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(56) Related Art
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ABSTRACT

A method of producing a liquid food and beverage product in a bottle made from a polymeric material that is closed by a roll-on tamper evident ("ROTE") closure is disclosed. The method includes a step of applying a top load of less than 120 kg to a bottle filled with the liquid food and beverage product to apply the ROTE closure to the filled bottle.

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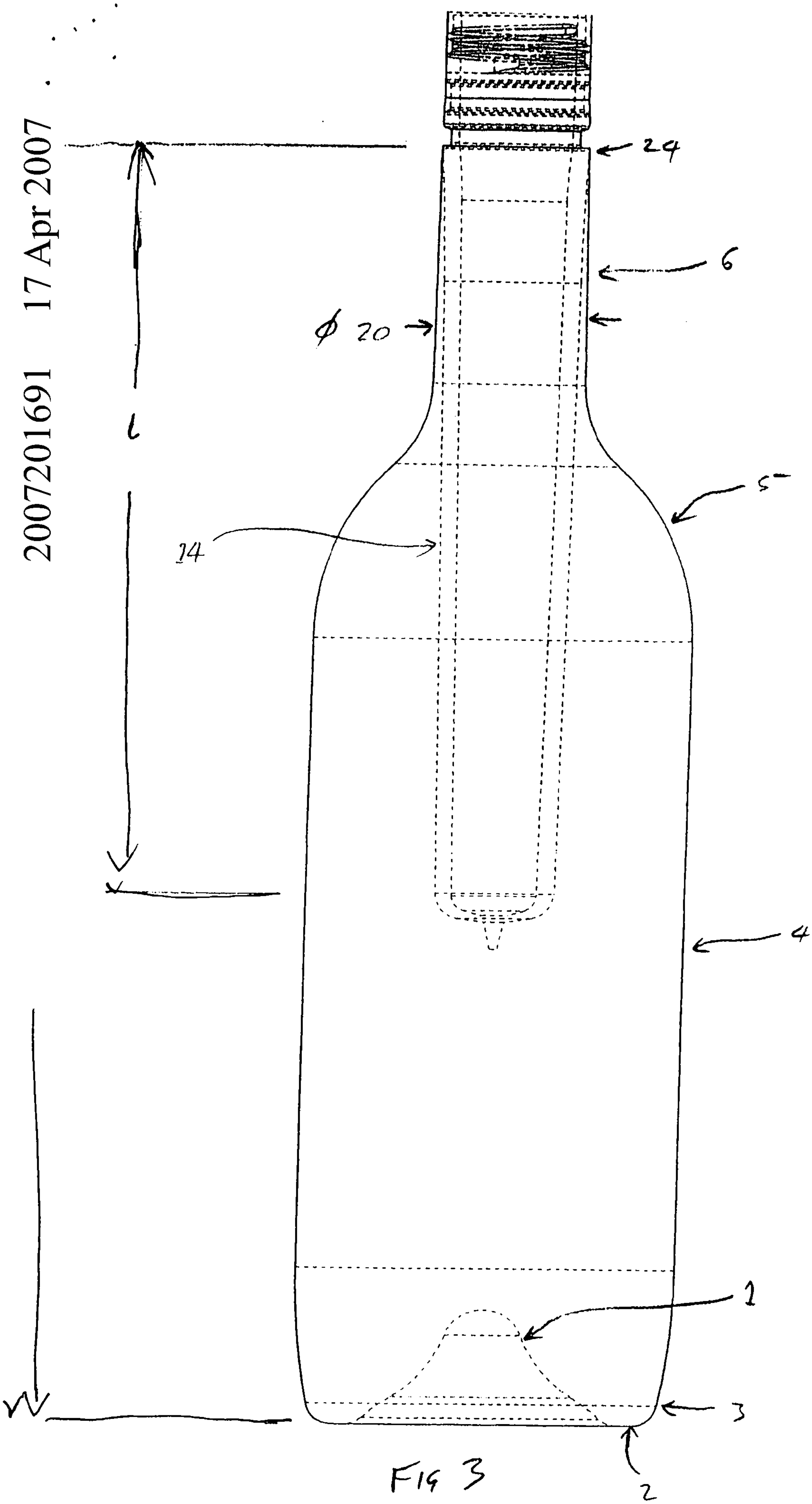

Fig 3

SCALE 1.000

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AUSTRALIA

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COMPLETE SPECIFICATION

Standard Patent

Applicant(s):

AMCOR LIMITED

Invention Title:

A BOTTLE

The following statement is a full description of this invention, including the best method for performing it known to me/us:

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A BOTTLE

The present invention relates to bottles used to hold what are regarded in the market as premium liquid food and beverage products, such as wine, olive oils, boutique vinegars, dressings, and other high value food products, where the aesthetic appearance of the package is an important part of brand image.

For these products, the traditional sealing system is cork or other stoppers.

More recently, roll-on tamper evident ("ROTE") screw-cap closures, typically formed from aluminium, have become an accepted premium product closure. An example of this type of closure is the "Stelvin®" 30 x 60 mm (diameter by height) closure used in the wine industry and the olive oil industry (for premium olive oil).

ROTE closures comprise a cap and a skirt which are interconnected by frangible tamper evident ribs that are broken when the cap is removed from a bottle. The cap is typically screw threaded and can be repeatedly opened and closed as desired. When positioned on a bottle, the cap fits over a bottle finish and the skirt extends down a bottle neck.

On first removing the cap from a bottle, an audible breaking sound of the frangible ribs can be heard indicating that the bottle has not been previously opened. The skirt is retained in an axial direction on the bottle by the profile of the skirt being pressed and formed into an annular groove in the neck of the bottle which is commonly known as the "tuck under". The unscrewing action of the cap places the frangible ribs under tension which ultimately cause the breakage of the ribs.

The use of screw-cap closures is discussed in depth in a publication entitled "Taming the Screw - a manual for winemaking with screw caps", by Tyson Stelzer, 2005, Wine Press, of Brisbane, Australia. On page 48 of this text, Stelzer discusses a process of redraw, which imparts a seal between a liner of a ROTE closure and a side of a bottle finish (near the top) and between the liner and a nominally flat surface on the top of the bottle finish. The process is dependent on the finish on a bottle, known as a "Bague Verre Stelvin" or BVS finish, in which the top of the bottle thread starts 2.8mm from the top of the bottle. The closure is formed in toward the finish region to achieve the side seal. The redraw process is very popular for ROTE closures because it reduces leakage due to side impact on a top of a closure after a bottle is sealed.

Traditionally, bottles for premium food and beverage products, particularly 750 mm wine bottles, have been made from glass.

However, issues in the market with glass bottles can be the transport weight and the lack of robustness of glass premium packaging.

