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(54) **FLEX RING BASE**

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(60) Provisional application No. 61/063,883, filed on Feb. 7, 2008.

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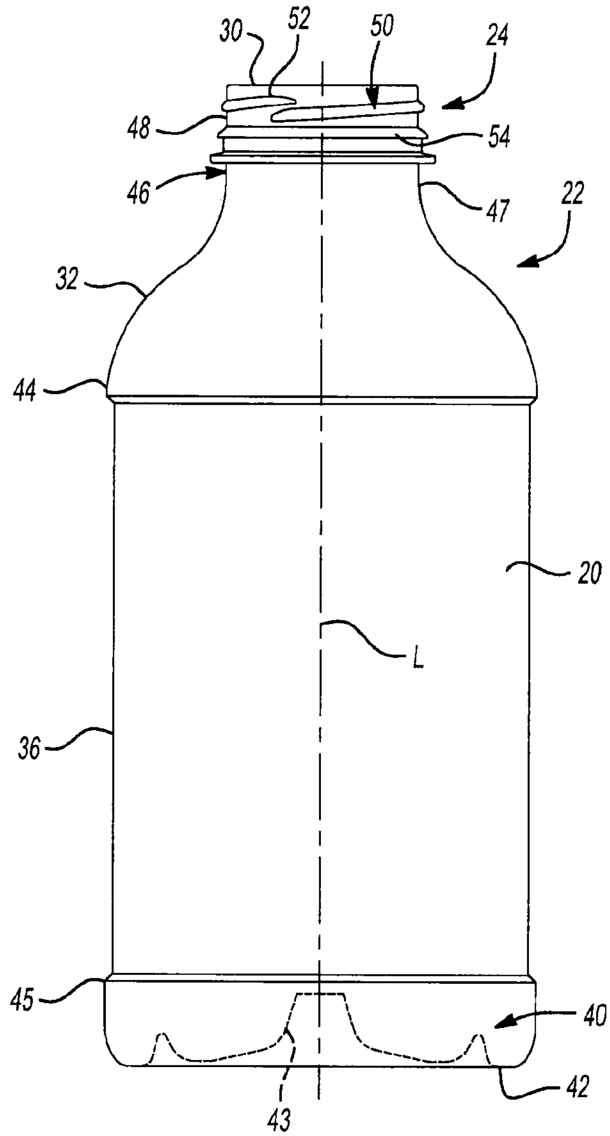
(57) **ABSTRACT**

A plastic container includes a cylindrical body defining a longitudinal axis. The body has an upper portion, a sidewall portion and a base portion having a base. The base portion defines a radial sidewall and a central inset portion defined inboard of a thinned wall portion formed around at least a portion of the base.



