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(54) Title: CLOSURES WITH AN ANNULAR REMOVAL ELEMENT

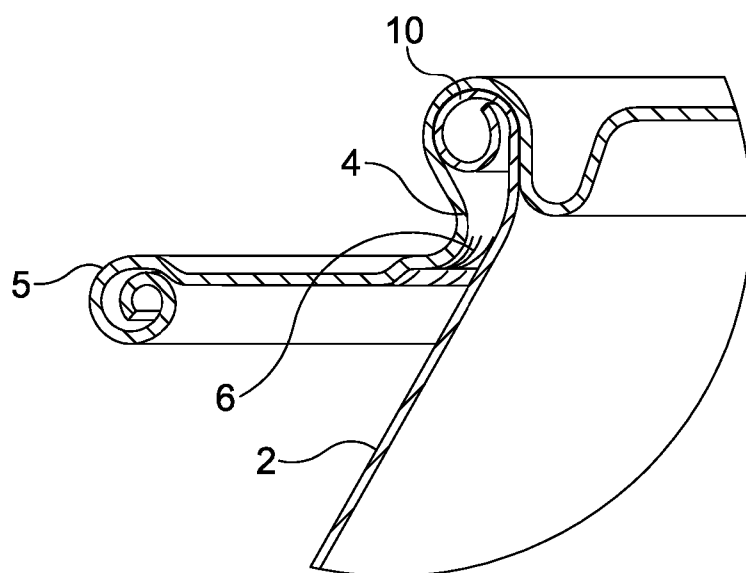


Figure 5C

(57) Abstract: A one-piece closure (1) for a container (2) is provided which comprises an end panel (3), a sidewall (4) depending from the end panel for extending circumferentially around and gripping a wall surrounding an opening of the container, and a brim (5). The brim is located radially outward of the sidewall and is connected to the sidewall by an annular region extending in a plane substantially parallel to a plane across which the centre panel extends. Movement of the brim relative to the sidewall imparts tension to the annular region and creates a radially outward pulling force to loosen the grip of the closure on the container during opening. A method of manufacture of the one-piece closure is also provided.

CLOSURES WITH AN ANNULAR REMOVAL ELEMENT

Technical Field

5 The invention relates to containers and closures, and to a method of manufacture of closures.

Background

10 Many types of closure are known for cans, jars and bottles, with many requiring some type of thread or rolled seam or crimp to hold them in place. In some cases, a partial vacuum inside the container is used to help retain the closure.

Closures (commonly known as “easy-open ends”) that are currently available for
15 beverage cans are fixed permanently to the can bodies by seaming the closures onto the flanged open ends of the can bodies after filling. An aperture is formed during opening by tearing a scored region of the closure. These closures have a tab component attached in order to open around the score. If the closure is of the “stay-on-tab” type, then the space available for the aperture is limited. If a “full-aperture” is
20 required, then the tab, attached together with the unsafe sharp-edged metal part from the aperture, is detached during opening and requires safe disposal. Neither of these closure types is re-closable. Re-closable beverage can closures are available (for example as described in US6206222), but these generally comprise expensive plastic moulded valves which restrict the aperture available for drinking or pouring.

25 Easy-open ends for beverage cans are commonly available to suit cans with open ends down to around 50mm. Below this size, seaming of ends onto cans becomes more difficult, and there is less space available for the scored aperture, the tab and its attachment.

30 Beverage cans having an opening smaller than 38mm in diameter are generally referred to as metal bottles, and are commonly used with types of closures suited to glass or plastic bottles. Provision of curls and threads at the openings of metal bottles often requires several manufacturing process steps and complex tooling. Threads are

more complex to manufacture than simple curls, but are often the only option available for metal bottle apertures greater than around 20mm in diameter.

5 It is therefore currently difficult to provide cost-effective easy-to-open closures or pressurised metal beverage cans or bottles having apertures between 20 and 50mm, and even more so for apertures between 30 and 45mm.

10 Closures for bottles and jars, such as "Crown" closures that are typically used for bottled beverages, may be applied by pressing them onto a bottle and crimping. However, these normally require a tool to open and are only commonly available to suit bottles with narrow openings up to around 20mm in diameter. "Twist-Off-Crowns" are available that can be released by twisting, but these can be uncomfortable and even injurious to open, and require the bottle to have moulded screw threads to create a mating thread during crimping. "Twist-Off-Crowns" are not commonly used on metal
15 bottles due to the inability to provide threads of sufficient strength.

Another type of closure, known as Maxi-Crown and described in US 4768667 A, is available that can be crimped on and torn open, but this exposes sharp edges after opening and requires safe disposal.

20

Closures are available for bottles and jars that are pressed-on over a thread on the container, such that the sealing material within the closure conforms to the thread and enables them to be twisted off. Such closures are commonly used for small quantities of foodstuffs such as spreads and baby-food in glass jars. However the threads and
25 the sealing material have to be accurately formed and the sealing material must be specially formulated, and so manufacturing costs are high.

Closures may be screwed onto cans, bottles and jars that have screw threads. Such closures may have corresponding screw threads, lugs that engage with the container threads, or may have a plain metal surface that can be rolled to conform to the
30 container threads. All such closures are twisted to remove them.

All the closure types described above have both advantages and disadvantages. Closures that require twisting to open them are less prone to unintentional opening by
35 accidental impacts, but it is often expensive and difficult to provide the necessary screw

threads. Closures that do not require twisting are generally crimped tightly and require a tool to remove them. When a crimped closure is opened, it is usually distorted such that the closure cannot be used to re-close the container. This has the advantage that there is evidence that the container has been opened (tamper-evidence), but the disadvantage that it cannot be reclosed.

Closures may be provided with slits or cuts to create joining regions that might be defined as spokes, to be torn to create a separate band when opened. This provides evidence of opening and additional security before opening. Typical examples are aluminium "roll-on pilfer-proof" capsules for wine and other bottles, and plastic caps with tear bands for containers such as plastic milk containers. However, it is not always desirable for the closure to be torn when opened as this exposes sharp edges.

Often it is not practical to provide a container and closure made from the same material, which hinders recycling.

Summary of the invention

According to a first aspect of the invention there is provided a one-piece closure for a container, the closure comprising an end panel, a sidewall depending from the end panel for extending circumferentially around and gripping a wall surrounding an opening of the container, and a brim. The brim is located radially outward of the sidewall and is connected to the sidewall by an annular region extending in a plane substantially parallel to a plane across which the centre panel extends. Movement of the brim relative to the sidewall imparts tension to the annular region and creates a radially outward pulling force to loosen the grip of the closure on the container during opening.

The one-piece closure may be of metal or a metal alloy.

The annular region may comprise a multiplicity of spokes to which tension is imparted by circumferential twisting of the brim about an axis of the container.

The spokes may be substantially straight or may be curved.

The annular region may be a substantially flat, continuous region.

The brim may be provided by an inwardly curled edge of the closure.

5

The sidewall may comprise one or more regions of weakening configured to tear during opening.

The lines of weakening may extend into the annular region.

10

The one-piece closure may be configured such that, when affixed to a container, movement of the brim about the container permanently distorts or tears a part of the closure to provide evidence of such movement.

15

The one-piece closure may be configured such that, when affixed to a container, rotation of the brim about the container is substantially not impeded by the container other than by forces exerted on the brim via the annular component.

The closure may be unthreaded and may be configured to be affixed to an unthreaded container.

20

The central region of the end panel may be one of substantially flat, domed, recessed, and recessed and reverted.

25

The one-piece closure may be dimensioned to close a container having an internal aperture diameter between 20 mm and 50 mm and more preferably of between 30 and 45mm.

The brim may have a diameter that is at least 1.1 times bigger than the diameter of the sidewall.

30

The one-piece closure may be configured to allow the side wall, and optionally at least part of the annular region, to be secured to a neck of the container by crimping.

According to a second aspect of the present invention there is provided a method of attaching a closure according to the first aspect above to a container, the method comprising placing the closure over the opening of the container and crimping the sidewall against the container wall to form a seal between the closure and the container.

The container may be one of a beverage can, a metal bottle and a glass or plastic bottle.

According to a third aspect of the present invention there is provided a method of manufacturing a one-piece closure according to the first aspect above, the method comprising providing a shell having a centre panel and an annular channel surrounding the centre panel, and curling an outer substantially vertical wall of the annular channel inwardly to form the brim.

Following the step of curling, the method may comprise supporting a portion of the bottom wall of the annular channel while pressing the remainder of the bottom wall to form the annular region and a U-shaped channel inwardly of the annular region.

The method may comprise supporting the remainder of the bottom wall from beneath, radially inward of the curled brim, while pressing.

The method may comprise the shell being recessed and reverted such that a countersink is present between the centre panel and said annular channel.

Wherein the annular region of the closure comprises a multiplicity of spokes to which tension is imparted by circumferential twisting of the brim about an axis of the container, the method may comprise cutting a plurality of radial slits into the outer substantially vertical wall of the shell prior to said step of curling.

According to a fourth aspect of the present invention there is provided a container comprising a closure according to the first aspect of the invention and a container body adapted to accommodate the closure and having a curled aperture with an internal diameter between 20 mm and 50 mm.

According to a fifth aspect of the present invention there is provided a container comprising a closure according to the first aspect of the invention and a container body adapted to accommodate the closure and having a curled aperture with an internal
5 diameter between 30 mm and 45 mm

Brief Description of the Drawings

Figure 1A shows a perspective view of a flat panel closure;
10 Figure 1B shows a cross section of the flat panel closure of Figure 1A;
Figure 2A shows a perspective view of a recessed panel closure;
Figure 2B shows a cross section of the recessed panel closure of Figure 2A;
Figure 3A shows a perspective view of a recessed and reverted metal closure;
Figure 3B shows a cross section of the recessed and reverted metal closure of Figure
15 3A;
Figure 4A shows a perspective view of a metal container;
Figure 4B shows a cross section of the metal container of Figure 4A;
Figure 4C shows a partial enlarged cross section of the metal container of Figure 4A;
Figure 5A shows a perspective view of a recessed and reverted metal closure fixed to
20 a metal container;
Figure 5B shows a cross section of the closure and container of Figure 5A;
Figure 5C shows a partial enlarged cross section of the closure and container of Figure 5A;
Figure 6A shows a perspective view of a crimping tool arrangement;
25 Figure 6B shows a cross section of the crimping tool arrangement of Figure 6A;
Figure 6C shows a partial enlarged cross section of the crimping tool arrangement of Figure 6A before crimping;
Figure 6D shows a partial enlarged cross section of the crimping tool arrangement of Figure 6A after crimping; and
30 Figure 7A shows a schematic plan view of a closure before rotation of the brim;
Figure 7B shows a schematic plan view of the closure following rotation of the brim.
Figure 8A shows a perspective view of an alternative recessed and reverted metal closure;
Figure 8B shows a cross section of the alternative recessed and reverted metal closure
35 of Figure 8A;

- Figure 9A shows a perspective view of a closure shell;
Figure 9B shows a cross section of the closure shell of Figure 9A;
Figure 10A shows a perspective view of a partly manufactured closure;
Figure 10B shows a cross section of the partly manufactured closure of Figure 10A;
5 Figure 10C shows a plastic closure;
Figure 10D is an enlarged partial internal view of the plastic closure of Figure 10C;
Figure 11A shows a perspective view of a flat panel closure;
Figure 11B shows a cross section of the flat panel closure of Figure 11A;
Figure 11C shows a partial enlarged view of Figure 11B;
10 Figure 11D shows a perspective view of an alternative flat panel closure;
Figure 11E shows a cross section of the flat panel closure of Figure 11D;
Figure 11F shows a partial enlarged view of Figure 11E;
Figure 12A shows a perspective view of a recessed panel closure;
Figure 12B shows a cross section of the recessed panel closure of Figure 12A;
15 Figure 13A shows a perspective view of a recessed and reverted metal closure;
Figure 13B shows a cross section of the recessed and reverted metal closure of Figure 13A;
Figure 14A shows a perspective view of a metal container;
Figure 14B shows a cross section of the metal container of Figure 4A;
20 Figure 14C shows a partial enlarged cross section of the metal container of Figure 14A;
Figure 15A shows a perspective view of a recessed and reverted metal closure fixed to a metal container;
Figure 15B shows a cross section of the closure and container of Figure 15A;
Figure 15C shows a partial enlarged cross section of the closure and container of
25 Figure 15A;
Figure 16A shows a perspective view of a crimping tool arrangement;
Figure 16B shows a cross section of the crimping tool arrangement of Figure 16A;
Figure 16C shows a partial enlarged cross section of the crimping tool arrangement of Figure 16A before crimping;
30 Figure 16D shows a partial enlarged cross section of the crimping tool arrangement of Figure 16A after crimping;
Figure 17A and 17B show diagrams of tilting forces applied to the closure and container of Figure 15C;
Figure 18A shows a cross section of the closure and upper part of the container of
35 Figure 17 after the brim has been partially tilted;

Figure 18B shows a diagram of tilting forces applied to the closure and container of Figure 17;

Figure 19A shows a perspective view of a closure shell;

Figure 19B shows a cross section of the closure shell of Figure 19A;

5 Figure 20A shows a perspective view of a partly manufactured closure;

Figure 20B shows a cross section of the partly manufactured closure of Figure 20A;

Figure 21A is a cross sectional view of a tooling arrangement to produce the shell of Figure 19A and 19B shown in an initial position;

Figure 21B is a partial enlarged view of Figure 21A;

10 Figure 22A is a cross sectional view of a tooling arrangement to produce the shell of Figure 19A and 19B shown in a second position;

Figure 22B is a partial enlarged view of Figure 22A;

Figure 23A is a cross sectional view of a tooling arrangement to produce the shell of Figure 19A and 19B shown in a third position;

15 Figure 23B is a partial enlarged view of Figure 23A;

Figure 24A is a cross sectional view of a tooling arrangement to produce the shell of Figure 19A and 19B shown in a fourth position;

Figure 24B is a partial enlarged view of Figure 24A;

Figure 25A is a cross sectional view of a tooling arrangement to produce the shell of

20 Figure 19A and 19B shown in a final position;

Figure 25B is a partial enlarged view of Figure 25A;

Figure 26A is a cross sectional view of a tooling arrangement to produce the closure of Figure 13A and 13B shown in an initial position;

Figure 26B is a partial enlarged view of Figure 26A;

25 Figure 27A is a cross sectional view of a tooling arrangement to produce the closure of Figure 13A and 13B shown in a second position;

Figure 27B is a partial enlarged view of Figure 27A;

Figure 28A is a cross sectional view of a tooling arrangement to produce the closure of Figure 13A and 13B shown in a third position;

30 Figure 28B is a partial enlarged view of Figure 28A;

Figure 29A is a cross sectional view of a tooling arrangement to produce the closure of Figure 13A and 13B shown in a fourth position;

Figure 29B is a partial enlarged view of Figure 29A;

Figure 30A is a cross sectional view of a tooling arrangement to produce the closure of

35 Figure 13A and 13B shown in a final position;

Figure 30B is a partial enlarged view of Figure 30A;

Figure 31A is a cross-sectional view of a tooling arrangement to cut radial slits;

Figure 31B and Figure 31C are partial enlarged views of figure 31A;

Figure 31D is a perspective view of the lower slitting tool of Figure 31A; and

5 Figure 31E is a partial enlarged view of figure 31D.

Detailed Description

10 A thread-less closure for a container is illustrated in the accompanying Figures 1 to 10, where the closure is identified by reference numeral 1 and the container, where shown, is identified by reference numeral 2. As will be clear from the following discussion, the closure 1 is loosened during operation by twisting its brim relative to the container 2.

15 Referring to Figure 1A and 1B, there is provided an exemplary closure 1, which comprises a generally flat central panel region 3 adjoining a downwardly dependent and generally cylindrical side wall 4, which is in turn connected to an outer brim 5 by a multiplicity of radially extending spokes 6. The periphery of the cap is curled in on itself to create the brim 5 and to avoid presenting a sharp edge to the user.

20 It is preferable that the closure 1 should be made of a material identical or similar to that of the container 2 to optimise recycling. For application to an aluminium container, the closure 1 is preferably made of aluminium or an aluminium alloy. The surfaces of closure 1 may be protected with a polymer layer or organic coating and may be decorated to enhance the appearance and provide visual information. It will be
25 appreciated that the closure 1 may of course be made of any other appropriate material such as steel or plastics.

30 Considering the centre panel 3, a generally flat centre panel is preferred if the closure is to be applied to a rigid (e.g. glass) bottle container 2 having a small aperture. However, the panel may alternatively be domed or recessed. A recessed centre panel 3, as shown in Figure 2A and 2B, is preferred if the closure is to be applied to a less rigid (e.g. aluminium) bottle container 2 having a small aperture. A recessed and
35 reverted centre panel 3, as shown in Figure 3A and 3B, is preferred if the closure 1 is to be applied to a can or bottle having a larger aperture. The recess may be shaped to accommodate a tool to provide radial support during crimping.

Considering further the spokes 6, these extend radially inwardly from the brim 5 and meet the side wall 4. The spokes 6 may form part of the region of the closure that is crimped, although they will generally not extend above that region as the seal might otherwise be compromised. The spokes 6 are configured to provide sufficient structure to hold the brim 5 in place and to allow it to be twisted around the side wall 4. The spokes 6 may be formed by cutting slits in the metal sheet from which the closure is formed.

Figure 4A illustrates a metal container 2 to which the closure is to be affixed. The container comprises a necked region forming an aperture. As will be clear from Figures 4B and 4C, the rim surrounding the aperture is curled to form a lip 10. The lip may have a width of between 1mm and 6mm and more preferably between 1.5mm and 4mm. The container 2 may be any suitable container having an aperture that a closure can be crimped onto, and may contain any product including food-stuffs or beverages. The container may be a non-threaded metal beverage can or metal bottle having an internal aperture diameter between 20mm and 50mm and more preferably between 28mm and 45mm, and more preferably between 35mm and 45mm.

It is preferable to curl the aperture of the container 2 in two steps to enhance its rigidity: firstly forming a curl of a smaller radius and then a curl of a larger radius, such that the first curl is surrounded by the second curl. Further forming steps may be carried out to stiffen the curl further or to more accurately control or alter the profile or dimensions of the curl.

Figure 5A to 5C illustrate the recessed and reverted closure 1 of Figures 3A and 3B fixed to the container 2 of Figures 4A to 4C. The closure is pressed against the neck of the container 2, beneath the outwardly curled lip 10 of the container, in order to secure the closure in place. The closure will typically be sealed to the neck using a crimping procedure in order to push a crimp region tightly against the neck of the container. Although not shown in the Figures, a sealing compound such as a polymer may be provided around the inner surface, or a portion of the inner surface, of the closure in order to aid sealing. The sealing compound may also contain substances to enhance the intended contents of the container 2, such as oxygen scavengers for example.

35

Figures 6A to 6D illustrate further the process for attaching the closure 1 to the container 2. The recessed and reverted closure 1 is first placed over the necked region of the container. A pair of rollers 8 is moved around the side wall 4, exerting a force against the side wall in order to form the crimp. The closure is supported during crimping by placing a tool 9 within the recess (Figure 6C). The rollers 8 orbit the closure 1 and move radially inwards, as shown in Figure 6D. Alternatively, the container 2 and closure 1 may be rotated whilst the roller or rollers are moved radially inwards. During crimping, it is anticipated that the spokes 6 will become taut and the height of the side wall 4 will decrease as its diameter is reduced.

The closure 1 is removed from the container 2 by firstly twisting the brim 5 about the axis of the container. This imparts tension into the spokes 6, which in turn pulls the side wall 4 radially outwards, to enable the closure to then be pushed or pulled upwards off the container 2.

