

BLOW-MOLDED DRUM

This application claims priority to U.S. Provisional Application 60/563,562, filed April 18, 2004, entitled "BLOW-MOLDED DRUM," which is incorporated herein by reference.

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Field of the Invention

The present invention relates to drums. More particularly, the present invention relates to drum chimes having buckling regions that prevent rupturing of the drum and drums including anchors for securing drum closures.

Background of the Invention

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In industries such as semiconductor processing, pharmaceutical, and chemical manufacturing, high purity, highly corrosive, and highly caustic liquids are often utilized. Due to safety and quality considerations, these liquids must be contained in containers and dispensing systems having high reliability and integrity. The connections, tubing, and fittings for handling these fluids must be formed from highly inert materials. Fluoropolymers have been found to be suitable for use in these environments. The tubing is commonly formed of PFA, while the fittings, valve components, and dispense heads may be formed of components such as PFA, PTFE, and other various other fluoropolymers.

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Containers for handling these liquids are typically plastic drums formed of high purity polyethylene, such as shown in U.S. Patent No. 6,045,000, which is owned by Applicant and incorporated herein by reference. These containers typically have at least one threaded nipple or bung defining an access opening or bunghole for dispensing chemicals into and out of the drum. A cap or closure is placed on the threaded nipple for shipment and storage of the drum. At least one chime or carrying and transportation ring can also be included on the drum shell for grabbing by conventional mechanized drum handling equipment.

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Drums and closure devices used for shipping hazardous chemicals, such as many of the chemicals used in semiconductor processing, must pass rigorous tests required by the U.S. Department of Transportation for transport within the United States and the

United Nations for transport internationally. An example of one such test is described in 49 C.F.R. § 178.603 (2001), which requires that the drum be inverted and dropped. The drum must maintain its structural integrity and must not leak fluid after the test. During the drop test, conventional chimes can bend, puncturing the bung and causing the hazardous chemicals to escape.

Conventional chimes are either shorter than the nipple, as illustrated in U.S. Patent No. 4,925,049, or longer than the nipple, as illustrated in U.S. Patent No. 5,597,085. One problem with shorter chimes is that they can expose the bung to physical contact and potential damage, particularly where drums are stacked. One problem with longer conventional chimes is that they can bend, causing the chime to damage the bung. Additionally, because conventional chimes are often integrally formed to the drum shell, a bent chime can create a crack at an intersection of the chime and the walls of the drum, thus potentially allowing fluid contained within the drum to escape.

Because the general problems discussed above have not been addressed by conventional drums, there is a current need for a drum addressing the problems and deficiencies inherent with conventional designs.

Summary of the Invention

The drum of the embodiments of the invention substantially solves the aforementioned problems of conventional drums. The chime included on the drum of the embodiments of the present invention can have a chime transition portion or recess, thus creating a natural bending region on the chime that prevents any damage to the bung and drum shell upon dropping.

A feature and advantage of embodiments of the invention is that the chime is reinforced with a chime transition portion and will not damage the bung or closure if it is bent as a result of dropping.

Another feature and advantage of embodiments of the invention is that the chime transition defines a buckling region that divides the chime into a base portion and a buckling portion.

Another feature and advantage of embodiments of the invention is that a recess defines a bending region that divides the chime into a base portion and a buckling portion.

Another feature and advantage of embodiments of the invention is that an anchor is provided allowing a tamper evident cover to be tethered to the anchor.

5 Another feature and advantage of embodiments of the invention is that the bottom of the drum includes a handle portion for ease of manual lifting of the drum.

Brief Description of the Drawings

Fig. 1 is side elevational view of a drum with a partial cutaway depicting a chime and anchor according to an embodiment of the present invention;

10 Fig. 2 is a cross-sectional view of a drum comprising a pair of bungs and a pair of anchors according to an embodiment of the present invention;

Fig. 3 is a cross-sectional view of a chime according to an embodiment of the present invention;

15 Fig. 4 is a cross-sectional view of a chime flange according to an embodiment of the present invention;

Fig. 5 is a cross-sectional view of a chime depicting a bending region according to an embodiment of the present invention;

Fig. 6 is a top plan view of a drum depicting a reinforced chime and an anchor according to an embodiment of the present invention;

20 Fig. 7 is a cross-sectional view of a chime depicting a bending region according to an embodiment of the present invention;

Fig. 8 is a cross-sectional view of a chime depicting a bending region according to an embodiment of the present invention;

25 Fig. 9 is a side elevational view of the pair of anchor tethers according to an embodiment of the present invention;

Fig. 10 is a cross-sectional view of a top wall of a drum depicting an anchor and a bung according to an embodiment of the present invention;

Fig. 11 is a cross-sectional view of an anchor depicting a knockout portion according to an embodiment of the present invention; and

5 Fig. 12 is a bottom plan view of a drum depicting a handle portion according to an embodiment of the present invention.

