67



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*Primary Examiner*—Joseph R. Leclair
*Assistant Examiner*—James R. Garrett
*Attorney*—Chasan and Sinnock



**ABSTRACT:** Thermoplastic containers having a single open end of improved vertical strength properties are secured by employing a series of interconnected, vertically disposed supporting columns as part of the wall of the container. Preferably, the supporting columns extend laterally, outwardly from the noncolumn containing surface of the container sidewall. Each of the columns comprises two substantially identical isosceles trapezoids, each having a base and a side opposite therefrom of from 25 to 75 percent of the length of the base, and an elongated rectangular member of a length substantially equal to the length of the base of the trapezoids. The rectangular member is positioned between and connected to the bases of the trapezoids. Successive columns are interconnected along the side opposite the base of the trapezoids.

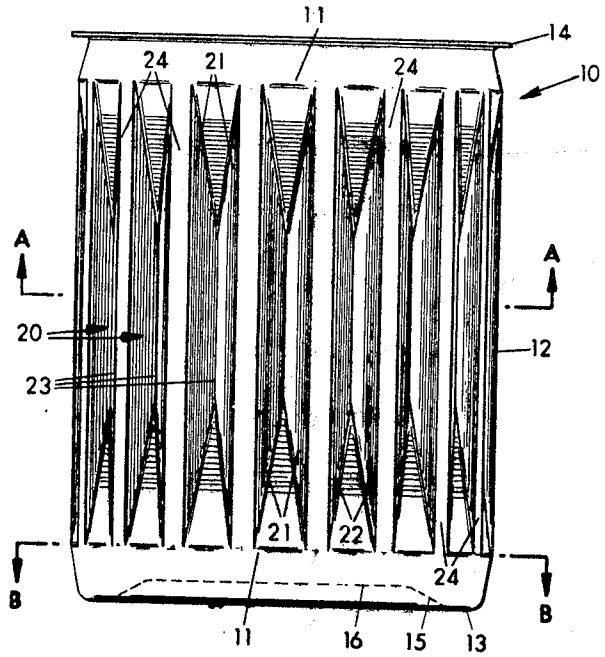
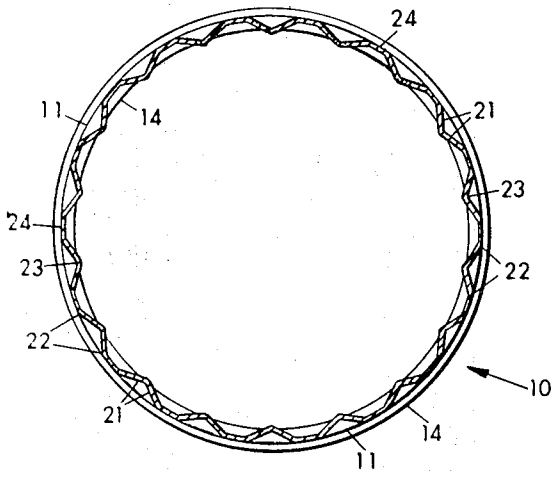



