(19) DANMARK

(10) DK/EP 2555984 T3

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***B 65 D 1/16 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2016-12-05**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2016-08-24**

(86) Europæisk ansøgning nr.: **11717204.9**

(86) Europæisk indleveringsdag: **2011-04-06**

(87) Den europæiske ansøgnings publiceringsdag: **2013-02-13**

(86) International ansøgning nr.: **EP2011055383**

(87) Internationalt publikationsnr.: **WO2011124626**

(30) Prioritet: **2010-04-06 GB 201005717** **2010-04-06 GB 1005717**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **BLADFORMET BASE TIL FRITSTÅENDE BEHOLDER OG BEHOLDER DERTIL**

(56) Fremdragne publikationer:
WO-A1-2006/000408
WO-A1-2008/022605
JP-U- S59 178 214
US-A- 4 301 933
US-A- 4 318 489
US-A- 6 112 924
US-A1- 2006 118 560

DESCRIPTION

[0001] This invention relates to self-standing containers, more specifically to a petaloid base , according to the preamble of claim 1, for such a container. Such containers may be blow-moulded of plastics material such as polyethylene terephthalate (PET).

[0002] As will be understood in the art, the generic term 'PET' includes compositions that predominantly contain polyethylene terephthalate - but may also including other materials. For example, a suitable composition may comprise approximately 95% polyethylene terephthalate and 5% nylon. As is known in the art, these materials may be mixed, or provided in different layers, for example via multilayer injection moulding and overmoulding.

[0003] Blow-moulded PET containers have long been used as bottles for beverages. More recently, they have been proposed for use as kegs for transporting, storing and dispensing beverages such as beer. An example of such a keg is disclosed in WO 2007/064277.

[0004] The example of WO 2007/064277 is given for background reference only: the broad concept of this invention is not limited to any particular use, material or method of manufacture of a container. However the invention has particular advantages in the context of thin-walled blow-moulded containers of the type apt to be manufactured from PET. It is in that context that the invention will be described in this specification.

[0005] Early PET containers had a plain hemispherical base and were rendered self-standing by the attachment of a separate base moulding to the base. Whilst a hemispherical base is simple, light and strong in isolation, the addition of a separate base moulding increases material and production costs and may hinder recycling.

[0006] To make a PET container self-standing without recourse to a separate base moulding, it is now well known to provide the container with an integrally-moulded petaloid base.

[0007] The term 'petaloid' refers to a multi-footed base shape whose feet are disposed in an angularly-spaced arrangement around the base, the resulting shape resembling the petals of a flower when viewed from under the container in use. The container usually has a cylindrical side wall of circular horizontal cross-section, in which case the feet typically lie on a contact circle that is concentric with, and whose diameter is smaller than, the circular cross-section of the side wall. The feet act together to provide a stable multi-point support for the container.

[0008] There is continual pressure in the art of containers to reduce material and production costs and to ease recycling. Not only has this led to the adoption of one-piece containers with petaloid bases, but efforts continue to improve the petaloid base so that containers can be produced more economically while still performing reliably during storage, transportation and use. It is particularly desirable to reduce the amount of material necessary to give the container sufficient integrity and stability for commercial use. Even a small saving of material per container has a massive effect on the cost of production when reproduced across potentially tens to thousands of millions of containers per annum.

[0009] The correct trade off between the amount of material used and the integrity of the container is especially important when the container is to be used as a pressurised vessel. For example, the container may be used for storing, transporting and dispensing effervescent beverages such as beer. The beverage itself may be carbonated, or a propellant gas may be injected into the container at superatmospheric pressure to force the beverage out of the container. Such a container needs to withstand these internal pressures under a range of environmental conditions. As well as withstanding internal pressures, the container needs to survive rough handling during transportation of the container.

[0010] WO 2006/000408 A1 describes a container with an ovoid or cylindrical wall and a hemispherical bottom type continuing that wall from which originate feet spaced from one another. The ratio of the weight of the wall to the weight of the bottom is at least 4.

[0011] It is against this background that the present invention has been devised. From one aspect, the invention resides in a petaloid base of a blow-moulded self-standing container, the base having a spheroidal underlying base contour and a plurality of spheroidal foot formations that interrupt and project from the underlying base contour to define a corresponding plurality of feet, wherein the foot formations radiate from a central protrusion and the foot formations are ovoid. To define feet with minimal usage of material, the elongate foot formations have respective longitudinal axes, which axes lie in planes extending radially from a central axis of the base. Those axes of the foot formations suitably extend outwardly and upwardly in conical relation from the central axis of the base.

[0012] As the feet are spheroidal, it will be understood that their contact with a planar surface on which the base can rest is via a convex surface. Preferably therefore, contact between a given foot and that planar surface is via a point on the curved surface of that foot. To maximise the capacity and strength of the container while minimising material usage, the underlying base contour is preferably substantially hemispherical. The contour may, for example, be that of an oblate spheroid whose polar axis coincides with a central axis of the base. For similar reasons, the foot formations are ovoid (partially egg-shaped), in which case the contact points of the feet are most conveniently defined by the widest part of the cross-section of each foot formation being offset inwardly toward an inner end of the foot formation. In other words, the foot formations taper to a greater extent at their radially outer portions than their radially inner portions with respect to the central axis of the base.

[0013] Preferably, the base comprises formations, such as foot formations, whose shapes are substantially rotationally symmetrical about an axis. For example, shapes such as spheroids, ellipsoids and ovoids that define the foot formations are preferably substantially rotationally symmetrical about an axis. Advantageously, if these shapes that form the base are rotationally symmetrical, the material used to form these structures can be minimised. At the same time the internal capacity of the base, as well as its strength can be maximised.

[0014] Each foot formation may have an elliptical, preferably ovate intersection with the underlying base contour. To reduce stress concentration, the intersection is preferably of concave cross section.

[0015] To strengthen the base, the foot formations radiate from a central protrusion. That protrusion may be approximately polygonal, with a number of sides corresponding to the number of foot formations.

[0016] The foot formations are suitably separated by valleys, that may for example radiate from apices of the polygonal protrusion. To minimise material usage,

[0017] In plan view, each foot formation may have an enlarged central region from which the foot formation tapers inwardly across an inner portion to an inner end. In that case, the inner portions of the foot formations suitably lie in segmented relation around the base. To minimise material usage, it is preferred that in plan view, each foot formation tapers from the enlarged central region outwardly across an outer portion to an outer end of the foot formation.

[0018] The inventive concept extends to a blow-moulded container such as a keg or a bottle having the base of the invention. The container is constructed by blow-moulding a preform, ideally made of PET.