Bottles made from polymeric material packaging such as PET have a number of advantages compared to glass bottles, such as lower cost, lighter weight, and much greater resistance to shattering. They are also eminently suitable for public events, whereas glass packaging is increasingly becoming restricted from many public events and places, for example sports stadiums, because of the public safety risks of broken glass. Polymeric material packaging is also preferable on aeroplanes as it reduces the risks from broken glass in the tight confines of an aeroplane cabin. These risks could include the use of broken glass in a terrorism event.

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However, notwithstanding the above advantages, polymeric material packaging does not have the same market acceptance as glass packaging for premium food and beverage products.

It is desirable to be able to offer to the market a polymeric material package that has premium branding which provides both shelf life performance and brand equity.

The use of a ROTE closure on a closed bottle made from PET or other polymeric materials makes it possible to design bottles having a similar appearance to traditional glass bottles used in this market, thereby potentially improving the perceived value of the product in the mind of consumers. This is particularly the case when the accepted 30 x 60 mm ROTE closure is used.

In reading this disclosure, it must be understood that the technical functions required of a closure for these premium products, such as ability to close, sealing efficiency, gas barrier, and tamper evidence can readily be achieved by the use of closures other than the 30 x 60 mm ROTE closures. The reason for the choice of this closure is based entirely on aesthetic and brand image factors, in particular that the 30 x 60 mm ROTE closure is associated in the minds of many consumers with a premium product.

The matching glass bottle thread designs (finishes) are referred to internationally as the CETIE BVS-GRP-29394 finish or the Rotel-GRP-0417 finish.

The market demand for polymeric material bottles fitted with ROTE closures has been proven by their existing availability in small size bottles. For example, 187 ml PET bottles fitted with (smaller) ROTE closures are used in airline catering, for the reasons discussed above.

However the use of PET bottles in larger sizes, in particular the 750 ml volume size very commonly used for wine, has been limited and not successful to this point in time due to mechanical issues achieving the required sealing performance for standard ROTE closures.

More specifically, it has been traditionally understood that the proper placement of a ROTE closure onto glass packaging requires the application of a vertical load in capping of between 150 kg and 200 kg, with a vertical load specification of 170-180 kg being commonly quoted, to properly re-form the closure around the glass finish.

Table 1 sets out details of recommended head pressures for commercially available 30 x 60 mm ROTE closures that support the above-mentioned traditional view.

Table 1 - Recommended head pressures for 30 x 60 mm ROTE closures.

Supplier	Recommended head pressure with redraw, kg
Auscap	120 - 180
Global	180 +/- 10
Newpak	182 +/- 10
Amcor	170

The data for the Auscap, Global, and Newpak closures is sourced from Stelzer, Appendix 3, and the data for the Amcor closure is sourced from the applicant.

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The applicant has determined by Finite Element Analysis (FEA) that achieving a vertical load resistance in excess of 170kg for larger size PET bottles, such as 750 mm PET bottles for wine, is not commercially feasible using the current injection moulding manufacturing process used by the applicant in Australia.

The current manufacturing process is based on an injection stretch blow moulding manufacturing process, where firstly PET resin is melted and formed into a preform in an injection mould and, after conditioning to a controlled temperature, the preform is stretched then blown into the final shape of the bottle within a blow mould. The process may be the known "one stage" process, where the preform is blown immediately after injection moulding, or the known "two stage" process, where injection moulding and blowing are physically separate processes.

In particular, the current manufacturing process requires the following:

- A thread section formed in the first stage of the process of the same geometry as the final thread section, as this section is used to support the bottle during blow moulding.
- A straight neck section below the thread to mimic a standard wine bottle.
- A tapering preform to permit easy removal from the injection mould.
- A degree of vertical stretch of the preform during blow moulding of about 1.5:1 so as to impart a vertical orientation to the polymer strands, which helps to increase the top load of the blown bottle.

- A maximum wall thickness of the preform due to cooling requirements. As the wall gets thicker the required cooling time inside the injection mould increases exponentially and this quickly leads to production and economic issues with excessively thick wall.

The above requirements combine to define a maximum volume of polymer material for a preform using the existing equipment of the applicant.

The maximum volume in turn leads to a maximum PET weight of the preform of approximately 55 g.

While in this case the applicant has been limited to 55 g because of the above mentioned manufacturing issues, it should be appreciated that a light weight bottle has many advantages of its own account, such as lower cost (due the reduction in the amount of resin required), lower environmental impact, and lower transport weight. Notwithstanding the above, the advantages of the solution to the above identified manufacturing issues will apply even in cases where it is only possible to manufacture 750 ml polymeric bottles with a net weight of greater than 55 g.

Using Finite Element Analysis, the top load resistance of a 55 g PET bottle is 120-130 kg. This has been confirmed with pilot bottle production.

Being less than the 170 kg top load resistance considered necessary for glass bottles, the applicant was concerned that the resulting closure would not have adequate sealing capability.

One potential option to match capping load with achievable top load is to redesign the ROTE closure to

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work with a reduced top load. While feasible, the redesign would involve significant research and development costs. In addition, the applicant, along with other suppliers in this market, already has a 30 x 60 mm ROTE closure production facility in Australia, and the plants in Australia where the wine bottle are filled are already configured to apply 30 x 60 mm ROTE closures, and so a change in closure design could require significant capital costs to both the applicant, other suppliers of ROTE closures, and the various bottle filling plants and is undesirable on this basis.

Having determined that achieving the standard capping top load resistance for ROTE closures on a 55 g PET bottle is not feasible, the applicant also determined that the reason for the high top load requirement for glass bottles was unevenness of the bottle finish due to the vagaries of glass formation.

The applicant has theorized that hermetic sealing of ROTE closures may be achievable at reduced application load, provided the variation of finish dimensions are reduced compared to the BVS finish for glass used in actual industry practice.

In particular, the BVS finish specification permits variation in the diameter of the critical external diameter of the finish in the redraw area of 0.6 mm, and is silent on the allowable deviation from flat.

The variance and comparison to capping dimensions shown in typical commercial glass bottles is shown in Table 2.

Table 2. Finish variation and capping tolerances for 30BVS finish, as measured by the applicant.

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Glass Finish Root Diameter "E"	25.8-26.4 mm
Redraw Anvil bore	27.4-27.6 mm
Closure Metal Thickness	0.23-0.24 mm
Liner Thickness	2.0-2.1 mm
Gap between redrawn metal and glass (to accommodate liner)	0.4-1.0 mm
Liner Compression	50-80%
Measured finish height variation (from bottle base)	Supplier 1: 0.06-0.34 mm Supplier 2: 0.07-0.24 mm Supplier 3: 0.24 mm

It is clear from the data in Table 2 that the variation of glass finishes for wine bottles, either as specified (E diameter) or unspecified (finish height variation) is significant. As a consequence, a high top load is required to ensure adequate sealing in the presence of this variation.

