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(54) Tamper-evident closure

(57) A unitary, tamper-evident closure (21) for use on the threaded neck of a container (20) includes a molded plastic closure body (24) having a series of internal threads, an annular, tamper-evident band (23) constructed and arranged out of a suitable plastic for being ultrasonically welded to a portion of the container, and a plurality of frangible elements (25) constructed and arranged out of a suitable plastic for connecting the tamper-evident band to the closure body at a plurality of spaced-apart locations. The tamper-evident band is free of any undercut beads and the sole structural connection of the tamper-evident band to the container is by means of ultrasonic welding.

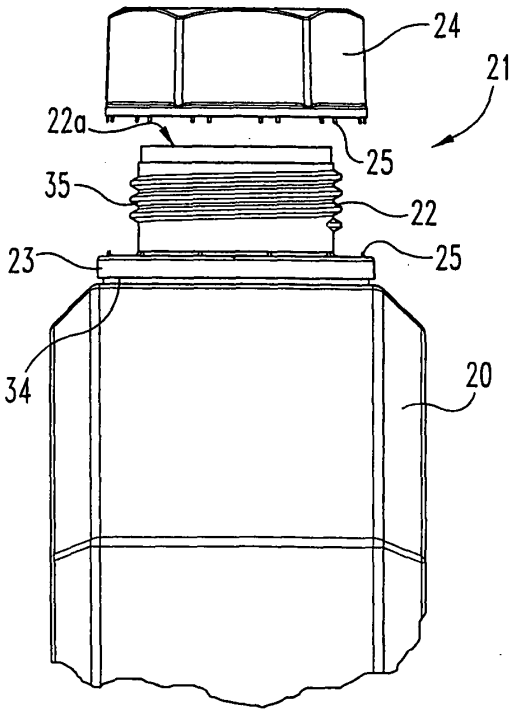

Fig. 2

EP 1 847 468 A1

Description

[0001] The present invention relates in general to an internally-threaded closure for a container with an externally-threaded neck, wherein the closure includes a tamper-evident band. The tamper-evident band is initially attached to an upper body portion of the closure by a plurality of frangible elements or by a weakened score line in the form of a severable web. Once the frangible elements are broken, the upper body portion separates from the tamper-evident band and provides a closing cap for the container. More specifically, the present invention relates to this style of internally-threaded closure where the tamper-evident band is constructed and arranged to be retained on the neck of the container at the time of closing cap removal, after breaking the frangible elements or severing the web. As the upper body is unscrewed from the container neck, the tamper-evident band stays connected to the neck and the frangible elements break, or the web severs, separating the upper body portion (now the closing cap) from the tamper-evident band.

[0002] Traditionally, tamper-evident closures of the type generally disclosed above have a plurality of undercut beads that are constructed and arranged to engage cooperating beads or similar structural forms on the neck of the container that are located axially below the external threads. As the closing cap is unscrewed from the neck of the container, the cooperating sets of beads prevent the tamper-evident band from rising (axially) with the remainder of the closure (i.e., the closing cap). The referenced frangible elements may be constructed and arranged as molded strands or links in unitary construction with the tamper-evident band and with the closing cap. Alternatively, the frangible elements can be created by making a circumferential slit around the circumference of the closure between the tamper-evident band and the closing cap. The intent is to construct a weakened zone between the tamper-evident band and the closing cap that fractures as the closing cap is unscrewed from the container neck, leaving the tamper-evident band behind on the container. This particular configuration can be accomplished by the use of a weakened, severable web or by a similar weakened portion located between the closing cap and the tamper-evident band.

[0003] One of the problems discovered with the use of undercut beads on the tamper-evident band is that the frangible elements are disturbed and often broken by the ejection process during molding and/or during the capping process. As the tamper-evident band is forced over the cooperating annular bead formed on the neck of the container, the deflections and stress can cause some of the frangible elements to break. One approach to try and prevent such breakage is to design the frangible elements to be stronger by making them larger. While these stronger (larger) frangible elements may survive the molding and capping process, they do not thereafter break or fracture reliably, as would be desired and intended, during closure (upper body portion) removal from the neck of the container. This in turn means that the frangible elements, in cooperation with the tamper-evident band, do not provide a tamper-evident capability to the closure.

[0004] Another design adjustment or modification to try and help the frangible elements survive the molding and capping process involves the depth and angle of engagement of the undercut beads. These depth and angle values or dimensions are kept (reduced) at values which detract from the ability of the undercut beads relative to the bead or beads on the neck of the container to be able to provide a robust tamper-evident capability. When the undercut is reduced in this manner and to this extent, the tamper-evident band is able to slip over the container bead. This means that the closure can be removed (intact) without fracture of the frangible elements.

