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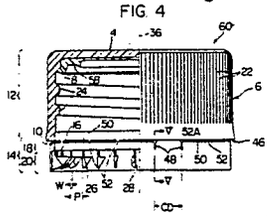
(54) Pilfer-proof plastic closure for containers.

(57) A pilfer-proof plastic closure comprising a top panel wall (4) and a cylindrical skirt wall (6) extending downwardly from the peripheral edge of the top panel wall (4).

An axial breaking line (48) is formed in the pilfer-proof bottom portion (14) which extends downwardly from the upper end of the pilfer-proof bottom portion but is non-existent in at least a greater portion of the lower part of the pilfer-proof bottom portion. At least a greater portion of the base edge (28) of each of the engaging flaps is positioned in the aforesaid lower part where the axial breaking line (48) does not exist.

FIG. 4



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PILFER-PROOF PLASTIC CLOSURE FOR CONTAINERS

FIELD OF THE INVENTION

This invention relates to a pilfer-proof plastic closure for containers, and more specifically, to a pilfer-proof plastic closure for application to a container of the kind referred to in the pre-characterizing portion of patent claim 1. Such a closure is known from US-A- 4 418 828.

DESCRIPTION OF THE PRIOR ART

Pilfer-proof metallic closures for containers holding various drinks have recently been superseded by pilfer-proof plastic closures. A typical example of such plastic container closures is disclosed in Japanese Laid-Open Patent Publication No. 74445/1981 and U.S. Patent No. 4,418,828.

The closure disclosed in these patent documents has a top panel wall and a cylindrical skirt wall extending downwardly from the peripheral edge of the top panel wall. A circumferentially extending breakable line is formed in the skirt wall to divide it into a main portion above the breakable line and a pilfer-proof bottom portion below it. The circumferentially extending breakable line composes of a plurality of circumferentially extending slits spaced from each other in the circumferential direction and a plurality of bridging portions positioned among the circumferential slits. An internal thread is formed on the inner surface of the main portion, and a plurality of radially inwardly projecting engaging flaps are formed on the inner surface of the pilfer-proof bottom portion at circumferentially spaced positions.

The plastic closure of the above structure is applied to a container equipped with a mouth-neck portion having an external thread formed on its peripheral surface and a holding jaw portion located beneath the external thread. To close the mouth-neck portion of the container with the closure, the closure is put over the mouth-neck portion and turned in a closing direction to fit the external thread of the mouth-neck portion in the internal thread of the closure. As a result, the closure turns in the closing direction with respect to the mouth-neck portion and at the same time, moves axially downwardly. At this time, the holding jaw portion formed on the outer surface of the mouth-neck portion interferes with the engaging flaps formed on the inner surface of the pilfer-proof bottom portion to elastically bend them radially outwardly. When the engaging flaps completely go past the holding jaw portion, they elastically return radially inwardly and are held to the undersurface of the holding jaw portion. To open the mouth-neck portion of the container, the closure is turned in an opening direction which is reverse to the closing direction. As a result, the internal thread of the closure is moved along the external thread of the mouth-neck portion, and therefore, the closure turns in the opening direction and simultaneously moves axially upwardly. The pilfer-proof bottom portion of the closure, however, cannot move axially upwardly because the engaging flaps formed on its inner surface engage the undersurface of the holding jaw portion of the mouth-neck portion. This results in a considerable stress on the bridging portions of the breakable line formed in the skirt wall of the closure. Consequently, the bridging portions are broken to separate the skirt wall into the main portion and the pilfer-proof bottom portion. Thereafter, the top panel wall and the main portion of the skirt wall are removed from the mouth-neck portion. The mouth-neck portion thus opened, and the pilfer-proof bottom portion remains attached to the mouth-neck portion.

It is important that container closure of the above structure and function should meet the following two requirements. Firstly, in closing the mouth-neck portion of the container with the closure, the engaging flaps should be easily bendable elastically in the radially outward direction during their passage over the holding jaw portion, so as to mount the closure on the mouth-neck portion with a relatively low rotating torque and to accurately prevent generation of an excessive stress on the bridging portions of the breakable line which will result in its breakage. Secondly, in opening the mouth-neck portion of the container, the engaging flaps should fully accurately engage the holding jaw portion so as to accurately prevent the closure from slipping out of the mouth-neck portion without the breakage of the bridging portions of the breakable line as a result of the engaging flaps going past the holding jaw portion while being bent radially outwardly. It will be appreciated that if this slipping occurs, the pilfer-proof characteristics of the closure will be impaired. In order for the closure to meet these two requirements, it is necessary to reduce sufficiently the downwardly rotating torque which must be exerted on the closure when the engaging flaps are passed over the holding jaw portion axially downwardly from above, to increase sufficiently the upwardly rotating torque which must be exerted on the closure when the engaging flaps are passed over the holding jaw portion axially upwardly from below, and to adjust the breaking rotating torque which must be exerted on the closure for breaking

the bridging portions of the breakable line as desired to a value between the required downwardly rotating torque and the required upwardly rotating torque.

In conventional container closures, however, no sufficient difference can be set up between the required downwardly rotating torque and the required upwardly rotating torque, and frequently, owing to errors in production, the containers do not meet the aforesaid first or second requirement.

