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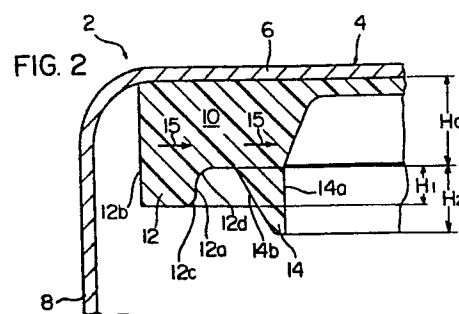
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54 Container closure having an improved liner.

57 A container closure comprising a shell (4) having a circular top panel (6) and a substantially cylindrical skirt (8) extending downwardly from the peripheral edge of the circular top panel, and a plastic liner (10) disposed in the inside of the top panel of the shell. The liner has at least two annular protrusions. A first annular protrusion (12) located outwardly includes an inner circumferential surface (12a) to be brought into contact with the peripheral surface of an opening end of a container to be sealed. A second annular protrusion (14) located inwardly is disposed such that it faces the top surface of the opening end of the container, and is adapted to be brought into close contact with the top surface of the opening end.



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CONTAINER CLOSURE HAVING AN IMPROVED LINER

Field of the Invention

This invention relates to a container closure, and more specifically, to a container closure of the type comprising a shell having a circular top panel and a substantially cylindrical skirt extending downwardly from the peripheral edge of the circular top panel, and a plastic liner disposed in the inside of the top panel of the shell.

Description of the Prior Art

In container closures of the aforesaid type, the form of the plastic liner disposed in the inside of the top panel of the shell is very important to the sealing properties of the closure for an opening portion of a container. Japanese Laid-Open Patent Publication No. 65184/78 discloses that in order to provide improved sealing properties for an opening portion of a container, a liner having an outside annular protrusion including an inner circumferential surface to be brought into close contact with the peripheral surface of the opening end of a container to be sealed, and an inside annular protrusion including a peripheral surface to be brought into close contact with the inner circumferential edge of the opening end is molded in the inside of a top panel of a shell. The container closure including a liner of such a form has improved sealing properties over container closures having a liner of the previously

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proposed forms, as can be understood from a working example given in the above-cited Japanese Patent Publication. Experiments of the present inventors, however, have shown that the sealing properties of a container closure having a liner of the aforesaid form are degraded when a considerably large impact is exerted on it, and it is desired to solve this problem.

Summary of the Invention

It is an object of this invention to improve the form of a liner in the aforesaid type of container closure so as to maintain sufficient sealing properties even when a considerably large impact is exerted.

Extensive investigations and experiments of the present inventors have led to the discovery that sufficient sealing properties can be maintained in a closure container under a considerably high impact force exerted thereon if a liner to be disposed in the inside of a top panel of its shell has a first annular protrusion including an inner circumferential surface to be brought into close contact with the peripheral surface of an opening end of a container to be closed and a second annular protrusion being disposed inwardly of the first annular protrusion such that it faces the top surface of the opening end of the container, and being adapted to be brought close into contact with the top surface of the opening end of the container.

Thus, according to this invention, there is provided a container closure comprising a shell having a circular top panel and a substantially cylindrical skirt extending downwardly from the peripheral edge of the circular top panel and a plastic liner disposed in the inside of the top panel of the shell, said liner having at least two concentrically arranged annular protrusions with a first annular protrusion located outward having an inner circumferential surface to be brought into close contact with the peripheral surface of an opening end of a container to be sealed, characterized in that a second annular protrusion located inward is

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disposed such that it faces the top surface of the opening end, and is adapted to be brought into close contact with the top surface of the opening end.

In a preferred embodiment of the container closure of the present invention, the protruding height H_2 of the second annular protrusion is larger than the protruding height H_1 of the first annular protrusion. According to this structure, the impact resistance of the sealing properties of the closure is further increased, and a reduction in sealing properties, which is due to a so-called doming phenomenon (the phenomenon exhibited by the top panel of a container closure deformed upwardly in convex form by the pressure present within a container), can be more surely prevented.

15 Brief Description of the Drawings

Figure 1 is a cross-sectional view showing one embodiment of the container closure constructed in accordance with this invention;

20 Figure 2 is a partial cross-sectional view on an enlarged scale showing the form of a liner of the closure shown in Figure 1;

Figure 3 is a partial cross-sectional view, similar to Figure 2, showing a modified example of the liner;

25 Figure 4 is a partial cross-sectional view showing on an enlarged scale the relative positions of a container closure and a container mouth portion before sealing the container mouth portion with the container closure shown in Figure 1;

30 Figure 5 is a partial cross-sectional view showing on an enlarged scale the state of the container closure in Figure 1 after it has been tightly fitted over the mouth portion of a container;

Figure 6 is a partial cross-sectional view, similar to Figure 2, showing another embodiment of the container closure constructed in accordance with this invention;

Figure 7 is a partial cross-sectional view,

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similar to Figure 4, showing the relative positions of the container closure shown in Figure 6 and the mouth portion of a container before the container closure has been tightly fitted over the container mouth portion;

5 Figure 8 is a partial cross-sectional view, similar to Figure 5, showing the state of the container closure shown in Figure 6 after it has been tightly fitted over the mouth portion of a container;

10 Figure 9 is a partial perspective view showing a modified example of the container closure constructed in accordance with this invention, in which a thin bulging bottom portion is provided in a liner;

 Figure 10 is a partial cross-sectional view of the container closure shown in Figure 9;

15 Figure 11 is a partial cross-sectional view, similar to Figure 10, showing a modified example of the thin bulging bottom portion;

20 Figure 12 is a partial perspective view, similar to Figure 9, showing still another modified example of the thin bulging bottom portion;

 Figure 13 is a simplified view for illustrating an impact test performed in Experimental Example A; and

25 Figure 14 is a partial cross-sectional view for illustrating the degree of peeling in Experimental Example B.

Detailed Description of Preferred Embodiments

The container closure of this invention is described below in greater detail with reference to the accompanying drawings showing preferred embodiments.

30 Referring to Figure 1, the container closure generally shown at 2 is constructed of a shell 4 having a circular top panel 6 and a substantially cylindrical skirt 8 extending from the peripheral edge of the top panel 6 and a plastic liner 10 disposed in the inside of the top panel 6 of the shell 4. The shell 4 can be produced from
35 an easily deformable metallic blank by methods known to those skilled in the art. Aluminum-base alloy plates, tin plates, and chromium-treated steel plates can be cited

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as suitable metallic blanks. The aluminum-base alloy plates are especially preferred. The plastic liner 10 can be formed by molding a synthetic resin, for example, a polyolefin resin such as polyethylene, and polyvinyl chloride by methods known per se (for example, the methods disclosed in Japanese Patent Publications Nos. 13156/65, 5588/66, 5706/73 and 19886/73, Japanese Laid-Open Patent Publication No. 105689/74, and U. S. Patents Nos. 3135019, 3212131 and 3278985).

10 Referring to Figures 1 and 2, the form of the liner 10 improved in accordance with this invention is described.

The illustrated liner 10 improved in accordance with this invention has concentrically arranged two annular protrusions 12 and 14. The annular protrusion 12 which is located outward may be of any desired shape so long as it has an inner circumferential surface 12a which is to be brought into close contact with the peripheral surface of an opening end of a container when the closure 2 is tightly fitted over the opening portion of the container to be sealed, as will be described hereinbelow. Advantageously, as shown clearly in Figure 2, the first annular protrusion 12 is provided substantially perpendicular to the top panel 6 of the shell 4 spaced some distance from the inner surface of the skirt 8 of the shell 4, and both of its inner circumferential surface 12a and peripheral surface 12b are substantially perpendicular to the top panel 6 of the shell 4. Desirably, the end 12c of the inner circumferential surface 12a is inclined radially outwardly in view of the ease of engagement with the opening end of a container, especially in such a manner that it forms a curved surface having a suitable curvature. Preferably, the base portion 12d of the inner circumferential surface 12a is inclined radially inwardly to form a thick bottom portion for the purpose of reinforcing the first annular protrusion 12 and for facilitating molding. When a very high impact is likely to be exerted on the shoulder

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portion (the boundary between the top panel 6 and the skirt 8) of the shell, the peripheral surface 12b of a first annular protrusion 12 can be contacted with the inner surface of the skirt 8 of the shell, as illustrated in Figure 3. The second annular protrusion 14 which is located inwardly is disposed such that it faces the top surface of the opening end of a container to be sealed, and as illustrated hereinbelow, it is adapted to be brought into close contact with the top surface of the opening end of the container when the closure 2 is tightly mounted on the opening portion of the container to be sealed. Preferably, the second annular protrusion 14 projects further downwardly beyond the forward end of the first annular protrusion 12, and the protruding height H_2 of the second annular protrusion 14 is larger than the protruding height H_1 of the first annular protrusion 12. Moreover, in view of various factors such as the strength of contact to the top surface of the opening end of the container (which affects the sealing properties) and the ease of molding, the second annular protrusion 14 preferably has a shape illustrated clearly in Figure 2, i.e. a shape which meets the following requirements (a) and (b).