[0019] Preferably, where the material used is PET, the container has an average pressure resistance to material usage ratio of greater than 3 MPa / kg. More preferably, the average pressure resistance to material usage ratio is greater than 3.75 MPa / kg. Also, preferably, the container has a capacity to material usage ratio of over 40 litres / kg. More preferably, the container has a capacity to material usage ratio of over 80 litres / kg.

[0020] In order that the invention may be more readily understood, reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a plan view from underneath a container having a petaloid base in accordance with the invention;

Figure 2 is a side view of the petaloid base of the container shown in Figure 1;

Figure 3 is a sectional side view through the petaloid base of the container shown in Figure 1;

Figures 4(a), 4(b) and 4(c) are, respectively, an underneath plan view, a side view and a perspective view of a container having a base as shown in Figures 1 to 3, embodied in this example as a bottle of 0.33 litre capacity;

Figures 5(a), 5(b) and 5(c) are, respectively, an underneath plan view, a side view and a perspective view of another container having a base as shown in Figures 1 to 3, embodied in this example as a keg of 20 litres capacity;

Figures 6(a), 6(b) and 6(c) are, respectively, an underneath plan view, a side view and a perspective view of another container having a base in accordance with the invention, embodied in this example as a bottle of 1.5 litres capacity, the base of this example being a variant having seven feet;

Figure 7 is the underneath plan view of the container as shown in Figure 1 marked in this instance with section lines referred to in Figures 8 and 9;

Figure 8 is an enlarged partial sectional side view through the petaloid base of the container of Figure 7, taken along section line VIII-VIII;

Figure 9 is an enlarged partial sectional side view through the petaloid base of the container of Figure 7, taken along section line IX-IX;

Figure 10 is a side view of a container having a five-footed petaloid base as shown in Figures 1 to 3, embodied in this example as a keg having a non-cylindrical side wall, and of 18-litre capacity;

Figure 11 is a side view of a plastics preform for blow moulding into the 18-litre capacity keg as shown in Figure 10; and

Figure 12 is an enlarged sectional side view of the container base as shown in Figure 3, together with a beverage dispensing tube within the container.

[0021] Referring firstly to Figures 1 and 2 of the drawings, a container 10 in this example of the invention comprises a hollow body of blow-moulded PET. The body of the container 10 is of circular horizontal section, the radius of that circle extending orthogonally from a central longitudinal axis 12 that extends centrally through the closed base 14 of the container 10. Above the base 14, but not shown in Figures 1 and 2, is a substantially cylindrical side wall surmounted by a neck portion. The side wall is integral with and terminates at its lower end in the base 14; in turn, the side wall is integral with and terminates at its upper end in the neck portion at the top of the container 10.

[0022] The fundamental or underlying shape of the base 14 is a slightly flattened hemisphere, that hemisphere being rotationally symmetrical about the central longitudinal axis 12 of the container 10. More generally, the underlying shape of the base 14 is an oblate spheroid, being a rotationally symmetric ellipsoid having a diameter on its polar axis (coinciding with the central longitudinal axis 12) that is shorter than the diameter of the equatorial circle whose plane bisects it. This approximately hemispherical shape maximises resistance to internal pressure, reduces stress concentrations to resist cracking, and also maximises internal volume while minimising material usage.

[0023] In accordance with the invention, the base 14 further includes integrally-moulded blister-like feet disposed in a petaloid arrangement around the base, the feet being defined in this example by five hollow ovoid foot formations 16 that radiate equi-angularly from a relatively shallow generally pentagonal convex protrusion 18 on the central longitudinal axis 12. More generally, the foot formations 16 are elongate ellipsoids in the form of prolate spheroids, a prolate spheroid being a spheroid whose diameter along its polar axis is greater than its equatorial diameter.

[0024] The polar axes 20 of the spheroidal foot formations 16 extend outwardly and upwardly in equi-angularly spaced radially-disposed planes from the central longitudinal axis 12 of the container 10. Thus, the polar axes 20 of the foot formations 16 (see Figure 2) lie on a virtual frusto-conical surface surrounding the central longitudinal axis 12.

[0025] Circumferentially adjacent pairs of foot formations 16 are separated by valleys 22 that radiate equi-angularly from the apices 24 of the pentagonal central protrusion 18. The valley floors follow the spheroidal shape of the base 14 and open at their outer ends to an outer portion of the base 14 that lies radially outwardly beyond the foot formations 16. Furthermore, each foot formation 16 and the central protrusion 18 are joined via a transition portion that curves smoothly without distinct transitions or discontinuities. Thus, as shown in Figure 3, a foot formation 16, the smoothly curving transition portion and the central protrusion 18 together define a sinuous cross section.

[0026] Also as shown in Figure 3, the convex central protrusion 18 has a radius of curvature r that is smaller than the general radius of curvature R of the spheroidal base 14: thus $R > r$. Moreover, the convex central protrusion 18 extends to a level beyond - and thus, in use, below - the lowermost apex of the underlying base contour. Also, the convex central protrusion 18 extends to a level within - and thus, in use, above - the extent of the foot formations 16.

[0027] The foot formations 16 bulge outwardly from the underlying spheroidal contour of the base 14 by virtue of an ovoid convex wall. The convex wall of each foot formation 16 is surrounded by a concave transition zone 26 in the shape of an ovate ring. The transition zone 26 extends smoothly into the spheroidal wall of the base with a large radius of curvature to reduce stress concentration and hence to minimise stress cracking. The transition zones 26 of circumferentially adjacent foot formations 16 partially define the valley 22 between those foot formations 16.

[0028] Each foot formation 16 is generally elliptical (in this example, ovate) in underneath plan view, reaching a maximum width in an enlarged central region 28 between its inner end 30 and its outer end 32. Thus, each foot formation 16 tapers in opposite directions from the widest part of the central region 28: along an inner portion 34 moving inwardly toward the central longitudinal axis 12 to the inner end 30; and along an outer portion 36 moving outwardly away from the central longitudinal axis 12 to the outer end 32.

[0029] In underneath plan view, the inwardly-tapering inner portions 34 of the foot formations 16 fit closely between their neighbours around the circular base 14 like segments of an orange. These inner portions 34 of the foot formations 16 alternate with, and are separated by, narrow inner sections 38 of the valleys 22, which may be approximately parallel but, in this example, widen slightly as they extend outwardly from the pentagonal central protrusion 18. However where they extend outwardly into their outer sections 40 beyond the widest part of the foot formations 16, the valleys 22 widen near-exponentially between the tapering outer portions 36 of the foot formations 16 until they reach a maximum width between the outer ends 32 of adjacent foot formations 16.

[0030] Thus, moving along the valleys 22 from the central longitudinal axis 12 toward the outer diameter of the base 14, the gap between the foot formations 16 increases. In contrast, in a previously-known petaloid base such as that disclosed in EP 0671331, this gap decreases.