The diagram of Figure 7A and 7B illustrate schematically how tension is generated in the spokes to pull the sidewall radially outwards. Figure 7A shows an arrangement comprising a circle of diameter D_1 which represents the rigid brim and a circle of diameter D_2 which represents the less-rigid sidewall. The two circles are joined in this example by four exemplary spokes of length L . Figure 7B shows the arrangement after the brim has been rotated relative to the sidewall. In order for the spokes to retain their length L , the diameter of the sidewall is increased from D_2 to D_3 . A mechanical advantage is illustrated by the distance of circumferential movement M_1 of the brim relative to the distance of radial movement of the sidewall M_2 . This mechanical advantage increases the radial force of the spokes on the sidewall in relation to the circumferential force applied by the brim. Movement of the brim in any direction generally perpendicular to the spoke will create tension in the spoke in this way, and it is thus intended that the closure may be removed from the container by any combination or sequence of rotation of the brim in either direction and of lifting or tilting the brim relative to the closure axis.

Preferably the strength of each part of the closure 1 is adapted so that this is easily achieved without the use of any tool. The strength of each part of the closure 1 may be adapted to require a grip and/or a level of force or torque that for example only an adult

could be expected to be able to apply. However, if desired for additional security, the closure 1 may be made strong enough to require the use of a tool.

5 The frictional contact between the closure 1 and the container 2, including that of the seal and from any interference fit inward of the side wall 4, may be adapted to resist rotation of the closure 1 during opening. Additional features, such as lugs for example, may also be provided to prevent such rotation.

10 If the closure 1 is made of metal, then the strength of each part of the closure may be adapted to require the brim 5 to be twisted more than once in opposing directions to sufficiently release the side wall 4. It is preferable that opening causes sufficient permanent distortion to indicate that the closure has been opened.

15 The strength of each part of the closure 1 may be adapted to allow the closure 1 to be re-attached to the container 2 after it has been opened. Re-attachment may provide any extent of re-sealing, spillage resistance or intentional ventilation, according to the desired purpose.

20 Figure 8A and 8B illustrate a modified closure construction according to which the spokes 6 are slightly curved prior to attachment of the closure to a container. The result of crimping the closure around the container neck causes the spokes to become more radially aligned. The edges of the spokes 6 may be twisted slightly up or down to prevent them jamming against one another during opening.

25 Considering now a manufacturing process for a closure of the type illustrated in Figure 3, i.e. having a recessed and reverted central panel region, it is preferred to manufacture firstly a shell 7 from a blank metal disk, as shown in Figures 9A and 9B, comprising the features of a recessed and reverted centre panel 3 surrounded by an annular profile. The brim 5 is formed by curling the outer wall of the shell 7, preferably
30 by firstly forming a curl of a smaller radius and then a curl of a larger radius, such that the first curl is surrounded by the second curl. Slits are cut in the upper face of the annular profile as required to create the spokes 6, as shown in Figure 10A and 10B. This may be achieved using a multiple shearing tool. Alternatively, the slits may be cut using some other process such as laser cutting. The side wall 4 is preferably formed
35 by drawing the upper face down, without altering the centre panel 3. Forming the side

wall 4 in this way enables the inner ends of the slits, and hence the inner ends of the spokes 6 to turn upwards to join vertically and become part of the lower end of the side wall 4. The steps of forming the rim curls may be combined with the steps of cutting the slits and forming the side wall 4, or they may be carried out separately.

5

Figure 10C illustrates an alternative closure 1 that is produced by injection moulding of a plastics material. Such a closure may be used with a container having a rim formed around its opening such that the closure is pressed and snapped over the rim. With this closure, the side wall 4 is segmented, and the profiles of the segments are configured to provide a fulcrum, thereby allowing the spokes 6 to partially lever the crimp out of engagement with the container. Such a plastic closure may simply be pushed axially down over the top of a container 6, with or without the use of a roller.

10

Figure 10D shows an enlarged internal detail of the plastics closure of Figure 10C and from which it can be seen that the central panel 3 is connected via the sidewall 4 to a multiplicity of downwardly dependent legs 11. The downwardly dependent legs are joined to circumferentially directed arms 12. Engagement features 13 are positioned at the farthest end of the arms 12 and are directed radially inwards to retain the closure on a container. Spokes 6 are also positioned at the ends of the arms 12 and are directed radially outwards. The outermost ends of the spokes are connected flexibly to the brim 5. When secure to a container, the engagement features exert a force beneath and against the rim of the closure, thereby resisting rotation of the closure. Twisting the brim 5 in the direction of Arrow A pulls on the spokes and disengages the engagement features 13 by moving them radially outward in the direction of Arrow C, whilst bending the arm 12 and twisting the leg 11 in the direction indicated by Arrow B. Once sufficient rotational force has been exerted on the brim by the user, the engagement feature will be pulled outwardly from underneath the rim of the container such that the user can then pull the closure off the container.

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In the case of a closure made of moulded plastic, it may be preferable to provide additional features, for example that tear during twisting, to indicate that the closure has been opened.

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Considering further modifications to the closure, the closure may have a fluted side wall 4. In this case, the process of affixing the closure to a container may involve pressing

the sidewall inwards by moving an annular tool axially downwards, in the same manner as a "crown" closure is applied to a bottle. When cutting the slits, it may be desirable to shear the metal so as to distort the cut edges to form twists or louvers. Drawing the upper face down to form the side wall 4 may flatten these twists, but residual stresses and strains will enable them to partially regenerate during subsequent operations including crimping and opening.

The side wall 4 of the closure 1 may be intentionally weakened along lines extending from the slits between the spokes 6, for example by scoring or shearing partly through the metal. In this way the spokes extend up into the side wall 4 by way of the scores. Twisting of the brim 5 and hence of the spokes 6 will cause the weakened lines to tear, assisting loosening of the closures and reducing the force required to open.

A further embodiment of the thread-less closure will now be described with reference to Figures 11 to 18. The closure is identified by reference numeral 21 and the container, where shown, is identified by reference numeral 22. The closure 21 comprises an end panel 23, a sidewall 24 depending from the end panel 23 for extending circumferentially around an opening of the container 22 and for gripping a wall surrounding the container opening. The closure 21 further comprises a brim 25 which is located radially outward of the sidewall 24. The brim 25 is connected to the sidewall 24 by an annular component which extends radially between the sidewall 24 and the brim 25, such that movement of the brim 25 relative to the sidewall 24 imparts tension to the annular component. This creates a radially outward pulling force to loosen the grip of the closure 21 on the container 22 during opening.

In this embodiment and as shown in Figure 11, the annular component comprises an annular region 26 to which tension is imparted by tilting or levering of the brim 25 relative to the sidewall 24. An outer circumference of the brim 25 is curled inwardly towards the sidewall 24, as shown in Figures 11A, 11B and 11C. Alternatively, the brim 25 may be curled outwardly, as shown in Figures 11D, 11E and 11F. The curling of the brim 25 either way avoids presenting a sharp edge to a user.

The closure 21 is preferably made of a single piece of sheet aluminium, aluminium alloy or steel. When made of steel, this may be sheet steel or tinplate. Ideally, the closure 21 should be made from a material similar or identical to that of the container,

as this makes recycling easier. The closure 21 may be protected by a polymer layer or organic coating, and may be marked with indicia or decorated.

Figures 11A to 11F show a closure 21 with a substantially flat end panel 23. This is preferred where the closure is to be used with a rigid container having a small aperture. Alternatively, a central region of the end panel 23 may be recessed, as shown in Figures 12A and 12B. A recessed centre panel is preferred where the container is less rigid. Figures 13A and 13B show a closure 21 having an end panel 23 which is recessed and reverted. The recess is substantially shaped in order to accommodate a tool to provide radial support during crimping of the closure 21 onto a container. A recessed and reverted end panel is preferred where the container (e.g. a bottle or can) has a larger aperture. In use with a pressurised container, the recess also provides better resistance to internal pressure. The end panel 23 may be otherwise shaped, for example, the end panel 23 may be domed.

The annular region 26 extends radially between the sidewall 24 and the brim 25. The annular region is substantially flat and perpendicular to an axis of the container. The region 26 may become slightly conical during manufacture or during crimping of the closure 21 onto a container.

Figures 14A, 14B and 14C illustrate a metal container 22 having a necked region forming an opening. The rim around the opening is curled inwards to form a lip 30, having a width of between 1mm and 6mm and more preferably between 1.5mm and 4mm. The curling of the rim may be carried out in two steps, as discussed with reference to Figures 4A, 4B and 4C above. The container 22 may be any suitable non-threaded container onto which the closure 21 may be crimped. The internal diameter of the container opening may be between 20mm and 50mm and more preferably between 28mm and 45mm, and most preferably between 35mm and 45mm.

The closure 21 may be pressed against the container 22 neck, beneath the lip 30 in order to secure it in place. Figures 15A to 15C show the recessed and reverted closure 21 of Figures 13A and 13B affixed to the container 22 of Figures 14A to 14C above. A layer of sealing compound (not shown here) may be provided around at least a portion of an inner surface of the closure 21 to aid sealing. The sealing compound may comprise a polymer and/or other substances such as oxygen scavengers.

Typically, the closure 21 will be sealed to the container 22 neck by crimping. Figures 16A to 16D illustrate an exemplary crimping process. The closure 21 is placed over the necked region of the container 22. A pair of rollers 28 is moved around the side wall 24 of the closure, forming the crimp by exerting a force against the side wall 24. The side wall 24 is supported during this process by placing a tool 29 within the recess of the recessed and reverted end panel 23, as best shown in Figure 16C. The rollers 28 move around the closure 21, moving radially inwards as they do so. The annular region 26 becomes taut and the height of the side wall 24 is reduced as its diameter is reduced, as shown in Figure 16D. This process crimps a part of the side wall 24 and at least a part of the annular region 26, allowing the closure 21 to be secured to the neck of the container 22.

In an alternative crimping process, not shown here, the container 22 and closure 21 may be rotated while the rollers 29 move radially inwards. In a further alternative crimping process, the rollers 29 are replaced by a plurality of non-rotating fingers which move radially inwards to crimp the closure 21 to the container 22. In this latter case, the crimp may be wavy or intermittent in form. In a further alternative process, the closure 21 may be snapped over the lip 30 of the container 22 in order to form a seal.

Figures 17A to 18B illustrate the removal of the closure 21 from the container 22. When affixed to a container 22, movement of the brim 25 about the container 22 is substantially not impeded by the container 22, other than by forces exerted on the brim 25 by the annular region 26. As previously discussed, the closure 21 and the container 22 neck are both unthreaded. The gripping force which is exerted by the side wall 24 on the container 24 is relaxed by movement of the brim 25 relative to the side wall.

As shown in Figure 17A, a region of the brim 25 is tilted about an axis of the container 22. This imparts tension to the area of the annular region 26 which adjoins the brim 25, which in turn pulls the adjoining side wall 24 radially outwards. This loosens the crimp in that area. Tilting or levering of the brim 25 also provides a bending moment which also loosens the crimp. Further areas of the brim 25 may then be tilted to progressively loosen the crimp so that the closure 21 may be pushed or pulled upwards off the container 22 neck.

As each area of the loosened crimp is lifted up over the lip 30 of the container 22, the point at which the closure 21 contacts the lip 30 provides a fresh fulcrum about which tilting of the brim 25 provides additional loosening force. Figures 17A and 17B show how imparting tension to the annular region 26 pulls the side wall 24 outwards. Tilting the brim in the direction indicated by arrow A of Figure 17A pulls that region of the region 26 and hence the adjoining side wall 24 outward in the direction indicated by arrow A1. The same applies to tilting or levering the areas indicated by arrows B and C. In this way, the closure 21 may be progressively loosened until it can be removed from the container 22 neck.

The brim 25 typically has a diameter that is at least 1.1 times bigger than the diameter of the sidewall 24. Figure 17B indicates a mechanical advantage ratio $M1:M2$ arising from the distance of peripheral movement $M1$ of the brim relative to the distance of radial movement of the sidewall $M2$. This increases the radial force of the region 26 on the side wall 24 in relation to the circumferential force applied by the brim 25. Since movement of the brim 25 in any direction perpendicular to the axis of the closure 21 will impart tension to the annular region 26, the closure may be loosened by sequentially tilting or levering the brim 25 perpendicular to the closure axis in either direction at several positions.

Application of a tilting force to the brim also results in a bending moment about a fulcrum F , as shown in Figure 17B, which corresponds to the position where the sidewall 24 makes contact with the lip 30 of the container 22. This bending moment also acts to loosen the closure 21. As shown in Figures 18A and 18B, as the closure 21 is loosened and moved upwards, a new fulcrum position $F1$ is formed. Mechanical advantage ratio $M1':M2'$ is also increased since the distance of peripheral movement $M1'$ of the brim relative to the distance of radial movement of the sidewall $M2'$ is increased.

The closure 21 is adapted so that opening of the container 22 by removal of the closure 21 is achievable by hand and without the use of a tool. The strength of each part of the closure 21 may be adapted to require a level of force such that only an adult could be expected to be able to open the container 22. Alternatively, the closure 21 may be adapted to be strong enough such that opening the container 22 does require the use of a tool.

The closure 21 may be provided with regions of weakening, such that tilting or levering of the brim 25 about the container 22 permanently distorts or even tears a part of the closure 21. For example, the brim 25 and/or the annular region 26 may be permanently distorted. This distortion or tearing provides evidence of such movement i.e. the closure 21 is made tamper evident. The regions of weakness in the closure 21 which are designed to tear during opening of the container 22 may comprise lines of weakening which extend from the annular region 26 into the side wall 24. Alternatively, the closure 21 may be configured to be re-attached to the container 22 after initial opening of the container 22. Such re-attachment may provide any extent of re-sealing, spillage resistance or intentional ventilation, according to the desired purpose.

A method of manufacture of the one-piece closure 21 of Figures 11 to 18 will now be described with reference to Figures 19 to 31. The method comprises providing a metal shell 27 as shown in Figures 19A and 19B and curling a vertical wall of the shell 27 to form a brim 25. The brim 25 may be curled inwardly. The method further comprises forming a side wall 24 and an annular region 26 located radially inward of the brim 25.

The vertical-walled shell 27 of Figures 19A and 19B, used in the manufacture of the closure 21, is manufactured from a blank metal sheet, preferably in a single manufacturing step. The shell 27 comprises an end panel 23, a vertical outer wall and an annular channel running therebetween, as best shown in Figure 19B. The vertical outer wall presents a substantially flat upper face 56.

Figure 21A illustrates schematically an example of a preferred tooling assembly to produce the vertical-walled shell 27 of Figure 19. For simplicity, items such as fasteners and seals are not shown in the Figures. Figure 21B illustrates a detail of the tooling assembly of Figure 21A. A metal disc 50 that is to be pressed into the shell is identified by reference numeral 50.

The lower shell tooling sub-assembly 60 of Figures 21A and 21B comprises a fixed lower holder 61, a centre-ring 62, a lower pressure ring 63, a panel-forming pad 64 and a cutting die 65. Both the lower pressure ring 63 and the panel-forming pad 64 are

pushed upwards using compressed air pressure, although means such as springs may alternatively be used for this purpose.

5 The upper shell tooling sub-assembly 70 of Figures 21A and 21B comprises an axially moving upper holder 71, a punch 72, a stripper retainer 73, a stripper 74, an upper pressure ring 75 and an inner draw punch 76. Both the upper pressure ring 75 and the stripper 74 are pushed downwards using compressed air pressure, although other means such as springs may be used for this purpose.

10 Figure 22A, and detail 22B, show the upper shell tooling sub-assembly 70 having been moved downwards to cut the metal sheet 50 between the sharp edge 77 of the punch 72 and the edge 66 of the cutting die 65, and further downwards to draw the resulting blank around the radius 78 on the punch 72 to form a cup shape 51, corresponding to the profile of the centre-ring 63. The cup shape 51 has a vertical outer wall 53. The
15 remaining scrap 52 from the metal sheet 50 is held down against the cutting die 65 by the stripper 74. Formation of wrinkles in the cup shape 51 is prevented by force applied to the blank by the lower pressure ring 63 during drawing.

20 Figures 23A and detail 23B show that the upper shell tooling sub-assembly 70 has been moved further downwards to its lowermost position. The inner draw punch 76 has drawn the centre of the cup shape 51 around the inner radius 68 of the centre-ring 62 to form a vertical inner wall 54. The vertical outer wall 53' has been shortened by partially drawing it around the outer radius 67 of the centre-ring 62. Formation of wrinkles is prevented by force applied by the upper pressure ring 75 during drawing. In
25 this position, the panel-forming pad 64 has been pushed downwards by the inner draw punch 76 acting through the centre of the cup shape 51.

30 In Figures 24A and detail 24B, the upper shell tooling sub-assembly 70 has been moved back up. This has allowed the panel-forming pad 64 to move upwards to form a centre panel 23 in the cup 51. A "U" shaped channel 55 has also been created in the cup 51 in the annular space between the panel-forming pad 64 and the centre-ring 63. The geometry of the "U" shaped channel 55 is influenced by the profile 68 of the panel-forming pad 64, and this profile may be optimised to maximise the strength of the closure 21 to resist pressure when attached to a container 22.

35

In Figures 25A and detail 25B, the upper shell tooling sub-assembly 70 has been moved back to its original position, to enable removal of the finished vertical-walled shell 27 from the sub-assembly.

5 The vertical walled shell 27 (Figure 19A and 19B) is now transferred to a further tooling assembly for conversion into the one-piece closure 21 of Figure 13. This conversion process is carried out in a single manufacturing step. In an alternative example, not shown here, a single machine may be used for both the manufacture of the shell 27 and for its conversion to the closure 21.

10

Figures 26A and detail 26B illustrate a schematic example of a preferred tooling assembly to convert the vertical-walled shell 27 of Figure 19 into the closure 21 of Figure 13 in a single manufacturing step. For simplicity, items such as fasteners and seals are not shown in the tooling figures.

15

The lower tooling sub-assembly 80 comprises a base 81, a holder 82, a curling die 83, a pressure ring 84, a panel support 85, and a support ring 86. Both the curling die 83 and the pressure ring 84 are pushed upwards using compressed air pressure, although other means such as springs may be used for this purpose.

20

The upper tooling sub-assembly 90 comprises an actuator 91, a pusher 92 and a profiled clamp 93. The profiled clamp 93 is pushed downwards by using for example compressed air pressure or springs. A fixed knockout tool 94 is also provided which does not move with the upper tooling sub-assembly 90.

25

As shown in Figures 27A and detail 27B, the upper tooling sub-assembly 90 has been moved downwards to guide the vertical outer wall 53 of the shell 27 centrally downwards into the curling die 83, and to grip the upper face 56 of the shell 27 between the pressure ring 84 and the pusher 92. The profiled clamp 93 also guides the inner vertical wall 54 and enters the "U" shaped channel 55 of the shell 27.

30

In Figures 28A and detail 28B, the upper tooling sub-assembly 90 has been moved further downwards to push the outer vertical wall 53 of the shell into the profile of the curling die 83 to form the curled brim 25. It is preferable that the edge of the vertical

outer wall 53 is curled through a total angle of over 270 degrees and more preferably over 360 degrees, in order to maximise the stiffness of the brim.

The shell 27 now has the form depicted in Figure 20. The profiled clamp is now able to grip the end panel 23 of the shell against the panel support 85. In this position, the faces 87 of the pressure ring 84 and curling die 83 contact one-another to fix the height of the brim 25, whilst the width of the brim 25 is fixed by the profile of the curling die 83 and the outer diameter of the pressure ring 84. The shape of the brim 25 is also controlled by the profile of the pusher 92.

Figures 29A and detail 29B illustrate the steps of forming the side wall 24 and annular region 26 of the closure 21. The upper tooling sub assembly 90 has been moved further downwards to its lowermost position, which may be fixed by contact between the faces 88 of the curling die 83 and the base 81. The movement of the profiled clamp 93 may be limited by its contact with the actuator 91 at the faces 95. Upper face 56, extending radially inwards of the curled brim 25, is pushed downwards to form the sidewall 24 and annular region 26, while the profiled clamp 93 remains in the U-shaped channel 55' (now the recess of the recessed and reverted end panel 23). The final shape and dimensions of the closure 21 between the panel 23 and sidewall 24 are determined by the shapes and positions of the profiled clamp 93, support ring 86 and panel support 85. The shape of the "U" shaped channel 55' may be altered by these tools if it is desired to optimise the strength of the closure.