(a) It progressively decreases in thickness toward its protruding end.

(b) In meeting the requirement (a), the inner circumferential surface 14a is substantially perpendicular to the top panel 6 of the shell 4, whereas the peripheral surface 14b is inclined radially inwardly toward the protruding end and thus, as will be described hereinbelow, bends radially inwardly when closely contacted with the top surface of the opening end of the container.

The dimensions of the various parts of the liner 10 of the above-described form can be properly set on the basis of the dimensions of the various parts of the opening end of a container to be sealed. Referring to Figure 4 also, suitable examples of the dimensions of

the various parts of the liner 10 with regard to the outside diameter D_1 and the inside diameter D_2 of the opening end of the container are shown in Table 1.

Table 1

Dimension	Preferred range	Especially preferred range
Outside diameter d_1 of the first annular protrusion 12	$1.03D_1 - 1.10D_1$	$1.05D_1 - 1.08D_1$
Inside diameter d_2 of the first annular protrusion 12	$0.96D_1 - 1.02D_1$	$0.98D_1 - 1.01D_1$
Outside diameter d_3 of the second annular protrusion 14	$0.90D_1 - 0.97D_1$	$0.92D_1 - 0.94D_1$
Inside diameter d_4 of the second annular protrusion 14	$1.02D_2 - 1.15D_2$	$1.05D_2 - 1.12D_2$
Protruding height H_1 of the first annular protrusion 12	0.4 mm - 1.0 mm	0.6 mm - 0.8 mm
Protruding height H_2 of the second annular protrusion 14	0.5 mm - 1.6 mm	0.85mm - 1.2 mm
Thickness H_0 of the base portion between the first annular protrusion 12 and the second annular protrusion 14	0.4 mm - 1.8 mm	0.5 mm - 1.2 mm

Now, referring to Figures 4 and 5, there will be described the behaviors of the first annular protrusion 12 and the second annular protrusion 14 of the liner 10 which are exhibited when tightly mounting the closure 2 on the opening portion 18 (only a part thereof is shown in Figures 4 and 5) of a container to be sealed.

In order to mount the container closure 2 tightly on the opening portion 18, it is the practice, as well known to those skilled in the art, to put the closure 2 over the opening 18 of the container, exert a pressing force on the outside surface of the top panel 6

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of the shell 4 to push the closure 2 against the opening portion 18, and in such a condition, to deform the skirt 8 of the shell along a screw thread 20 formed on the peripheral surface of the opening portion 18 thereby to
5 form a screw thread 22 on the skirt 8 (roll-on operation) and simultaneously to deform the shoulder portion of the shell 4 radially inwardly. This results in engagement of the screw thread 20 of the opening portion 18 with the screw thread 22 formed in the skirt 8 to hold the
10 closure 2 surely over the opening portion 18 and thus to seal the opening portion 18.

When the container closure 2 is tightly mounted on the opening portion 18 of the container in this manner, the first annular protrusion 12 of the
15 liner 10 is elastically deformed in the shape shown in Figure 5 and its inside circumferential surface 12a is brought into close contact with the end of the opening portion 18 of the container, i.e. the peripheral surface 24a of the opening end 24, because in Figures 4 and 5, the closure 2 is pushed downwardly and the shoulder
20 portion of the shell 4 is deformed radially inwardly. On the other hand, because the closure 2 is pushed downwardly in Figures 4 and 5, the second annular protrusion 14 of the liner 10 is caused to abut against a top
25 surface 24b of the opening end 24 whereby it is bent elastically inwardly in the radial direction and is brought into close contact with the top surface 24b of the opening end 24. Accordingly, the opening portion 18 of the container is exactly sealed as a result of
30 the close contact of the inner circumferential surface 12a of the first annular protrusion 12 with the peripheral surface 24a of the opening end 24 and the close contact of the second annular protrusion 14 with the top surface 24b of the opening end 24.

35 Preferably, there should be some space 25 between the liner 10 and the opening end 24, as shown in Figure 5, at a site between an area of close contact of the inner circumferential surface 12a of the first annular

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protrusion 12 with the peripheral surface 24a of the opening end 24 and an area of close contact of the second annular protrusion 14 with the top surface 24b of the opening end 24. When impact is exerted on the shoulder
5 portion, for example, of the shell 4 of the closure 2, the liner 10 is elastically deformed into a shape which causes reduction or disappearance of the space 25, and by this elastic deformation, at least a part of the impact is absorbed, thereby making it possible to
10 effectively prevent the occurrence of cracks or the like in the liner 10 which is due to the impact.

The protruding height H_2 of the second annular protrusion 14 needs not always to be larger than the protruding height H_1 of the first annular protrusion 12, and
15 may be equal to, or smaller than, the protruding height H_1 of the first annular protrusion 12. But when the protruding height H_2 of the second annular protrusion 14 is made larger than the protruding height H_1 of the first annular protrusion as in 12 as in the illustrated embodiment, the following advantages can be obtained. Specifically, when
20 the protruding height H_2 of the second annular protrusion 14 is made larger than the protruding height H_1 of the first annular protrusion 12, the pressure of close contact between the inner circumferential surface of the first annular protrusion 12 and the peripheral surface 24a of the opening
25 end 24 decreases relatively, but the pressure of close contact between the second annular protrusion 14 and the top surface 24b of the opening end 24 increases relatively. Consequently, as will also be seen from an impact test to be
30 described hereinbelow, the impact resistance of the sealing properties increases. Moreover, a reduction in sealing properties owing to the so-called doming phenomenon of the closure 2 can be more exactly prevented. When the container contains a carbonated beverage for example,
35 the top panel 4 of the closure 2 is deformed upwardly in convex form by the pressure generated within the container as shown exaggeratedly by the two-dot chain line in Figure 5. As a result, the pressure of close

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contact between the second annular protrusion 14 and the top surface 24b of the opening end 24 is reduced, and the sealing properties of the closure are likely to be destroyed. However, in the illustrated container closure 2 in which the protruding height H_2 of the second annular protrusion 14 is larger than the protruding height H_1 of the first annular protrusion 12, the pressure of close contact between the second annular protrusion 14 and the top surface 24b of the opening end 24 is increased relatively, and therefore any tendency of the sealing properties of the closure to be destroyed can be more exactly avoided even when the top panel 4 of the closure 2 is deformed.

Figure 6 shows a modified example of the liner improved in accordance with this invention.

The liner 110 shown in Figure 6 includes a first annular protrusion 112 similar to the first annular protrusion 12 and a second annular protrusion 114 similar to the annular protrusion 14, and a third annular protrusion 126 located inwardly of the second annular protrusion 114. As clearly shown in Figure 7, the third annular protrusion 126 has a peripheral surface 126a which is located opposite to an inner circumferential surface 124c of an opening end 124 of a container to be sealed or to an inner circumferential edge 124d of the top surface thereof.

As can be readily appreciated from Figure 7, in the container closure 102 having the liner 110 having the form illustrated in Figure 6, when the container closure 102 is put over an opening portion 118 of the container and pushed downwardly in Figure 7, the inner circumferential surface 126a of the third annular protrusion 126 abuts against the peripheral surface 124c of the opening end 124 of the container or the inner circumferential edge 124d of the top surface thereof, whereby the container closure is accurately guided to, and positioned at, the desired site with respect to the opening portion 118 of the container. Accordingly,

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mounting imperfections such as oblique capping, top cracking or poor drawing can be removed almost completely.

