ABSTRACT

This invention relates to a closure for a drinking container and is particularly concerned with spill-proof closures, which remain in place while drinking. The inexpensive, effective and durable closures according to this invention are suitable for both disposable and nondisposable applications, where both cost and performance are important.
Closure attached to container via threads, snap fit, or the like.
ONE MATERIAL, ONE PIECE SPILL-PROOF CLOSURE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Provisional Application No. 60/278,645, filed Mar. 26, 2001.

FIELD OF THE INVENTION

The present invention is directed to containers that hold liquids, preferably drinking containers, having spill-proof closures. Specifically, this invention comprises a spill-proof closure that remains in place while drinking. The inexpensive, effective and durable closures according to this invention are suitable for both disposable and nondisposable applications where both cost and performance are important.

BACKGROUND OF THE INVENTION

In several prior art arrangements, a valved spout is used to prevent unintentional loss of liquid (see, for example, U.S. Pat. No. 5,050,758 to Freeman et al.). However, embodiments of this approach are relatively complex, multi-piece structures which are costly to make and do not lend themselves to mass production methods or disposable applications.

Another prior art approach is to attach a separate thin membrane component to the inner or outer surface of the spout, through which the liquid and air flow (see, for example, U.S. Pat. No. 5,890,621 to Bachman et al.). However, this approach also involves costly production of multiple components and/or costly production by multiple operations. Additionally, it may involve handling and processing of multiple different materials to yield such a closure. The relatively high cost of making such closures is not appealing or suitable for the disposable market where cost is a critical factor.

What is needed in the art is a closure which overcomes the disadvantages of the prior art, more specifically, the manufacturing complexities and high costs associated with the prior art multi-component closures and multi-material closures.

SUMMARY OF INVENTION

Accordingly, the present invention overcomes the disadvantages of the prior art by providing a spill-proof closure for a container, preferably a drinking container. The spill-proof closure will prevent or limit leakage when tipped over or dropped on the floor inadvertently.

In a first aspect, the present invention provides a spill-proof closure comprising a single component. The spill-proof closure is constructed from a single material in one molding operation. The spill-proof closure also has its own integral nozzle or spout region or regions for liquid exit and air entry upon suction from the user. The spill-proof closure may further include either an integral or a separate liner component placed inside the closure to seal the liquid from seepage past the region of attachment of the closure to the container.

In another aspect, the present invention provides a spill-proof closure comprising a single component and a single material that also has an integral liner feature inside the closure to seal the liquid from seepage past the region of attachment of the closure to the container. The liner is molded in the same manufacturing step as the closure.

In a further aspect, the present invention provides a spill-proof closure for a liquid container that is cost effective to produce and that it is suitable for new disposable liquid container markets.

These and other objects and features of the invention will be apparent from the detailed description set forth below.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings. The description and drawings are given by way of illustration only, and thus do not limit the present invention.

FIG. 1 is an external isometric view of a preferred embodiment of the closure of the invention.

FIG. 2 illustrates a preferred embodiment closure on a drinking container.

FIGS. 3A and 3B are cross sections through a preferred embodiment closure of the invention showing that the liquid exit and air entry regions are the same material as the remainder of the closure and integral with the closure (shown with integral liner).

FIGS. 4A, 4B and 4C are cross sections, including enlarged views, through a preferred embodiment closure showing the closed state of the entry and exit regions of the closure while no suction is applied by the user.

FIGS. 5A, 5B and 5C are cross sections, including enlarged views, through a preferred embodiment closure showing the open state of the entry and exit regions of the closure as suction is applied by the user.

FIG. 6 is a top view of a preferred embodiment closure showing the oval geometry of the entry and exit regions.

FIGS. 7A and 7B are close up sectional views of the entry and exit regions of a preferred embodiment closure showing the wall thickness variation (without chamfers shown).

FIGS. 8A and 8B are additional close-up sectional views of the entry and exit regions of a preferred embodiment closure showing the wall thickness variation with the chamfers shown. The edges are chamfered or rounded to prevent mechanical binding between mating edges.

DETAILED DESCRIPTION OF INVENTION

Generally, the preferred embodiment in accordance with the present invention is a spill-proof closure for a liquid container comprising a single component. The spill-proof closure is constructed from a single material in a single manufacturing operation. The container to which the spill-proof closure attaches can be made of any material known in the art for drinking containers. Examples of materials suitable for use as the liquid container include, but are not limited to, polyethylene, polypropylene, polyethylene...
terephthalate, polyethylene naphthalate, polyvinyl chloride, nylon, ethylene vinyl alcohol, glass, aluminum, tin and combinations thereof. The container may be made by any means known in the art, such as blow molding, injection molding, extrusion molding or glass forming.