Partially for this reason, field experience has shown the top seal alone to be insufficient to provide a sufficient seal for robust commercial use of bottles. In particular, field experience has shown that the use of redraw to in excess of 1 mm down the closure has been necessary, and the compression in the redraw zone varies markedly as disclosed. A redraw load of approximately 170 kg has been found by empirical experience to be necessary to compensate for the variation in glass dimensions.

The fine scale roughness of the sealing surface of a glass wine bottle (the edge at the very top of a screw-top bottle) is routinely inspected during glass bottle manufacturing, and the inspection system is set up to reject bottles with narrow defects of around 0.1 mm in depth or greater. Using reject parameters for diameter or flatness of less than 0.1 mm is uncommercial as such control is outside the capability of current glass bottle making technology.

The present invention is based on a realisation that finish dimensions for bottles made from polymeric materials can be considerably less susceptible to variations than is the case for glass finish dimensions, with a result that high top loads to seal ROTE closures onto polymeric material bottles are not necessary.

According to the present invention there is provided a method of producing a liquid food and beverage product in a bottle made from a polymeric material that is closed by a roll-on tamper evident ("ROTE") closure, which method includes a step of applying a top load of less than 120 kg to a bottle filled with the liquid food and beverage product to apply the ROTE closure to the filled bottle.

Preferably the method includes applying a top load of less than 110 kg to a filled bottle.

More preferably the method includes applying a top load of less than 100 kg to a filled bottle.

Preferably the filled bottle contains greater than 700 ml of the liquid food and beverage product.

Preferably the as-manufactured bottle has a net weight of 60 gm or less.

Preferably the as-manufactured bottle is a 750 ml capacity bottle and has a net weight of 60 gm or less.

Preferably the as-manufactured bottle has defects in a sealing surface at a top of the bottle of less than 0.1 mm in height or depth.

Preferably the as-manufactured bottle includes a

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finish that is flat to within 0.4 mm, more preferably 0.2 mm, with reference to the bottle standing on a horizontal surface.

Also preferably, the external diameter of the finish is less than 0.2 mm, more preferably 0.1 mm, oval shaped.

Preferably the average diameter of the finish is within 0.4 mm, more preferably 0.2 mm, of a nominal diameter.

Most preferably, the bottle finish is flat to less than 0.2 mm, oval shaped to less than 0.05 mm, and has an average diameter within 0.1 mm of a nominal diameter.

Preferably the ROTE closure includes a cap for opening and closing the bottle and a skirt that is frangibly connected to the cap and is retained on the bottle when the cap is removed.

Preferably the as-manufactured bottle includes a neck having a first section on which the skirt of the closure can be fitted and a second section which, when the bottle is located in an upright orientation, is a region immediately below the first section, and wherein an outer diameter of the first section is less than an outer diameter of the second section.

It is preferred that the length of the first section in an axial direction of the bottle be in the range of 20 mm to 60 mm.

Preferably the first section has a length that is substantially the same as the length of the skirt and the end of the skirt abuts against the second section of the bottle neck. This arrangement minimises the possibility of a person cutting himself or herself on the end of the skirt. This arrangement also prevents the appearance of any spacing or gap between the inside face of the skirt and the surface of the first section from being visible and thereby improves the appearance of the bottle, which is important when for selling upmarket products such as wine.

Although it is possible that the change in diameter from the first to the second sections be a gradual increase, it is preferred that the change in diameter be an incremental or step change.

It is not necessary that the first, or second, or both sections be cylindrical in form. In a preferred embodiment, one or both section are frusto-conical to carefully locate the cut edge of the closure radially at the step between the sections, and to maintain a pleasing aesthetic in the finished package.

When the closure and in particular the skirt is fitted to the bottle, it is preferred that the first section of the bottle has an external diameter that is less than the internal diameter of the skirt of the closure by 0.2 mm to 2.0 mm.

Preferably the external diameter of the first section is less than the internal diameter of the skirt of the closure by 0.2 to 0.5 mm.

When the skirt of the closure has been applied or fitted to the bottle, it is preferred that the external diameter of the second section of the neck be equal to or up to 0.5 mm greater than the external diameter of the skirt of the closure.

In a situation where the closure is a 30 x 60 mm ROTE closure, it is preferred that the first section of the neck of the bottle has a diameter or cross-section in the range of 26 to 29.5 mm and, suitably, 28 to 29 mm.

When the skirt of the closure has been fitted to the bottle, it is preferred that the skirt be able to freely rotate about the bottle neck.

The term "freely rotate" is understood herein to mean that the skirt can be hand rotated about the bottle neck without friction between the skirt and the bottle neck impeding rotation of the skirt.

Preferably the as-manufactured bottle is made is from PET or PBT or a combination of different polymeric materials.

The bottle may include colorant materials, UV barrier additive, passive gas barrier materials, and active barrier materials (oxygen scavengers).

Preferably the bottle is an injection stretch blow moulded bottle.

According to the present invention there is provided a bottle made from a polymeric material and having any one or more of the structural features described above that is closed by a roll-on tamper evident ("ROTE") closure by the method described above.

The present invention is described further hereinafter by way of example with reference to the accompanying Figures, of which:

Fig 1 shows a typical glass wine bottle;

Fig 2 shows a published finish specification of the applicant for 30BVS finishes on glass bottles;

Fig 3 shows one embodiment of a polymeric material bottle of the present invention suitable for use in an embodiment of the method of the present invention, overlaid with a preform suitable for performance of the method of the invention;

Fig 4 shows the preform of Fig 3 in greater detail;

Fig 5 shows another embodiment of a polymeric material bottle of the present invention suitable for use in an embodiment of the method of the present invention; and

Fig 6 shows an enlarged view of a portion of the neck of the bottle contained within the circle shown in Fig 2.

Fig 1 shows a typical glass bottle of the known art. The bottle comprises a base punt (or upstand) 1, a stand area 2, a heel 3, a label panel 4, a shoulder 5, an elongated neck 6, and a finish 7 defining an opening 8 of the bottle.

The finish 7 comprises a top surface 9, a side seal surface 10, a thread 11, and a tamper ledge 12.

The neck 6 of the bottle further comprises a controlled diameter section 13 at 59.5 mm from the sealing surface 9, where the glass finish is the finish known as 30BVS-60 as commonly used in the wine industry.

The finish 7 is described in more detail in Fig 2. The combined compression seal area, defined by the top surface 9 and side seal area defined by the side seal surface 10, is shown in bold in this figure and identified by the numeral 29 - see the section A-A.

As is discussed above, the applicant has found that variations in diameter of the side seal surface area 10, a lack of flatness of the top seal surface 9, and a non-parallel relationship of the top seal surface 9 and the stand area 2 of Fig 1 are the basis for high capping requirements for glass bottles of the known art - as discussed above.

