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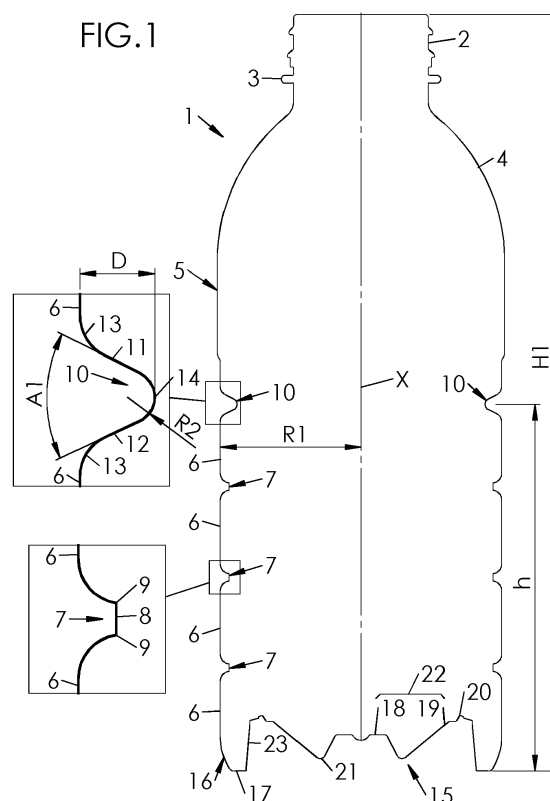
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Remarks:

Amended claims in accordance with Rule 137(2) EPC.

(54) **Container including an invertible vault and a resilient annular groove**

(57) Container (1) having a sidewall (5) and a bottom (15), said bottom (15) having an annular seat (17) and a central vault (22) invertible between a lower position, in which the vault (22) protrudes outwards with respect to the container (1), and an upper position, in which the vault (22) protrudes inwards with respect to the container (1), wherein the sidewall (5) is dimensionally stable, except in an annular groove (10) capable of opening under inversion of the vault (22).



Description

FIELD OF THE INVENTION

[0001] The invention generally relates to the manufacturing of containers, such as bottles, which are produced by blow molding or stretch-blow molding from preforms made of plastic (mostly thermoplastic, e.g. PET) material. More specifically but not exclusively, the invention relates to the processing of hot-fill containers, i.e. containers filled with a hot pourable product (typically a liquid), the term "hot" meaning that the temperature of the product is greater than the glass transition temperature of the material in which the container is made. Typically, hot filling of PET containers (the glass transition temperature of which is of about 80°C) is conducted with products at a temperature comprised between about 85°C and about 100°C, typically at 90°C.

BACKGROUND OF THE INVENTION

[0002] U.S. Pat. Appl. No. 2008/0047964 (Denner et al, assigned to CO2PAC) discloses a container comprising a pressure panel located in the bottom portion of the container. According to Denner, the pressure panel is movable between an outwardly-inclined position and an inwardly-inclined position to compensate for a change of pressure inside the container. In order to alleviate all or a portion of the vacuum forces within the container, the pressure panel is moved from the outwardly-inclined position by a mechanical pusher after the container has been capped and cooled, in order to force the pressure panel into the inwardly-inclined position.

[0003] In addition, in one embodiment Denner's container sidewall is smooth like that of a conventional glass container. Tests conducted on this container showed that inversion of the pressure panel such increases pressure in the container that the sidewall distorts to an oval shape and hence loses the rigidity required to properly stack the container in a pallet. When stacking or palletizing the containers, there is a risk for the lower containers to bend under the weight of upper containers, and hence a risk for the whole pallet to collapse.

[0004] In another embodiment, the container sidewall is provided with reinforcing rings. Tests conducted on that container showed that inversion of the pressure panel requires a great effort on the mechanical pusher, whereby the risk of cracking - or even perforating - the bottom portion of the container is high.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to propose a container, the bottom of which is provided with an invertible vault and having a good shape stability under inversion of the vault.

[0006] It is another object of the invention to propose a container provided with an invertible vault and allowing

for a lower mechanical effort to be applied on the vault during inversion.

