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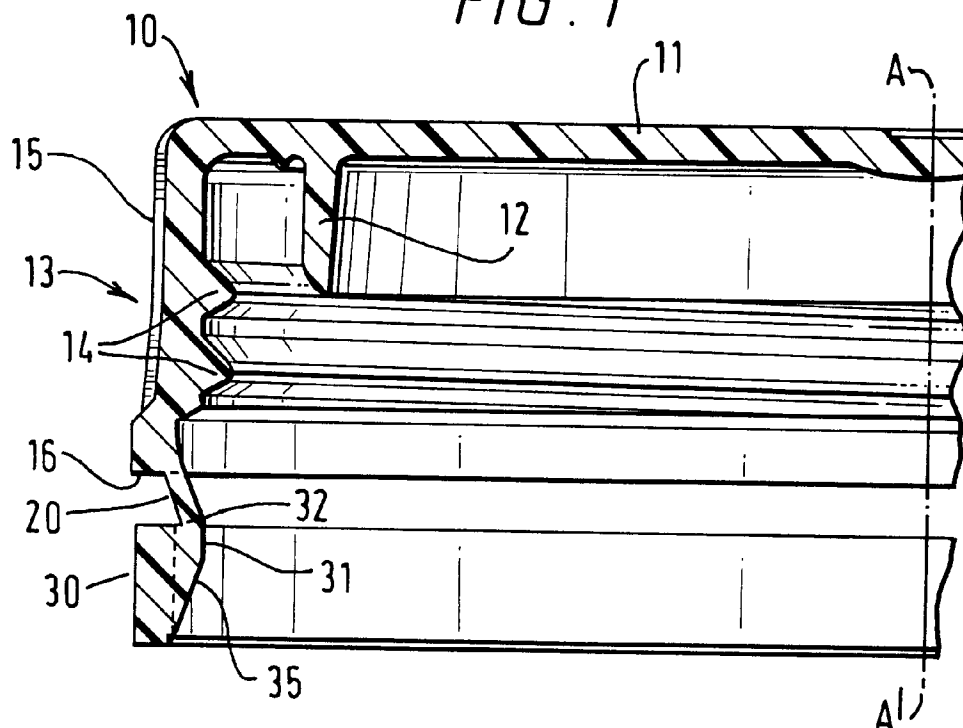
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(54) **Closure device**

(57) A closure 10 comprises a cap 11 having a skirt 13 depending therefrom. Skirt 13 has an internal screw thread 14 or equivalent for engagement with a complementary formation on a container (not shown). Closure 10 further comprises a tamper-evident ring 30 attached to skirt 13 by frangible bridges 20. At least a portion of tamper-evident ring 30 has shelf means 32 characterised by an acute-angled vertical cross-section for engagement behind a projection on the neck of a container

during removal of closure 10. This ensures effective separation of tamper-evident ring 30 from closure 10, with retention of tamper-evident ring on the container neck. Preferably, bridges 20 extend in a non-axial direction from the lower rim 16 of skirt 13 to the radially innermost extremity of tamper-evident ring 30. Bridges 20 may be narrower in section adjacent skirt 13. Optionally, skirt 13 and tamper-evident ring 30 have complementary formations (46, 36; See Figure 4) which interengage when closure 10 is screwed onto a container.

FIG. 1**EP 0 729 894 A2**

Description

The present invention relates to a closure device and, in particular, to a closure device adapted for screw-threaded or like engagement with a plastics container such as those used for milk/juice packaging or for other food and non-food products commonly sold in super-markets. More particularly, the invention is concerned with the provision of an improved tamper-evident arrangement for such a closure device.

Closures having tamper-evident means are well known and serve to reassure would-be purchasers of goods that the contents of a bottle or similar container have not been subject to tampering after filling.

One form of known device is described in British Patent No. 1 457 991 and comprises a tamper-evident ring which is attached to the downwardly-depending skirt of a closure by frangible bridges that sever on the first occasion that the closure is unscrewed. In this known device, the tamper-evident ring is of greater diameter than the closure itself, with the result that manipulation of the closure is hampered by the radially outwardly projecting tamper-evident ring. Sometimes this projection causes minor injuries to users' fingers. Nevertheless, this type of arrangement currently enjoys widespread use by stores retailing milk and non-carbonated fruit drinks in polyethylene containers.

Another drawback of this known design is that the tamper-evident ring is not held captive on the container neck once separated from the closure. As a result, there is a tendency for the tamper-evident ring to fall into drinks when the container is tilted, especially when the volume of drink remaining in the container reaches a low level. This problem has led to increasing customer dissatisfaction.