FIG. 2



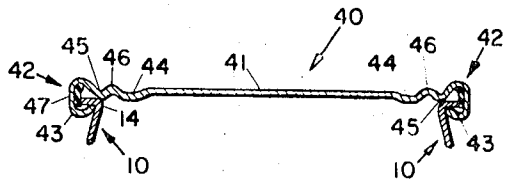




FIG. 4

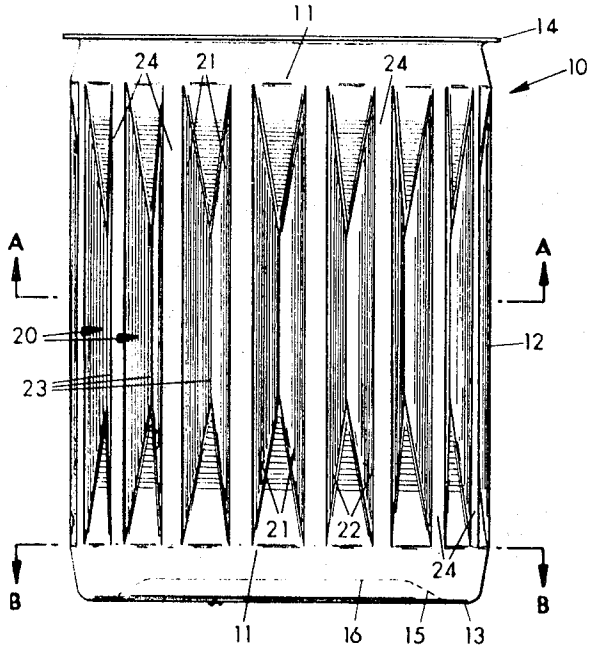



FIG. 1

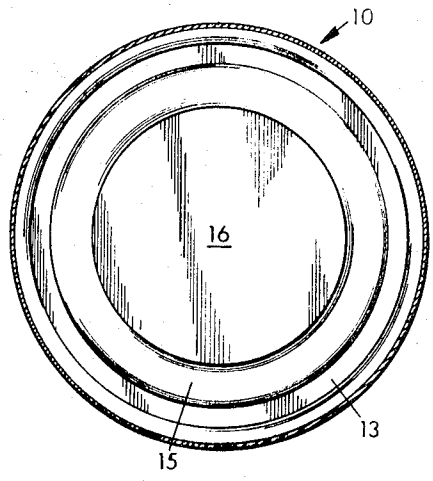



FIG. 3

R. R. FRITZ
G. R. INGRAM
L. D. BARR
INVENTORS

BY

ATTORNEY

# THERMOPLASTIC CONTAINER

This application is a continuation-in-part of application Ser. No. 623,448 filed Mar. 15, 1967, now abandoned, by the same inventors.

## BACKGROUND OF THE INVENTION

This invention relates to an improved container for products such as motor oil, and other heavy, dense liquids. More particularly, the invention is directed to an improved container, the main body portion thereof being formed of a thermoplastic resin and having a sidewall configuration particularly adapted for a container made of such material. The top closure part of the container is preferably a metal lid.

Containers formed from thermoplastic material are gradually assuming greater commercial importance. There are many obvious advantages in forming containers for heavy, dense fluids such as motor oil from thermoplastic materials as containers are light in weight, can be readily pigmented and can be produced in large quantities are relatively low cost. However, thermoplastic containers possess several deficiencies which deter their ready acceptance in the market place. For example, lube oil containers, when fabricated from a thermoplastic resin, are not readily stackable nor can they be easily opened with conventional bayonet type openers as the wall of walls of the container tends to deform with the application of the compressive pressures encountered upon stacking and opening. If the container wall deforms upon the exertion of a vertically applied pressure, opening of the container with a conventional bayonet type opener is extremely difficult and sometimes impossible. If a container deforms from stacking forces, a warehouse stack will begin to tilt and ultimately collapse, presenting imminent danger to warehouse personnel and an economically intolerable damage rate.

Numerous solutions have been advanced for improving the vertical strength characteristics of thermoplastic containers. These solutions normally take the form of modification made to the sidewall of the container to render the same less subject to deformation or stress cracking. Typical sidewall designs that have been advanced involve (1) forming the container sidewall with a plurality of vertically disposed members of the type depicted in FIGS. 1 and 2 of U.S. 2,063,013 or (2) modifying the container sidewall with a plurality of horizontally disposed reinforcement members of the type shown in U.S. Design Patents 199,869 and 200,444. However, even with these modifications, thermoplastic containers do not possess sufficient vertical strength to render them readily suitable for applications where the container must withstand high levels of compressive pressure without sidewall deformation or stress cracking.

Accordingly, it is the object of the present invention to provide an improved container structure which substantially eliminates the above discussed shortcomings of containers having a plastic body.

## SUMMARY OF THE INVENTION

This object is accomplished by employing as part of the sidewall of the container a plurality of vertically disposed interconnected supporting columns that extend outwardly from the noncolumn containing surface of the container sidewall. Each of the columns is composed of two essentially identical inwardly inclining isosceles trapezoids each having a base and a side opposite therefrom of from 25 to 75 percent of the length of the base and an elongated rectangular member. The bases and opposite sides of the trapezoids are disposed substantially parallel to the longitudinal axis of the container. The elongated rectangular member is of a length substantially equal to the length of the base of the trapezoids and is positioned between and connected to the bases of the trapezoids. The planes of the trapezoids recede inwardly from the planes of the rectangle by an amount between 10 and 25 degrees. Successive columns are interconnected along the aid side opposite the bases of the trapezoids.



## BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will become more apparent with the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a side elevational view of a container for motor oil formed according to the principles of the present invention;

FIG. 2 is a cross-sectional view of the container taken along lines A–A;

FIG. 3 is a cross-sectional view of the container taken along line B–B; and

FIG. 4 is a vertical sectional view of a lid showing the configuration thereof when the lid is clinched onto the container of FIG. 1, the upper portion of the container being shown in FIG. 4.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Container **10** comprises a relatively deep cup-shaped body **11** (preferably of circular horizontal cross section) having a sidewall **12** stacking ring **13** and a lid flange **14**. Flange **14** extends completely about the upper outer periphery of the container **10** and extends outwardly from the inner periphery of the container. A metal lid is attached to the flange during closing operations to provide an essentially leakproof enclosure. Stacking ring **13** present on the container to prevent tipping or jiggling of containers when stacked on top of each other. The lower portion of container **10** is made up of stacking ring **13**, transitional plane **15** and bottom segment **16**.

The outer periphery of sidewall **12** of container **10** is composed of a plurality of vertically disposed laterally extending, interconnected supporting columns **20** of substantially the same length. Each of the columns **20** is composed of two substantially identical inwardly inclining isosceles trapezoids **20**, each having a base **22** and a geometrically opposite second side **23** opposite therefrom of from 25 to 75 percent of the length of the base **22**, and an elongated rectangular member **24** of a length substantially equal to the length of base **22** of the trapezoids. The planes of the trapezoids recede inwardly of the planes of the rectangles by an amount of between 10 to 25 degrees. The rectangular member **24** having a length of the base of the trapezoids, is positioned between and connected to the bases **22** of the trapezoidal sections **21**. The columns preferably extend completely about the outer periphery of sidewall **12** and are interconnected by joining the opposite second side **23** of the trapezoid of an individual column with the opposite sides **23** of the trapezoid of the next adjacent supporting column **20**. Preferably the said opposite sides of all of the trapezoids employed in the supporting columns are of the same length.

The total length of the base of the trapezoids varies from 8 cm. to 12 cm. for 1-quart containers, or more broadly from 55 to 85 percent of the total height of the container. For 1-quart lube oil containers, the base of the trapezoidal sections is preferably 75 to 85 percent of the total height of the container. The number of supporting columns used to lend vertical rigidity to a thermoplastic container can vary from about 10 to 20, preferably 13 to 18.

Typically, a 1-quart container having a single open end and a configuration as shown in FIG. 1 has 18 columns of a length of about 4.4 inches; an overall height of about 5.5 to 5.6 inches; a maximum diameter as defined by lid flange **14** of about 4.11 to 4.14 inches; a maximum sidewall diameter of about 4.09 inches (as defined by rectangular segments **24**); and a minimum diameter of about 3.91 to 3.92 inches (as defined by the points of junction of the opposite sides of **23** of the trapezoidal sections of two individual columns). Flange **14** of the container is of a thickness varying from 0.015 to 0.035 inches, preferably 0.020 to 0.025 inches, and extends from the planar surface **11** of the container about 0.090 to 0.015 inches. Preferably flange **14** is inclined upwardly from the horizontal at an angle of about 1 to 3 degrees.

The containers of the present invention may be conveniently formed using blow-molding techniques. With this technique, a thermoplastic tube or parison is formed using extrusion techniques. The severed parison is then transferred to a blow-molding station. At the blow-molding station, the open ends of the parison are clinched between the upper end lower edges of the sectional molds normally employed. A blowing needle or mandrel or other similar device is then injected into the parison and air forced into the parison, thereby forcing the parison into conformity with the walls of the mold. Thereafter, the rough container is cooled, taken from the sectional mold and the upper and lower portions of the rough container trimmed away, leaving as the finished product a container having a single open end.