[0031] Viewed now from the side, the foot formations 16 extend to a level beyond - and thus, in use, below - the lowermost apex of the base 14 defined by the central pentagonal protrusion 18. The foot formations 16 all extend to the same level. Thus, at that level, each foot formation 16 defines a contact point 42 that will lie stably upon a flat support surface (not shown) orthogonal to the central longitudinal axis 12 of the container 10.

[0032] Figure 2 shows that the foot formations are somewhat egg-shaped with the widest part of their cross-sections offset slightly inwardly and downwardly toward their inner ends 30.

[0033] The contact points 42 of the foot formations 16 are equi-spaced on and around a contact circle centred on the central longitudinal axis 12 of the container 10. The diameter (x) of the contact circle relates to the side wall diameter (*Dy*) of the container 10 in a ratio as follows:

$$\frac{Dy}{0.5x} = k$$

[0034] In accordance with the invention, k is preferably between 3.6 and 5.5, more preferably between 4.0 and 5.3, still more preferably between 4.2 and 5.0 and typically 4.7. This may be contrasted with typical PET bottles on the market whose corresponding ratio k is typically 2.5 to 3.5. The relatively large value for k in the invention stems from a relatively small value for x. This is advantageous because a small contact circle creates a small - and hence inherently stiff - diaphragm between the contact points 42.

[0035] The result is a central area within the contact circle between the contact points 42 of the foot formations 16 that is quite rigid and hence resistant to movement during internal pressure, up to burst pressure. The rigidity of the area within the contact circle is enhanced by the undulating wall section defined by the inner portions 34 of the foot formations 16, the valleys 22 between them, and the central protrusion 18.

[0036] Stiffness within the contact circle is important not just for a high burst pressure but also for stability. This is because the lowest point on the central longitudinal axis (the lowermost apex of the base 14 defined by the central pentagonal protrusion 18) will tend to be pushed down under internal pressure. If that lowest point moves so far as to contact a supporting surface in use, the container cannot rest stably on the contact points 42 of the foot formations 16. The stiffness of the base shape of the invention means that compared to previously known designs, the distance from the central apex of the base to a supporting surface is relatively small, to the benefit of stability and capacity relative to the height of the container.

[0037] Viewing any one foot formation 16 end-on (i.e. from the side of the container 10 looking inwardly towards the central longitudinal axis 12), the contour of that foot formation 16 describes a substantially constant convex radius between the concave radii of the transition zones 26 to each side. A conventional petaloid base typically has flatter surfaces defining a V-shaped valley between the feet, to the detriment of material usage and stress concentration. Stress concentrations create areas of a container that are particularly vulnerable to rupture under high internal pressure.

[0038] The arrangement of the base 14 of the present invention is particularly suited to containers for dispensing liquids under pressure. In particular, the increased value for k makes the base stiffer and hence better suited for retaining stability whilst the container is subject to high internal pressure. Furthermore, by increasing the value of k, it is possible to have the convex central protrusion 18 positioned axially lower than would otherwise be possible for a container that is subject to high internal pressure. This can maximise the quantity of beverage that can be practically dispensed from the container 10. This advantage is discussed with reference to Figure 12 in which is shown the same sectional side view of the container base 14 of Figure 3, together with a beverage dispensing tube 120.

[0039] In this context, the container is used as a beer keg 10 that is provided with a closure assembly that is sealed on to the tubular neck of the keg 10 in a push-fit arrangement. The tube 120 is coupled to the closure assembly (not shown) and extends from it along the central longitudinal axis 12 into the base of the keg 10. The axially lower end of the tube 120 extends into the central protrusion 18. The end of the tube 120 sits within the central protrusion 18 and hangs just inside the apex of the central protrusion 18, thereby providing an annular gap through which a beverage can pass from the keg 10 into the tube 120 or visa-versa. The shape of the central protrusion 18 also enables the axially lower end of the tube 120 to be correctly located and retained within the central protrusion during fitting and use.

[0040] In use, when dispensing a beverage, the keg 10 is maintained in an upright position. The closure assembly allows a pressurised gas to be introduced into the headspace of the keg 10 to force the beverage out through the tube 120. As the axially lowermost end of the tube 120 is located within the central protrusion 18, and the central protrusion 18 is disposed at a relatively low axial position within the keg 10, this ensures that almost all of the beverage within the keg 10 can be extracted from it.

[0041] It may be possible to further increase the amount of beverage that can be practically extracted from the keg 10 by extending the tube 120 into one of the foot formations 16. In such an arrangement, the tube 120 would need to bend away from the central longitudinal axis 12 at its lower end. Although this may marginally increase the amount of beverage that can be dispensed from the keg 10, this can complicate process of fitting the closure assembly and tube 120 to the keg 10. In particular, inserting a bent tube 120 into the keg 10 can require a complicated automated fitting process. Furthermore, the bending of the tube 120 away from the central longitudinal axis 12 can subject the closure assembly to which the tube 120 is attached at its axially upper end to uneven forces. This can reduce the reliability of the closure assembly, which is of particular concern when the keg 10 is subject to high internal pressure.

[0042] The petaloid base of the invention may be applied to a wide range of containers such as bottles and kegs. Figures 4(a), 4(b) and 4(c) and Figures 5(a), 5(b) and 5(c) show a five-footed base of the invention applied, respectively, to a bottle 44 of 0.33 litre capacity, which may typically be used for carbonated soft drinks, and a keg 46 of 20 litres capacity, which may typically be used for beer. These drawings show features omitted from Figures 1 and 2, namely a substantially cylindrical side wall 48 surmounted by a neck portion 50. The side wall 48 is integral with and terminates at its lower end in the base 14; in turn, the side wall 48 is integral with and terminates at its upper end in the neck portion 50 at the top of the container.

[0043] Figure 10 shows a further five-footed base of the invention applied to a keg 104 of 18-litre capacity with a non-cylindrical side wall 108. In this example, the side wall 108 is convex, rotationally symmetrical about the central longitudinal axis of the keg 104 and so generally follows the shape of an ovoid. At its axially lower end portion, the side wall curves smoothly into the spheroidal underlying contour of the base of the present invention. At its axially upper end portion, which tapers to a greater extent than the axially lower end portion, the side wall curves smoothly into the concave neck of the keg 104. The convex side wall 108 is shaped in this way to maximise internal pressure resistance, maximise the internal capacity of the keg 104 and minimise material usage. Figure 11 is an enlarged side view of a plastics preform for blow moulding into the container as shown in Figure 10.