In another known closure device described in International Patent Application No. WO94/18085, the tamper-evident ring is dimensioned to be an interference fit with the container neck and becomes permanently stressed when the closure is applied to a container. As a result, severance of the frangible bridges does not provide on-shelf evidence of tampering because the tamper-evident band does not fall away from the closure. Rather, it remains fixed in position on the container neck.

In general, the types of container for which the present invention is intended will be produced by blow-moulding polyethylene, although other materials and moulding processes can be used.

Mass produced blow moulded containers, particularly when manufactured to a lightweight design in polyethylene, tend to exhibit a less well-defined neck finish than other containers. This means that, for a closure to function consistently correctly, it must be capable of accommodating a wide spread of neck finish tolerances.

Although other materials and container manufacturing processes can be used, particularly for non-food applications, it is unlikely that the present level of customer

dissatisfaction will persuade high volume users of lightweight polyethylene containers to switch to alternative types, especially in view of the low cost, low weight and compatibility that they exhibit with the products with which they come into contact. This is particularly true for the dairy and non-carbonated drinks industries.

It is therefore an object of the present invention to provide a closure device which is adapted to accommodate a wide range of tolerances in container neck finishes and which addresses the other problems outlined above.

The invention is a plastics closure adapted for releasable engagement with a container, said closure comprising a cap portion extending in a plane perpendicular to a rotational axis of the closure, said cap portion having a skirt portion depending therefrom and said skirt portion having retaining formations on a circumferential inner surface thereof adapted for engagement with complementary retaining formations on a container, and further comprising a tamper-evident ring attached by a plurality of frangible bridges to a lower rim of the skirt portion remote from said cap portion, characterised in that at least a portion of the tamper-evident ring has shelf means formed on the radially inner periphery of an upper surface thereof, said shelf means being moulded with an acute-angled vertical cross-section and being dimensioned to engage projection means on a container during removal of the closure such that separation of the tamper-evident ring from the skirt is effected.

The advantage conferred by the acute-angled vertical cross-section of the shelf means is that it serves to concentrate frictional forces between the projection means on the container neck portion and the tamper-evident ring. This means that the tamper-evident ring effectively bites into the projection means during the action of removal of the closure for the first time. As a result, the tamper-evident ring is prevented from riding over the projection means. This arrangement is particularly effective to ensure retention of the tamper-evident ring on the container neck. Moreover, the relative dimensions of the tamper-evident ring and the container neck are such that the tamper-evident ring falls away from the lower rim of the closure skirt portion once the frangible bridges have been broken. This ensures that tampering can be spotted by would-be purchasers of the goods whilst they are still on the shelves in the store. These advantages are obtained even where wide tolerances occur in the neck finishes of the containers to which the closure is applied.

The invention represents a significant improvement over known closures that present a bluff surface or chamfered surface to the retaining projection means on the container, or that use a permanently-stressed tamper-evident ring which does not drop away from the closure skirt when the frangible bridges are broken.

Preferably, the shelf means defines an angle β relative to a plane perpendicular to the rotational axis of the closure, which angle lies in the range from 5 to 25°.

A most preferred value for β is 15° . Angles falling outside this range are less effective in achieving the objects of the invention. If the angle is too shallow, the tamper-evident ring does not engage the retaining projection with a sufficiently positive action and the tendency for the tamper-evident ring to ride over the retaining projection increases. If the angle is too steep, the shelf means resembles a flap and has an excessive degree of flexibility. Such flexibility is detrimental to the object of the invention because it enables the shelf means to be bent over by the retaining projection. Again, the likelihood of the tamper-evident ring riding over the retaining portion is increased.

The portion of the tamper-evident ring on which the shelf means is provided may be a continuous bead. However, in an especially preferred form of the invention, the shelf means is formed as a series of radially inwardly projecting nibs provided on the inner circumference of the tamper-evident ring. Such an arrangement offers the advantage over the continuous bead variant that it makes the tamper-evident ring more flexible and hence better suited for push-on application when the closure is first fitted. This is particularly advantageous in high speed bottling plant.

Where first application by screw-fitting is contemplated, the lower rim of the skirt portion and the upper rim of the tamper-evident ring may be provided with complementary formations which interengage when the closure is subjected to a compressive force as it is screwed onto a container. The complementary formations may be in the form of a series of projections and recesses. In such an arrangement, the frangible bridges flex under the compressive force, causing the separation between the skirt portion and the tamper-evident ring to decrease so that the complementary formations interengage. During the screwing-on process, the skirt portion and the tamper-evident ring effectively behave as a single unit, thereby avoiding stretching of the frangible bridges.