When the container closure 102 is fully pushed
5 against the opening portion 118 of the container and mounted tightly as desired, the third annular protrusion 126 is deformed elastically as illustrated in Figure 8, and moves away from the opening end 124 of the container. It is of course possible to provide the third annular
10 protrusion 126 such that when the container closure 102 is mounted tightly on the opening portion 118 of the container as desired, the peripheral surface 126a of the third annular protrusion 126 is brought into close contact with the inner circumferential surface 124c
15 of the opening end 124 of the container or with the inner circumferential edge 124d of the top surface thereof. However, in this structure, a part of the pressure of contact between the liner 110 and the opening end 124 of the container takes part in the close
20 contact of the peripheral surface 126a of the third annular protrusion 126 with the inner circumferential surface 124a of the opening end 124 or the inner circumferential edge 124d of the top surface. Hence, the pressure of close contact between the inner circumferen-
25 tial surface 112a of the first annular protrusion 112 and the peripheral surface 124a of the opening end 124 and the pressure of close contact of the second annular protrusion 114 to the top surface 124b of the opening end 124 are decreased correspondingly. This may tend
30 to reduce the sealing properties of the container closure 102 slightly when impact is exerted on it.

Figures 9 and 10 show a modified example of a liner improved in accordance with this invention which results from modifying of the liner 10 shown in Figures
35 1 and 2 in the following manner.

As already stated hereinabove with reference to Figure 3, the peripheral surface 12b of the first annular protrusion 12 of the liner 10 may be contacted

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with the inner surface of the skirt 8 of the shell 4. But in order to minimize the total volume of the liner and the amount of plastic material required for molding of the liner, it is desirable that as shown in Figures 1 and 2, the peripheral surface 12b of the first annular protrusion 12 in the liner 10 should be spaced away from the inner surface of the skirt 8 of the shell 4 radially inwardly to leave a space between the peripheral surface 12b and the inner surface of the skirt 8. Experiments of the present inventors have shown however that this structure tends to pose the following problem. Specifically, it has been found that when the liner 10 of the form shown in Figures 1 and 2 is molded in the inside of the top panel 6 of the shell 4, the liner 10 is bonded as required to the inside of the top panel 6 of the shell 4 during or immediately after the molding, but that as the time elapses from the molding, the outside edge portion of the liner 10 tends to peel off gradually from the inside of the top panel 6 of the shell 4. The cause of this peeling is not entirely clear, but the present inventors presume that because the liner material is caused to flow during its molding, a residual stress acting radially inwardly as shown by the arrow 15 in Figure 2 exists in the molded liner 10, and the residual stress which acts concentrately on the first annular protrusion 12 and the second annular protrusion 14 causes the outside edge portion of the liner 10 to peel off from the top panel 6 of the shell 4.

On the other hand, when the closure container 2 having the liner 10 of the form shown in Figures 1 and 2 is mounted on the opening portion 18 (Figures 4 and 5) of a container to be sealed, a relatively high stress is exerted on the first annular protrusion 12 and thus on the second annular protrusion 14 of the liner 10 owing to various factors as well known to those skilled in the art, and it is not infrequent that cracks occur in the first and second annular protrusions 12 and 14 of the liner 10 because of the presence of this stress. If the

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liner 10 is bonded as required to the top panel 6 of the shell 4, no problem arises even when the cracks occur. But when the liner 10 peels off from the top panel 6, the inside of the container will communicate with the outside of the container through the cracks and the area where peeling of the liner occurs, and this is likely to destroy the sealing of the opening portion 18 of the container.

The modified example shown in Figures 9 and 10 has been provided to solve the aforesaid problem residing with the liner 10 of the form illustrated in Figures 1 and 2. In the modified embodiment shown in Figures 9 and 10, too, the liner 210 has concentrically arranged first and second annular protrusions 212 and 214 as in the liner shown in Figures 1 and 2. The peripheral surface 212b of the first annular protrusion 212 is spaced radially inwardly from the inner surface of the rising part of skirt 208 of shell 202 leaving a space between them. When the distance between the peripheral surface 212b of the first annular protrusion 212 of the liner 210 and the inner surface of the rising part of the skirt 208 is increased, the amount of plastic material required for molding the liner 210 can be correspondingly decreased. But if the distance is made excessively large, the radial thickness of the first annular protrusion 212 necessarily becomes excessively small and the strength of the first annular protrusion 212 decreases excessively. Consequently, when the container closure 202 is mounted on the opening portion of the container, a load which is exerted on it at the time of mounting the closure 202 on the opening portion of a container will damage the first annular protrusion 212. In view of this, the distance x_1 in the radial direction between the peripheral surface 212b of the first annular protrusion 212 and the inner surface of the rising part of the skirt 208 is generally about 0.50 mm to about 5.00 mm, preferably about 0.70 mm to about 3.50 mm.

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The following improvements are achieved in the liner 210 illustrated in Figures 9 and 10. Specifically, a thin bulging bottom portion 217 which extends radially outwardly from a base portion of the peripheral surface 212b of the first annular protrusion 212 is provided in the liner 210. The thin bulging bottom portion 217 in the illustrated embodiment extends radially outwardly over the entire periphery from the base portion of the peripheral surface 212b of the first annular protrusion 212, and therefore, the general shape of the thin bulging bottom portion 217 is extending continuously in the circumferential direction.

When the thin bulging bottom portion 217 is provided in the liner 210, the strength of bonding of the thin bulging bottom portion 217 to the inside of the top panel 206 of the shell 204 fully prevents the peeling phenomenon of the outside edge portion of the liner 210 which is presumed to be due to the residual stress that acts concentratively on the first and second annular protrusions 212 and 214 of the liner 210 as stated hereinabove.

In order to prevent the peeling phenomenon of the outside edge portion of the liner 210 mentioned above, it may be possible to provide a considerably thick bulging bottom portion which extends radially outwardly from the base portion of the peripheral surface 212b of the first annular protrusion 212 to the inside surface of the skirt 208 of the shell 204 or its vicinity. However, this naturally leads to an increase in the amount of the plastic material required for molding the liner 210, and the cost of producing the container closure increases considerably. In addition, it is especially noteworthy that when the thickness of the bulging bottom portion increases, a considerably large residual stress of the type mentioned above also exists in the bulging bottom portion itself, and causes the bulging bottom portion to undergo the peeling phenomenon, with the result that the peeling phenomenon of the

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outside edge of the liner 210 cannot be fully prevented. Furthermore, in the container closure 202 of the form illustrated in Figures 9 and 10, the shoulder portion (i.e., the boundary between the top panel 206 and the skirt 208) of the shell 204 is deformed radially inwardly when the closure 202 is mounted on the opening portion of a container as mentioned hereinabove. When the protruding bottom portion becomes thick, there is an increased resistance to the application of such deformation.

For this reason, it is important that the bulging bottom portion projecting radially from the base portion of the peripheral surface 212b of the first annular protrusion 212 of the liner 210 should be the thin bulging bottom portion 217. Preferably, the thin bulging bottom portion 217 gradually decreases in thickness radially outwardly, and the thickness $t_{\max}$ of the radial inward end (having a maximum thickness) of the thin bulging bottom portion 217 following the base portion of the peripheral surface 212b of the first annular protrusion 212 is 0.10 to 1.00 mm, preferably 0.15 to 0.40 mm. In the embodiment shown in Figures 9 and 10, the surface (the under surface in Figures 9 and 10) of the thin bulging bottom portion 217 is defined by a curved surface having a suitable curvature conforming to the inside of the top panel 206 of the shell 204 at the protruding end of the thin bulging bottom portion 217, and the thickness of the thin bulging bottom portion 217 gradually decreases from the maximum thickness $t_{\max}$ at the radial inward end thereof as it extends radially outwardly.

In order to achieve the desired effect of inhibiting the increases of the amount of the plastic material required for molding the liner 210 and to fully prevent the peeling phenomenon mentioned above, the bulging length of the thin bulging bottom portion 217, i.e., the radial bulging length x_2 of the bottom portion 217 from the base portion of the peripheral surface

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212b of the first annular protrusion 212 is preferably smaller than the distance x_1 in the radial direction between the base portion of the peripheral surface 212b of the first annular protrusion 212 and the inside surface of the rising part of the skirt 208 (x_1 is preferably 0.50 to 5.00 mm, especially 0.70 to 3.50 mm, as stated hereinabove), and is about 0.10 to 3.00 mm, especially about 0.20 to about 1.00 mm.