Detailed Description of the Drawings

Referring to Fig. 1, a chime for blow-molded thermoplastic drums according the various embodiments of the present invention is depicted and is generally indicated by the
10 numeral 20. The principle components of the invention are a drum 10 having a peripheral wall 12, a first end or top wall 14, and a second end or bottom wall 16 that is generally opposed the top wall 14. The drum 10 also comprises an interior 18 for typically holding chemicals, which are often high purity, highly corrosive, and highly caustic liquids. The drum 10 typically has at least one bung 22 defining an access opening or bunghole 28 for
15 used to dispense fluids into and out of the interior 18 of the drum 10. In one embodiment, the bung 22 comprises internal threads 29 configured to match threading on conventional drum inserts or bung closures.

The drum 10 also can include a chime 20 that is preferably integrally formed to and extending from a perimeter of the top wall 14 of the drum 10. In other embodiments,
20 the chime 20 can be distinct from and operably attached to a perimeter of the top wall 14 of the drum 10. The drum 10 can also include one or more labels 21 for displaying trademarks, trade names, drum or product information, warnings, instructions, bar codes, or the like, as depicted in Fig. 1.

The drum 10 can be constructed of single or multiple layers, such as polymers
25 formed in a blow molding process. While the drum according to one embodiment is constructed of a fluoropolymer, such as polyethylene, other polymer materials can be used without departing from the scope of the present invention. Examples of drums 20 that can be employed with the various embodiments of the present invention are disclosed in U.S.

Patent No. 6,045,000 and U.S. Patent Application Publication No. 2002/0050494, both of which are owned by the Applicant and are incorporated herein by reference.

As can be seen in Fig. 2, the drum 10 can also include one or more anchors 24 and a rib 26. The anchors 24 can be used for anchoring a closure to the top wall 14 of the drum 10, as will be described in greater detail herein.

Referring to Fig. 3, the chime 20 can be integral with the top wall 14 and peripheral wall 12 of the drum 10. The chime 20 preferably extends about and away from the drum 10 such that the chime 20 has a top edge or lip 30. In one embodiment, the chime 20 can extend angularly away from the top wall 14 of the drum 10. The angle can vary depending upon the conventional drum handling equipment being used to move and transport the drums 10. In another embodiment, the chime 20 is generally co-planar with the side wall 12 of the drum 10.

Referring to Fig. 4, the chime 20 has an inner contact surface 32 and an outer contact surface 34 that can be used to receive operable contact with drum handling equipment. In the depicted embodiment, a flange 36 can extend outwardly from the outer contact surface 34 of the chime 20 and proximate the top edge 30 to receive operable engagement by the drum handling equipment. The flange 36 can be positioned generally offset from the lip 30. The flange 36 can include an upper surface portion 38 and a lower surface portion 40. The upper 38 and lower 40 surface portions can be generally curvilinear. The degree of curvature of the upper 38 and lower 40 surface portions can vary depending upon the intended drum handling equipment. In other embodiments, the upper 38 and lower 40 surface portions can be generally linear without departing from the scope of the present invention.

In one embodiment of the present invention, the upper 38 and lower 40 surface portions can be textured to increase the gripping of the drum handling equipment on the flange 36. As best depicted in Fig. 4, the upper 38 and lower 40 surface portions can have a plurality of teeth or projections 38 extending away therefrom. Various other textures, such as bumps or texture laminates, can be utilized to increase the grip of the drum handling equipment on the flange 36. The projections 38 can also aid manufacturing equipment during the manufacturing process. For example, the projections can aid equipment to hold the drum 10 in place.

Referring to Fig. 5, the chime 20 can have a base portion 44 and a chime transition 52 (generally indicated by the region bounded by the broken lines in Fig. 5) adjacent to the top 14 and peripheral 12 walls of the drum 10 and integrally formed with the base portion 44. The chime transition 52 includes a chime transition surface 57 generally contiguous
5 the inner contact surface 32. The chime 20 can also have a buckling or bending portion 46 that extends from the base portion 44 and preferably includes the flange 36 and lip 30 of the chime 20.