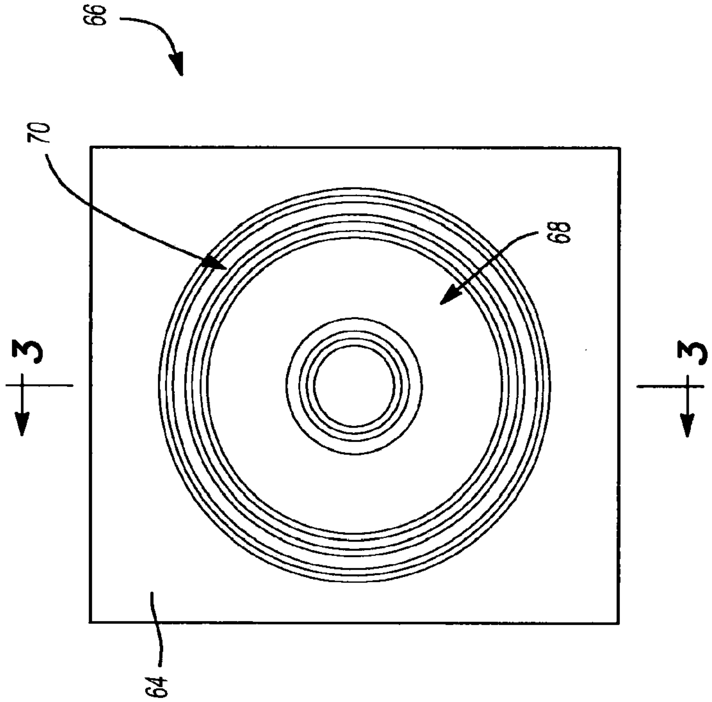


Fig-2

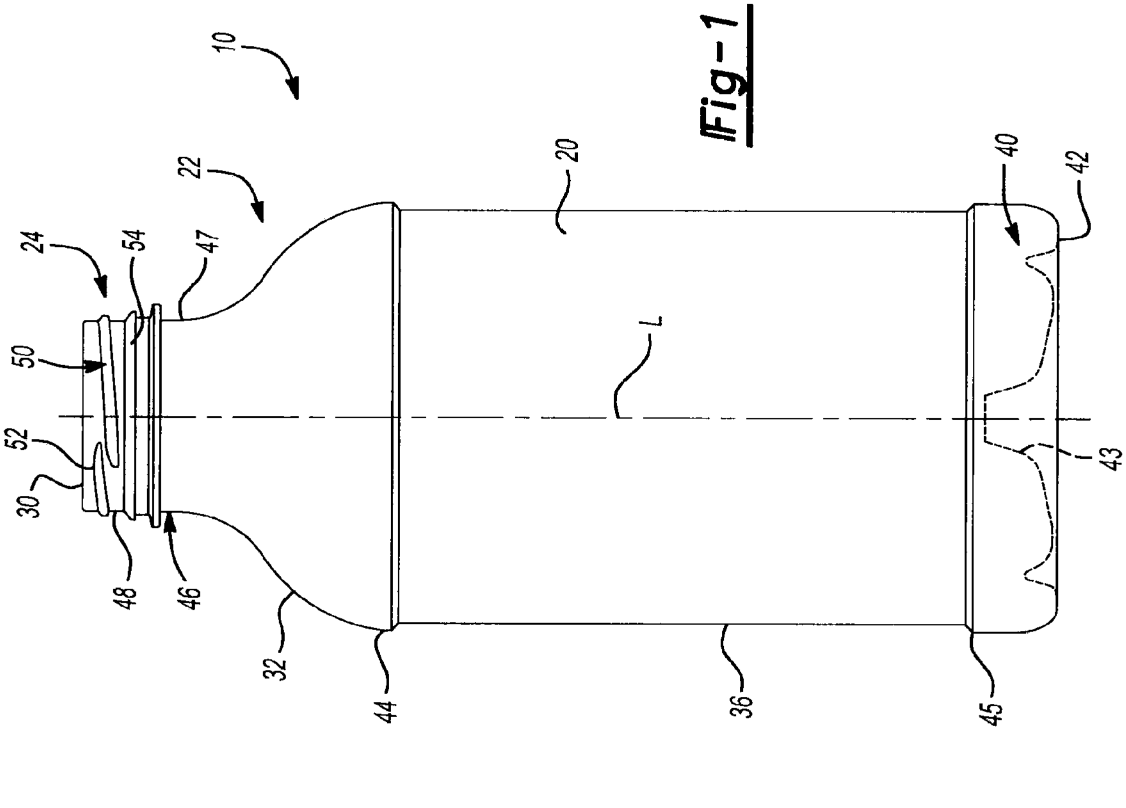


Fig-1

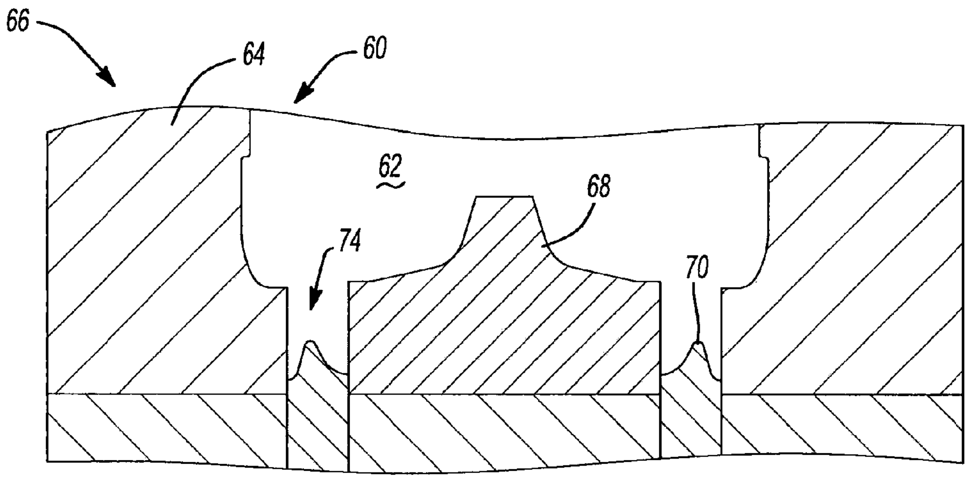


Fig-3

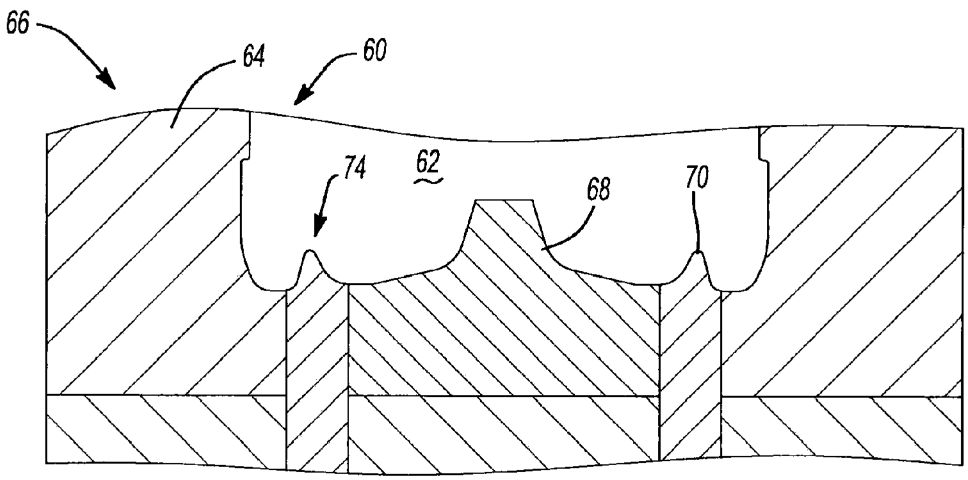


Fig-4

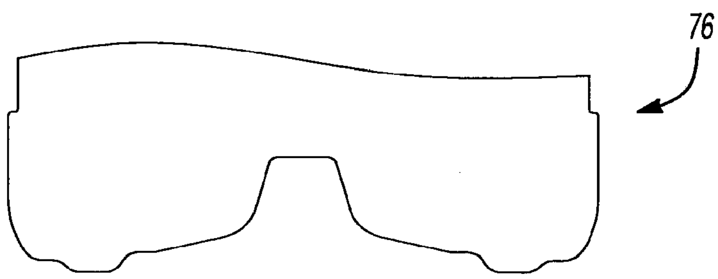


Fig-5

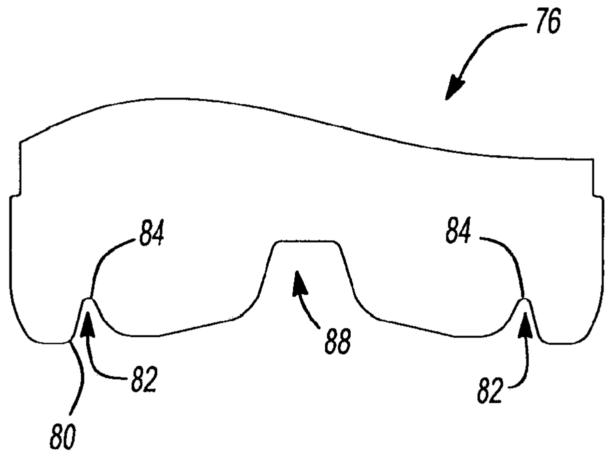


Fig-6

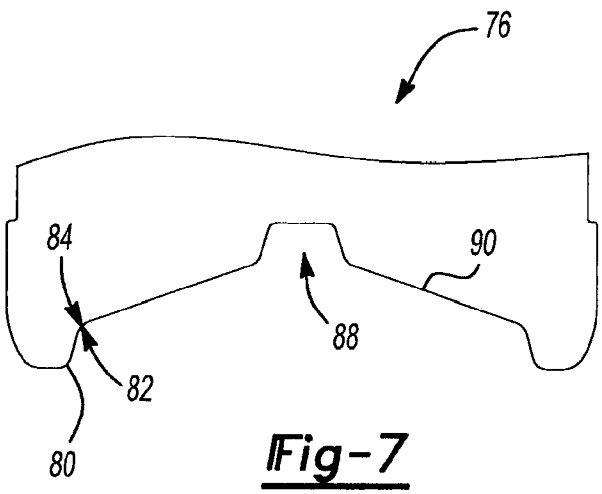


Fig-7

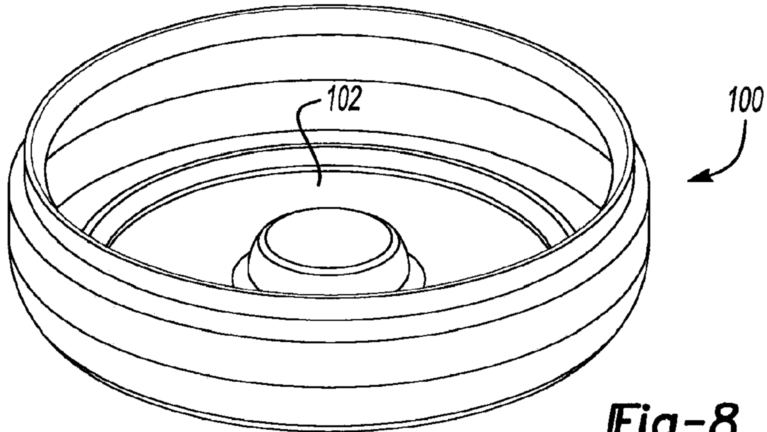


Fig-8

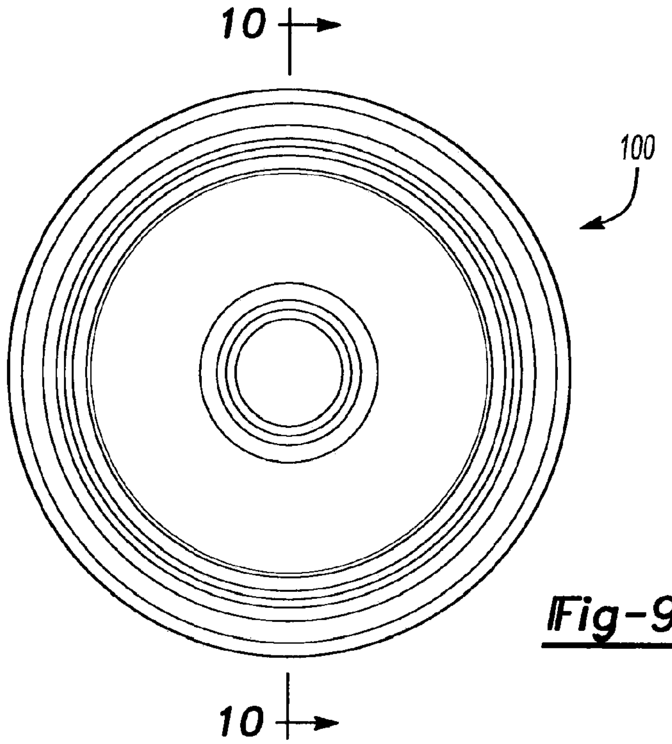


Fig-9

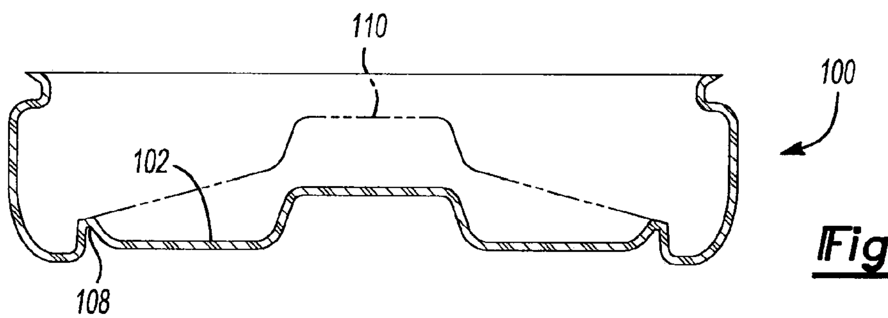


Fig-10

FLEX RING BASE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 12/367,002 filed on Feb. 6, 2009, which claims the benefit and priority of U.S. Provisional Patent Application No. 61/063,883, filed Feb. 7, 2008. The entire disclosures of the above applications are incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure generally relates to containers for retaining a commodity, such as a solid or liquid commodity. More specifically, this disclosure relates to a blown polyethylene terephthalate (PET) container having a flex ring base and related method of making the same.

BACKGROUND

[0003] As a result of environmental and other concerns, plastic containers, more specifically polyester and even more specifically polyethylene terephthalate (PET) containers are now being used more than ever to package numerous commodities previously supplied in glass containers. Manufacturers and fillers, as well as consumers, have recognized that PET containers are lightweight, inexpensive, recyclable and manufacturable in large quantities.