Figure 11 shows a modified example of the thin bulging bottom portion 217. In the modified example shown in Figure 11, the surface of the thin bulging bottom portion 217 of the liner 210 (i.e., the under surface in Figure 11) is defined not by a curved surface but by a flat surface extending inclinedly and radially outwardly from the base portion of the peripheral surface 212b of the first annular protrusion 212 toward the inside of the top panel 206 of the shell 204 and conforming to the inside of the top panel 206 of the shell 204 at the bulging end of the thin bulging bottom portion 217, and the thickness of the thin bulging bottom portion 217 is gradually decreased from the maximum thickness $t_{\max}$ at the radial inside end of the bottom portion 217 as it extends radially outwardly.

Figure 12 shows still another modified example of the thin bulging bottom portion 217. In the modified example shown in Figure 12, the thin bulging bottom portion 217 of the liner 210 is composed of a plurality of sections extending radially outwardly from the base portion of the outer circumferential surface 212b of the first annular protrusion 210 at a plurality of positions spaced from each other in the circumferential direction. Preferably, each of the sections constituting the thin bulging bottom portion 217 is gradually decreased in thickness not only radially outwardly but also toward both sides in the circumferential direction. The width in the circumferential direction of each of the sections constituting the thin bulging bottom portion 217 can also be progressively decreased

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radially outwardly, as shown in Figure 12.

Experimental Example A

One surface of an aluminum-base alloy plate having a thickness of 0.25 mm was printed and coated with a vinyltype protective lacquer, and its other surface was coated with an epoxy paint containing oxidized polyethylene. The coated metal plate was pressed so that the surface coated with the epoxy paint was located inwardly. Thus, a metallic shell of the form illustrated in Figure 1 was obtained. The shell was heated to about 180°C, and high-pressure polyethylene (density 0.92 g/cm³, melt index 4.0 g/10 min.) melted at 220°C was put into the shell and molded to form a liner having the profile shown in Figures 1 and 2. Thus, a container closure (Example 1) of the present invention was produced. The dimensions of the various parts of its liner were as follows:

	Outside diameter d_1 of the first annular protrusion	26.0 mm
20	Inside diameter d_2 of the first annular protrusion	25.0 mm
	Outside diameter d_3 of the second annular protrusion	22.4 mm
	Inside diameter d_4 of the second annular protrusion	21.5 mm
25	Protruding height H_1 of the first annular protrusion	1.1 mm
	Protruding height H_2 of the second annular protrusion	0.8 mm
30	Thickness H_0 of the base portion between the first and second annular protrusions	0.55 mm

A container closure having the same specification as above except that the protruding height H_2 of the second annular protrusion was larger than the protruding height H_1 of the first annular protrusion (i.e., $H_1=0.8$ mm, $H_2=1.1$ mm) was produced in the same way as above (Example 2).

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For comparison, a container closure having the same specification as in Example 1 was produced in the same way as above except that the form of the liner was as illustrated in Figure 4 of Japanese Laid-Open Patent Publication No. 65184/78 cited hereinabove (Comparative Example).

Each of the container closures of Examples 1 and 2 and Comparative Example was mounted on an opening portion of a container in which the opening end had an outside diameter D_1 of 24.1 mm and an inside diameter D_2 of 19.3 mm, and the sealed containers were subjected to an impact test as shown below.

Sulfuric acid and sodium hydrogen carbonate were filled in an amount of 120 ml into a 120 ml container so that the gas volume after sealing was 4 volumes (1 volume of gas denotes a condition in which 1 cc of carbon dioxide gas is dissolved in 1 cc of water at 15.5°C under a pressure of 1 atmosphere), and then each of the container closures to be tested was mounted on the container to seal it. The sealed containers were each allowed to stand upright for a day in a constant-temperature chamber kept at 40°C. Then, as shown in Figure 13, the sealed container was positioned within a vertically disposed cylinder with its opening end facing downward so that the falling distance would be 300 and 400 mm respectively. The container was then allowed to fall spontaneously onto a mass of steel having a top surface with an inclination angle θ of 10° which was disposed at the bottom of the cylinder. The containers so subjected to impact were then allowed to stand upright at room temperature for one week. Then, the pressure inside the container was measured. When the pressure was decreased to 3.7 volumes or less than that from the original pressure of 4 volumes, it was assumed that leakage occurred in the container.

The above impact test was performed on fifty closure samples for each of the closures obtained in Examples 1 and 2 and Comparative Example. The number of

sample closures which developed leakage was counted, and the results are shown in Table 2.

Table 2

Falling distance	Comparative Example	Example 1	Example 2
300 mm	16	4	0
400 mm	43	6	1

5 Experimental Example B

A container closure was produced in the same way as in Example 1 of Experimental Example A except that the liner had a thin bulging bottom portion of the form shown in Figure 9 (Example 3).

10 The dimensions of the various parts in relation to the thin bulging bottom portion were as follows:

Distance x_1 in the radial direction
between the base portion of the outer
circumferential surface of the outside
15 annular protrusion and the inside surface
of the rising part of the skirt 0.90 mm
Bulging length x_2 in the radial direc-
tion of the thin bulging bottom
portion 0.25 mm
20 Maximum thickness $t_{\max}$ of the thin
bulging bottom portion at its inside
end in the radial direction 0.25 mm

A container closure in accordance with this
invention (Example 4) was produced in the same way as in
25 Example 1 of Experimental Example A except that the liner
had a thin bulging bottom portion of the form shown in
Figure 12. The thin bulging bottom portion was composed
of 16 sections disposed at equal intervals in the
circumferential direction. The width in the circum-
30 ferential direction of each of the 16 sections of the
thin bulging bottom portion at its radially inside end
was 0.23 mm.

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In order to determine the degree of peeling of the liner with time in the closures of Examples 1, 3 and 4, these closures were each subjected to the following test.

5 One hundred samples were used for each of the closures of Examples 1, 3 and 4, and the degree of peeling of the liner was examined during a period of 1 week and 1 month respectively after production of the samples in the wintertime. A mixture of ethanol and a
10 dyed paint was poured into the space between the inside surface of the skirt of the shell and the outer circumferential surface of the outside annular protrusion by a syringe. After the ethanol mixture was dried, the degree of peeling of the liner was determined by the
15 dimension of an area of adhesion of the dyed paint to that surface of the liner which faced the inside of the top panel of the shell (normally, this surface of the liner adheres to the inside of the top panel and does not permit adhesion of the dyed paint). The degree of
20 peeling was evaluated by S which shows that the dyed paint adhered to a region shown by S in Figure 14 starting at the outer circumferential surface of the outside annular protrusion, and M which shows that the dyed paint adhered to a region shown by M in Figure 14.
25 The results are shown in Table 3.

Table 3

Degree of peeling Period	Example 1		Example 3		Example 4	
	S	M	S	M	S	M
1 week	18	62	0	0	3	0
1 month	20	63	0	0	4	0

The numerals shown in Table 3 show the number of container closures out of 100 samples in each of Examples 1, 3 and 4 which developed peeling of the liner. For example, in Example 1, 18 samples developed

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liner peeling to a degree of S and 62 samples developed liner peeling to a degree of M after one week, and therefore, 20 samples did not develop liner peeling.

While some specific embodiments of the container closure constructed in accordance with this invention have been described hereinabove with reference to the accompanying drawings, it should be understood that the present invention is in no way limited to these specific embodiments, and various changes and modifications are possible without departing from the spirit and scope of the invention.

In particular, the foregoing description has been directed to a roll-on type closure which is adapted to be mounted tightly on an opening portion of a container having a screw thread formed on the outer circumferential surface of its opening portion by deforming the shell skirt along the aforesaid screw thread, and in which the shoulder portion of the shell is deformed radially inwardly at the time of sealing the opening portion of the container. However, the present invention is not limited to this specified type of container closure, and can be applied to various types of container closures, such as an ordinary roll-on type closure in which no deformation is exerted on the shoulder portion of the shell, and a screw-type closure having a screw thread formed in the skirt before sealing the opening portion of a container.