The complementary formations may be configured such that positive engagement between them is facilitated in the forward or screwing-on sense of rotation but inhibited in the reverse or removal sense of rotation. This may be achieved, for example, by providing non-symmetrical driving teeth on one of the components. These are oriented such that they have steeply-pitched trailing surfaces which are engageable against respective bluff surfaces formed in recesses provided on the other component. The teeth have gently-pitched leading surfaces which, in the reverse sense of rotation, engage with similarly-inclined surfaces provided on the recesses, so that there is a tendency for the components to slide over each other and rotate relative to one another. This relative rotation leads to rupture of the frangible bridges when the closure is removed for the first time.

Advantageously, the radially inwardly projecting nibs have a ratchet configuration when viewed from above or below. The leading edge of the nib, when

judged in relation to a screwing-on action, has a shallow chamfered surface. The angle of the chamfer is, typically, between 10 and 30° . The trailing edge has a much steeper profile and may be substantially radial. This ratchet configuration of the nibs is intended to facilitate installation of the closure on a container for the first time in cases where the container is provided with ratchet dogs on its neck surface beyond the tamper-evident ring projection means.

The tamper-evident ring may be provided with a chamfer in the axial direction to facilitate installation of the closure by push-fitting rather than screw-fitting. In this particular arrangement, the tamper-evident ring has a surface which converges radially inwardly from the lower rim of the tamper-evident ring. In industrial scale bottling plant, a push-fit closure offers the advantages of being able to increase line speeds and reduce operational complexity because the need for torque-sensing clutch mechanisms to determine when a closure has been screw-tightened sufficiently is avoided.

In another particularly preferred form of the invention, the frangible bridges are attached to the closure and tamper-evident ring, respectively, such that they extend in a non-axial direction from the lower rim of the closure skirt portion to the radially innermost extremity of the upper rim of the tamper-evident ring. This means that the frangible bridges form a series of links which converge towards the centre axis of the closure in the direction from the lower rim of the skirt towards the tamper-evident ring.

The advantage of this arrangement is that, when the tamper-evident ring stretches radially outwardly to ride over the retaining projection means on a container during installation of the closure, the frangible bridges are also able to flex in the radially outward direction with minimal stretch or stress due to the additional length which results from their non-axial disposition. This arrangement therefore provides the means whereby the frangible bridges may be formed with increased length relative to conventional bridges, without the disadvantage of making them too long such that their ability to break is compromised on the occasion of first removal of the closure from a container. This is particularly important on shallow closures such as those used on milk and non-carbonated fruit drinks containers. Shallow closures have a limited screw-thread engagement and it is unlikely that a tamper-evident ring which is attached to a closure skirt by longer axial bridges would be capable of sufficient thread engagement to enable good separation to take place between the closure skirt and the tamper-evident ring when the closure is removed for the first time.

Typically, the bridges are inclined at an angle of between 15 and 30° to the central axis of the closure. The most preferred angular range is from 20 to 25° , with an angle of 22° being especially preferred. Observance of these angles is important to ensure that the closure can be ejected readily from the mould during manufacture.

This is an essential point to be borne in mind for components which need to be jumped from an undercut feature on a mould core. If the angle is too shallow, then severe dragging of the nibs occur, rendering them ineffective. If it is too steep, there is a risk that the frangible bridges will be so excessively long that their extension to breaking point cannot occur within the available travel provided by the threads.

In another preferred variation, the frangible bridges are of non-uniform cross-section, being narrower adjacent the closure skirt. This means that, upon severance, the tails of the bridges remain attached to the tamper-evident ring and the closure itself presents a relatively clean lower rim. Although of seemingly minor importance, this is another factor which influences customer satisfaction.

Preferably, the outer diameter of the tamper-evident ring is the same as the outer diameter of the closure skirt. This provides a greater gripping area on the sides of the closure skirt because it is not inhibited by a so-called "external" tamper-evident ring. Such an arrangement is more comfortable for the user.

The invention will now be described by way of example only with reference to the drawings, in which:

- Figure 1 is a side sectional partial view of a preferred embodiment of the present invention;
- Figure 2 is a top plan view of the tamper-evident ring of Figure 2, showing the ratchet configuration of the nibs and complementary ratchet dogs on a drinks container neck;
- Figure 3 is a side sectional view of a preferred form of tamper-evident ring, showing the acute-angled vertical cross-section of the radially-inwardly projecting nibs.
- Figure 4 is a side sectional partial view of another embodiment of the invention, showing the skirt portion and the tamper-evident ring with complementary driving formations, and
- Figure 5 is a similar view to Figure 4 showing the complementary formations in the engaged condition.