[0004] Blow-molded plastic containers have become commonplace in packaging numerous commodities. PET is a crystallizable polymer, meaning that it is available in an amorphous form or a semi-crystalline form. The ability of a PET container to maintain its material integrity relates to the percentage of the PET container in crystalline form, also known as the "crystallinity" of the PET container. The following equation defines the percentage of crystallinity as a volume fraction:

$$\% \text{ Crystallinity} = \left(\frac{\rho - \rho_a}{\rho_c - \rho_a}\right) \times 100$$

where ρ is the density of the PET material; ρ_a is the density of pure amorphous PET material (1.333 g/cc); and ρ_c is the density of pure crystalline material (1.455 g/cc).

[0005] Container manufacturers use mechanical processing and thermal processing to increase the PET polymer crystallinity of a container. Mechanical processing involves orienting the amorphous material to achieve strain hardening. This processing commonly involves stretching an injection molded PET preform along a longitudinal axis and expanding the PET preform along a transverse or radial axis to form a PET container. The combination promotes what manufacturers define as biaxial orientation of the molecular structure in the container. Manufacturers of PET containers currently use mechanical processing to produce PET containers having approximately 20% crystallinity in the container's sidewall.

[0006] Thermal processing involves heating the material (either amorphous or semi-crystalline) to promote crystal growth. On amorphous material, thermal processing of PET material results in a spherulitic morphology that interferes with the transmission of light. In other words, the resulting crystalline material is opaque, and thus, generally undesirable. Used after mechanical processing, however, thermal processing results in higher crystallinity and excellent clarity for those portions of the container having biaxial molecular orientation. The thermal processing of an oriented PET container, which is known as heat setting, typically includes blow molding a PET preform against a mold heated to a temperature of approximately 250° F.-350° F. (approximately 121° C.-177° C.), and holding the blown container against the heated mold for approximately two (2) to five (5) seconds. Manufacturers of PET juice bottles, which must be hot-filled at approximately 185° F. (85° C.), currently use heat setting to produce PET bottles having an overall crystallinity in the range of approximately 25%-35%.

[0007] In one method of forming such a plastic container, a mold assembly includes a base mechanism that raises a base insert and a ring insert up into position such as against a heel insert. In some instances, moving the base insert and the ring insert may require significant force to overcome internal pressures of the container.

SUMMARY

[0008] A plastic container is disclosed that includes a cylindrical body defining a longitudinal axis. The body has an upper portion, a sidewall portion and a base portion having a base. The base portion defines a radial sidewall and a central inset portion defined inboard of a thinned wall portion formed around at least a portion of the base.

[0009] Also, a molding system for making a blow-molded plastic container having a base portion that supports the container is disclosed. The molding system includes a mold defining a mold cavity. The mold has a base forming assembly that is configured to form the base portion of the container. The base forming assembly includes a base insert and a movable ring insert that is movable relative to the base insert. Moreover, the molding system includes an actuator that is configured to move the movable ring relative to the base insert while the base portion remains in the mold cavity to advance the movable ring insert into the base portion to define a thinned flex point in the base portion.

[0010] Furthermore, a plastic container is disclosed that includes a body defining a longitudinal axis, a container interior, and a container exterior. The body has an upper portion, a sidewall portion, and a base portion. The base portion has a heel portion and a hinge portion. The hinge portion is disposed inboard and extends toward the container interior relative to the heel portion.

[0011] Additional benefits and advantages of the present disclosure will become apparent to those skilled in the art to which the present disclosure relates from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a side elevational view of a plastic container constructed in accordance with the teachings of the present disclosure.

[0013] FIG. **2** is a plan view of a mold assembly including exemplary base forming portions according to the present teachings including a fixed base insert and a movable ring insert.

[0014] FIG. **3** is a partial cross-sectional view of the mold assembly of FIG. **2** used during formation of the plastic container shown in FIG. **1**, the movable ring insert shown in a down position.

[0015] FIG. **4** is a partial cross-sectional view of the mold assembly of FIG. **3** shown with the movable ring insert in an up position.

[0016] FIG. **5** is a side perspective view of an exemplary container base being formed by the mold assembly of FIG. **3** and representative of the movable ring insert of the mold assembly in the down position.

[0017] FIG. **6** is side perspective view of the exemplary container base of FIG. **5** and representative of the movable ring insert of the mold assembly in the up position.

[0018] FIG. **7** is a side perspective view of the exemplary container base of FIG. **6** and representative of the center portion of the container base inverted subsequent to product cooling.

[0019] FIG. **8** is a perspective view of an exemplary base formed according to the present teachings according to additional features and shown prior to inversion of the base.