[0007] It is yet another object of the invention to propose a container, which, after inversion of the vault, still has a good shape stability even under cooling of the content.

[0008] It is therefore provided a container having a sidewall and a bottom, said bottom having an annular seat and a central vault invertible between a lower position, in which the vault protrudes outwards with respect to the container, and an upper position, in which the vault protrudes inwards with respect to the container, wherein the sidewall is dimensionally stable, except in a resilient annular groove capable of opening under inversion of the vault.

[0009] The vault absorbs at least part of the volume difference between the lower position and the upper position of the vault, whereby the pressure of the content is lowered to prevent inversion of the vault back to its lower position.

[0010] Other features may be provided, either alone or in combination:

- while the sidewall has a transversal overall half-width R1, and the annular groove is V-shaped and has a depth D and an angular aperture A1, the ratio D/R1 is comprised between 0.03 and 0.15;
- angular aperture A1 is comprised, before inversion of the vault, between 40° and 70°;
- angular aperture A1 is of about 50°;
- the annular groove has an upper flange and a lower flange, which connect through a toroidal belt;
- the toroidal belt has, in an axial sectional plane, an arc-of-a circle shape, the radius of which is greater than or equal to 1.5 mm;
- the sidewall is provided with a series of annular stiffening recesses;
- the bottom includes a standing ring, which forms the seat, and the vault comprises a central portion and a diaphragm extending from the standing ring;
- the container is heat set.

[0011] The above and other objects and advantages of the invention will become apparent from the detailed description of preferred embodiments, considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG.1 is an axial sectional view of a first embodiment of a container the bottom of which is provided with an invertible vault standing in an outwardly-inclined position, with an upper enlarged detail centered on a resilient groove and a lower enlarged detail centered on a stiffening recess.

FIG.2 is a view similar to **FIG.1**, showing the con-

tainer of **FIG.1** in an outwardly-inclined position of the vault, after filling, capping and cooling of the content, with an enlarged detail centered on the resilient groove.

FIG.3 is a view similar to **FIG.1** and **FIG.2**, showing the container of **FIG.2** after inversion of the vault, with an enlarged detail centered on the resilient groove.

FIG.4 is an enlarged sectional detail showing the resilient groove of the container of **FIG.3** after a while.

FIG.5 is a view similar to **FIG.1**, showing a second embodiment of a container.

DETAILED DESCRIPTION

[0013] **FIG.1-3** show a container **1** suitable for being filled with a hot product (such as tea, fruit juice, or a sports drink).

[0014] In order to endure the mechanical stress due to the hot temperature of the product, the container **1** is heat set, which means it is blow molded in a mold, the sidewall of which is heated at a predetermined temperature much greater than the average ambient temperature and which, in a preferred embodiment, is comprised between 80°C and 180°C.

[0015] The container **1** includes an upper open cylindrical threaded upper portion or neck **2**, which terminates, at a lower end thereof, in a support collar **3** of greater diameter. Below the collar **3**, the container **1** includes a shoulder **4**, which is connected to the collar **3** through a cylindrical upper end portion of short length.

[0016] Below the shoulder **4**, the container **1** has a sidewall **5** having an outer surface **6**, which is substantially cylindrical around a container main axis **X** and has a transversal overall half-width **R1**. In the depicted example, the sidewall **5** has symmetry of revolution around main axis **X**, i.e. the sidewall **5** has a circular shape in a sectional plane perpendicular to main axis **X**. In this case, **R1** denotes the overall radius of the outer cylindrical surface **6**.

[0017] In the embodiment depicted on **FIG.1-3**, the sidewall **5** includes a series of annular stiffening recesses **7** protruding radially inwardly (i.e. towards the axis **X**) from the outer surface **6**.

[0018] The recesses **7** are capable of resisting radial stresses which would otherwise tend to make the sidewall **5** oval when viewed in a horizontal section (such a deformation is known as ovalization). The recesses **7** are also capable of resisting axial stresses, which would tend to compress or, on the contrary, to elongate the sidewall **5**.