Referring now to Figure 1, reference numeral 10 denotes a closure for use on a container such as a milk or other type of bottle containing food or non-food products. The closure itself is moulded from polypropylene and is shown here in enlarged form for ease of reference, a typical diameter for such closures being 38 mm.

Closure 10 comprises a cap portion 11 having an internal closure plug 12 for sealing engagement with the lip of a container (not shown) during use, and a downwardly depending skirt 13. The skirt 13 has an internal screw thread 14 for engagement with a complementary external screw thread on the neck of the container, and is provided on its outer surface with a gripping portion 15 having a knurled or serrated finish to enable a good

grip to be obtained by the user when unscrewing or replacing the closure 10.

A tamper-evident ring 30 is attached at the bottom rim 16 of the closure 10 by a plurality of frangible bridges 20. The outer periphery of the tamper-evident ring 30 is substantially co-extensive with that of the skirt 13 so that the gripping portion 15 remains unhindered by radially-outwardly projecting features.

The tamper-evident ring 30 is formed on its radially inner surface with a series of nibs 31, each of which is provided with an upwardly-directed projection on its radially innermost portion to define an undercut formation 32, or shelf means. This undercut formation 32 serves to engage the underside of a retaining projection (51, see ghost outline in Figure 3) provided on the neck of the container.

During the action of unscrewing the closure 10 from the neck 50 of a container for the first time, the engagement of the undercut formation 32 against the retaining projection 51 of the container causes axial movement of the tamper-evident ring 30 to be arrested. The closure skirt 13 is able to continue its axial movement by virtue of mutual engagement between the screw threads 14 of the skirt 13 and the external screw threads (not shown) of the container. As a result, the frangible bridges 20 are caused to stretch beyond their breaking points, which breaking points are reached before complete disengagement of the respective screw threads. Although separated from the closure skirt 13, the tamper-evident ring 30 is held captive on the container, behind the retaining projection. The relative dimensions of the tamper-evident ring 30 and the container neck 50 are such that the tamper-evident ring is free to drop away from the retaining projection 51 when the container is in an upright orientation.

Referring now to Figure 2, this shows a view from above of the tamper-evident ring 30 discussed above with reference to Figure 1. The neck 50 of a container is shown in cross-section. This view shows the ratchet profile of the radially-inwardly projecting nibs 31. When judged in relation to the screwing-on direction, as represented by arrow A in the Figure, the leading edge 33 of each nib has a shallow chamfered surface. By contrast, the trailing edge 34 presents a much steeper profile, being substantially radial. The nibs 31 are adapted to co-operate with complementary ratchet dogs 52 formed on the outer periphery of the neck 50 of a container.

Typically, the tamper-evident ring 30 has nibs 31 formed at 20° intervals around its periphery. Not all of the nibs have an associated frangible bridge 20 as this would greatly increase the force required to unscrew the closure 10 and effect separation thereof from the tamper-evident ring 30. Conveniently, a frangible bridge 20 is formed at every third nib 31, so that a total of 6 frangible bridges 20 is provided on the complete closure 10. These are shown in cross-section on the Figure.

When the closure 10 is first screwed on to a con-

tainer neck, the leading edges 33 of the nibs 31 are able to ride over the ratchet dogs 52 formed on the neck because the leading edges 53 of the ratchet dogs 52 are also gently chamfered. However, rotation in the opposite sense, i.e. to unscrew the closure, causes the trailing edges of the ratchet dogs 54 to butt against the trailing edges 34 of the nibs 31, thereby resisting rotation of the tamper-evident ring 30 relative to the container neck 50. Rotation of the closure skirt 13 is, however, still possible against the resistive force of the frangible bridges 20, thereby causing them to elongate.

The elongation of the frangible bridges 20 during removal of the closure 10 for the first time is therefore caused by a combination of factors: Firstly, axial movement of the tamper-evident ring 30 is prevented by engagement of the undercut formation 32 of the nibs 31 against the retaining projection 51 on the container neck 50. Secondly, rotational movement of the tamper-evident ring 30 is prevented by abutment of the trailing edges 34 of the nibs 31 against the ratchet dogs 52. In addition, the frangible bridges become stretched around the profile of the retaining projection 51 of the container neck 50.