~~WHAT WE CLAIM IS:-~~

CLAIMS

1. In a container closure comprising a shell having a circular top panel and a substantially cylindrical skirt extending downwardly from the peripheral edge of the circular top panel and a plastic liner disposed in the inside of the top panel of the shell, said
5 liner having at least two concentrically arranged annular protrusions with a first annular protrusion located outward having an inner circumferential surface to be brought into close contact with the peripheral surface
10 of an opening end of a container to be sealed, the improvement wherein a second annular protrusion located inwardly is disposed such that it faces the top surface of the opening end of the container, and is adapted to
15 be brought into close contact with the top surface of the opening end of the container.
2. The closure of claim 1 wherein the protruding height H_2 of the second annular protrusion is larger than the protruding height H_1 of the first annular
20 protrusion.
3. The closure of claim 2 wherein the protruding height H_1 of the first annular protrusion is 0.4 to 1.0 mm, and the protruding height H_2 of the second annular protrusion is 0.5 to 1.6 mm.
- 25 4. The closure of claim 3 wherein the protruding height H_1 of the first annular protrusion is 0.6 mm to 0.8 mm, and the protruding height H_2 of the second annular protrusion is 0.85 mm to 1.2 mm.
5. The closure of any one of claims 1 to 4 wherein
30 the second annular protrusion progressively decreases in thickness as it extends toward its protruding end.
6. The closure of claim 5 wherein the outer circumferential surface of the second annular protrusion is inclined radially inwardly as it extends toward its
35 protruding end, and when it is brought into close contact with the top surface of the opening end of the container, it is bent radially inwardly.
7. The closure of any one of claims 1 to 6 wherein

the liner has a third annular protrusion located inwardly of the second annular protrusion, and the third annular protrusion has an outer circumferential surface which is adapted to face the inner circumferential surface of the opening end of the container or the inner circumferential edge of the top surface of the opening end.

8. The closure of any one of claims 1 to 7 wherein the peripheral surface of the first annular protrusion is spaced a distance from the inner surface of the skirt of the shell radially inwardly, and has provided therein a thin bulging bottom portion extending radially outwardly from the base portion of the peripheral surface of the first annular protrusion.

9. The closure of claim 8 wherein the distance x_1 in the radial direction between the base portion of the peripheral surface of the first annular projection and the inner surface of the rising part of the skirt is from 0.50 mm to 5.00 mm, and the protruding length x_2 of the thin bulging bottom portion in the radial direction from the base portion of the peripheral surface of the first annular protrusion is from 0.10 mm to 3.0 mm.

10. The closure of claim 9 wherein the distance x_1 is from 0.70 mm to 3.50 mm, and the protruding length x_2 is from 0.20 mm to 1.00 mm.

11. The closure of any one of claims 8 to 10 wherein the thin bulging bottom portion progressively decreases in thickness as it extends radially outwardly, and the thickness $t_{\max}$ of the radially inside end of the bottom portion extending from the base portion of the peripheral surface of the first annular protrusion is from 0.10 mm to 1.00 mm.

12. The closure of claim 11 wherein the thickness $t_{\max}$ is from 0.15 mm to 0.40 mm.

13. The closure of any one of claims 8 to 12 wherein the thin bulging bottom portion is annular and extends continuously in the circumferential direction.

14. The closure of any one of claims 8 to 12 wherein the thin bulging bottom portion is composed of

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a plurality of sections extending radially outwardly from the base portion of the peripheral surface of the first annular protrusion at a plurality of spaced-apart positions in the circumferential direction.

5 15. The closure of any one of claims 1 to 14 which is of a roll-on type which is adapted to be tightly mounted on an opening portion of a container to be sealed having a screw thread formed on the peripheral surface of the opening portion by putting it
10 over the opening portion and deforming the skirt of the shell along said screw thread.

16. The closure of claim 15 wherein when the closure is to be mounted on the opening portion of the container, the shoulder portion of the shell is deformed
15 radially inwardly, whereby the inner circumferential surface of the first annular protrusion of the liner is brought into close contact with the opening end of the container.