[0019] As depicted in the lower enlarged detail of **FIG.1**, each recess **7** has an annular belt **8** limited by sharp edges **9**, whereby the belt **8** provides mechanical strength and hence resistance to elongation or compression of the sidewall **5** along the axis **X**, and also resistance to ovalization.

[0020] As depicted on the drawings, the sidewall **5** is

also provided with a resilient annular groove **10** protruding radially inwardly from the outer cylindrical surface **6**. The annular groove **10** is capable of opening under stresses tending to elongate the sidewall **5**, and on the contrary to close under stresses tending to compress the sidewall **5**.

[0021] In one embodiment depicted on the drawings, the annular groove **10** is V-shaped. More precisely, the annular groove **10** has an upper straight flange **11** and a lower straight flange **12**, which respectively connect to the outer surface **6** through fillet radiuses **13**, and which connect to each other through a toroidal belt **14**, which, in an axial sectional plane (as in **FIG.1**), has an arc-of-a-circle shape (the radius of which is noted **R2**) and which is tangent to the flanges **11**, **12**. Radius **R2** is preferably greater than or equal to 1.5 mm.

[0022] In the absence of stresses applied to the container **1**, the annular groove **10** has an angular aperture **A1** defined between the flanges **11**, **12**. In a preferred embodiment, the angular aperture **A1** is comprised between 40° and 70°. In the depicted example, the angular aperture **A1** is of about 50°.

[0023] Measured from the outer cylindrical surface **6** of the sidewall **5** to the radial apex of the toroidal belt **14**, the groove **10** has a depth **D** which, in a preferred embodiment, is such that, in the absence of stresses applied to the container **1**, ratio **D/R1** is comprised between 0.03 and 0.15.

[0024] At a lower end of the sidewall **5**, the container **1** has a bottom **15**, which closes the container **1** and allows it to be put on a planar surface such as a table.

[0025] The bottom **15** includes a standing ring **16** which forms an annular seat **17** extending in a plane substantially perpendicular to the main axis **X**, a central portion **18** and a diaphragm **19** extending from the standing ring **16** to the central portion **18**. The container **1** has a height **H1**, measured from the seat **17** to the end of the neck **2**.

[0026] The diaphragm **19** connects to the standing ring **16** at an outer junction **20** and to the central portion **18** at an inner junction **21**. Both the outer junction **20** and the inner junction **21** are preferably curved (or rounded). The central portion **18** and the diaphragm **19** together form a vault **22**.

[0027] The container **1** is blow-molded with the vault **22** in a lower position protruding outwards with respect to the container **1**, wherein the diaphragm **19** stands in an outwardly-inclined position and wherein the inner junction **21** is located below the outer junction **20** (the container **1** being held normally neck up). The lower position of the vault **22** is illustrated in **FIG.1** and **FIG.2** and, in dotted lines, in **FIG.3**.

[0028] In a preferred embodiment depicted on the drawings, the standing ring **16** is a high standing ring, i.e. the standing ring **16** is provided with a frusto-conical inner wall **23**, a top end of which forms the outer junction **20** (and hence the outer articulation with the diaphragm **19**), whereby in the lower position of the vault **22** (i.e. in the outwardly-inclined position of the diaphragm **19**) the cen-

tral portion **18** stands above the standing ring **16**.

[0029] The outer junction **20** forms an outer articulation of the diaphragm **19** with respect to the standing ring **16** and the inner junction **21** forms an inner articulation of the diaphragm **19** with respect to the central portion **18**, whereby the vault **22** is invertible with respect to the standing ring **16** from the lower position to an upper position protruding inwards with respect to the container **1**, wherein the diaphragm **19** stands in an inwardly-inclined position and wherein the inner junction **21** is located above the inner junction **20**. The upper position of the vault **22** is illustrated in **FIG.4**.

[0030] After the container **1** has been blow-molded (as depicted on **FIG.1**), it is hot-filled or ambient-filled with a liquid, paste or any other content, respectively at hot or ambient temperature. Once poured, the content reaches a filling level **24**, which is symbolized on **FIG.2** by a horizontal line in the vicinity of the collar **3**.