[0022] The present invention is suitable for any application or container, and it is particularly suitable for containers holding liquids, such as drinking containers. Often, drinking containers used by children require a spill proof closure so that the liquid is not spilled on the child, the furniture, the floor, etc. These containers require that the liquid be dispensed while the container is tilted nozzle or spout down toward the user’s mouth. Generally, a slight suction is applied to the spout to dispense the liquid.

[0023] FIG. 1 illustrates an external isometric top view of a preferred embodiment of the present invention. The closure 8 comprises a planar portion 16 that has an air entry valve 14 and a nozzle or spout 12. The spout 12 further comprises a liquid exit valve 10. The planar portion preferably has a height \( H_1 \) of from about 0.10 to 1.50 inches, more preferably from about 0.25 to 0.75 inches, and most preferably about 0.40 to about 0.50 inches, although other heights may be used, depending on the overall size of the closure and the desired look. The height \( H_2 \) of the spout is not critical, as long as it can perform the intended application. For example, if used on a drinking container, the spout must be long enough for a user to position it in his or her mouth to take a drink. Generally, the spout is preferably from about 0.30 to 1.50 inches high, more preferably from about 0.50 to about 1.20 inches high, and most preferably from about 0.70 to about 0.80 inches high, although other heights are possible, depending on the application and the size of the closure. The radius, \( R_c \), of the planar portion depends on the diameter of the container to which the spill-proof closure will be attached. The spill-proof closure must be made to fit on or attach securely to the intended container.

[0024] In some embodiments, there may only be one valve 10 which will function as both a liquid exit valve and an air entry valve. This valve 10 will allow liquid to exit the container when the user takes a drink, and air to return through the valve after liquid has exited.

[0025] FIG. 2 shows a preferred embodiment closure 8 on a drinking container 18. Note that the container 18 shown is wider at the bottom, but other configurations, such as containers having a constant diameter, or containers that are wider at the top than the bottom, are also applicable. Any container known in the art may be used. The closure 8 can be attached to the container 18 in many ways, such as via thread fittings, a snap fit, or the like. In one preferred embodiment, the container 18 and the closure 8 are both threaded, and the closure is turned onto the container for a secure fit. In another preferred embodiment, the container 18 and the closure 8 may snap together for a secure fit.

[0026] FIG. 3A is a top view of a preferred embodiment closure 8 of the invention showing the air entry valve 14 and the liquid exit valve 10. FIG. 3B depicts a cross section of the closure 8 of FIG. 3A, taken at line A-A. In this preferred embodiment of the present invention, the entire closure 8, including the liner 22, comprises one component made of one material. In some embodiments, the liner 22 may be a separate component, but in this preferred embodiment, the liner 22 is integral. As used herein, “integral” refers to a part, such as the liner, which is molded in the same, single molding operation as the other parts. For example, as used herein, the liner is integral if it is molded of the same material and during the same molding operation as the spill-proof closure.

[0027] In one preferred embodiment, slits are incorporated into the air entry valve 14 (if there is one) and the liquid exit valve 10 to facilitate air and liquid entry or exit. These slits function to split each valve region into mating sections. The slits may or may not provide gaps between the mating sections of the regions.

[0028] Preferably, the slits are from about 0.000 to about 0.015 inches wide. Even more preferably, the slits are from about 0.005 inches wide. These slits may be made during the same molding operation as the spill-proof closure, or in a secondary separate manufacturing operation, after the closure is molded. If the slits are made after the molding operation, the slits could be made by a method such as slicing with a knife or laser.

[0029] In another embodiment, the valve regions are molded thin enough that the slits could be made by puncturing or pushing through the valve region during a secondary operation.

[0030] In another embodiment, no slits are provided in the closure in its finished state. After purchase of the spill-proof closure, the user would be expected to make the slits using a controlled force. In this case, the valve regions are so thin and may have grooves and/or another type of geometry, which makes it easy for the user to make the slits upon application of a small, controlled force from a finger or other suitable object.

[0031] The spill-proof closures of the prior art have the disadvantage of separate components and/or multiple materials in the air entry valve and liquid exit valve regions of the closure. For example, the closure may be of a harder material, such as a polypropylene, and the valves may be a softer material, such as an elastomer. The inventors have found that a functional spill-proof closure can be constructed as a single part out of one material in a single molding operation by varying the wall thickness and providing mechanical relief at the mating sections of the openings. In order to accomplish this, the closure must be molded of an appropriate material which is flexible and elastic when thin but rigid when thick. As used herein, “thin” mean a wall thickness from about 0.001 inches to about 0.03 inches thick. Also as used herein, “thick” refers to a wall thickness from about 0.03 inches to about 0.10 inches. For a closure for a larger container, the thickness may be greater if necessary. In a preferred embodiment, the thickness of the material of the entry and exit valves vary from about 0.01 to about 0.10 inches at the edges to about 0.000 to about 0.03 at the center of the valve.

