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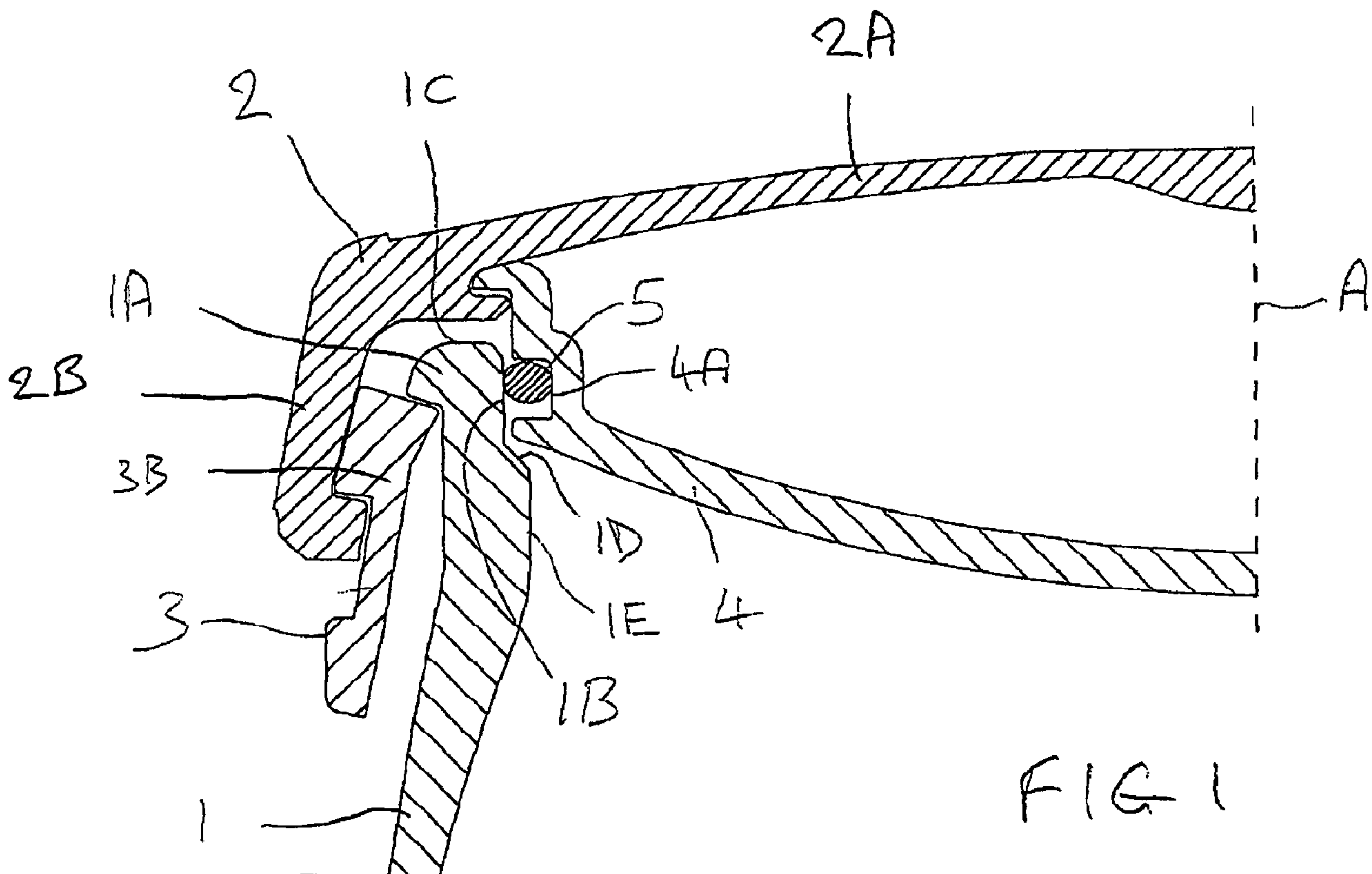
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(54) Title: CLOSURE FOR A CONTAINER



(57) Abrégé/Abstract:

A closure for a container (1) having a circular opening defining an axis (A), the closure being securable to the container so as to close said opening, the closure having an o-ring sealing member (5) mounted thereon so as to provide a seal with a sealing surface



(57) **Abrégé(suite)/Abstract(continued):**

(IB) of the container, when the closure is secured to the container, the sealing surface extending around an upper surface or an internal surface of the container. The closure may comprise a bore feature (4) which, in use, extends through the opening into the interior of the container and the o-ring seal (5) may be provided on the bore feature. Various forms of closure are described, eg for closing a bottle neck and a wide-mouth closure. The closure may comprise an inner component (3) and an outer component (2), eg cap - on - collar closure, and the container preferably has no thread features on the exterior thereof so it is comfortable to drink from.

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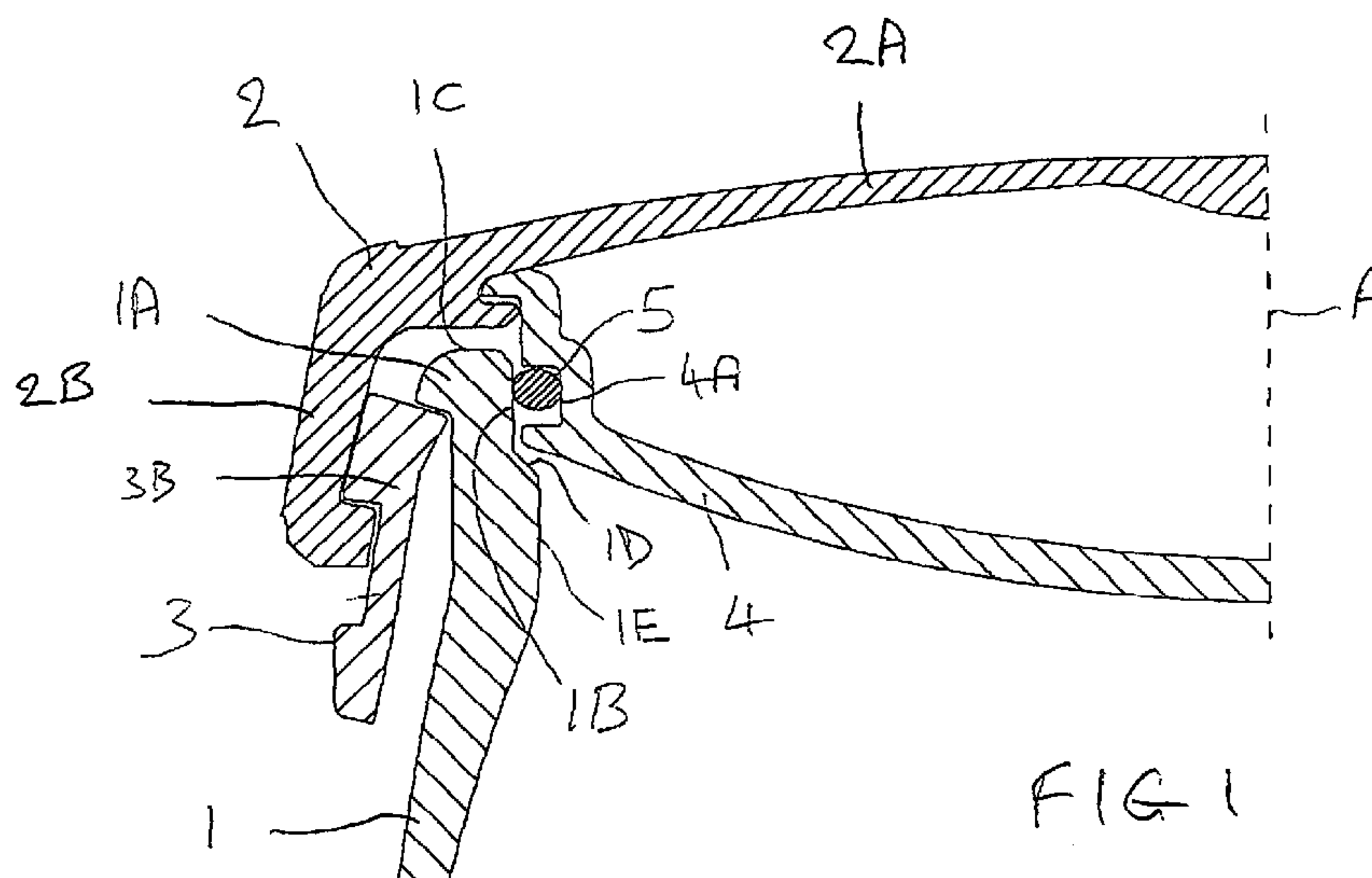
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(54) Title: CLOSURE FOR A CONTAINER



(57) Abstract: A closure for a container (1) having a circular opening defining an axis (A), the closure being securable to the container so as to close said opening, the closure having an o-ring sealing member (5) mounted thereon so as to provide a seal with a sealing surface (IB) of the container, when the closure is secured to the container, the sealing surface extending around an upper surface or an internal surface of the container. The closure may comprise a bore feature (4) which, in use, extends through the opening into the interior of the container and the o-ring seal (5) may be provided on the bore feature. Various forms of closure are described, eg for closing a bottle neck and a wide-mouth closure. The closure may comprise an inner component (3) and an outer component (2), eg cap - on - collar closure, and the container preferably has no thread features on the exterior thereof so it is comfortable to drink from.

CLOSURE FOR A CONTAINER

TECHNICAL FIELD

This invention relates to a closure for a container, in particular a closure for a beverage or other foodstuff (although the closure can be used on other types of container).

BACKGROUND ART

A variety of closures for beverage containers are known. For example, cap-on-collar closures as described in WO2006/000774 and WO2007/091068 and one-piece twist-off closures as described in WO2007/057659. Such prior art describes a variety of seal members, such as compression gaskets, for providing a seal between the closure and the container.

There is a requirement to provide a seal which is able to withstand high pressures within the container, eg when the container holds a carbonated beverage and is subject to high temperatures, yet which does not make it difficult for a user to remove the closure from the container. A variety of problems can arise with such seals, for example: high frictional engagement between the seal and the container, (particularly for wide-mouth containers), seals losing their resilience and/or becoming adhered to the container after prolonged storage and imperfections in the seal or the container (particularly if a glass container is used) leading to weak points in the seal.

The present invention provides an alternative form of seal for such closures which seeks to reduce or overcome one or more of the problems experienced with the prior art.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a closure for a container having a substantially circular opening defining an axis, the closure being securable to the container so as to close said opening, the closure having an o-ring sealing member mounted or mountable thereon so as to provide a seal with a sealing surface of the container, said sealing surface extending around an upper surface or an internal surface of the container.

It should be noted that the term o-ring seal as used herein is to be understood to include a seal comprising a toroid or loop of elastomer material having a circular cross-section, as well as other cross-sections, including an oval cross-section, a substantially square cross-section and a x-shaped cross-

section (sometimes referred to as an x-ring). It is also to be understood to cover other forms of seal which simulate the function of an o-ring (as described further below).

In addition to the elastomer toroid, an o-ring seal comprises a groove (referred to as a gland) in which the toroid is located. This groove typically has a substantially square cross-section but other shapes can be used, including triangular and semi-circular. The groove provides locating means for locating the o-ring and at least one side wall. The side wall is located so that when one side of the o-ring is subject to elevated pressure, the o-ring is pressed against the side wall so as to seal a gap between the side wall and the sealing surface of the container body. For a container in which the internal pressure is reduced, eg a vacuum pack, the side wall is on the inner side of the o-ring and for a container in which the internal pressure is elevated, the side wall is on the external side of the o-ring. If a side wall is provide on both sides of the o-ring, it can provide a sealing function in both circumstances.

The invention also relates to a closure as described above in combination with a container adapted to be closed by said closure.

The invention is particularly applicable to widemouth closures (eg with a diameter of 50 to 80 mm) as the larger the opening the more difficult it is to provide an effective and reliable seal between the closure and the container whilst ensuring the closure is still relatively easy to remove. However, the invention is also applicable to narrower openings, eg of a bottle such as those having a 28 mm diameter opening.

Directional terms, such as upper and lower, as used herein are to be understood to refer to refer to directions relative to a container standing on a horizontal surface with the axis passing through its opening being substantially vertical (unless the context clearly requires otherwise).

Preferred and optional features of the invention will be apparent from the following description and from the subsidiary claims of the specification.

BRIEF DESCRIPTION OF DRAWINGS

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

Figure 1 is a part cross-sectional view of a first embodiment of a closure according to the present invention when fitted to a container body;

Figure 2 is a part cross-sectional view of a second embodiment of a closure according to the present invention when fitted to a container body;

Figure 3 is a part cross-sectional view of a third embodiment of a closure according to the present invention when fitted to a container body;

Figure 4A is a perspective view of a fourth embodiment of a closure according to the present invention and of a container body to which it can be fitted;

Figure 4B is a perspective view, part cut-away, of the fourth embodiment when fitted to the container;

Figure 5A is a perspective view, part-cut-away, of a fifth embodiment of a closure according to the present invention when fitted to a container body;

Figure 5B is a perspective view, part-cut-away, of a modified version of the fifth embodiment using a different form of o-ring;

Figure 6A is a perspective view, part-cut-away, of a sixth embodiment of a closure according to the present invention when fitted to a container body;

Figure 6B is a perspective view, part-cut-away, of a modified version of the sixth embodiment using a different form of o-ring;

Figures 7A to 7C are schematic diagrams illustrating the function and parameters of an o-ring seal.

Figures 8 and 9 are cross-sectional views of an embodiment of a closure described in co-pending GB1011800.8 which, as described therein, may be modified to include a bore feature and an o-ring in accordance with a further embodiment of the present invention; Figure 8 shows the parts thereof prior to securement to a bottle neck and Figure 9 shows the parts when the closure has been moved into secure engagement with the bottle neck;

Figures 10A and 10B show a side view and a cross-sectional view (taken on line E-E of Fig 10A) of an inner component of the closure shown in Figures 8 and 9;

Figures 11A and 11B show perspective views from above and beneath of the inner component of Figure 10;

Figures 12A and 12B show a side view and a view from beneath of an outer component of the closure shown in Figures 8 and 9; and

Figures 13A and 13B show perspective views from above and beneath of the outer component of Figure 12.

The embodiments shown in Figures 1 to 3 comprise cap-on-collar closures. This type of closure is known from prior art, such as WO2006/000774 and WO2007/091068 mentioned above, so will not be described in detail.

Figure 1 illustrates an embodiment that comprises a closure for a container body 1 having a substantially circular opening with an axis A and with an outwardly projecting lip 1A around the opening. The closure comprises a cap 2 to close the opening and a collar 3, the collar 3 being arranged to engage beneath the outwardly projecting lip 1A and to fit between the container body 1 and the cap 2 so as to secure the cap 2 to the container body 1 in the manner described in the prior art. The cap, collar and container are typically formed of a plastics material eg polyethylene terephthalate (PET) but may be formed of other materials. The container may, for instance, be formed of glass and the closure formed of metal.

The cap 2 has a circular upper portion which extends across the container opening and a skirt portion 2B depending therefrom. The cap also has a bore member 4 which, in use, extends through the opening into the interior of the container 1 and has an o-ring sealing member 5 on the outer surface of the bore member 4 for providing a seal with an internal surface 1B of the container.

The bore member 4 may be an integral part of the cap 2 or, as shown, may be a separate component carried by the cap 2 and is arranged to be a close fit within the interior of the container 1 (but slightly spaced therefrom). A recess, eg in the form of a groove 4A, is provided in the outer surface of the bore member around the circumference thereof for receiving an o-ring 5 formed of resilient elastomer material, such as rubber.

The cap 2 is rotatable relative to the collar 3, eg by means of a screw thread therebetween. The collar 3 has radially moveable parts 3B which engage beneath the lip 1A of the container body 1 and as the cap is rotated in the tightening direction it is arranged to press the parts inward under the lip 1A and to hold them securely in this position, eg by means of cam features at spaced apart locations around the internal surface of the cap. Alternatively, the moveable parts may be biased inwards by their own

resilience and the cap 2 rotated to a position in which it holds the parts securely beneath the lip 1A by preventing them from moving or flexing radially outwards.

Preferably, as the cap 2 is rotated in the tightening direction relative to the collar 3, the cap 2 is drawn axially downwards towards an upper surface 1C of the lip 1A. It may engage this upper surface 1C when in the closed position or, as shown (in an exaggerated form) in Fig 1, may be spaced therefrom to reduce the risk of becoming adhered thereto over time. If it is spaced therefrom, the spacing is preferably relatively small, eg less than 0.5 mm so as to minimise the scope for vertical movement of the closure relative to the container body when in the sealed position.

In a further arrangement (not shown), the cap 2 may engage the upper surface 1C of the lip directly or via a secondary sealing member 6 therebetween to provide a secondary seal between the cap 2 and the container body 1.

As indicated above, when the closure is mounted on the container body 1, the bore member 4 extends into the interior of the container body 1 and the sealing member 5 is a close fit with the internal surface 1B of the container body. As the cap 2 is rotated relative to the collar 3 in the tightening direction, the bore member 4 is drawn further into the container body 1 and the o-ring provides a seal between the bore member 4 and the interior of the container body 1.