After the thermoplastic container body has been formed, and the container filled, the can or container **10** is conveniently closed with a top or lid as shown in FIG. **4**. The metal lid **40**, typically metal and preferably formed of tin plated steel or aluminum, consists of a central disc portion **41** and an upstanding, continuous, peripheral portion in the form of a circular groove **42**. The upstanding, continuous peripheral portion or flange **42** may be in the form of a circular groove (when viewed from below in FIG. **4**). The flange may also include an outwardly turned portion **43** which when inwardly rotated (as shown in FIG. **4**) is clinched to the flange portion **14** of container **10**. Sealing may be facilitated by coating **47** in the groove **42**. The lid **40** may also include the inner depressed annular portion **44** and the outer depressed annular portion **45** which define annular ride ridge portion **46**. When the lid is positioned on the container body, the free circular flange portion **14** and adjacent marginal portions of body **11** are enclosed and concealed by the outwardly turned portions of the flange **45** of the lid **40** at circumferentially closely spaced pints of or circumferentially continuously to the circular flange area **14**. This is accomplished with equipment utilizing either a rolling action or segmental jaws. When the container and lid are so circumferentially clinched, the outer wall of the lid groove is embedded in the outer portion of the flange area of the container and the inner wall of the groove coextensively engaging the inner portion of the container flange **14**.

The inside surface of the metallic can lid may be either coated or uncoated depending upon the materials to be packed within the container. For example, the container lid may be coated with a thin film of various types of resins. Acrylic resins, alkyd resins, epoxy-amine resins, epoxy-ester resins, epoxy-phenolic resins, polybutadiene resins, etc., are suitable as lid-coating materials.

Thermoplastic materials that can be used to form the container body of this invention include polyvinylchloride; high molecular weight homopolymers and copolymers of alpha-olefins such as polypropylene, polybutene, ethylene-propylene copolymers, ethylene-butene copolymers, propylene-butene copolymers, etc., polypropylene blended with from 2 to 40 wt. percent, preferably from 4 to 18 wt. percent of low, medium or high density polyethylene, polyisobutylene, isobutylene-isoprene copolymers, and ethylene-propylene rubber; high density polyethylene having a density of at least 0.957 grams/cc., acrylonitrile-butadiene-styrene resins; and a polymethylmethacrylate. High density polyethylene and polyvinylchloti polyvinylchloride are particularly preferred container forming materials.

Low density polyethylene (density less than 0.94 grams/cc.) and polystyrene are generally not suitable container construction materials if the containers are to be used to carry lubricating oils. Low density polyethylene lacks rigidity and tends to become oil-soluble and polystyrene is brittle and is also softened or swollen by oil.

The invention will be further illustrate illustrated by the following examples;

## EXAMPLE 1

To demonstrate the superior compressive strength of containers having the sidewall configuration of the present invention, a series of tests were conducted with polyethylene containers of substantially the same height (5.545 inches) and a maximum outside body diameter (4.090 inches) The containers differed only in their sidewall configuration.

The first type of container (Case **1**) tested had a plain sidewall of substantially uniform thickness. The second type of container (Case **2**) evaluated was of the type depicted in FIG. **2** of U.S. 3,297,194 and had a sidewall with a series of horizontally disposed reinforcement members. The horizontal members consisted of five concavely or inwardly directed ribs that extended completely about the outer periphery of the container. The depth of the reinforcement ribs was approximately three thirty-seconds inch inward from the outer planar surface of the container. The rib width was seven thirty-seconds inch. The ribs were spaced 0.5 inches apart and the first rib was formed about 1.52 inches from the top of the container. The third container type (Case **3**) evaluated had a plurality of vertically disposed reinforcement members positioned in the sidewall of the container. A total of 34 reinforcing members having a length of 4.4 inches and a width of 0.100 inches were used. The reinforcing members extended approximately 0.030 inches from the planar surface of the container and were placed approximately 0.375 inches apart. The last container tested (Case **4**) had the design configuration of the present invention. Into the sidewall was formed a series of 18 supporting columns. The base of the trapezoidal sections forming the columns had a length of about 4.40 inches and the opposite side of the trapezoidal sections had a length of about 1.47 inches. The supporting columns were centered on the container wall, with the columns beginning at about 0.5 inches from the top of the container and terminating about 0.58 inches from the bottom of the container.

In each of the tests, the containers were filled with one quart of lubricating oil and then sealed with a metal lid using conventional techniques. The filled containers were then placed in an Instron machine and a compressive load applied. The load necessary to achieve a 0.25 inch deflection (reduction in the height of the container) and the deflection secured with the application of a 50 pound load were recorded. All tests were conducted at 75° F. and 50 percent relative humidity. The results of the tests are set forth in Table I.