[0044] Other variations of the invention are possible without departing from the inventive concept. For example, a variant of the base of the invention shown in Figures 6(a), 6(b) and 6(c) is applied to a bottle 52 of 1.5 litres capacity. This variant has seven foot formations 54 instead of five, with a generally heptagonal central protrusion 56 between them. Like the five-footed base variant, seven-footed base variants can be applied to any size of container, such as bottles of 0.33 litres, 0.5 litres, 1 litre, 1.5 litres or larger, and kegs of 20 litres or other capacities.

[0045] An odd number of feet is preferred for optimum stability, there being at least three feet (in which case the central protrusion is generally triangular) but preferably not more than seven feet; five or seven feet are considered optimal.

[0046] To put the invention into context but without limiting its broadest scope as defined in the claims, various dimensional characteristics will now be given by way of example.

[0047] Firstly, the table below sets out a volume comparison between a conventional base and a base in accordance with the invention, assuming in this instance that the base defines five feet. Volumes in the table are expressed in millilitres (ml). The volume refers to the internal volume of the base, defined as the portion of the container below the cylindrical side wall of the container. It will be noted that the base of the invention has a volume approximately five times greater than the volume of a conventional petaloid container base, to the benefit of compactness and material usage for a given container capacity.

Container with five feet	Conventional base	Base of the invention
20 litre keg, dia 235 mm	128 (20%)	634
0.33 litre bottle, dia 60 mm	2.7 (18%)	15
0.5 litre bottle, dia 65 mm	3.5 (18%)	19
1.0 litre bottle, dia 80 mm	6.5 (18%)	36
1.5 litre bottle, dia 95 mm	11 (20%)	55

[0048] Secondly, the following dimensions help to define the base shape for each of the above capacities of container:

Container with five feet	Radius of underlying base contour	Radius of transition from underlying base contour to side wall
20 litre keg, dia 235 mm	135.0 mm	49.6 mm
0.33 litre bottle, dia 60 mm	34.5 mm	19.1 mm
0.5 litre bottle, dia 65 mm	37.4 mm	20.7 mm
1.0 litre bottle, dia 80 mm	46.0 mm	25.4 mm
1.5 litre bottle, dia 95 mm	54.6 mm	30.2 mm

Container with five feet	Radial projection of foot formations beyond radius of underlying base contour	Diameter of contact circle
20 litre keg, dia 235 mm	18.1 mm	99.9 mm
0.33 litre bottle, dia 60 mm	5.3 mm	28.6 mm
0.5 litre bottle, dia 65 mm	5.5 mm	31.0 mm
1.0 litre bottle, dia 80 mm	7.1 mm	38.1 mm
1.5 litre bottle, dia 95 mm	8.4 mm	45.3 mm

Container with five feet	Length of foot formations along polar axis*	Width of foot formations across polar axis*
20 litre keg, dia 235 mm	80.2 mm	59.5 mm
0.33 litre bottle, dia 60 mm	22.9 mm	15.6 mm
0.5 litre bottle, dia 65 mm	24.8 mm	16.9 mm
1.0 litre bottle, dia 80 mm	30.6 mm	20.8 mm
1.5 litre bottle, dia 95 mm	36.3 mm	24.7 mm

**Including transition zone*

Container with seven feet	Radius of underlying base contour	Radius of transition from underlying base contour to side wall
20 litre keg, dia 235 mm	135.0 mm	49.6 mm
0.33 litre bottle, dia 60 mm	34.2 mm	18.9 mm
0.5 litre bottle, dia 65 mm	37.3 mm	20.7 mm
1.0 litre bottle, dia 80 mm	46.2 mm	25.6 mm
1.5 litre bottle, dia 95 mm	54.6 mm	30.2 mm

Container with seven feet	Radial projection of foot formations beyond radius of underlying base contour	Diameter of contact circle
20 litre keg, dia 235 mm	18.1 mm	99.9 mm
0.33 litre bottle, dia 60 mm	5.3 mm	28.5 mm
0.5 litre bottle, dia 65 mm	5.8 mm	31.0 mm
1.0 litre bottle, dia 80 mm	7.2 mm	38.5 mm
1.5 litre bottle, dia 95 mm	8.4 mm	45.4 mm

Container with seven feet	Length of foot formations along polar axis*	Width of foot formations across polar axis*
20 litre keg, dia 235 mm	78.9 mm	54.8 mm
0.33 litre bottle, dia 60 mm	22.4 mm	14.0 mm
0.5 litre bottle, dia 65 mm	24.4 mm	15.3 mm
1.0 litre bottle, dia 80 mm	30.3 mm	19.0 mm
1.5 litre bottle, dia 95 mm	35.7 mm	22.4 mm
		**Including transition zone*

	Radius of transition zone (five feet)	Radius of transition zone (seven feet)
20 litre keg, dia 235 mm	12.0 mm	8.0 mm
0.33 litre bottle, dia 60 mm	3.15 mm	1.88 mm
0.5 litre bottle, dia 65 mm	3.44 mm	2.05 mm
1.0 litre bottle, dia 80 mm	4.26 mm	2.54 mm
1.5 litre bottle, dia 95 mm	5.0 mm	3.0 mm

[0049] Figures 7 to 9 provide additional dimensional information relating to a 20-litre keg having a five-footed base 14. Figures 10 and 11 respectively show dimensional information relating to an 18-litre keg 104 having a five-footed base and its preform 106.

[0050] Figure 8 shows a partial sectional side view through the petaloid base of the 20-litre keg of Figure 7, taken along section line VIII-VIII. The resulting section plane intersects a foot formation 16 at its contact point 42, and is parallel to and is radially-spaced at a distance of 50 mm from the central longitudinal axis 12 of the keg 10.

[0051] At this section of the foot formation 16, its contour is a substantially constant convex radius of 23.0 mm between the concave radii of 12.0 mm of the transition zones 26 to each side.