Figures 30A and detail 30B show the upper tooling sub-assembly 90 having been moved back up to its original position, together with the curling die 83, pressure ring 84 and profiled clamp 93. During this movement, it is preferable that the force applied to the closure 21 by the profiled clamp 93 is not so great as to deform the closure. Retention of the closure 21 in the upper tooling is prevented by the knockout tool 94. It is also preferable, for example, that compressed air is fed into the space 89 below the closure 21, to lift it clear of the lower tooling assembly 80. Thus the closure 21 is left in a position approximately as shown in Figures 30A and 30B for easy removal from the tooling.

The methods and apparatus as described above may also be used to manufacture the closure 1 of Figures 1 to 10B, as described above. It is preferable that spokes are

created by cutting radial slits in the upper face 56 of the shell 27 shown in Figure 19, prior to converting the shell into the closure 1 of Figures 1A to 10B.

Figure 31A and details 31B to 31E illustrate a preferred tooling arrangement for cutting radial slits in the upper face 56 of the vertical-walled shell 27 shown in Figure 19A and 19B. The tooling comprises an upper slitting tool 101 and a lower slitting tool 102 arranged to be moved axially together. These tools 101,102 are guided using alignment features 103 to maintain concentricity, to avoid rotation relative to one another and to maintain appropriate shearing clearances between their cutting edges 106.

The slitting portions 104 and 105 of the lower 102 and upper 101 slitting tools are provided with a pattern of matching cutting edges 106. These edges 106 are created by machining asymmetric "V" shaped slots each having one wall 107 perpendicular to the tool face and the other wall 108 at an angle. These slots are preferably machined wider and deeper at their radially outer ends than their radially inner ends, to facilitate machining using, for example, a wire erosion method along a line at an angle α whilst avoiding contact with the opposite side of the slitting portion 104,105. The upper 101 and lower 102 slitting tools are typically aligned using guide pins positioned in the cylindrical alignment features 103.

The lower slitting tool 102 may be adapted to centralise the vertical-walled shell 27 by guiding its vertical inner wall 54 against the inside wall 109 of the slitting portion 104. The shape of the lower slitting tool 102 may be used to determine the length and position of the slits.

The vertical-walled shell 27 is placed over the cutting portion 104 of the lower slitting tool 102, and slits are cut in the upper face 56 by moving one of the tools 101,102 towards the other. The length of the slits may be further determined by the distance by which the cutting edges 106 overlap. The further the cutting edges 106 overlap, the more the slit edges will distort to create louvres.

The slits thus created in the upper face 56 of the vertical-walled shell 27 will ultimately form the multiplicity of radially extending spokes 6 which connected the side wall 4 of the closure 1 to the outer brim 5. Once provided with slits, as described with reference

to Figures 31A to 31E above, the shell 27 may be transferred to the tooling assembly of Figures 26A and 26B for conversion into the one-piece closure 1 of Figures 1A to 10A. The steps of this conversion process are substantially as described with reference to Figures 27A to 30B above.

5

It will be appreciated by the person of skill in the art that various modifications may be made to the above described embodiments without departing from the scope of the invention.

10

CLAIMS:

1. A one-piece closure for a container, the closure comprising:
 - an end panel;
 - 5 • a sidewall depending from the end panel for extending circumferentially around and gripping a wall surrounding an opening of the container; and
 - a brim which is located radially outward of the sidewall and which is connected to the sidewall by an annular region extending in a plane substantially parallel to a plane across which the centre panel extends,
- 10 wherein movement of the brim relative to the sidewall imparts tension to the annular region and creates a radially outward pulling force to loosen the grip of the closure on the container during opening.
2. A one-piece closure as claimed in claim 1 and being of metal or a metal alloy.
- 15 3. A one-piece closure as claimed in claim 1 or 2, wherein the annular region comprises a multiplicity of spokes to which tension is imparted by circumferential twisting of the brim about an axis of the container.
- 20 4. A one-piece closure as claimed in claim 3, wherein said spokes are substantially straight or are curved.
5. A one-piece closure as claimed in claim 1 or 2, wherein the annular region is a substantially flat, continuous region.
- 25 6. A one-piece closure as claimed in any preceding claim, wherein the brim is provided by an inwardly curled edge of the closure.
7. A one-piece closure as claimed in any preceding claim, wherein the sidewall
- 30 comprises one or more regions of weakening configured to tear during opening.
8. A one-piece closure as claimed in claim 7, wherein said lines of weakening extend into said annular region.

9. A one-piece closure as claimed in any preceding claim and configured such that, when affixed to a container, movement of the brim about the container permanently distorts or tears a part of the closure to provide evidence of such movement.

5

10. A one-piece closure as claimed in any preceding claim, configured such that, when affixed to a container, rotation of the brim about the container is substantially not impeded by the container other than by forces exerted on the brim via the annular component.

10

11. A one-piece closure as claimed in any preceding claim, wherein the closure is unthreaded and is configured to be affixed to an unthreaded container.

12. A one-piece closure as claimed in any preceding claim, wherein a central region of the end panel is one of substantially flat, domed, recessed, and recessed and reverted.

15

13. A one-piece closure as claimed in any preceding claim and being dimensioned to close a container having an internal aperture diameter between 20 mm and 50 mm and more preferably of between 30 and 45mm.

20

14. A one-piece closure as claimed in any preceding claim, wherein the brim has a diameter that is at least 1.1 times bigger than a diameter of the sidewall.

15. A one-piece closure as claimed in any preceding claim and configured to allow the side wall, and optionally at least part of the annular region, to be secured to a neck of the container by crimping.

25

16. A method of attaching the closure of claim 15 to a container and comprising placing the closure over the opening of the container and crimping the sidewall against the container wall to form a seal between the closure and the container.

30

17. A method according to claim 16, wherein the container is one of a beverage can, a metal bottle and a glass or plastic bottle.

35

18. A method of manufacturing a one-piece closure according to any one of claims 1 to 15 and comprising:

5 providing a shell having a centre panel and an annular channel surrounding the centre panel; and

curling an outer substantially vertical wall of the annular channel inwardly to form said brim.

10 19. A method according to claim 18 and comprising, following said step of curling, supporting a portion of the bottom wall of the annular channel while pressing the remainder of the bottom wall to form said annular region and a U-shaped channel inwardly of the annular region.

15 20. A method according to claim 19 and comprising supporting said remainder of the bottom wall from beneath, radially inward of the curled brim, while pressing.

20 21. A method according to claims 18 to 20, wherein said shell is recessed and reverted such that a countersink is present between the centre panel and said annular channel.

22. A method according to any one of claims 18 to 21, wherein the closure is a closure according to claim 3, and comprising cutting a plurality of radial slits into the outer substantially vertical wall of the shell prior to said step of curling.

25 23. A container comprising a closure according to any one of claims 1 to 15 and a container body adapted to accommodate the closure and having a curled aperture with an internal diameter between 20 mm and 50 mm.

30 24. A container comprising a closure according to any one of claims 1 to 15 and a container body adapted to accommodate the closure and having a curled aperture with an internal diameter between 30 mm and 45 mm.

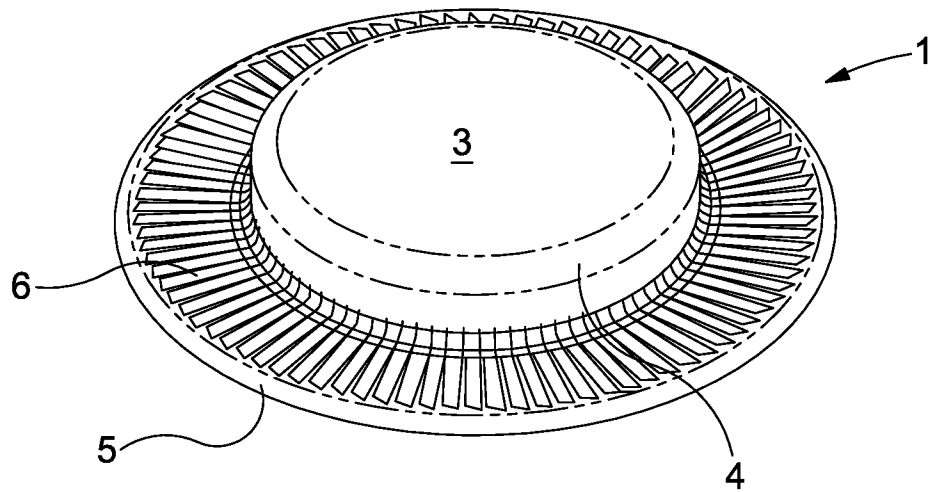


Figure 1A

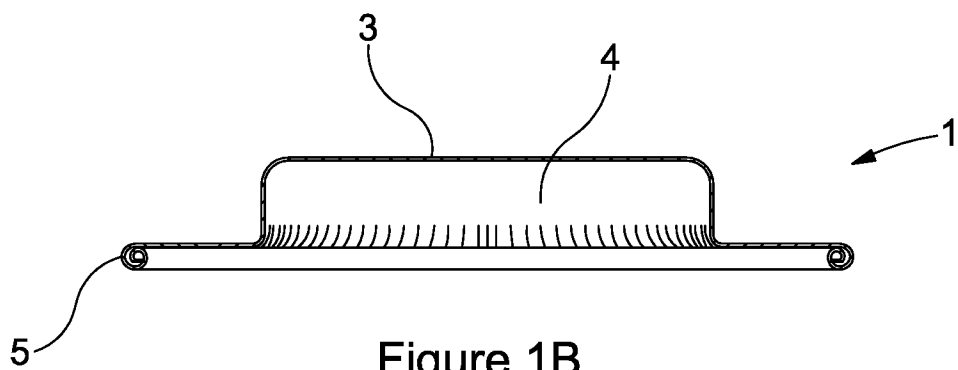
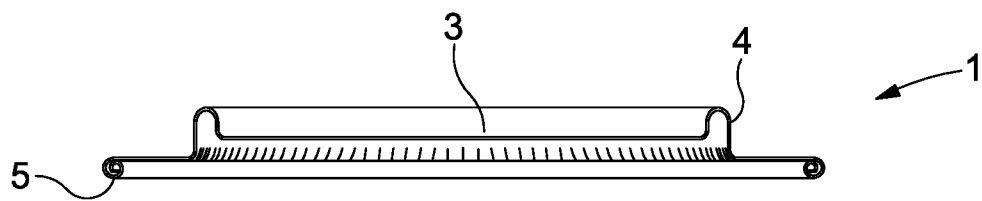
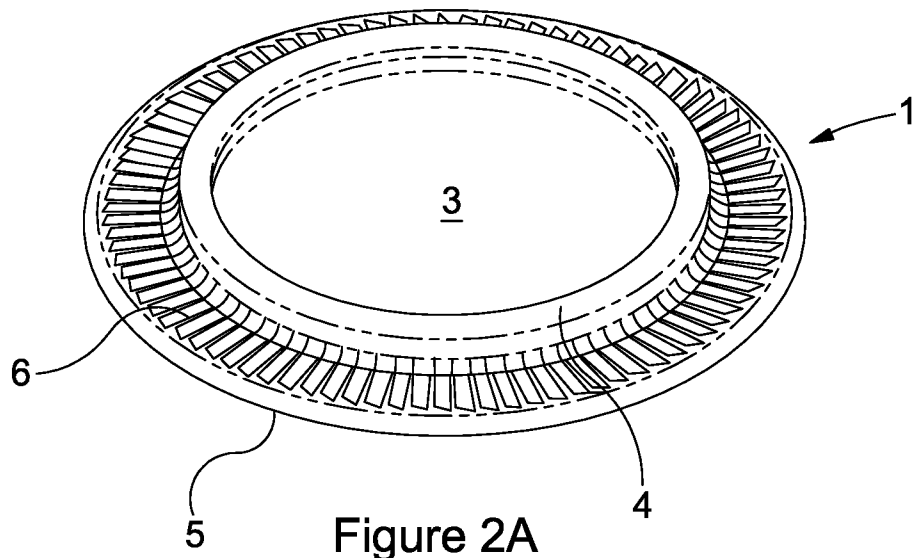
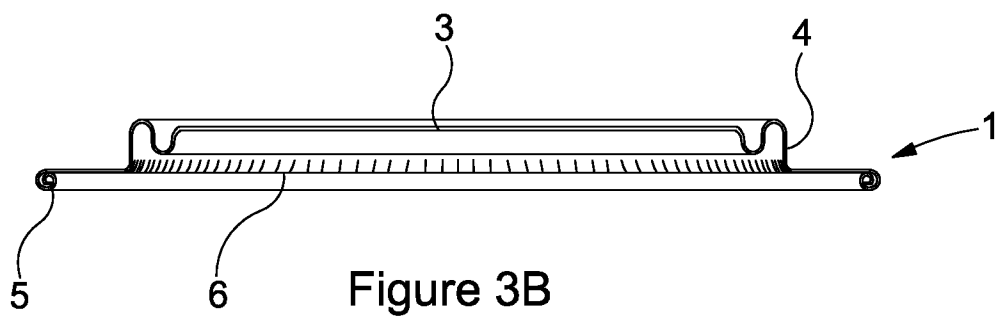
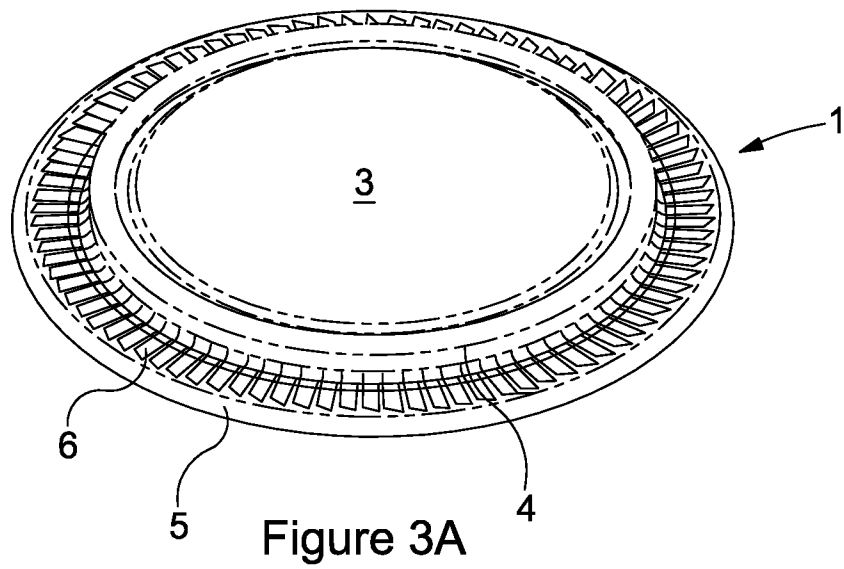