[0031] Once filled, the container **1** is closed by means of a cap **25** clipped and/or screwed onto the neck **2**. As the filling level **24** does not reach the upper end of the container **1**, there remains, between the filling level **24** and the cap **25**, a residual volume of air **26** called headspace. Filling and closing of the container **1** may be conducted on a same filling and capping machine.

[0032] After hot filling, the capped container **1** is temporarily stored to let its content cool down from the temperature at which it was poured to a temperature equal or close to the ambient atmospheric temperature. As its temperature drops, the overall volume of the container **1** (including both the poured content and the headspace **26**) shrinks. The resulting vacuum is however compensated by an elastic deformation of the resilient groove **10**, which closes to an angular aperture **A2** smaller than the initial angular aperture **A1**. The rest of the sidewall **5**, however, remains dimensionally stable. The container height shortens to a value **H2** lower than **H1** (otherwise noted, $H2 < H1$).

[0033] After the content has cooled down, if the content **1** was previously hot filled, or after filling in the case of a filling at ambient temperature, the vault **22** is inverted from its lower position (shown in dotted lines on **FIG.3**) to its upper position (shown in solid lines on **FIG.3**) by means of a mechanical pusher (e.g. mounted on a linear actuator such as a hydraulic, pneumatic or electric jack). In one embodiment, the mechanical pusher has a mandrel provided with a top apex capable of being received within the central portion **18** and which is moved upwards as the container **1** is held tight.

[0034] Inversion of the vault **22** is provided by simultaneous articulation of the diaphragm **19** with respect to the standing ring **16** around the outer junction **20**, and articulation of the central portion **18** with respect to the diaphragm **19** around the inner junction **21**.

[0035] In its upper, inverted position, the vault **22** is capable of supporting constraints applied by the content without inverting back to the lower position.

[0036] During inversion, the respective pressures of

the content and the headspace **26** increase to compensate for the volume loss in the container **1** due to inversion of the vault **22**.

[0037] The sidewall **5** is dimensionally stable except in the annular groove **10** which, as a result of its structure as depicted hereinbefore, opens during inversion of the vault **22** to an angular aperture **A3**, which is either larger than **A2**, in case of hot filling followed by a cooling (otherwise noted, $A3 > A2$), or larger than **A1** in case of cold or ambient filling (otherwise noted, $A3 > A1$). The resilience of the groove **10** helps to reduce the stresses within the sidewall **5** and to compensate for the pressure increase which, otherwise, would tend to push the vault **22** back to its lower position. After inversion, the filling level **24** of the content has raised only a little, since the groove **10** has absorbed most part of the volume difference due to vault inversion. Height of the container **1** raises to a value **H3** greater than **H2** (otherwise noted, $H3 > H2$).

[0038] After capping, oxidation of the content begins, due to the absorption of oxygen molecules from the headspace **26**. For that reason, headspace **26** (and hence the whole inner volume of the container **1**) shrinks a little. As the sidewall **5** remains dimensionally stable except in the annular groove **10**, the angular aperture thereof decreases from the value **A2** to a smaller value **A4** ($A4 < A3$). Depending on the decrease of the content volume, **A4** may even be lower than **A1** ($A4 < A1$). The filling level **24** remains, however, substantially constant.

[0039] The annular groove **10** is located on the sidewall **5** at a height **h** (measured axially from the seat **17**, see **FIG.1**) preferably greater than one fifth of the overall height **H1** of the just molded container **1**. In the depicted example, **h** is of about half the overall height **H1**.

[0040] Hence, the groove **10** is far enough from the bottom **15** to avoid bending of the container **1** and be covered by an advertising label glued to the sidewall **5**, to the benefit of container performance and aesthetics.

[0041] The sidewall **5** is preferably provided with one resilient groove **10** only, whereby the sole groove **10** absorbs all deformations of the sidewall **5**, which would otherwise tend to distort.