On the other hand, if the pilfer-proof bottom portion remains attached to the mouth-neck portion, it must be removed when the container is to be used again. This removing operation, however, is considerably complex. Moreover, when the pilfer-proof bottom portion remains in the mouth-neck portion and the top panel wall and the main portion of the skirt wall which have once been removed are again mounted on the mouth-neck portion, it is not rare that the bridging portions of the closure which have been broken at the time of opening the mouth-neck portion look as if they were not broken, and the pilfer-proof characteristics of the closure are not sufficiently evident. For these reasons, it is often desired in plastic closures as is realized in metallic closures to remove the pilfer-proof bottom portion also together with the other portions of the closure at the time of opening the mouth-neck portion. To achieve this desire, it is necessary as in the case of the metallic closures to make the strength of at least one bridging portion higher than the other bridging portions and form a breaking line axially in the pilferproof bottom portion. When this structure is employed, the axial breaking line is broken at the time of opening the mouth-neck portion and the pilfer-proof bottom portion is opened in a tape form. In the meantime, the bridging portion having a higher strength is retained without breakage. Accordingly, the pilfer-proof bottom portion opened in a tape form remains attached to the main portion of the skirt wall by the higher strength bridging portion and the pilfer-proof bottom portion is also removed from the mouth-neck portion together with the other portions of the closure.

In the production of plastic container closures which meet the above requirement, the following problem to be solved exists with regard to the formation of an axial breaking line in the pilfer-proof bottom portion.

The axial breaking line is formed of a so-called perforation or score as in the case of metallic closures. It is desired in this case to provide the axial breaking line simultaneously with, or separately from, the provision of the circumferential slits in the circumferentially extending breakable line after forming a closure blank by injection molding, compression molding, etc. as is the case with the metallic closures. To provide the perforation or score on the pilfer-proof bottom portion, it is necessary to apply cutting tools to the pilfer-proof bottom portion from both its outside and inside surfaces. There will be no particular problem if the actuating projecting portion of an inside cutting tool to be applied from the inside surface of the pilfer-proof bottom portion is smaller than the circumferential distance between the adjoining engaging flaps and is properly positioned between the engaging flaps. In actual production, however, it is impossible or extremely difficult to position the actuating projecting portion of the inside cutting tool between the engaging flaps because it causes a drastic decrease in the speed of production. If the actuating projecting portion of the inside cutting tool is not positioned between the engaging flaps but at least partly overlaps the engaging flaps, it will be readily understood that the actuating projecting portion of the inside cutting tool exerts a great pressing force on the engaging flaps and consequently a great degree of deformation is undesirably generated on the engaging flaps.

SUMMARY OF THE INVENTION

The object of this invention is to provide a pilfer-proof plastic container closure which, without involving the aforesaid problem, can meet the requirement that the pilfer-proof bottom portion is surely broken axially and opened in tape form at the time of container opening.

According to the present invention this object is achieved with a pilfer-proof plastic closure as claimed.

Dependent claims are directed on features of preferred embodiments of the invention.

Other advantages and features of this invention will become apparent from the following description of one embodiment of the present invention.

The present inventors have conducted extensive investigations and experiments on a process for manufacturing pilfer-proof plastic closures, and have found that (i) if an axial breaking line which may be a slit or score is formed on the pilfer-proof bottom portion extending from its upper end to the upper end of its lower part or to a point somewhat below it, the lower part of the pilfer-proof bottom portion is axially broken following the axial breaking line at the time of container opening and the pilfer-proof bottom portion is opened in tape form without any particular need to form a slit or score in at least a greater portion of the lower part of the pilfer-proof bottom portion; and (ii) if at least a greater portion of the base edge of each of the engaging flaps is positioned in the lower part of the pilfer-proof bottom portion in which the axial

breaking line does not exist, the above axial breaking line can be formed without causing a drastic decrease in the speed of production and without a likelihood of greatly deforming the engaging flaps. This discovery has led to the achievement of the second object of the invention.

According to this invention, there is provided a pilfer-proof plastic closure for a container equipped with a mouth-neck portion having an external thread on its peripheral surface and an holding jaw portion located beneath the external thread, said closure comprising a top panel wall and a cylindrical skirt wall extending downwardly from the peripheral edge of the top panel wall, said skirt wall having formed therein a circumferentially extending breakable line dividing the skirt wall into a main portion above the circumferential breakable line and a pilfer-proof bottom portion below it, said main portion having formed on its inner surface an internal thread to be engaged with the external thread of the mouth-neck portion of the container and said pilfer-proof bottom portion having formed on its inner surface a plurality of radially inwardly projecting engaging flaps at circumferentially spaced positions; wherein an axial breaking line is formed in the pilfer-proof bottom portion extending downwardly from the upper end of the pilfer-proof bottom portion but being non-existent in at least a greater portion of the lower part of the pilfer-proof bottom portion, and at least a greater portion of the base edge of each of the engaging flaps is positioned in said lower part of the pilfer-proof bottom portion in which the axial breaking line does not exist.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevation showing, partly in section, a blank to be formed into one embodiment of the closure constructed in accordance with this invention;

Figure 2 is a partial perspective view showing an engaging flap in the blank of Figure 1;

Figure 3 is a partial bottom view showing the engaging flap in the blank of Figure 1;

Figure 4 is a side elevation showing, partly in section, one embodiment of the closure constructed in accordance with this invention;

Figure 5 is a sectional view taken along line V-V of Figure 4;

Figure 6 is a side elevation showing, partly in section, the closure of Figure 4 as it is mounted on the mouth-neck portion of a container; and

Figure 7 is a side elevation showing the closure of Figure 4 as it is detached from the mouth-neck portion of a container after it has been once mounted on it.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention will be described in greater detail with reference to the accompanying drawings.