Fig 3 shows one embodiment of a bottle of the present invention for use in the method of the present invention and a precursor preform (shown in dotted lines) and identified by the numeral 14 to form the bottle.

The bottle and the preform 14 are manufactured using a single stage injection stretch blow moulding machine as known in the art, in this case an Aoki SBIII - 100 (Aoki Technical Laboratory, Japan). The present invention is not confined to the use of this particular machine. In addition, the present invention is not confined to manufacturing bottles by a single stage injection stretch blow moulding process.

The following discussion of physical limitations of the bottle and the preform 14 applies equally to other single stage and to two stage processes for manufacture of injection stretch blow moulded bottles.

Fig 3 shows a bottle with the same numbering used to describe the same features as the glass bottle of Fig 1.

Fig 4 shows the preform 14 in detail. The preform 14 comprises a finish area 15, a preform body 16,

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an end cap 17, and an injection sprue residue 18.

It will be understood by those knowledgeable in the art that the finish area 15 is formed in an injection mould and remains intact after stretch blow moulding, and the body of the preform 14 is stretched vertically to form the body, the heel and the base of the bottle.

Those skilled in the art will also understand that the diameter of the external surface of the preform 14 shown by the numeral 19 must be smaller than the diameter of the neck of the bottle shown in Fig 3 by the numeral 20 to allow the preform 14 to fit inside a mould as the mould is closed.

It will be further understood that the diameter must taper from point 21 near the open end of the preform 14 to point 22 near the closed end of the preform 14 to allow the part to be removed from an injection mould.

Further still, it will be understood that the inner surface 23 of the preform 14 must also taper, at nearly an identical angle to the external surface, to allow the part to be removed from an injection mould, and also to maintain a generally even thickness from points 21 to 22 of the preform 14.

The length l of the formable portion of the preform 14 in Fig 3 is also limited, and related to the formed length L in the body. The ratio of the length L to the length l is typically approximately 1.5:1, based on empirical findings about the properties of the commonly used PET resin.

Increasing the total volume and thus the weight of the preform 14 is possible by increasing the wall thickness t of the preform. However, this is impractical due to material cost (which increases linearly with thickness t) and machine cycle effects (which increase exponentially with thickness, due to cooling requirements).

Increasing the total volume, and thus the weight, by increasing the length l of the preform 14, is also possible. However, as the preform length l is increased as a proportion of the length L of the bottle, the ability to stretch the upper regions of the preform 14 is lost, and the extra material is distributed naturally to the neck area 6 of the bottle, where it does not contribute to improve load bearing capacity.

The total preform weight approximates 55 g when (a) the bottle diameter between points 24 and the critical diameter point 20 is at the maximum permissible for a 30 x 60 mm ROTE closure (approximately 29.1 mm), (b) the diameter of the preform 14 at point 21 is sufficiently smaller than the bottle mould diameter to avoid accidental contact, (c) the preform wall thickness t is at the maximum practical, and (d) the formable length l is at the maximum practicable.

The applicant has determined the capping performance of ROTE closures on polymeric material bottles, specifically PET bottles, of the type shown in Fig 3 by laboratory testing.

To this end, a mandrel at nominal dimensions of the 30BVS finish was made, with injection moulded finish tolerances. A redraw anvil to normal specification and tolerance was also made. The trial parts were mounted in a tensile tester (Instron Corporation) and closures were re-drawn to controlled vertical load. Testing of liners in the absence of the metal closure shells was also performed.

It was found that for the PET bottle variability trialled in the test mandrel, liner compression could be achieved at a vertical load of approximately 80 kg, re-form of the closure body began to occur at 75 kg, and sufficient re-form to provide a useful and commercial side-seal was achieved by a 100 kg vertical load.

The applicant determined that the reason for the lower top loads required for PET bottles compared to when closing glass bottles is that the polymeric material bottle can be formed with a smoother, flatter sealing surface.

Typically, PET bottles can be manufactured with E diameter variation and surface flatness of less than 0.1 mm.

Figs 5 and 6 show another embodiment of a bottle of the present invention for use in the method of the present invention, with the same numbering used to describe the same features as the bottle of Fig 3.

The main feature of the bottle is the structure of the neck 6 of the bottle. In this connection, notwithstanding the stated advantages of PET and other polymeric material bottles, PET bottles typically have different frictional characteristics than glass bottles. In particular, the friction of the PET material in contact with the inside of the ROTE closures is higher than for glass in contact with the ROTE closures. This can cause difficulties for consumers removing ROTE closures from PET bottles. The bottle shown in Figs 5 and 6 eliminates the issue of friction by maintaining the diameter of the neck of the bottle, for the length of the closure skirt, less than the internal diameter of the closure.

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With reference to Fig 5, the neck 6 has an upper section 13 and a lower section 16. The upper section 13 has a diameter D on which the skirt of the closure can be fitted or applied. The lower section 16 is immediately below the upper section 13 of the neck 6 and has a larger diameter D1. The neck 6 has an incremental increase in diameter or step 18 at the interface of the sections 13 and 16. The arrangement is such that the neck 6 has a diameter D1 located at a distance L from an opening or upper surface of the bottle. Diameter D1 is equal to, or greater than, the external finished diameter of the ROTE closure (not shown in Fig 5) and defines the lower section of the neck. The distance L is equal to, or greater than, the length of the closure for which the bottle is adapted to be fitted. Diameter D1 can be derived from specifications and drawings of closures of the art suited to the package in question. Length L can be determined from published data, but is ideally determined by measurement of commercially applied closures on bottles of the known art.

Fig 6 is an enlarged view of the of the bottle that is circled in Fig 5 and in particular shows the profile of step 18 located at the interface between the upper and lower sections 13 and 16 of the neck 6 of the bottle.

One advantage of the smaller diameter D of the upper section is that the ROTE closure can be conveniently fitted or applied to the bottle without friction forces interfering with the assembly process.

Furthermore, the increase in diameter of the neck 6 at the step 18 is advantageous because it provides a profile between the upper and lower sections of the neck that can avoid the formation of an ugly gap appearing between the base of the fitted ROTE closure and the neck of the bottle.

In addition, if the cut edge of the ROTE closure is sharp or rough, the cut edge of the closure will abut against the step 18 advantageously minimising any risk of injury to a consumer.

Many modifications may be made to the embodiment of the present invention described above without departing from the spirit and scope of the invention.

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CLAIMS

1. A method of producing a liquid food and beverage product in a bottle made from a polymeric material that is closed by a roll-on tamper evident ("ROTE") closure, which method includes a step of applying a top load of less than 120 kg to a bottle filled with the liquid food and beverage product to apply the ROTE closure to the filled bottle, characterised in that the as-manufactured bottle has a net weight of 60 gm or less, and characterised in that the as-manufactured bottle has any one or more of the following features:

(a) all of the defects in a sealing surface (9) at a top of the bottle are less than 0.1 mm in height or depth,

(b) a finish (7) that is flat to within 0.2 mm with reference to the bottle standing on a horizontal surface,

(c) an external diameter of the finish (7) of less than 0.1 mm oval shaped, and

(d) an average diameter of the finish (7) of within 0.2 mm of a nominal diameter.