[0042] A second embodiment of the container **1** is depicted on **FIG.5**, wherein like references show like elements or part of the container **1**. All the preceding description applies to the container **1** of **FIG.1-4**, except that the sidewall **5** is smooth and has no recesses apart from the annular groove **10**.

[0043] Dimensional stability of the sidewall **5** outside the annular groove **10** may be provided by a greater thickness or a greater cristallinity rate, provided by a longer heat setting within the blowing mold.

[0044] The container **1** has good shape stability under inversion of the vault **22**, due to resilience of the annular groove **10**.

[0045] The groove **10** permits to lower the mechanical effort to be applied on the vault **22** during inversion.

[0046] In addition, due to the resilience of the annular groove **10**, the container **1** remains stable in shape even

under cooling of the content.

Claims

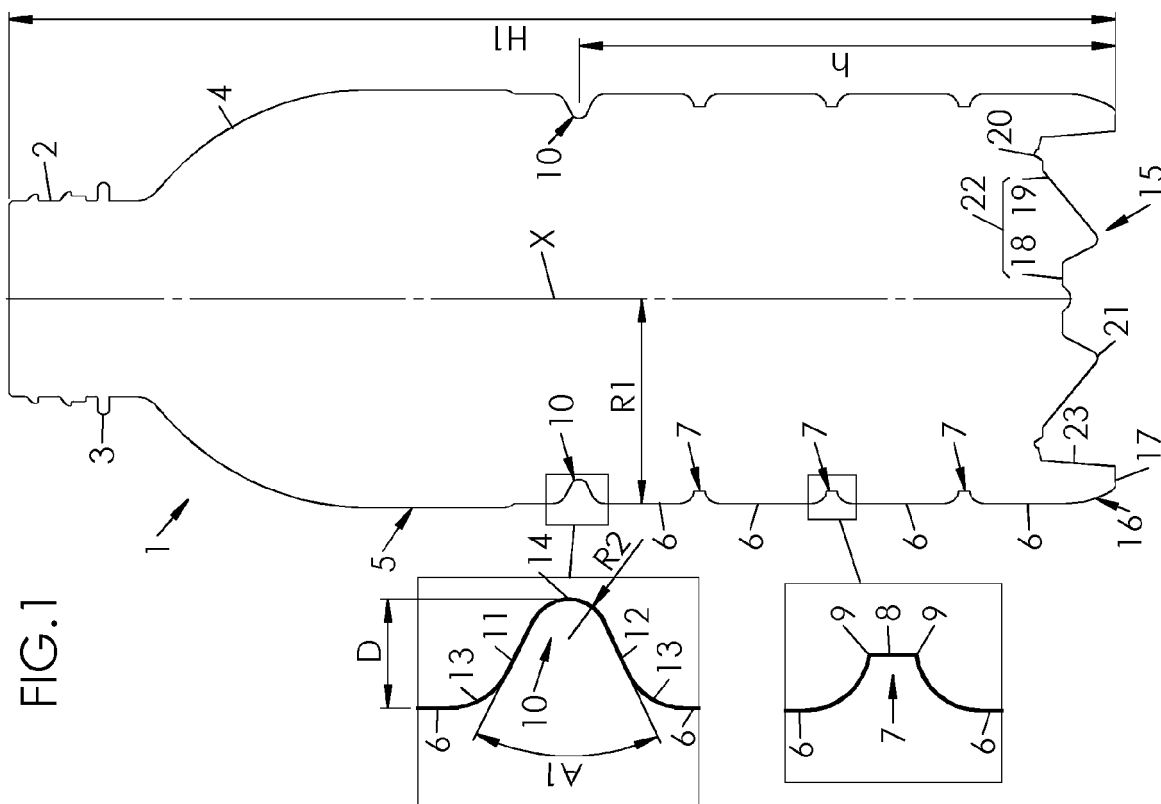
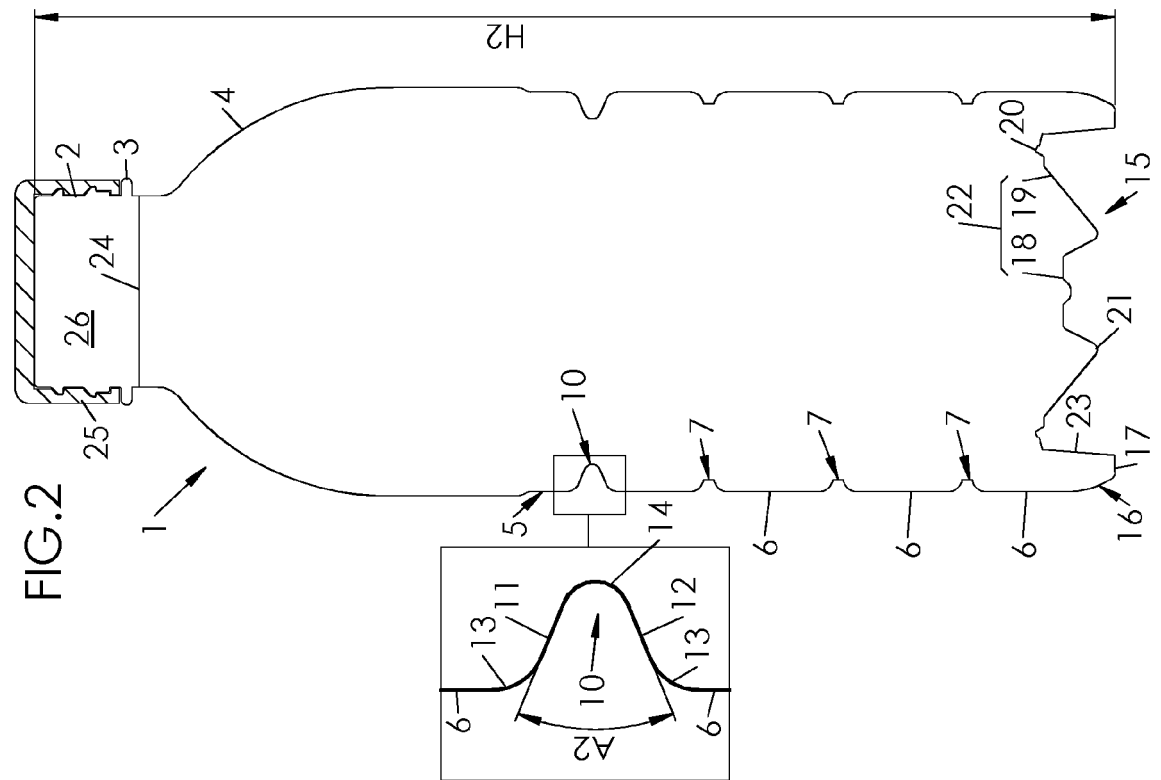
1. Container (1) having a sidewall (5) and a bottom (15), said bottom (15) having an annular seat (17) and a central vault (22) invertible between a lower position in which the vault (22) protrudes outwards with respect to the container (1), and an upper position in which the vault (22) protrudes inwards with respect to the container (1), wherein the sidewall (5) is dimensionally stable, except in a resilient annular groove (10) capable of opening under inversion of the vault (22).
2. Container (1) according to claim 1, wherein:
 - the sidewall has a transversal overall half-width R1,
 - the annular groove is V-shaped and has a depth D and an angular aperture A1,
 - ratio D/R1 is comprised between 0.03 and 0.15 ;
 - angular aperture A1 is comprised, before inversion of the vault, between 40° and 70°.
3. Container (1) according to claim 2, wherein angular aperture A1 is of about 50°.
4. Container (1) according to claim 2 or 3, wherein the annular groove (10) has an upper flange (11) and a lower flange (12), which connect through a toroidal belt (14).
5. Container (1) according to claim 4, wherein the toroidal belt (14) has, in an axial sectional plane, an arc-of-a circle shape, the radius (R2) of which is greater than or equal to 1.5 mm.
6. Container (1) according to any of claims 1-5, wherein the sidewall (5) is provided with a series of annular stiffening recesses (7).
7. Container (1) according to any of claims 1-6, wherein the bottom (15) includes a standing ring (16) which forms the seat (17), and wherein the vault (22) comprises a central portion (18) and a diaphragm (19) extending from the standing ring (16).