Figure 1 shows a closure blank to be processed into one embodiment of the closure constructed in accordance with this invention. The blank shown generally at 2, which is formed from a suitable plastic material such as polypropylene or polyethylene by injection molding, compression molding, etc., has a circular top panel wall 4 and a cylindrical skirt wall 6 extending downwardly from the peripheral edge of the top panel wall 4. An annular protrusion 8 is formed in the upper end portion of the inner surface of the skirt wall 6 so that it projects radially inwardly from the upper end portion. In the lower part of the peripheral surface of the skirt wall 6 is formed a step portion 10 displaced diametrically inwardly. A portion 12 above the step portion 10 has a considerable wall thickness, whereas the thickness of a portion 14 below the step portion 10 is descreased. In the illustrated embodiment, a step portion 16 is formed also on the inner circumferential surface of the skirt wall 6 below the step portion 10, and the portion 14 has a relatively thick portion 18 above the step portion 16 and a relatively thin portion 20 below the step portion 16. As will be clear from a description given hereinbelow, the thickness t_1 of the portion 20 is sufficiently small, and preferably 0.05 to 0.75 mm, especially 0.20 to 0.50 mm. The thickness t_2 of the relatively thick portion 18 is conveniently 0.50 to 1.10 mm, especially 0.75 to 0.85 mm. If desired, the thickness t_2 of the portion 18 can be made sufficiently small as in the portion 20 (therefore, the step portion 16 does not exist). A raised and depressed or knurled portion 22 is formed on the peripheral surface of the portion 12 of the skirt wall 6 in order to prevent slippage of a finger which engages it. An internal thread 24 is formed on the inner circumferential surface of the portion 12 of the skirt wall 6. A plurality of circumferentially spaced engaging flaps 26 are formed on the inner circumferential surface of the portion 14 of the skirt wall 6. Each of the engaging flaps 26 is projected radially inwardly from its base edge 28 connected to the inner circumferential surface of the portion 14. As will be clear from a description given hereinbelow, it is important that at least a greater portion of the base edge 28 of each of the engaging flaps 26 be positioned in the relatively

thin portion 20 below the step portion 16 in the portion 14. In the illustrated embodiment, the upper end of the base edge 28 of each of the engaging flaps 26 is positioned in alignment with the step portion 16. Hence, the entire base edge 28 of each of the engaging flaps 26 is positioned in the relatively thin portion 20 below the step portion 16.

According to this invention, the following improvement is made in the engaging flaps 26. With reference to Figures 2 and 3, each of the engaging flaps 26 is bent along a bending line 30 and defined by a first portion 32 extending from the base edge 28 to the bending line 30 and a second portion 34 extending from the bending line 30 to its free end. The base edge 28 extends substantially parallel,and therefore substantially vertically,to the central axis 36 (Figure 1) of the blank 2. If desired, however, the base edge 28 may be inclined in a suitable direction with respect to the central axis 36 (Figure 1) of the blank 2; namely it may be inclined downwardly at a suitable angle to the closing direction of the closure for mounting the closure on the mouth-neck portion of the container (the clockwise direction as viewed from above in Figure 1, the direction shown by arrow 36 in Figures 2 and 3) or in an opposite direction. Preferably, the first portion 32 is inclined in a direction opposite to the aforesaid closing direction and extends radially inwardly from the base edge 28. The angle α of inclination of the first portion 32 to the inner surface of the portion 20 is preferably $5^\circ \leqq \alpha \leqq 85^\circ$, more preferably $20^\circ \leqq \alpha \leqq 80^\circ$, especially preferably $30^\circ \leqq \alpha \leqq 70^\circ$. It is important that the second portion 34 extending radially inwardly from the bending line 30 should extend inclinedly with respect to the first portion 32 in the aforesaid closing direction. The angle β of inclination of the second portion 34 to the first portion 32 is preferably $0^\circ < \beta \leqq 90^\circ$, more preferably $0^\circ < \beta \leqq 70^\circ$, especially preferably $5^\circ \leqq \beta \leqq 45^\circ$. The bending line 30 may extend substantially parallel, and therefore substantially vertically to the central axis 36 (Figure 1) of the blank 2, or may be inclined downwardly approaching the inner surface of the portion 20. Preferably, it is inclined downwardly in a direction away from the inner surface of the portion 20. The angle γ of inclination of the bending line 30 to the downward direction away from the inner surface of the portion 20 is preferably $5^\circ \leqq \gamma \leqq 80^\circ$, more preferably $10^\circ \leqq \gamma \leqq 60^\circ$, especially preferably $20^\circ \leqq \gamma \leqq 50^\circ$.

As shown in Figures 1 and 2, the upper edge 38 of the first portion 32 conveniently extends downwardly inclinedly in a radially inward direction forming a gentle curve, and the upper edge 40 of the second portion 34 extends nearly horizontally. On the other hand, it is convenient that the lower edge 42 of the first portion 32 and the lower edge 44 of the second portion 34 extend upwardly inclinedly in a radially inward direction. Generally, the angle δ_2 of inclination of the lower edge 44 of the second portion 34 is slightly larger than the angle δ_1 of inclination of the lower edge 42 of the first portion 32. Conveniently, the angle δ_1 of inclination is $10^\circ \leqq \delta_1 \leqq 30^\circ$, and the inclination angle δ_2 is $20^\circ \leqq \delta_2 \leqq 50^\circ$.

With reference to Figure 4 together with Figure 1, to produce the container closure of this invention, a circumferential breakable line 46 is formed in the blank 2, and preferably simultaneously with the provision of the circumferential breakable line 46, axial breaking line 48 are formed in the blank 2. As shown in Figure 4, the circumferential breakable line 46 is disposed immediately below the step portion 10, and therefore, the portion 12 having a considerable thickness located above the step portion 10 constitutes a main portion of the skirt wall 6, and the portion 14 having a decreased thickness below the step portion 10 composed of the relatively thick portion 18 and the relative thin portion 20 constitutes a pilfer-proof bottom portion. The circumferential breakable line 46 itself is comprised of a plurality of circumferentially spaced and circumferentially extending slits 50 and a plurality of bridging portions 52 located among the slits 50. The portion 14, i.e. the pilfer-proof bottom portion 14, is connected to the portion 12, i.e. the main portion 12 of the skirt wall 6, via the bridging portions 52. One bridging portion 52A among the plurality of bridging portions 52 is formed as a high strength bridging portion which has a larger circumferential length than the other bridging portions 52 and higher strength than the others. If desired, two or more of them may be formed as high strength bridging portions.