[0020] FIG. **9** is a plan view of the base of FIG. **8**; and

[0021] FIG. **10** is a cross-sectional view of the base of FIG. **9** taken along line **10-10**, and shown with the base prior to upward movement or inversion (solid line) and subsequent to upward movement or inversion (phantom line).

DETAILED DESCRIPTION

[0022] The following description is merely exemplary in nature, and is in no way intended to limit the disclosure or its application or uses.

[0023] FIG. **1** shows one preferred embodiment of the present container. In the Figures, reference number **10** designates a one-piece plastic, e.g. polyethylene terephthalate (PET), hot-fillable container. Those of ordinary skill in the art would appreciate that the following teachings are applicable to other containers, such as rectangular, triangular, hexagonal, octagonal or square shaped containers, which may have different dimensions and volume capacities. It is also contemplated that other modifications can be made depending on the specific application and environmental requirements.

[0024] The container **10** according to the present teachings defines a body **20** and includes an upper portion **22** having a finish **24**. The finish **24** defines an opening **30** into the container **10**. Integrally formed with the finish **24** and extending downward therefrom is a shoulder region **32**. The shoulder region **32** merges into and provides a transition between the finish **24** and a sidewall portion **36**. The sidewall portion **36** extends downward from the shoulder region **32** to a base portion **40** having a base **42**. The base portion **40** defines a central inset portion **43**. An upper bumper portion **44** may be defined at a transition between the shoulder region **32** and the sidewall portion **36**. A lower bumper portion **45** may be defined at a transition between the base portion **40** and the sidewall portion **36**. A neck **46** defining a cylindrical sidewall **47** is integrally formed with the finish **24** and extends between the finish **24** and the shoulder region **32**. In one example, the cylindrical sidewall **47** can define a uniform radius along its entire height. The container **10** can define a central longitudinal axis L. As will become appreciated, the instant disclosure is directed toward the base portion **40** and the base **42**. As such, the configuration of other portions of the container **10** may take on forms other than shown in FIG. **1**. Likewise, the geometrical configurations of the base portion **40** and the base **42** are also exemplary as the teachings herein and are applicable to plastic containers and associated methods of making plastic containers having alternate configurations of the base portion **40** and the base **42**.

[0025] The container **10** has been designed to retain a commodity. The commodity may be in any form such as a solid or liquid product. In one example, a liquid commodity may be introduced into the container **10** during a thermal process, typically a hot-fill process. For hot-fill bottling applications, bottlers generally fill the container **10** with a liquid or product at an elevated temperature between approximately 155° F. to 205° F. (approximately 68° C. to 96° C.) and seal the container **10** with a cap (not shown) before cooling. In addition, the container **10** may be suitable for other high-temperature pasteurization or retort filling processes or other thermal processes as well. In another example, the commodity may be introduced into the container **10** under ambient temperatures.

[0026] The finish **24** of the container **10** generally includes a radial sidewall **48** defining a threaded region **50** having threads **52**, and a tamper evident (TE) band **54**.

[0027] The container **10** according to the figures of the present disclosure is a blow molded, biaxially oriented container with a unitary construction from a single or multi-layer material. A well-known stretch-molding, heat-setting process for making the container **10** generally involves the manufacture of a preform (not shown) of a polyester material, such as polyethylene terephthalate (PET), having a shape well known to those skilled in the art similar to a test-tube with a generally cylindrical cross section and a length typically approximately fifty percent (50%) that of the container height.

[0028] Turning now to FIGS. **2-4**, an exemplary mold assembly according to the present teachings is shown and generally identified at reference **60**. The mold assembly **60** can generally define a mold cavity **62** (partially shown) and includes a first blow mold portion **64** (such as a heel insert, partially shown), and a base forming assembly **66**. The base forming assembly **66** includes a fixed base mold insert **68** and a movable ring insert **70**. According to one example, the first blow mold portion **64** can comprise or additionally include a heel insert or a body insert. As can be appreciated by those skilled in the art, the portions of the mold assembly **60** shown in FIGS. **3** and **4** only represent portions of a mold assembly directed toward formation of a base portion (i.e., **40**) of a resultant plastic container (i.e., **10**). As such, other mold inserts such as, but not limited to, a shoulder insert and/or others may be included.