Returning once again to Figure 1, the nibs 31 are also formed with a chamfer 35 in the axial sense. This arrangement allows the closure to be installed on a container neck for the first time by push-fitting rather than screw-fitting.

Referring now to Figure 3, this shows a side sectional part view of the closure skirt 13 and tamper-evident ring 13 of Figures 1 and 2, joined together by a frangible bridge 20. Here it is clearly shown that the frangible bridge 20 is inclined at angle α to the rotational axis AA' of the closure by virtue of the fact that the lowermost extremity 22 of the bridge 20 is attached to the radially-innermost part 32 of the nib 31. This inclination is helpful in enabling the bridge 20 to ride over the retaining projection 51 of a container 50 when the closure is first installed. The additional length of the bridge 20, relative to a prior art bridge having an axis parallel to the rotational axis AA' of the closure, enables the bridge to flex in the direction of the arrow C without extension to breaking point.

The preferred value for the angle of inclination α of the bridges 20 is between 15 and 30°, more preferably between 20 and 25°. The most preferred angle, as shown in the present example, is 22°.

The view of Figure 3 also shows the non-uniform section of the bridge 20. At the upper end 21, adjacent the lower rim 16 of the skirt 13, the bridge 20 is slightly narrower than at the lower end 22 adjacent nib 31. As a result, when the bridge 20 is stretched to breaking point, the preferred fracture point is in the vicinity of the narrow section at the upper end 21. The advantage of this arrangement is that the skirt 13 presents a relatively clean lower rim 16 after separation from the tamper-evident ring 30. The severed tails of the frangible bridges 20 remain attached to the tamper-evident ring 30 which

is held captive on the container neck.

This Figure also shows detail of the configuration of the undercut formation 32 of the nib 31. Preferably, the angle β of the undercut formation lies in the range from 10 to 20°, a preferred value being 15°.

Referring now to Figures 4 and 5, these views show another embodiment of the closure depicted in Figures 1 to 3. In the Figures, like reference numerals are used to denote features common to both embodiments and it is therefore unnecessary to describe in detail those features of the Figure 4 and 5 embodiment which have already been discussed above.

In Figure 4, the lower rim 16 of the closure skirt portion 13 is provided with a plurality of recesses 46 which are formed with a steeply-pitched trailing surface 47 and a shallow-pitched leading surface 49. Intervening root surface 48 lies substantially parallel to the lower rim 16 of the skirt portion 13.

The tamper-evident ring 30 is formed with a series of projections 36 around its top rim. These projections 36 are configured to complement the recesses 46 formed in the lower rim 16 of the skirt portion 13. They each have a steeply-pitched trailing surface 37, a shallow-pitched leading surface 39 and an intervening crown surface 38 which is substantially parallel to the top rim of the tamper-evident ring 30.

The terms "leading surface" and "trailing surface" are used here for convenience and should be interpreted with reference to the act of screwing the closure onto a container, indicated by rotation in the sense of arrow B in Figure 5.

Figure 4 depicts this embodiment of the closure in a relaxed condition, either prior to fitting to a container, or after fitting to a container for the first time. In the relaxed condition, the frangible bridges 20 hold the skirt portion 13 and the tamper-evident ring 30 in spaced-apart relationship. The gap between these components is larger than the distance by which the crowns 38 of projections 36 protrude beyond the top rim of the tamper-evident ring 30.

In Figure 5, the closure is depicted in a compressed condition in which the gap between the skirt portion 13 and the tamper-evident ring 30 is decreased as a result of flexure of the frangible bridges 20. This occurs when the closure is applied to a container for the first time.

In the compressed condition, the projections 36 on the tamper-evident ring 30 protrude into the recesses 46 on the lower rim 16 of the skirt portion 13.

When the closure is rotated in the sense of arrow B, the steeply-pitched trailing edges 37 of the projections 36 engage with the steeply-pitched trailing edges 47 of the recesses 46. This engagement resists relative rotation between the skirt portion 13 and the tamper-evident ring 30, enabling the closure to be screwed onto a container as a unitary assembly without risk of rupturing the frangible bridges 20.

When the closure is rotated in the opposite direction, i.e. for unscrewing, there is less likely to be an ap-

plied compressive force acting to reduce the gap between the skirt portion 13 and the tamper-evident ring 30. However, in the event that there is slight compression, the leading edges 39 of the projections 36 engage against leading edges 49 of recesses 46. Both sets of leading edges have shallow pitch, so the resistance to relative rotation between the skirt portion 13 and the tamper-evident ring 30 is easily overcome. Such relative rotation causes the frangible bridges 20 to elongate until they become stretched beyond breaking point, thereby effecting separation of the tamper-evident ring 30 from the skirt portion 13.