The inner edge of the container lip is preferably chamfered so as to provide a lead-in surface for the o-ring 5. The o-ring 5 then engages a portion 1B of the internal surface of the container body which comprises a substantially parallel sided cylindrical surface. The function of an o-ring 5 will be described further below in relation to Figures 7A and 7B. The cylindrical surface 1B extends axially for a distance (typically several millimetres), sufficient to accommodate axial movement (up or down) of the bore member 4, eg due to pressure differentials between the interior and exterior of the container. As this surface 1B is parallel sided, such movement can be accommodated without affecting the seal between the closure and the container body.

It will be seen that the groove 4A within the bore member 4 is three-sided and, together with said internal surface 1B of the container body, defines a four-sided enclosure for constraining the cross-section of the o-ring 5. The side walls of the groove 4A are preferably substantially perpendicular to the sealing surface 1B. As will be described further below, the enclosure only needs to be 3-sided, ie two sided (eg L-shaped or V-shaped groove) together with the sealing surface of the container.

A shoulder 1D is optionally provided beneath the cylindrical surface 1B of the internal wall of the container leading to a reduced diameter portion 1E of the container wall. Beneath this, the container

wall may have any desired shape. The reduced diameter portion 1E is provided so that automatic handling tools, eg in a filling line, can grip the interior of the container without damaging the cylindrical sealing surface.

The shoulder 1D may also provide a stop feature for limiting the movement of the bore feature into the container.

It will be appreciated that in arrangements in which the thread form has an inclined portion rotation of the cap relative to the collar is converted into axial movement of the o-ring within the container and so provides a significant mechanical advantage in effecting this movement. In addition, compression of the o-ring is primarily in the horizontal direction so does not resist axial movement of the ring. This greatly reduces the torque required to tighten the closure.

As indicated above, the bore member 4 may be integrally formed with the cap 2 or may be a separate component. In the latter case, there are more options for forming the bore member 4 from a material, eg a metal, different to that from which the cap 2 is formed. A metal bore member is advantageous as it is generally impermeable to gas. If a plastics bore member is used, it is preferably formed of a plastic material which has been modified to reduce its gas permeability. A metal bore member also has the advantage that it expands as the temperature increases and thus further compresses/deforms the o-ring seal to enhance the seal with the container.

A separate bore member 4 may be mounted to the underside of the cap 2 in a variety of ways, eg by being adhered or welded thereto or by simply being clipped therein (as shown in Fig 1). The engaging portions of the cap and bore feature are preferably provided at localised areas around the circumference to reduce the frictional engagement therebetween (the benefit of which is discussed below). The cross-section shown in Fig 1 is through one of these locations.

The bore member 4 may be arranged such that the cap 2 is rotatable relative to the bore member 4 so, once the o-ring 5 has frictionally engaged the sealing surface 1B, the bore member 4 no longer rotates relative to the container body 1 as the cap 2 is rotated further relative to the collar 3. Instead, if the frictional engagement between the bore member 4 and the container body 1 is greater than that between the bore member 4 and the cap 2, the bore member 4 merely moves axially within the container body 1. This means that the o-ring 5 also only has to move axially within the container, rather than rotating relative thereto, as the cap is tightened or loosened on the collar 3, and so greatly reducing the torque required to tighten or loosen the closure. In such an arrangement, rotation of the cap thus serves to drive the bore member (and o-ring) axially further into the container. In other cases, this need not be the case.

Figure 2 shows a closure which is similar to that of Figure 1 (with corresponding parts having reference numbers increased by 10) except that the bore member 14 is integrally formed with the cap 12 and the upper portion 12A of the cap has an annular form (rather than being circular and extending across the container opening). In this case, it is just the bore member 14 that extends across and closes the container opening.

This embodiment has the advantage of simplicity as it comprises fewer components. The recess 12C in the closure can also provide a location for a promotional item (not shown).

Figure 3 shows a third embodiment similar to that of Figure 1 (with corresponding parts having reference numbers increased by 20) but in this case, the o-ring sealing member is part of a resilient member 25 fitted to the underside of the bore member. The resilient member 25 is moulded to fit the underside of the bore member 24 and has a portion 25A which simulates a toroidal o-ring. This portion 25A has an approximately circular cross-section, eg square with rounded corners as shown in Fig 3, and is located in a groove 24A which extends around the circumference of the bore member 24. As shown, this groove 24A comprises an upper face and a rear face and these faces, together with the cylindrical face 21B of the container body, constrain the cross-section of said part 25A, at least when subject to an elevated pressure within the container 21 (NB this embodiment would not be suitable to for use in applications in which the pressure in the container is reduced, ie in a vacuum pack, as the groove does not have a lower face to constrain said part against movement into the container).

Figures 4 and 5 show embodiments in which the closure is secured directly to the container, eg by means of a thread on the exterior of the container, ie without the need for a collar. These embodiments also employ an o-ring to provide a seal between the closure and the container and many features correspond to those described above (and are given similar reference numbers but increased by 30 or 40).

Figures 4A and 4B show a fourth embodiment with a one piece closure that is rotatably secured to the container by means of a threaded engagement therebetween. The closure comprises a cap 32 with a circular portion 32A that closes the mouth of the container 31 and a skirt portion 32B. The skirt portion 32B has thread features 32C at spaced apart positions around its circumference which engage with thread features 31A spaced around the exterior of the container lip 31B. As shown in Fig 4B, the circular portion 32A is part of a bore member 34 that extends into the container 31 and an o-ring seal 35 is provided in a groove 34A in the exterior of the bore member 34. The o-ring seal 35 engages a sealing surface 31C around the inner circumference of the container 31. Preferably, this surface 31C is substantially cylindrical (as discussed above) but, as shown in Fig 4B, may also be part of a surface

that reduces in diameter towards the mouth of the container 31. With this arrangement, an elevated pressure within the container 31 urges the cap 32 upwards so the o-ring 35 engages a sealing surface 31C of reduced diameter so the sealing engagement therewith is increased.

The cap 32 shown in Figure 4 may be made from metal and the thread features 32C thereof formed by a pressing operation. As shown, the thread form is preferably a multi-start thread form, in this case an eight-start thread form that requires a rotation of only about 45 degrees to fasten or release the closure.

Figure 5A shows a fifth embodiment of a closure. This is similar to the one-piece closure of Fig 4 except that the o-ring 45 is mounted in a groove which is positioned on the bore feature 44 such that the sealing surface 41C that the o-ring engages is a conical surface of the container 41. In the example shown, this conical surface 41C lies at an angle of substantially 45 degrees with the axis A and comprises the chamfer which extends from an upper surface of the container lip into the interior of the container 41. The conical surface 41C may lie at other angles to the axis A depending upon the application, the nature and magnitude of the internal pressures and the hardness of the o-ring material 45.

This embodiment has the advantage that the cap 42, and particularly the groove used to housing the o-ring, is easier to form by a pressing operation than the arrangement shown in Fig 4.

Also, as the sealing surface 41C has a vertical component, the o-ring moves down this surface as the cap 42 is tightened onto the container 41. This reduces the force required to tighten the closure (compared to an arrangement in which the sealing surface is perpendicular to the axis A) as this force moves the o-ring downwards as well as compressing the ring. As the sealing surface is inwardly inclined, it also serves to compress the o-ring in the horizontal direction.

Figure 5B shows a modified form of the fifth embodiment in which an o-ring seal 45' having a cruciform cross-section (sometimes referred to as an x-ring) is used in place of an o-ring with a circular cross-section. This form of o-ring has the advantage that it seals at four points rather than two.

Figure 6A shows a sixth embodiment of a closure. This is similar to the one-piece closure of Fig 4 except that the o-ring 35 is mounted in a groove which is positioned so that the sealing surface that the o-ring engages is an upper surface of the container lip. Preferably, as shown, the cap still has a bore member that extends into the interior of the container. In the arrangement shown, the sealing surface is a radially inner portion of the upper surface which abuts the internal surface of the container. If the interior of the container is subject to reduced pressure, eg in a vacuum container, the o-ring is thus pressed into the gap between the bore member and the inner rim of the container. The seal thus

formed may thus be regarded as being formed with the interior surface of the container if the corner where this meets the upper surface is included as part of the interior surface.

Figure 6B shows a modified form of the sixth embodiment in which an o-ring seal 55' having a cruciform cross-section (sometimes referred to as an x-ring) is used in place of an o-ring with a circular cross-section. As indicated above, this form of o-ring has the advantage that it seals at four points rather than two.

In a further modification (not shown) of the sixth embodiment, the upper surface of the container lip may be shaped so that the sealing surface that the o-ring engages is not the uppermost surface of the lip. This sealing surface may be provided on the inner side of the lip, in which case the bore feature and the o-ring carried thereby extend through the opening of the container into the interior of the container (in a similar manner to that shown in Fig 5).

Alternatively, the sealing surface may be around the exterior of the upper surface of the container lip, eg in the form of a recess or chamfer about the external diameter of the lip. As indicated above, if the sealing surface is inclined (so as to have a vertical component), the torque required to tighten the closure is reduced as the forces applied to compress the o-ring are at an angle to the axis A so are not directly opposed to the vertical movement (along axis A) of the closure.

Thus, in these modifications, the sealing surface is an upper surface of the container lip (or an internal surface of the container) but not necessarily the uppermost surface of the lip.

Preferably, as will be seen that in each of these embodiments, the side walls of the groove housing the o-ring are substantially perpendicular to the sealing surface of the container.

Figures 7A to 7C illustrate the function and parameters of an o-ring seal. Figure 7A shows a cross-section of an o-ring 75 with a circular cross-section in an undeformed state. The cross-section has a diameter or width CS. Figure 7B shows the o-ring 75 located in a groove or gland 74A having a depth D and compressed between the rear sealing face 74B of the groove and an external sealing face 71B (such as the internal surface of the container body). In this case, the o-ring 75 is subject to equal pressures on either side thereof (left and right in Fig 7B).

An o-ring has an inner and outer diameter and a cross-sectional diameter CS (which is the difference between the inner and outer diameters). The outer diameter is determined by the diameter of the container opening (and is typically slightly greater than the diameter of the container opening). The cross-sectional diameter CS will depend upon the application but for containers having a diameter in

the range 50 – 80 mm will preferably be in the range of 2.0-3.0 mm. For narrower mouth containers, eg with a 28 mm diameter opening, CS will preferably be in the range 1.0-2.0 mm. It should be noted that CS refers to the cross-section of the uncompressed o-ring when mounted in the groove. If the ring is stretched when located in the groove this cross-section will be smaller than the cross-section in an unstretched condition.

O-rings are typically formed of elastomers. Elastomers may be synthetic or natural resilient materials with sufficient memory to return to their original shape after a major or minor distortion. The resilience is what enables an o-ring to provide a seal and the parameters of the seal and the gland are selected to make effective use of this.

The o-ring is positioned in an enclosed space which both compresses and locates the o-ring. The containment ensures that the sealing function is maintained and the o-ring retained in the desired position. The enclosed space is formed by the walls of the groove or gland and a sealing surface facing the open side of the groove or gland. Figure 7B illustrates an enclosed space having a height H and a width W. The gland is formed in a relatively rigid material (and thus from a different material from the o-ring). The o-ring positioned in this space is compressed so its cross-sectional width is reduced from CS (shown in Fig 7A) to H.

The term 'compressed' is used herein to describe this change of shape. However, it should be noted that elastomers are substantially incompressible so the term 'deformation' is technically more accurate. The cross-sectional area of the o-ring in the 'compressed' state is thus substantially the same as it is in the uncompressed state.

The opposing surfaces 71B and 74B of the gland are sealing surface and their spacing H is less than the o-ring cross-section CS so the o-ring is compressed as shown resulting in sealing forces between the o-ring and each of the surfaces 71B and 74B.

The opposing surfaces 74A and 74C are containing surfaces and the distance W between them is equal to or larger than the diameter CS of the o-ring. The primary function of these surfaces is to keep the o-ring in place.

Two of the most important parameters that affect the performance of an o-ring seal are the compression squeeze and the compression ratio. The compression squeeze is defined as;

Compression squeeze = CS – H

And the compression ratio expresses what percentage the compression squeeze is of the uncompressed o-ring cross-section:

$$\text{Compression ratio} = (\text{compression squeeze}/\text{CS}) \times 100$$

The compression squeeze should have a minimum value of 0.1mm and is preferably at least 0.15mm.

The compression ratio should be in the range 5% to 35% and preferably in the range 20% to 25%.

Another parameter of an o-ring seal is the extrusion gap G which is the height of the spacing between the sealing surface 71B and the outer surface of the bore member (or other component) adjacent the opening of the groove formed therein. The gap G is the difference between the dimensions H and D: so $G = H - D$.

The gap G should be significantly smaller than the cross-section CS of the o-ring, eg no greater than 20% of CS and preferably no greater than 10% of CS. In most cases, the gap G is very small, eg 0.5mm or less and preferably 0.25mm or less. However, in some cases, the gap may be slightly larger due to manufacturing tolerances in the formation of the container and the bore member of the closure, or due to specific designs, such as food applications, whether it may be desirable for the o-ring to be allowed to extrude partially into the gap.

If the gap G is very small, this means that the depth D of the gland is thus preferably 65% - 95% of the o-ring cross section CS and preferably 75% to 80% of the cross-section CS.

In cases where the gap G is larger, the depth D of the gland should still be at least 50% and preferably at least 60% of the cross-section CS.

Another important parameter of an o-ring seal is gland fill. This is the percentage of the gland that is occupied by the o-ring. The cross-section area (CSA) of a circular o-ring is $\pi \times (\text{CS}/2)^2$ and the gland cross-sectional area (CSA) is $H \times W$. Thus, the gland fill is given by:

$$(\text{o-ring CSA}/\text{gland CSA}) \times 100$$

The gland fill should lie in the range 50% to 90% and preferably in the range 65% to 85%.

Figure 7C illustrates how the o-ring 75 moves within the groove 74A and is deformed when subject to pressure P from one side (the right side of Fig 7C). The o-ring 75 moves within the groove 74A away

from the higher pressure P and is pressed against the side face 74C at the other side of the groove 74A. It is deformed so as to seal the gap 76 between the component housing the groove 74A and the face 71B. Given the nature of the o-ring (and the size of the gap), deformation of the o-ring into this gap is usually minimal. It will also be seen that a substantial proportion (greater than 50%) of the o-ring surface is engaged with a surface (71B, 74B, 74C) of the gland so as to provide a seal therewith.

The parameters described above have been described in relation to a conventional o-ring with a circular cross-section. However, similar parameters apply to other variants of a o-ring, eg when the o-ring has other cross-sectional shapes and/or when the gland has other forms (eg a 3-sided gland as shown in Fig 3, or an L-shaped or V-shaped gland formed by two inclined side walls) with the appropriate dimensions used in place of those illustrated in Fig 7. It will be appreciated that when the o-ring is subject to a pressure differential acting to move it in one direction, the gland only need have one side wall, eg so the groove is L-shaped.

The function of o-ring seals, and their technical parameters, are further described in the Dichtomatik O-Ring Handbook published by Dichtomatik North America (and available in 2010 on their web site at <http://www.dichtomatik.us/Literature/O-ring-Handbook.aspx>)

It will be appreciated that the sealing action of an o-ring is very different to that of known beverage container seals such as a sealing gasket which is trapped between two flat surfaces, a seal with one or more flexible sealing fins or a wedge seal trapped in a tapering gap between a plug member and a container bore. The principal sealing surfaces of an o-ring are the opposing surfaces 71B and 74B between which the o-ring is compressed and the engagement of the o-ring therewith.

Figures 8 to 13 illustrate a two-part closure as described in co-pending GB1011800.8. The inner and/or outer component of this two-part closure may, as described in GB1011800.8, comprise a bore feature (not shown) which projects through the mouth of the container into the interior thereof and the bore feature may be provided with an o-ring seal which engages and seals with the interior of the container (or an upper surface thereof). These further embodiments of the two-part closure thus form further embodiments of the present invention. The two-part closure will be described with reference to Figs 8 - 13 followed by description of the arrangements (not shown in these Figures) having a bore feature and an o-ring seal.

The closure shown in Figures 8-13 comprises an inner component having a collar portion for fitting about the exterior of a container 82, in this case a bottle neck having a container opening defining an axis A, and which has radially moveable parts 83 spaced around its circumference for

engaging beneath a lip 82A of the container 82, and an outer component having a skirt part 84A for locating about the radially moveable parts 83 of the inner component.

The outer component 84 is designed to be located over the inner component 81 by substantially axial movement therebetween and comprises one or more cam surfaces 84B on its inner surface which engage the upper ends of the radially moveable parts 83 as the components are moved axially so as to progressively press the parts 83 inwards into tight frictional engagement with the exterior of the container beneath the lip 82A of the container 82. The cam surfaces are thus arranged to hold and/or press an expandable/contractable portion of the inner component into secure engagement with the container beneath said lip,

Once the outer component 84 has been moved axially over the inner component 81 so as to press the radially moveable parts 83 inwards, it is twisted relative to the inner component 81 about the axis A so as to engage securement means which releasably secure the inner and outer components together in this position. In the embodiment shown, the securement means comprises substantially upwardly facing surfaces 85A of inward projections 85 at the lower end of the skirt part 84A of the outer component and substantially downwardly facing surfaces 83A of the radially moveable parts 83. The surfaces 85A and 83A may provide a bayonet-form of engagement between the inner and outer components and/or a thread-like engagement therebetween. The surfaces may be shaped or inclined such that said relative rotation between the inner and outer components also causes axial movement therebetween.