FIG. 1

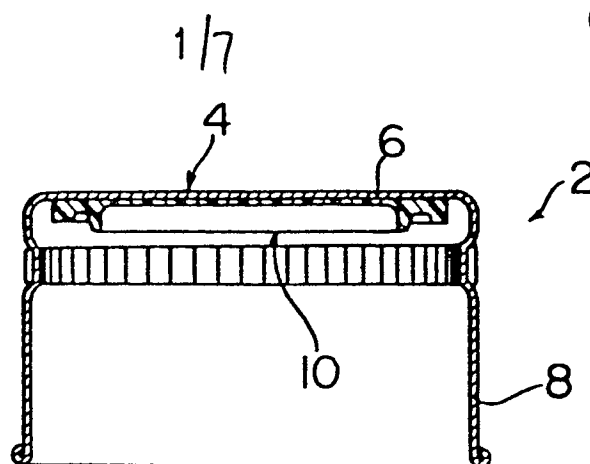


FIG. 2

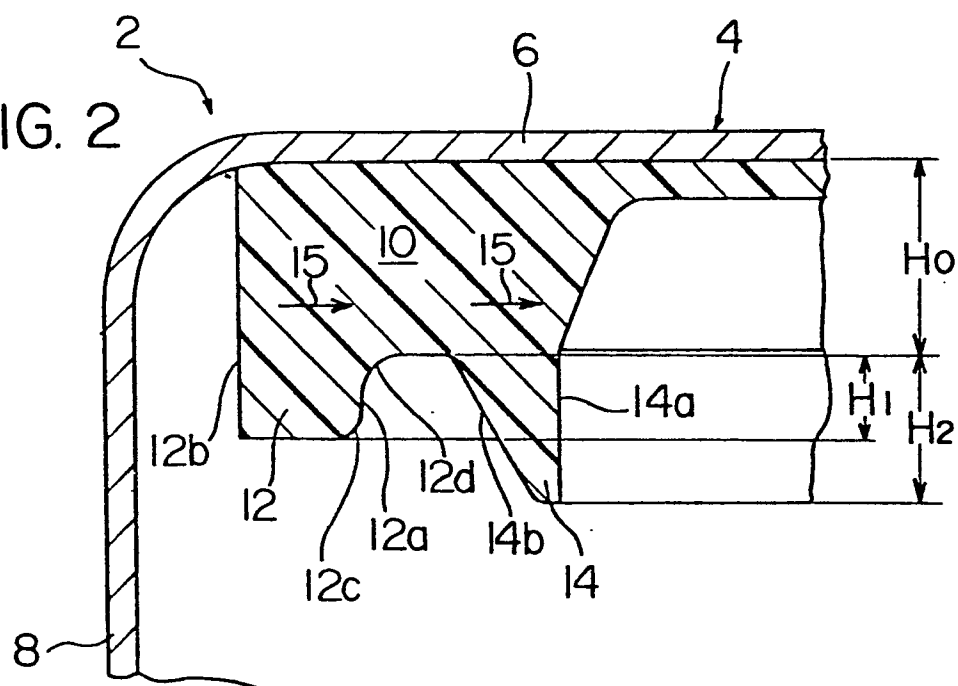


FIG. 3

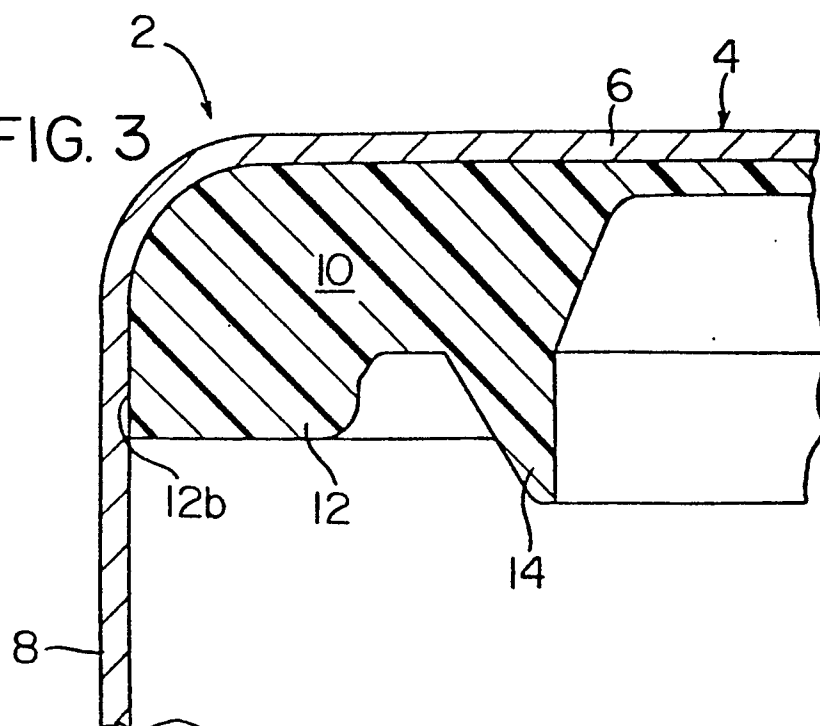


FIG. 4

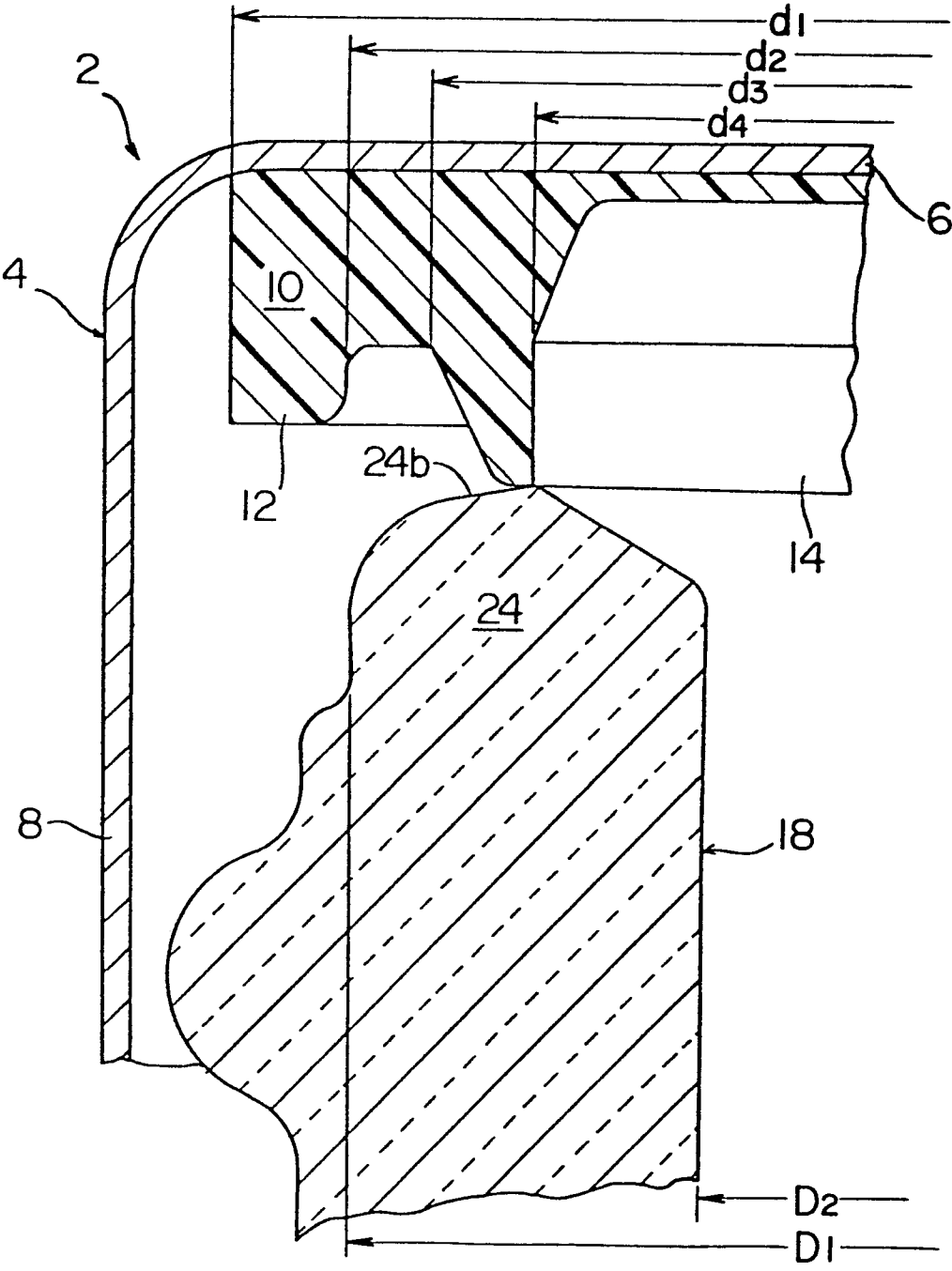
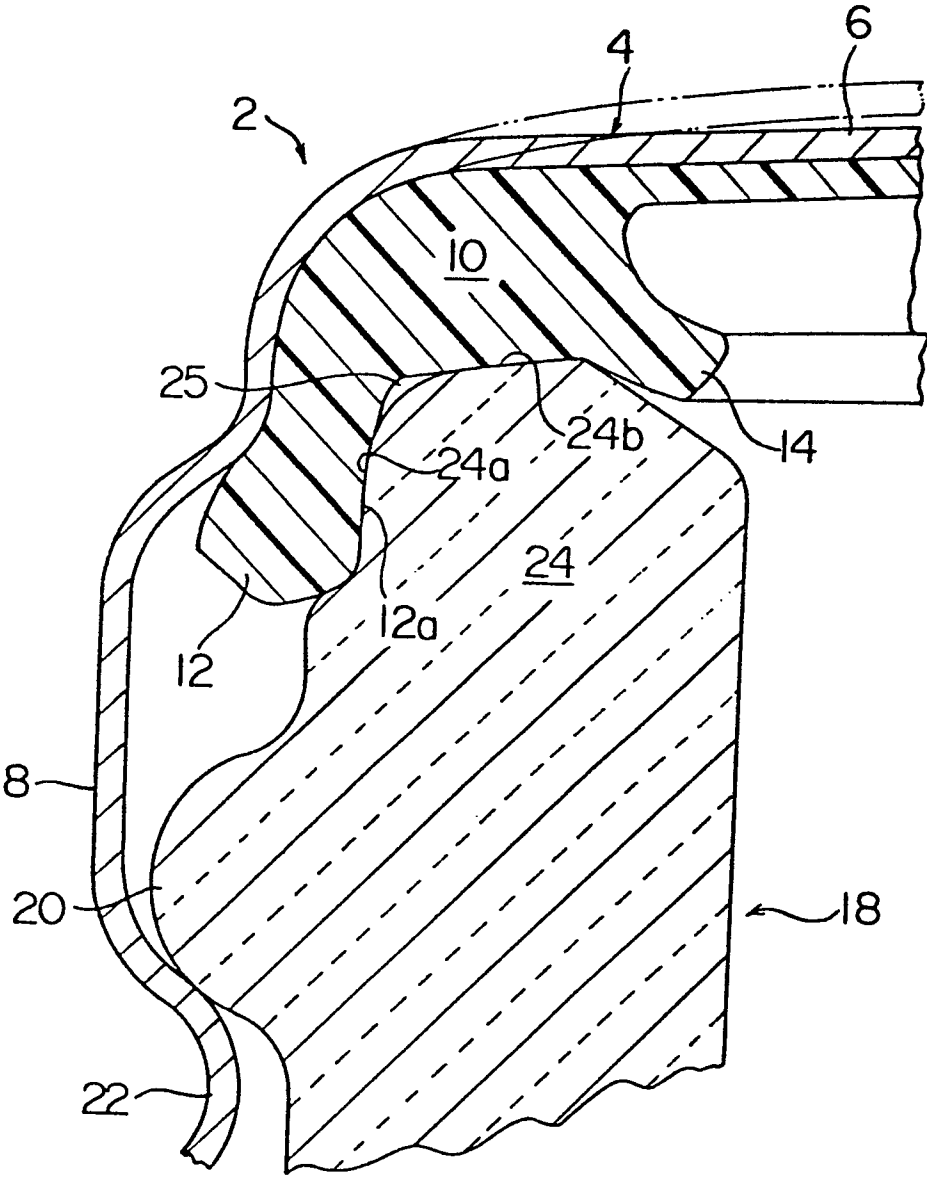