Figure 1B





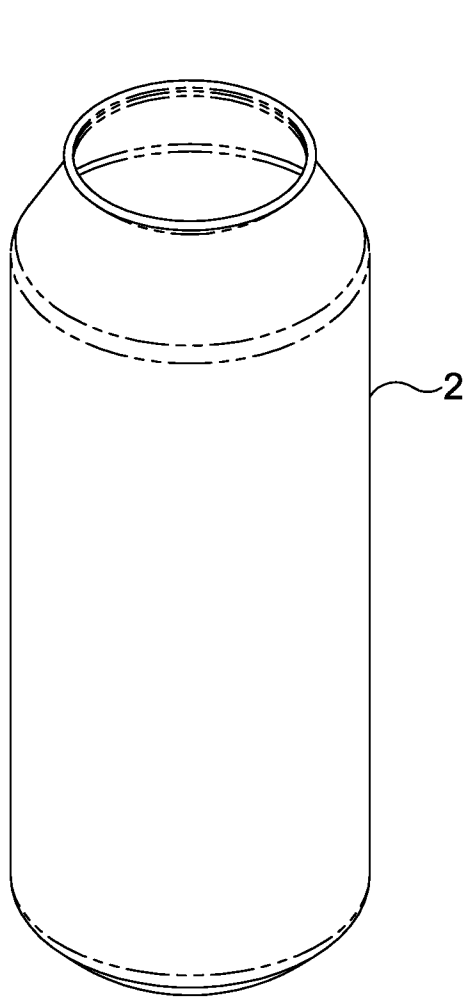


Figure 4A

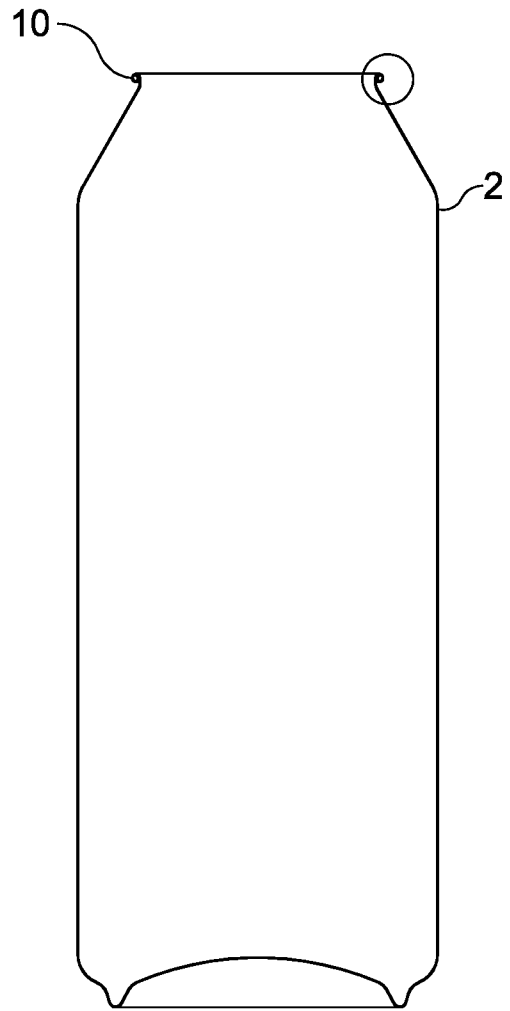


Figure 4B

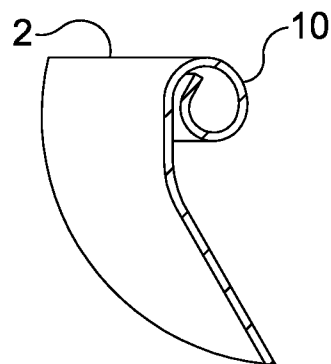


Figure 4C

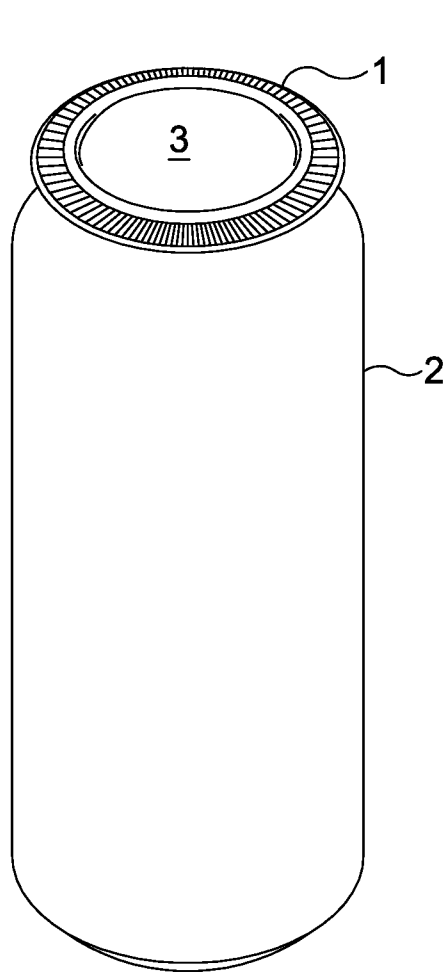


Figure 5A

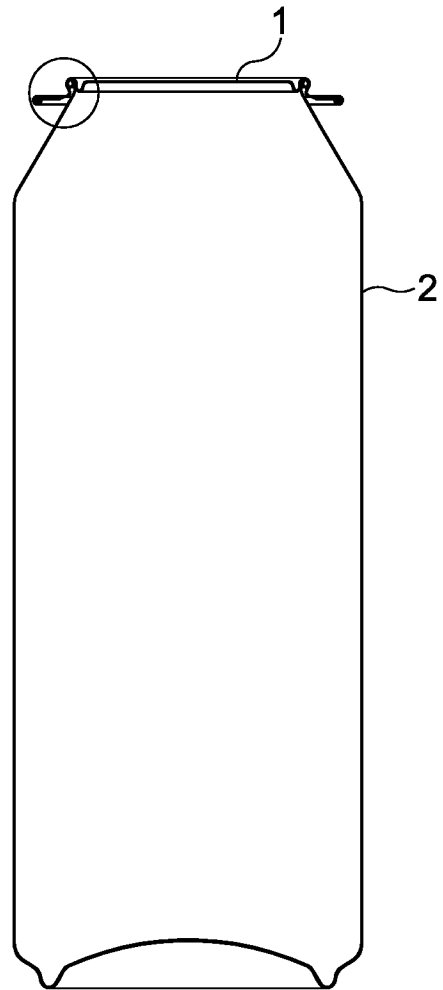


Figure 5B

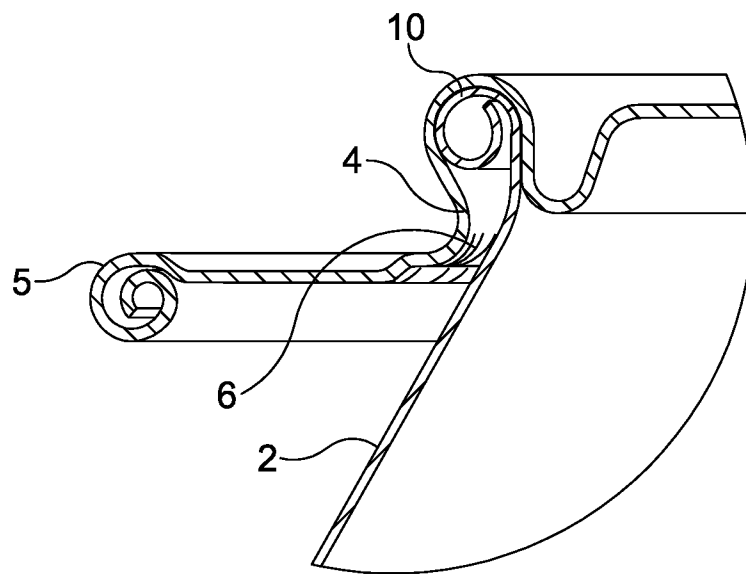


Figure 5C

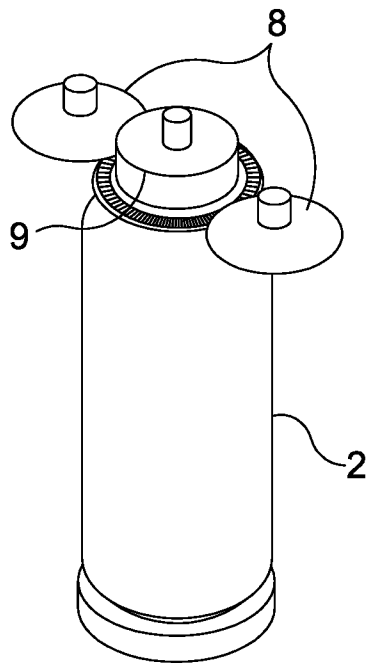


Figure 6A

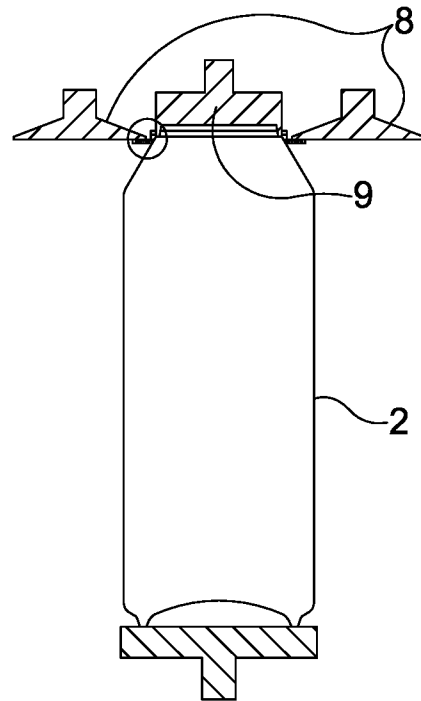


Figure 6B

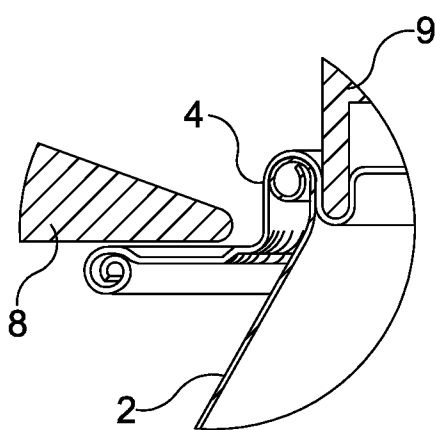


Figure 6C

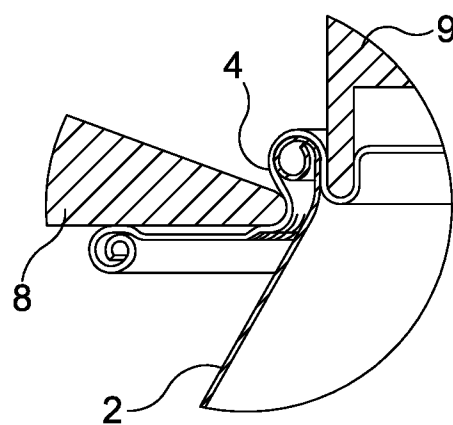


Figure 6D

Figure 7A

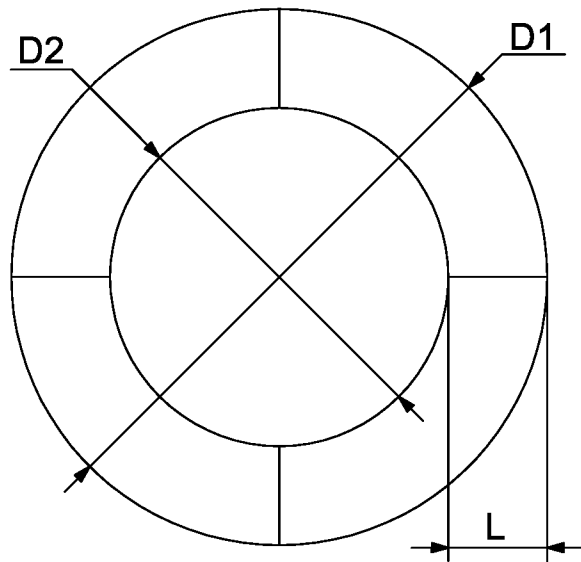
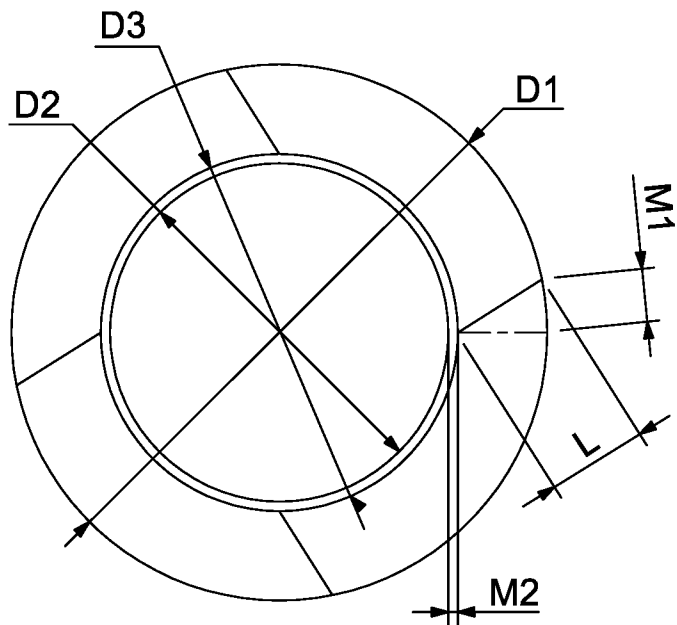
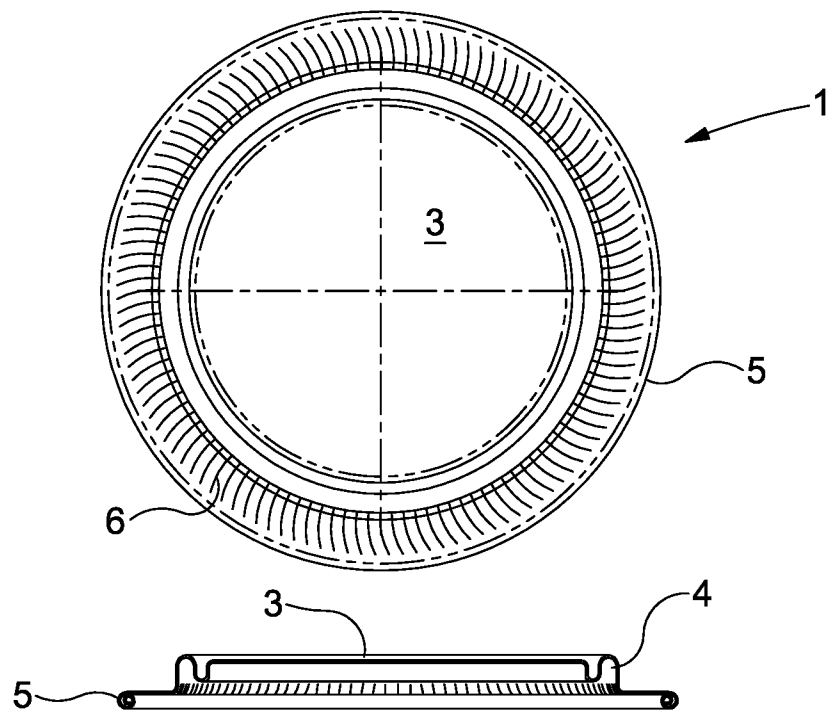
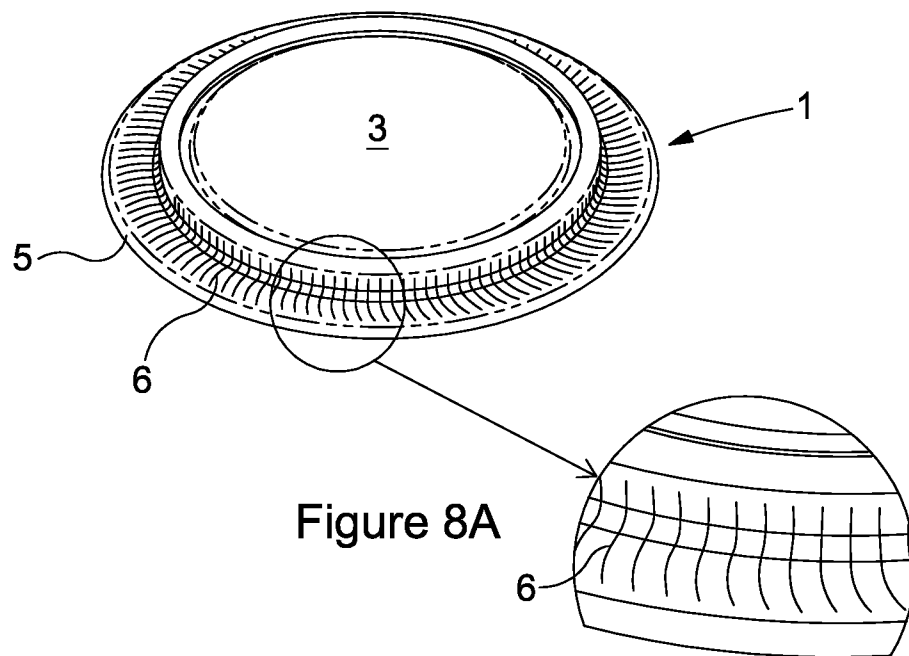


