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(54) **NON-SPILL CONTAINER WITH FLOW CONTROL STRUCTURE INCLUDING BAFFLE AND ELASTIC MEMBRANE HAVING NORMALLY-CLOSED PINHOLES**

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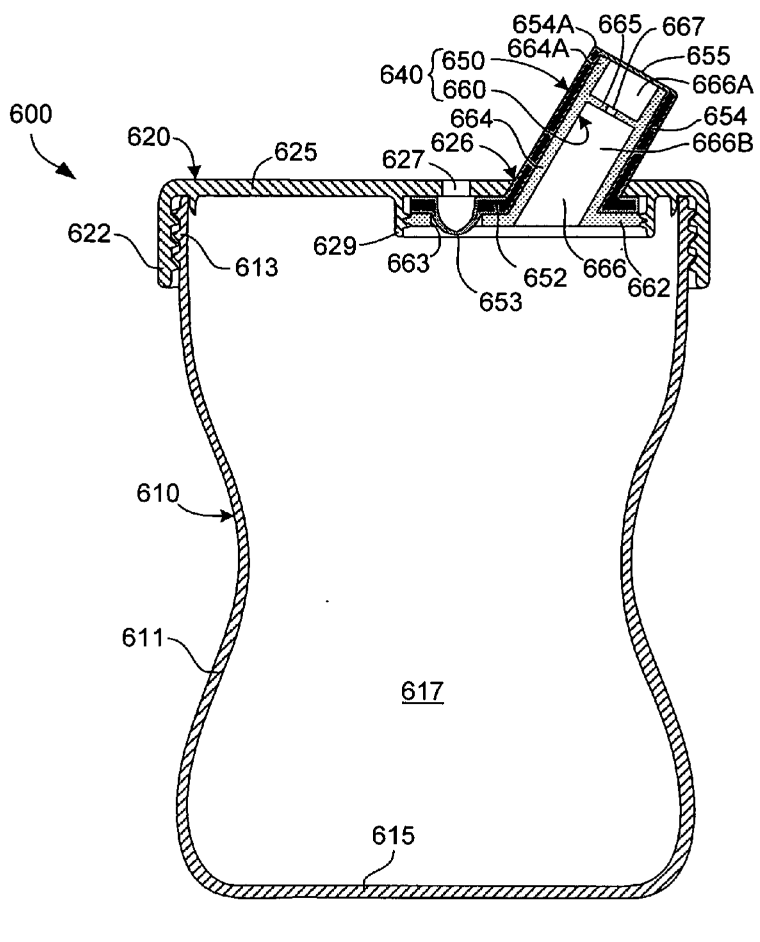
(57) **ABSTRACT**

A flow control structure for a non-spill beverage container that includes a tube-like spout defining a flow channel, and a substantially flat membrane supported by the spout over one end of the flow channel, and an annular baffle mounted in the flow channel. The membrane punctured to form multiple, substantially round pinholes arranged in a two-dimensional pattern that remain closed to prevent fluid and air flow under normal atmospheric conditions, and open and to facilitate fluid flow rate through the membrane under an applied pressure differential (e.g., when sucked on by a child). The annular baffle defines an opening that limits differential pressures applied to the membrane when not in use, thereby acting in combination with the membrane to prevent leaks. The baffle opening is also sized such that, during normal use (e.g., sucked on by a child), substantial flow is generated through the membrane.



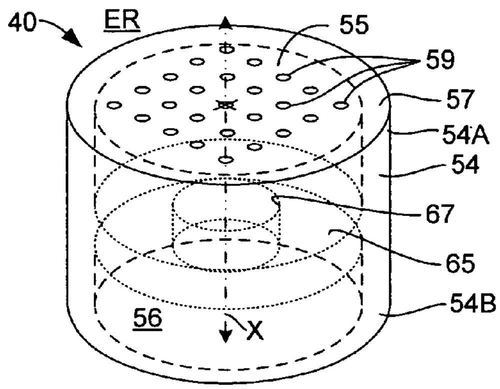


FIG. 1

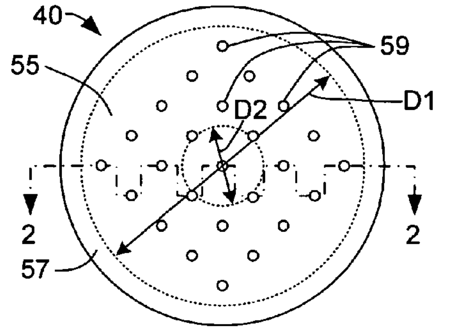


FIG. 2(A)

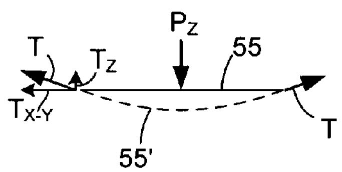


FIG. 3(A)

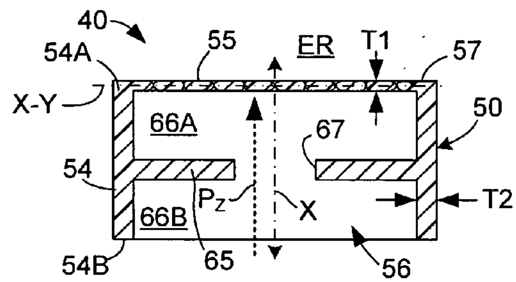


FIG. 2(B)

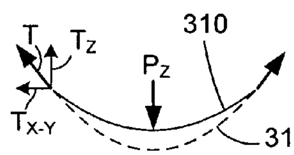


FIG. 3(B)

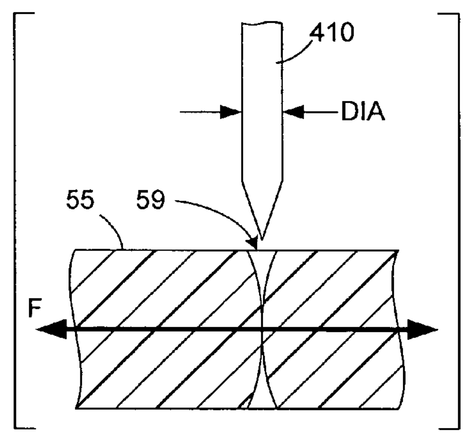


FIG. 4(A)

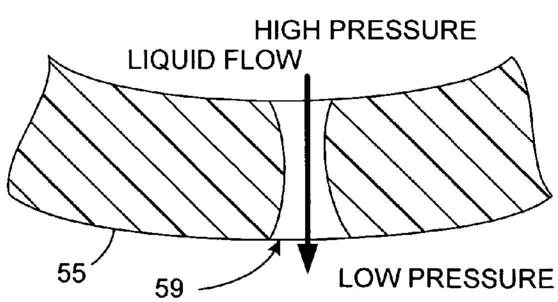


FIG. 4(B)