In the closure shown in Figs 8 and 9, the inner component 81 also comprises a flexible sealing portion 86 which extends over the opening in the bottle neck, over an upper surface of the container lip and extends down the exterior of the bottle neck. The flexible portion 86 is preferably integrally formed with the radially moveable parts, e.g. by a two-shot moulding process. The radially moveable parts are formed of a relatively rigid material, e.g. polyethylene terephthalate (PET), and the flexible portion of a relatively flexible material e.g. an elastomer. The function of the flexible sealing portion 86 will be described further below.

The outer component 84 comprises a top part from which the skirt part depends and which extends across the upper surfaces of the lip 82A and across the container opening.

The inner component 81 will be described in more detail with reference to Figures 10A and 10B. As shown in these figures, the inner component comprises two principal parts: a collar portion which comprises a ring 83B with a plurality of radially moveable parts 83 upstanding from the ring 83B and circumferentially spaced around the ring 83B and a flexible sealing portion (described further below). Each of the moveable parts 83 has a rounded upper end 83C for engagement with the cam surfaces 84B described above and for engaging the underside of the container lip 82A. Preferably, the

upper end 83A of the moveable parts 83 is shaped to substantially match the concave profile of the container on the underside of the lip 82A (as shown in Fig 9).

The outer face 83D of each of the moveable parts is substantially flat so as to be a snug fit within the skirt 84A of the outer component 84 when the closure is in an unsecured position (as shown in Fig 8). Each moveable part 83 also has a lower, substantially downwardly facing surface 83A as described above. This acts to retain the inner component 81 within the outer component 84 in the unsecured position (as shown in Figure 8) so the inner and outer components can be easily pre-assembled; the inner component 81 being a snap fit within the outer component 84 as they are brought together in the axial direction, the moveable parts 83 flexing as they pass over the inward projections 85 until they snap outwards so the lower surface 83A of the moveable part engages the upper surface 85A of the inward projections 85.

In the position shown in Fig 8, the surfaces 83A and 85A are substantially horizontal i.e. perpendicular to axis A. However when the inner and outer components are moved axially relative to each other to the position shown in Fig 9, the moveable parts 83 are flexed inward. The lower surface 83A of the moveable part is thus tilted inwards so as to be inclined to the horizontal. Accordingly, the upper surfaces 85A are preferably shaped so that when the outer component 84 is twisted to the secured position the surface 85A is similarly inclined to the surface 83A.

In addition, in many cases, is desirable for the engagement between the surfaces 83A and 85A, as the outer component 84 is rotated or twisted about axis A to a second position, for the inner and outer component to be drawn together axially whereby the outer component 84 is drawn down towards the upper surface of the container lip 82A and the moveable parts 83 drawn tightly upwards beneath the lip 82A of the container. The surfaces 83A, 85A are thus inclined in the circumferential direction in the manner of a screw thread to effect a tight securement of the closure to the container as the inner and outer components rotated relative to each other in a tightening or closing direction about axis A. As the outer component is rotated relative to the inner component, the outer component is drawn down so as to compress the flexible sealing portion of the inner component against the upper surface of the container lip and the moveable members 83 are pressed upwardly into secure engagement with the container beneath the container lip.

In the embodiment shown, the ring 83B projects beneath the skirt 84A of the outer component so is visible from the exterior (as shown in Fig 8 and 9). However, in other embodiments, the ring may be concealed by the skirt, at least when in a secured position corresponding to that shown in Fig 9.

An important feature of the collar portion of the inner component is that the upper ends of the moveable components that are free to flex radially inwards and outwards, this movement taking place

about a pivot at or towards the lower end of the collar (in contrast to a collar which is located the other way up i.e. with the moveable parts extending downwards from a ring portion).

The other principal part of the inner component is the flexible sealing portion 86. In the embodiment shown, this is in the form of a cap with an upper end 86A extending across the upper end of the container 82 and an upper surface of the lip and a skirt portion extending down the outside of the bottle neck to the ring 83B of the collar.

The flexible portion 86 performs several functions. First, it acts as a sealing component in that it is sandwiched between the outer component 84 and the upper surface of the lip 82A of the container so as to provide a gasket seal therebetween. In the arrangement shown, it also extends across the mouth of the container and so closes the container opening. In addition the flexible portion lies between the substantially rigid moveable parts 83 and the outer surfaces of the bottle neck and acts as a high friction component between these surfaces.

As indicated, the collar portion and the sealing portion are preferably integrally formed. This can be achieved, for example, by a two-shot moulding technique in which the different materials are consecutively injected so they are integrally bonded or connected to each other. This also has the significant advantage that the closure comprises just two parts: the inner component and the outer component. In known cap-on-collar closures, it is usually necessary for the sealing component to be provided separately or secured in some manner to the underside of the outer component.

The outer component 84 will now be described in more detail with reference to Figures 12A and B and Figures 13A and B.

In the embodiment shown, the outer component is in the form of a cap with an upper portion 84C which extends over the upper surface of the lip 82A and extends across the opening of the container 82 and has a skirt portion 84A depending therefrom.

The skirt portion 84A is provided with inwardly extending projections 85 at or toward the lower end thereof. As described above, the upper surface 85A of each projection 85 is preferably inclined circumferentially so it acts as a screw thread and tilts radially inwards to an increasing extent along its circumferential length so as to match the inclination of the lower surface 83A of the moveable part 83 that it engages. This thread path may extend over two or three adjacent parts 83.

The closure is designed so that only a relatively small twist is required to move it from an unsecured (Fig 8) position to a secured (Fig 9) position. In the embodiment shown, a twist of only approximately 60 degrees is required. Accordingly, the inward projection 85 comprises six sections around the inner circumference of the skirt portion 84A as shown in Figures 12B and 12B.

As indicated above, the outer component engages downwardly facing surfaces of the radially moveable parts so as to secure and/or tighten the inner and outer components together in the axial direction. This is an important feature as it enables both the inner and outer components to be relatively short in the axial direction so they can be formed to resemble a conventional cap-like closure. This also means that the threaded engagement between the inner and outer components comprises circumferentially spaced apart features (the surfaces 83A of the respective parts 83). This enables the threaded engagement therebetween to require only a relatively small rotation or twist (rather than several complete rotations as required by a continuous helical thread form). Furthermore, this provides a very compact and robust construction. The upwardly facing surfaces 85A of the outer component apply an upward force which is directly transmitted via surfaces 83A through parts 83 which have a rigid, strut-like form to the underside of the lip 82A.

This high friction engagement can also be provided in other ways. The collar component may be provided with a lining of high friction material (irrespective of whether this is connected to a sealing component that passes over the upper surface of the container lip) or the inner surface of the collar component could be provided with a roughened finish which is sufficient to increase the frictional engagement with the container to the required level. In another alternative, a high friction sleeve, eg of rubber, could be fitted around the container neck.

In addition, the flexible sealing component extends over the upper surface of the lip 82A and so provides a sealing member between the closure and the container. The provision of a single component that acts both as a collar for fitting around the exterior of the container and as a sealing component between the closure and the container, is a significant feature of this closure.

As described, when the outer component is moved with respect to the inner component so as to press the moveable parts 83 inwards, this movement is primarily axial. In other embodiments, this axial movement may be provided by means of a small twisting movement although it is the axial component that moves the cams downwards so as to press the parts 83 inwards. The twisting movement is preferably less than 360 degrees and more preferably less than 90 degrees or less than 60 degrees. This is in contrast to arrangements in which a small axial movement is a consequence of several complete rotations of the outer component relative to the inner component, eg as provided by a continuous helical threadpath.

In further embodiments (not shown) of the closure shown in Figs 8-13, in particular closures for widemouth containers, the inner and/or outer component may comprise a bore feature which projects through the mouth of the container into the interior thereof. The bore feature preferably comprise a relatively rigid component, eg formed of PET or metal, and may be integrally formed with the outer component or secured thereto. In a particularly advantageous arrangement, the outer component is

able to rotate about the axis A relative to the bore feature. The outer component can thus be rotated, eg to fasten or release the closure whilst the bore feature moves axially within the bore without rotating therein.

The bore feature may also be provided with an o-ring seal which engages and seals with the interior of the container (or an upper surface of the container lip). The bore feature and o-ring may be as described above. The o-ring may be in the form of a toroid of an elastomer located in a groove or gland on the outer surface of a bore feature. The o-ring may also be part of a resilient member moulded to fit the underside of the bore feature. The resilient sealing portion described above in relation to Figs 8 - 13 may include such a member. Thus, if the outer member shown in Figure 9 projects into the bore of the container (rather than being flat) and the resilient sealing portion follows the underside of this feature (again, rather than being flat) the resilient component may be formed with a portion which simulates the function of an o-ring to provide a seal with the interior of the container.

In such embodiments employing an o-ring seal, the seal provided by the sandwiching of the flexible part of the inner component between the outer component and the upper surface of the container lip may no longer be required. In this case, the outer component need not engage and/or compress the flexible sealing component against the upper surface of the lip.

These further embodiments thus provide a closure for a container having a circular opening defining an axis and a lip around said opening, the closure comprising: an inner component having a collar portion for locating about the exterior of the container beneath the lip of the container and a sealing portion which, in use, extends from said collar portion over an upper surface of said lip; and an outer component for fitting over the inner component and interacting therewith for releasably securing the collar portion thereof under said lip, the closure having an o-ring seal for providing a seal between the closure and an upper or interior surface of the container.

The o-ring may be provided on a bore feature which, in use, projects through the opening into the interior of the container, the bore feature being part of the inner and/or the outer component.

In a preferred arrangement, the collar portion may be relatively rigid and the sealing portion relatively flexible and the collar portion and the sealing portion may be integrally formed with each other, eg by a two-stage moulding process.

Preferably, the outer component has a skirt part for locating about the collar portion of the inner component, the collar portion comprising a plurality of spaced apart radially moveable parts around its

circumference pivotally joined at their lower ends by a structure extending around the entire circumference of the collar portion.

The provision of an o-ring seal between the bore member and the internal surface of the container body has a number of advantages:

- It has relatively stable geometry when subject to pressure-induced lifting of the closure (compared to that of a seal provided on the upper surface of the container lip)
- The degree of o-ring compression that is required is reduced (compared to a seal on the upper surface of the container lip) and the direction of the compression does not increase the frictional engagement of the thread so the torque required to compress the seal is reduced
- Increased pressure within the container presses the o-ring seal more tightly into the gap between the closure and the cap so improving seal quality at higher pressures
- Positive internal pressure also assists in releasing the seal by applying an upward force against the underside of the closure so helping overcome the frictional engagement between the o-ring and the container wall.
- The sealing surface are spaced from the container lip and thus less susceptible to damage, eg during handling of the container.
- The bore member allows the head space within the container to be significantly reduced.
- The o-ring (in an appropriately shaped gland) is able to provide a seal irrespective of whether the internal pressure is higher or lower than the external pressure so can be used both for carbonated beverages and for vacuum packs. Other forms of seal tend to be designed cater for one or the other application.

Using a bore feature which is formed separately from the cap also provides the additional advantages:

- Further reducing the torque required as the bore feature (and hence the seal carried thereby) does not have to rotate with the cap

- Allows the bore feature to be formed of a different material, eg a metal to reduce its gas permeability to almost zero
- Makes it easier to separate the different components of the closure for ease of recycling

As described, the o-ring is preferably a separate component, typically having a circular cross-section (although other cross-sectional shapes are possible) located within a recess extending around the circumference of a bore member. However, in other embodiments, the seal member may have other forms which simulate the sealing action of an o-ring and may be integrally formed with a bore member, for example by using an over-moulded elastomer to form a virtual o-ring element.

An o-ring typically needs to be compressed by 10-30% to provide an effective seal, whereas a compression gasket can require a much higher degree of compression.

If the o-ring is located within a groove 4A as shown in Figure 8, it is preferably able to move axially within this groove in response to increases or decreases in pressure within the container body. This enables the o-ring to respond to the increase in pressure and adopt a shape/position which is better able to withstand the pressure.

In each of the embodiments described, an o-ring is used to provide a seal between a closure and a container. The o-ring preferably seals against an internal surface of the container but, in some embodiments, may seal against an upper surface thereof (particular at the point where this meets the internal surface). The sealing surface extends around either the internal or the upper surface of the container.

The o-ring is located in a groove which has at least one side wall, the arrangement being such that, when the closure is installed on the container, when subject to a pressure differential, the o-ring is moved and/or deformed so as to seal a gap between side wall and the container, the width of said gap being smaller than the cross-sectional width of the o-ring.

The closure may take a wide variety of forms including a cap-on-collar and other two-part arrangements such as those described as well as a one piece closure. Preferably, the closure is arranged to be installed and/or released from the container by rotation around the axis passing through the container opening.

An additional advantage of having a bore member which extends into the interior of the container is that this occupies space at the upper end of the container that in a beverage container would usually

otherwise be occupied by a gas or provide a 'headspace', above the beverage. Reduction of the volume of this headspace, if it is occupied by air, reduces the amount of oxygen trapped within the container so increasing the shelf-life of the beverage or, if it is filled with an inert gas, reduces the quantity of inert gas required.

In some cases, the cap or outer component may comprise an annular component that has an upper portion that overlies the upper surface of the container lip so that it can provide a downward force on the lip, or on a seal member located between the lip and the cap, and a skirt portion which interacts with a collar or inner component (as described above) whereby the cap is secured to the container body.

The thread form used between the cap and the collar or inner and outer components (for a two-part closure) or between the cap and the container (for a one-piece closure) is preferably a multi-start thread form such that less than 360 degrees of rotation is required to install or remove the closure. With an eight-start threadform, the closure needs to be rotated by only about 45 degrees to install or release the closure.

Intermittent threadforms and bayonet style threadforms such as those described in WO2006/000774 and WO2007/091068 may be used. In the case of a bayonet threadform, the cap or outer component need not be moved axially as the outer component is rotatably secured to the inner component. Similar threadforms may also be used with a one-piece closure (with the thread form provided on the container neck rather than on a collar).

For the avoidance of doubt, the verb "comprise" as used herein has its normal dictionary meaning, ie to denote non-exclusive inclusion. The use of the word "comprise" (or any of its derivatives) does not therefore exclude the possibility of further features being included.

All of the features disclosed in this specification (including the accompanying claims, and drawings) may be combined in any combination (other than combinations where at least some of the features are mutually exclusive).

Each feature disclosed in this specification (including the accompanying claims and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is just an example of a generic series of equivalent or similar features.

The invention is also not restricted to the details of the embodiments described herein or to the specific combinations of features of the embodiments described. In particular, the invention includes arrangements as described in the claims with the addition of any one or more features described or claimed herein including generalisations of which those feature(s) are illustrative.

CLAIMS

1. A closure for a container having a substantially circular opening defining an axis, the closure being securable to the container so as to close said opening, the closure having an o-ring sealing member mounted or mountable thereon so as to provide a seal with a sealing surface of the container, when the closure is secured to the container, said sealing surface extending around an upper surface or an internal surface of the container.
2. A closure as claimed in claim 1 in which the o-ring sealing member is a torus of resilient material located in a groove provided in the closure.
3. A closure as claimed in claim 2 in which the groove comprises two or three faces which, together with said sealing surface of the container when the closure is secured to the container, define an enclosure for constraining the cross-section of the torus.
4. A closure as claimed in claim 1, 2 or 3 in which said sealing surface of the container is parallel to or inclined to said axis.
5. A closure as claimed in any preceding claim having a bore member which, when the closure is secured to the container, extends through said opening into the interior of the container.
6. A closure as claimed in claim 5 in which the o-ring sealing member is provided in or on an outer surface of the bore member.
7. A closure as claimed in claim 5 in which the o-ring sealing member is part of a moulding of resilient material provided in or on the outer surface of the bore member.
8. A closure as claimed in claim 6 or 7 in which the o-ring sealing member is located in a groove provided in the outer surface of the bore member, said groove comprising at least two faces for constraining the cross-section of the sealing member.
9. A closure as claimed in any preceding claim in which the closure comprises a cap having an upper portion and a skirt portion depending from said upper portion.
10. A closure as claimed in claim 9 in which said upper portion is circular and, when the closure is secured to the container, extends across the opening of the container.