In the illustrated embodiments, two axial breaking lines 48 are provided circumferentially at predetermined intervals (the intervals will be described further hereinafter), although the number of such axial breaking lines 48 may be 1 or 3 or more. One of the axial breaking lines 48 is disposed adjacent to one end of the high strength bridging portion 52A as viewed circumferentially, and the other, adjacent to the other end of the high strength bridging portion 52A as viewed circumferentially. It is important that the axial breaking lines 48 extend downwardly from the upper end of the pilfer-proof bottom portion 14, but terminate at the upper end (therefore, the step portion 16) of the relatively thin portion 20 of the pilfer-proof bottom portion 14 or at a point slightly below it, and that they do not exist at least in a greater portion of the relatively thin portion 20. The axial breaking lines 48 may extend substantially parallel to the axis 36, or with a slight inclination to the axis 36, as shown in the drawing. The axial breaking lines 48 themselves may be formed of a slit made by completely cutting a material, or of a score of a perforation made by partly cutting the material in the thickness direction. With reference to Figure 5 together with Figure 4, each of the

illustrated axial breaking lines 48 is comprised of a slit 54 extending from the upper end of the pilfer-proof bottom portion 14 to the step portion 16 (therefore, along the entire portion 18 of the pilfer-proof bottom portion 14) and a score 56 following the slit 54 and extending downwardly over some distance (therefore, along the relatively thin portion 20 of the pilfer-proof bottom portion 14). In the score 56, the cut depth of the material is progressively descreased as it extends downwardly. Accordingly, the thickness of the remaining material is progressively increased as it extends downwardly.

With regard to the axial breaking lines 48, the following fact should be noted. In forming the axial breaking line 48, more specifically the slit 54 and the score 56, simultaneously with or separately from the formation of the circumferential breakable line 46, more specifically the slit 50, it is generally necessary to apply an outside cutting tool having cutting blades corresponding to the slit 50 and the slits 54 and 56 formed at its peripheral edge to the blank 2 from its peripheral surface and at the same time, apply an inside cutting tool having actuating projecting portions cooperating with the cutting blades to it from its inner circumferential surface. The axial breaking line 48, however, terminates at the upper end of the relatively thick portion 20 of the pilfer-proof bottom portion 14 or at a point slightly below it and does not exist in at least a greater portion of the relatively thin portion 20. Hence, it is not at all necessary to apply the actuating projecting portion of the inside cutting tool to at least a greater portion of the relatively thin portion 20. In addition, at least a greater portion of the base edge 28 of each of the engaging flaps 26 is positioned in the relatively thin portion 20. Accordingly, the axial breaking line 48 can be formed without the need for an operation of setting the angular relation between the blank 2 and the inside cutting tool at a predetermined one, which is complex and cause a drastic decrease in efficiency. Furthermore, this can be achieved while surely avoiding the deformation of the engaging flaps 26 by the great pressing force of the actuating projecting portion of the inside cutting tool.

The following fact should also be noted with regard to the formation of the axial breaking line 48. When the angular relation between the blank and the outside and inside cutting tools is set at a predetermined one in providing the axial breaking lines 48, the efficiency will be drastically reduced as stated hereinabove. Accordingly, it is desired to perform the cutting operation without particularly setting the aforesaid angular relation. When the cutting operation is performed without particularly setting the aforesaid angular relation, the axial breaking line 48 is formed at an arbitrary angular position. As will be understood from a description given hereinafter, in opening the closure, the relatively thin portion 20 of the pilfer-proof bottom portion 14 should be broken following the axial breaking line 48. When the axial breaking line 48 is formed at an angular position at which it is aligned with, or overlaps, the base edge 28 of the engaging flap 26, the breaking of the relatively thin portion 20 becomes considereably difficult owing to the presence of the engaging flap 26. In view of this fact, the engaging flaps 26 are arranged circumferentially at equal intervals in the illustrated embodiment, and moreover, the circumferential distance CD of the two axial breaking lines 48 is set as follows with respect to the circumferential pitch P of the engaging flap 26 and the circumferential width W of the base edge 28 of the engaging flap 26.

$$(n+1)P - W > CD > nP + W$$

Where n is 0 or a positive integer.

Under these conditions, at least one of the two axial breaking lines 48 is at an angular position at which it is not aligned with, or does not overlap, the base edge 28 of the engaging flap 26. Accordingly, at the time of opening the closure, the relatively thin portion 20 of the pilfer-proof bottom portion 14 can be surely and easily broken following the breaking of at least one of the two axial breaking lines 48.

Again, with reference to Figure 4, a sealing liner 58 of a suitable plastic material may be formed on the inside furface of the top panel wall 4 of the blank 2, or more specifically on the annular projection 8 formed on the inside surface of the top panel wall 4, after or before the provision of the circumferential breakable line 46 and the axial breaking lines 48. The formation of the sealing liner 58 can be effected by a molding method known per se. Instead of forming the sealing liner 58 separately, a sealing protrusion of a suitable shape may be integrally formed on the inner surface of the top panel wall 4 of the blank 2.

The finished closure 60 so formed is applied to a container having a mouth-neck portion 62 of the form indicated in Figure 6. On the cylindrical peripheral surface of the mouth-neck portion 62, an external thread 64 and a holding jaw portion 66 beneath it are formed.