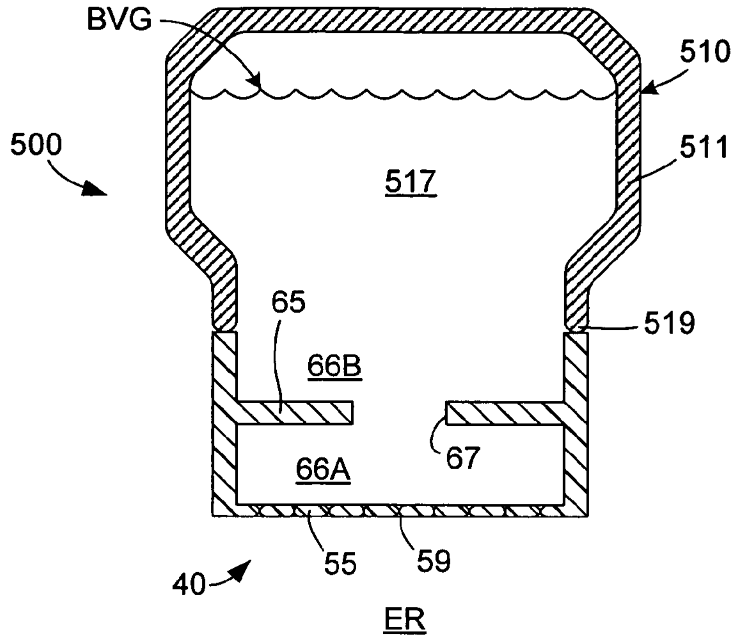
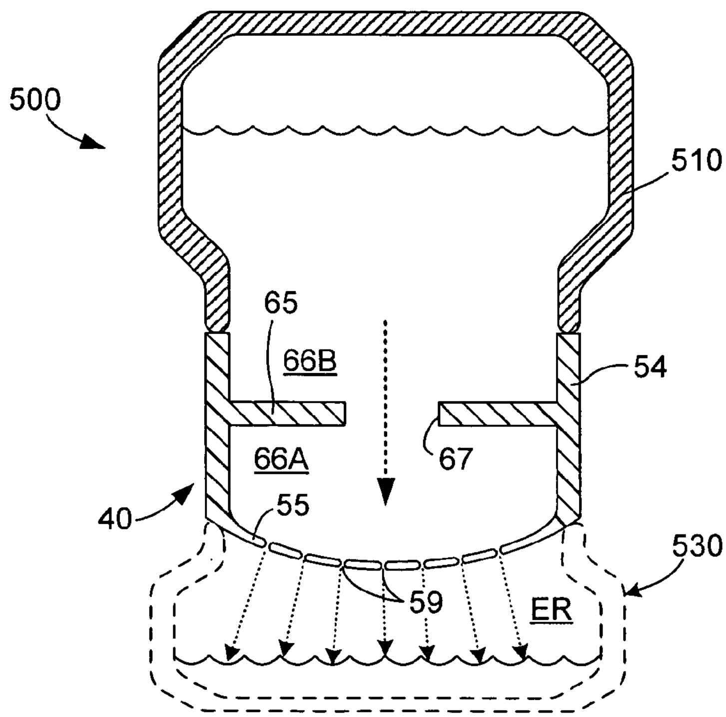

BVG
510
500
511
517
65
519
66B
67
66A
55
59
40
ER

FIG. 5(A)


500
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ER

FIG. 5(B)

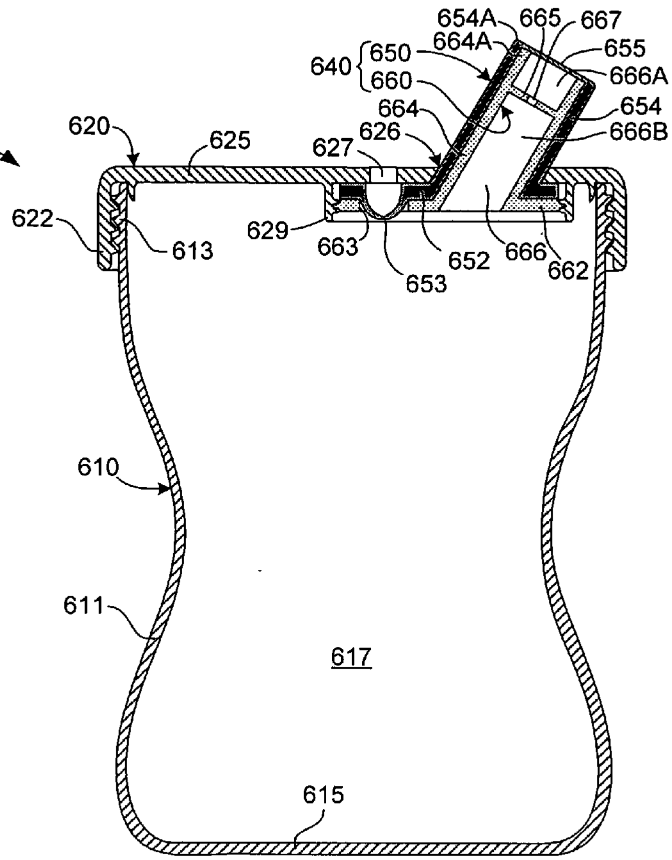


FIG. 6

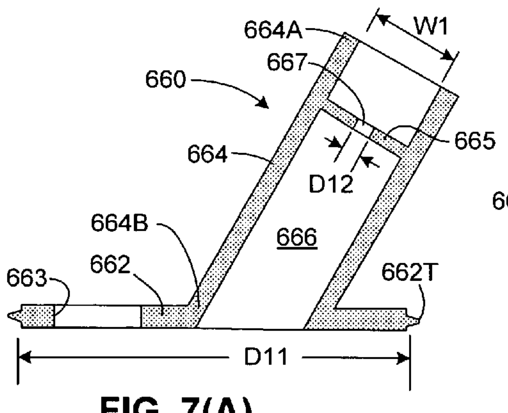


FIG. 7(A)

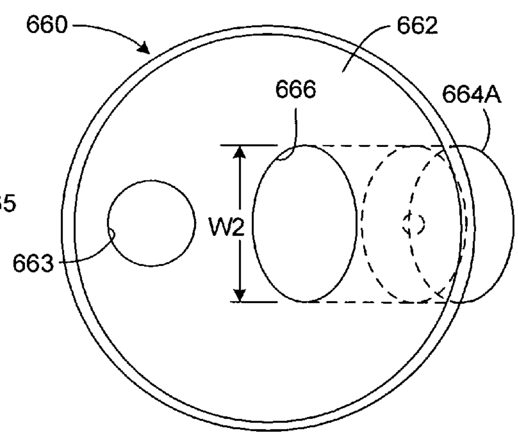


FIG. 7(B)

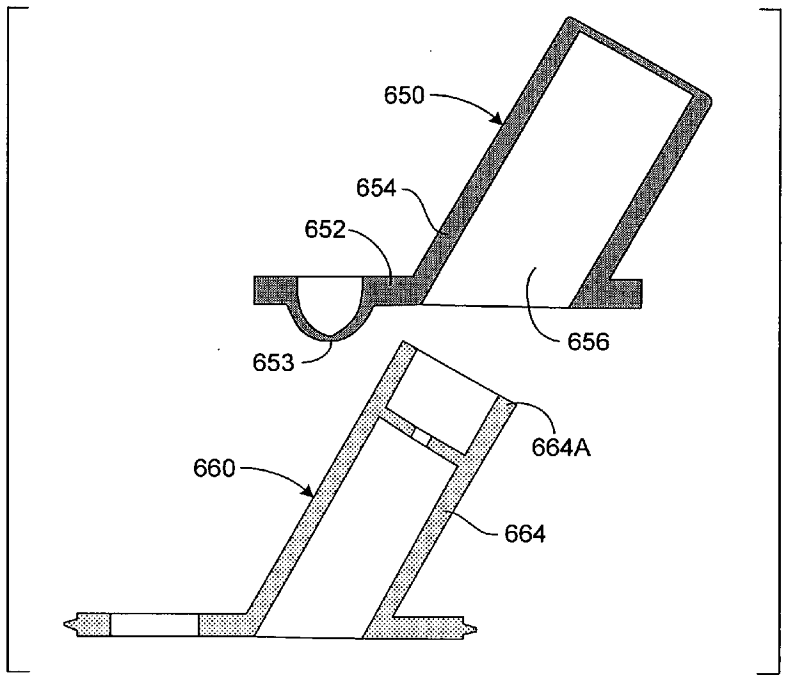
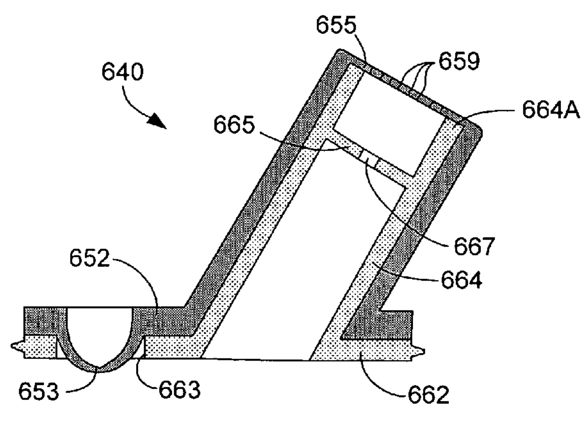