[0052] Figure 9 is a partial sectional side view through the petaloid base of the 20-litre keg of Figure 7, taken along section line IX-IX. The resulting section plane is aligned with the central longitudinal axis 12 of the keg 10, and intersects the same foot formation 16 as shown in Figure 8 at its contact point 42. The view shown in Figure 9 corresponds to the view shown in Figure 3, but provides the following additional dimensional information relating to the 20-litre keg:

RADIUS DATA	
Radius of underlying base contour	135.0 mm
Radius of convex central protrusion	35.0 mm
Radius of concave transition zone between the convex central protrusion and the radially inner end of a foot formation	12.0 mm
Radius of a foot formation at a position on the inner portion adjacent the radially inner end	35.0 mm
Radius of a foot formation at a position on the inner portion between the radially inner end and the central region of the foot formation	43.0 mm
Radius of a foot formation at a position on the central region between the contact circle and the inner portion	50.0 mm
Radius of a foot formation at a position on the central region that is radially inner of and adjacent to the contact circle	20.5 mm
Radius of a foot formation at a position on the central region that is radially outer of and adjacent to the contact circle	24.0 mm
Radius of a foot formation at a position on the central region between the contact circle and the outer portion	32.0 mm
Radius of a foot formation at a position on the outer portion between the radially outer end and the central region of the foot formation	27.75 mm
Radius of a foot formation at a position on the outer portion adjacent the radially outer end of the foot formation	120.0mm
Radius of concave transition zone between underlying base contour and radially outer end of a foot formation	12.0 mm
Radius of transition from underlying base contour to side wall	49.6 mm

[0053] These radius measurements are also applicable to points on other foot formations 16 of the container 10. These points typically lie within any one of the planes aligned with both the central longitudinal axis 12 of the container and a polar axis of a given foot formation 16.

DISTANCE DATA	
Distance along central longitudal axis between convex central protrusion and plane containing the contact circle	3.0 mm
Axial depth of convex central protrusion along central longitudinal axis	4.5 mm
Distance along central longitudinal axis from underlying base contour to plane containing the contact circle	8.0 mm
Distance along axis aligned with central longitudinal axis from transition zone (between central protrusion and a foot formation) to plane containing the contact circle	7.5 mm
Axial depth of the base portion (i.e. axial distance from plane containing the contact circle to axially lower end of cylindrical side wall)	91.2 mm
Radial length from central longitudinal axis to transition between base contour and foot formation	84.66 mm

[0054] In addition to dimensional data, the following data derives from pressure tests indicating the typical burst pressure of the 20-litre keg 10 having a five footed petaloid base 14 according to the present invention. By way of comparison, pressure tests were also carried out on a conventional petaloid base under similar conditions. The values represent the burst pressure in bar.

Test	**Conventional Base burst pressure (bar)**	**Base of the invention burst pressure (bar)**
1	9.29	9.55
2	7.68	9.04

Test	Conventional Base burst pressure (bar)	Base of the invention burst pressure (bar)
3	9.09	8.59
4	8.92	9.57
5	8.8	9.29
6	5.99	7.78
7	5.96	8.69
8	6.25	8.08
9	9.14	9.31
10	8.82	8.33
AVG	7.99	8.82
MAX	9.29	9.57
MIN	5.96	7.78
DIFF	3.33	1.79

[0055] Thus, it can be seen that the average burst pressure of the 20-litre keg having a five-footed base is approximately 8.8 bar = 880 kPa. Furthermore, the material usage of the 20 litre keg corresponds to 0.234 kg of PET. Accordingly, ratios directed to the pressure resistance, capacity and material usage can be derived for this 20-litre keg:

Average pressure resistance to material usage ratio = 3.76 MPa / kg

Capacity to material usage ratio = 85 litres / kg

[0056] It will be understood that similar ratios can be extrapolated for containers of different shapes and sizes, but also incorporating the base 14 according to the present invention.

Figure 10 provides additional dimensional data corresponding to the 18 litre keg 104:

Convex radius of underlying base contour	135.0 mm
Diameter of body at widest point	287.0 mm
Convex radius of body contour	352.0 mm
Convex radius of contour between body and neck	185.0 mm
Concave radius of neck contour	65.0 mm
Diameter of neck	65.0 mm
Total axial length	490.0 mm
Axial length from base to neck collar	472.0 mm
Axial length from keg opening, to beverage fill point (FP) mark - denoting an 18 litre fill from a level base	112.5 mm

Figure 11 provides additional dimension data corresponding to the preform 106 of the 18 litre keg 104 of Figure 10:

Total axial length	195.0 mm
Axial length from base to neck collar	177.0 mm
Axial thickness of base	6.0 mm
Thickness of each cylindrical side wall	11.0 mm
Axial length of cylindrical neck portion below neck collar	15.0 mm
Axial length of neck portion from below neck collar to cylindrical side wall (including cylindrical neck portion and frustoconical neck portion)	57.3 mm
Diameter of cylindrical neck portion	64.2 mm
Diameter of cylindrical side wall	77.0 mm
Internal bore diameter of the preform	55.0 mm
Diameter of the neck collar	81.0 mm

[0057] The approximate burst pressure of this 18-litre keg having a five-footed base is approximately 14 bar = 1400 kPa. The material usage of the 18-litre keg corresponds to 0.468 kg of PET. Accordingly, ratios directed to the pressure resistance, capacity and material usage can be derived for this 18-litre keg:

Average pressure resistance to material usage ratio = ~3 MPa / kg.

Capacity to material usage ratio = 41 litres / kg.

[0058] For a base with five feet, the following ratios apply in these examples:

For 20-litre keg:

Length of foot formations along polar axis/width of foot formations across polar axis = 1.35

Diameter of contact circle/ width of foot formations across polar axis = 1.68

Radius of underlying base contour/diameter of side wall = 0.57 Radius of underlying base contour/radius of transition from underlying base contour to side wall = 2.72

Radial projection of foot formations beyond radius of underlying base contour/radius of underlying base contour = 1.13

For bottles of various capacities:

Length of foot formations along polar axis/width of foot formations across polar axis = 1.47

Diameter of contact circle/ width of foot formations across polar axis = 1.83

Radius of underlying base contour/diameter of side wall = 0.58 Radius of underlying base contour/radius of transition from underlying base contour to side wall = 1.81

Radial projection of foot formations beyond radius of underlying base contour/radius of underlying base contour = 1.15

[0059] Similarly, for a base with seven feet, the following ratios apply in these examples:

For 20-litre keg:

Length of foot formations along polar axis/width of foot formations across polar axis = 1.44

Diameter of contact circle/ width of foot formations across polar axis = 1.82

Radius of underlying base contour/diameter of side wall = 0.57 Radius of underlying base contour/radius of transition from underlying base contour to side wall = 2.72

Radial projection of foot formations beyond radius of underlying base contour/radius of underlying base contour = 1.13

For bottles of various capacities:

Length of foot formations along polar axis/width of foot formations across polar axis = 1.59

Diameter of contact circle/ width of foot formations across polar axis = 2.03

Radius of underlying base contour/diameter of side wall = 0.57

Radius of underlying base contour/radius of transition from underlying base contour to side wall = 1.8

Radial projection of foot formations beyond radius of underlying base contour/radius of underlying base contour = 1.15