Figure 7B





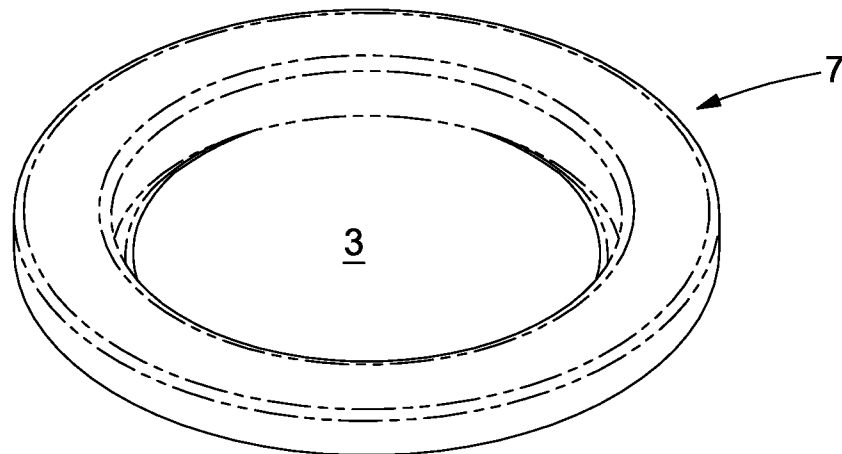


Figure 9A

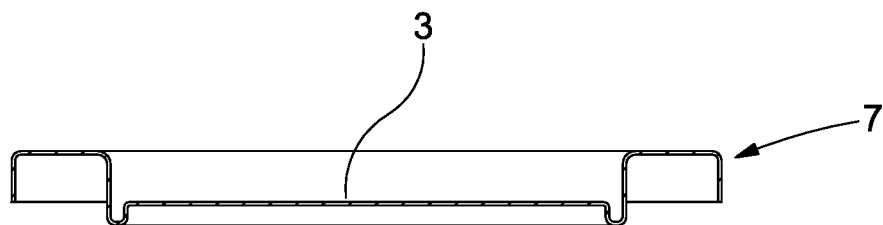


Figure 9B

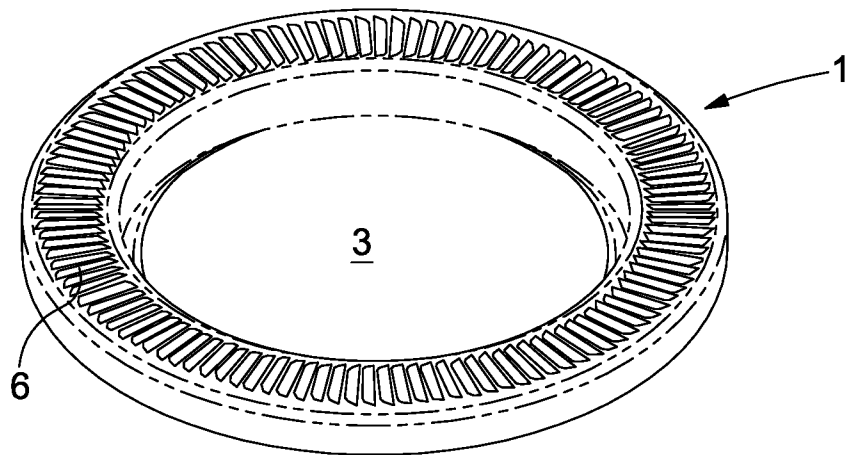


Figure 10A

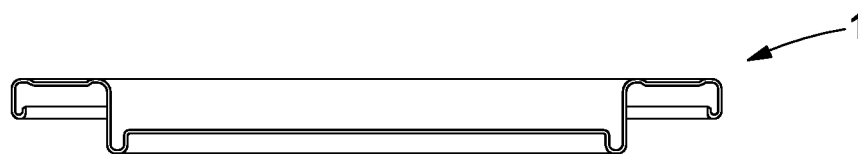


Figure 10B

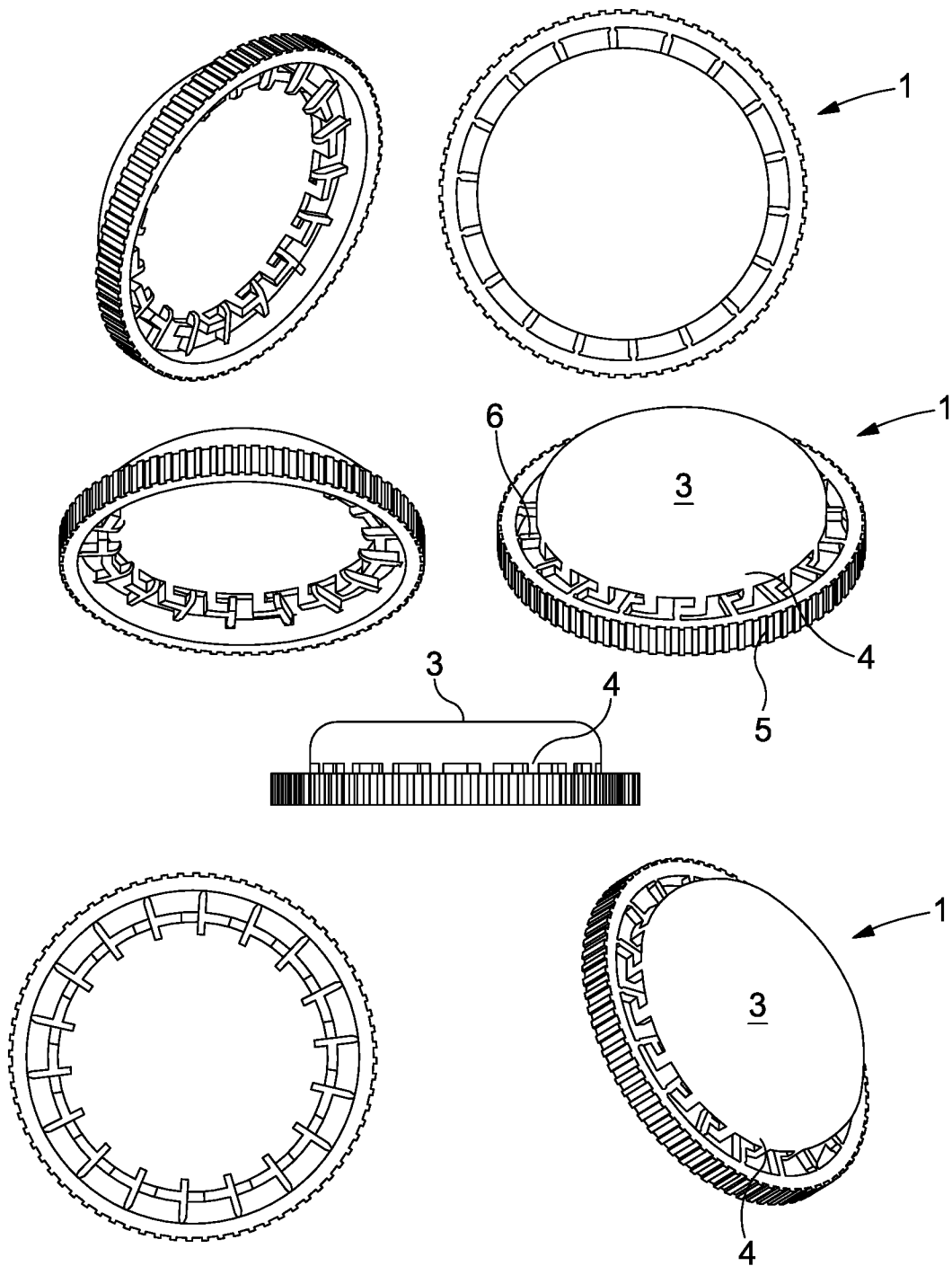


Figure 10C

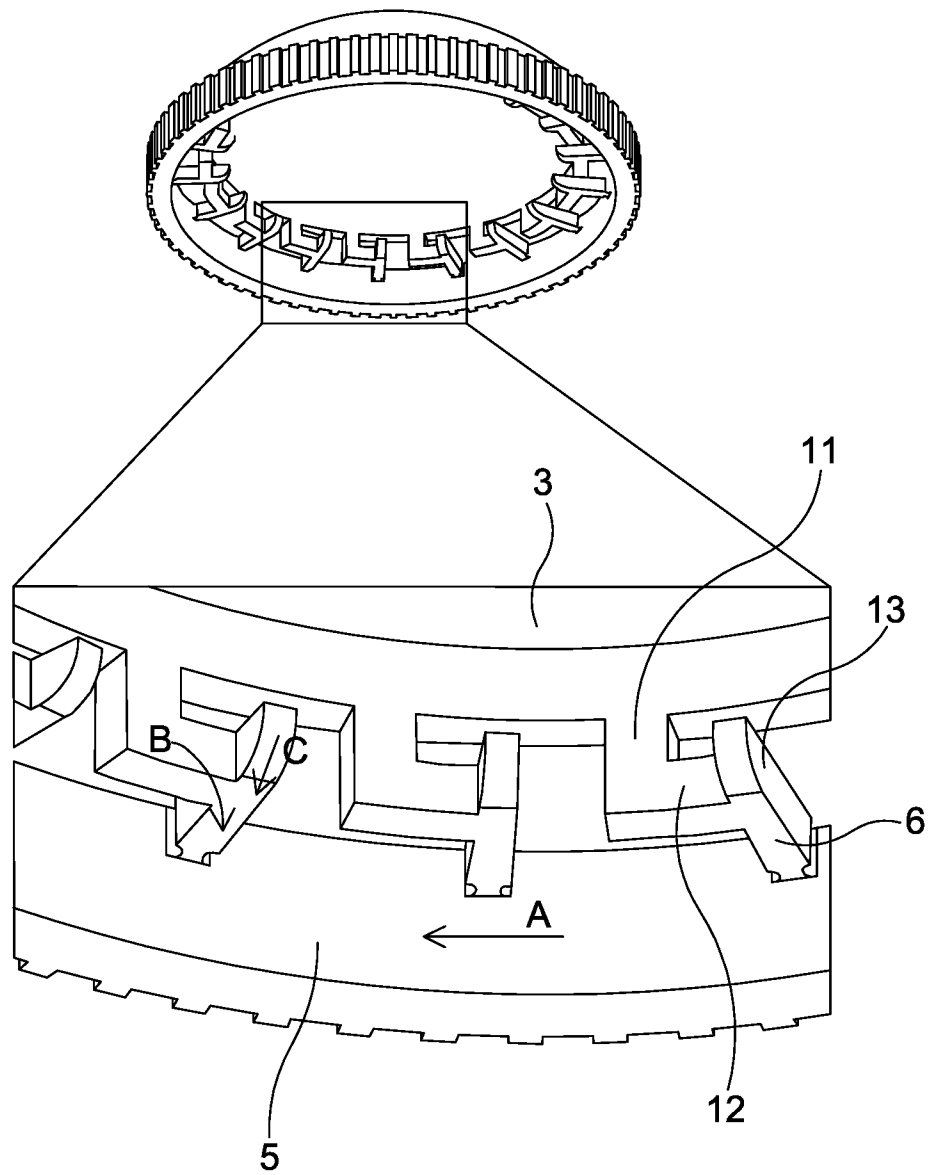


Figure 10D

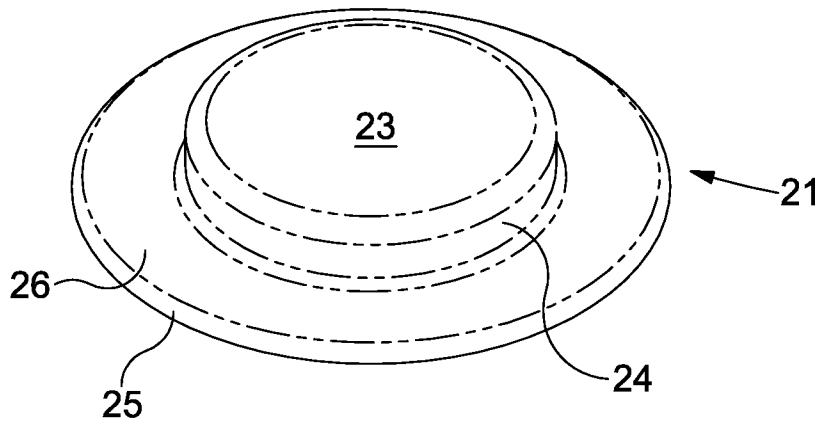


Figure 11A



Figure 11B

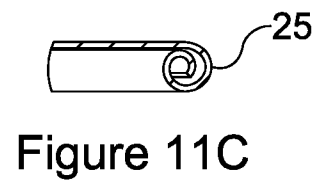


Figure 11C

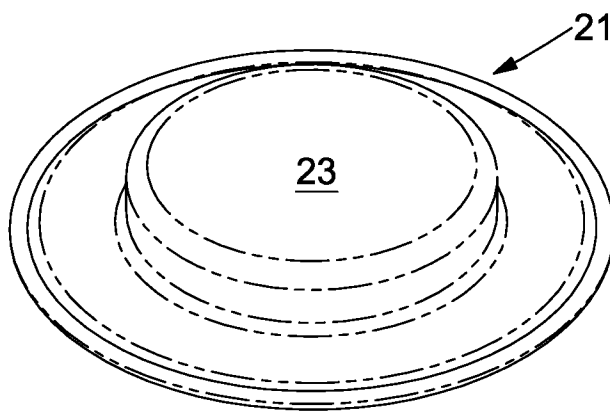


Figure 11D

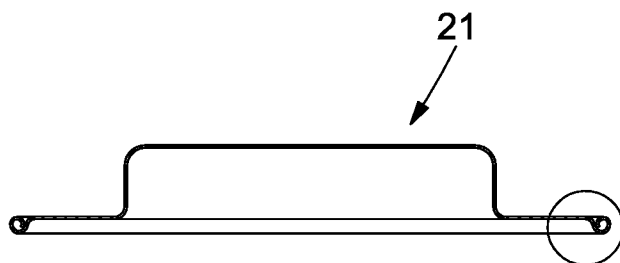


Figure 11E



Figure 11F

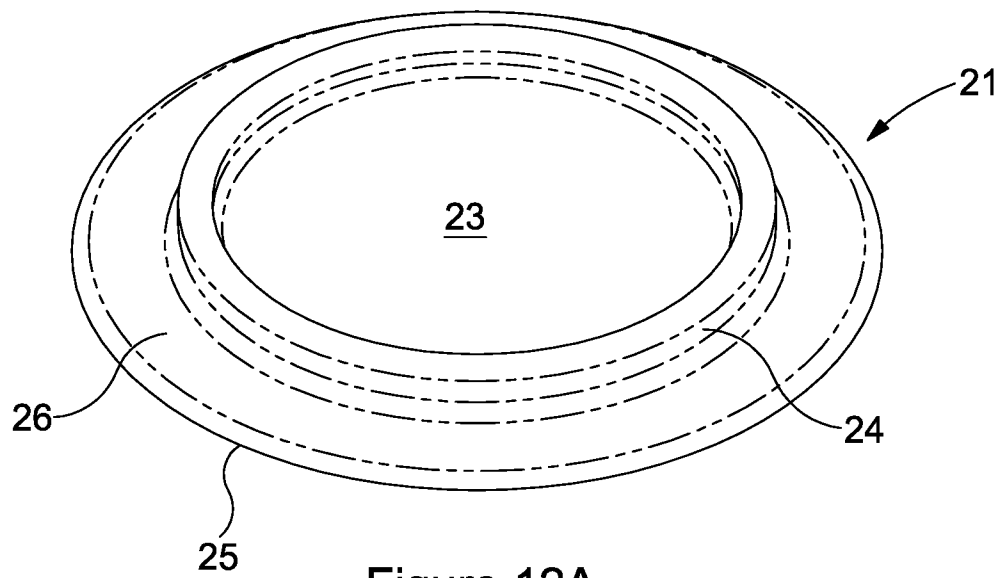


Figure 12A

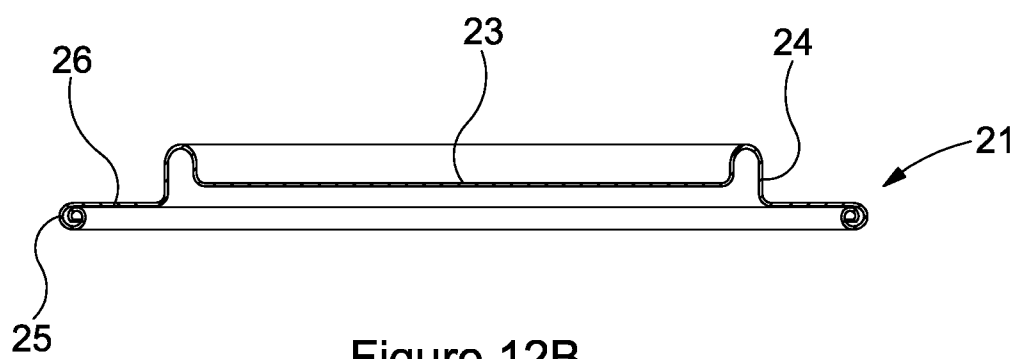
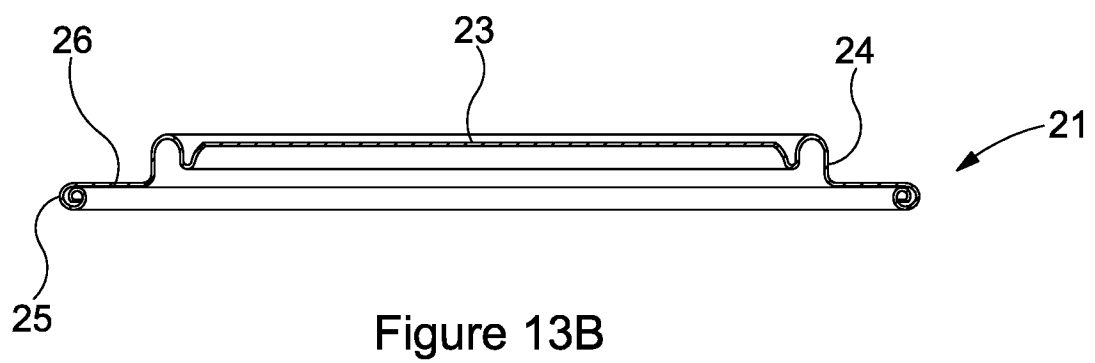
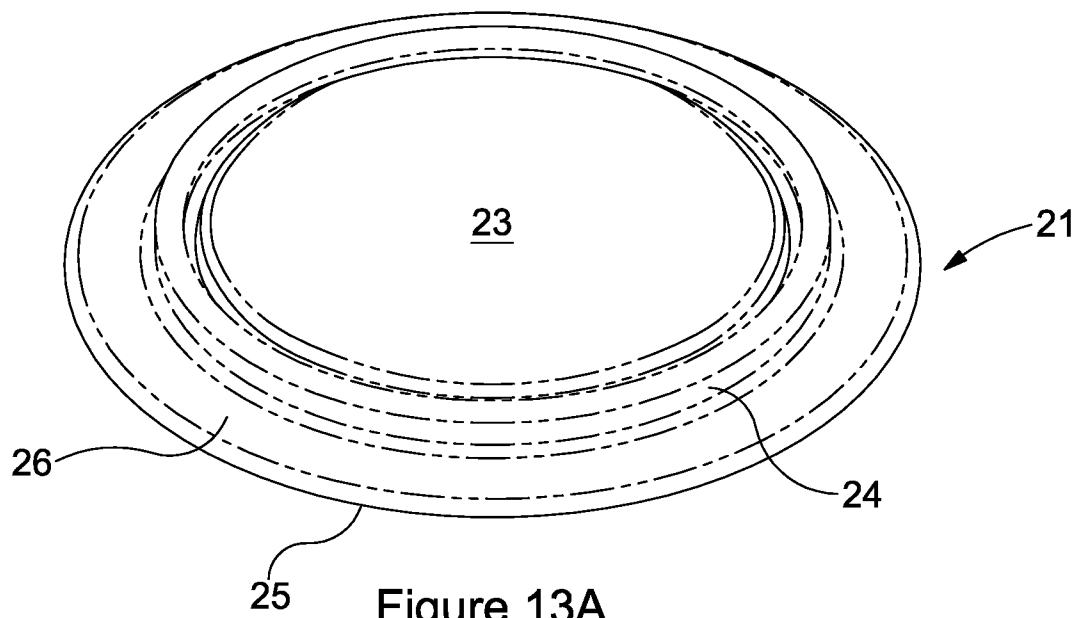