[0032] The closure may be made of any formable materials known in the art that have the properties described above. Examples of materials suitable for use as the closure include, but are not limited to, polypropylene, polyethylene, polyvinyl chloride, polyamide, ethylene vinyl acetate, thermoplastic elastomers, thermoplastic elastomers and blends or copolymers of these materials. Preferably, the closure is formed from a thermoplastic elastomer modified polyethyl-
Additional materials known in the art, such as appropriate fillers, pigments, dyes, and the like, may be added as desired. The closure may be manufactured by any suitable method known in the art, including, for example, compression molding, compression injection molding, thermoforming, and the like. Preferably, the closure is formed by injection molding.

**[0033]** FIG. 4A is a cross section of the closure 8 showing the closed state of the air entry valve 14 and the liquid exit valve 10 of the closure 8. FIG. 4B is an enlarged view of detail A of FIG. 4A, showing the closed liquid exit valve 10 in more detail. FIG. 4C is an enlarged view of detail B of FIG. 4A, showing the closed air entry valve 14 in more detail. The closure 8 will maintain this closed state when the container is not in use, such as when a child or other user is not drinking from the container and therefore no suction is applied.

**[0034]** FIG. 5A is a cross section of the closure showing the open state of the air entry valve 14 and the liquid exit valve 10 of the closure 8. FIG. 5B is an enlarged view of detail A of FIG. 5A, showing the open liquid exit valve 10 in more detail (scale 4:1). FIG. 5C is an enlarged view of detail B of FIG. 5A, showing the open air entry valve 14 in more detail (scale 4:1). Note that both valves are open to allow air to enter as liquid exits. In some embodiments, there is no air entry valve 14, therefore liquid will exit, and air will later enter or be drawn into the container, through the same valve (valve 10), which functions as both a liquid exit and air entry valve. As a child or other user takes a drink from the container, suction is applied to the closure and it opens, allowing liquid to pass to the user's mouth.

**[0035]** The entry and exit valves or regions do not allow liquid to exit when the container is just simply tilted upside down. This is important for drinking containers as well as any other container that holds liquid where it is important that the liquid not spill, such as a container holding a toxic or flammable substance. In order for liquid to pass through the closure, the pressure differential between the inside and outside of the container must become significant enough to open the valve. The pressure differential increases as the user takes a drink, thus applying suction to the closure. As suction is applied, the entry and exit regions deflect sufficiently to allow air to enter and liquid to exit the container. When no suction is applied (such as when the user is not drinking from the container, or the closed state), there is ambient pressure of approximately 1 atmosphere or 14.7 psi outside the container. Inside the container, the pressure on both the entry and exit regions of the inverted container is approximately 14.7 psi plus the pressure due to the weight of the liquid above the region. The pressure due to the weight of the liquid is equal to the density of the liquid in the container (approximately 0.0361 lb/in³ for many liquids such as juice, water, milk, etc.), multiplied by the force of gravity, and multiplied by the depth of liquid above the region. Accordingly, the combination of the closure design of the present invention, the closure material and the process of manufacturing produces a closure which will allow the entry and exit regions to deflect only when the pressure differential between the inside and outside of the container slightly exceeds the pressure produced by the weight of liquid in a full container plus an additional amount. The additional amount is desirable to withstand forces of impulse, such as when the container is dropped, thrown, shaken, etc. This amount of pressure differential is approximately equal to the amount of pressure generated by typical suction created by a child sucking on a nipple or drinking spout.

**[0036]** FIG. 6 is a top view of the closure 8 showing the oval geometry of the air entry valve 14 and liquid exit valve 10 of a preferred embodiment of the invention. Although in a preferred embodiment the closure is oval for ease of manufacture and for ease of use (that is, drinking), other shapes and designs may also be used. For example, the entry and exit regions may also be round, elliptical, rectangular, and the like, depending upon the function of the closure and the desire of the manufacturer or customer. As detailed above, optional slits may be added in a separate step to facilitate air and liquid entry and exit.

**[0037]** FIGS. 7A and 7B are additional cross sectional views of the air entry valve 14 and liquid exit valve 10 of detail A and detail B of FIG. 4A depicting the change in wall thickness from the thick, main portion or wall 28 of the closure 8 to the very thin center of the entry and exit regions. This variation in wall thickness allows the closure to be manufactured in a single component from a single material in one single molding operation. As detailed above, some preferred embodiments have slits added in a separate step to facilitate air and liquid entry and exit.