[0060] It will be apparent from the foregoing description that the improved petaloid base shape of the invention has various additional advantages. Its softly-curving shape with an absence of sharp radii is beneficial to resist stress cracking. Also, importantly, its surface area is less than equivalent known designs. Thus, for a given amount of resin, the invention allows a thicker wall and hence a stronger base. Alternatively it is possible to reduce weight and material usage while maintaining the strength of the base. A strong base is particularly important in applications where the containers are subjected to elevated internal pressure and/or elevated temperature, such as carbonated soft drinks, beer and hot-fill or pasteurised liquids.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO2007064277A **[0003] [0004]**
- WO2006000408A1 **[0010]**
- EP0671331A **[0030]**

Patentkrav

1. Bladformet base (14) af en blæsestøbt fritstående beholder (10), hvilken base (14) har en kugleformet underliggende basekontur og en flerhed af kugleformede fodformationer (16), der bryder og rager frem fra den underliggende basekontur for at definere en tilsvarende flerhed af fødder (16); kendetegnet ved, at:

fodformationerne (16) udstråler fra et centralt fremspring (18);

fodformationerne (16) er æglignende; og

fodformationerne (16) har tilsvarende længdeakser (20), hvis akser ligger i planer, der strækker sig radialt fra en central akse (12) af basen, hvor:

fodformationernes længdeakser (20) strækker sig udefter og opefter i et konisk forhold fra basens centrale akse (12).

2. Base (14) ifølge krav 1, hvor den underliggende basekontur er en fladtrykt kugle, hvis polarakse falder sammen med en central akse (12) for basen (14); og/eller den underliggende basekontur i alt væsentligt er halvkugleformet.

3. Base ifølge krav 1 eller krav 2, hvor fodformationerne (16) er aflange ellipsoider og/eller langstrakte kugler.

4. Base (14) ifølge krav 3, hvor den bredeste del af tværsnittet af hver fodformation (16) er forskudt indefter mod en indre ende af fodformationen (16).

5. Base (14) ifølge et hvilket som helst af de foregående krav, hvor fodformationernes længdeakser (20) mødes ved basens (14) centrale akse (12) ved en position aksialt under basen (14).

6. Base (14) ifølge et hvilket som helst af de foregående krav, hvor hver fodformation (16) har en ellipseformet gennemskæring med den underliggende basekontur, hvilken gennemskæring ideelt er ægformet og/eller har et konkavt tværsnit.

7. Base (14) ifølge et hvilket som helst af de foregående krav, hvor det centrale fremspring (18):

har en krumningsradius, der er mindre end den underliggende bases krumningsradius; og/eller

strækker sig til et niveau ud over den underliggende basekonturs laveste toppunkt.

8. Base (14) ifølge et hvilket som helst af de foregående krav, hvor en fodformation (16) og det centrale fremspring (18) er samlet via en let kurvet overgangsdel, hvor ideelt:

fodformationen (16), den let kurvede overgangsdel og det centrale fremspring (18) sammen definerer et bølgeformet tværsnit; og/eller overgangsdelen definerer en kurve, hvis krumning er konkav modsat krumningen af mindst én af fodformationerne (16) og det centrale fremspring (18).

9. Base (14) ifølge et hvilket som helst af de foregående krav, hvor:

det centrale fremspring (18) i alt væsentligt er konvekst i forhold til det ydre af beholderen (10); og/eller

det centrale fremspring (18) definerer en indskæring i forhold til det indre af beholderen, hvilken indskæring er placeret til at lokalisere og fastholde en fri ende af et fluidindgivelsesrør inde i beholderen (10); og/eller

det centrale fremspring (18) generelt er polygonalt med et antal sider, der svarer til antallet af fodformationer (16).

10. Base (14) ifølge et hvilket som helst af de foregående krav, hvor fodformationerne (16) er adskilt af fordybninger (22) fortrinsvis hvor:

fordybningerne (22) stråler ud fra toppunkterne af et generelt polygonalt centralt fremspring (18), hvilken polygon har et antal sider svarende til antallet af fodformationer (16).

11. Base (14) ifølge krav 10, hvor fordybningerne (22) udvides ved bevægelse udefter over basen, ideelt hvor:

hver fordybning (22) har en indre og ydre sektion, og hvor fordybningens (22) vægge divergerer skarpere i den ydre sektion end i den indre sektion, og ideelt hvor fordybningens (22) vægge divergerer i både fordybningens indre og ydre sektion.

12. Base (14) ifølge et hvilket som helst af de foregående krav, hvor, set fra oven, hver fodformation (16) har et forstørret centralt område, der spidser til indefter over en indre del til en indre ende af fodformationen (16) fortrinsvis hvor:

hver fodformation tilspidser fra det forstørrede centrale område udefter over en ydre del til en ydre ende af fodformationen (16).

13. Blæsestøbt, fritstående beholder (10) med en base (14) som defineret i et hvilket som helst af de foregående krav.

14. Beholder (10) ifølge krav 13, hvor basens (14) fodformationer (16) definerer tilsvarende kontaktpunkter, der sammen er placeret med afstand omkring en kontaktcirkel, hvis diameter (x) er relateret til en diameter (Dy) på beholderens (10) sidevæg som:

$$\frac{Dy}{0{,}5x} = k$$

hvor k er mellem 3,6 og 5,5, fortrinsvis mellem 4,0 og 5,3, mere fortrinsvis mellem 4,2 og 5,0.

15. Beholder (10) ifølge krav 13 eller krav 14, hvilken beholder omfatter et fluidindgivelsesrør (120), der er tilpasset efter en central længdeakse af beholderen (10), hvilket rør (120) strækker sig mellem beholderens (10) base (14) og en åbning i beholderen (10).