Figure 12B



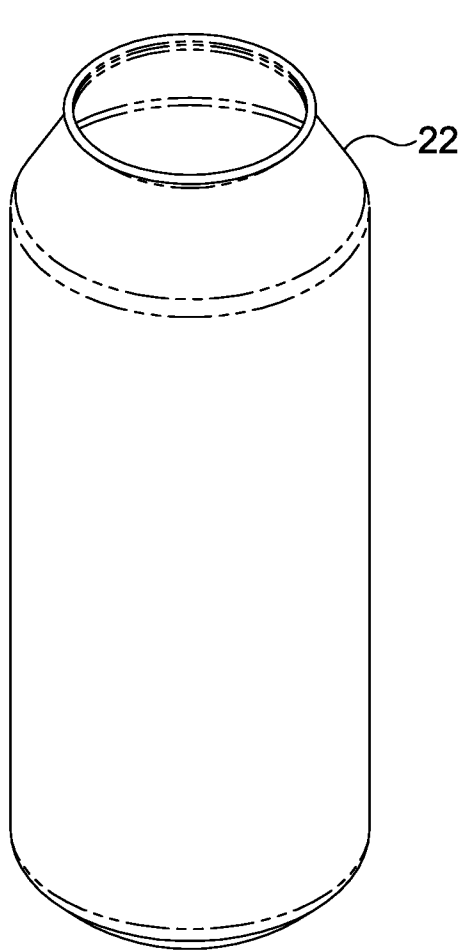


Figure 14A

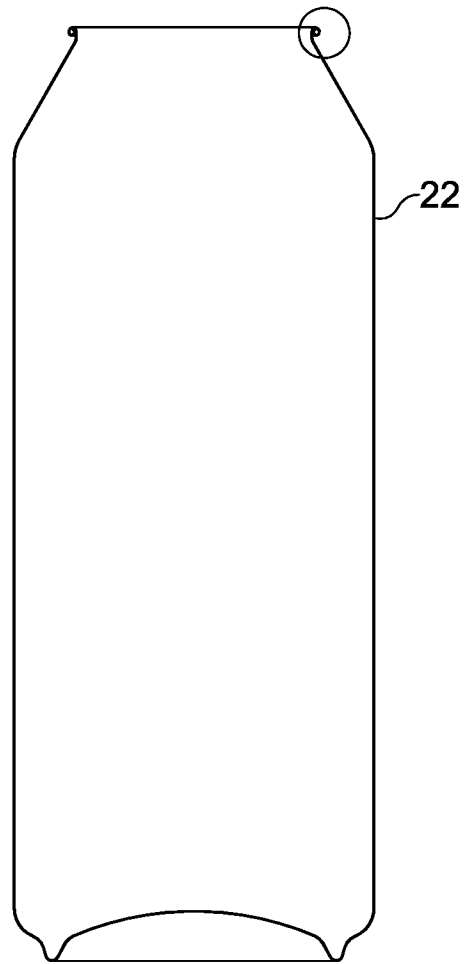


Figure 14B

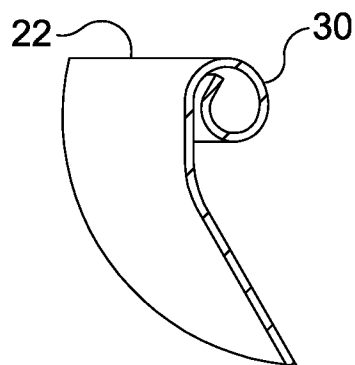


Figure 14C

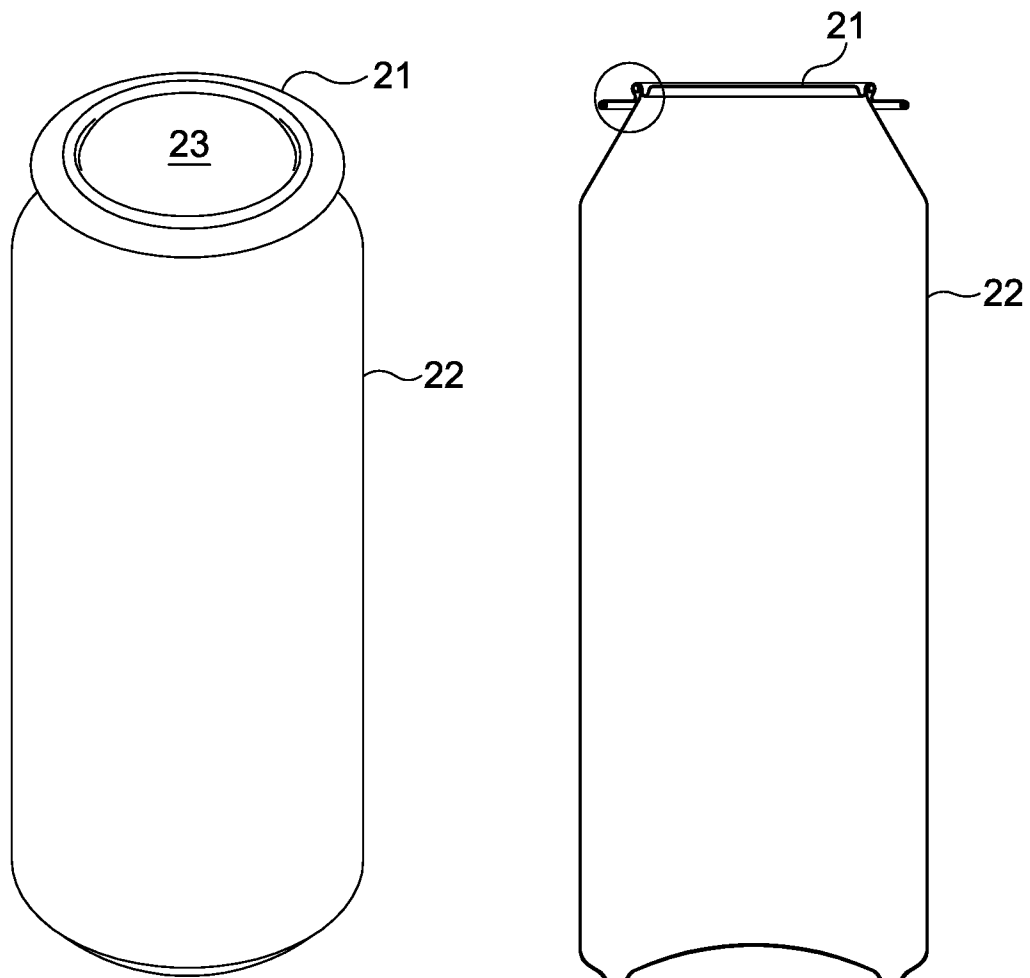


Figure 15A

Figure 15B

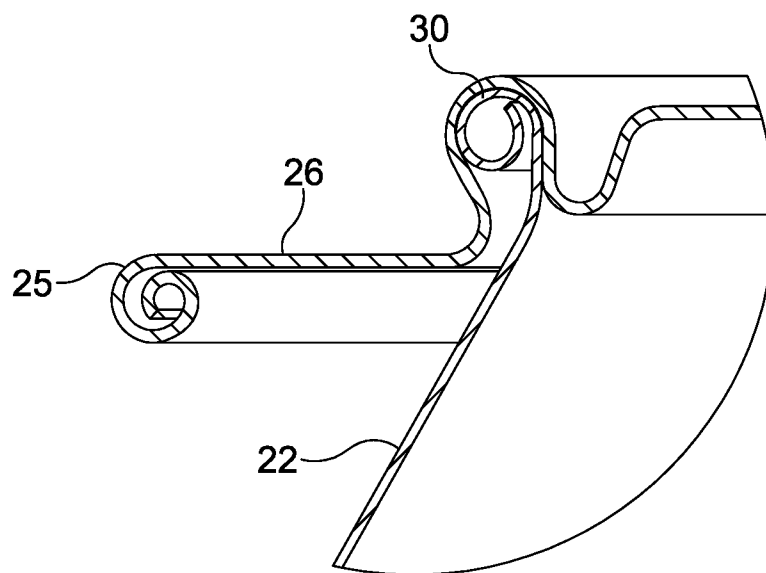


Figure 15C

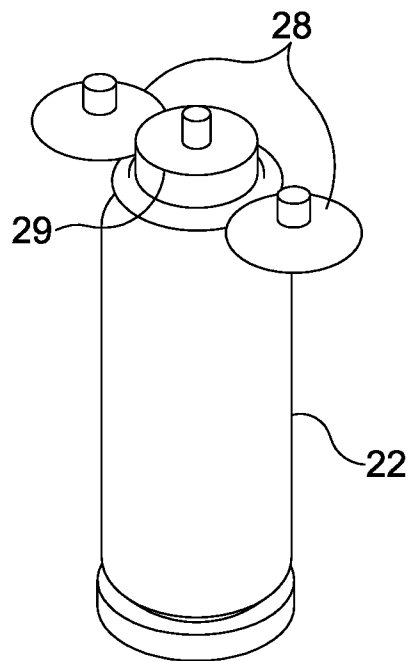


Figure 16A

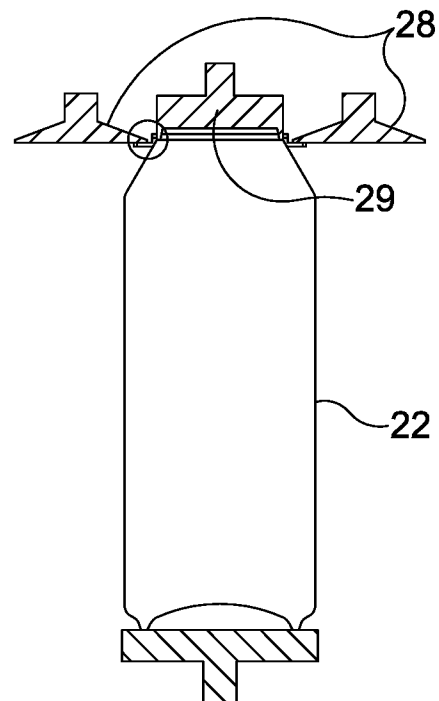


Figure 16B

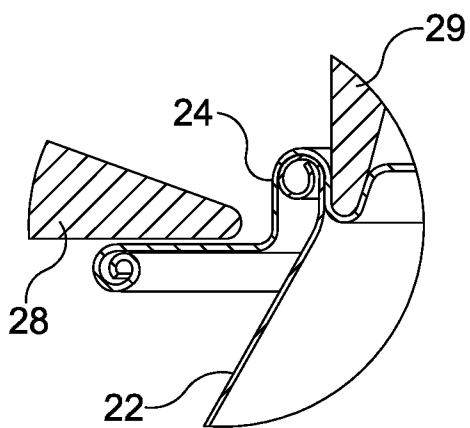


Figure 16C

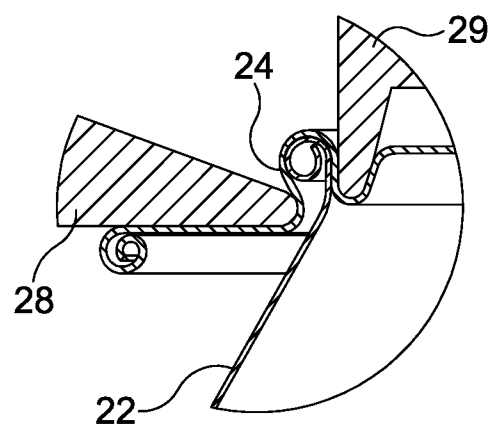


Figure 16D

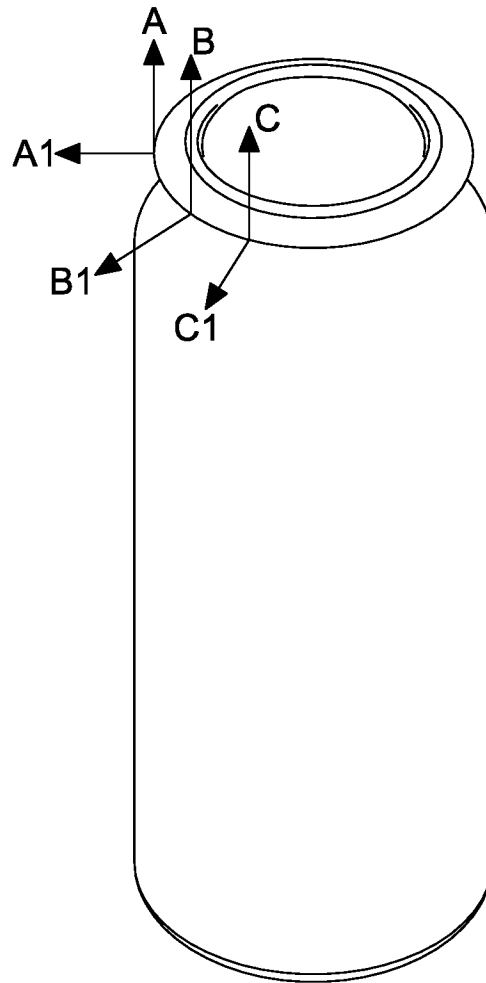


Figure 17A

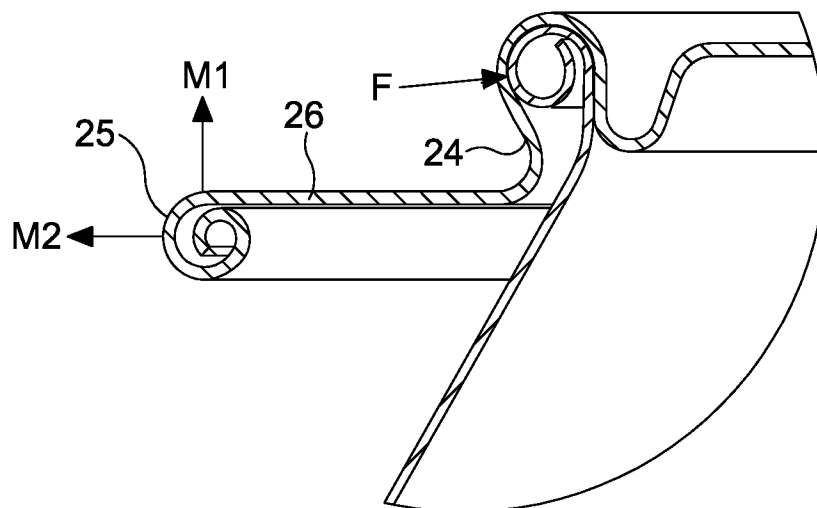


Figure 17B

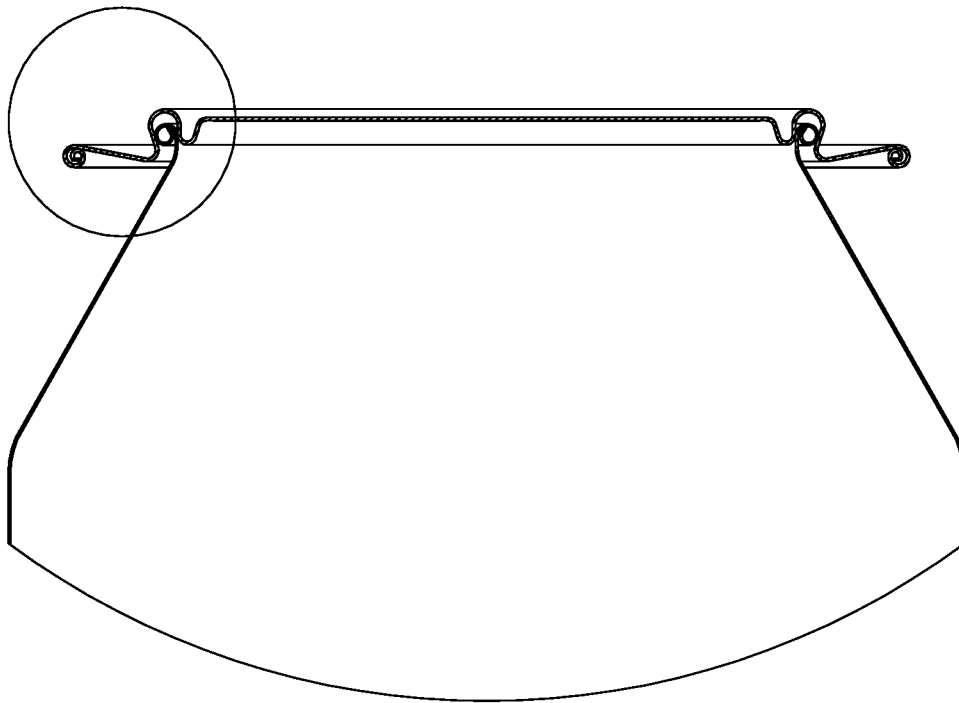


Figure 18A

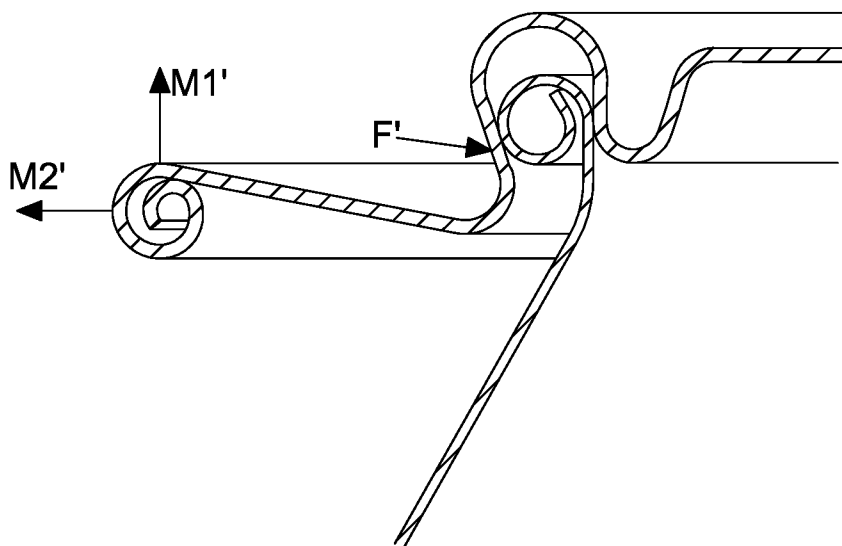


Figure 18B

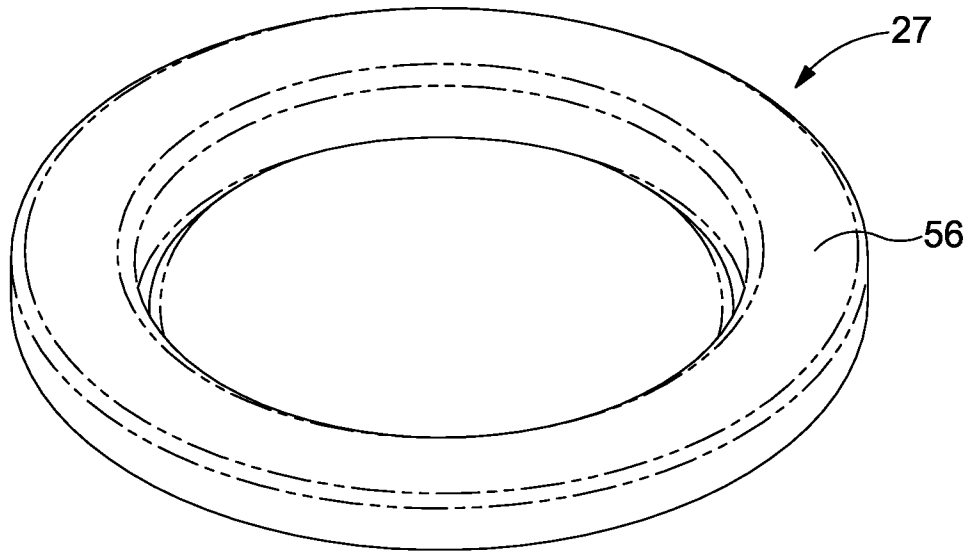


Figure 19A

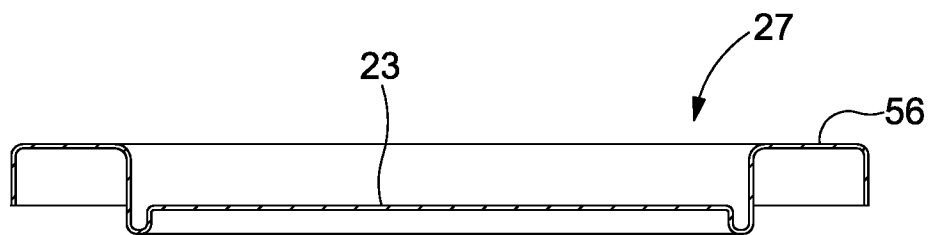


Figure 19B

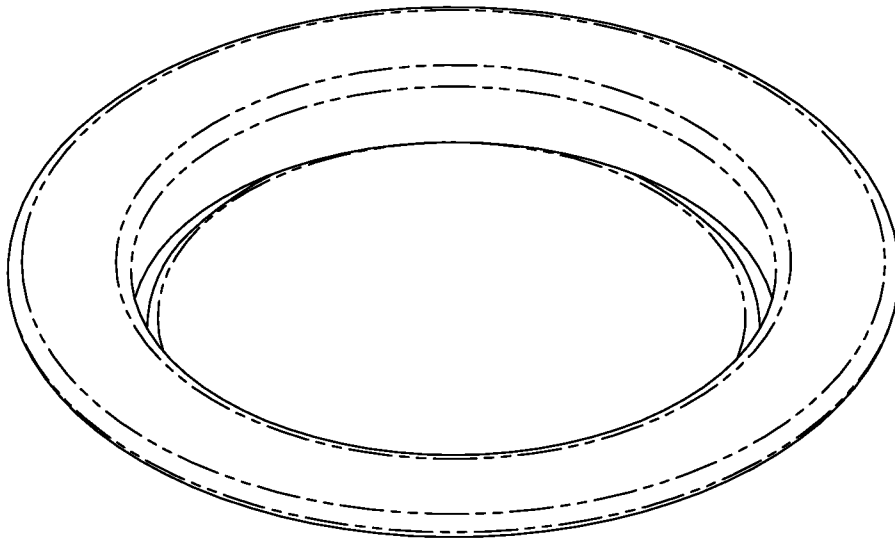


Figure 20A

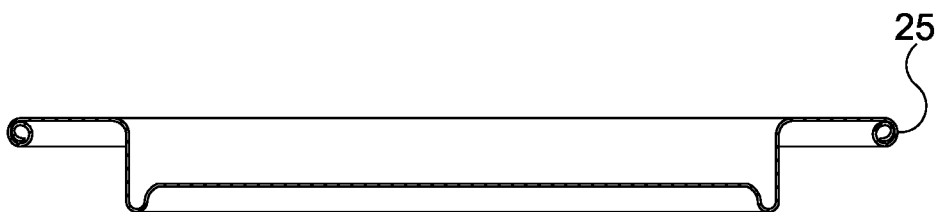


Figure 20B

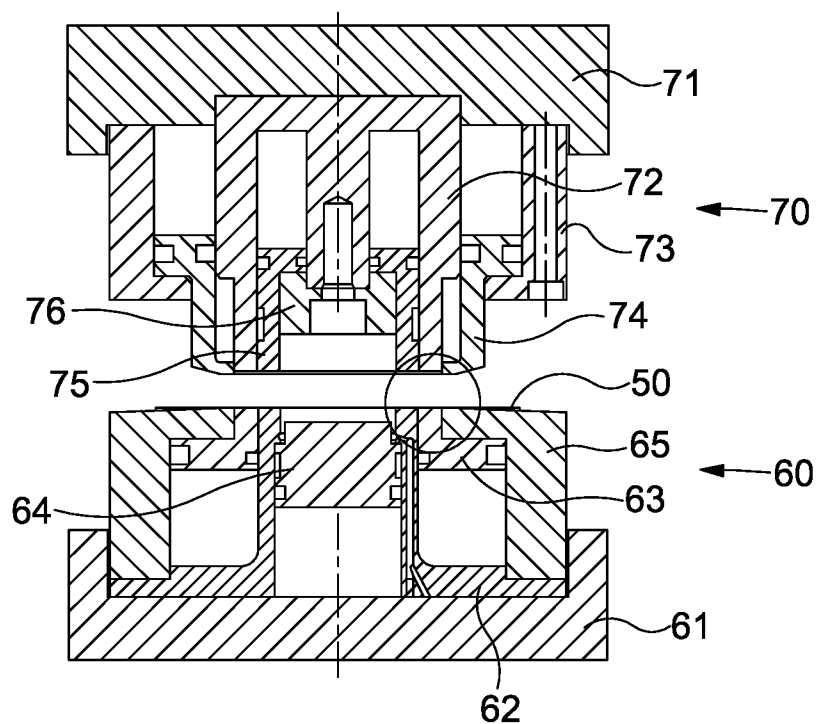


Figure 21A

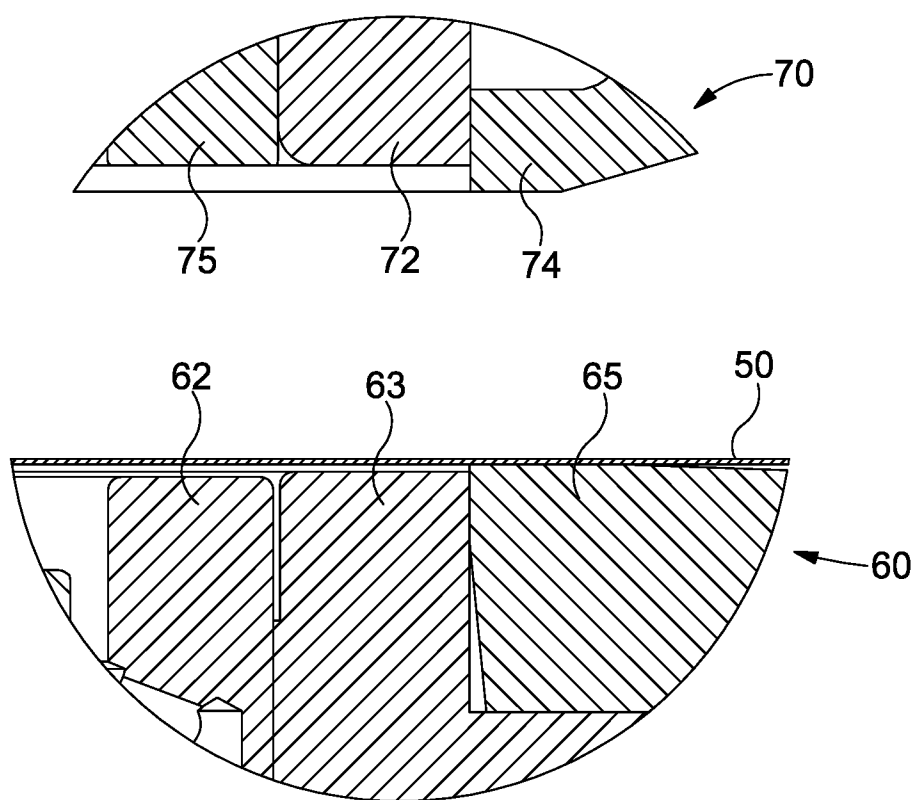


Figure 21B

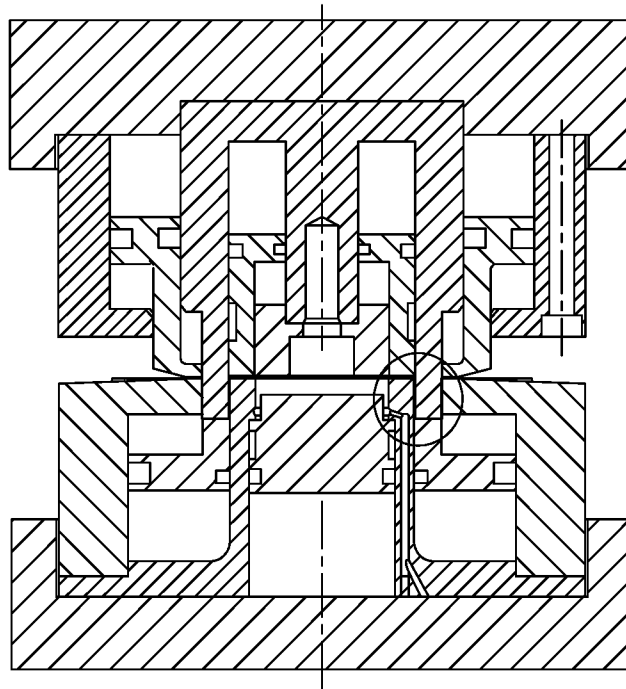


Figure 22A

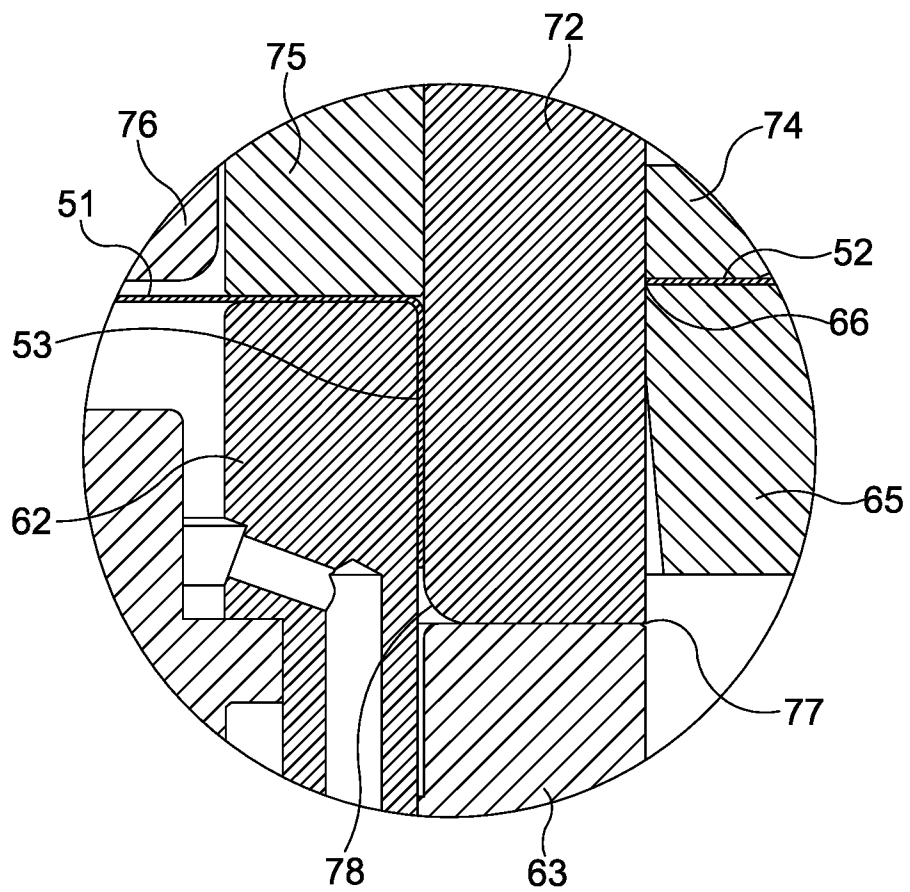


Figure 22B

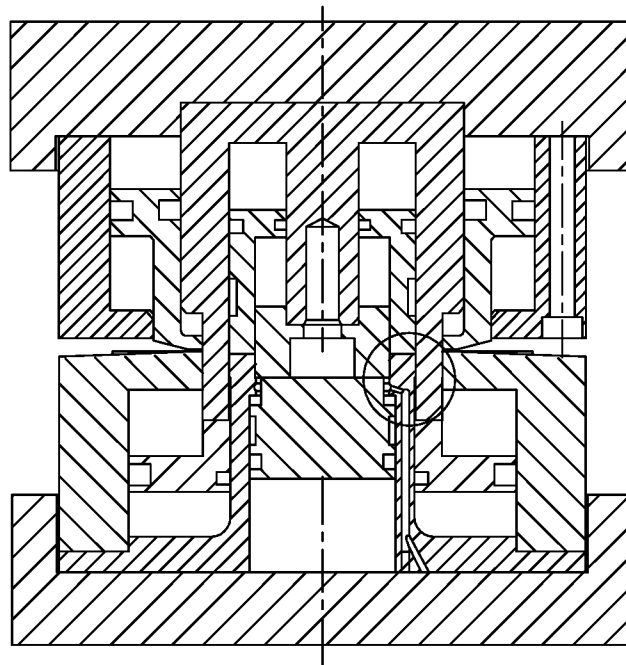


Figure 23A

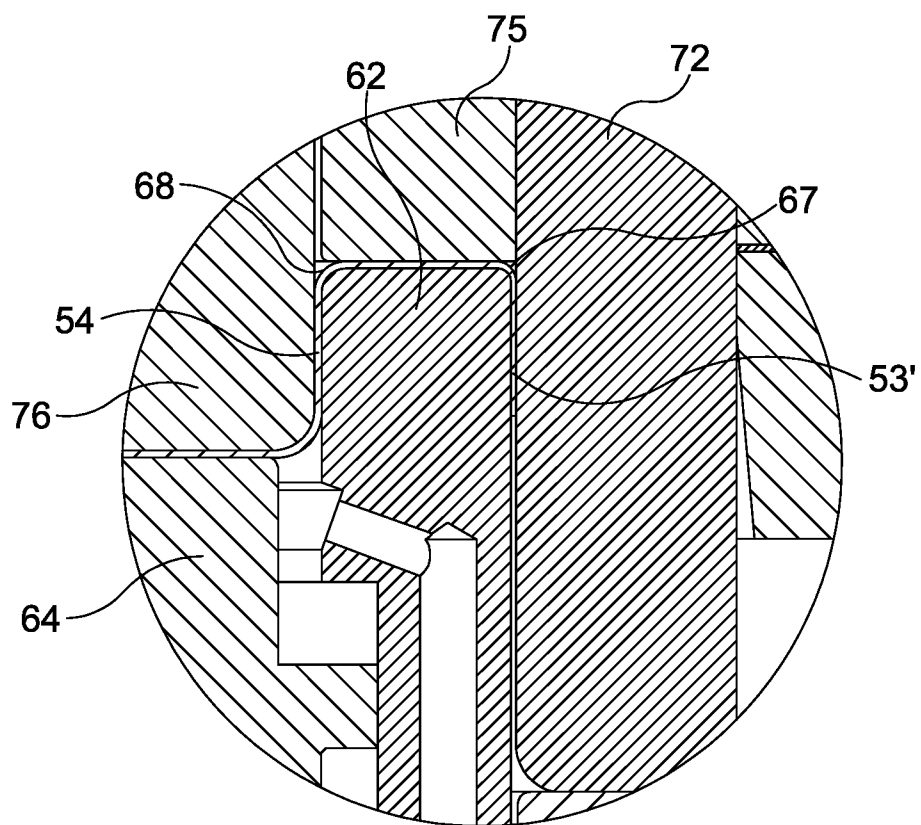