650
654
652
653
656
660
664A
664

FIG. 8(A)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640
665
664A
667
652
664
653
663
662

FIG. 8(B)

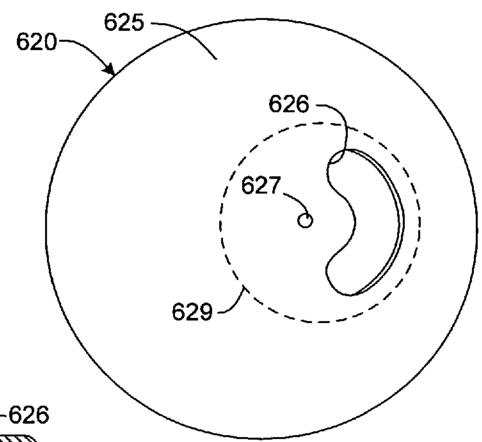

FIG. 9

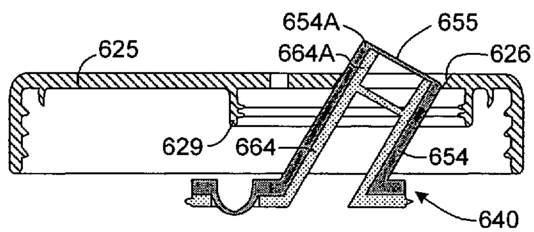

FIG. 10(A)

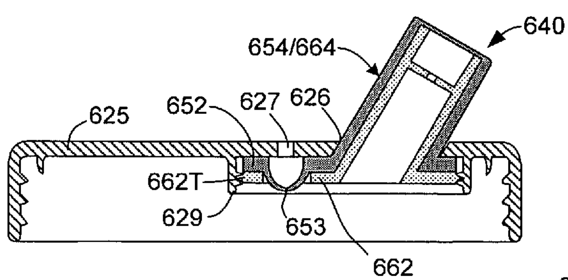

FIG. 10(B)

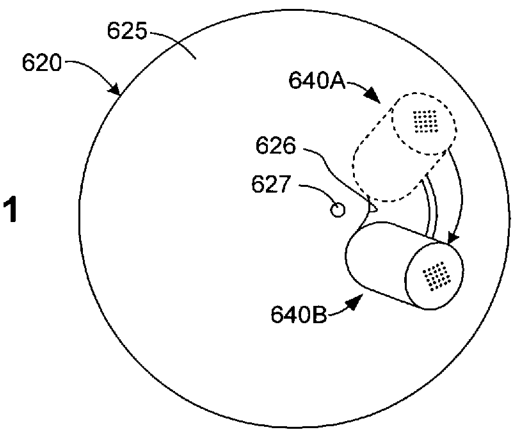

FIG. 11

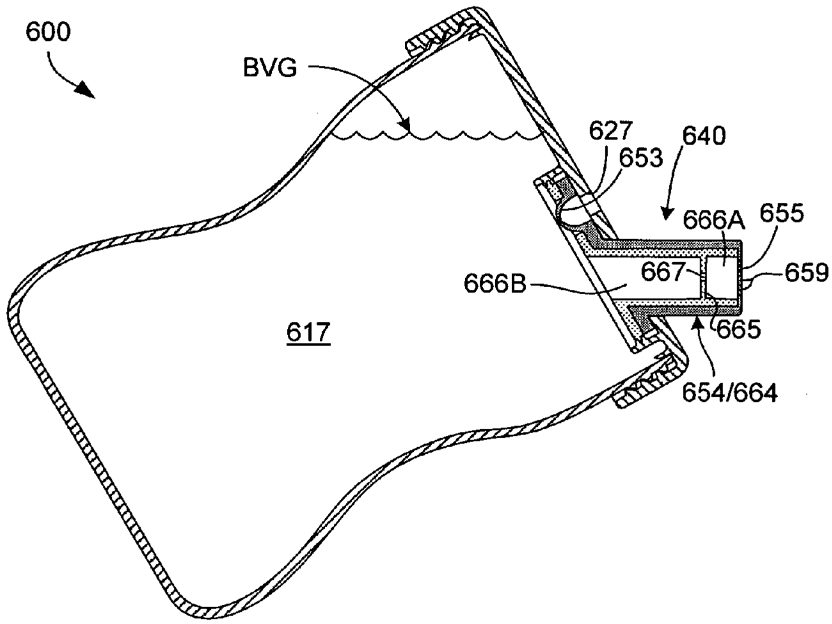

FIG. 12(A)

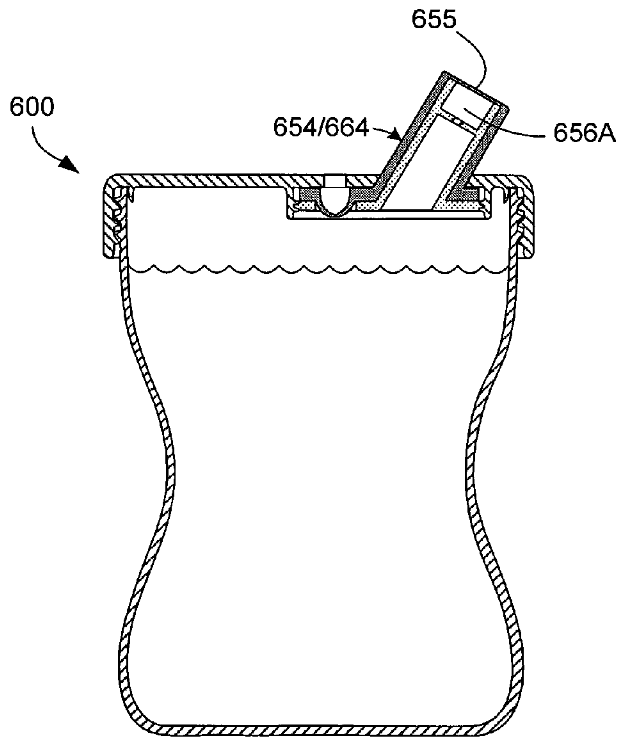

FIG. 12(B)

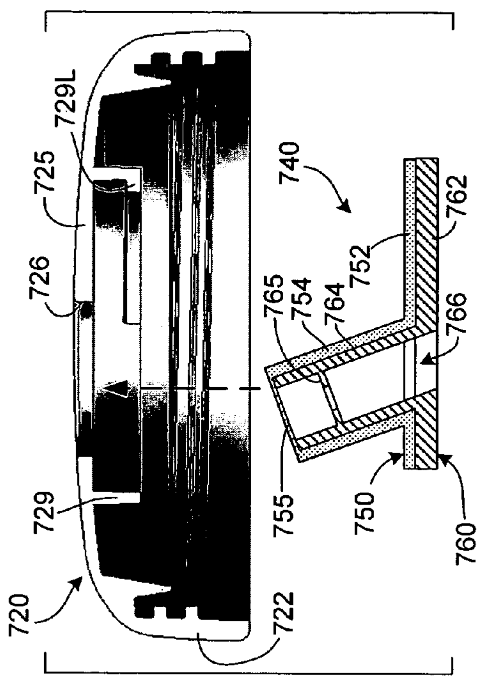

FIG. 14(A)

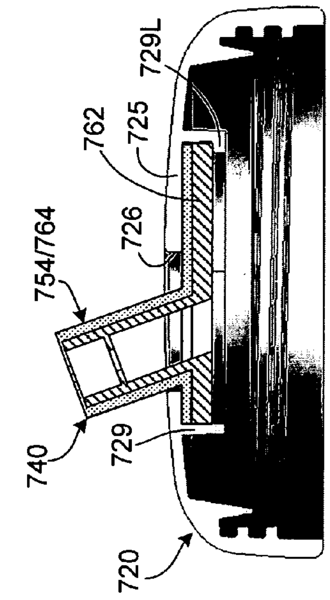

FIG. 14(B)