[0029] An exemplary method of forming the container **10** will be described. Those skilled in the art will appreciate that the teachings of the instant disclosure are applicable toward plastic container formation by way of a traditional injection-stretch blow molding process or by a blown finish blow molding process. In the traditional injection-stretch blow molding process, the finish remains substantially in its injection molded state while the container body is formed below the finish. The finish may include at least one thread extending radially outwardly around an annular sidewall defining a thread profile. In one application, a closure member or cap may define a complementary thread, or threads, that are adapted to cooperatively mate with the threads of the finish. In the blown finish blow molding process, the finish portion of the container is created in the blow mold. This alternative process enables production of a more lighter-weight finish portion, and thus container, than is possible through the traditional injection molding production method. During formation of a plastic container by way of the blown finish method, a moil portion is formed in the mold above the blown finish. The moil portion is severed from the blown finish, as is known in the art, to reveal the resultant container.

[0030] At the outset, a preform (not shown) may be placed into the mold cavity **62**. In general, the mold cavity **62** has an interior surface corresponding to a desired outer profile of the blown container (i.e., **10**). In one example, a machine (not illustrated) places the preform heated to a temperature between approximately 190° F. to 250° F. (approximately 88° C. to 121° C.) into the mold cavity **62**. The mold cavity **62** may be heated to a temperature between approximately 250° F. to 350° F. (approximately 121° C. to 177° C.). A stretch rod apparatus (not illustrated) stretches or extends the heated preform within the mold cavity **62** to a length approximately that of an intermediate container (i.e., a structure collectively defined by a moil and the end container), thereby molecularly orienting the polyester material in an axial direction generally corresponding with the central longitudinal axis L of the container **10**. While the stretch rod extends the preform, air having a pressure between 300 PSI to 600 PSI (2.07 MPa to 4.14 MPa) assists in extending the preform in the axial direction and in expanding the preform in a circumferential or hoop direction thereby substantially conforming the polyester material to the shape of the mold cavity **62** and further molecularly orienting the polyester material in a direction generally perpendicular to the axial direction, thus establishing the biaxial molecular orientation of the polyester material in most of the intermediate container. The polyester material is allowed to form into a void **74** (FIG. **3**) created by the movable ring insert **70** in the down position (FIG. **3**). As shown in FIG. **5**, a container base **76** is illustrated during formation in the void **74**. The container base **76** includes an annular projection having a concave profile.

[0031] At this point, the movable ring insert **70** of the base forming assembly **66** moves from the position shown in FIG. **3** (down position) under high pressure through an air chamber, to the position shown in FIG. **4** (up position). With additional reference to FIGS. **5** and **6**, the exemplary container base **76** is shown corresponding to the base forming sequence of FIGS. **3** and **4**, respectively. During translation of the movable ring insert **70** from the down position (FIG. **3**) to the up position (FIG. **4**), a heel **80** and a thinned flex point **82** are created in the container base **76** (FIG. **6**). During advancement, the movable ring insert **70** moves in a direction long the longitudinal axis of the base **42** (i.e., the longitudinal axis L, FIG. **1**).

[0032] As will be described, when the movable ring insert **70** translates upward, it inverts an annular hinge forming portion **84** defined at the thinned flex point **82** to a position shown in FIG. **6**. The wall thickness of the polyester material at the annular hinge forming portion **84** is thereby thinned creating the flexibility required to allow an inner central portion **88** of the container base **76** to move upward or invert in response to vacuum forces resulting from hot-filling and subsequent cooling of the contents of the container. The annular hinge forming portion **84** and the thinned flex point **82** can be both defined as a continuous annular structure around the container base **76**. In other examples, the hinge forming portion **84** and the thinned flex point **82** can be discontinuous or segmented around the container base **76**. Notably, the fixed base mold insert **68** remains stationary during translation of the movable ring insert **70**. As such, the desired flexible base (i.e., the inner central portion **88**) can be formed using less force as compared to conventional push-up methods that involve movement of a base insert.

[0033] In one example, the pressurized air holds the mostly biaxial molecularly oriented polyester material against the mold cavity **62** for a period of approximately two (2) to five (5) seconds before removal of the plastic container **10** from the mold cavity **62**. If the plastic container **10** is formed by the blown finish method, the moil (not shown) can be severed thereby creating a resultant plastic container **10**. As can be appreciated, much less force is required to move just the movable ring insert **70** as compared to also requiring movement of the fixed base mold insert **68**. A commodity can be introduced into the resultant plastic container **10** during a hot-fill process. When the resultant container **10** filled with hot product starts to cool, the inner central portion **88** of the container base **76** draws up under vacuum thus displacing volume. The inner central portion **88** of the container base **76** is illustrated subsequent to product cooling in FIG. **7**. As can be appreciated, the thinned flex point **82** created by the movable ring insert **70** acts as a hinge to influence the vacuum action at the inner central portion **88** of the container base **76** during product cooling. The resulting vacuum forces cause the inner central portion **88** of the container base to move upward or invert, and define a central inset portion **90** (FIG. **7**). It is appreciated that the description above with respect to the container base **76** and central inset portion **90** is applicable to the base **42** and inset portion **43** (FIG. **1**).