[0005] According to an embodiment of the present invention, the described problem and design challenge is addressed by replacing the undercut beads with an alternative structure to hold the tamper-evident band down during closing cap removal. This alternative structure, according an embodiment of the present invention, involves ultrasonically welding the tamper-evident band directly to the neck of the container. With the tamper-evident band securely retained on the container neck in this manner, the fabrication problems of the undercut beads are eliminated. This in turn allows the geometry and construction of the frangible elements to be optimized for the desired tamper-evident capability. Without providing any bead or beads on the neck of the container, there is no deflection or stress introduced into the frangible elements during the molding and capping process. This means that the frangible elements do not have to be enlarged or made more robust in order to be made stronger.

[0006] A unitary, tamper-evident closure for use on the threaded neck of a container according to one embodiment of the present invention comprises a closure cap having a series of threads formed on an inner surface, an annular, tamper-evident band constructed and arranged for being ultrasonically welded to a portion of the container, a plurality of frangible elements constructed and arranged for connecting the tamper-evident band to said closure cap at a plurality of spaced-apart locations and wherein the tamper-evident band is free of any undercut beads and the sole (or main) structural connection of the tamper-evident band to the container is by way of ultrasonic welding.

[0007] One object of the present invention is to provide an improved tamper-evident closure.

[0008] Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a front elevational view of a tamper-evident closure assembled to a container according to a typical embodiment of the present invention.

FIG. 2 is an exploded, front elevational view of the

FIG. 1 closure and container combination with a portion of the closure separated from a tamper-evident band.

FIG. 3 is a front elevational view of the FIG. 1 tamper-evident closure.

FIG. 4 is a top plan view of the FIG. 3 tamper-evident closure.

FIG. 5 is a bottom plan view of the FIG. 3 tamper-evident closure.

FIG. 6 is a front elevational view of the FIG. 3 tamper-evident closure as viewed along line 6-6 in FIG. 4.

FIG. 7 is a front elevational view of a tamper-evident closure assembled to a container according to another embodiment of the present invention.

FIG. 8 is an exploded, front elevational view of the FIG. 7 closure and container combination with a portion of the closure separated from a tamper-evident band.

FIG. 9 is a front elevational view of the FIG. 8 tamper-evident closure.

FIG. 10 is a top plan view of the FIG. 9 tamper-evident closure.

FIG. 11 is a bottom plan view of the FIG. 9 tamper-evident closure.

FIG. 12 is a front elevational view of the FIG. 9 tamper-evident closure as viewed along line 12-12 in FIG. 10.

FIG. 13 is a front elevational view of a tamper-evident closure according to another embodiment of the present invention.

FIG. 14 is a front elevational view of a tamper-evident closure according to another embodiment of the present invention.

[0009] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

[0010] Referring to FIGS. 1 and 2, there is illustrated a container 20 and a tamper-evident plastic closure 21 assembled to container 20 according to one embodiment of the present invention. This container and closure combination has the FIG. 1 appearance as a result of the initial capping operation following filling of the container.

[0011] Container 20 includes a generally cylindrical, externally-threaded neck 22 that defines an annular dispensing opening 22a. The contents of container 20 are to be dispensed by way of opening 22a after opening of the container following the initial filling and capping. Closure 21 has the form of an internally-threaded cap and is constructed and arranged for secure threaded connection directly to the threaded neck 22. Closure 21 includes a closed end and an opposite open end as further illustrated in FIGS. 3-6.

[0012] The tamper-evident closure 21 is a unitarily molded, plastic component that includes three cooperating portions. These cooperating portions include a tamper-evident band 23, a closing cap that is also described as being the closure body 24, and a plurality of spaced-apart frangible elements 25 that span the circumferential gap 26 between band 23 and body 24 and connect to the tamper-evident band 23 and the closure body 24. The plurality of frangible elements is considered to constitute one "portion" of closure 21. The circumferential gap 26 provides axial spacing between the lower edge of the closure body 24 and the upper edge of the tamper-evident band 23.

[0013] Each frangible element 25 is a small strand of plastic that is unitarily molded as part of the one-piece closure 21 and spans the axial separation as defined by circumferential gap 26. One end 27 of each frangible element is joined (unitarily molded) to the upper edge 28 of tamper-evident band 23 and the opposite end 29 of the corresponding frangible element is joined (unitarily molded) to the lower edge 30 of closure body 24. Circumferential edges 28 and 30 define gap 26 while each of the frangible elements 25 extends across and spans the axial height of gap 26. Since the only connection between the tamper-evident band 23 and the closure body 24 is by way of the frangible elements 25, the location of gap 26 becomes a weakened location in terms of the overall construction of tamper-evident closure 21.