As can be seen in Fig. 2, the chime transition 52 can taper from a position that is generally adjacent to the top wall 14 of the drum shell 12 toward the intersection of the
10 base 44 and buckling 46 portions of the chime 20. In one embodiment, the tapering of the chime transition 52 terminates at a position below the flange 36. The thickness of the buckling portion 46 can be uniform from the point intersection between the base 44 and buckling 46 portions to the lip 30. The difference in thickness between the combined base
15 44 and chime transition 52 portions and the buckling portion 46 creates a bending region 48 at the intersection of the base 44 and buckling 46 portions, wherein when the drum 10 is dropped on the chime 20, it will then bend at the bending region 48. In one embodiment of the present invention, the chime transition 52 portion, and thus the bending region 48, can extend around the entire circumference of the chime 20 and can be a uniform distance above the top wall 14 of the drum 10.

20 In another embodiment, as can be seen in Fig. 6, the chime transition portion 52 can extend around only selected portions of the chime 20 and the distance of the bending region 48 from the top wall 14 of the drum 10 can vary around the circumference of the chime 20. While the each chime transition portion 52 in Fig. 6 is depicted as extending approximately 180° around the drum for a combined 360°, in other embodiments each
25 chime transition portion 52 can extend less than 180° around the drum, *e.g.*, 120° centered upon the portion of the chime 20 closest to the bung 22. In the preferred embodiments, as illustrated in Figs. 1 and 2, the bending region 48 is located on the chime 20 at a height generally greater than a height of the bung 22, such that when the buckling portion 46 of the chime 20 bends, it does not damage the bung 22 or create a crack in the top 14 and/or
30 peripheral 12 walls of the drum 10. In another embodiment, as illustrated in Figs. 5 and 6, the distance between the top wall 14 of the drum 10 and the bending region 48 can decrease as a distance between the chime 20 and the bung 22 increases. In this

embodiment, a length of the buckling portion 46 of the chime 20 gradually increases while a length of the base 44 and chime transition 52 portions gradually decrease until, as illustrated in Fig. 6, the buckling portion 46 can extend generally an entire length of the chime 20.

5 Referring to Figs. 7 and 8, in another embodiment of the present invention, the bending region 48 can be created by a recess 50 extending into the inner 32 and/or outer 34 contact surfaces of the chime 20. The recess 50 can be notches, perforations, grooves, channels or other indentations. As can be seen in Fig. 7., the recess 50 is a notch. As can be seen in Fig. 7., the recess 50 is a generally rounded groove. Any type of indentation
10 that generally decreases a thickness of the chime 20, thus creating a natural point or region of bending, can be used. The recess 50 can be created during the molding process or can be formed or machined into the chime after the molding process is completed. As with other embodiments of the present invention, the recess 50 can be a generally uniform or varying distance from the top wall 14 of the drum 10.

15 In an embodiment of the present invention, as illustrated in Fig. 1, an anchor 24 or anchors can be formed on the top wall 14 of the drum 10 for anchoring a bung closure or tamper evident cover 53 to the drum 10. As can be seen in Fig. 10, the closure is preferably coupled to the anchor 24 by a generally flexible tether 55. The anchor 24 can be positioned adjacent the bung 22 for providing a convenient attachment location.
20 Referring to Fig. 11, the anchor 24 includes a pair of generally opposed surfaces 54, which can be generally planar and generally parallel. An aperture 58 preferably extends through the opposed surfaces 54 and can be used to receive the tether and permitting a user to tie the operably tether to the anchor 24. During manufacturing, a knockout portion 60 can be left in the aperture 58. The knockout 60 generally comprises a thin web of drum 10
25 material, which can be easily removed with any conventional tool, such as a screwdriver, if the anchor 24 is needed.

In another embodiment, as illustrated in Fig. 9, multiple anchors 24 can be formed on the top wall 14 of the drum 10 during the blow molding process at the juncture of the two primary mold halves to provide places for attaching multiple closures. In this
30 embodiment, the multiple anchors 24 are preferably positioned generally adjacent a respective bung 22. A rib member 26 can also be formed on the top wall 14 of the drum 10 and can extend between and be integrally formed with the multiple anchors 24 to

increase the rigidity of the top wall 14. As can be seen in Fig. 9, the rib member 26 preferably has a height generally that is less than a height of the multiple anchors 24, such that an anchor top edge 56 of the anchors 24 extends beyond the rib member 26. However, a height of the rib member 26 can selectively varied to increase the rigidity of the top wall 14.