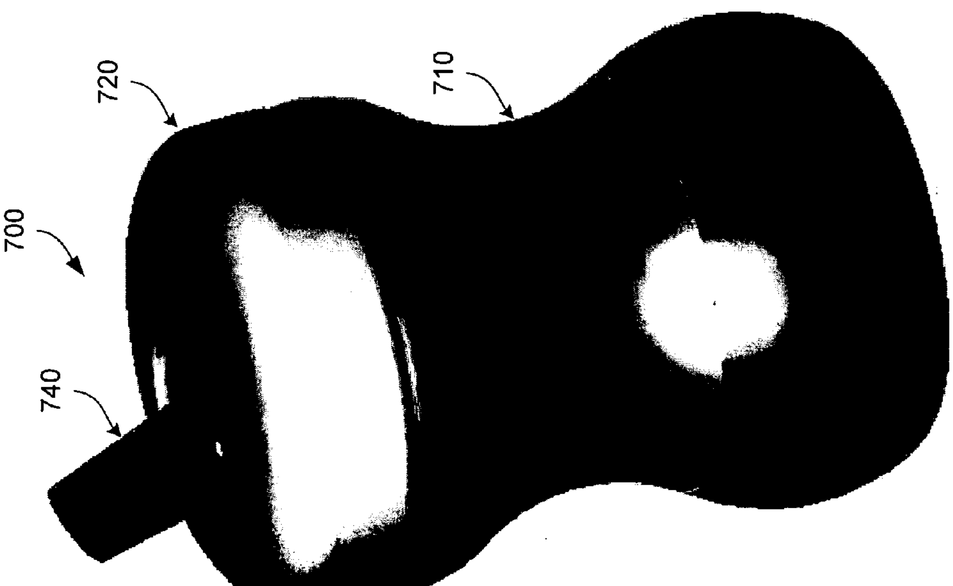

FIG. 13

NON-SPILL CONTAINER WITH FLOW CONTROL STRUCTURE INCLUDING BAFFLE AND ELASTIC MEMBRANE HAVING NORMALLY-CLOSED PINHOLES

FIELD OF THE INVENTION

[0001] The present invention relates to fluid flow control devices for non-spill beverage containers, and more specifically it relates to "no drip" flow control structures for, e.g., child sippy cups and adult "travel" mugs.

RELATED ART

[0002] Sippy cups and travel mugs represent two types of non-spill beverage containers that utilize flow control devices to control the ingestion of beverage in response to an applied sucking force. Sippy cups are a type of spill-resistant container typically made for children that include a cup body and a screw-on or snap-on lid having a drinking spout molded thereon. An inexpensive flow control element, such as a soft rubber or silicone outlet valve, is often provided on the sippy cup lid to control the flow of liquid through the drinking spout and to prevent leakage when the sippy cup is tipped over when not in use. Adult non-spill "travel" mugs are usually fabricated from a thermally insulating material, and have a narrow spout that restricts flow of a hot beverage (e.g., coffee). A valve similar to that used on child sippy cups is sometimes incorporated into such travel mugs to prevent spills.

[0003] "No drip" sippy cup flow control valves typically include a sheet of the elastomeric material located between the inner cup chamber and the open end of the drinking spout that defines one or more slits formed in an X or Y pattern. As a child tilts the container and sucks liquid through the drinking spout, the slits yield and the flaps thereof bend outward, thereby permitting the passage of liquid to the child. When the child stops sucking, the resilience of the causes the slits to close once more so that were the cup to be tipped over or to fall on the floor, liquid cannot pass out of the container through the drinking spout.

[0004] One problem associated with conventional non-spill cups is that the elastomeric material used to form the slit-type "no drip" flow control valves can fatigue in the region of the slits and/or become obstructed over time, and the resulting loss of resilience can cause leakage when the slit flaps fail to fully close after use. This failure of the slit flaps to close can be caused by any of several mechanisms, or a combination thereof. First, repeated shearing forces exerted at the end of each slit due to repeated use can cause tearing of the elastomeric material in this region, thereby reducing the resilient forces needed to close the slit flaps after use. Second, thermal cycling or mechanical cleaning (brushing) of the elastomeric material due, for example, to repeated washing, can cause the elastomeric material to become less elastic (i.e., more brittle), which can also reduce the resilience of the slit flaps. Third, solid deposits left by liquids passing through the slits can accumulate over time to impede the slit flaps from closing fully.

[0005] A second problem associated with conventional non-spill cups is that the "no drip" flow control valves are typically located inside the short, straw-like drinking spout such that a small, open upper section of the spout is located above the valve. During each sip, liquid is drawn through the valve (which is pulled open by the applied suction), and the passes through the open upper section of the drinking spout into the drinker's mouth. Because the valve closes at the end of each sip (i.e., when the applied suction is terminated), a small amount of liquid is typically "trapped" (retained) in the upper section (i.e., between the now-closed valve and the open end of the drinking spout). Because the upper end of the drinking spout is open to the air, this small amount of liquid can drip or be shaken from the end of the drinking spout and create, for example spots on a light colored carpet.

[0006] What is needed is a flow control structure for non-spill sippy cups and travel mugs that exhibits superior non-spill, no-drip characteristics. What is also needed is a flow control structure that automatically adjusts its fluid flow rate to the applied suction, and avoids the clogging and tearing problems associated with conventional slit-type elastic flow control structures. What is also needed is a non-spill beverage container that omits the small, open upper section of the drinking spout.

SUMMARY

[0007] The present invention is directed to a flow control structure for a non-spill beverage container (e.g., a child sippy cup or an adult travel mug) that includes a tube-like spout defining a relatively wide flow channel, a membrane extending across an end of the flow channel, and a baffle supported in the flow channel that provides a small opening between a beverage storage chamber and the membrane. The membrane is formed from a suitable elastomeric material (e.g., soft rubber, thermoplastic elastomer, or silicone) that is punctured to form multiple, substantially round pinholes that remain closed to prevent fluid flow through the membrane and flow channel under normal atmospheric conditions (i.e., while the membrane remains non-deformed), thereby providing a desired "no drip" characteristic. The baffle further enhances this "no drip" characteristic by acting to limit fluid pressure in the region between the baffle and the membrane (i.e., in the presence of a higher fluid pressure downstream of the baffle). Conversely, when subjected to such an applied pressure differential (e.g., when sucked on by a child), the membrane stretches (deforms), thereby causing some or all of the pinholes to open and to facilitate fluid flow rate through the membrane, which is substantially unimpeded by the baffle under these conditions. Because the amount that the pinholes open, and the associated fluid flow through the pinholes, is related to the applied pressure differential, the present invention provides a flow control structure that automatically adjusts its fluid flow rate to the applied suction. In addition, because the pinholes are substantially round, the pinholes resist the clogging and tearing problems associated with slit-type flow control structures.

[0008] According to another embodiment of the present invention, a non-spill beverage container includes a container body, a cap mounted over an open end of the container body, and a flow control structure mounted on the cap such that a spout of the flow control structure extends through an opening in the cap. The flow control structure includes an outer, relatively flexible member that includes a tube-like outer spout portion and the membrane, and an inner, relatively rigid member that includes the baffle. The inner member includes a base that is screwed, snap-coupled or otherwise secured to the cap, and an inner spout portion that forms the flow channel. The outer member mounts over the

inner spout portion such that the membrane is positioned at the upper end of the spout. Because the membrane is located at the end of the spout, when a user finishes drinking and the pinholes close, beverage that may be retained in the flow channel is prevented from dripping from the spout by the membrane, thus avoiding the dripping problem associated with conventional non-spill beverage containers.

[0009] The present invention will be more fully understood in view of the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a perspective side view showing a flow control structure according to a generalized embodiment of the present invention;

[0011] FIGS. **2**(A) and **2**(B) are top and cross-sectional side views, respectively, showing the flow control structure of **FIG. 1**;

[0012] FIGS. **3**(A) and **3**(B) are simplified diagrams illustrating tensile forces generated in flat and curved membranes;

[0013] FIGS. **4**(A) and **4**(B) are simplified enlarged cross-sectional views showing the opening of a pinhole formed in the flow control element of **FIG. 2** during operation;

[0014] FIGS. **5**(A) and **5**(B) are cross-sectional side views showing the flow control structure of **FIG. 1** during operation.