2. The method defined in claim 1 includes applying a top load of less than 110 kg to the filled bottle.

3. The method defined in claim 1 includes applying a top load of less than 100 kg to the filled bottle.

4. The method defined in any one of the preceding claims wherein the filled bottle contains greater than 700 ml of the liquid food and beverage product.

5. The method defined in any one of the preceding claims wherein the as-manufactured bottle is a 750 ml capacity bottle and has a net weight of 60 gm or less.

6. The method defined in any one of the preceding claims wherein the as-manufactured bottle includes a finish that is flat to less than 0.2 mm, oval shaped to less than 0.05 mm and has an average diameter within 0.1 mm of a nominal diameter.

7. The method defined in any one of the preceding claims wherein the ROTE closure includes a cap for opening and closing the bottle and a skirt that is frangibly connected to the cap and is retained on the bottle when the cap is removed.

8. The method defined in claim 7 wherein the as-manufactured bottle includes a neck having a first section on which the skirt of the closure is applied and a second section which, when the bottle is located in an upright orientation, is a region immediately below the first section, and wherein an outer diameter of the first section is less than an outer diameter of the second section.

9. The method defined in claim 8 wherein the length of the first section in an axial direction of the bottle is in the range of 20 mm to 60 mm.

10. The method defined in claim 8 or claim 9 wherein the first section has a length that is substantially the same as the length of the skirt and the end of the skirt abuts against the second section of the bottle neck.

11. The method defined in any one of claims 8 to 10 wherein the difference in diameter between the first and the second sections of the neck is the result of an incremental or step change.

12. The method defined in any one of claims 8 to 11 wherein, when the closure is applied to the bottle, the

first section of the bottle has an external diameter that is less than the internal diameter of the skirt of the closure by 0.2 mm to 2.0 mm.

13. The method defined in any one of claims 8 to 12 wherein, when the skirt of the closure is applied to the bottle, the external diameter of the second section of the neck is equal to or up to 0.5 mm greater than the external diameter of the skirt of the closure.

14. The method defined in any one of the preceding claims wherein the bottle is made is from PET or PBT.

15. The method defined in any one of the preceding claims wherein the as-manufactured bottle is an injection stretch blow moulded bottle.

16. A bottle made from a polymeric material that is closed by a roll-on tamper evident ("ROTE") closure by the method defined in any one of the preceding claims.

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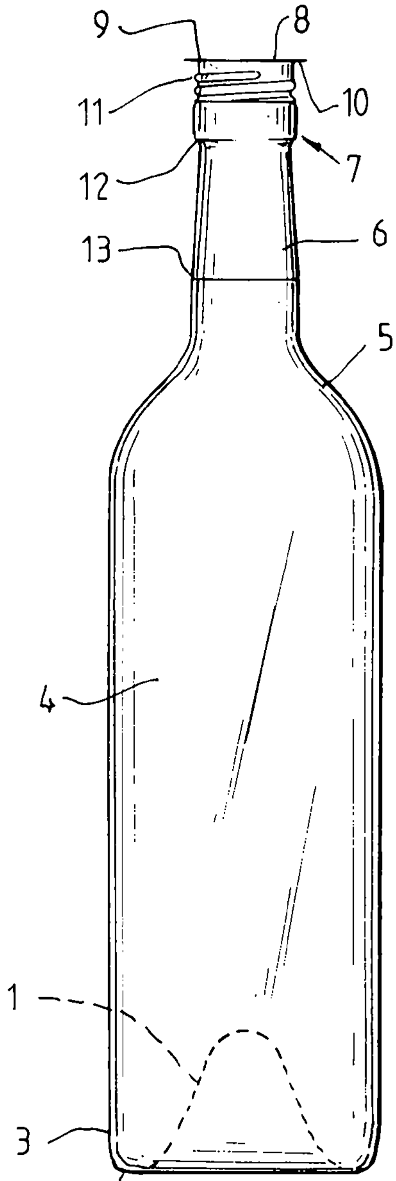

FIG. 1.

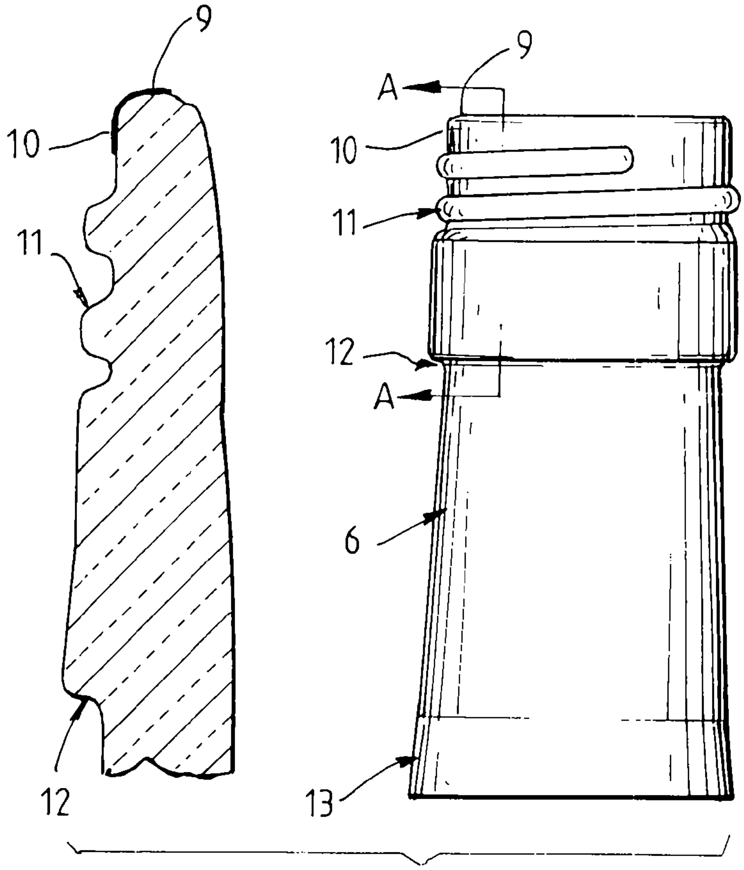

FIG. 2.