11. A closure as claimed in claim 9 or 10 in which the bore member is integrally formed with the cap.
12. A closure as claimed in claim 9 or 10 in which the bore member is a separate component mounted within the cap.
13. A closure as claimed in claim 12 in which the bore member is rotatable about said axis relative to the cap.
14. A closure as claimed in any preceding claim in which said sealing surface is a substantially parallel sided cylindrical surface on the interior of the container.
15. A closure as claimed in any of claim 1-13 in which said sealing surface, is a conical surface with its widest end towards said opening.
16. A closure as claimed in claim 1 in which said sealing surface is a radially inner portion of an upper surface of the container which abuts the internal surface of the container.
17. A closure as claimed in any preceding claim in which the closure is securable to the container by rotation about said axis.
18. A closure as claimed in claim 17 having a thread form by which the closure is securable to a threadform on the container.
19. A closure as claimed in claim 18 in which said threadform is a multi-start thread form which requires rotation of less than 360 degrees between the cap and the container to fasten and/or remove the closure from the container.
20. A closure as claimed in any of claims 1 to 19 in which the closure comprises an inner component having a collar portion for locating about the exterior of the container and an outer component for fitting over and/or around the inner component and interacting therewith so as to releasably secure the inner component to the container.
21. A closure as claimed in claim 20 in which the outer component comprises a cap with an upper portion and a skirt portion depending therefrom and the inner component comprises a collar, the

collar being arranged to engage beneath an outwardly projecting lip of the container and to fit between the container and the cap so as to secure the cap to the container body.

22. A closure as claimed in claim 20 in which the inner component comprises a collar portion and a sealing portion which, in use, extends from said collar portion over an upper surface of the lip and the outer component is arranged to fit over the inner component so as to releasably secure the collar portion beneath an outwardly projecting lip of the container.

23. A closure as claimed in claim 22 in which the collar portion is relatively rigid and the sealing portion is relatively flexible.

24. A closure as claimed in claim 22 or 23 in which the collar portion and the sealing portion are integrally formed with each other.

25. A closure as claimed in any of claims 20 – 24 in which the outer component is axially and/or rotatably engageable with the inner component.

26. A closure as claimed in claim 25 in which said rotational engagement is provided by a multi-start thread form which requires rotation of less than 360 degrees between the outer component and the inner component to fasten and/or remove the closure from the container.

27. A closure as claimed in of claims 20 - 26 arranged so that when the outer component is rotated relative to the inner component in the tightening direction, the upper portion of the outer component is drawn down towards the lip of the container.

28. A closure as claimed in any of claims 20 - 27 in which the collar or collar portion comprises a ring portion, or other structure extending around the entire circumference of the collar portion, and a plurality of radially moveable portions spaced around the circumference of the ring portion.

29. A closure as claimed in claim 28 in which the radially moveable parts are joined at their lower ends to said ring portion or other structure.

30. A closure as claimed in claim 28 or 29 in which the outer component has a skirt portion with a plurality of cams spaced around its internal circumference for urging and/or holding said radially moveable portions in an inner position in which they are engaged beneath the lip of the container body.

31. A closure as claimed in any of claims 28- 30 in which the radially moveable portions are resiliently biased towards said inner position.

32. A closure as claimed in any of claims 28--31 in which the radially moveable portions are relatively rigid and are moveable radially by pivoting or flexing relative to the ring portion.

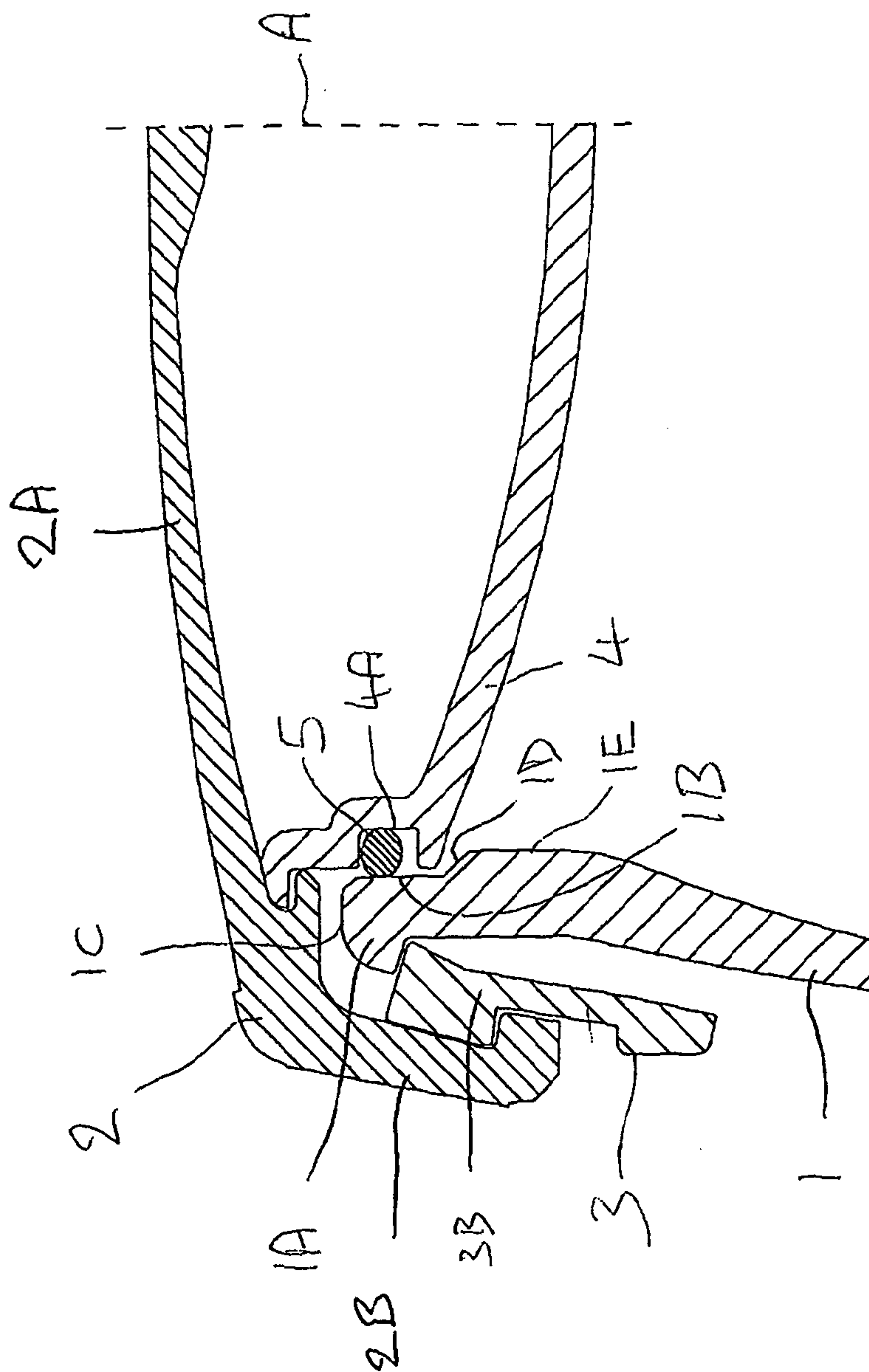
33. A closure as claimed in claim 5 and claim 20, and any claim dependent thereon, in which the o-ring is provided on a bore feature, the bore feature being part of the inner and/or the outer component.

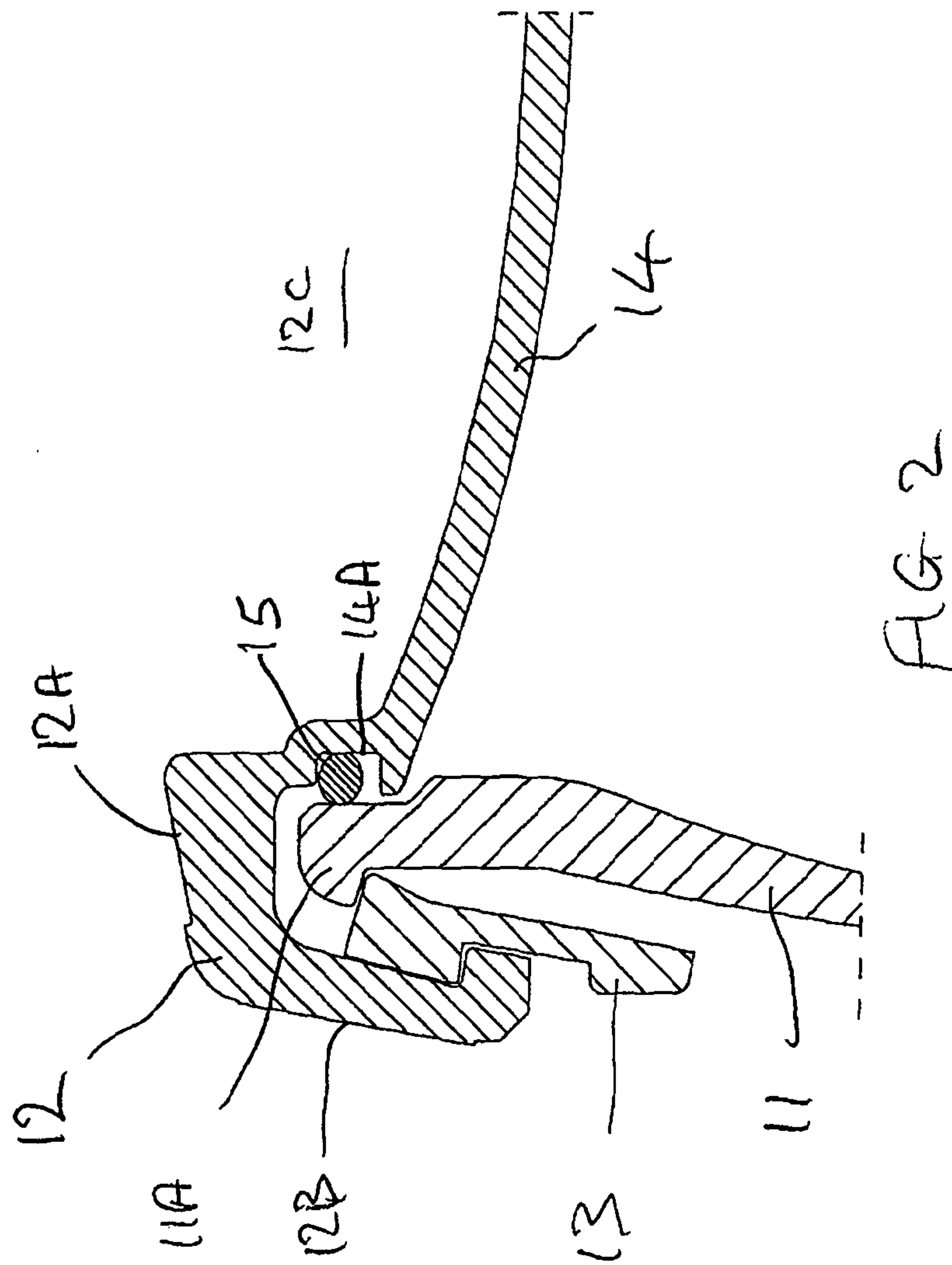
34. A closure as claimed in any preceding claim in combination with a container adapted to be closed by said closure.

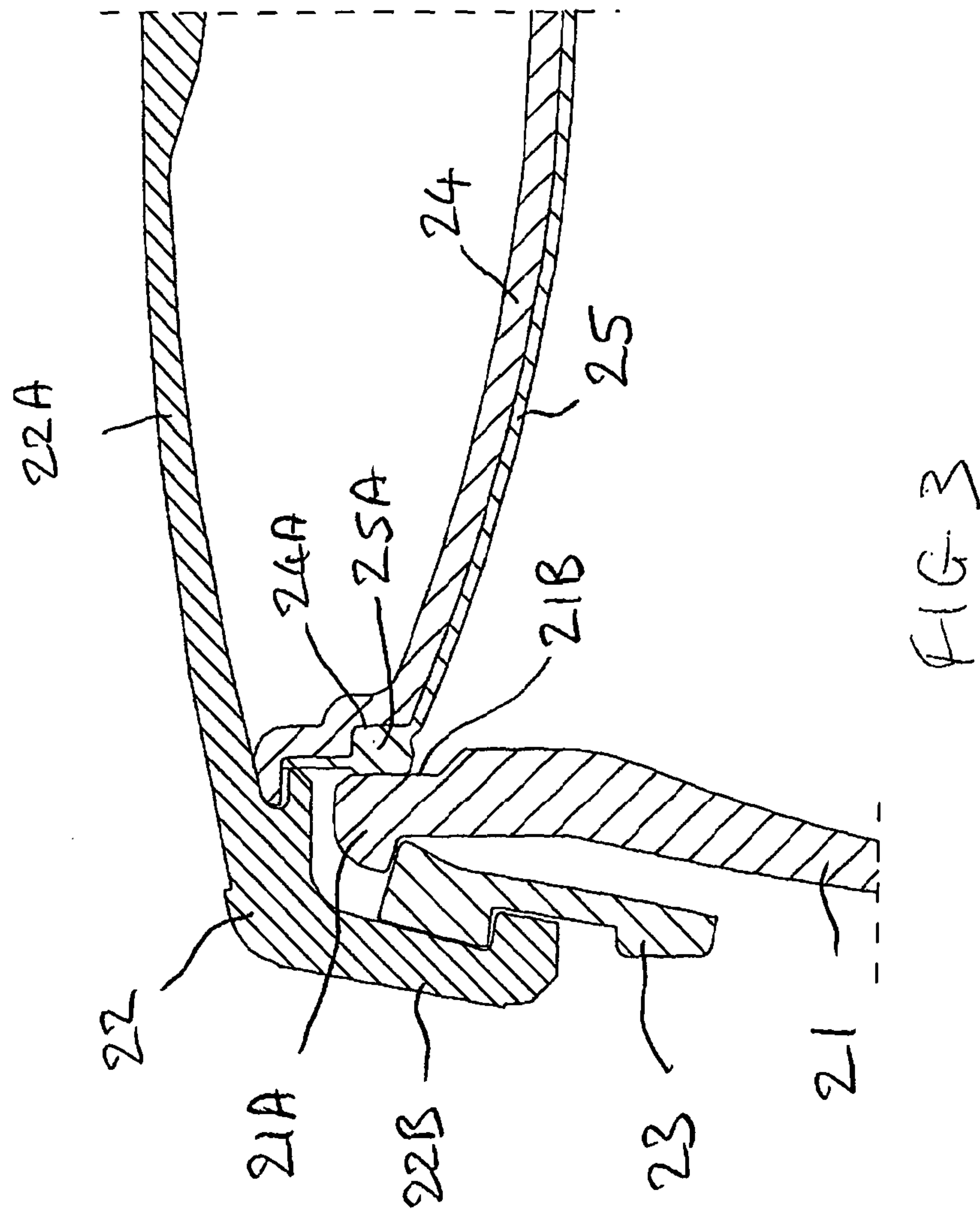
35. A closure as claimed in claim 34 in which the compression ratio of the o-ring (as herein defined) is in the range 5% to 35% and preferably in the range 20% to 25%.

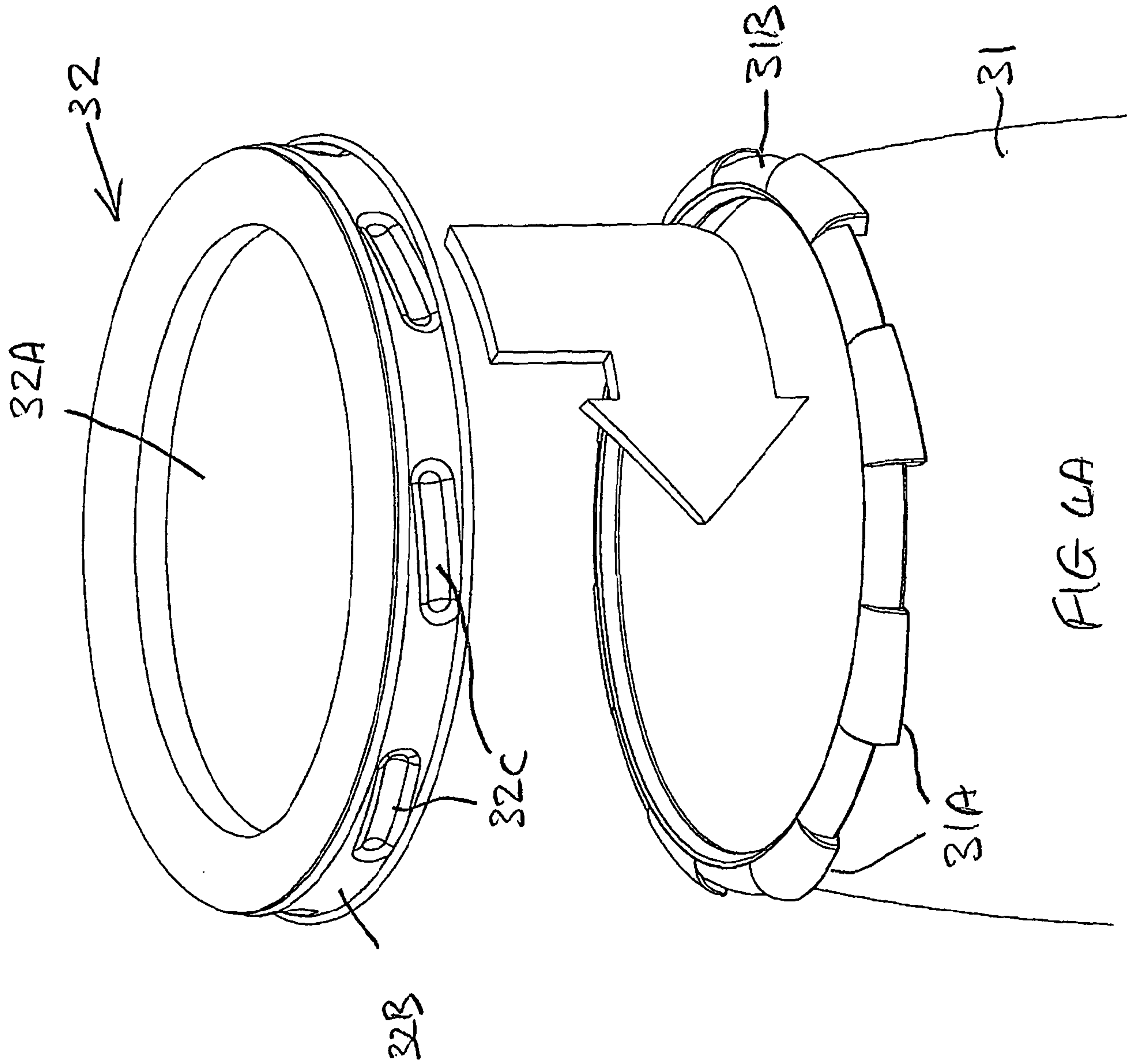
36. A closure as claimed in claim 34 or 35 in which the gland fill (as herein defined) is in the range 50% to 90% and preferably in the range 65% to 85%.

