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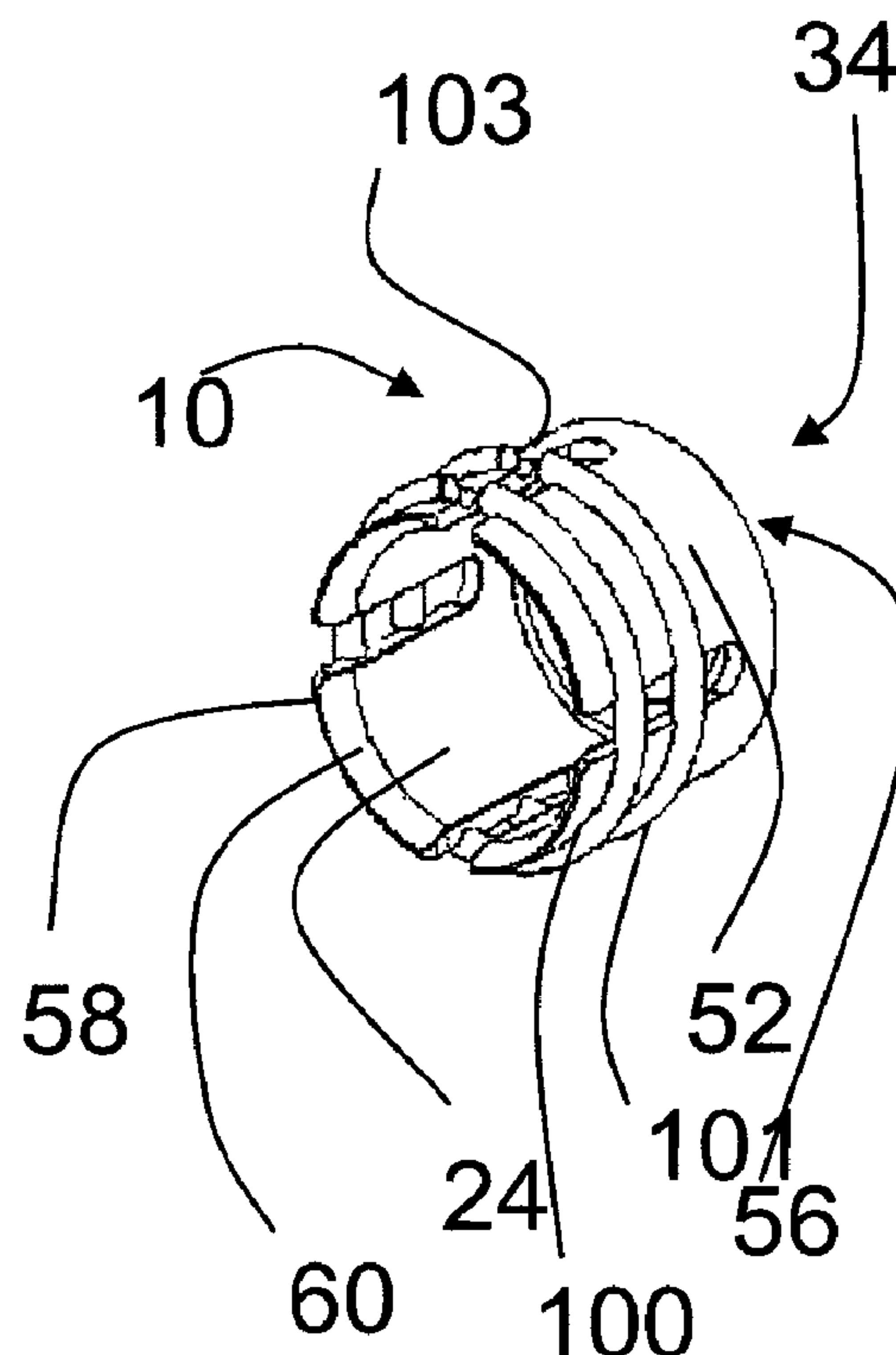
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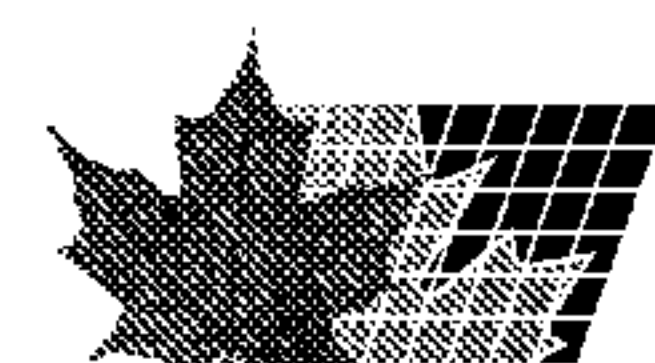
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(54) Title: VALVE SPRING DAMPER