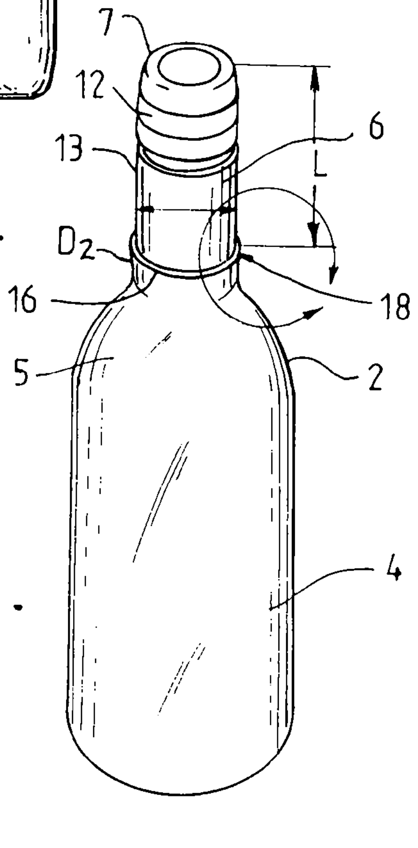

FIG. 5.

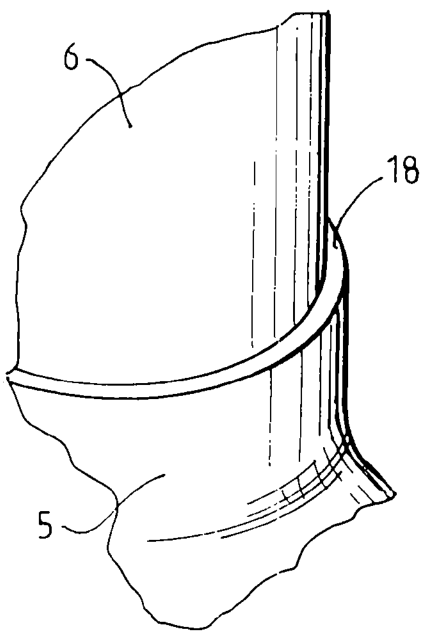

FIG. 6.

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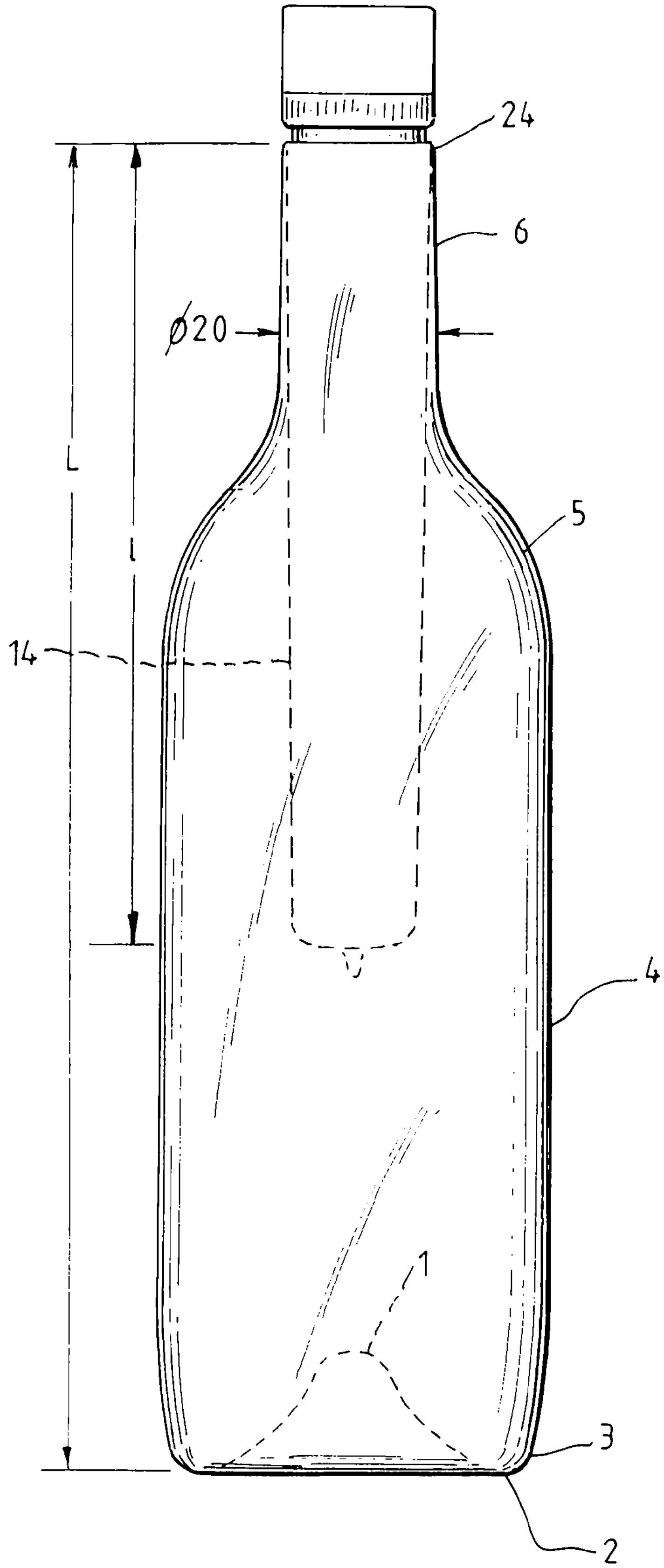

FIG. 3.

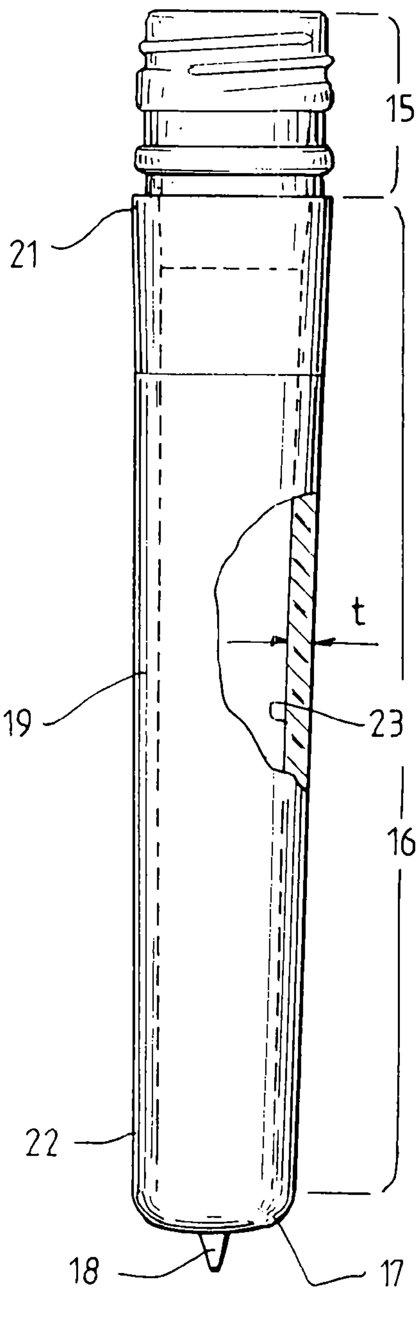

FIG. 4.