37. A closure as claimed in claim 34, 35 or 36 in which the depth of a groove in which the o-ring is located is at least 50% and preferably at least 60% of the width of the o-ring cross-section in the corresponding direction.









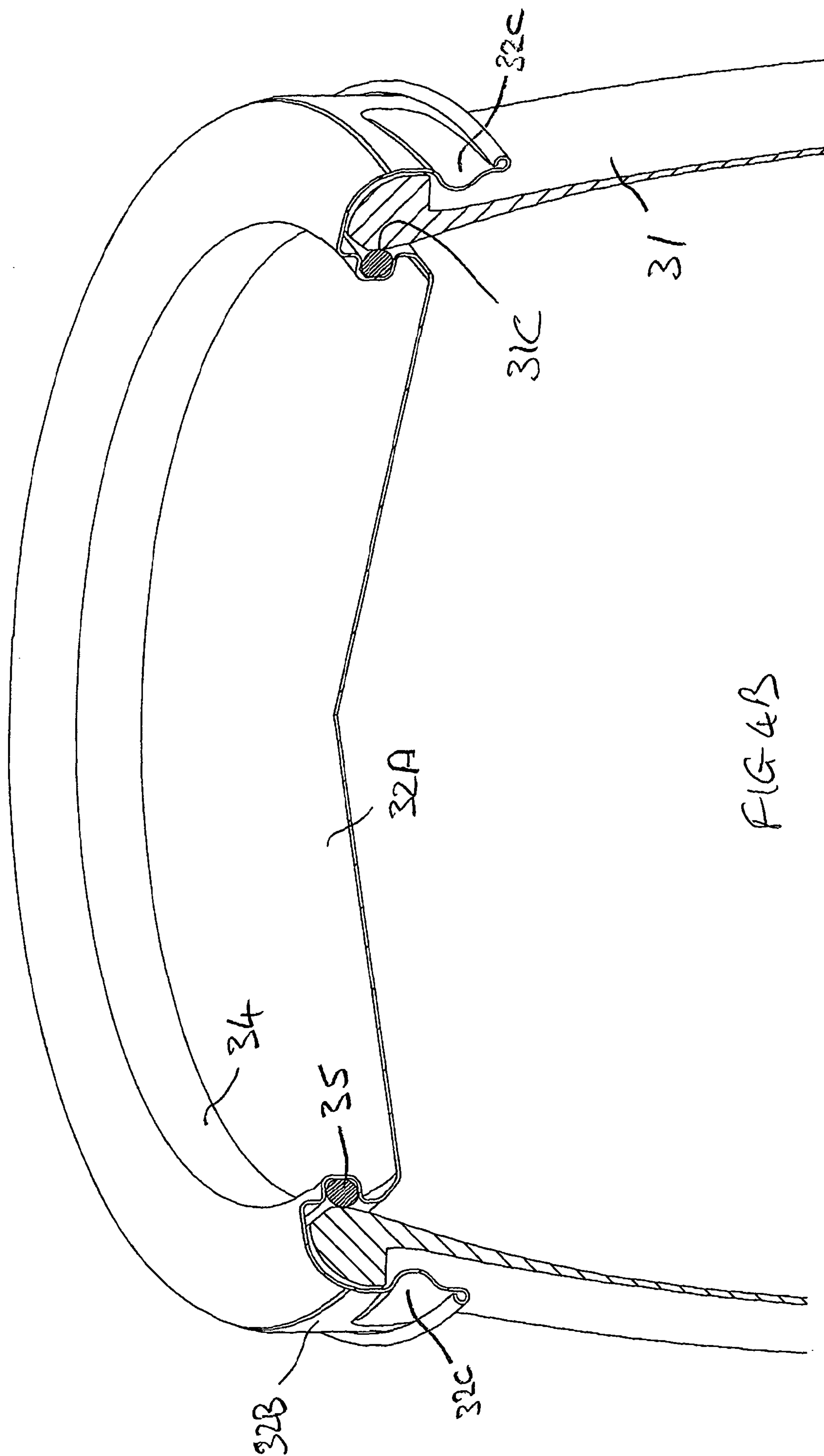
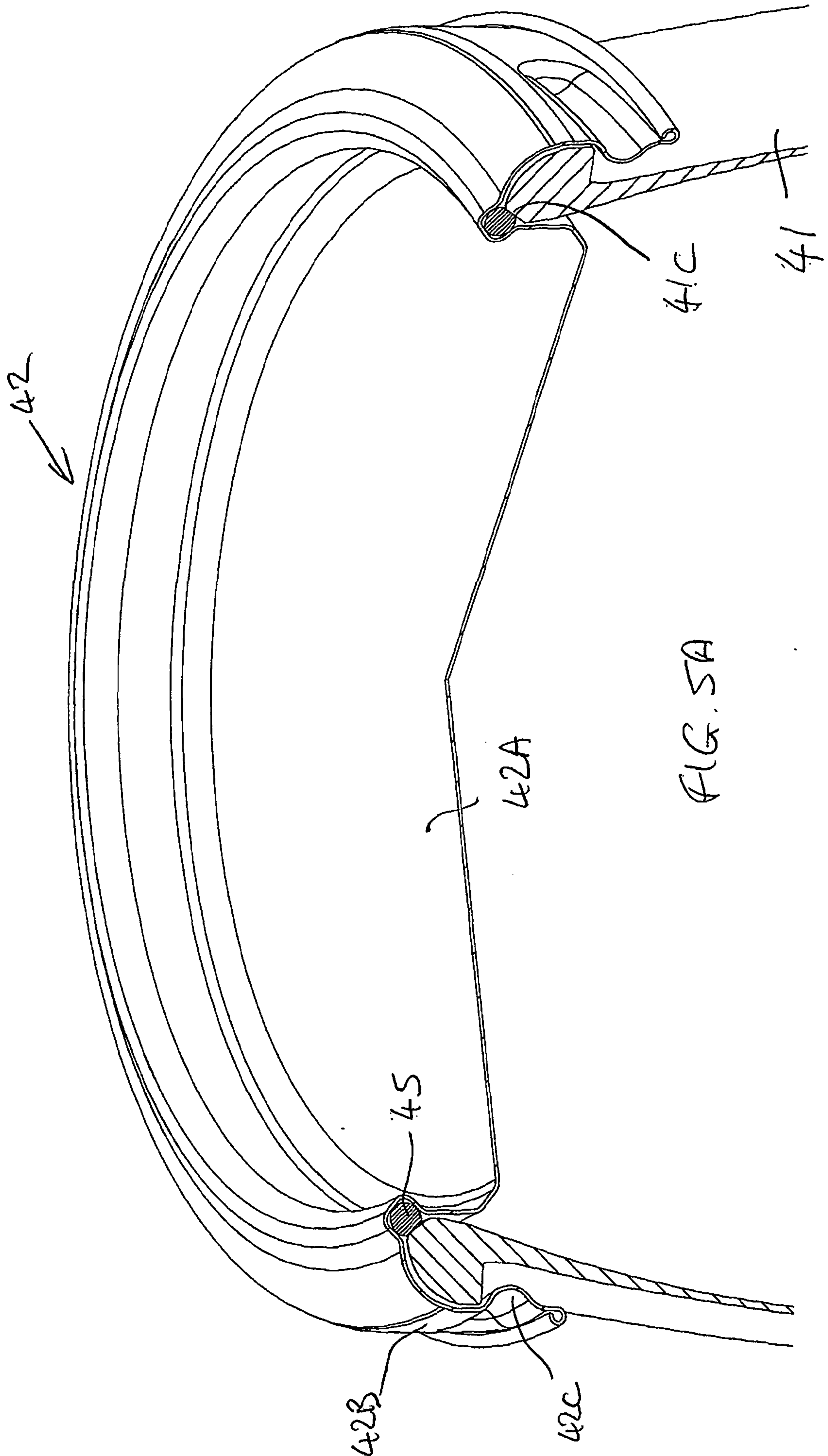