TABLE I

| Design | Container wt., grams | Load, lbs. at 0.25 inch deflection | Deflection, inch at 50 lb. load |
|---|---|---|---|
| Case 1 | 56 | 270 | 0.030 |
| Case 2 | 42 | 120 | 0.090 |
| Case 2 | 48 | 175 | 0.060 |
| Case 2 | 56 | 230 | 0.045 |
| Case 3 | 56 | 225 | 0.060 |
| Case 4 (Invention) | 42 | 205 | 0.030 |
| Case 4 (Invention) | 53 | 290 | 0.025 |
| Case 4 (Invention) | 58 | 330 | 0.020 |

As can be seen by referring to the data of Table **1**, at equivalent container weights, the containers having the structure of the present invention (Case **4**) exhibited the highest compressive strengths of all of the polyethylene blow-molded containers having various sidewall configurations. All of the containers were formed from polyethylene resins having a density of about 0.958 and a melt index of 0.30 as determined by ASTM method D–1238.

The deflection values secured upon the application of a 50 pound load to the containers are significant. A 50 pound load is approximately the maximum load a container might experience in a 15 case (24 cans to the case packed on two levels) high stack with wooden pallets placed between the fifth

and sixth and tenth and eleventh cases. The data presented indicates that the container having the configuration of the present invention has the greatest resistance to deflection upon the application of a 50 pound load. As a result, warehousing of containers having the design of the present invention is greatly simplified as the containers resist deformation. Hence, tilting and collapsing of warehouse stacks is avoided.

## EXAMPLE 2

Exposure to certain chemical environments (particularly detergents) and/or elevated temperatures is known to induce stress cracking in polyolefin resins. Container design and the molecular weight and density of the resin used in the formation of thermoplastic containers can also significantly effect stress crack resistance properties.

To demonstrate the superior stress crack resistance of containers having the configuration of the present invention, a series of containers having the configurations described with reference to Example 1 were formed from polyethylene resin having a density of about 0.958 grams/cc. and a melt index of 0.30 as determined by ASTM method D–1238. Each container was filled with high detergent content lubricating oil sealed with a conventional metal lid, a 50 pound vertical load applied and the containers aged at 140° F. The individual containers were inspected periodically and the failure time (leaking of container contents) of each container noted. The mean failure time ($F_{50}$) was then determined from a probability/time plot for each design. The average failure times are tabulated in Table II.

TABLE II

| Design | Container wt., grams | Stress crack resistance; $F_{50}$, days |
|---|---|---|
| Case 1 | 56 | 7.5 |
| Case 2 | 42 | 3.1 |
| Case 2 | 48 | 5.2 |
| Case 2 | 56 | 6.2 |
| Case 3 | 56 | 5.5 |
| Case 4 (Invention) | 56 | 11.0 |

As can be seen by referring to the data above, the containers of the present invention (Case 4) exhibit the best stress crack resistance of the polyethylene containers. Since all of the containers were formed from equivalent resins, the superior performance of the container of this invention can be primarily attributed to its design. Containers formed having a plurality of vertically spaced ribs demonstrated the poorest stress crack resistance performance at equivalent container weight levels.

Numerous modifications can be made to the container structures previously described without departing from the spirit of the invention. For example, stacking ring **13** can be removed and the container provided with a simple flat base for applications where stacking stability is not critical. Similarly, the upper opening of the container can be provided with a threaded or beaded structure rather than a flange **14**, thereby permitting the use of other types of container closures such as threaded caps and the like.

We claim:

**1.** A thermoplastic container comprising a hollow thermoplastic, cup-shaped body of generally circular, horizontal cross section having a bottom portion and a sidewall portion terminating in a single open end provided with an outwardly turned peripheral flange, said sidewall portion having formed therein a series of vertically disposed, interconnected supporting columns, each of said columns comprising two substantially identical isosceles trapezoids each having a base and a geometrically opposite second side parallel to said base of from 25 to 75 percent of the length of the base, and an elongated rectangular member having a length substantially equal to the length of the base of said trapezoids located on the outermost surface of said cup body, said rectangular member being positioned between and connected to the bases of the said trapezoids with the planes of said trapezoids receding inwardly of the planes of said rectangles by an amount of between 10—25 degrees and wherein said columns are interconnected through joinder of the opposite second sides of the trapezoids of one column with said opposite second side of the trapezoids of adjacently located columns.

**2.** The container of claim **1** having a metal lid comprising a central disc portion and an upstanding, continuous, peripheral flange with an outwardly turned portion thereof, circumferentially clinched to the flange portion of the said container.