[0014] According to the present invention, the initial assembly of closure 21 onto container 20 occurs after the filling of container 20 with the desired contents. The assembly procedure involves the first step of threading closure 21 directly onto neck 22 and applying the requisite tightening torque. The next step is to perform a plastic weld operation in order to securely anchor the tamper-evident band 23 directly to the base 34 of neck 22 below the series of external threads 35. While various procedures might be suitable for this rigid connection requirement, the preferred procedure for the present invention is to ultrasonically weld the tamper-evident band 23 to the container 20 at the base 34 of neck 22. This approach of ultrasonic welding is considered to be more reliable and more cost effective than other possible procedures. The intent of this ultrasonic welding step is to make certain that the tamper-evident band 23 remains on the neck 22 of container 20 and stays securely connected to the neck as the remainder of closure 21, specifically closure body 24, is removed (i.e., unscrewed). During the ultrasonic welding process, a vibrating metal horn pushes on selected points of the outside diameter surface of the tamper-evident band 23 and the transmitted vibrations cause the surface area of contact between the inside diameter of the tamper-evident band 23 and the outside surface of the base of the neck 22 to actually melt together, thereby creating the ultrasonic weld between these

two plastic members.

[0015] The completed and filled container and closure combination, according to the present invention, includes container 20 that is filled with the desired contents and closure 21 that is tightly and securely threaded onto the neck 22 with the tamper-evident band 23 ultrasonically welded to the base 34 of the neck 22. The tightly threaded closure prevents any loss or leakage of the contents and the tamper-evident band 23 acts to prevent any retrograde movement of the closure 21 during transportation and handling. While the frangible elements 25 are constructed and arranged to break when purposefully unscrewing the closure body 24, they are strong enough to resist any anticipated vibrational loads that might be induced due to transportation and handling of the filled container 20.

[0016] When it is desired to open the filled container 20 to dispense some or all of the contents, the end user simply grasps or secures the container and grasps the outside surface of the closure body 24 (or alternatively applies an appropriate hand tool), and the twists in a counterclockwise (i.e., retrograde) direction to unscrew the closure body 24 from the neck 22 of container 20. This unscrewing action, whether manual or tool-assisted, causes the closure body 24 to move upwardly in an axial direction. Since the tamper-evident band 23 is ultrasonically welded to the base of the neck 22, the tamper-evident band 23 does not rotate relative to the neck 22 and does not move axially with the closure body 24. This stationary condition of tamper-evident band 23 relative to container 20, while closure body 24 is being unscrewed, results in both a twisting force and an axial pulling or stretching force on each frangible element 25. While these combined forces are not necessarily equal on every frangible element 25, once a first frangible element breaks, these two forces, which continue to increase with the unscrewing action, are now applied against and resisted by a fewer number of frangible elements. Rapidly, the remaining frangible elements each break, thereby allowing the closure body 24 to be removed from the neck of the container while the tamper-evident band 23 remains securely connected to the neck 22. This entire separation step of separating the closure body 24 from the tamper-evident band 23 typically occurs quite rapidly. Once the closure body 24 is separated from the tamper-evident band, it can be repeatedly reapplied to and removed from the container neck. In this mode, the closure body 24 functions as a closing cap. In the embodiment of FIGS. 1-6, the number of frangible elements 25 is twelve (12) and these frangible elements are equally-spaced around the circumference of closure 21. The number of frangible elements can vary depending on their individual size and to some extent depending on closure and container sizes.

[0017] The specific style of closure illustrated in FIGS. 1-6 is what may be referred to as a hex or crown cap due to the raised hex contour of the closure body 24. This hex-shape provides six (6) flat faces 37 and alternating corner edges 38 and these features facilitate the use of automated capping equipment with a matching hex socket shape to be able to fit over the closure 21 and apply the desired tightening torque. The center area of the closure body 24 is recessed into circular socket 39.

[0018] As discussed and explained in the Background section, there are concerns with the use of undercut beads for tamper-evident bands and the present invention embodiment of FIGS. 1-6 provides an improved tamper-evident closure that eliminates the need for and use of undercut beads. The result is a better and more reliable tamper-evident closure without encountering any of the problems or concerns associated with the use of undercut beads.

[0019] Referring to FIGS. 7 and 8, there is illustrated a container 70 and tamper-evident plastic closure 71, as assembled according to another embodiment of the present invention. Except for those differences that will be described herein regarding the specific construction of closure 71, it should be understood that the use, function, and cooperation of closure 71 relative to container 70 is substantially the same as tamper-evident closure 21 relative to container 20. As with container 20, container 70 includes a generally-cylindrical, externally-threaded neck 72 that defines an annular dispensing opening 72a. The contents of container 70 are to be dispensed by way of opening 72a once closure 71 is removed. Closure 71 has the form of an internally-threaded cap and is constructed and arranged for secure threaded connection directly to the threaded neck 72 of container 70. Similar to the style of closure 21, closure 71 includes a closed end and an opposite open end, as illustrated in FIGS. 9-12.