FIG 4B



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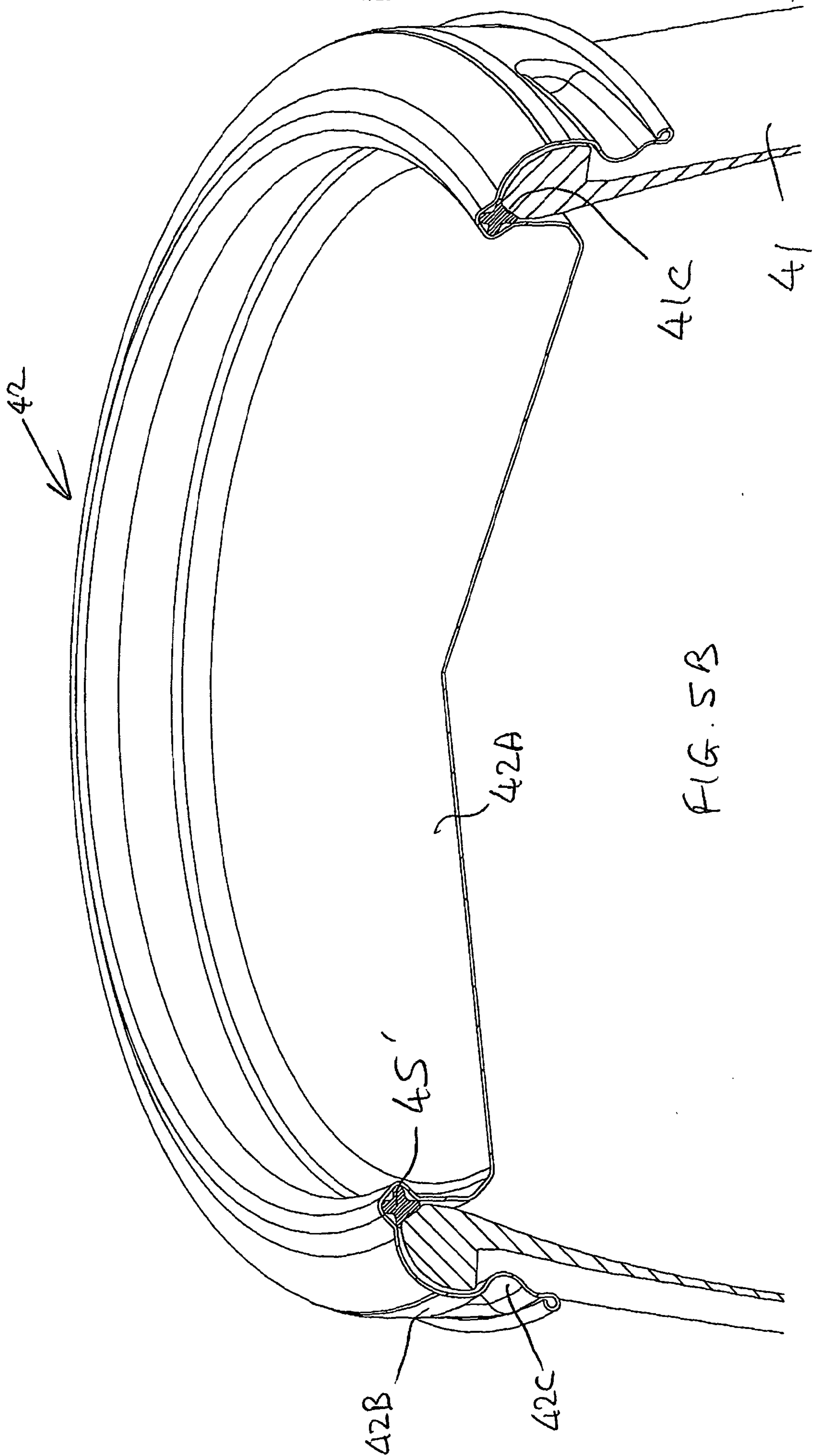
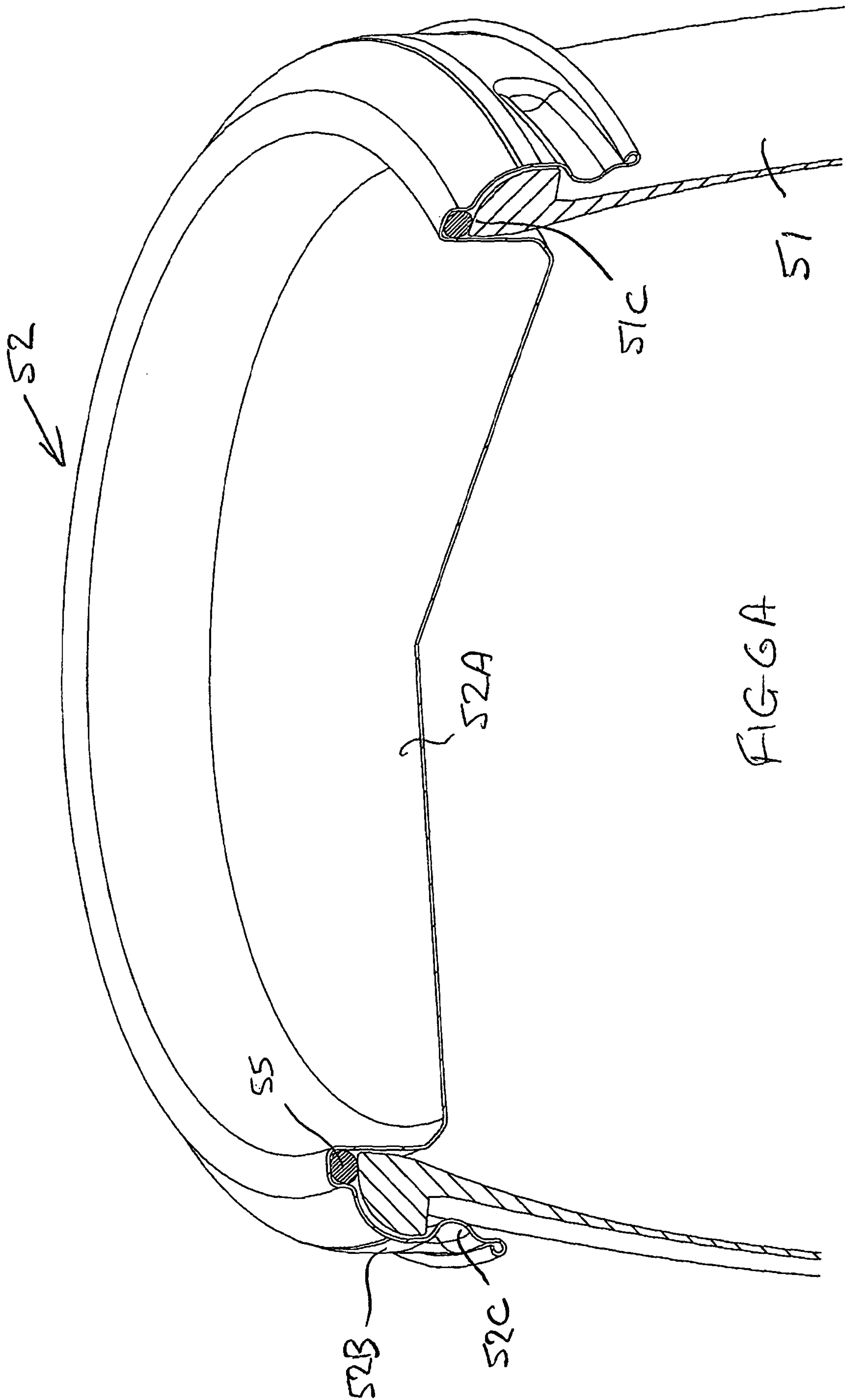
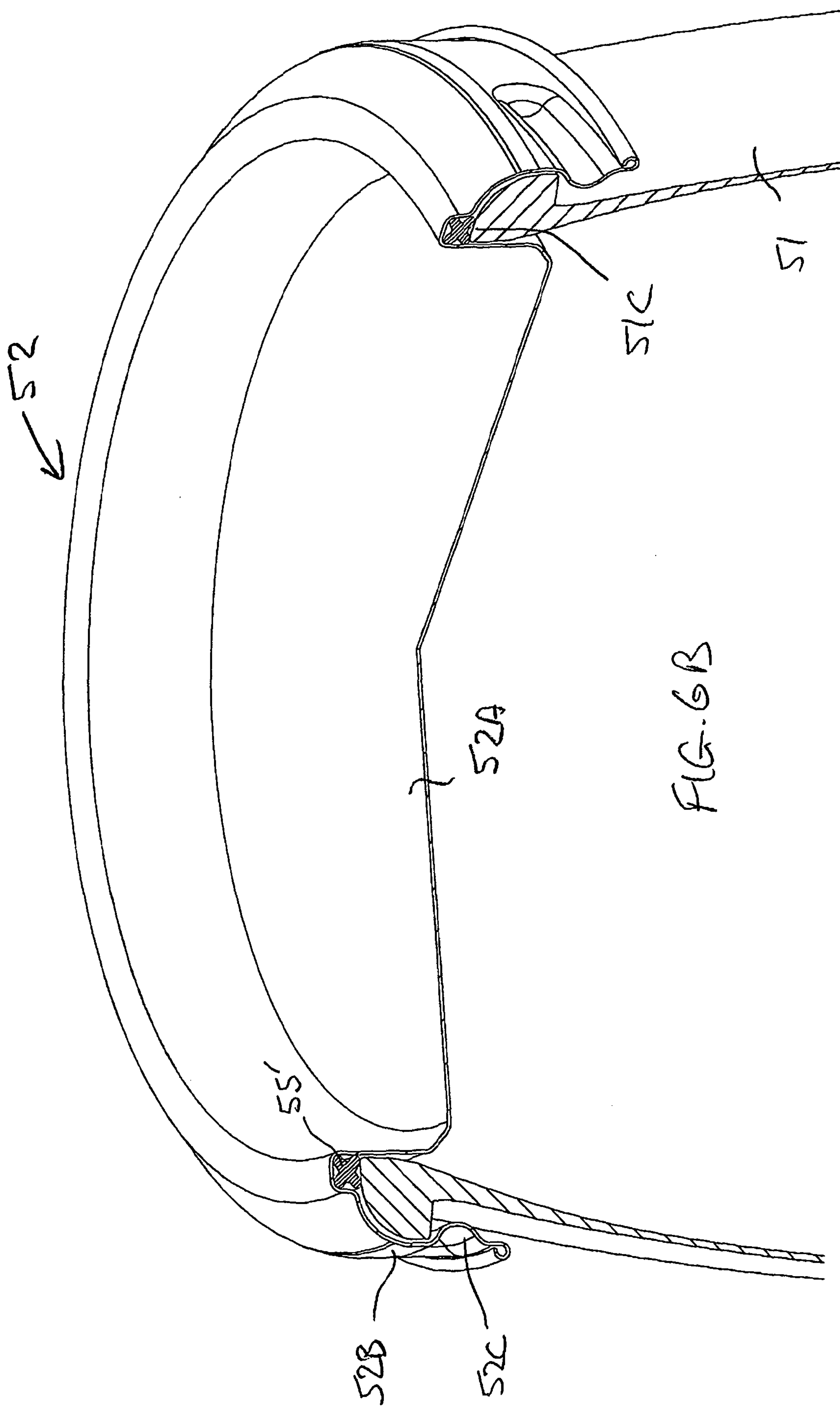
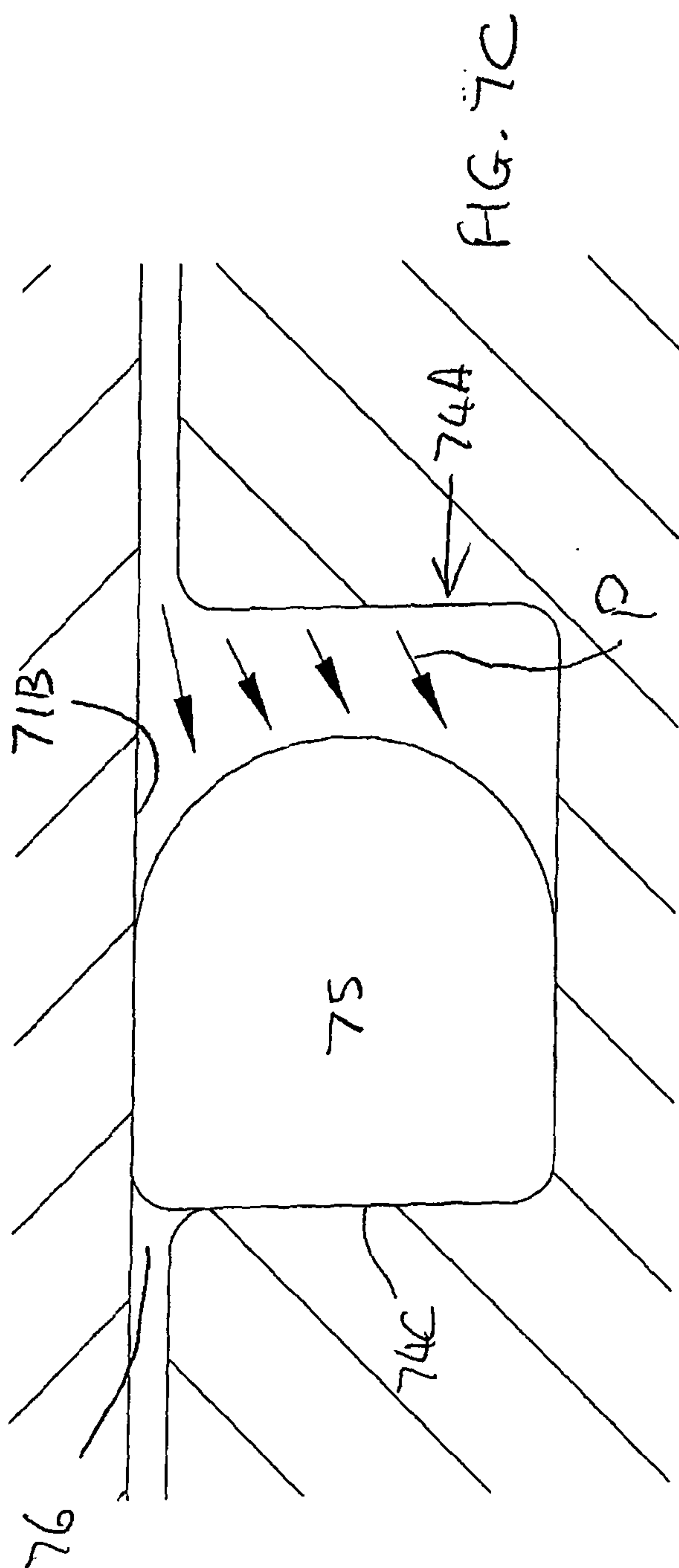
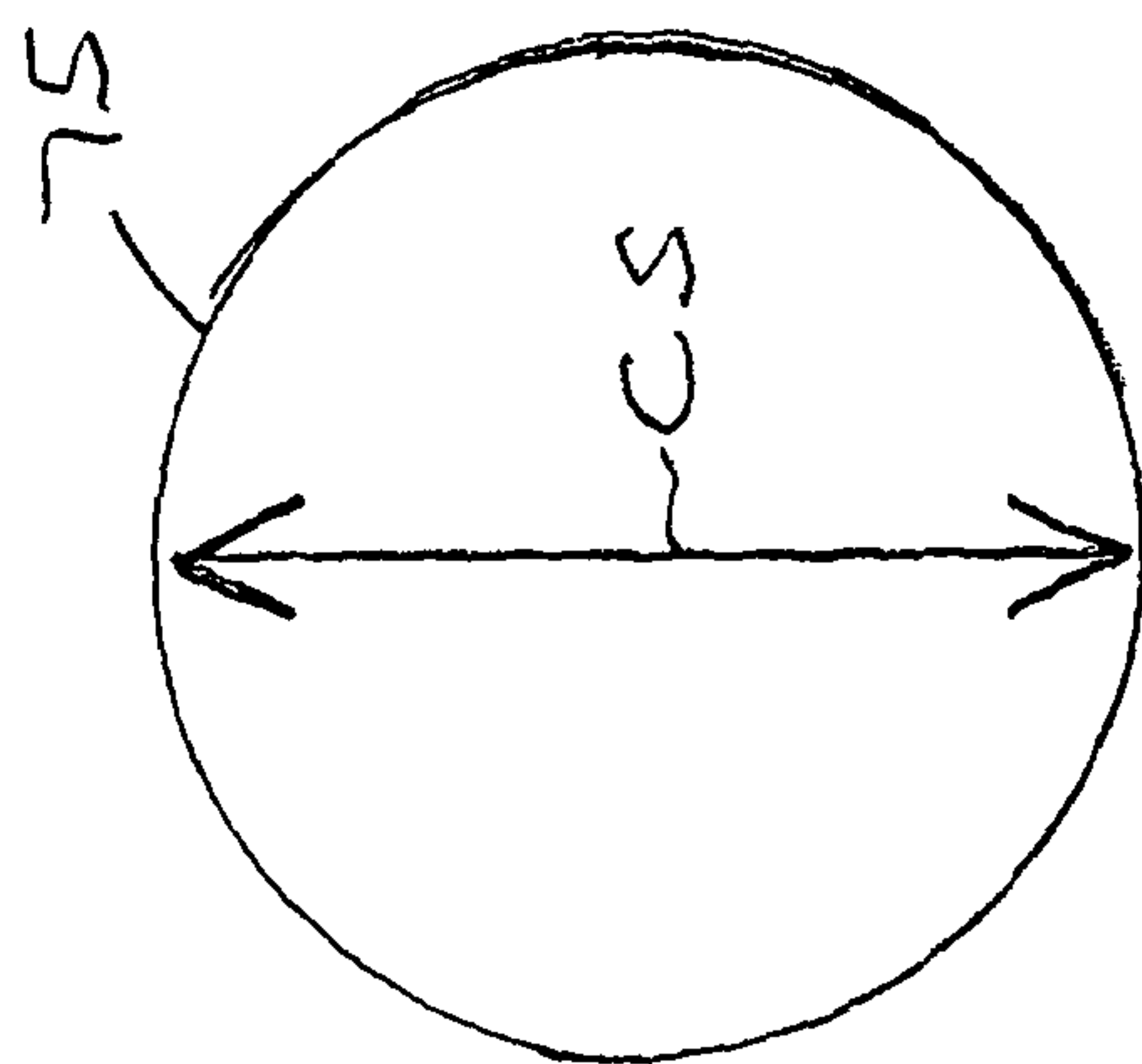
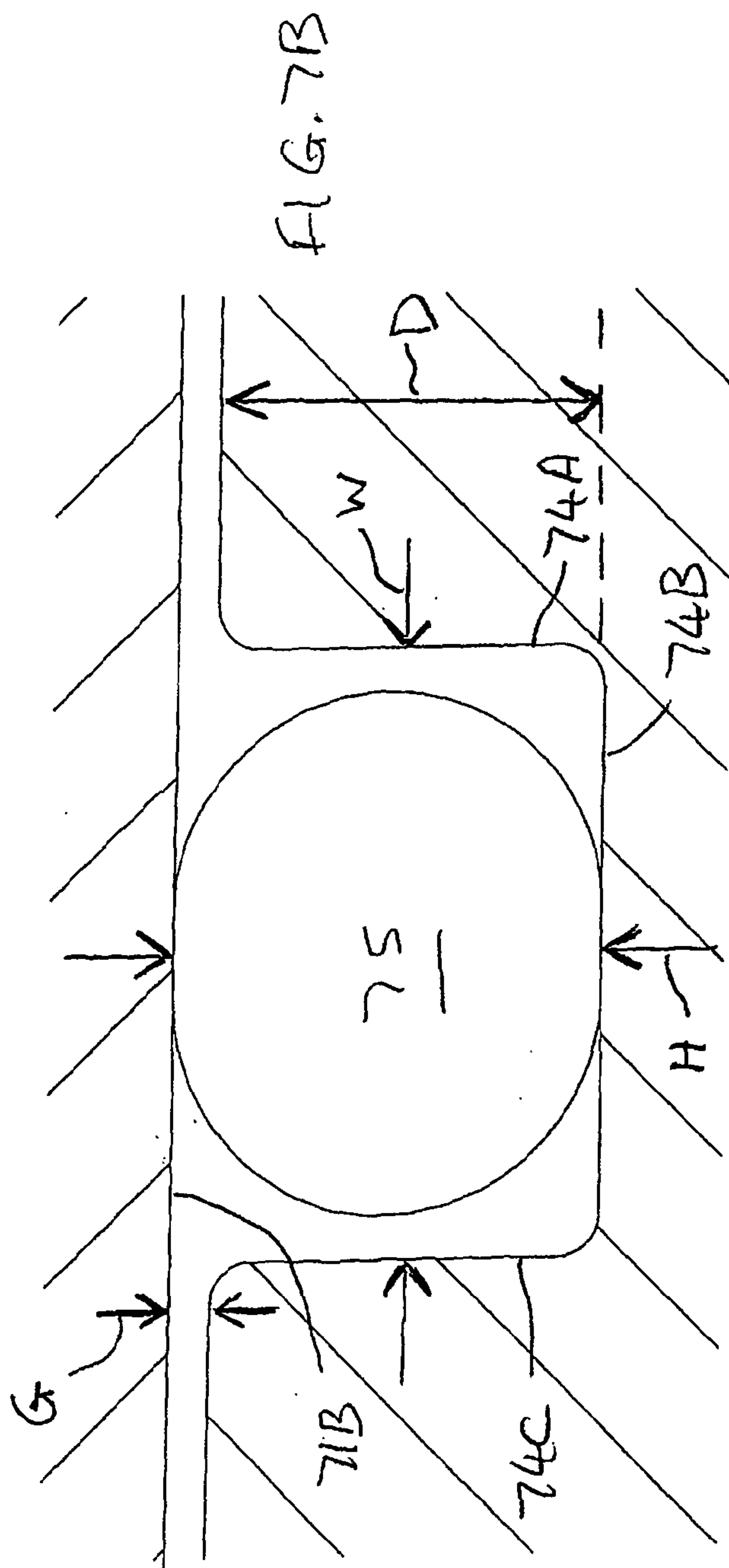