(57) Abrégé/Abstract:

A damper is shown for damping the movements of a valve spring in an engine. The damper comprises a body that is adapted to fit over the bottom end of a valve spring or, in another embodiment, within the body of a valve spring. The damper body comprises a plurality of slots in the side wall of the body creating a plurality of wall sections. The slots can be angled at a predetermined angle away from the axis of the body. Where the damper is placed over the bottom end of the valve spring at least one spring steel ring is wrapped around the damper body and seated into a groove in the damper body side wall. The ring is available in a number of configurations having concavo-convex dimples or indentations that are adapted to create enhanced pressure points on the sidewall of the damper body and hence modify the frictional engagement between the outside wall of the valve spring and the inside surface of the damper sidewall.



ABSTRACT

A damper is shown for damping the movements of a valve spring in an engine.

The damper comprises a body that is adapted to fit over the bottom end of a valve spring

5 or, in another embodiment, within the body of a valve spring. The damper body

comprises a plurality of slots in the side wall of the body creating a plurality of wall

sections. The slots can be angled at a predetermined angle away from the axis of the

body. Where the damper is placed over the bottom end of the valve spring at least one

spring steel ring is wrapped around the damper body and seated into a groove in the

10 damper body side wall. The ring is available in a number of configurations having

concavo-convex dimples or indentations that are adapted to create enhanced pressure

points on the sidewall of the damper body and hence modify the frictional engagement

between the outside wall of the valve spring and the inside surface of the damper

sidewall.

VALVE SPRING DAMPER

BACKGROUND OF THE INVENTION

5 The present invention relates generally to the field of spring dampers
and more particularly to the damping of valve springs in engines.

 An engine's valve train system is made up of the valves, valve springs, the camshaft and
other components. The valve train system controls the amount of intake air and fuel combustion
10 which determines engine performance. The springs are used to provide a positive means of valve
closure and to push the intake and exhaust valves firmly against the cam profile. The problems
associated with automobile engine valve train design are well known to modern automotive
engineers. Due to its mechanical nature, the valve train system produces a great deal of friction
which leads to engine output loss and a reduction in energy efficiency. In addition friction causes
15 vibrations and noise. The high speed and compact design of modern automobile engines
complicates the task of valve train design because of the dynamic excitation and oscillations
associated with opening and closing valves and compressing springs thousands of times per
minute. Problems associated with loss of valve control such as "valve float" and "valve bounce"
also causes significant engine power losses. Therefore, valve springs must be carefully matched to
20 the valve and associated cam in order to ensure a stable valve train and prevent undesirable spring
resonance. Spring dampers are used to specifically dampen the spring's natural frequency to
prevent resonance and prevent loss of valve control.

The known art discloses a variety of damper designs to control the harmonic oscillation of the valve spring. For example United States Patent 6,789,790 “Helical Coil Spring Damper Assembly” issued to Speckhart et al on September 14, 2004 discloses a device for reducing the resonant vibrations of a helical valve spring in a valve train by using a tension cable attached
5 between one end of the spring and a coil mid-section of the spring. However, this type of design is complicated to manufacture and therefore expensive to use in mass produced vehicles. Another example is United States Patent 4,470,383 “Valve Spring Damper” issued to DeBolt on September 11, 1984. DeBolt discloses an external type damper comprising a steel shell around the spring whereby dampening is caused by the frictional contact of the oscillating spring with the inside
10 surface of the shell. The DeBolt design is complicated and would be prone to extreme frictional heating and early wear and so is not appropriate for modern high speed engines.