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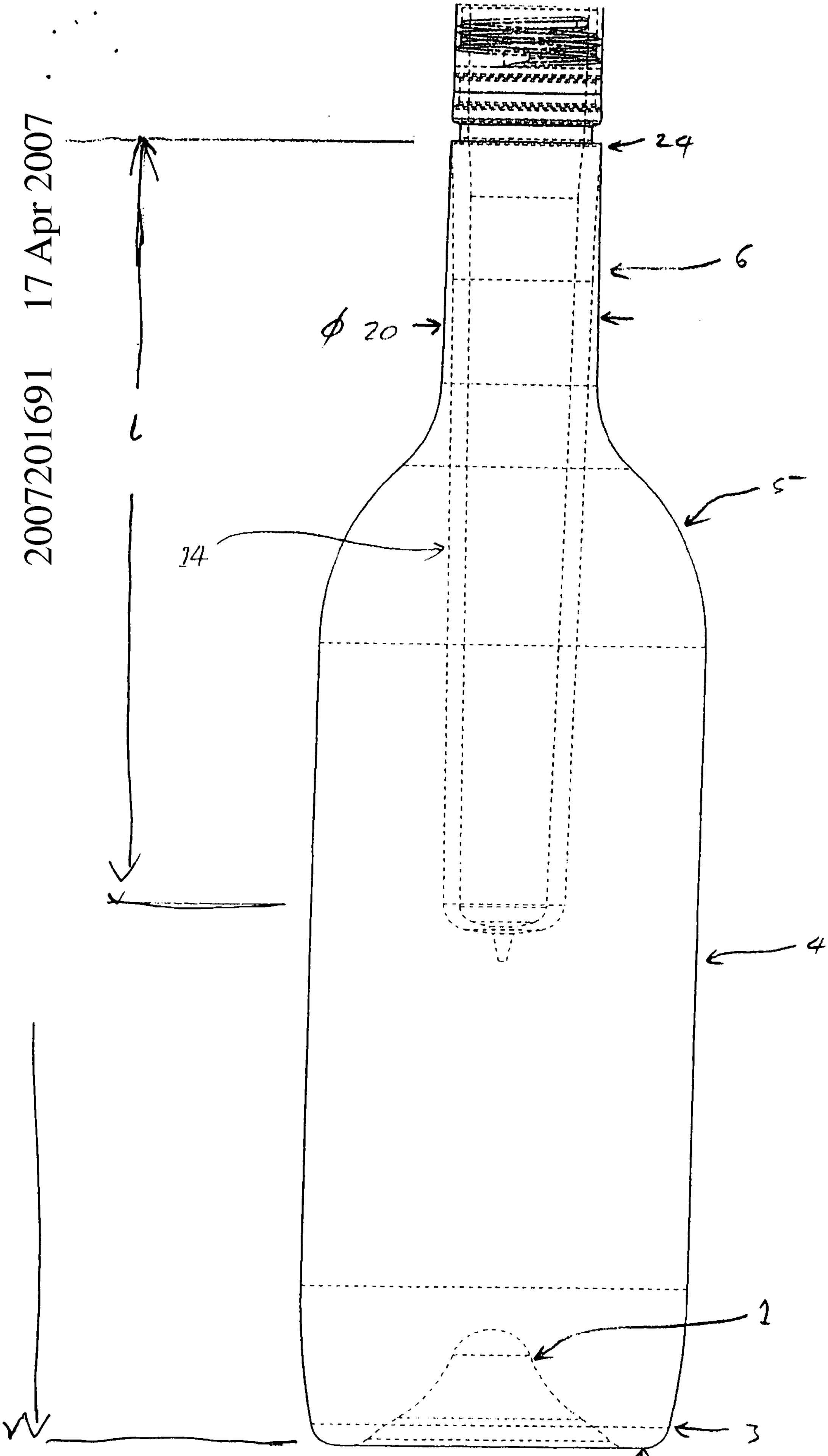

FIG 3

SCALE 1.000

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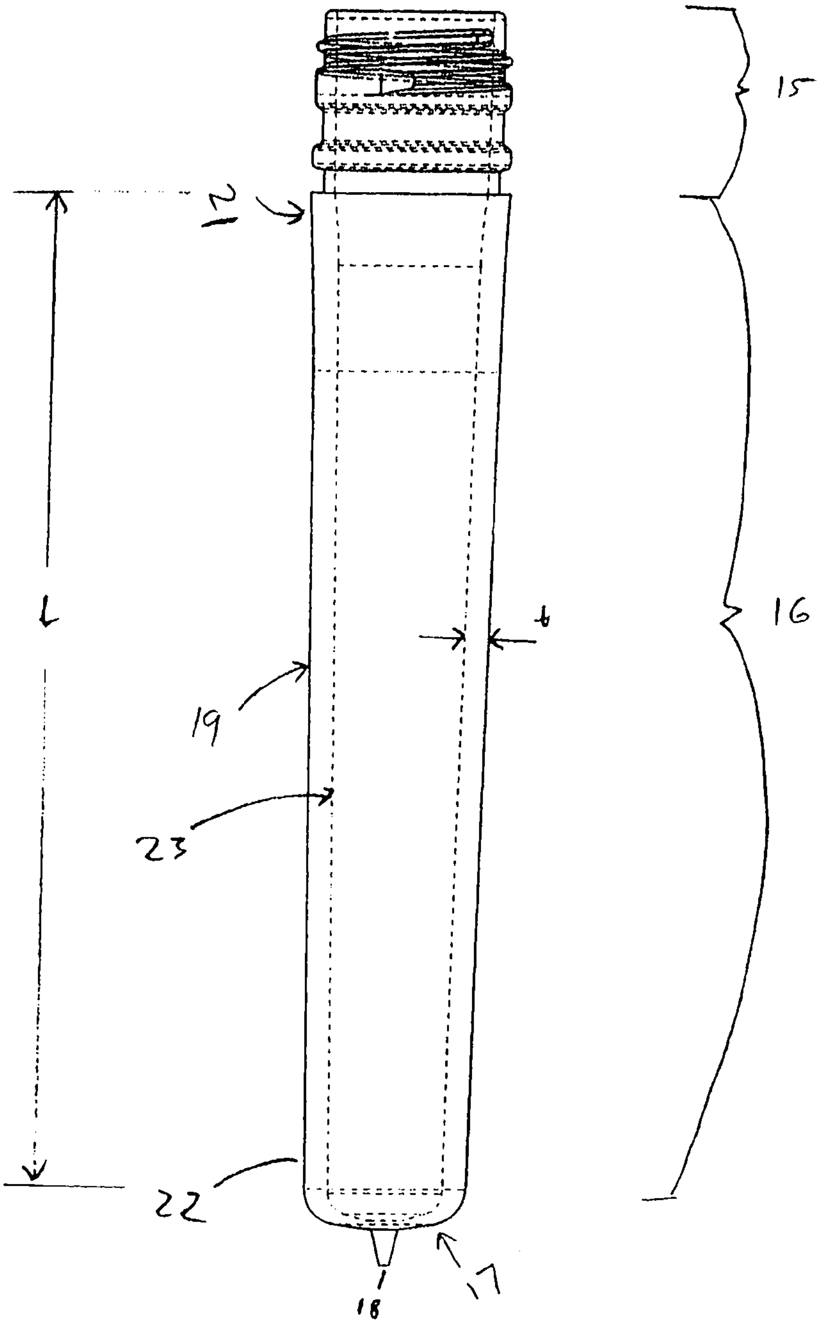