[0020] The tamper-evident closure 71 is a unitarily molded, plastic component that includes a tamper-evident band 73 and a closing cap that is also described as being the closure body 74. As will be described herein, this particular embodiment includes the creation of a plurality of spaced-apart frangible elements 75 that span a circumferential gap 76 that is created between the tamper-evident band 73 and closure body 74. Each frangible element 75 is a small strand of plastic that is left as a result of a post-molding slitting operation. While the "finished" closure 71 can be and is best described in terms of the three cooperating portions, the closure 71 begins as a unitary, molded plastic part effectively with a single portion. The closure 71 is then modified by this slitting operation and this results in three cooperating portions including the tamper-evident band 73, the closure body 74, and the plurality of spaced-apart frangible elements 75. The plurality of frangible elements is considered to constitute one "portion" of closure 71. Similar to what has been described with regard to tamper-evident closure 21 and its relationship to container 20, this post-molding slitting operation creates a lower edge as part of the closure body 74 and it creates an upper edge for tamper-evident band 73. These two edges define the axial width of the separation gap 76 that is created by this

slitting operation.

[0021] The unitarily molded closure 71 includes a plurality of axially-extending ribs 71a that are located on the inside diameter of the lower portion of closure 71, adjacent open end 71b. In lateral section, each rib 71a has a generally triangular shape. The converging sides of each rib 71a are directed radially inwardly. These ribs 71a are described herein as "energy directors" due to their participation, at least for some of them, in the ultrasonic welding process and the manner in which these ribs function in focusing and directing the ultrasonic energy being used to ultrasonically weld the tamper-evident band 73 to the neck of the container. These ribs 71a, while described as "energy directors", also later function, after the ultrasonic welding process is completed, as frangible elements in that these ribs 71a span the gap 76 between the tamper-evident band 73 and the closure body 74.

[0022] These axially-extending ribs 71a extend the full height of tamper-evident band 73 and extend into the lower portion of what becomes closure body 74 after the slitting operation. These ribs 71a also span the gap 76 that is created by the slitting operation. Ribs 71a are arranged as a uniformly spaced series and are located such that, regardless of the orientation of closure 71 on neck 72 of container 70, at least one pair of these energy directors (i.e., ribs 71a) are located adjacent the portions of the vibrating ultrasonic horn that contact the outer surface of the tamper-evident band 73.

[0023] The embodiment disclosed in FIGS. 7-12 is described as a "slit-band" style of closure due to the post-mold operating of cutting a 360 degree circumferential slit from the outside diameter surface of the tamper-evident band 73 inwardly. This slit is cut such that it extends completely through the annular wall of the molded closure. This results in the creation of gap 76 positioned between the tamper-evident band 73 and the closure body 74. The depth of cut of the circumferential slit is just slightly greater than the wall thickness of closure 71. The slit cuts through the wall of closure 71, but is not sufficiently deep to actually cut through or sever any of the axially-extending ribs 71a. Visually this "slit" may appear as a series of slit sections since the slit does not cut through any of the ribs 71. Each slit section appears as if located and extending between a corresponding pair of adjacent ribs 71a. However, the gap 76 resulting from the slitting operation is a full 360 degrees of the closure wall. The machined slit cuts through the wall of closure body 74 overlapping each rib 71a, as is illustrated. This vertical or axial location of the slit is at or near the top (upper axial direction) of each rib 71a. The "top" of each rib 71a is defined as the end of the rib that is closest to the closed end of closure 71. The described molding and subsequent machining to create gap 76 results in a finished closure 71 that includes a closure body 74, a tamper-evident band 73, and a plurality of frangible elements 75, some of which also function as energy directors for the ultrasonic welding step. The frangible elements 75 connect the tamper-evident band 73 with the closure body 74 in a manner similar to the first embodiment of FIGS. 1-6.

[0024] In terms of the assembly or connection of the closure 71 to container 70, the tamper-evident band 73 is ultrasonically welded to the neck 72 of the container in a manner similar to the first embodiment of FIGS. 1-6. It is important to note that the positioning of the vibrating metal horn adjacent the tamper-evident band is at a location below the slit line or gap 76, actually between the gap 76 and the open end 71b. This configuration and the positioning of the metal horn causes the tamper-evident band 73 to be ultrasonically welded to neck 72. While ribs 71a have been described as energy directors, this functional description only applies to the ribs 71a selected for ultrasonic welding (i.e., melting) and it only applies to the section or portion of each rib 71a that is below the slit line (gap 76). This is the only part of each selected rib that is acted upon by the vibrating metal horn as part of the ultrasonic welding process.