Therefore, there continues to be a need for a spring dampening mechanism that has none of the disadvantages of the prior art, is inexpensive to manufacture, easy to install and does not
15 generate significant amounts of heat.

SUMMARY OF THE INVENTION

A principal object of the present invention is the provision of an improved valve spring
20 damper.

Another object of the present invention is the provision of an improved valve spring damper that is easy and inexpensive to manufacture.

Still another object of the present invention is the provision of an improved valve spring damper that resists frictional heating and has a long operational life.

Yet another object of the present invention is the provision of an improved valve spring
5 damper whose performance can be tuned to meet the performance requirements of the engine.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawings which illustrate the preferred embodiments thereof.

10

A valve spring damper in accordance with the present invention comprises a hollow tubular body comprising an inside diameter, an outside diameter, a height and an axis. The valve spring fits inside the damper hollow tubular body. The hollow tubular body further comprises a bottom comprising a ring having an aperture co-axial with the axis. The hollow tubular body has an open
15 top and a side wall having at least one groove circumferentially disposed therein and at least four parallel slots radially disposed therein. Each of the slots has an open top end, two parallel sides and a bottom arch having an apex. The slots divide the side wall into at least four side wall segments. The valve spring damper further includes a biasing steel ring in each of the at least one grooves adapted to exert compressive forces against the outside surface of the side wall so that
20 when the valve spring is in its compressed position and its outside surface is in frictional contact with the inside surface of the side wall, side wall integrity is maintained. The ring may have a circular cross-section or a rectangular cross-section. In operation, the valve spring damper applies dampening forces to the reciprocating spring by permitting frictional contact between the outside surface of the valve spring and the inside surface of the damper body when the valve spring is in its

compressed state. The dampening effect of the valve spring damper can be adjusted by varying the number of grooves and hence the number of rings interposed within them. The valve spring damper body may also include sealing means to seal the valve stem.

- 5 In another embodiment of the invention, the tubular hollow body is adapted for positioning inside the valve spring. The dampening action occurs when the valve spring is in a tensioned state and it's inside surface is in frictional contact with the outside surface of the damper side wall.

BRIEF DESCRIPTION OF DRAWINGS

- 10 Figure 1 is a perspective view of a valve spring damper of one embodiment of the invention.
 Figure 2 is a top view of the embodiment of Figure 1.
 Figure 3 is a cross-sectional side view along A-A of the embodiment of Figure 2.
 Figure 4 is a perspective view of a valve spring in combination with a valve spring damper of the embodiment in Figure 1.
- 15 Figure 5 is a top view of the embodiment shown in Figure 4.
 Figure 6 is a cross-sectional side view along A-A of the embodiment shown in Figure 5.
 Figure 7 is a perspective view of another embodiment of the valve spring damper body having a plurality of angled slots therein.
 Figure 8 is a top view of the embodiment of Figure 7,
- 20 Figure 9 is a cross-sectional side view along A-A of the embodiment of Figure 8.
 Figure 10 is yet another embodiment of the valve spring damper wherein the rings have a rectangular cross-section.
 Figure 11 is a top view of the embodiment shown in Figure 10.
 Figure 12 is a cross-sectional side view along A-A of the embodiment of Figure 11.

Figure 13 is a perspective view of still another embodiment of the valve spring damper in combination with a valve spring wherein the single ring has a rectangular cross-section.

Figure 14 is a top view of the embodiment of Figure 13.

Figure 15 is a cross-sectional side view along A-A of the embodiment of Figure 14.

5 Figure 16 is the same view as Figure 13.

Figure 17 is a top view of the embodiment of Figure 16.

Figure 18 is a cross-sectional side view along A-A of the embodiment shown in Figure 17.