FIG. 5B







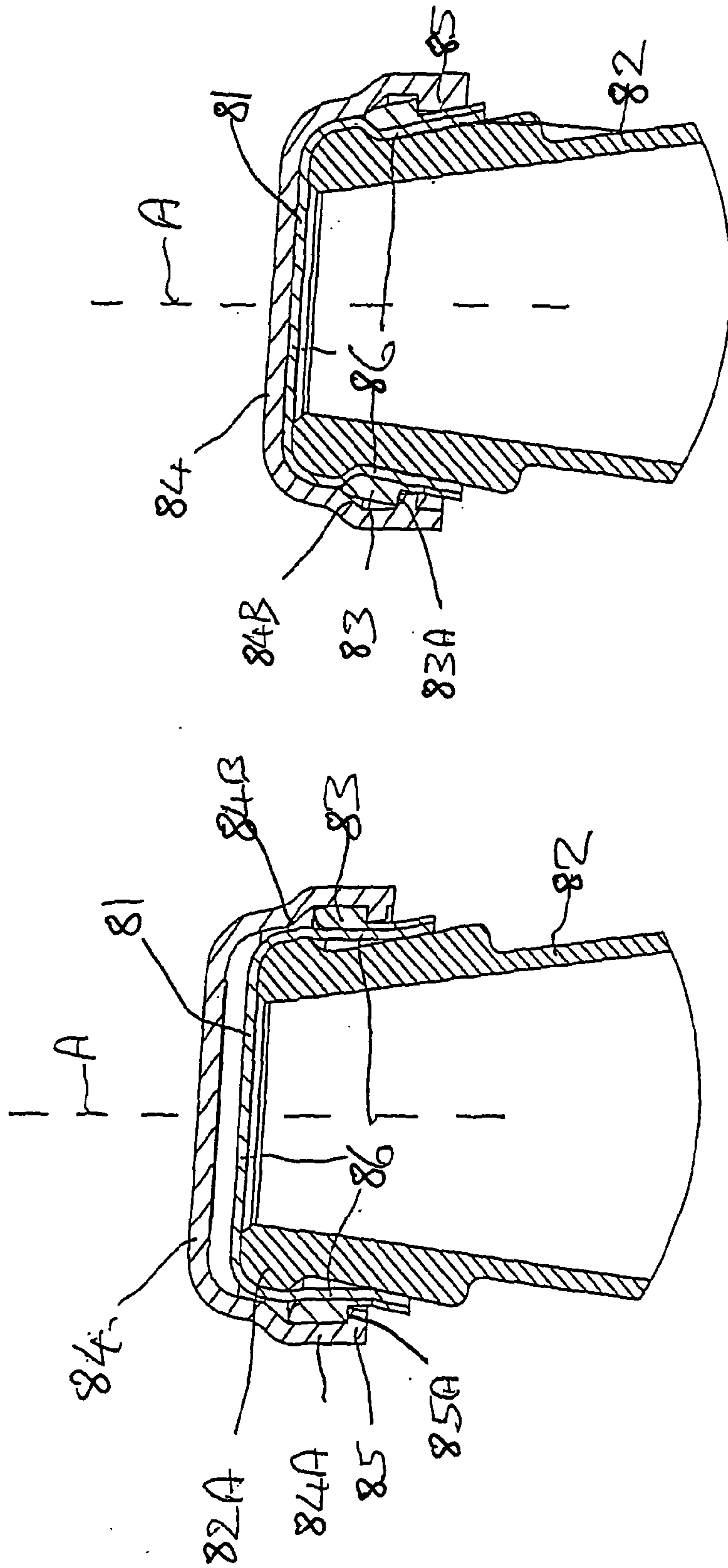
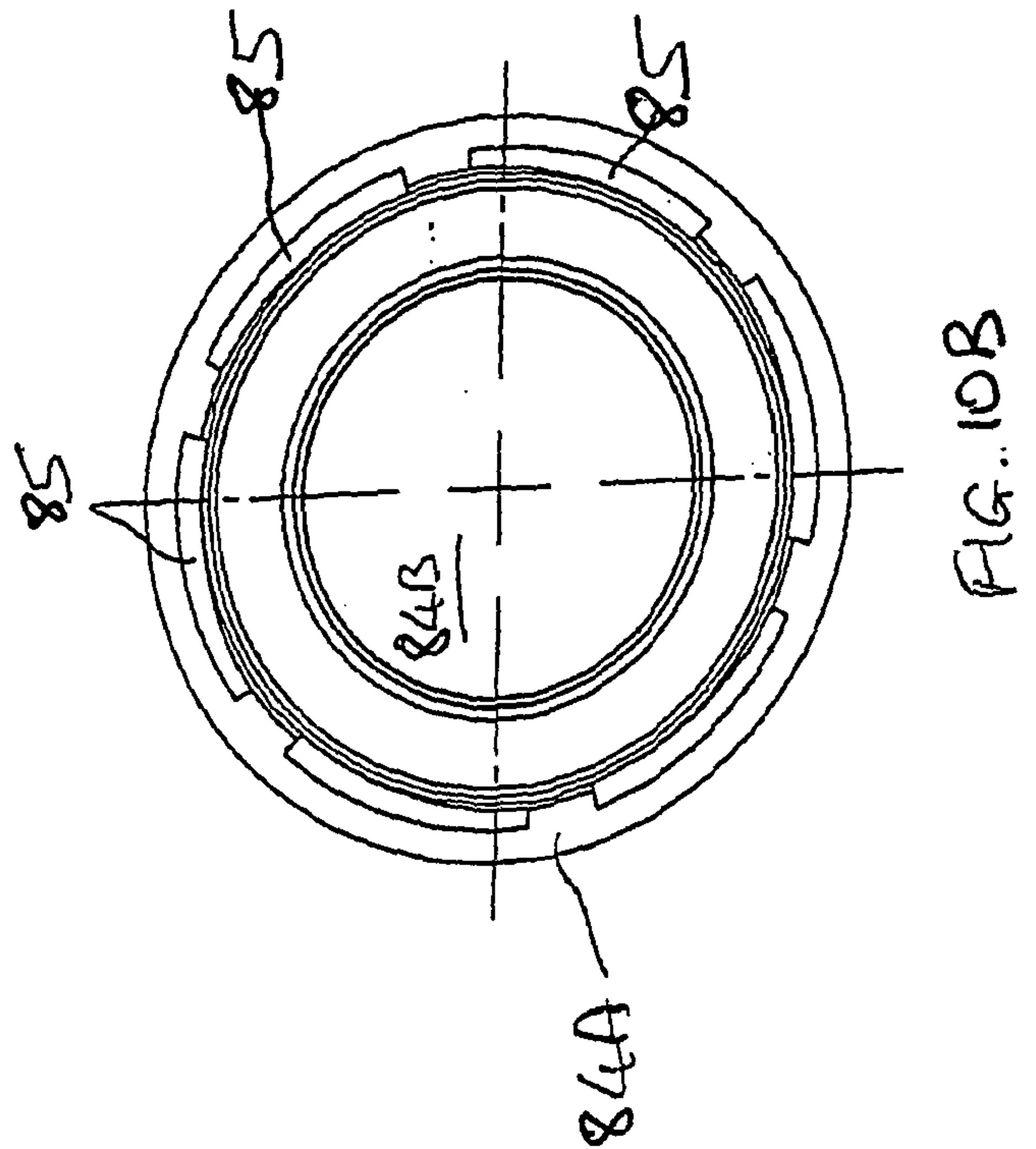
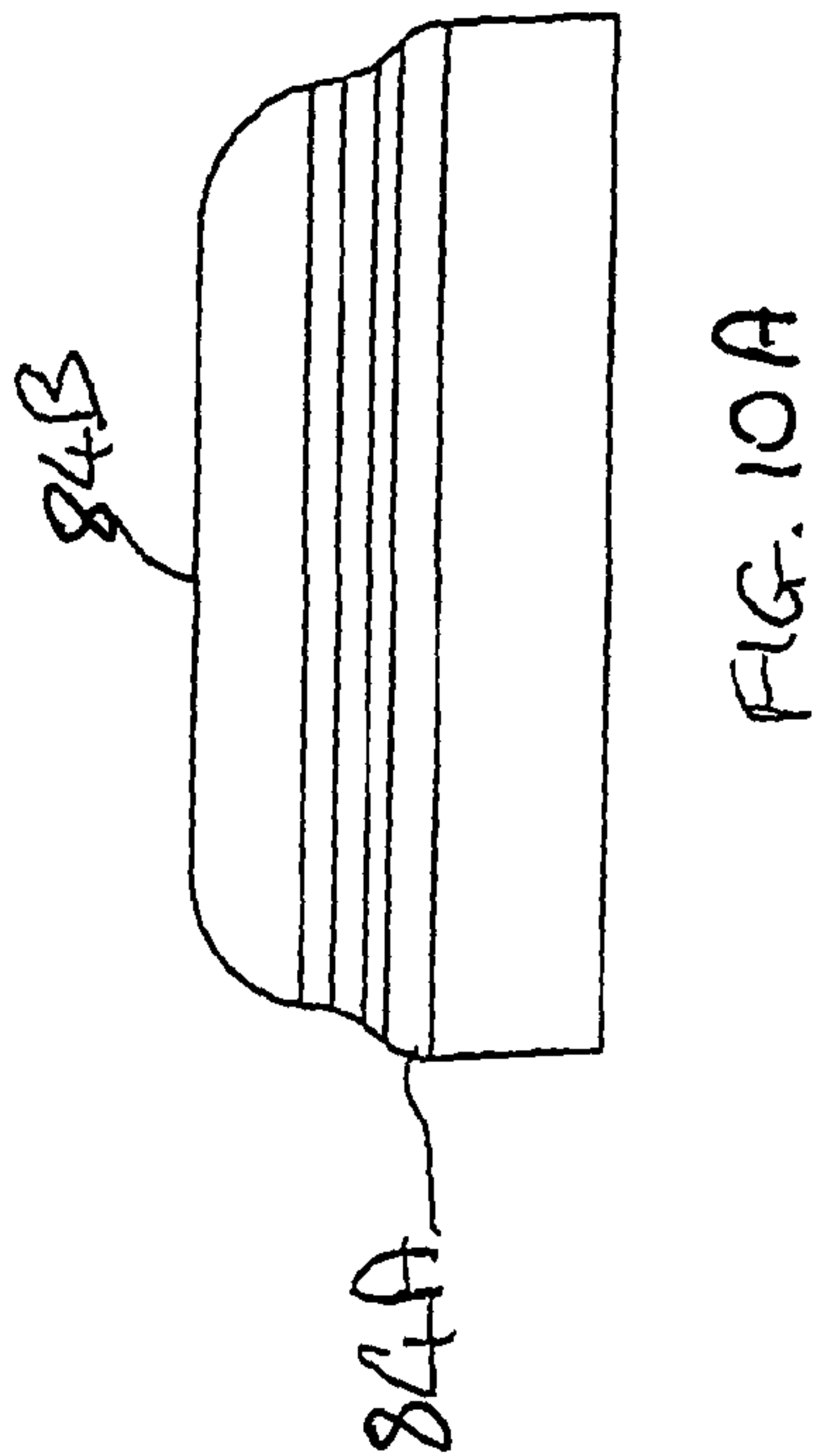
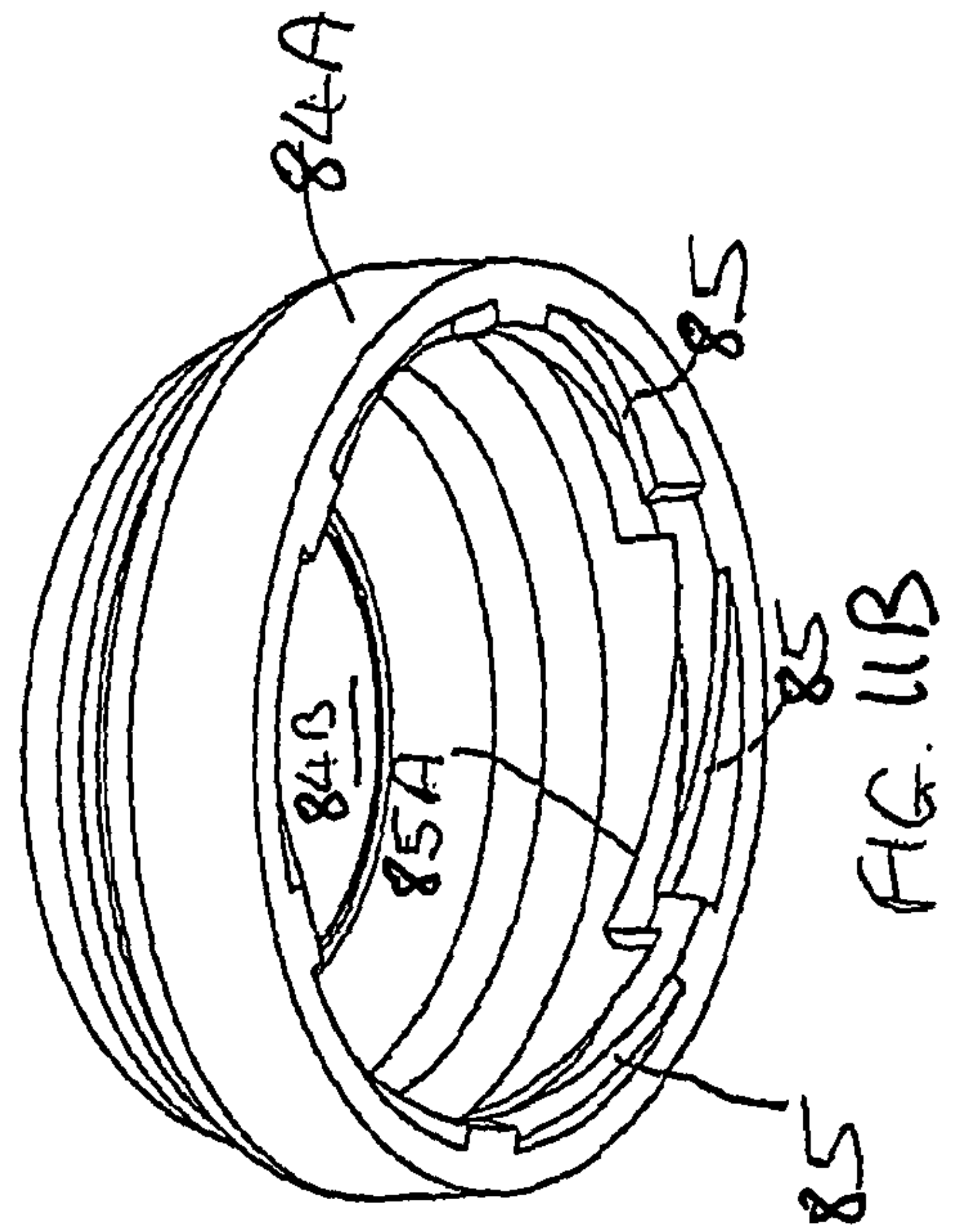
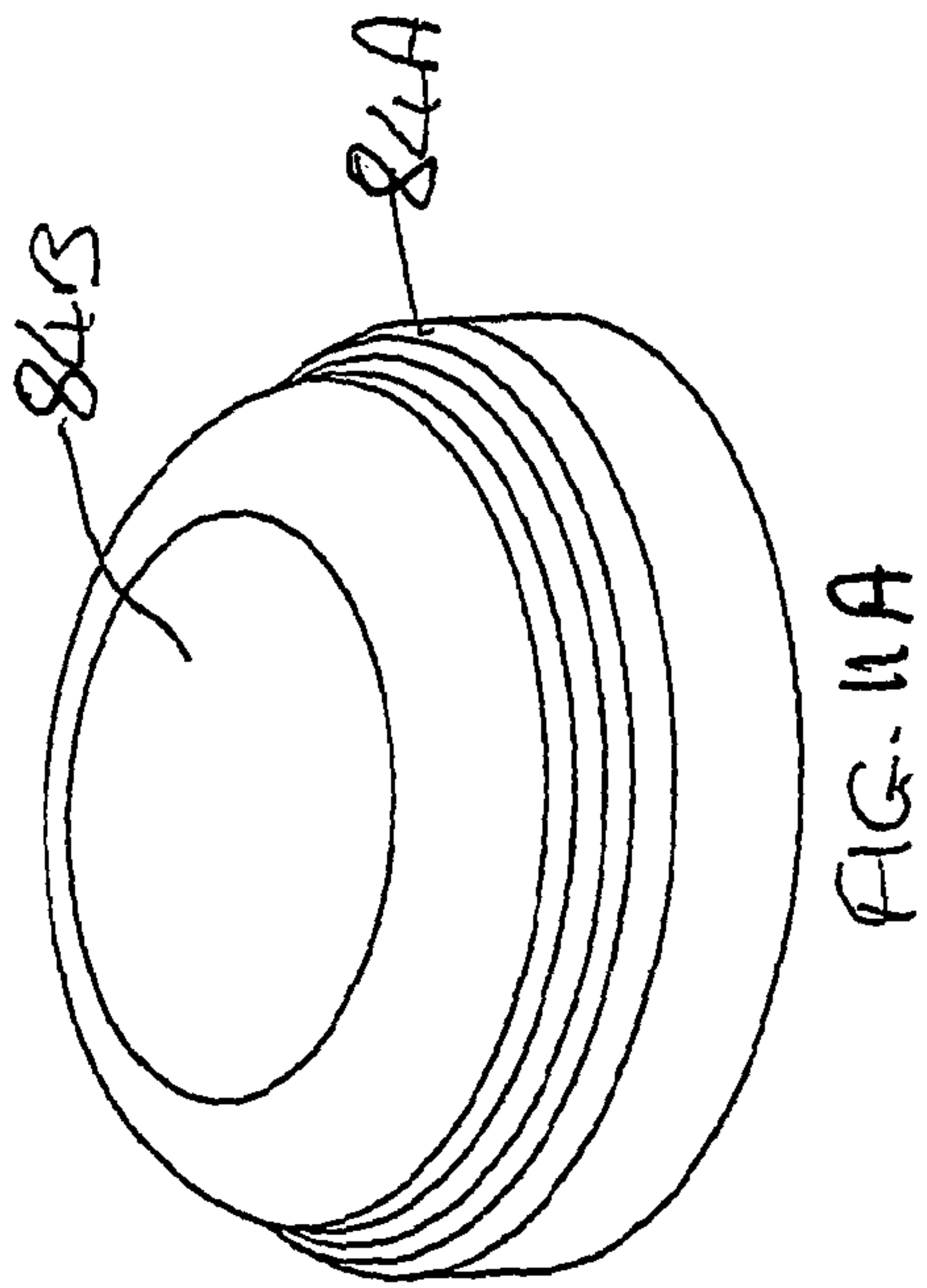
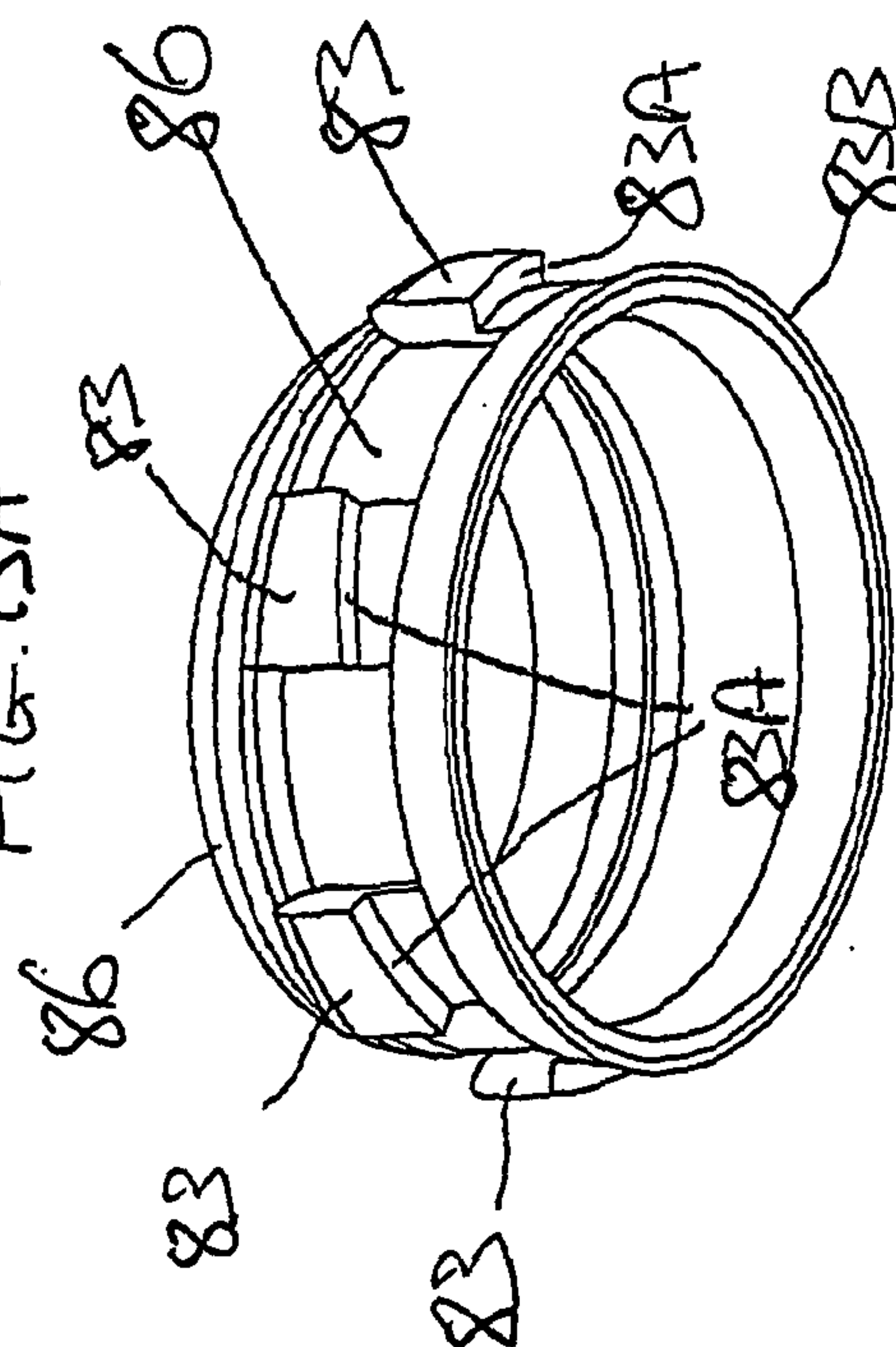
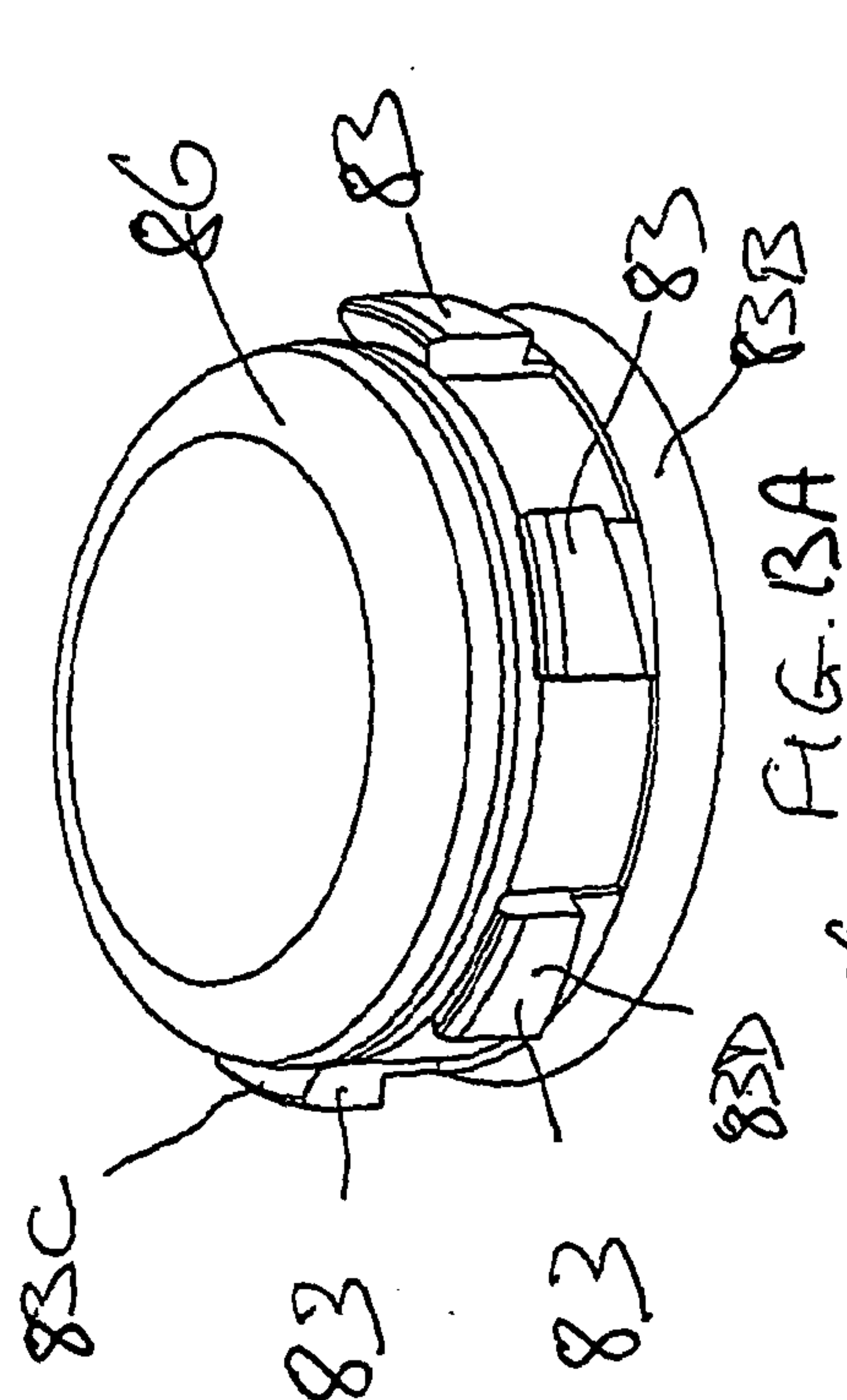
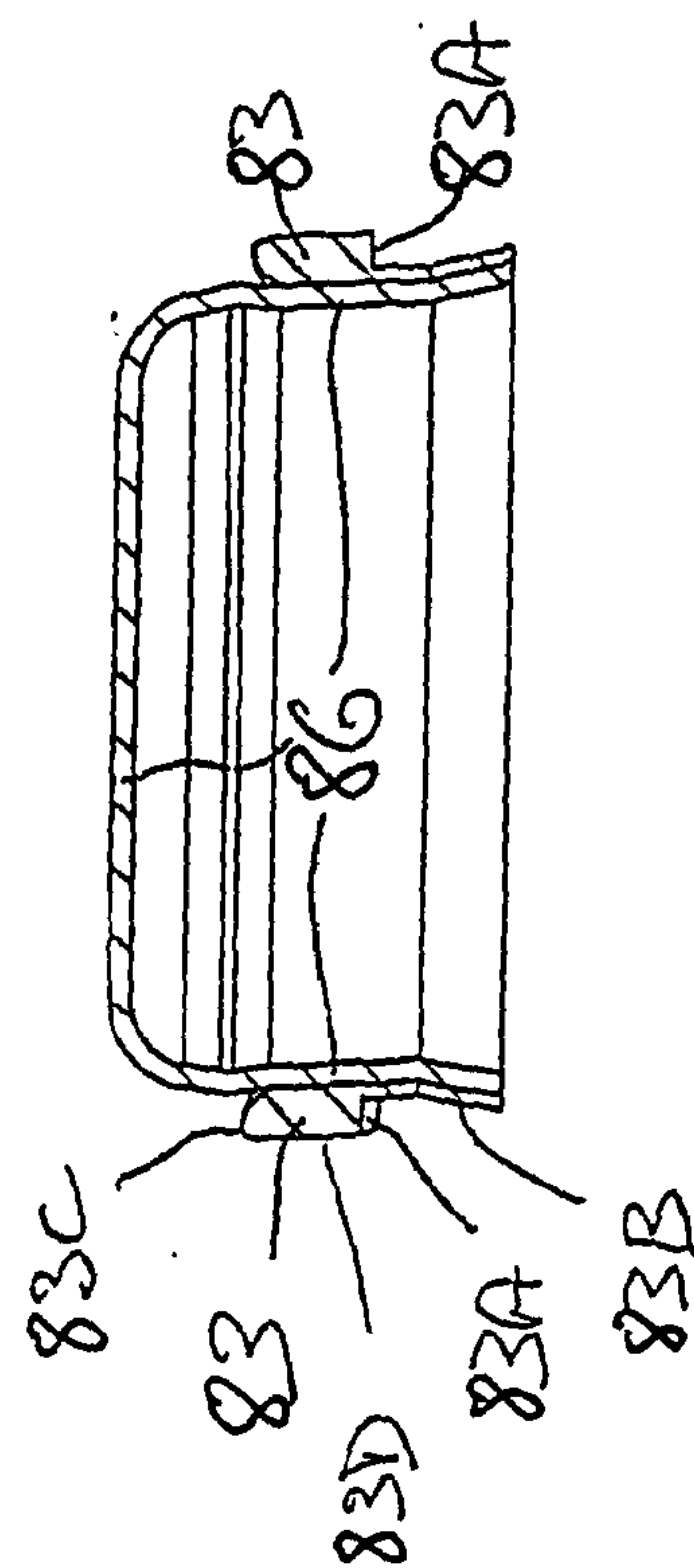
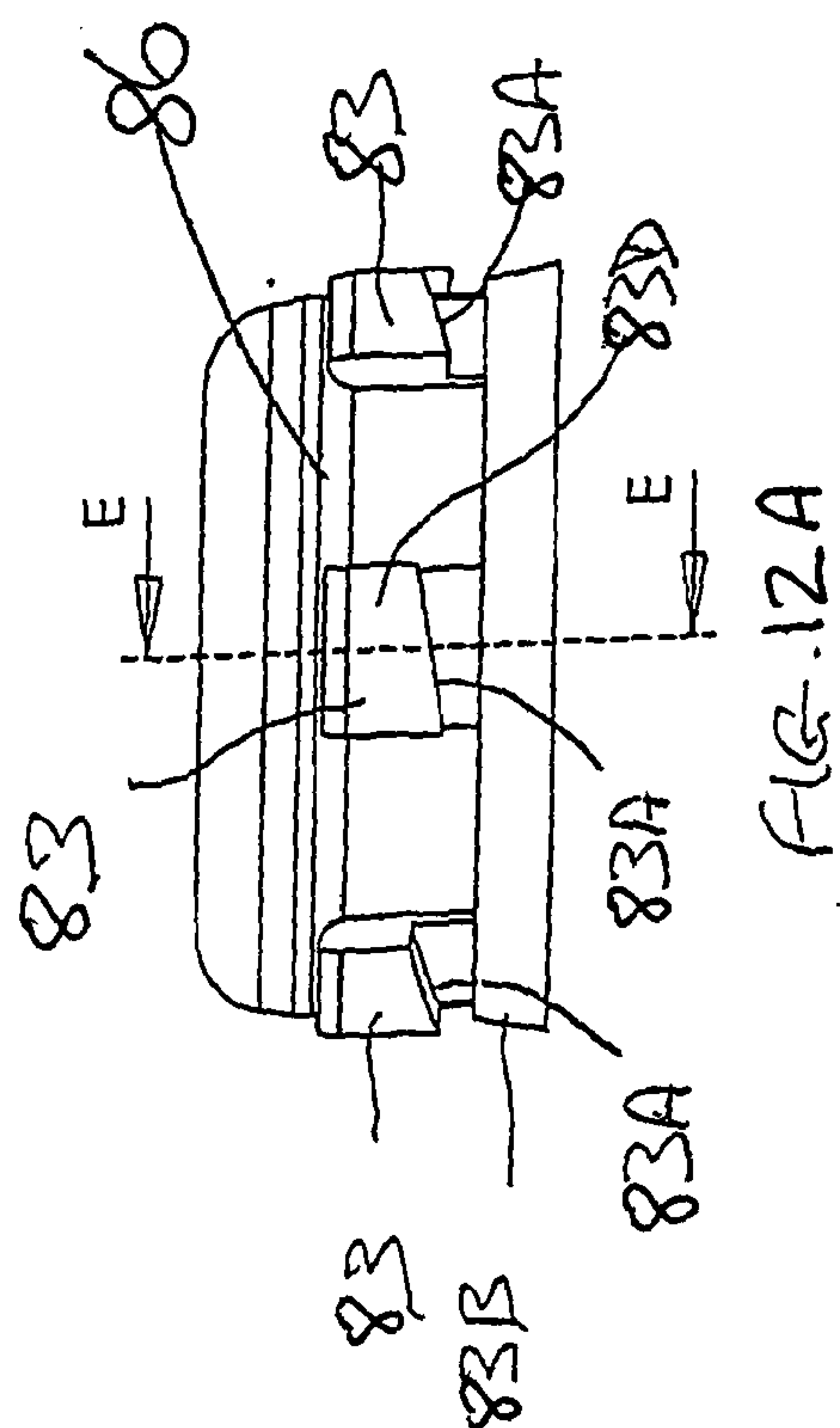