DRAWINGS

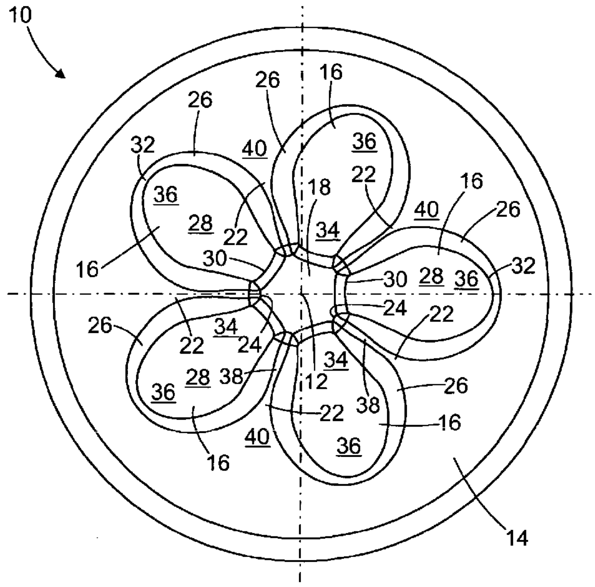


Fig. 1

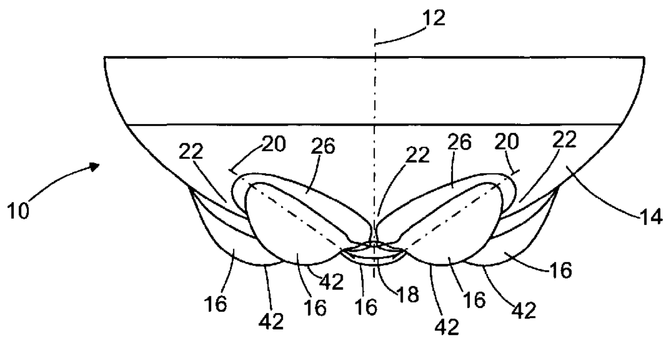


Fig. 2

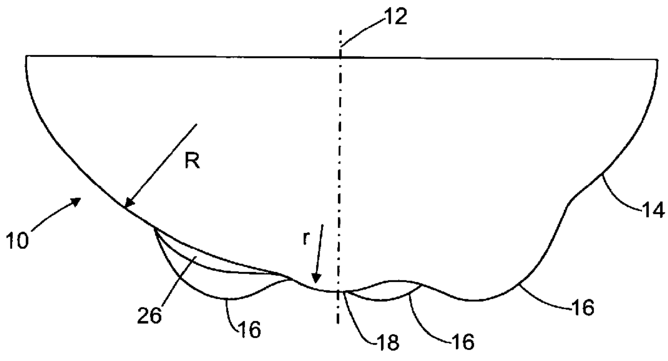


Fig. 3

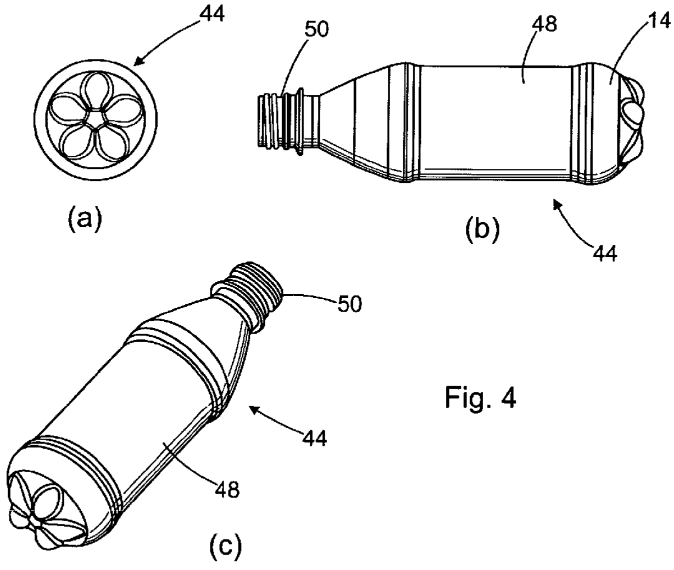


Fig. 4

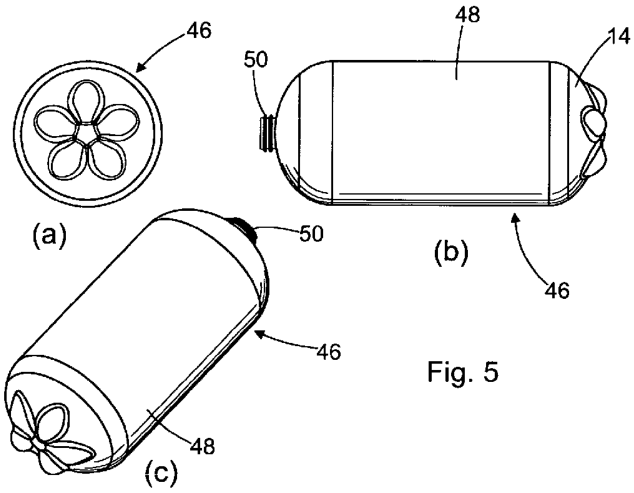


Fig. 5

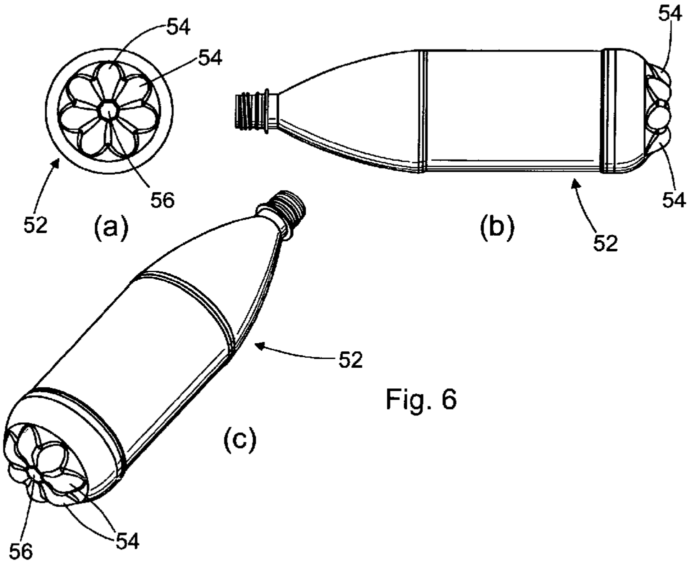


Fig. 6

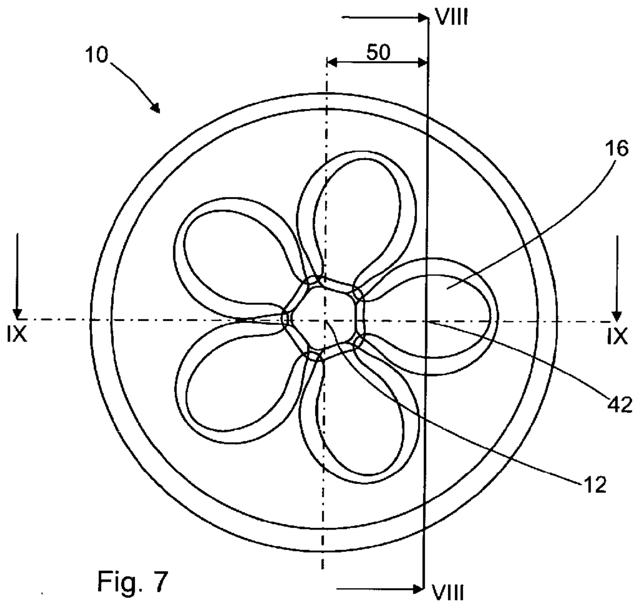


Fig. 7

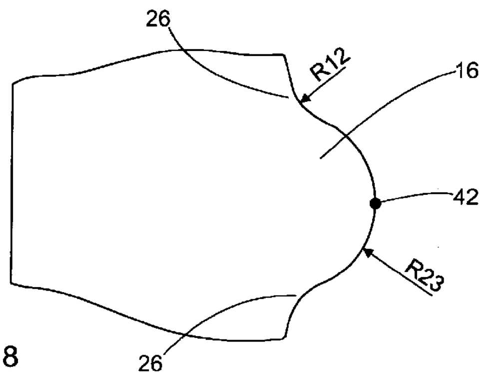