Figure 23B

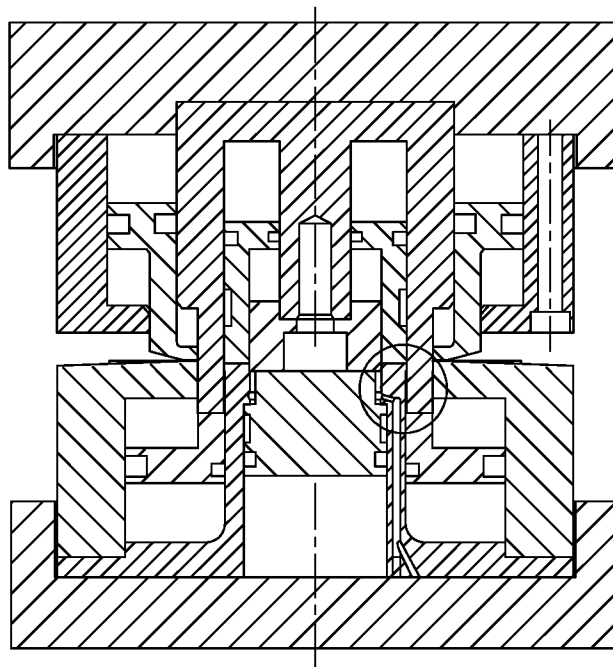


Figure 24A

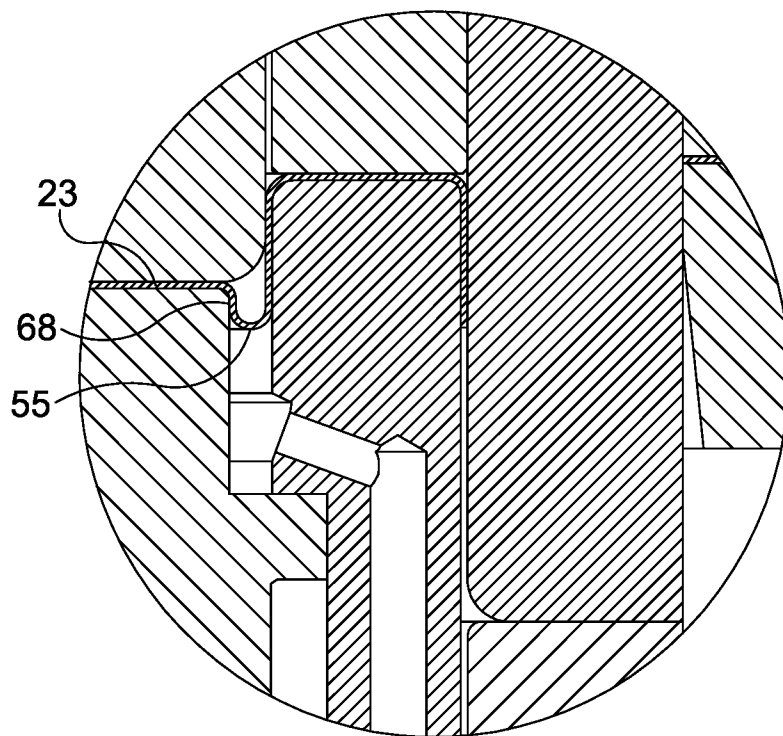


Figure 24B

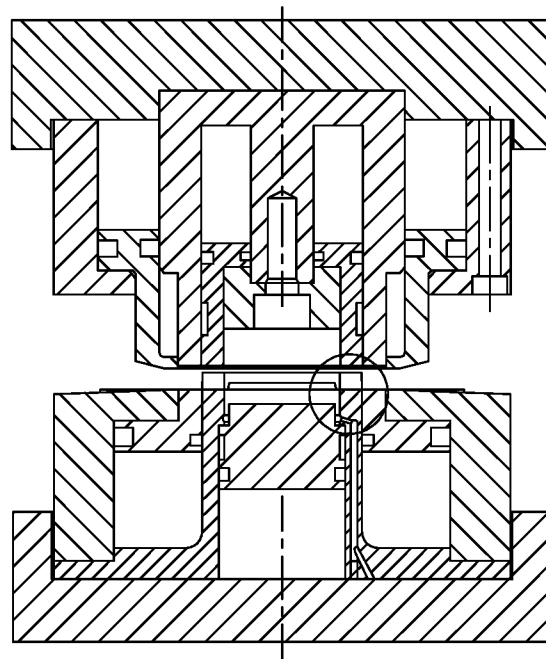


Figure 25A

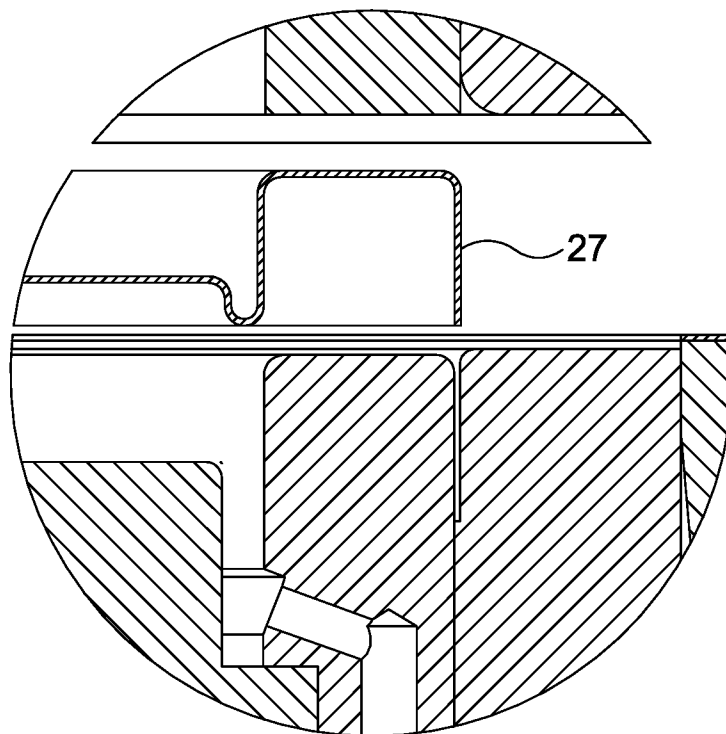


Figure 25B

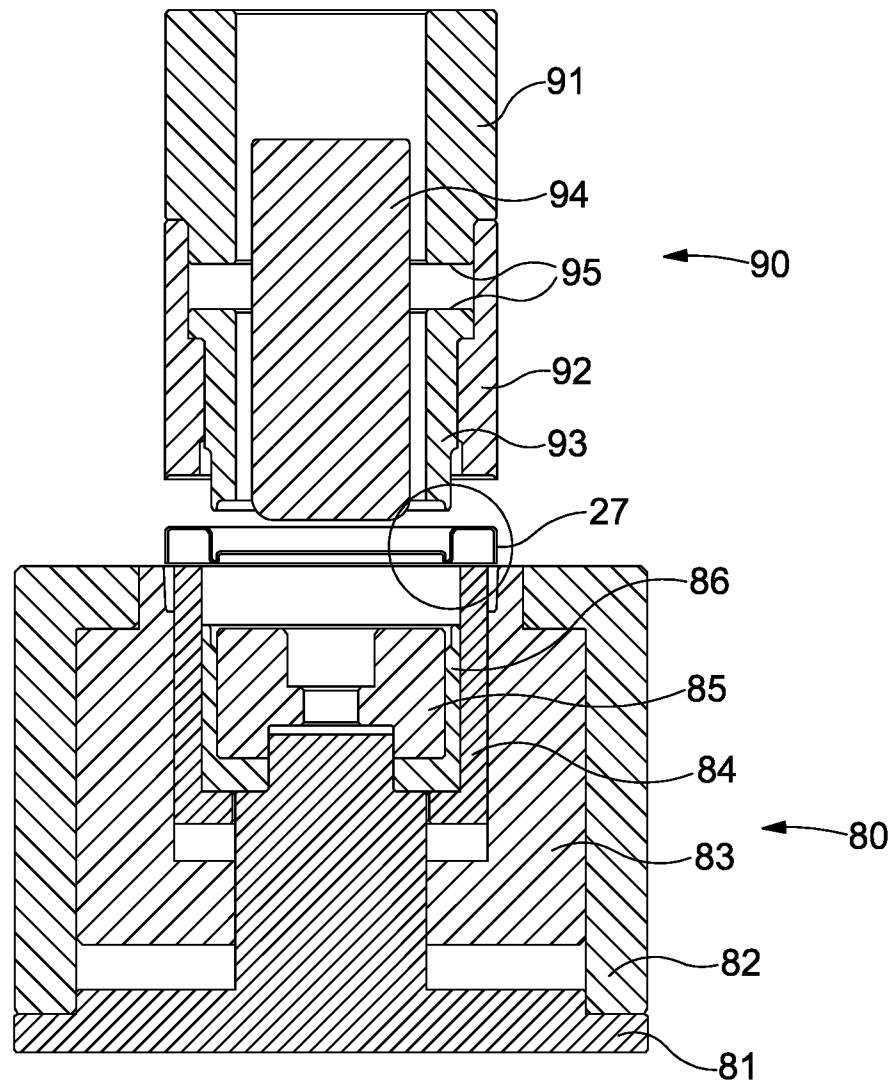


Figure 26A

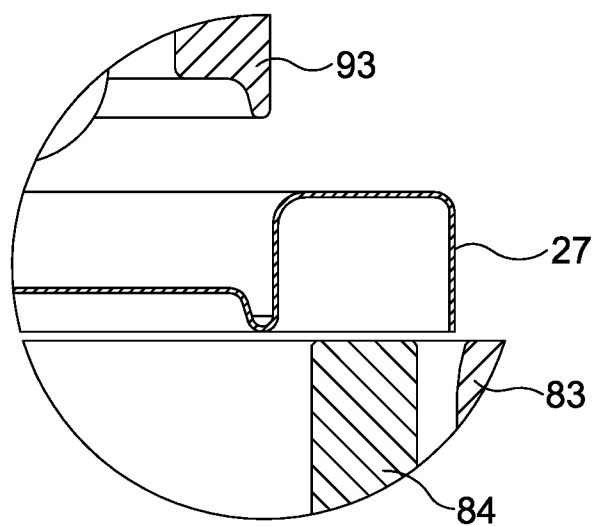


Figure 26B

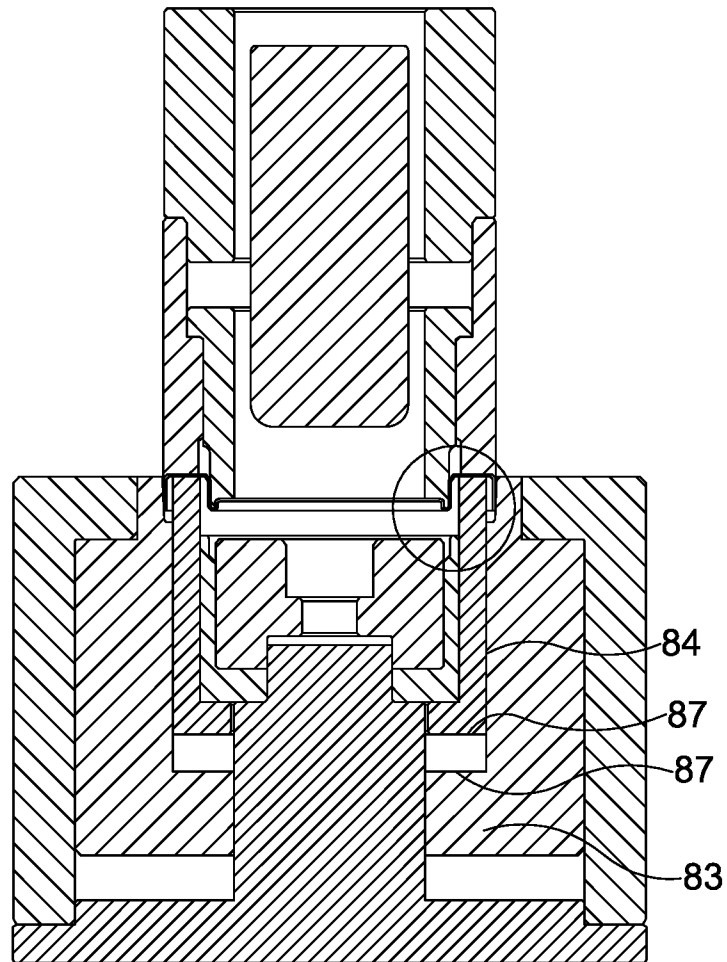


Figure 27A

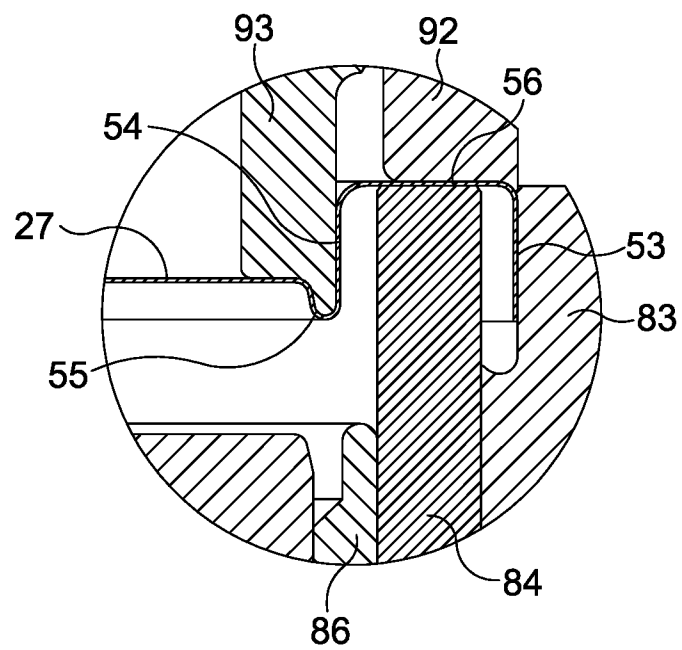


Figure 27B

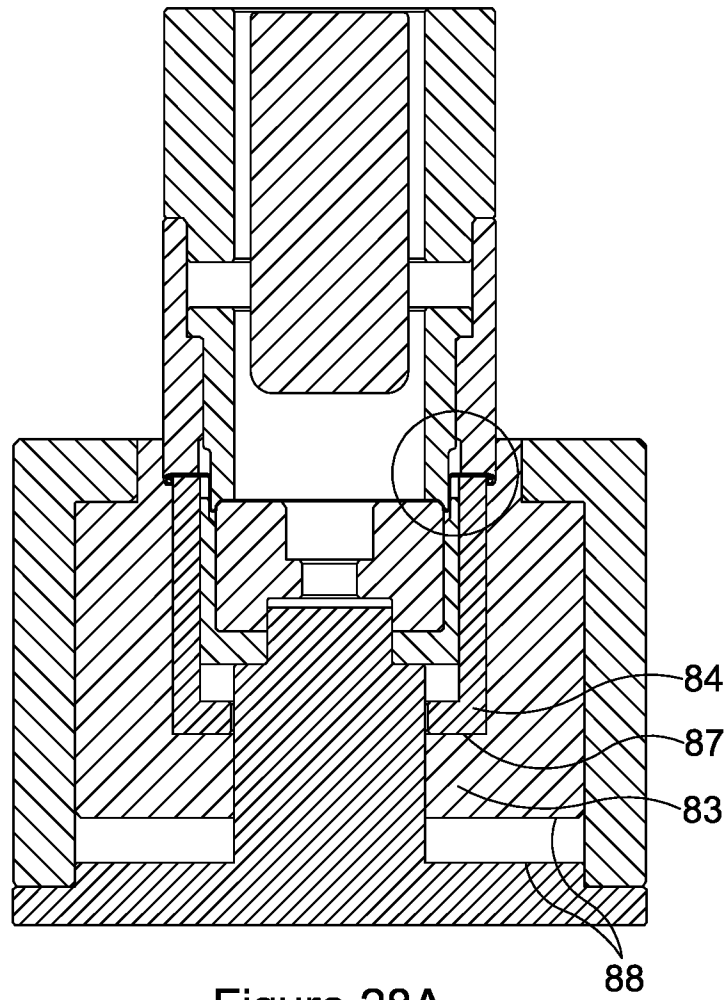


Figure 28A

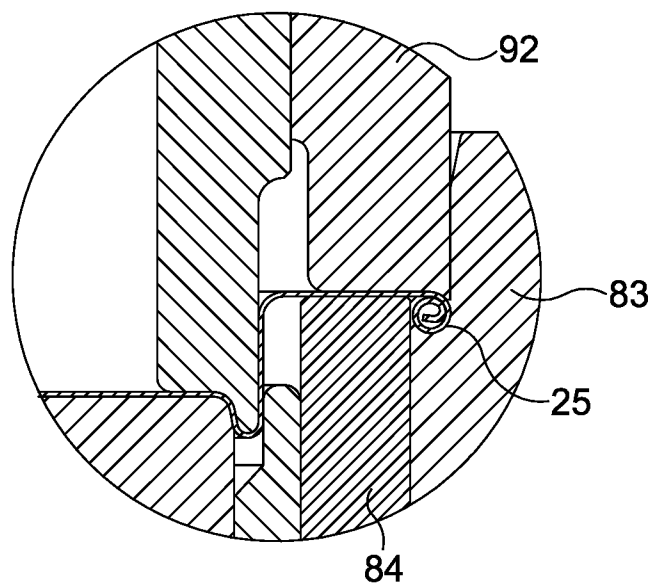
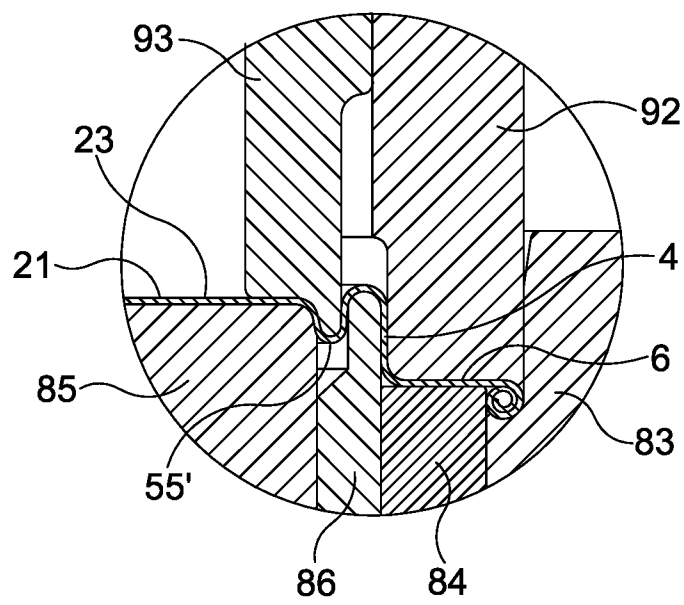
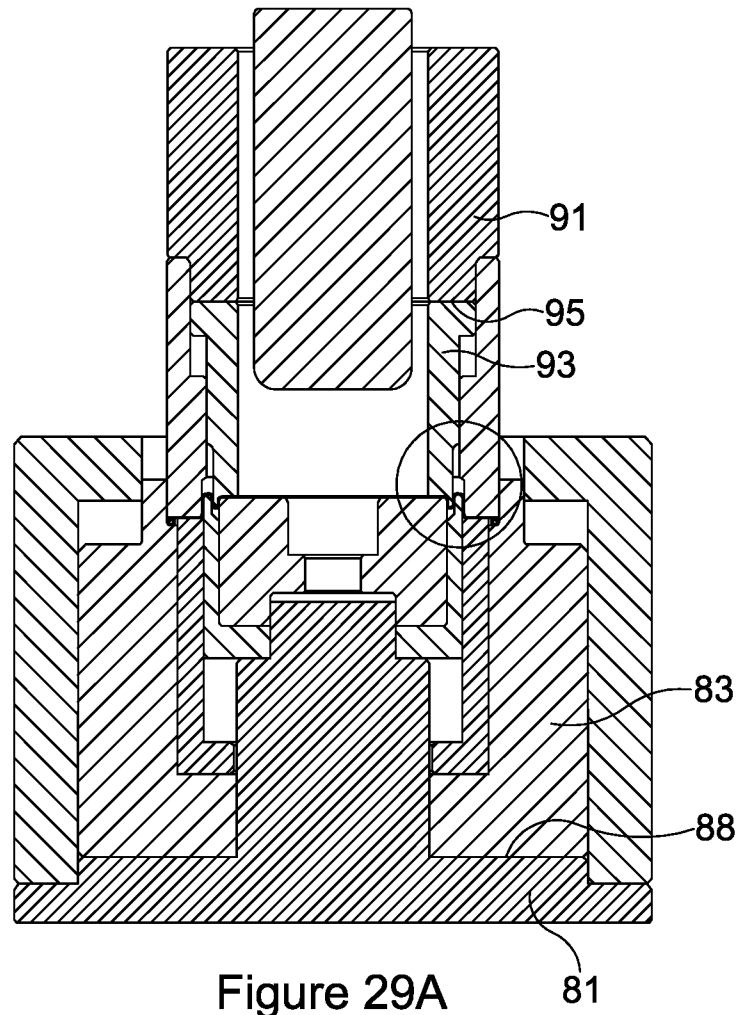


Figure 28B



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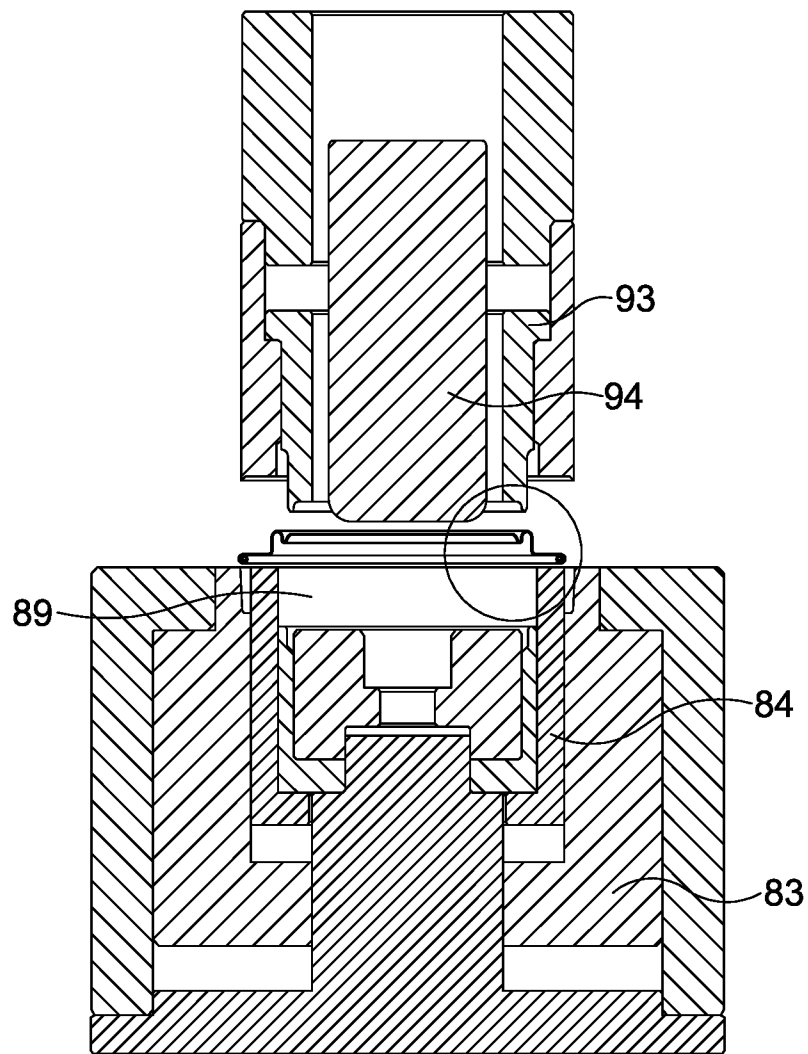


Figure 30A

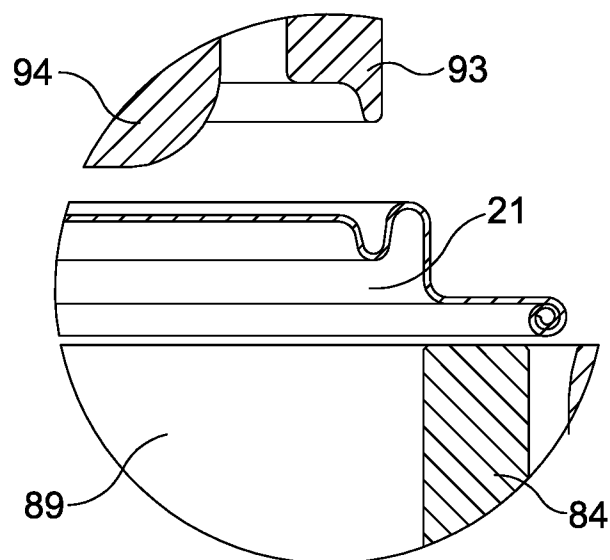


Figure 30B

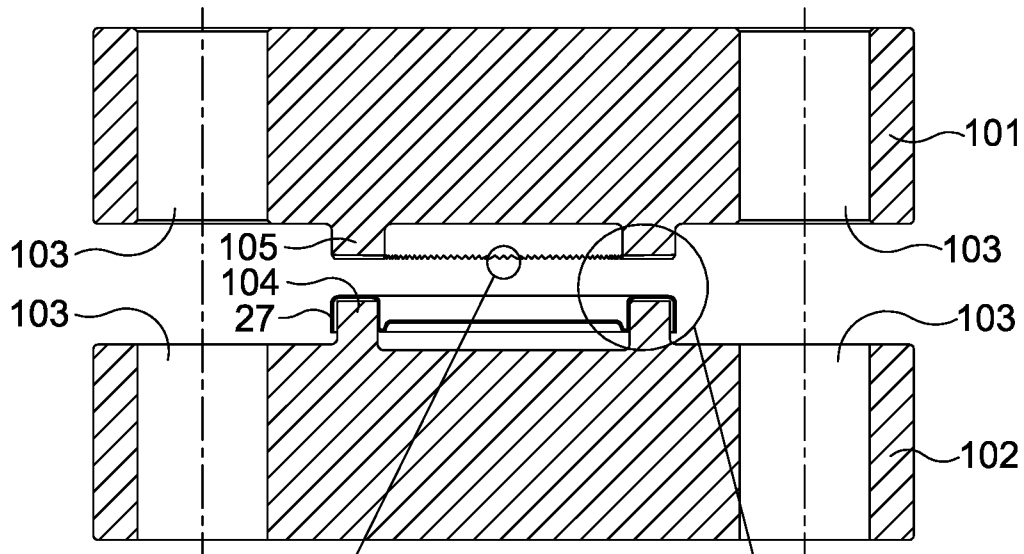


Figure 31A

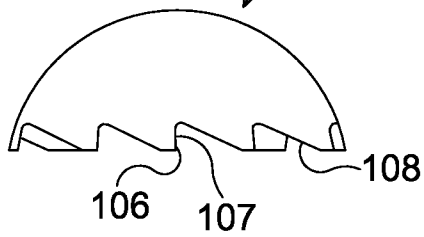


Figure 31B

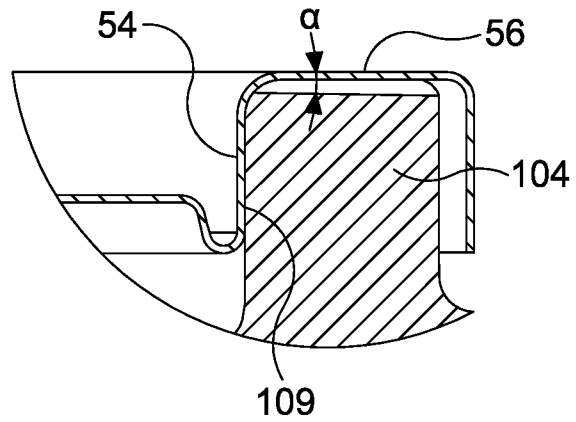
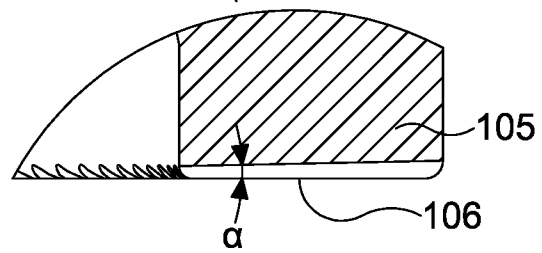


Figure 31C

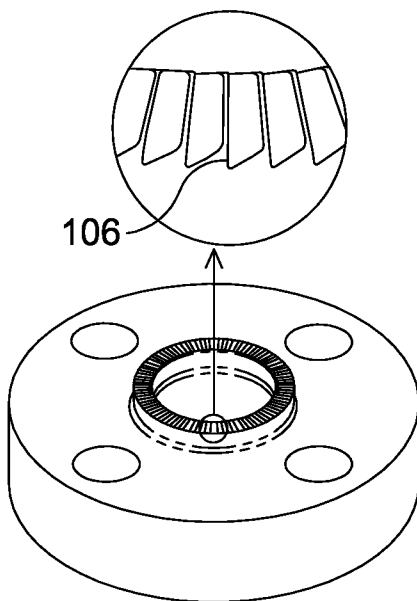


Figure 31D

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/075618

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D43/02 B65D41/04 B65D41/12 B65D41/42