Figure 19 is a perspective view of still another embodiment of the valve spring damper showing a valve spring within the valve spring damper body having a single ring with a rectangular cross-

10 section.

Figure 20 is a top view of the embodiment of Figure 19.

Figure 21 is a cross-sectional side view along section A-A of the embodiment of Figure 20

Figure 22 is a perspective view of the valve spring damper body of the embodiment of Figure 19.

Figure 23 is a top view of the embodiment of Figure 22.

15 Figure 24 is a cross-sectional side view along section A-A of the embodiment of Figure 23.

Figure 25 is a perspective view of an embodiment of the valve spring damper wherein the damper body is placed within the spring.

Figure 26 is a top view of the embodiment of Figure 25.

Figure 27 is a cross-sectional side view along section A-A of the embodiment of Figure 26.

20 Figure 28 is a perspective view of the valve spring damper body of the same embodiment of Figure 25.

Figure 29 is a top view of the embodiment of Figure 28.

Figure 30 is a cross-sectional side view along section A-A of the embodiment of Figure 29.

Figure 31 is a graph illustrating advantages of the present invention over the known art.

Figure 32 is a schematic drawing of the action of the valve damper body against the valve spring and the action of the ring against the valve damper body outside surface.

Figure 33 is one preferred embodiment of the ring of the present invention having a linear gap.

Figure 34 is another preferred embodiment of the ring of the present invention having an aperture
5 and two notches.

Figure 35 is yet another embodiment of the ring of Figure 34 wherein there are two parallel trains of concavo-convex dimples on the outside surface thereof.

Figure 36 is another embodiment of the ring of Figure 34 having a single groove.

Figure 37 is yet another embodiment of the ring of Figure 34 having two parallel grooves.

10 Figure 38 is another embodiment of the ring of Figure 34 having a plurality of indentations each having apertures therein.

Figure 39 is yet another embodiment of the ring of Figure 38 wherein there are no apertures in the indentations.

Figure 40 is one embodiment of the ring of Figure 34 having a single train of concavo-convex
15 dimples each having an aperture therein.

Figure 41 is another embodiment of the ring of Figure 40 having single train of concavo-convex dimples without apertures.

Figure 42 is one embodiment of the ring of Figure 34 wherein there are three parallel trains of concavo-convex dimples each having apertures therein.

20 Figure 43 is another embodiment of the ring of Figure 42 wherein there are two parallel trains of concavo-convex dimples each having apertures therein.

Figure 44 is one embodiment of the ring of Figure 34 wherein there are three parallel trains of concavo-convex dimples therein without apertures.

Figure 45 is another preferred embodiment of the ring having inter-digitized fingers.

Figure 46 is still another preferred embodiment of the ring of Figure 45 having a single groove therein.

Figure 47 is another embodiment of the preferred embodiment of the ring of Figure 45 wherein there are two grooves therein.

- 5 Figure 48 is yet another embodiment of the preferred embodiment of the ring of Figure 45 wherein there is a plurality of indentations therein.

Figure 49 is another embodiment of the preferred embodiment of the ring of Figure 45 wherein there is a single train of concavo-convex dimples therein.

- Figure 50 is yet another embodiment of the preferred embodiment of the ring of Figure 45 wherein
10 there are two parallel trains of concavo-convex dimples therein.

Figure 51 is still another embodiment of the preferred embodiment of the ring of Figure 45 wherein there are three parallel trains of the concavo-convex dimples therein.

Figure 52 is one embodiment of the preferred embodiment of Figure 49 wherein each of the dimples includes an aperture.

- 15 Figure 53 is another embodiment of the ring having two parallel trains of dimples having apertures.

Figure 54 is yet another embodiment of the ring having three parallel trains of dimples having apertures.

Figure 55 is another embodiment of the preferred embodiment of Figure 48 wherein each of the indentations includes an aperture.

- 20 Figure 56 is a preferred embodiment of the ring having an "S" shaped gap.

Figure 57 is one embodiment of the ring having an "S" shaped gap and a single groove.

Figure 58 is another embodiment of the ring of Figure 57 having two grooves.