In closing the mouth-neck portion 62 with the closure 60, the closure 60 is put over the mouth-neck portion 62 and turned in a closing direction, that is, in the clockwise direction as viewed from above in Figure 6. As a result, the internal thread 24 formed in the closure 60 is engaged with the external thread 64 formed in the mouth-neck portion 62, and the closure 60 is moved axially downwardly. Each of the engaging flaps 26 formed in the closure 60 thus goes past the external thread 64 formed on the mouth-neck

portion 62 and further passes over the holding jaw portion 66. During passage over the holding jaw portion 66, each of the engaging flaps 26 undergoes interference by the holding jaw portion 66 and is elastically bent radially outwardly. When the internal thread 24 of the closure 60 is fully engaged with the external thread 64, each of the engaging flaps 26 completely goes past the holding jaw portion 66 and is released from interference by the holding jaw portion 66. As a result, the engaging flaps 26 elastically returned to their original state.

It will be clearly understood from Example and Comparative Example given hereinbelow that the required downwardly rotating torque which must be exerted on the closure 60 of this invention during passage of the elastically bent engaging flaps 26 over the holding jaw portion 66 is nearly equal to that in a conventional container closure in which the second portion 34 of each engaging flap 26 is not bent with the first portion 32 but extends in a straight light with the first portion 32 as shown by a two-dot chain line in Figure 3, and is therefore sufficiently low. Accordingly, during mounting of the closure 60 on the mouth-neck portion 62, the generation of an excessive stress on the breakable line 46 and the breaking lines 48 can be surely prevented, and therefore, the breakable line 46 and the breaking lines 48 can be accurately prevented from breaking at this time.

When the engaging flaps 26 fully return to their original state, they engage the undersurface of the holding jaw portion 66 as clearly shown in Figure 6. When the internal thread 24 of the closure 60 is in full engagement with the external thread 64 on the mouth-neck portion 62, the sealing liner 58 is in intimate contact with the end surface portion of the mouth-neck portion 62, and thus seals up the mouth-neck portion 62.

To open the mouth-neck portion 62, the closure 60 is turned in the opening direction, i.e. counterclockwise as viewed from above in Figure 6. Thus, the internal thread 24 of the closure 60 moves along the external thread 64 of the mouth-neck portion 62, and therefore, the closure 60 moves axially upwardly as it is turned. The pilfer-proof bottom portion 14, however, cannot move axially upwardly since the engaging flaps 26 formed on its inner surface and engaged with the undersurface of the holding jaw portion 66 of the mouth-neck portion 62. Consequently, a considerable stress is generated on the circumferential breakable line 46, and more specifically on its bridging portions 52. The bridging portion 52 of the circumferential breakable line 46 are therefore broken while leaving the high strength bridging portion 52A as shown in Figure 7. Furthermore, as shown in Figure 7, the relatively thin portion 20 of the pilfer-proof bottom portion 14 is broken following the breaking of at least one of the two axial breaking lines 48. As a result, the pilfer-proof bottom portion 14 is opened in tape form, and the engaging flaps 26 are disengaged from the undersurface of the holding jaw portion 66. With regard to the breakage of the relatively thin portion 20, it has been experimentally determined that if the thickness t_1 of the portion 20 is sufficiently thin and preferably 0.05 to 0.75 mm, especially 0.20 to 0.50 mm, the portion 20 is surely broken following the axial breaking lines 48 without the need to form a score or the like. After the pilfer-proof bottom portion 14 has been opened in tape form and the engaging flaps 26 have come out of engagement with the undersurface of the holding jaw portion 66, the entire closure 60 including the pilfer-proof bottom portion 14 linked to the main portion 12 by the high strength briding portion 52A remaining unbroken is moved axially upwardly as it is turned. As a result, the entire closure 60 is removed from the mouth-neck portion 62 and the mouth-neck portion 62 is opened.

As will be clearly understood from the description of the following Example and Comparative Example, the engaging flaps 26 engage the undersurface of the holding jaw portion 66 more strongly in the closure 60 improved in accordance with this invention than in the conventional closure in which the second portion 34 of each engaging flap 26 is not bent with respect to the first portion 32 but extends in a straight line with the first portion 32 as shown by the two-dot chain line in Figure 3. In other words, the required upwardly rotating torque which must be exerted on the closure 60 of this invention when the engaging flaps 26 are passed in the elastically bent state over the holding jaw portion 66 in the axially upward direction is made considerably higher than that on the conventional closure. Hence, the closure 60 is surely prevented from being removed from the mouth-neck portion 62 without the desired breakage of the breakable line 46 and the breaking lines 48, and the pilfer-proof characteristics of the closure 60 can be retained.

If desired, it is possible to provide a holding protrusion on the outside surface of the pilfer-proof bottom portion 14, preferably adjacent to the right side of one of the breaking lines48, so that in opening the mouth-neck portion 62 by removing the closure 60 from it, the holding protrusion is pulled to break the breakable line 46 and simultaneously the breaking line 48 in its entirety, and thereafter, the closure 60 is turned counterclockwise as viewed from above in Figure 6.

EXAMPLE

Ten blanks having substantially the same form as the blank 2 shown in Figures 1 to 3 were molded from polypropylene having a melt index of 2.0 and a density of 0.90. Each blank has an internal thread inside diameter d of 25.4 mm, an upper portion outside diameter D of 30.0 mm and a total height H of 19.0 mm. Each of the engaging flaps 26 formed on the inner surface of the portion 20 had the following specification.

Thickness W: 0.35 mm
Length ℓ_1 of the lower edge 42 of the first portion 32: 1.9 mm
Length ℓ_2 of the lower edge 44 of the second portion 34: 2.0 mm
Inclination angle α: 50°
Inclination angle β: 10°
Inclination angle γ: 30°
Inclination angle δ_1: 20°
Inclination angle δ_2: 45°

The upper edge 38 of the first portion 32 was of an arcuate shape having a radius of 0.5 mm, and the upper edge 40 of the second portion 34 was substantially horizontal.