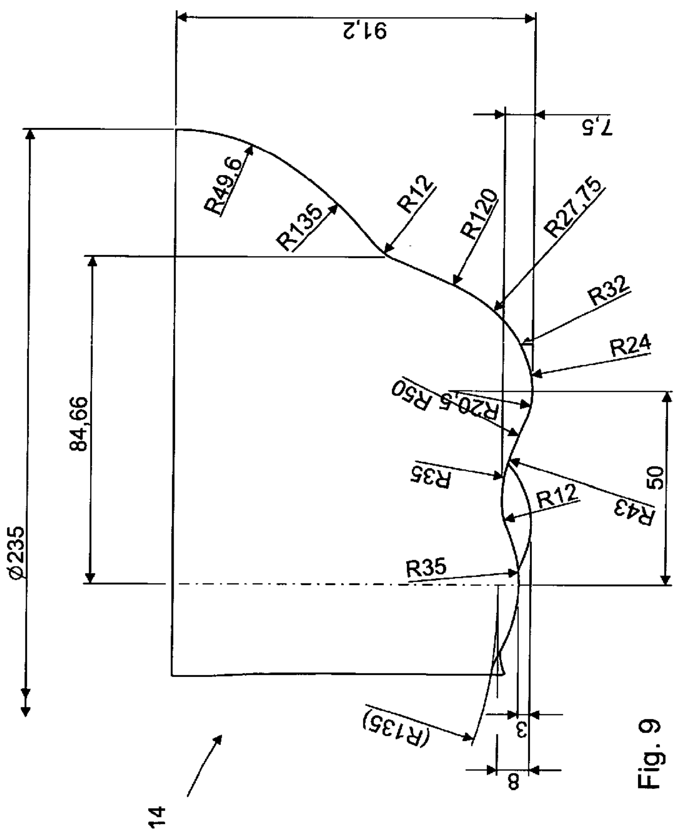


Fig. 8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R49,6
R135
R12
R120
R27,75
R32
R24
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R50
R35
R12
R43
R35
50
84,66
Ø235
(R135)
3
8
14

Fig. 9

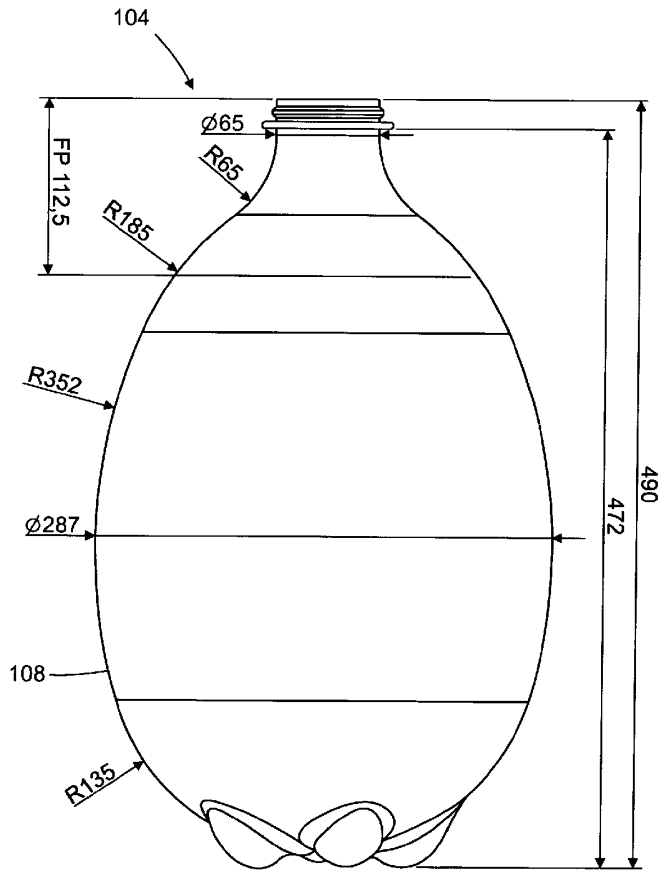

Fig. 10

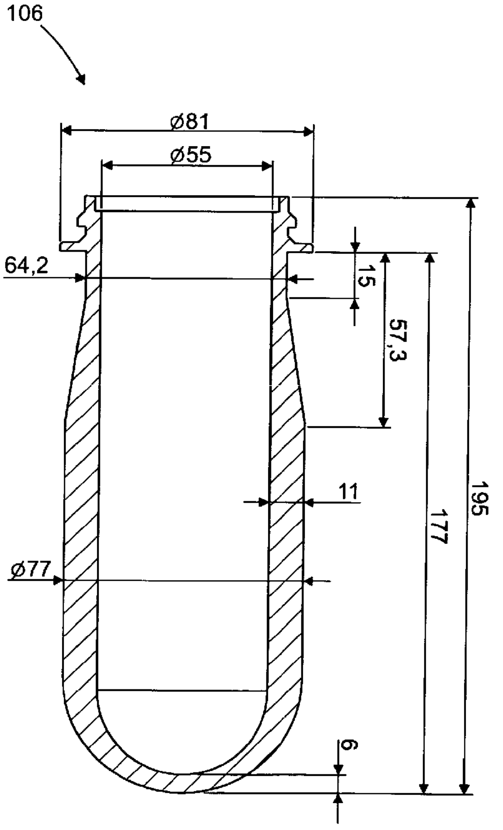

Fig. 11

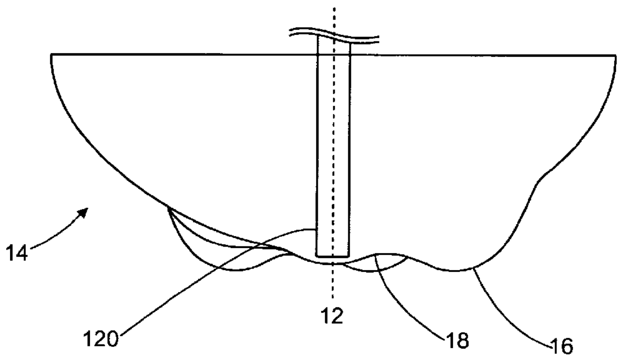

Fig. 12