**[0038]** FIGS. 8A and 8B are detailed cross sectional views of the air entry valve 14 and liquid exit valve 10 of detail A and detail B of FIG. 4A. The valves 10, 14 have mating sections where the two sides mate and these sections optionally have edges that are chamfered or radiused. FIGS. 8A and 8B depict the chamfered edges 30, 34 of the mating sections of the air entry valve 14 and the liquid exit valve 10. The edges 30, 34 are chamfered or radiused to prevent mechanical binding of the mating sections of the entry and exit valves 14, 10 when the container is manufactured. The chamfered or radiused edges are molded on the parts during the same molding operation as the rest of the spill-proof closure.

**[0039]** As previously discussed, some embodiments of the spill-proof closure have gaps between the mating sections that are molded during the molding of the spill-proof closure, while other embodiments have no gaps formed between the mating sections. The embodiments without molded in slits or gaps will require that slits be produced during a secondary operation or by the user, as previously described.

**[0040]** As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention. The scope of which is described in the appended claims.

Having described the invention, we claim:

1. A spill-proof closure for a liquid container, said closure comprising an integral spout comprising a liquid exit valve region which provides a liquid passageway from the container, wherein the liquid exit valve opens upon suction from a user, said closure further comprising a means for attaching the closure to said container, wherein the entire closure comprises a single component and is manufactured in one operation.
2. The spill-proof closure of claim 1, further comprising an air entry valve region which provides a separate air passageway to and from the container.

3. The spill-proof closure of claim 1, wherein the closure comprises a substantially planar portion conforming in shape to the open end of an associated container.

4. The spill-proof closure of claim 1, wherein the spout starts off center of the planar portion and extends upward from the planar portion to a desired height.

5. The spill-proof closure of claim 1, further comprising a liner in the closure.

6. The spill-proof closure of claim 5, wherein the liner is manufactured in the same operation as the closure.

7. The spill-proof closure of claim 5, wherein the liner is molded in a separate molding operation.

8. The spill-proof closure of claim 1, wherein the liquid exit valve region has a varying wall thickness, said wall thickness ranging from about 0.01 to about 0.10 inches at the edge of the valve and from about 0.000 to about 0.03 inches at the center of the exit valve of the spout.

9. The spill-proof closure of claim 2, wherein the air entry valve region has a varying wall thickness, said wall thickness ranging from about 0.01 to about 0.10 inches at the edge of the air entry valve region and from about 0.000 to about 0.03 inches at the center of the air entry valve region.

10. The spill-proof closure of claim 2, wherein at least one of the entry valve and exit valve regions has from 1 to 10 slits running from the center of the valve regions outward toward the edge of the valve regions.

11. The spill-proof closure of claim 10, wherein the individual slits are between from about 0.000 and 0.015 inches wide.

12. The spill-proof closure of claim 2, wherein at least one of the entry valve and exit valve regions is thin enough to allow the at least one valve to be easily punctured.

13. The spill-proof closure of claim 1, wherein the liquid exit valve further comprises mating sections, said mating sections having edges that are chamfered or radiused.

14. The spill-proof closure of claim 1, wherein the closure is made of a formable material selected from the group consisting of polypropylenes, polyethylenes, polyvinyl chlorides, polyamides, ethylene vinyl acetates, thermoset elastomers, thermoplastic elastomers, and blends or copolymers thereof.

15. The spill-proof closure of claim 1, wherein the closure is molded via injection molding, compression molding, compression injection molding, thermoforming, or a variation thereof.

16. A spill-proof closure for a liquid container, said closure comprising an integral spout comprising a liquid exit valve region which provides a liquid passageway from the container. an air entry valve region which provides a separate air passageway to and from the container, and a liner, wherein the liquid exit valve opens upon suction from a user, said closure further comprising an means for attaching the closure to said container. wherein the entire closure comprises a single component and is manufactured in one operation.

17. The spill-proof closure of claim 16, wherein the closure is made of a formable material selected from the group consisting of polypropylenes, polyethylenes, polyvinyl chlorides, polyamides, ethylene vinyl acetates, thermoset elastomers, thermoplastic elastomers, and blends or copolymers thereof.

18. The spill-proof closure of claim 16, wherein each valve region has a varying wall thickness, said wall thickness ranging from about 0.03 to about 0.10 inches at the edge of the valve region and from about 0.001 to about 0.03 inches at the center of the valve region.

19. The spill-proof closure of claim 16, wherein at least one of the entry valve and exit valve regions has from 1 to 10 slits running in thickness from about 0.000 to about 0.015 inches running from the center of the at least one valve region outward toward the edge of the at least one valve region.

20. The spill-proof closure of claim 16, wherein at least one of the entry valve and exit valve regions is thin enough to allow the at least one valve to be easily punctured.