Each of the blanks was mounted on the mouth-neck portion 62 of a glass container having the form shown in Figure 6 and a nominal diameter of 28 mm, and the required downwardly rotating torque was measured.

Thereafter, the blank was forcedly removed from the mouth-neck portion 62, and the required upwardly rotating torque was measured. The results are shown in Table 1 below.

COMPARATIVE EXAMPLE

For comparison, ten blanks same as in Example were molded except that each of the engaging flaps 26 formed on the inner surface of the portion 20 had the form shown by the two-dot chain line in Figure 3 (namely, the second portion 34 was not bent with respect to the first portion 32 but extended in a straight line with the first portion 32).

In the same way as in Example, the required downwardly rotating torque and the required upwardly rotating torque were measured. The results are shown in Table 1.

Table 1

	Required downwardly rotating torque (kg-cm)			Required upwardly rotating torque (kg-cm)		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Example	1.5	2.0	1.0	9.0	10.0	8.0
Comparative Example	1.4	2.0	1.0	4.0	4.5	3.5

Claims

1. A pilfer-proof plastic closure for a container equipped with a mouth-neck portion having an external thread formed on its peripheral surface and a holding jaw portion located below the external thread, said closure comprising a top panel wall (4) and a cylindrical skirt wall (6) extending downwardly from the peripheral edge of the top panel wall (4), said skirt wall (6) having formed therein a circumferentially extending breakable line (46) dividing the skirt wall (6) into a main portion (12) above the breakable line (46) and a pilfer-proof bottom portion (14) below it,said main portion (12) having formed on its inner surface an internal thread (24) to be engaged with the external thread on the mouth-neck portion (62) of the container and said pilfer-proof bottom portion (14) having formed on its inner surface a plurality of radially inwardly

projecting engaging flaps (26) at circumferentially spaced positions;
characterized in that
an axial breaking line (48) is formed in the pilfer-proof bottom portion (14) extending downwardly from the upper end of the pilfer-proof bottom portion (14) but being non-existent in at least a greater portion of the lower part (20) of the pilfer-proof bottom portion (14), and at least a greater portion of the base edge (28) of each of the engaging flaps (26) is positioned in said lower part (20) of the pilfer-proof bottom portion [14) in which the axial breaking line (48) does not exist.

2. The closure of claim 1 wherein the upper part (18) of the pilfer-proof bottom portion (14) has a relatively large thickness, and its lower part (20) has a relatively small thickness, and the axial breaking line (48) extends to the lower end of said upper part or to a point slightly below it.

3. The closure of claim 1 or 2 wherein the axial breaking line (48) is a slit or score, and at its lower end portion, the thickness of the remaining material is progressively increased as it extends downwardly.

4. The closure of claim 2 wherein the relatively thin lower part (20) of the pilfer-proof bottom portion (14) has a thickness t_1 of 0.05 to 0.75 mm.

5. The closure of claim 4 wherein the thickness t_1 is 0.20 to 0.50 mm.

6. The closure of any one of claims 1 to 5 wherein the circumferential breakable line (46) is comprised of a plurality of circumferentially spaced and circumferentially extending slits (50) and a plurality of bridging portions (52) located among the circumferential slits (50); at least one of the bridging portions is a high strength bridging portion (52A) having higher strength than the other bridging portions (52); and the axial breaking line (48) is located adjacent to the circumferential end of the high strength bridging portion (52A) as viewed circumferentially.