FIG. 5



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FIG. 6

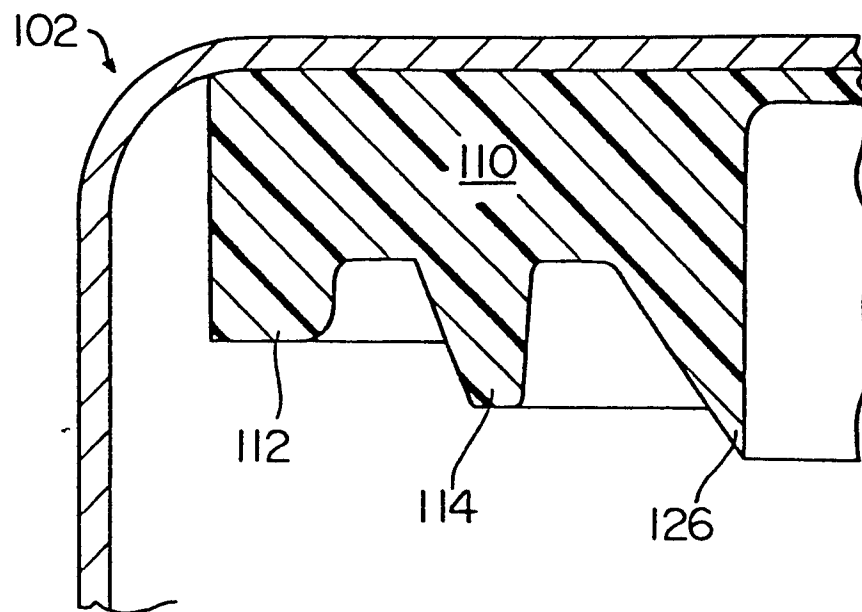


FIG. 7

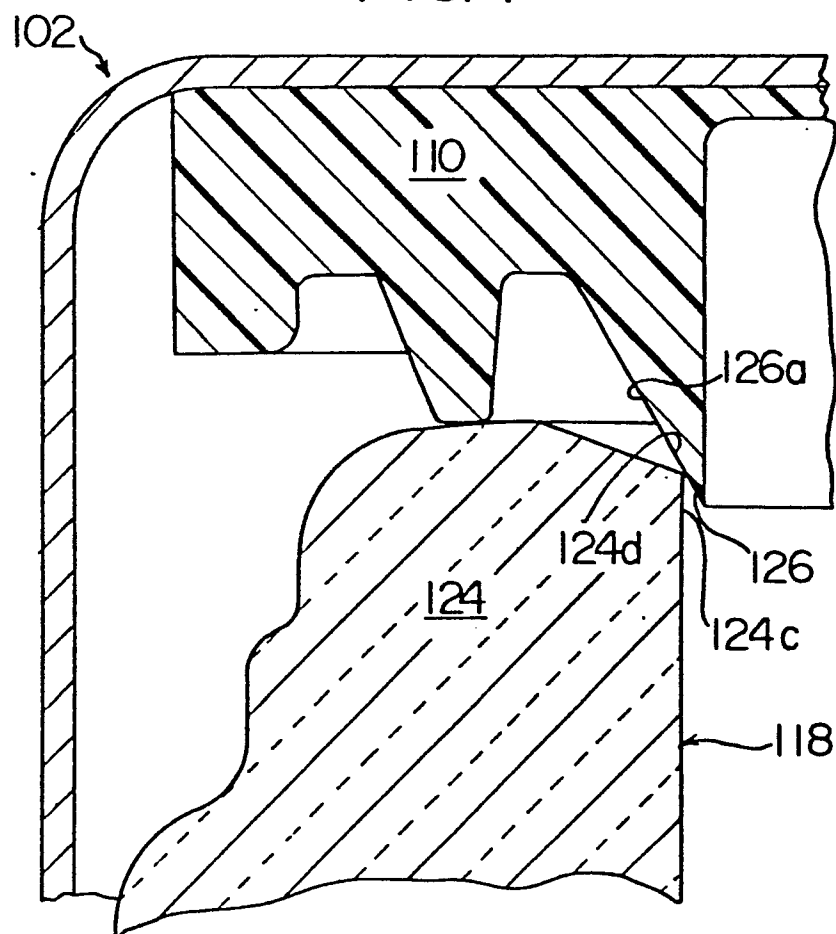
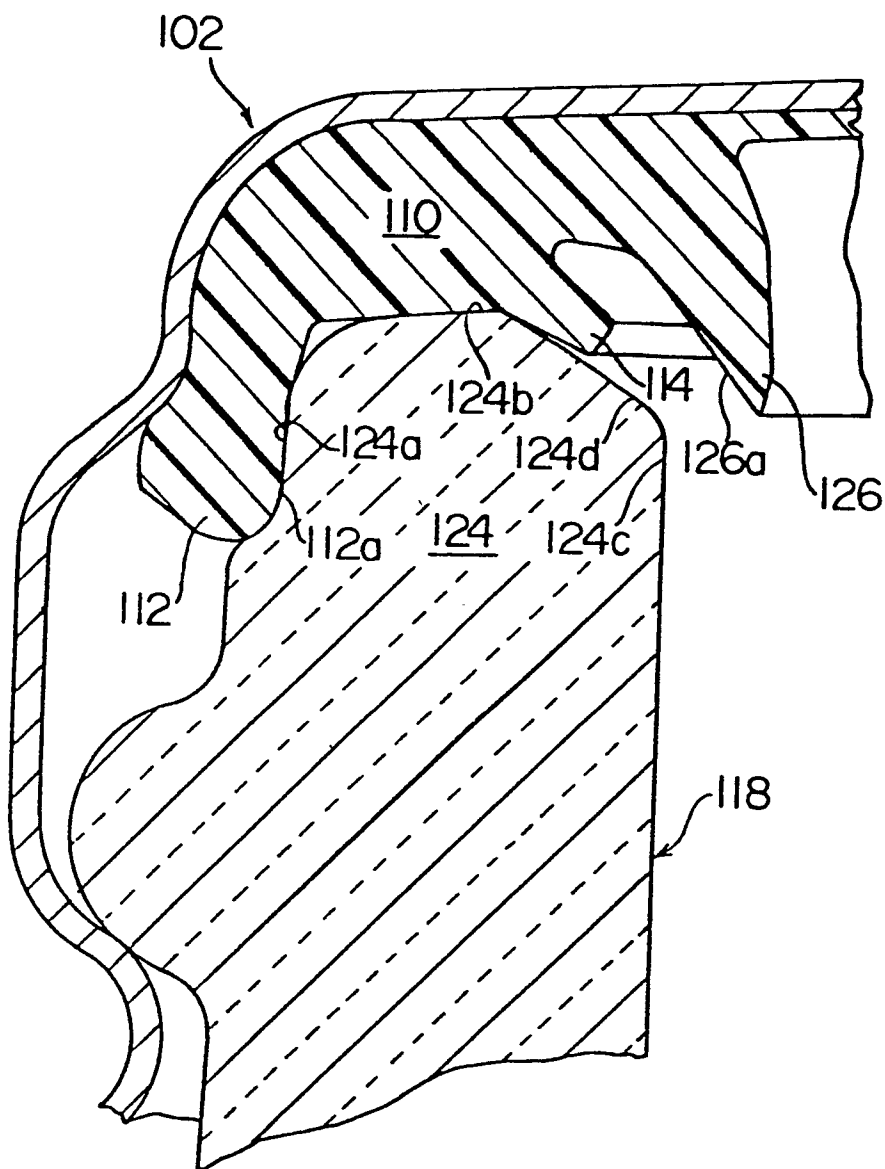