[0025] The part or section of each rib 71a that spans gap 76 is not melted as part of the ultrasonic welding process and thus becomes a frangible element 75, temporarily connecting the upper portion of tamper-evident band 73 with the lower portion of the closure body 74. The functioning as a frangible element 75 applies to each rib 71a.

[0026] When the closure 71 is attempted to be removed from the container 70 for the first time, the unscrewing action of closure body 74 results in the combination of an upward axial force and a twisting or circumferential force on each of the frangible elements 75. Since the tamper-evident band 73 is welded to the neck 72, it is unable to move in response to these combined forces. Further, these forces increase until the frangible elements 75 break, thereafter allowing the closure body 74 to be removed and leaving behind the tamper-evident band 73 securely attached to neck 72. This description of what occurs is basically the same as what has been described for the first embodiment as illustrated in FIGS. 1-6.

[0027] The completed and filled container combination, according to this embodiment of the present invention, includes a container 70 that is filled with the desired contents with the closure 71 tightly and securely threaded onto the neck 72 with the tamper-evident band 73 ultrasonically welded to the base 84 of neck 72. The tightly threaded closure prevents any loss or leakage of the contents and the tamper-evident band 73 acts to prevent any retrograde movement of the closure 71 during transportation and handling. While the frangible elements 75 are constructed and arranged to break when purposefully unscrewing the closure body 74, they are strong enough to resist any anticipated vibrational loads that might be induced due to transportation and handling of the filled container 70.

[0028] When it is desired to open the filled container 20 to dispense some or all of the contents, the end user

simply grasps or secures the container and grasps the outside surface of closure body 74 and twists in a counterclockwise (retrograde) direction to unscrew the closure body 74 from the neck 72 of container 71. This unscrewing action causes the closure body 74 to move upwardly in an axial direction.

[0029] While there are a number of similarities between the first embodiment and the second embodiment as described thus far, it will be noted that the style of closure body 74 is different from that disclosed for closure body 24. Rather than a hex shape, closure body 74 is generally cylindrical with a plurality of axially-extending exterior gripping ribs 85 that are spaced apart on the outside surface of closure body 74 and provide a convenient means for manually grasping the closure body 74 for unscrewing and separating from tamper-evident band 73 by breaking the frangible elements 75. In this second embodiment, there are sixteen (16) frangible elements that are equally-spaced and this increased number is desirable in terms of selected ones of these ribs 71a also functioning as the energy directors for the ultrasonic welding process.

[0030] The first embodiment of the present invention, as illustrated in FIGS. 1-6, includes a crown-style, hex-shaped closure body 24 and the frangible elements 25 are created as part of the unitary molding of closure 21. The second embodiment of the present invention, as illustrated by FIGS. 7-12, includes a generally cylindrical, ribbed closure body 74. In this second embodiment, the frangible elements 75 result from a slitting operation following the unitary molding of closure 71. It is to the understood that according to the present invention either style of closure body 24, 74, can be used with either style of frangible elements 25, 75. These two additional embodiments of the present invention are illustrated in FIGS. 13 and 14.

[0031] FIG. 13 illustrates closure body 74 in combination with frangible elements 25 and the style of tamper-evident band 23 that is used with frangible elements 25. In order to create this finished structure, the plastic closure 100 is unitarily molded, as illustrated, with a closure body 101, frangible elements 102, and a tamper-evident band 103. The gap 104 between the closure body 101 and the tamper-evident band 103 is defined by the molded structure and the molded frangible elements 102 span this gap 104.

[0032] FIG. 14 illustrates closure body 24 in combination with frangible elements 75 and the style of tamper-evident band 73 that is used with frangible elements 75. In order to create this finished structure, the plastic closure 120 is unitarily molded with a closure body 121 corresponding to the style of closure body 24. After the molding step, a slitting operation is performed and the webs of material that are left, corresponding to the energy directing ribs 122, create the frangible elements 123 that span the gap between the closure body 121 and the tamper-evident band 124.

[0033] While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

Claims

1. A unitary, tamper-evident closure for use on the threaded neck of a container, said tamper-evident closure comprising:

   a closure body having a series of threads formed on an inner surface;
   an annular, tamper-evident band constructed and arranged for being ultrasonically welded to a portion of said container;
   a plurality of frangible elements constructed and arranged for connecting said tamper-evident band to said closure body at a plurality of spaced-apart locations; and
   wherein said tamper-evident band being free of any undercut beads and the sole structural connection of said tamper-evident band to said container is by means of ultrasonic welding.

2. The unitary, tamper-evident closure of claim 1 wherein said tamper-evident band having a generally cylindrical inner surface, at least a portion of said inner surface being constructed and arranged for being ultrasonically welded to said container.

3. The unitary, tamper-evident closure of claim 1 or 2 wherein said closure body is spaced-apart from said tamper-evident band by a defined annular gap, said plurality of frangible elements extending axially across said defined annular gap.