FIG. 1

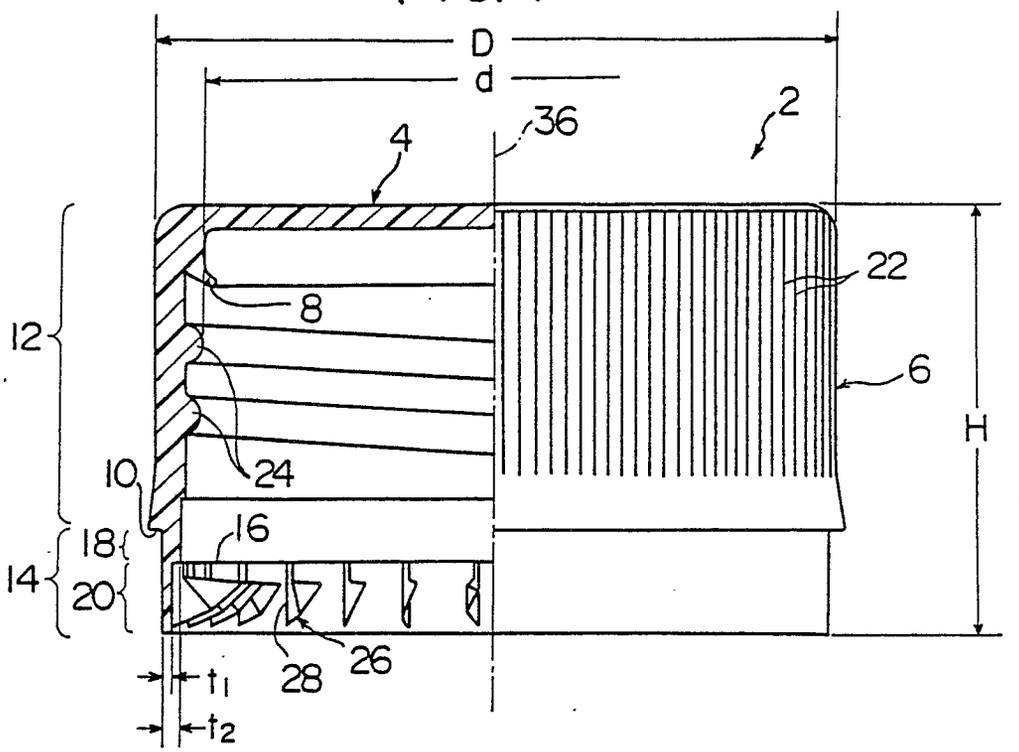

D
d
2
4
36
22
8
12
6
H
24
10
18
16
14
20
26
28
t_1
t_2

FIG. 4

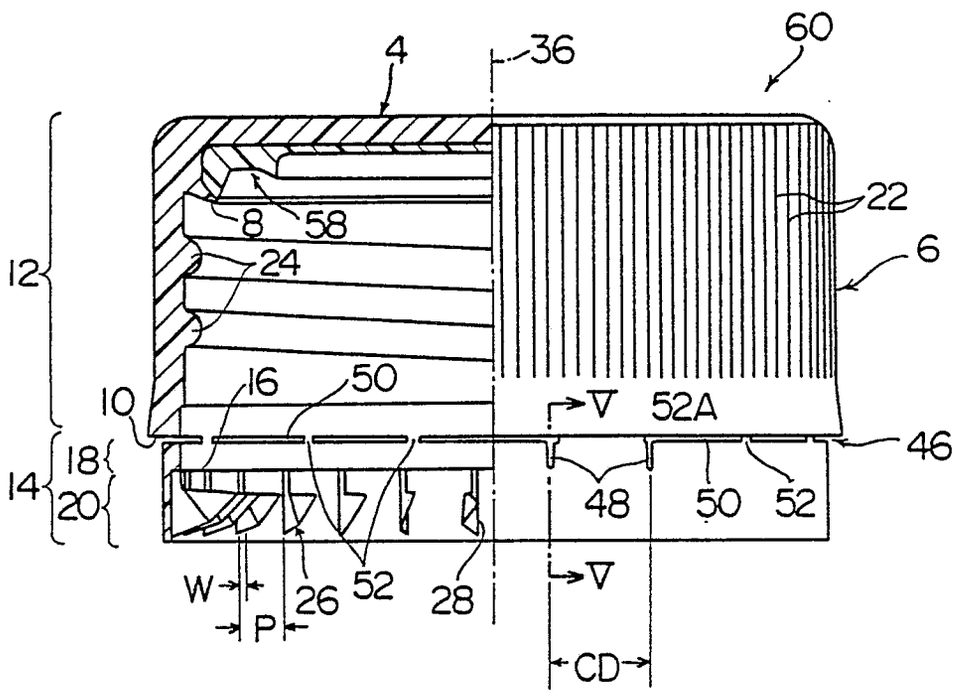

60
4
36
22
8
58
6
12
24
16
50
10
V
52A
46
18
14
20
48
50
52
W
26
52
28
P
CD

FIG. 2

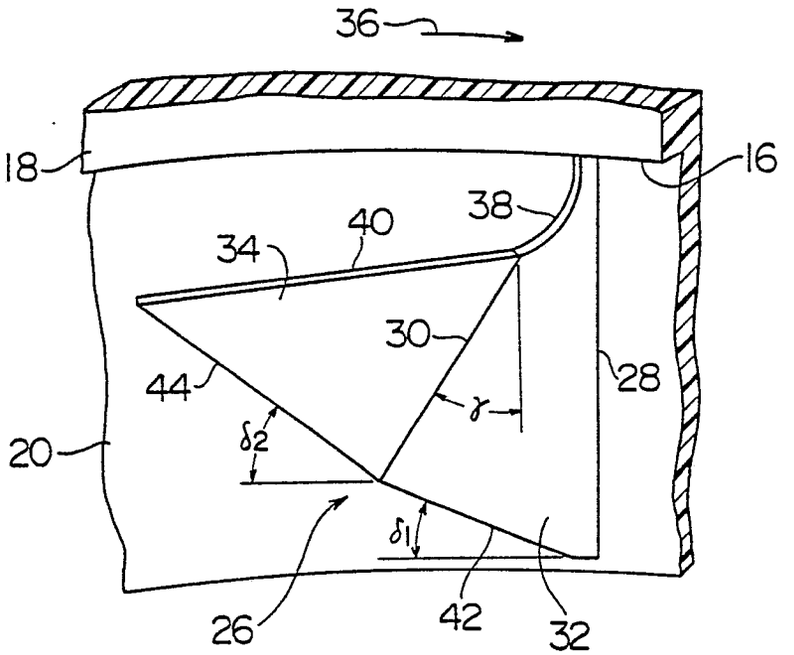