The bottom wall 16 of the drum 10 can include a handle portion 62 to facilitate ease of lifting by users manually lifting the drum 10. The handle portion 62 can also be used by drum handling equipment for additional contact surface. The bottom wall 16 can also include a removable insert 64 for accessing the interior 18 of the drum 10.

To manufacture the drum 10 according to the various embodiments of the present invention, the drum 10 can be blow-molded so that it includes the first end 14 having the access opening 28 defined thereon and the second end 16 that is generally opposed the first end 14, the drum 10 further comprising the peripheral wall 12 that extends between the first 14 and second 16 ends, such that the first end 14, second end 16, and peripheral wall 12 generally define a drum interior 18 for storing liquid. The chime 20 can be integrally molded to the drum 10 so that it extends from the first end 14 of the drum 10, the chime 20 comprising a base section 44 having a chime transition portion 52 and an upper section 46 extending from the base section 44, such that a bending region 48 is defined proximate the intersection of the base 44 and upper 46 sections. Lengths of the base 44 and upper 46 sections are selected to define a bending length between a top edge 30 of the chime 20 and the bending region 48, the bending length defined so as to be less than a distance between the chime 20 and the access opening 28.

In one embodiment, the base section 44 is molded so that it has a thickness greater than a thickness of the upper section 46, such that the bending region 48 is defined by a difference in thickness of the base section 44 and upper section 48.

In another embodiment, the recess 50 is formed between the base 44 and upper 46 sections, the recess 50 having a reduced cross-section, such that the bending region 48 is proximate the reduced cross-section. In an embodiment of the present invention, the handle portion 62 is molded into the second end 16 of the drum. In an embodiment of the present invention, the anchors 24 and reinforcing rib 26 are molded on the first end 14 of the drum 10.

In operation, if the blow-molded thermoplastic drum is dropped on its chime 20, *e.g.*, as required by 49 C.F.R. § 178.603, the manner that the buckling portion 46 will bend depends upon the location of the bending region 48. If the buckling portion 46 of the chime 20 closest to the bung 22 bends, its shortened length prevents it from reaching, and thus damaging, the bung 22. The bending region 48 also prevents the top 14 and peripheral 12 walls of the drum 10 from cracking as a result of the chime 20 bending, especially at the juncture of the peripheral wall 12 and chime 20. The length of the buckling portion 46 can increase as the distance from the chime 20 to the bung 22 increases, as the potential of damaging the bung 22 decreases with its distance from the chime 20. This can become important when handling the drum 10, as the increased length of the buckling portion 46 increases the available inner surface 32 contact area that conventional drum handling equipment can access.

If an anchor 24 is needed to operably attach a drum closure or bung cap, a user can simply punch the knockout 60 from the aperture 58 extending through the opposed surfaces 54 of the anchor 24. A tether can then be fed through the aperture 58 and tied about the anchor 24. A shipping cap lug on a closure 53 can then be tied to an opposed and free end of the tether and the closure can be coupled to the bung 22 for storage or transportation. In another embodiment of the present invention, anchor 24 can be used to connect color-coded or textual tags, bar code tags, RFID tags, or other identification means.

The present invention can be embodied in other specific forms without departing from the spirit of any of the essential attributes thereof. Therefore, the illustrated embodiments should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

CLAIMS:

1. A molded drum comprising:

a first end having an access opening defined thereon and a second end generally opposed the first end;

a peripheral wall extending between the first end and second end, the first end, second end, and peripheral wall generally defining a drum interior;

a chime extending from the first end of the drum, the chime comprising a base section having a chime transition portion and an upper section extending from the base section, the base section having a base thickness greater than a thickness of the upper section, such that a bending region is defined proximate an intersection of the base and upper sections; and

a bending length defined between a top edge of the chime and the bending region, the bending length selected such that the bending length is less than a distance between the chime and the access opening.

2. The drum of claim 1, wherein the bending length is generally uniform around a circumference of the chime.

3. The drum of claim 1, wherein the distance between the chime and the access opening varies along the chime and the bending length is greater at positions along the chime where the chime is furthest from the access opening than positions where the chime is closest to the access opening.

4. The drum of claim 1, wherein a base length is defined between the bending region and the first end of the drum, the base length being greater than the bending length.