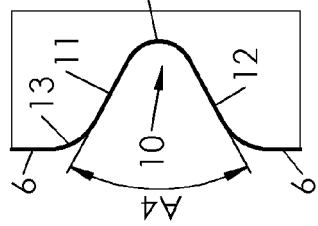
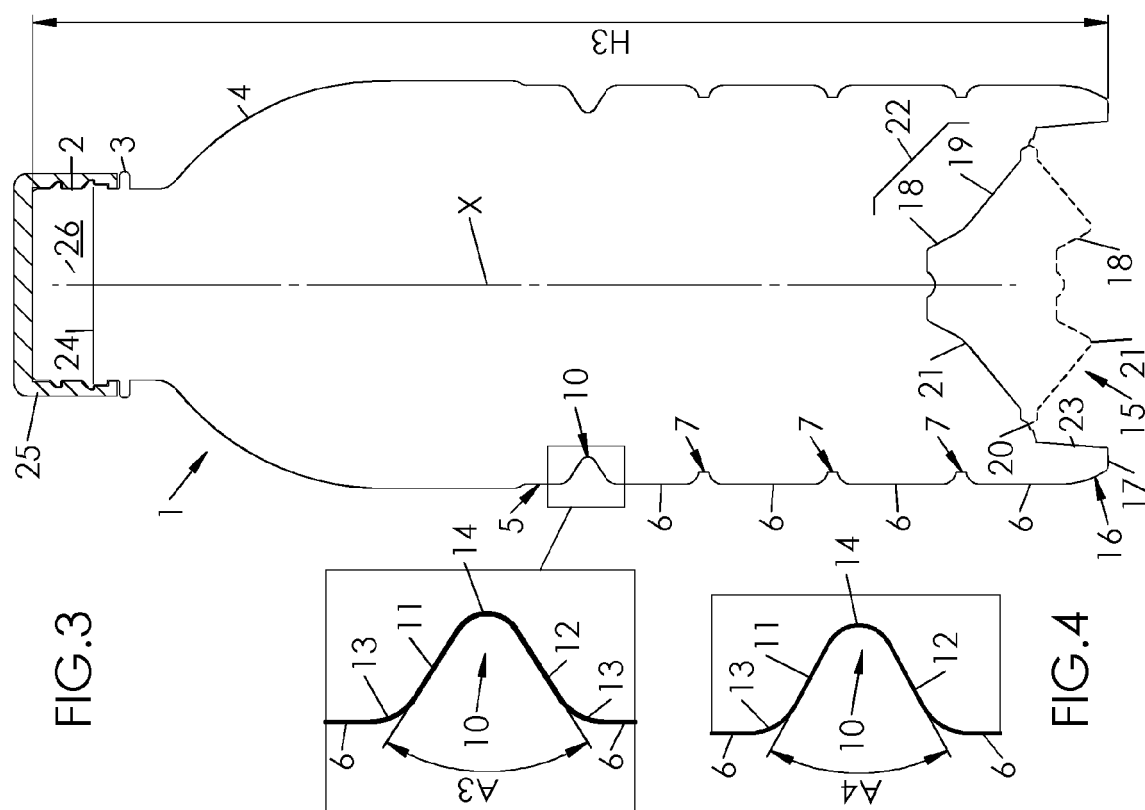
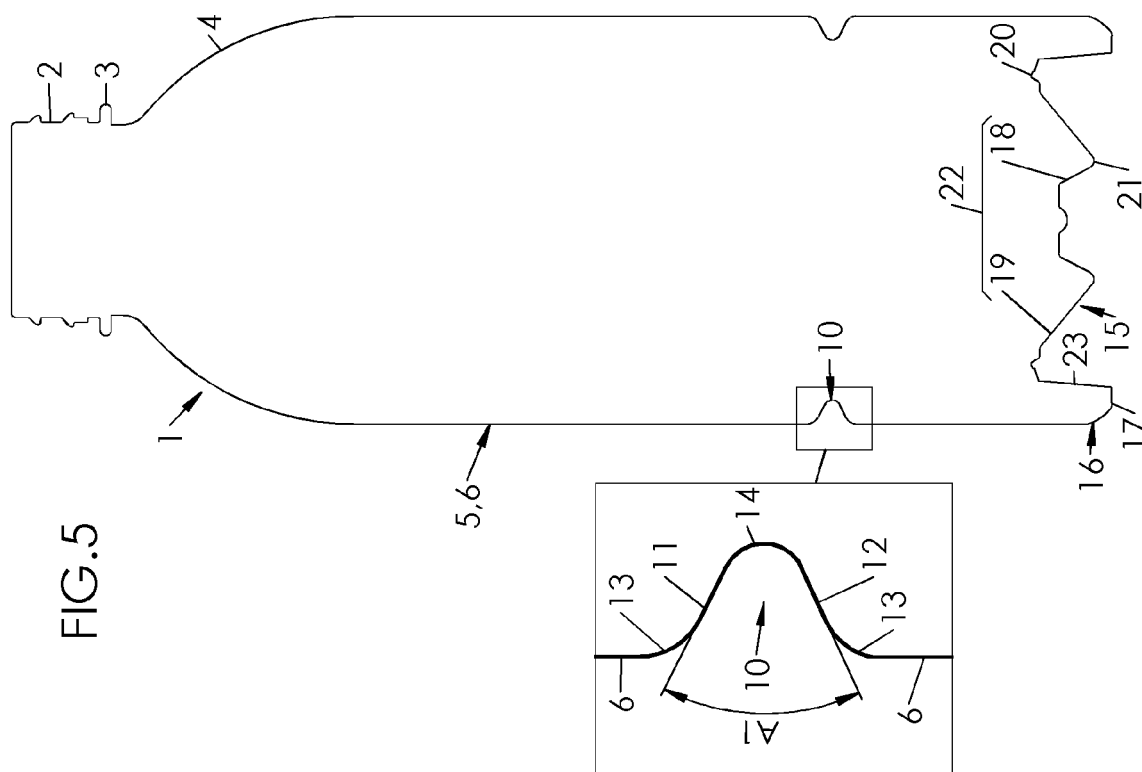
Amended claims in accordance with Rule 137(2) EPC.