[0015] **FIG. 6 a** cross-sectional side view showing a non-spill beverage container including a flow control structure according to an exemplary embodiment of the present invention;

[0016] FIGS. **7**(A) and **7**(B) are cross-sectional side and plan views showing an inner portion of the flow control structure utilized in the non-spill beverage container of **FIG. 6**;

[0017] FIGS. **8**(A) and **8**(B) are cross-sectional side views showing a process of assembling the flow control structure of **FIG. 6** in accordance with another aspect of the present invention;

[0018] **FIG. 9** is a top plan view showing a cap of the non-spill beverage container of **FIG. 6**;

[0019] FIGS. **10**(A) and **10**(B) are cross-sectional side views showing a process for mounting the flow control structure of **FIG. 8**(B) onto the cap of **FIG. 9** according to another aspect of the present invention;

[0020] **FIG. 11** is a top plan view showing a process for securing the flow control element of **FIG. 8**(B) to the cap of **FIG. 9**(B);

[0021] FIGS. **12**(A) and **12**(B) are cross-sectional side views showing the non-spill beverage container of **FIG. 6** during operation;

[0022] **FIG. 13** is a perspective side view showing a non-spill beverage container including a flow control structure according to another exemplary embodiment of the present invention; and

[0023] FIGS. **14**(A) and **14**(B) are cross-sectional side views showing a process for mounting the flow control structure onto the cap of the non-spill beverage container of **FIG. 13** according to another aspect of the present invention.

DETAILED DESCRIPTION

[0024] **FIG. 1** is a perspective view showing a flow control structure **40** according to a generalized embodiment of the present invention, and FIGS. **2**(A) and **2**(B) show flow control structure **40** in top plan and cross-sectional side views, respectively, where **FIG. 2**(B) is taken along section line **2-2** of **FIG. 2**(A).

[0025] Flow control structure **40** includes a molded (first) member **50** including a tube-like spout **54** defining a substantially cylindrical flow channel **56**, a membrane **55** mounted on an upper (first) end **54**A of spout **54**, and a baffle **65** mounted inside flow channel **56** between upper end **54**A and a lower end **54**B of spout **54**. Spout **54** is a relatively rigid (i.e., compared to membrane **55**) tube-like structure extending generally along a central axis X between upper end **54**A and lower end **54**B of spout **54**. As indicated in **FIG. 2**(A), in one embodiment spout **54** has a circular cross section having an inner diameter (width) D**1**. In other embodiments, spout **54** may have, for example, an oval, square or rectangular cross section.

[0026] Membrane **55** is relatively elastic (i.e., compared to spout **54**) and is connected to spout **54** adjacent to (i.e., at or slightly inset from) upper end **54**A such that membrane **55** is disposed across fluid flow channel **56** to impede flow from fluid flow channel **56** and an external region ER. In the disclosed embodiment, membrane **55** has a circular outer perimeter **57** that is secured to upper end **54**A of spout **54**. In one embodiment, elastic membrane **55** is formed from a suitable material (e.g., soft rubber, thermoplastic elastomer, or silicone) having a thickness T**1** in the range of 0.01 to 0.1 inches (more particularly 0.01 to 0.03 inches), and spout **54** is formed from the same material and has a thickness T**2** in the range of 0.05 to 0.12 inches. According to the present invention, membrane **55** defines a plurality of spaced-apart pinholes **59** formed using the procedure describe below such that when membrane **55** is subjected to normal atmospheric conditions (i.e., remains non-deformed), pinholes **59** remain closed to prevent fluid flow between fluid flow channel **56** and external region ER through membrane **55**. As described in additional detail below, pinholes **59** are also formed such that when membrane **55** is deformed (stretched) in response to an applied pressure differential between fluid flow channel **56** and external region ER, pinholes **59** open to facilitate fluid flow through membrane **55**. Accordingly, pinholes **59** facilitate adjustable fluid flow through membrane **55** that increases in direct relation to the applied pressure differential, thereby facilitating the formation of a non-spill beverage container.

[0027] As indicated in **FIG. 2**(B), according to an embodiment of the present invention, membrane **55** is substantially flat (planar) in its relaxed (i.e., non-deformed or unstretched) state, and lies in a plane X-Y that is perpendicular to central axis X of flow channel **56**. Two advantages are provided by making membrane **55** in this manner. A first advantage, which is illustrated by the simplified diagrams shown in FIGS. **3**(A) and **3**(B), is that a flat membrane is easier to stretch under an applied pressure than a curved membrane. In particular, as depicted in **FIG. 3**(A), a pressure P_Z applied perpendicular to substantially flat membrane **55** causes membrane **55** stretches (bows downward, as indicated by the dashed membrane **55'**). Note that because membrane **55** is substantially flat, virtually all of the resultant tensile force T generated in membrane **55** is directed in the X-Y plane (indicated by component T_{X-Y}), thereby generating little or no component T_Z in the Z-axis direction until the membrane is at least partially stretched. Because the tension component T_Z remains relatively small, planar membrane **55** is stretched (and the pinholes opened) in response to a relatively small applied pressure P_Z, thereby facilitating fluid flow through membrane **55** in response to a relatively small sucking force. In contrast, as indicated in **FIG. 3**(B), a pre-curved membrane **310** generates a significantly larger tensile force component T_Z, thereby requiring a substantially larger pressure P_Z to produce even a minimal stretching of membrane **310** from its resting position (e.g., as indicated by deformed membrane **310'**, shown in **FIG. 3**(B)). A second advantage to provided by making membrane **55** substantially flat is that, as described below, formation of the pinholes is greatly simplified and facilitated.

[**0028**] Although the preferred embodiment includes a substantially flat (planar) membrane, a curved membrane may also be used, although such membrane would necessarily be relatively thin (i.e., relative to a flat membrane formed from the same material) in order to facilitate a similar amount of deformation in response to an applied pressure. A problem posed by using a relatively thin membrane is the increased chance of rupture and/or tearing of the membrane material, which may result in the unintended ingestion of membrane material.

[**0029**] Referring to **FIG. 2**(A), according to an aspect of the present invention, membrane **55** defines a plurality of spaced-apart pinholes **59** that are arranged in a two-dimensional pattern. The term "spaced-apart" is used to indicate that the pinholes are separated by regions of non-perforated membrane material (i.e., there are no holes, cracks, slits, or other significant structural weaknesses in the membrane material in the regions separating adjacent pinholes). The spacing between pinholes **59** is selected based on the membrane material such that tearing of the membrane material between adjacent pinholes is avoided under normal operating conditions (i.e., the pinholes are spaced as far apart as is practical). Note that arranging pinholes **59** in a two-dimensional pattern provides the advantage of balancing the distribution of forces across membrane **55**, thereby reducing the chance of tearing of the membrane material.

[**0030**] According to an aspect of the present invention, spout **54** has a greater rigidity than the membrane **55** such that, when an applied pressure differential is generated between fluid flow channel **56** and external region ER, membrane **55** undergoes a greater amount of deformation than spout **54**. In one embodiment, membrane **55** and spout **54** are integrally connected to form an single-piece member **50**, which is molded from a suitable material (i.e., both spout **54** and elastic membrane **55** are molded in the same molding structure using a single molding material, e.g., silicone, a thermoplastic elastomer, or soft rubber), and the increased rigidity is provided by forming spout **54** to include a thickness T**1** that is greater than the thickness T**2** of membrane **55**. In an alternative embodiment, spout **54** may be formed at least partially from a relatively rigid material (e.g., a hard plastic), and membrane **55** may be separately formed from a relatively elastic material and then secured to wall member **54**. One example of this arrangement is described below with reference to the disclosed specific embodiment.