4. The unitary, tamper-evident closure of any of the preceding claims wherein said tamper-evident band has an inner surface that includes a plurality of energy-directing ribs for use as part of said ultrasonic welding.

5. The unitary, tamper-evident closure of claim 4 wherein one portion of each energy-directing rib extends into and is molded as a part of said closure body.

6. The unitary, tamper-evident closure of claim 4 or 5 wherein said tamper-evident closure defines a separation gap positioned between said closure body and said tamper-evident band, another portion of each energy-directing rib spanning said separation gap.

7. The unitary, tamper-evident closure of any of the preceding claims wherein said closure body has a hexagonal form.

8. The unitary, tamper-evident closure of any of the preceding claims wherein said closure body has a generally cylindrical form with a plurality of axially-extending ribs formed on an outer surface of said closure body.

9. In combination:

a container having an externally-threaded neck; and
a unitary, tamper-evident closure according to any of the preceding claims for use on the threaded neck of said container.

10. A method a capping closed a container with a tamper-evident closure, said method comprising the following steps:

(a) providing a container with a neck portion that is externally threaded;
(b) providing a tamper-evident closure having a tamper-evident band;
(c) threading said tamper-evident closure onto said container neck; and
(d) ultrasonically welding said tamper-evident band to said container.

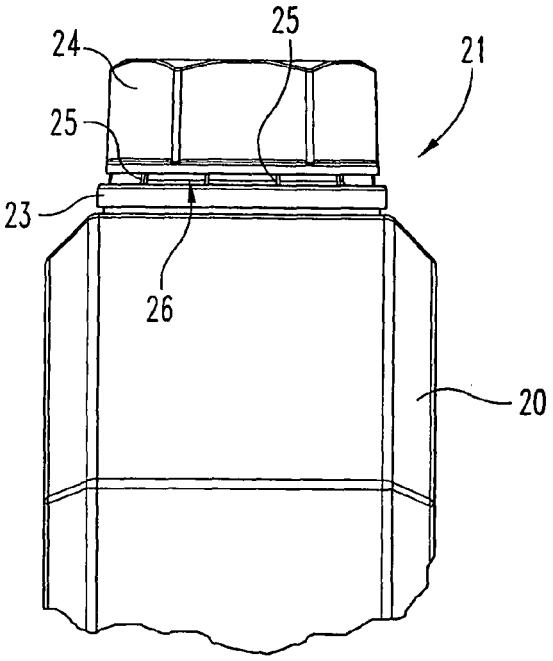

Fig. 1

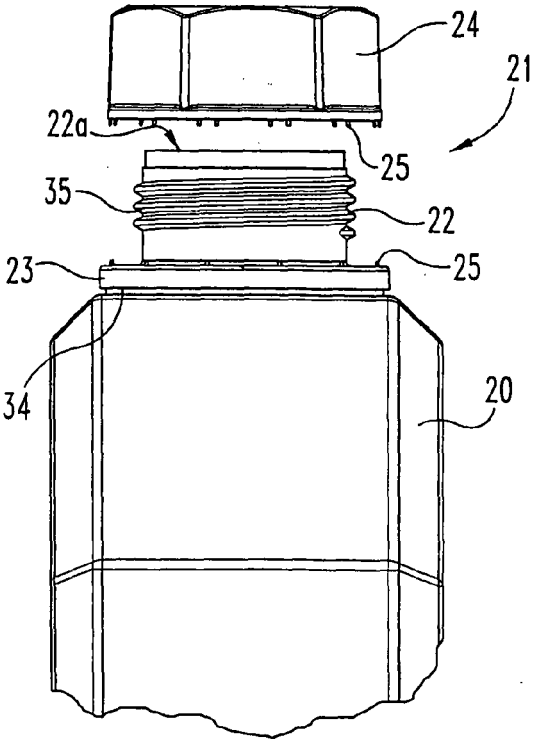

Fig. 2

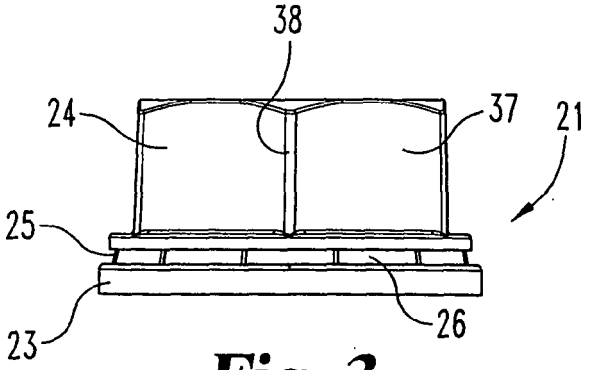