FIG. 3

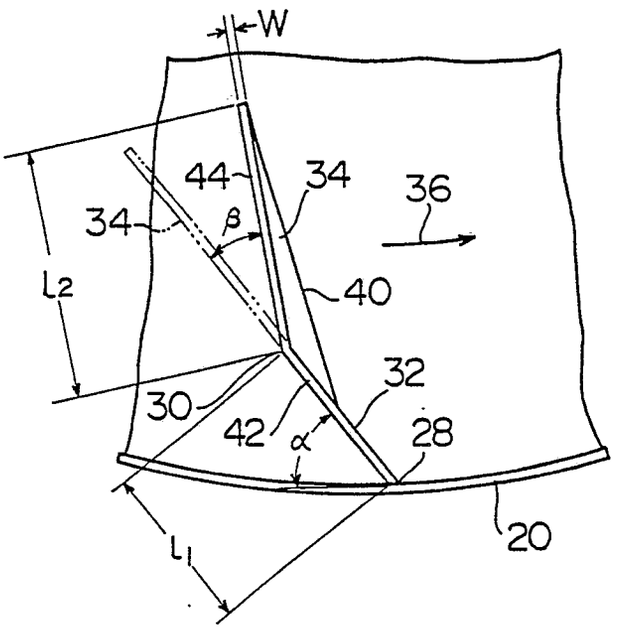


FIG. 5

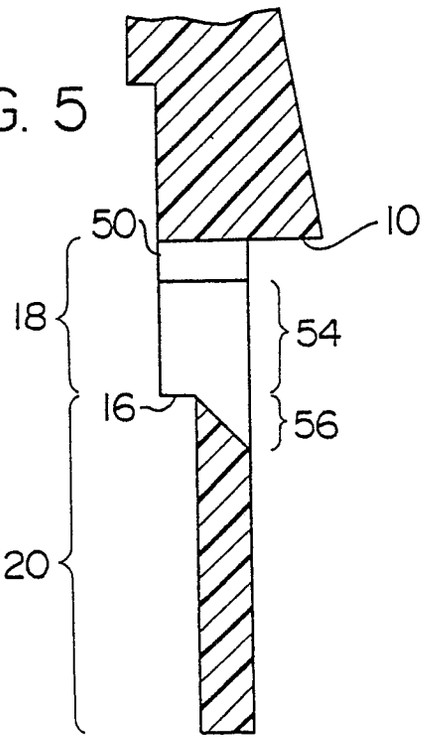


FIG. 6

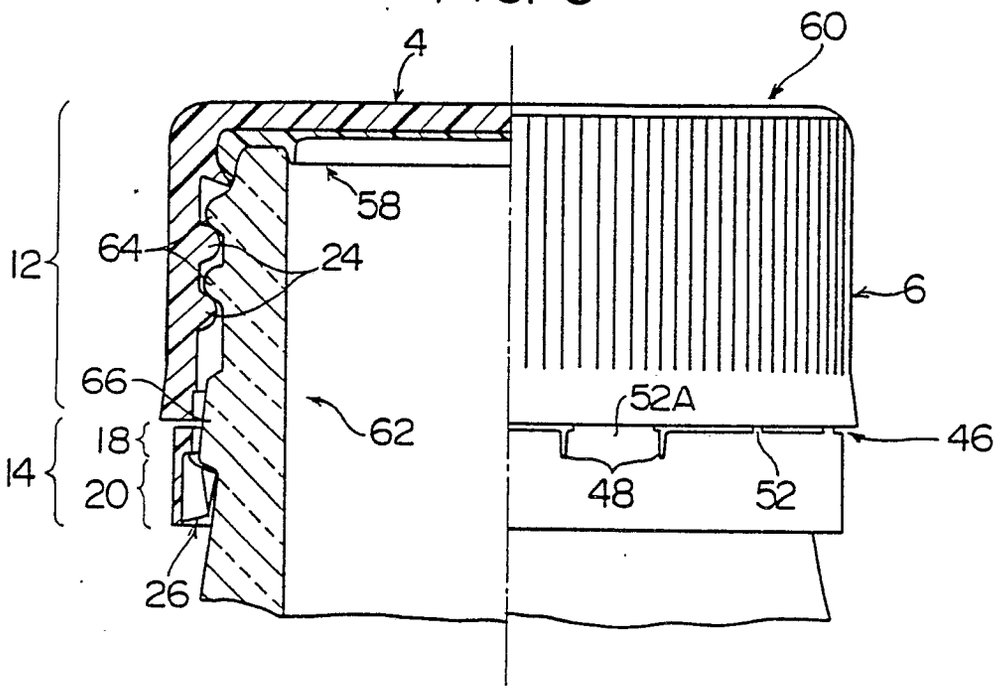
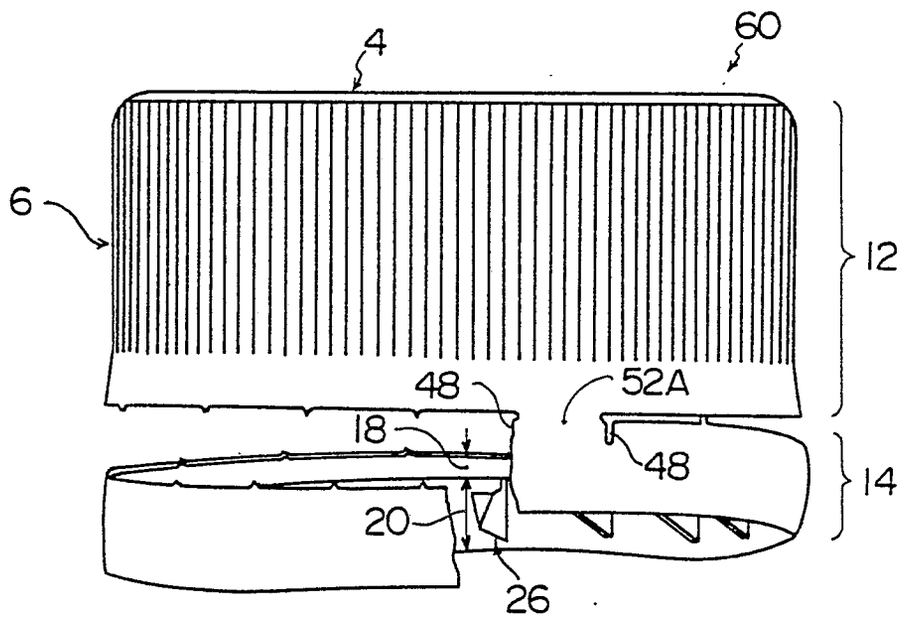

4
60
58
12
64
24
6
66
62
52A
46
18
14
20
48
52
26

FIG. 7


4
60
6
12
48
52A
18
48
14
20
26