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 377 859 A (HACKER TERRY F [US]) 3 January 1995 (1995-01-03)	1,2,5,6, 11-15, 23,24
A	figure 3 -----	16,17
X	US 6 015 061 A (LOWRY JAMES W [US]) 18 January 2000 (2000-01-18)	1,7-14, 23,24
A	figures 3,5 -----	2-6, 15-22
A	US 4 061 244 A (TUCKER JOHN A) 6 December 1977 (1977-12-06) column 3, line 46 - column 4, line 12; figures 1-5 -----	1-24
A	US 4 376 493 A (GALL JOHN C) 15 March 1983 (1983-03-15) column 7, line 32 - line 46; figure 7 -----	3,4,22



Further documents are listed in the continuation of Box C.



See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

7 January 2016

Date of mailing of the international search report

18/01/2016

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Fax: (+31-70) 340-3016

Authorized officer

Sundell, Olli

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2015/075618

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5377859	A	03-01-1995	NONE
US 6015061	A	18-01-2000	BR 9911979 A 27-03-2001 CA 2336389 A1 20-01-2000 DE 69902920 D1 17-10-2002 DE 69902920 T2 28-05-2003 EP 1097089 A1 09-05-2001 JP 3557171 B2 25-08-2004 JP 2002520230 A 09-07-2002 MX PA01000281 A 10-09-2003 PL 348251 A1 20-05-2002 US 6015061 A 18-01-2000 WO 0002791 A1 20-01-2000
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