Fig. 3

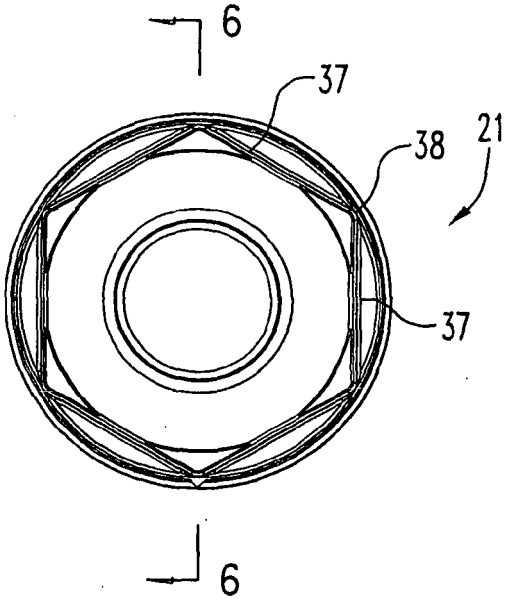

Fig. 4

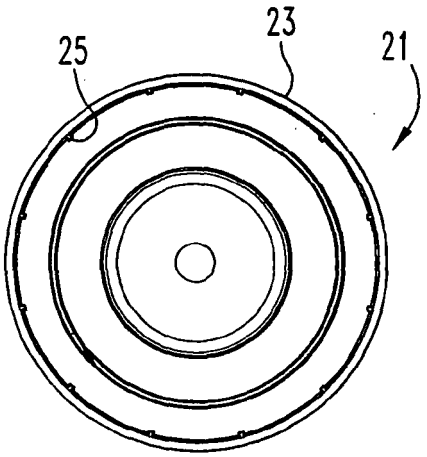

Fig. 5

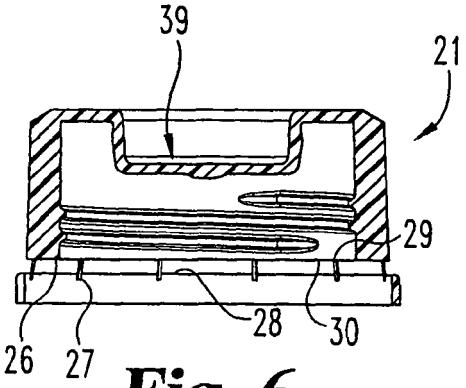

Fig. 6

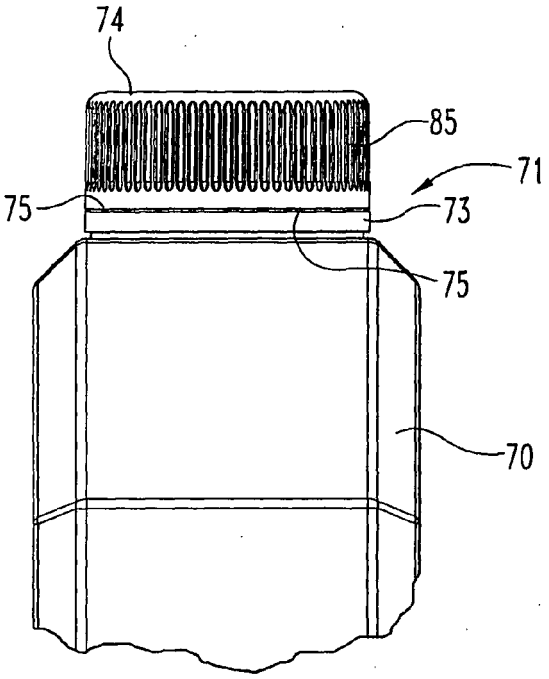

Fig. 7

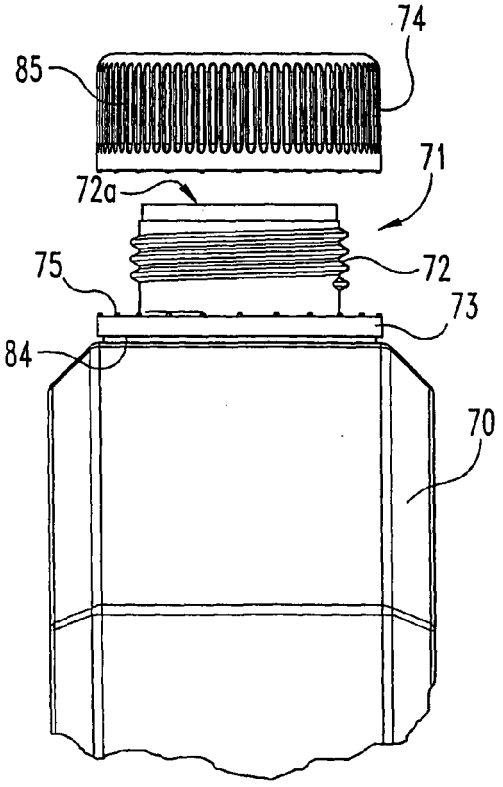

Fig. 8

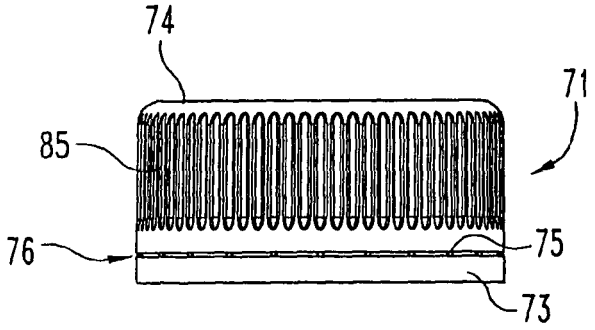

Fig. 9

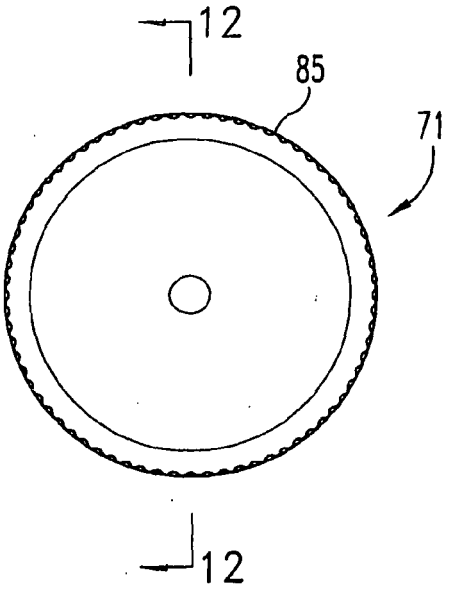

Fig. 10

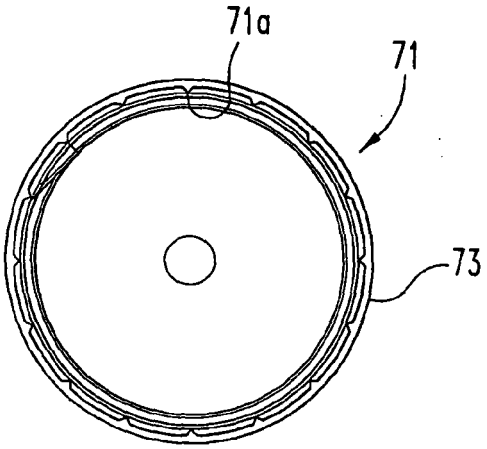

Fig. 11

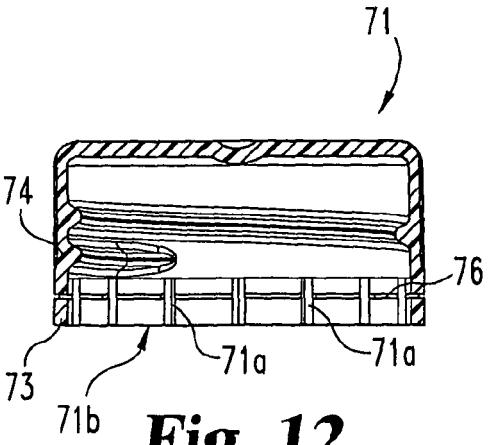

Fig. 12

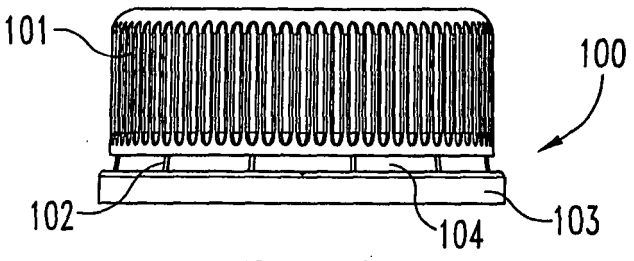

Fig. 13

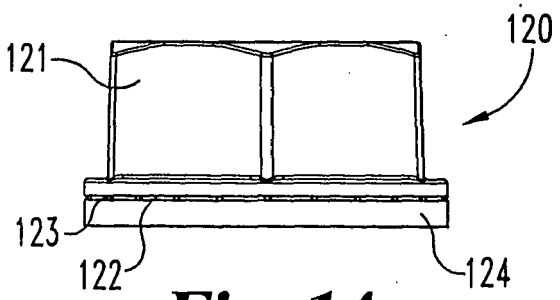

Fig. 14

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EUROPEAN SEARCH REPORT

Application Number
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B65D
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 June 2007	Dederichs, August

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