FIG. 8



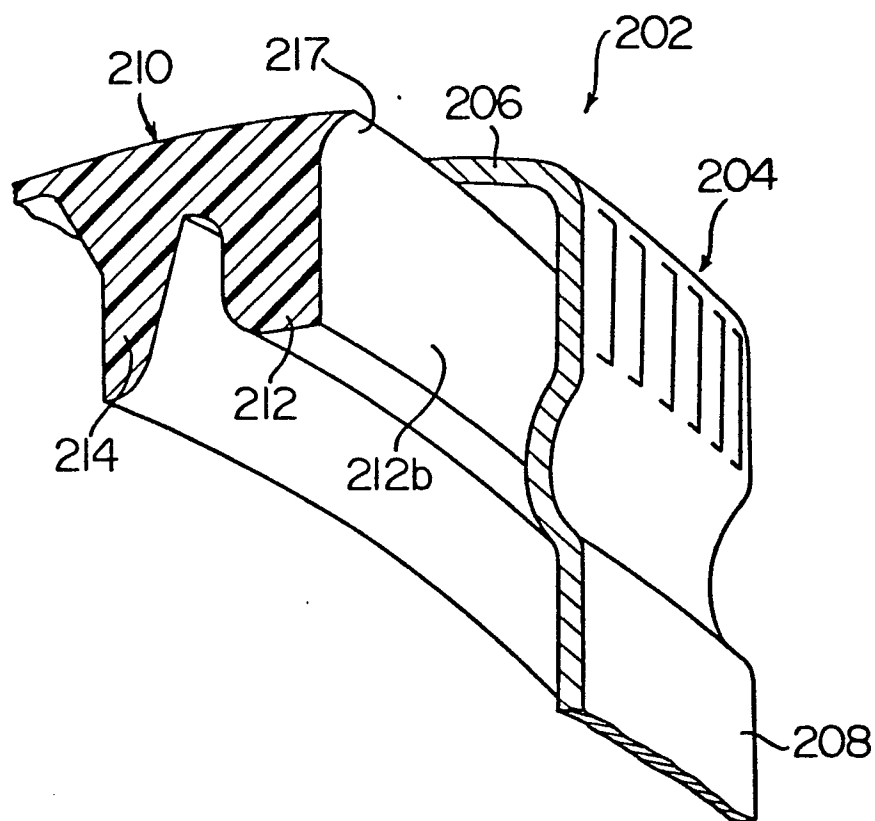
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FIG. 9

FIG. 10

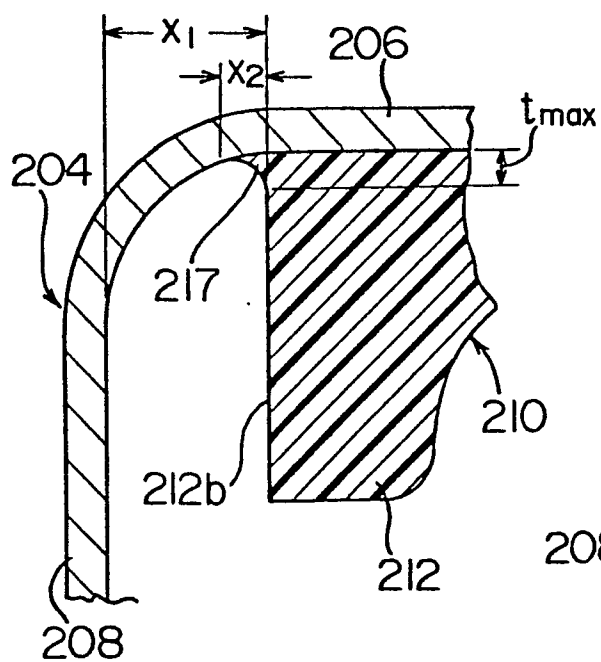


FIG. 11

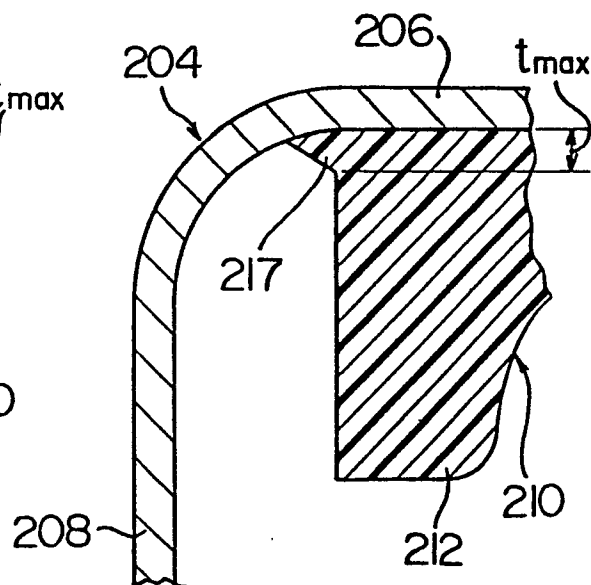


FIG. 12

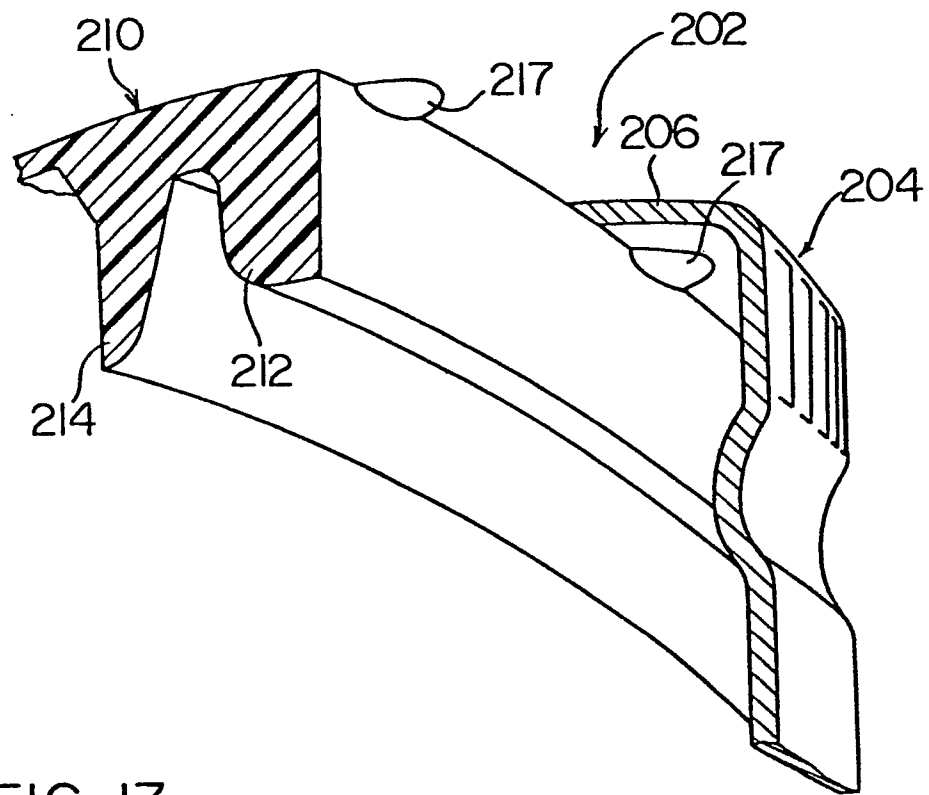


FIG. 13

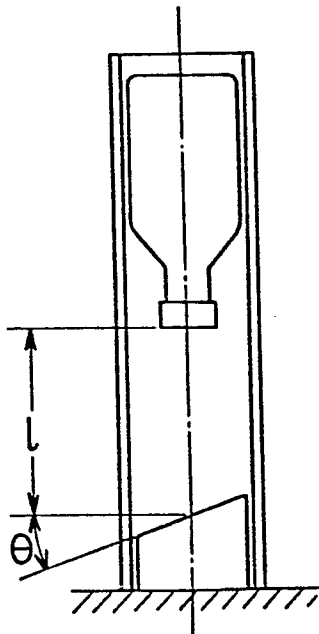
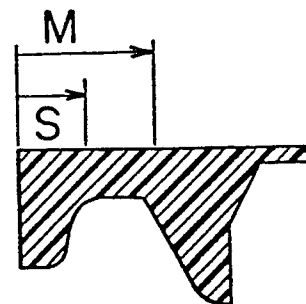


FIG. 14





DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>US - A - 4 114 775</u> (JAPAN CROWN CORK) + Fig.6,7,10 + --	1-6,8,15,16	B 65 D 41/04 B 65 D 53/04
	<u>GB - A - 1 025 933</u> (CONTINENTAL CAN.) + Fig.3,6 + --	1-15	
	<u>US - A - 3 257 021</u> (CONTINENTAL CAN.) + Fig. 3 + --	1,5-13	TECHNICAL FIELDS SEARCHED (Int.Cl. ³)
	<u>FR - E - 62 360</u> (GUINET) + Fig. 1,5 + --	2-7	B 65 D 41/00 B 65 D 53/00
	<u>GB - A - 969 103</u> (METAL CLOSURES LIMITED) + Fig. + ----	1,7	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
X	The present search report has been drawn up for all claims		&: member of the same patent family, corresponding document
Place of search VIENNA		Date of completion of the search 06-02-1981	Examiner TROJAN