5. The drum of claim 1, wherein the chime transition comprises a chime transition surface and the upper section comprises an inner surface generally at an angle to the chime transition surface, such that the chime transition surface is at a maximum transition length and the inner surface at a minimum upper length at a first position along the chime at which the chime is closest to the access opening, and the chime transition

surface is at a minimum transition length and the inner surface at a maximum upper length at a second position along the chime at which the chime is the furthest from the access opening.

6. The drum of claim 1, wherein the drum is constructed of blow-molded high-density polyethylene.

7. The drum of claim 1, further comprising a handle portion defined on the second end.

8. The drum of claim 1, wherein the first end further comprises a bung having a bung height and the chime comprises a chime height, such that the chime height is greater than the bung height.

9. A molded drum comprising:

a first end having an access opening defined thereon and a second end generally opposed the first end;

a peripheral wall extending between the first end and second end, the first end, second end, and peripheral wall generally defining a drum interior;

a chime extending from the first end of the drum at a juncture, the chime comprising a top edge and a recess intermediate the juncture and top edge, the recess having a recess cross section that is narrower than a cross section of the chime, such that a bending region is defined proximate the recess.

10. The drum of claim 9, wherein a bending length is defined between a top edge of the chime and the bending region and a base length is defined between the bending region and the first end of the drum.

11. The drum of claim 10, wherein the base length is greater than the bending length.

12. The drum of claim 9, wherein the bending length is generally uniform around a circumference of the chime.

13. The drum of claim 10, wherein a distance between the chime and the access opening varies along the chime and the bending length is greater at a first position along the chime at which the chime is furthest from the access opening than a second position along the chime at which the chime is closest to the access opening.

14. The drum of claim 10, wherein the bending length at a distinct point along the chime is selected such that the bending length is less than a distance between the chime and the access opening.

15. The drum of claim 9, wherein the drum is constructed of high-density polyethylene.

16. The drum of claim 9, further comprising a handle portion defined on the second end.

17. The drum of claim 9, wherein the chime comprises an inner surface and an outer surface, the recess defined on the inner surface.

18. The drum of claim 9, wherein the chime comprises an inner surface and an outer surface, the recess defined on the outer surface.

19. The drum of claim 9, wherein the recess is selected from the group consisting of:

notches;

grooves;

channels;

perforations;

indentations; or

any combination thereof.

20. The drum of claim 9, further comprising a handle portion defined on the second end.

21. A blow-molded drum comprising:

a top wall and a bottom wall generally opposed the top wall;

a shell extending between the first end and second end, the top wall, bottom wall, and shell generally defining an interior of the drum; and

an anchor defined on the first end, such that a closure can be operably attached to the anchor by a tether.

22. The drum of claim 19, further comprising a second anchor.

23. The drum of claim 20, further comprising a reinforcing rib defined between the anchor and second anchor.

24. The drum of claim 19, wherein the drum is constructed of high-density polyethylene.

25. The drum of claim 19, further comprising a handle portion defined on the second end.

26. A method of making a spill-proof drum comprising:

molding a drum having a first end having an access opening defined thereon and a second end generally opposed the first end, the drum further comprising a peripheral wall extending between the first end and second end, such that the first end, second end, and peripheral wall generally defining a drum interior for storing the liquid;

integrally molding a chime to extend from the first end of the drum, the chime comprising a base section having a chime transition portion and an upper section extending from the base section, such that a bending region is defined proximate an intersection of the base and upper sections; and

selecting a base length of the base section and an upper length of the upper section to define a bending length between a top edge of the chime and the bending region, the bending length defined so as to be less than a distance between the chime and the access opening.

27. The method of claim 26, further comprising molding the base section to comprise a thickness greater than a thickness of the upper section, such that the bending region is defined by a difference in thickness of the base section and upper section.

28. The method of claim 26, further comprising forming a recess between the base section and upper section, the recess defining a reduced cross-section, such that the bending region is proximate the reduced cross-section.

29. The method of claim 26, further comprising blow molding the drum using high-density polyethylene.

30. The method of claim 26, further comprising molding a handle portion on the second end of the drum.

31. The method of claim 26, further comprising molding an anchor on the first end of the drum.

32. The method of claim 31, further comprising molding a second anchor on the first end of the drum.

33. The method of claim 32, further comprising molding a reinforcing rib on the first end of the drum between the anchor and second anchor.