In a variant of the embodiment described above with reference to Figures 4 and 5, the positions of the projections 36 and of the recesses 46 can be switched so that projections 36 are provided on the lower rim 16 of the skirt portion 13 and recesses 46 are provided on the upper rim of the tamper-evident band 30. A combination of recesses and projections could also be provided on the respective components, provided that each projection is in register with a recess on the other component.

Although the invention has been described above with reference to particular examples, it will be understood by persons skilled in the art that the invention can be applied to a wide variety of containers and that various modifications are possible without departing from the scope of the claims which follow.

Claims

1. A plastics closure (10) adapted for releasable engagement with a container, said closure (10) comprising a cap portion (11) extending in a plane perpendicular to a rotational axis (AA') of the closure (10), said cap portion (11) having a skirt portion (13) depending therefrom and said skirt portion (13) retaining formations (14) on a circumferential inner surface thereof adapted for engagement with complementary retaining formations on a container, and further comprising a tamper-evident ring (30) attached by a plurality of frangible bridges (20) to a lower rim (16) of the skirt portion (13) remote from said cap portion (11), characterised in that at least a portion of the tamper-evident ring (30) has shelf means (32) formed on the radially inner periphery of an upper surface thereof, said shelf means (32) being moulded with an acute-angled vertical cross-section and being dimensioned to engage projection means (51) on a container during removal of the closure (10) such that separation of the tamper-evident ring (30) from the skirt portion (13) is effected.
2. A closure (10) as claimed in claim 1 wherein the shelf means (32) defines an angle (β) relative to a plane perpendicular to the rotational axis (AA') of

the closure (10), which angle lies in the range from 5 to 25°.

3. A closure (10) as claimed in claim 1 or claim 2 wherein the portion of the tamper-evident ring (30) which has the shelf means (32) is a series of radially inwardly projecting nibs (31) formed on the inner circumference of the tamper-evident ring (30).
4. A closure (10) as claimed in claim 3 wherein the nibs (31) have a ratchet configuration when viewed from above or below and wherein the leading edge of each nib (31), when judged in relation to a screwing-on action of the closure (10), has a shallow chamfered surface (33).
5. A closure (10) as claimed in any preceding claim wherein the tamper-evident ring (30) has a chamfer (35) in the longitudinal direction, converging radially inwardly from a lower rim of the tamper-evident ring (30).
6. A closure (10) as claimed in any preceding claim wherein the frangible bridges (20) are attached to the closure (10) and tamper-evident ring (30), respectively, such that they extend in a non-axial direction from the lower rim (16) of the skirt portion (13) to the radially innermost extremity of the tamper-evident ring (30).
7. A closure (10) as claimed in claim 6 wherein the frangible bridges (20) are inclined at an angle (α) of between 15 and 30° to said rotational axis (AA') of the closure (10).
8. A closure (10) as claimed in claim 7 wherein the angle of inclination (α) of the frangible bridges (20) is between 20 and 25°.
9. A closure (10) as claimed in any preceding claim wherein the frangible bridges (20) are non-uniform in cross-section, having a narrower cross-section in the region thereof adjacent the lower rim (16) of the skirt portion (13).
10. A closure (10) as claimed in any preceding claim wherein the outer diameter of the tamper-evident ring (30) is substantially the same as the outer diameter of the skirt portion (13).
11. A closure (10) as claimed in any preceding claim wherein the lower rim (16) of the skirt portion (13) and the top rim of the tamper-evident ring (30) are provided with complementary formations (36, 46) which are interengageable so as to resist relative rotation between the skirt portion (13) and the tamper-evident ring (30) when the closure (10) is first applied to a container.