[0034] With reference to FIGS. **8-10**, a container base **100** according to additional features is shown. FIG. **10** illustrates a central portion **102** prior to cooling (solid line) and corresponds to the movable ring insert **70** in the up position (FIG. **3**). A thinned flex point **108** created by the movable ring insert **70** acts as a hinge to influence the vacuum action at the central portion **102** of the container base **100** during product cooling. The resulting vacuum forces cause the central portion **102** of the container base **100** to move upward or invert and define a central inset portion **110** (phantom line).

[0035] Alternatively, other manufacturing methods using other conventional materials including, for example, high density polyethylene, polypropylene, polyethylene naphthalate (PEN), a PET/PEN blend or copolymer, and various multilayer structures may be suitable for the manufacture of container **10**. Those having ordinary skill in the art will readily know and understand container manufacturing method alternatives.

[0036] While the above description constitutes the present disclosure, it will be appreciated that the disclosure is susceptible to modification, variation and change without departing from the proper scope and fair meaning of the accompanying claims.

What is claimed is:

1. A plastic container comprising:

a cylindrical body defining a longitudinal axis and having an upper portion, a sidewall portion and a base portion having a base, the base portion defining a radial sidewall and a central inset portion defined inboard of a thinned wall portion formed around at least a portion of the base.

2. The plastic container of claim **1** wherein the base portion further defines an outer heel portion wherein the outer heel portion has an average wall thickness greater than an average wall thickness of the thinned wall portion.

3. The plastic container of claim **1** wherein the thinned wall portion is a continuous annular structure around the container base.

4. The plastic container of claim **1** wherein the thinned wall portion is a discontinuous annular structure around the container base.

5. The plastic container of claim **1** wherein the thinned wall portion is a segmented annular structure around the container base.

6. The plastic container of claim **1** wherein the plastic container is composed of polyethylene terephthalate (PET).

7. The plastic container of claim **1** wherein the upper portion includes a polyethylene terephthalate (PET) blown finish.

8. A molding system for making a blow-molded plastic container having a base portion that supports the container, the molding system comprising:

a mold defining a mold cavity, the mold having a base forming assembly that is configured to form the base portion of the container, the base forming assembly including a base insert and a movable ring insert that is movable relative to the base insert; and

an actuator that is configured to move the movable ring relative to the base insert while the base portion remains in the mold cavity to advance the movable ring insert into the base portion to define a thinned flex point in the base portion.

9. The molding system of claim **8**, wherein the actuator is configured to move the movable ring relative to the base insert to also define a central inset portion on the base portion that is moveable relative to another portion of the base portion due to a vacuum in the container.

10. The molding system of claim **8**, wherein the mold defines a void that is configured to form an annular projection on the base portion, the movable ring configured to advance into and retract the annular projection to define the thinned flex point.

11. The molding system of claim **8**, wherein the movable ring insert is at least partially cylindrical.

12. The molding system of claim **8**, wherein the actuator is configured to move the movable ring insert substantially parallel to a longitudinal axis of the container.

13. The molding system of claim **8**, wherein the base forming assembly is configured to form an outer heel portion of the base portion, and wherein the actuator is configured to move the movable ring to define the thinned flex point having a wall thickness that is less than an average wall thickness of the outer heel portion.

14. The molding system of claim **8**, wherein the movable ring insert is configured to form the thinned flex point to be continuously annular.

15. The molding system of claim **8**, wherein the movable ring insert is configured to form the thinned flex point to have a segmented annular structure.

16. A plastic container comprising:

a body defining a longitudinal axis, a container interior, and a container exterior, the body having an upper portion, a sidewall portion, and a base portion, the base portion having a heel portion and a hinge portion, the hinge portion being disposed inboard and extending toward the container interior relative to the heel portion.

17. The plastic container of claim **16** wherein the heel portion has an average wall thickness that is greater than an average wall thickness of the hinge portion.

18. The plastic container of claim **16** wherein the hinge portion is a continuous annular structure extending around the base portion.

19. The plastic container of claim **16** wherein the hinge portion is a discontinuous annular structure extending around the base portion.

20. The plastic container of claim **1** wherein the plastic container is composed of polyethylene terephthalate (PET).

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