FIG. 8

FIG. 9





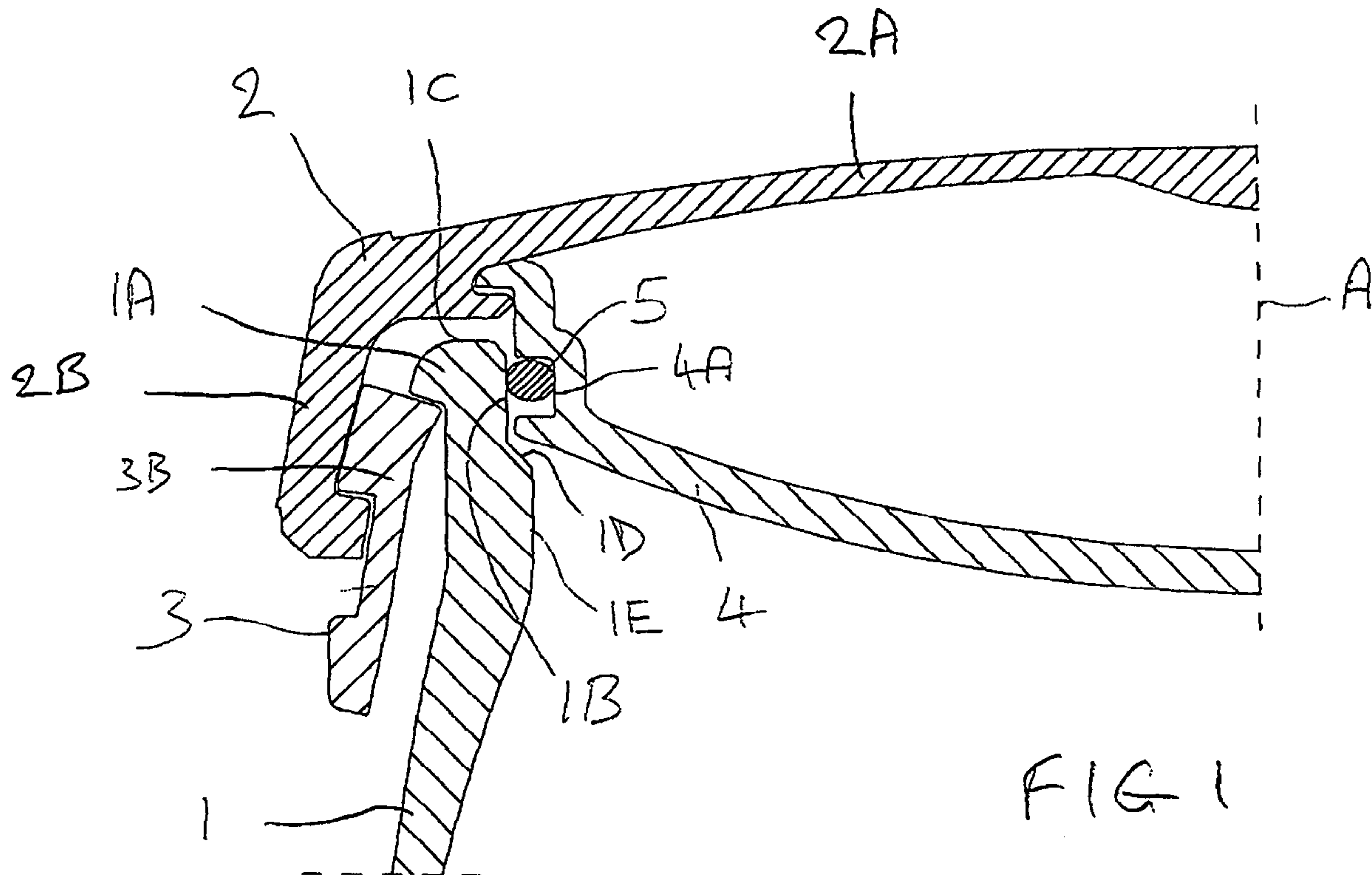


FIG 1