FIG. 1

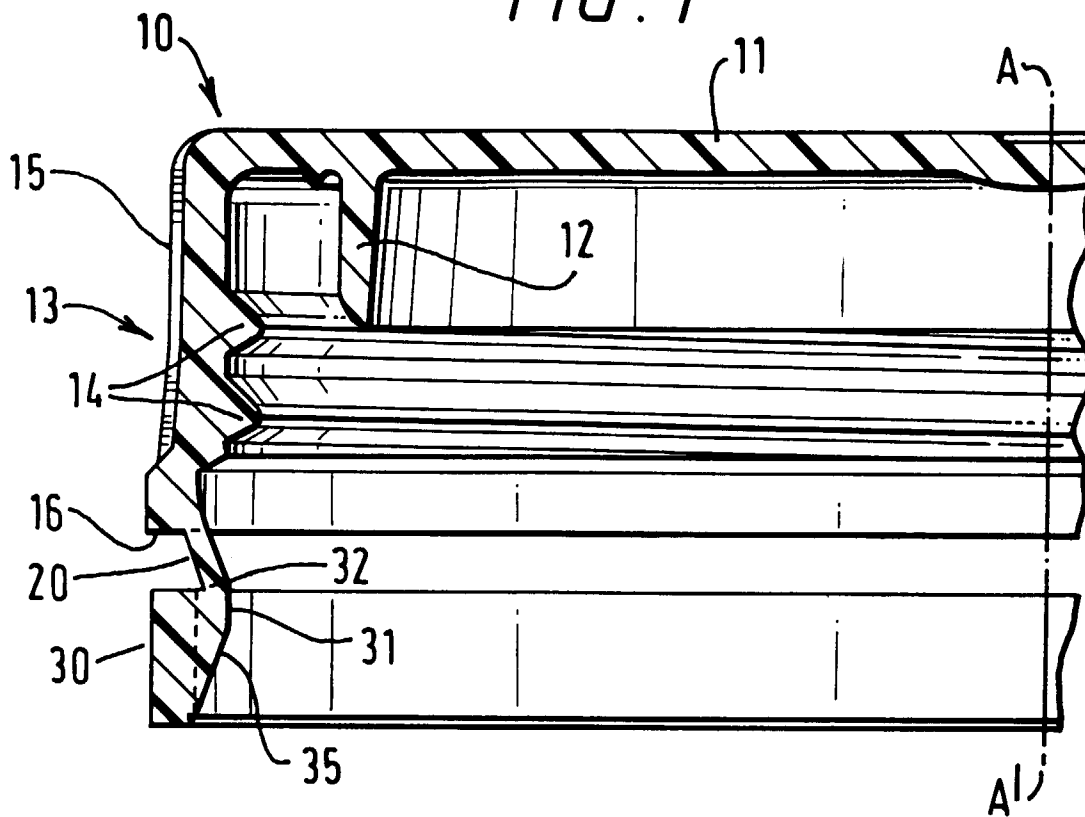


FIG. 2

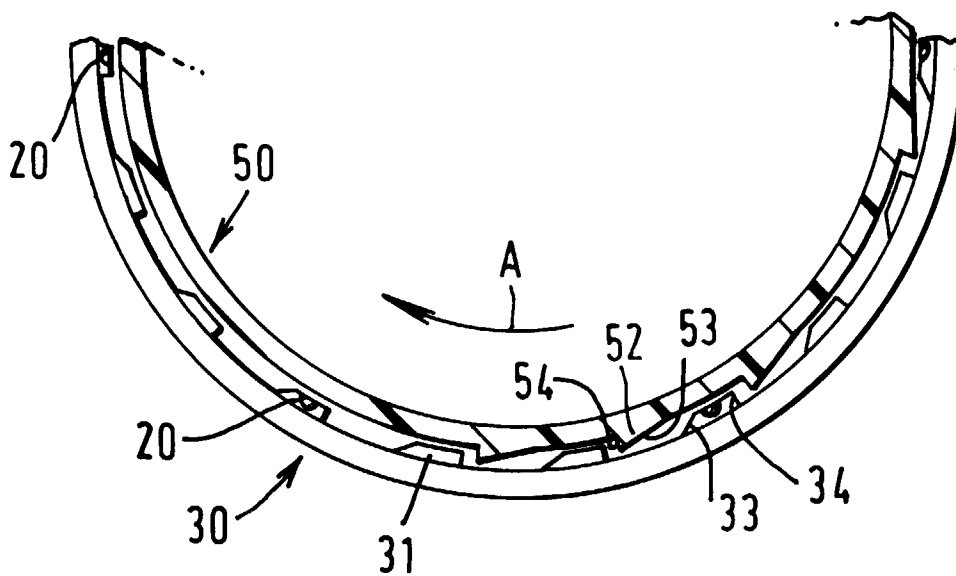