FIG 4

SCALE 1.000

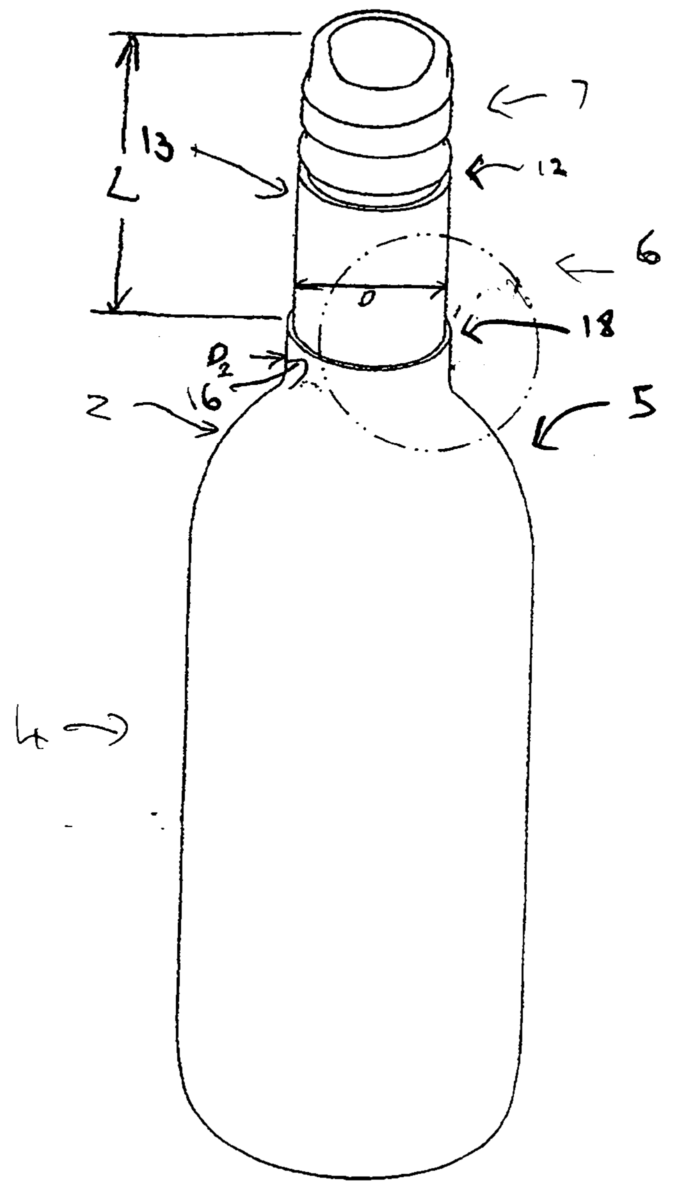

Fig. 5

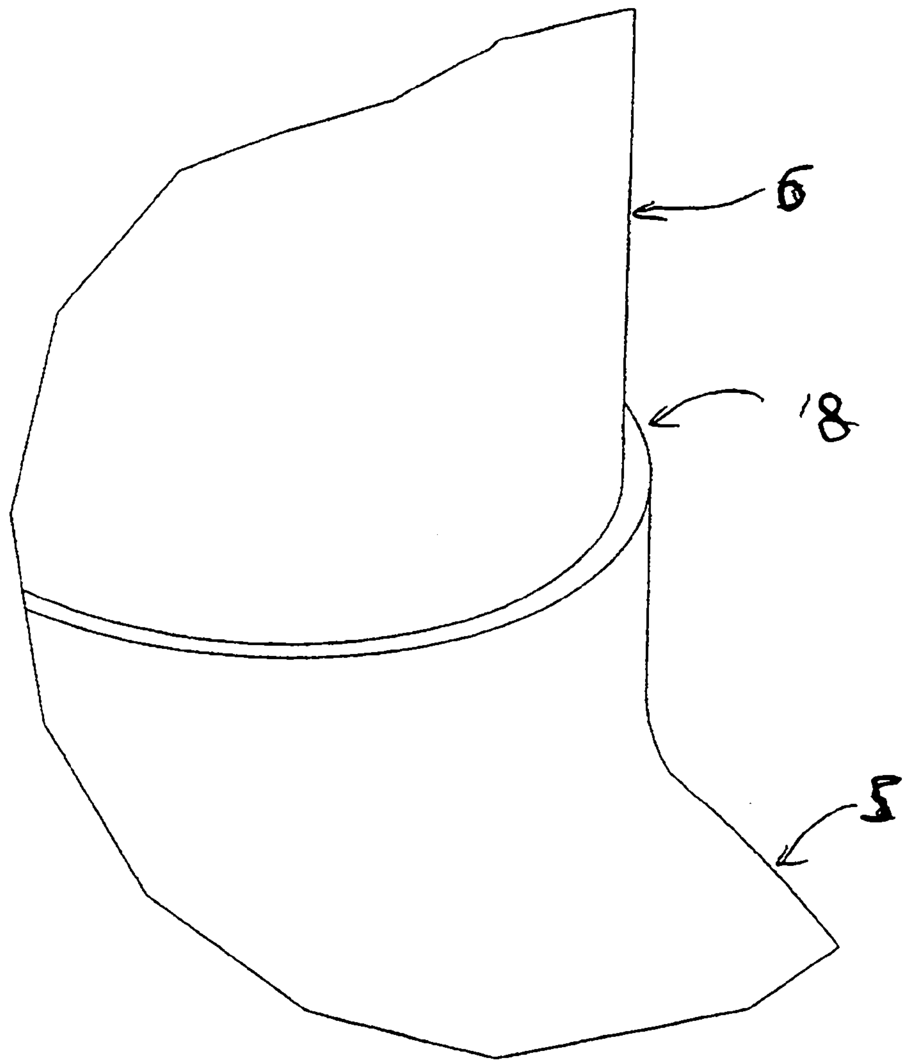

Fig. 6