[**0031**] Referring again to **FIGS. 1 and 2**(A), membrane **55** is depicted as being secured around its peripheral edge **57** to upper end **54**A of spout **54**. Alternatively, membrane **55** may be recessed into flow channel **56** to avoid damage caused, for example, by gumming or chewing on the end of flow control structure **40**, provided membrane **55** is positioned between baffle **65** and external region ER. However, significantly recessing membrane **55** creates an open upper region between the end of flow channel **56** (i.e., upper end **54**A of straw-like spout **54**) that may undesirably create a reservoir for small amounts of liquid that can drip after each sip, as described above with respect to conventional non-spill beverage containers.

[**0032**] In accordance with another aspect of the present invention, several pinholes **59** are formed in membrane **55** to facilitate liquid flow from flow channel **56** to external region ER in response to an applied pressure differential (e.g., an applied suction). As indicated in **FIG. 4**(A), each pinhole **59** is formed by piercing membrane **55** with a pin **410**, or other sharp pointed object, such that the pinhole is closed by the surrounding elastomeric material when pin **400** is subsequently removed. In a preferred embodiment, membrane **55** is stretched in a radial direction by a force F that is sufficient to increase the diameter of membrane **55** in the range of 1 to 10 percent during the formation of pinholes **59**. When the stretching force F is subsequently removed (i.e., membrane **55** returns to an unstretched state), pinholes **59** are collapsed by the surrounding membrane material to provide a reliable seal. In accordance with another aspect, each pin **410** is formed with a continuously curved (e.g., circular) cross section such that each pinhole **59** is substantially circular (i.e., does not have a slit or fold that would be formed by a cutting element having an edge). In one embodiment, pin **410** has a diameter in the range of 0.020 and 0.065 inches. Note that a pin having a diameter DIA of approximately 0.063 inches was used in a punch (8 mm depth on press) to produce successful pinholes in a membrane having a thickness of approximately 0.02 inches. The number of pinholes **59** and membrane thickness T**3** determine the amount of liquid flow through membrane **55** during use for a given pressure differential, as discussed below. During operation, as described in additional detail below, membrane **55** is positioned between a liquid beverage (not shown) and an external region. While atmospheric equilibrium is maintained (i.e., the pressure on both sides of membrane **55** is essentially equal), membrane **55** remains in the unstretched state illustrated in **FIG. 4**(A), wherein pinholes **157** remain closed to prevent leakage. During subsequent use (e.g., when a child sucks on spout **54** like a straw), a pressure differential is generated in which a relatively high pressure on the liquid side of membrane **55** becomes greater than the relatively low pressure on the suction side, thereby causing membrane **55** to stretch outward, as indicated in **FIG. 4**(B). The stretching of membrane **55** causes pinholes **59** to open, thereby allowing the liquid beverage to pass therethrough. Subsequently, when the pressure differential is relieved (i.e., the child stops sucking), membrane **55** then returns to its unstretched state, and pinholes **59** return to the closed state shown in **FIG. 4**(A). Note that because pinholes **59** do not include slits that can become weakened and/or trap deposits that can prevent slit flap closure, the flow control structure of the present invention facilitates leak-free operation that is substantially more reliable than that of conventional, slit-based flow control members.

[0033] Baffle **65** is an annular structure located inside flow channel **56** and spaced from membrane **55** such that an upper (first) flow channel region **56**A is defined between baffle **65** and membrane **55**, and a lower (second) flow channel region **56**B is located on a side of baffle **65** that is opposite to membrane **55** (e.g., between baffle **65** and a beverage reservoir). Flow channel regions **56**A and **56**B communicate through opening **67**, which has a relatively small diameter D2 (**FIG. 2**(A)). In one embodiment, baffle **65** is a substantially disk-shaped structure that is parallel to membrane **55** (when in its substantially planar, unstretched state), and opening **67** is aligned with the central axis X defined by spout **54**. In alternative embodiments baffle **65** is either integrally connected to spout **54** and membrane **55** (i.e., formed as part of first member **50**, as depicted in **FIG. 2**(B)), or fabricated separately from a second material (e.g., a rigid plastic), and inserted into flow channel **56**, such as described below with reference to the disclosed specific embodiment.

[0034] FIGS. **5**(A) and **5**(B) are cross-sectional side views showing a simplified beverage container **500** including flow control structure **40** during operation. Beverage container **500** includes a container body **510** having an outer wall **511** defining a beverage storage chamber **517** containing a liquid beverage BVG, and an opening **519**. Flow control structure **40** is mounted over open end **519** such that flow channel section **56**B communicates directly with chamber **517** via open end **519**, and baffle **65** is positioned between chamber **517** and flow channel section **56**A. **FIG. 5**(A) shows beverage container **500** in an inverted position prior to use (i.e., such that atmospheric pressure is applied to the outside surface of membrane **55**, and beverage BVG is prevented from leaking out of container **500** solely by flow control structure **40**), and **FIG. 5**(B) shows beverage container **500** while a suction is applied to flow control structure **40** by an external body **530** (e.g., a child's mouth). In one embodiment, as indicated in **FIG. 5**(B), spout **54** and baffle **65** respectively have a greater rigidity than membrane **55** such that, when the applied pressure differential is generated between fluid flow channel **56** and external region ER (e.g., inside external body **530**), membrane **55** undergoes a greater deformation than spout **54** and baffle **65** in order to, for example, prevent collapse of flow control element **40** during use.

[0035] According to another aspect of the present invention, baffle **65** and membrane **55** combine to further enhance the no-drip/non-spill characteristic of flow control structure **40**. First, the inventor discovered that providing baffle **65** in flow channel **56** limits the static pressure transmitted to membrane **55** while container **500** is held in the inverted position indicated in **FIG. 5**(A). More specifically, the inventor discovered that placing baffle **65** into flow channel **56** allowed the inventor to increase the flow rate characteristics of membrane **55** (e.g., reduce the thickness of membrane **55** and/or increase the size of pinholes **59**), making membrane **55** more suitable for high volume flow, without increasing the tendency for membrane **55** to leak in the inverted position. The inventor currently believes that this beneficial characteristic may be produced, at least in part, by a combination of baffle **65** acting to limit the static pressure transferred to flow channel region **56**A from chamber **517**, and by surface tension of beverage BVG in and around opening **67**. A second benefit of baffle **65** is that it impedes relatively high pressure spikes in flow channel region **56**A that are generated, for example, when beverage container **500** is shaken up and down or dropped while in the inverted position shown in **FIG. 5**(A). The inventors discovered that, when combined with a membrane that exhibits leakage in response to such pressure spikes in the absence of baffle **65**, the presence of baffle **65** significantly reduced and/or eliminated leakage through membrane **55**, even when an associated beverage container is shaken vigorously. As a third benefit, referring to **FIG. 5**(B), when subsequently subjected to suction by external body **530**, the relatively high static pressure differential creates liquid flow through membrane **55** that appears to be minimally impeded by baffle **65**. Accordingly, the inventor found that by combining the increased flow rate characteristics of membrane **55** with baffle **65**, flow control structure **40** provides superior non-spill, no-drip characteristics, compared to conventional non-spill designs. Further, membrane **55** operates as described above to automatically adjust the fluid flow rate through flow control structure **40** to the applied suction, and to avoid the clogging and tearing problems associated with conventional slit-type elastic flow control structures.

[0036] The present invention will now be described with reference to a specific embodiment.

[0037] **FIG. 6** is a side view showing a non-spill beverage container **600** that utilizes a flow control structure **640** formed in accordance with another specific embodiment of the present invention. Container **600** generally includes a hollow cup-shaped body **610**, and a cap **620** having flow control structure **640** mounted thereon. Body **610** includes a roughly cylindrical sidewall **611** having a threaded upper edge **613**, and a bottom wall **615** located at a lower edge of sidewall **611**. Sidewall **611** and bottom wall **615** define a beverage storage chamber **617** in which a beverage is received during use. Cap **620** includes a base portion **622** having threaded inside surface that mates with threaded upper edge **613** to connect cap **620** to body **610**, and an upper wall **625** mounted on an upper edge of base portion **622** that combines with body **610** to substantially enclose storage chamber **617**. Upper wall **625** defines an outlet passage **626** and a vent hole **627**. Provided at a lower surface of upper wall **625** is a cylindrical mounting structure **629** to which flow control structure **640** is secured. Note that cylindrical mounting structure **629** surrounds outlet passage **626** and vent hole **627**.