FIG. 3

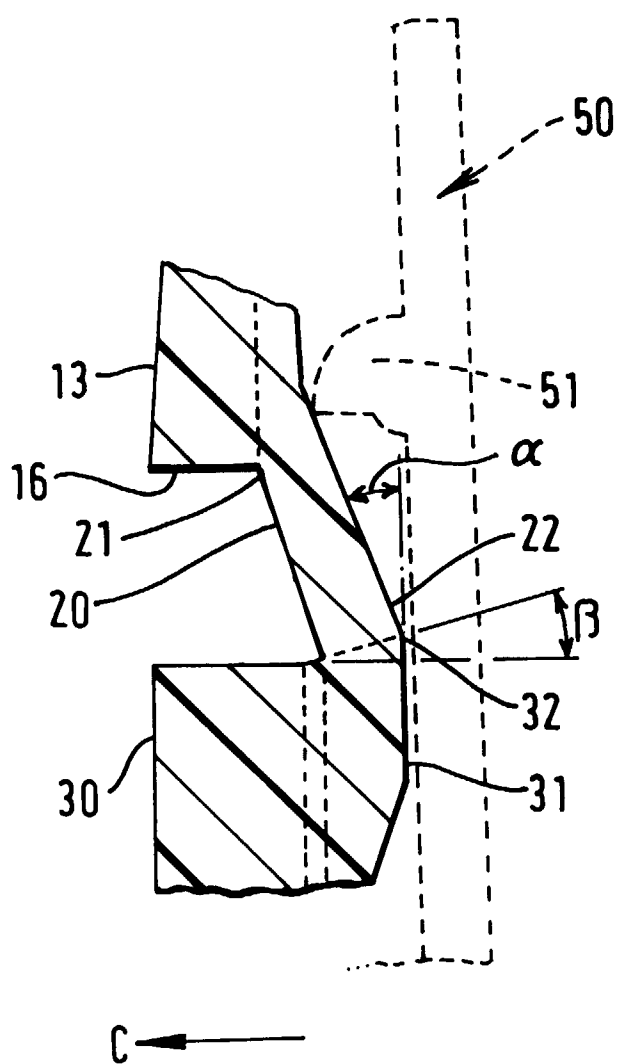


FIG. 4

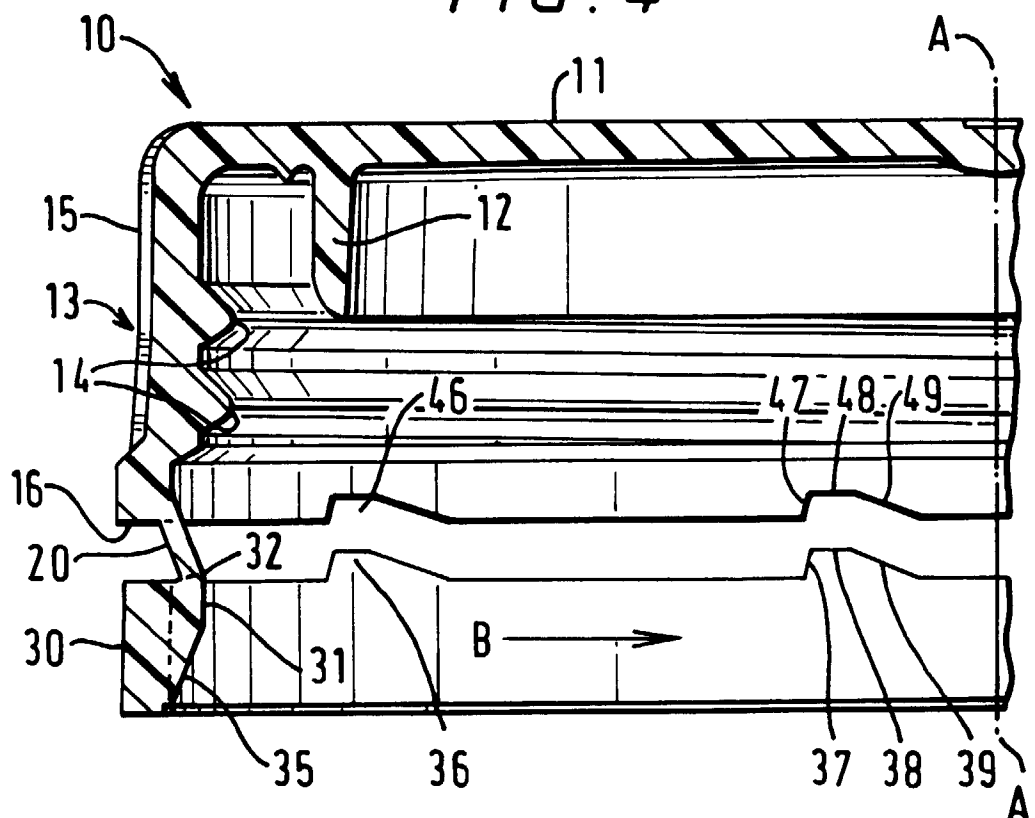


FIG. 5