1. Container (1) having a sidewall (5) and a bottom (15), said sidewall (5) having an outer surface (6) which is substantially cylindrical around a container main axis X and has a transversal overall half-width R1,

said bottom (15) having an annular seat (17) and a central vault (22) invertible between a lower position in which the vault (22) protrudes outwards with respect to the container (1), and an upper position in which the vault (22) protrudes inwards with respect to the container (1), wherein the sidewall (5) is dimensionally stable, except in a resilient annular groove (10) capable of opening under inversion of the vault (22).

2. Container (1) according to claim 1, wherein:
 - the sidewall (5) has a transversal overall half-width R1,
 - the annular groove (10) is V-shaped and has a depth D and an angular aperture A1,
 - ratio D/R1 is comprised between 0.03 and 0.15,
 - angular aperture A1 is comprised, before inversion of the vault (22), between 40° and 70°.
3. Container (1) according to claim 2, wherein angular aperture A1 is of about 50°.
4. Container (1) according to claim 2 or 3, wherein the annular groove (10) has an upper flange (11) and a lower flange (12), which connect through a toroidal belt (14).
5. Container (1) according to claim 4, wherein the toroidal belt (14) has, in an axial sectional plane, an arc-of-a circle shape, the radius R2 of which is greater than or equal to 1.5 mm.
6. Container (1) according to any of claims 1-5, wherein the sidewall (5) is provided with a series of annular stiffening recesses (7).
7. Container (1) according to any of claims 1-6, wherein the bottom (15) includes a standing ring (16) which forms the seat (17), and wherein the vault (22) comprises a central portion (18) and a diaphragm (19) extending from the standing ring (16).







EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
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