[0038] According to the specific embodiment, flow control structure **640** includes an outer (first) member **650** that is mounted over an inner (second) member **660**. Outer member **650** is molded from a relatively flexible elastomeric material (e.g., soft rubber, thermoplastic elastomer, or silicone), and inner member **660** is molded from a relatively rigid, food-safe plastic material (e.g., polypropylene). Outer member **650** includes a disk-shaped base **652** defining a vent structure **653**, a tube-like outer spout portion **654** connected at its lower end **654**B to base **652** and extending upward at an angle from base **652**, and a membrane **655** mounted across an upper end **654**A of outer spout portion **654**. Vent structure **653** is a domed protrusion that extends downward from disk-shaped base **652**, and includes a slit (not shown) that, similar to conventional valve structures, opens in response to relatively low air pressure inside beverage chamber **617** caused by beverage being drawn (sucked) through flow control structure **640**. Inner member **660**, which is shown in additional detail in FIGS. **7**(A) and **7**(B), includes a disk-shaped base **662** that defines a vent hole **663** and includes a thread **662**T formed on its peripheral edge, a tube-like inner spout portion **664** extending upward at an angle from base **662** and defining an oval flow channel **666** having a minimum width W**1** and a maximum width W**2**, and a baffle **665** mounted in spout **664** between an upper end **664**A and a lower end **664**B. As in the general embodiment described above, flow channel **666** is separated into two regions **666**A and **666**B by baffle **665**, with lower flow channel region **666**B communicating with beverage storage chamber **617**. In one embodiment, disk-shaped base has a diameter D**11** of approximately one inch, oval passage has a width W**2** of approximately 0.4, respectively, and opening **667** formed in baffle **665** has a diameter D**12** of approximately 0.01 to 0.1 inches. Note that disk-shaped base **652** has a diameter that is slightly smaller than diameter D**11**.

[**0039**] FIGS. **8**(A) and **8**(B) are cross-sectional side views showing a process of assembling flow control structure **640**. **FIG. 8**(A) shows outer member **650** positioned over inner member **660** such that upper end **664**A of inner spout portion **664** is positioned for insertion into an opening **656** defined by outer spout portion **654**. Valve member **650** is then pressed over spout **654** until a lower surface of base **652** rests on an upper surface of base **662**, and membrane **655** presses against upper end **664**A of inner spout portion **664**, with slit-like vent extending through vent opening **663**. As indicated in **FIG. 8**(B), membrane **655** defines several normally-closed pin-holes **659** that are formed and function as described above with reference to pin-holes **59**.

[**0040**] **FIG. 9** is a top plan view showing cap **620** in additional detail. Outlet passage **626** is a curved opening that extends partially around the circumference of cylindrical mounting structure **629** (indicated with dashed lines), which extents from the bottom side of wall **625**. Vent hole **627** is also located inside the circumference of cylindrical mounting structure **629**.

[**0041**] FIGS. **10**(A), **10**(B) and **11** depict a process for mounting flow control structure **640** onto cap **620**. As shown in **FIG. 10**(A), flow control structure **640** is positioned below wall **625** of cap **620** such that membrane **655** is positioned under outlet passage **626**. Flow control structure **640** is then pushed upward such that spout **654**/**664** passes through outlet passage **626** until threads **662**T formed on the outer edge of disk-shaped base **662** engage matching threads formed on the inside surface of cylindrical mounting structure **629**. As indicated in **FIG. 11**, with spout **654**/**664** protruding from upper wall **625** and positioned at the leftmost edge of outlet passage **626** (indicated by dashed line structure **640**A), flow control structure **640** is then screwed/secured onto cylindrical mounting structure **629** by manipulating (sliding) spout **654**/**664** along outlet passage **626** to its rightmost edge (as indicated by solid line structure **640**B), thus causing threads **662**T of disk-shaped base **662** to screw into cylindrical mounting structure **629** and to press base **652** against the lower surface of wall **625**, thus providing a reliable seal. Note that, when flow control structure **640** is in the "locked" position (i.e., represented by solid line structure **640**B in **FIG. 11**), vent hole **627** aligns with vent structure **653** (as indicated in **FIG. 10**(B)) thereby facilitating pressure equalization during use.

[**0042**] FIGS. **12**(A) and **12**(B) are cross-sectional side views showing the non-spill beverage container **600** when at least partially filled with a liquid beverage BVG). **FIG. 12**(A) shows non-spill beverage container **600** in a tipped position whereby beverage BVG is able to flow to membrane **655** by way of lower flow channel region **666**B, opening **667** formed in baffle **665**, and upper flow channel region **666**A. As described above with reference to the generalized embodiment, baffle **665** and membrane **655** combine to prevent leakage when a user is not applying suction to the end of spout **654**/**664**. When suction is applied by a user (not shown), the applied pressure differential causes membrane **655** to bend outward to open pinholes **659** in the manner described above. As beverage BVG is drawn by the user through spout **654**/**664**, the resulting vacuum generated in storage chamber **617** is equalized by way of vent hole **627** and vent structure **653**.

[**0043**] In accordance with another benefit of the present invention, as indicated in **FIG. 12**(B), because membrane **655** is located at the end of spout **654**/**664**, when a user finishes drinking and membrane **655** closes, beverage that may be retained in upper flow channel region **656**A is prevented from dripping or otherwise discharging from spout **654**/**664**, thus avoiding the dripping problem associated with conventional non-spill beverage containers.

[**0044**] **FIG. 13** is a perspective side view showing a non-spill beverage container **700** in accordance with another specific embodiment of the present invention. Container **700** generally includes a hollow cup-shaped body **710**, and a cap **720** having flow control structure **740** mounted thereon. Similar to the previous embodiment, body **710** is a cup-shaped structure including a roughly cylindrical sidewall having a threaded upper edge.

[**0045**] As shown in FIGS. **14**(A) and **14**(B), cap **720** includes a base portion **722** having a threaded surface that mates with body **710**, and an upper wall **725** mounted on an upper edge of base portion **722** that combines with body **710** to substantially enclose a beverage storage chamber. Upper wall **725** defines an outlet passage **726** and a vent hole (not shown). Provided at a lower surface of upper wall **725** around outlet passage **726** is a cylindrical mounting structure (wall) **729**, which includes a lip structure **729**L formed on an inside surface of cylindrical mounting structure **729** to which flow control structure **740** is secured as described below.

[**0046**] Flow control structure **740**, which is also shown in **FIGS. 13 and 14**, includes an outer (first) member **750** that is mounted over an inner (second) member **760**. Outer member **750** is molded from a relatively flexible elastomeric material (e.g., soft rubber, thermoplastic elastomer, or silicone), and inner member **760** is molded from a relatively rigid, food-safe plastic material. Outer member **750** includes a disk-shaped base **752** defining a vent structure (not shown), a tube-like outer spout portion **754** connected at its lower end to base **752** and extending upward from base **752**, and a membrane **755** mounted across an upper end of outer spout portion **754**. Inner member **760** includes a disk-shaped base **762** that defines a vent hole (not shown), a tube-like inner spout portion **764** extending upward from base **762** and defining a flow channel **766**, and a baffle **765** mounted between an upper end and a lower end of spout **764**. As in the general embodiment described above, flow channel **766** is separated into two regions by baffle **765**, with the lower flow channel region communicating with the beverage storage chamber (not shown).

[**0047**] FIGS. **14**(A) and **14**(B) illustrate a process for mounting flow control structure **740** onto cap **720**. As shown in **FIG. 14**(A), flow control structure **740** is positioned below wall **725** of cap **720** such that membrane **755** is positioned under outlet passage **726**. Flow control structure **740** is then pushed upward (i.e., in the direction of the dashed-line arrow) such that spout **754/764** passes through outlet passage **726** until the peripheral edge of disk-shaped base **762** engages (i.e., is snap-coupled to) lip structure **729**L formed on the inside surface of cylindrical mounting structure **729**, as indicated in **FIG. 14**(B). An advantage of this embodiment is that it avoids the need to turn (screw) flow control structure **740** relative to cap **720**, thereby simplifying the mounting procedure and eliminating the elongated groove needed in the previous embodiment.

[**0048**] In addition to the general and specific embodiments disclosed herein, other features and aspects may be added to the novel flow control structures that fall within the spirit and scope of the present invention. For example, outer members **650/750** of flow control structures **640/740** (described above) may omit base **652/752**, and instead rely on another mechanism to secure membranes **655/755** to inner spout portion **664/764**. The disclosed single-hole baffle structure may be replaced with a multi-holed baffle, or any baffle structure that defines at least one opening for permitting fluid flow, but limits dynamic pressure changes in the flow channel in the manner described herein. In addition, the disclosed cylindrical mounting structures may be a shape other than cylindrical, and base **662/762** may be removably attached to the mounting structure by a mechanism other than the disclosed threaded or snap-coupled connection, thereby removing the need for the elongated passage **626/726**. Further, the disclosed spout structures may extend at an angle from hte respective base other than that depicted (e.g., perpendicular to upper wall **625/725**). In another alternative embodiment, a cap may be formed that integrated the inner spout portion. Moreover, while the present invention works best with the pinhole membrane valve described herein, it may be possible to replace the pinhole membrane structure with another valve structure that, when combined in series with a baffle, produces at least some of the beneficial characteristics described herein. Therefore, the invention is limited only by the following claims.

1. A flow control structure comprising:

a tube-like spout having a first end and a second end, the spout defining a fluid flow channel extending from the first end to the second end of the spout, the flow channel having a first width;

a membrane connected to the spout across the flow channel and positioned adjacent to the first end; and

a baffle located in the flow channel and spaced from the membrane such that a first flow channel region is defined between a first side of the baffle and the membrane, and a second flow channel region is located on a second side of the baffle,

wherein the membrane defines a plurality of normally-closed pinholes, and

wherein the baffle defines an opening communicating between the first and second flow channel regions, said opening having a second width that is smaller than the first width of the flow channel.

2. The flow control structure according to claim 1, wherein the normally-closed pinholes are formed such that when the membrane is subjected to a relatively low pressure differential and the membrane remains undeformed, the plurality of pinholes remain closed to prevent fluid flow between the fluid flow channel and the external region through the membrane, and when the membrane is deformed in response to an applied relatively high pressure differential, the plurality of pinholes open to facilitate fluid flow through the membrane.

3. The flow control structure according to claim 1,

wherein the spout defines a central axis,

wherein the membrane is substantially flat and arranged perpendicular to the central axis, and

wherein the baffle parallel to the membrane, and the opening is aligned with the central axis.

4. The flow control structure according to claim 1, wherein the spout and the baffle respectively have a greater rigidity than the membrane such that, when an applied pressure differential is generated between the fluid flow channel and the external region, the membrane undergoes a greater deformation than the spout and the baffle.

5. The flow control structure according to claim 4, wherein the membrane and at least an outer spout portion are integrally connected and comprise at least one of silicone, a thermoplastic elastomer, and soft rubber.

6. The flow control structure according to claim 4, wherein the baffle is integrally connected to an inside surface of the spout.

7. The flow control structure according to claim 1, further comprising:

a first member including an tube-like outer spout portion and said membrane integrally connected to an end of the outer spout portion; and

a second member including an tube-like inner spout portion defining said flow channel, wherein said baffle is integrally connected to an inside surface of the inner spout portion,

wherein the outer spout portion is mounted over the inner spout portion such that the membrane is positioned adjacent to a first end of the inner spout portion.

8. A non-spill beverage container comprising:

a container body defining a beverage storage chamber and an opening; and

a flow control structure mounted over the opening, the flow control structure including:

a tube-like spout having a first end and a second end, the spout defining a fluid flow channel extending from the first end to the second end of the spout, the flow channel having a first width;

a membrane connected to the first end of the spout such that the membrane extends across the flow channel; and a baffle located in the flow channel and spaced from the membrane such that a first flow channel region is defined between a first side of the baffle and the membrane, and a second flow channel region is located on a second side of the baffle and communicates with the beverage storage chamber through the opening in the container body,

wherein the membrane defines a plurality of normally-closed pinholes, and

wherein the baffle defines an opening communicating between the first and second flow channel regions, said opening having a second width that is smaller than the first width of the flow channel.

9. The non-spill beverage container according to claim 8, wherein the normally-closed pinholes are formed such that when the membrane is subjected to a relatively low pressure differential and the membrane remains undeformed, the plurality of pinholes remain closed to prevent fluid flow between the fluid flow channel and the external region through the membrane, and when the membrane is deformed in response to an applied relatively high pressure differential, the plurality of pinholes open to facilitate fluid flow through the membrane.

10. The non-spill beverage container according to claim 8,

wherein the spout defines a central axis,

wherein the membrane is substantially flat and arranged perpendicular to the central axis, and

wherein the baffle parallel to the membrane, and the opening is aligned with the central axis.

11. The non-spill beverage container according to claim 8, wherein the spout and the baffle respectively have a greater rigidity than the membrane such that, when an applied pressure differential is generated between the fluid flow channel and the external region, the membrane undergoes a greater deformation than the spout and the baffle.

12. The non-spill beverage container according to claim 11, wherein the membrane and at least an outer spout portion are integrally connected and comprise at least one of silicone, a thermoplastic elastomer, and soft rubber.

13. The non-spill beverage container according to claim 11, wherein the baffle is integrally connected to an inside surface of the spout.

14. The non-spill beverage container according to claim 8, further comprising:

a first member including an tube-like outer spout portion and said membrane integrally connected to an end of the outer spout portion; and

a second member including an tube-like inner spout portion defining said flow channel, wherein said baffle is integrally connected to an inside surface of the inner spout portion,

wherein the outer spout portion is mounted over the inner spout portion such that the membrane is positioned adjacent to a first end of the inner spout portion.

15. The non-spill beverage container according to claim 14, further comprising a cap mounted over the opening defined by the container body, the cap including an upper wall,

wherein the flow control member is mounted on the cap such that the spout extends from the upper wall.

16. The non-spill beverage container according to claim 15,

wherein the cap includes a mounting structure integrally connected to a bottom surface of the upper wall, and the upper wall defines an outlet passage, and

wherein the second member further comprises a first base arranged such that the inner spout portion extends from the first base and the flow channel extends through an opening defined in the first base, and

wherein the second member is connected to the cap such that the first base is removably attached to the mounting structure and the spout extends through the outlet passage.

17. The non-spill beverage container according to claim 15,

wherein the first member further comprises a second base arranged such that the outer spout portion extends from the second base, and

wherein the second member is attached to the mounting structure such that the second base is pressed between the first base and the upper wall of the cap.

18. The non-spill beverage container according to claim 15,

wherein the mounting structure comprises a cylindrical wall and includes threads formed on an inside surface of the cylindrical wall, and

wherein the first base of the second member is a disk-shaped structure that includes threads formed on a peripheral edge of the disk-shaped structure that are operably engaged with the threads of the mounting structure.

19. The non-spill beverage container according to claim 15,

wherein the mounting structure comprises a cylindrical wall and includes a lip structure formed on an inside surface of the cylindrical wall, and

wherein the first base of the second member is a disk-shaped structure shaped such that a peripheral edge of the disk-shaped structure is snap-coupled the lip of the mounting structure.

20. A non-spill beverage container comprising:

a container body defining a beverage storage chamber and an opening; and

a flow control structure mounted over the opening, the flow control structure including:

a tube-like spout having a first end and a second end, the spout defining a fluid flow channel extending from the first end to the second end of the spout, the flow channel having a first width;

a valve structure connected to the first end of the spout such that the valve structure is located in the flow channel; and

means located in the flow channel between the beverage storage chamber and the valve structure for limiting dynamic fluid pressure applied to the valve structure, said means including at least one opening having a second width that is smaller than the first width of the flow channel.

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