Figure 59 is one embodiment of the ring of Figure 57 having two parallel trains of concavo-convex dimples therein.

Figure 60 is another embodiment of the ring of Figure 59 having three parallel trains of concavo-convex dimples therein.

Figure 61 is another embodiment of the ring having a single train of dimples wherein each dimple is apertured.

- 5 Figure 62 is another embodiment of the ring of Figure 59 wherein the dimples are apertured.

Figure 63 is one embodiment of the ring having an “S” shaped gap and a plurality of indentations therein.

Figure 64 is another embodiment of the ring of Figure 63 wherein each of the indentations is apertured.

- 10 Figure 65 is another preferred embodiment of the invention having an aperture, two grooves and a chevron-shaped gap.

Figure 66 is another embodiment of the ring having a chevron-shaped gap and a single groove therein.

Figure 67 is another embodiment of the ring of Figure 66 wherein there are two grooves.

- 15 Figure 68 is one embodiment of a ring having a chevron-shaped gap and a plurality of indentations therein.

Figure 69 is another embodiment of the ring of Figure 68 wherein of the indentations has an aperture.

- Figure 70 is another embodiment of the ring having a chevron-shaped gap including a single train
20 of dimples therein.

Figure 71 is another embodiment of the ring of Figure 70 wherein there are two parallel trains of dimples therein.

Figure 72 is yet another embodiment of the ring of Figure 70 wherein there are three parallel trains of dimples therein.

Figure 73 is one embodiment of the ring of Figure 70 wherein each dimple includes an aperture.

Figure 74 is one embodiment of the ring of Figure 71 wherein each dimple includes an aperture.

Figure 75 is one embodiment of the ring of Figure 72 wherein each dimple includes an aperture.

Figure 76 is a preferred embodiment of the ring having a gap at an angle.

5 Figure 77 is one embodiment of the ring having an angled gap and a single groove.

Figure 78 is another embodiment of the ring of Figure 77 wherein there are two parallel grooves.

Figure 79 is one embodiment of the ring having an angled gap and a plurality of indentations.

Figure 80 is another embodiment of the ring of Figure 79 wherein each indentation has an aperture.

Figure 81 is one embodiment of the ring having an angled gap and a single train of concavo-

10 convex dimples therein.

Figure 82 is another embodiment of the ring of Figure 81 wherein there are two parallel trains of concavo-convex dimples therein.

Figure 83 is yet another embodiment of the ring of Figure 81 wherein there are three parallel trains of concavo-convex dimples therein.

15 Figure 84 is another embodiment of the ring of Figure 81 wherein each dimple is apertured.

Figure 85 is another embodiment of the ring of Figure 82 wherein each dimple is apertured.

Figure 86 is another embodiment of the ring of Figure 83 wherein each dimple is apertured.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figures 1 to 6 the invention is a valve spring damper for dampening a

5 valve spring in an engine generally indicated as (10) adapted for placement over the bottom end (12) of a valve spring (14) having an axis (32), an untensioned length (16), an outside surface (18), an inside diameter (20) and an outside diameter (22). The valve spring damper comprises a hollow tubular body (24) comprising an inside diameter (26), an outside diameter (28), a height (30) and an axis (32). The hollow tubular body further comprises a bottom (34) having an aperture (38) co-

10 axial with the axis (32). The bottom (34) has an inside surface (39), an outside surface (40), an inside rim (42) and a concentric ring outside rim (44). The hollow tubular body also includes an open top (46) and a side wall (48). The side wall has a thickness (50), an outside surface (52), an inside surface (54), a bottom end (56) contiguous with the concentric outside rim (44) and a tapered inside top end (58) terminating at a top rim (60). There is further included two parallel

15 grooves (62) and (65) circumferentially disposed within the side wall outside surface and four equally spaced slots (80), (82), (84) and (86) disposed radially within the side wall (48) and parallel to the axis of the damper body. In other embodiments of the invention there may be additional or fewer grooves and slots in the sidewall. The equally spaced slots (80) to (86) are parallel to the axis (32) and perpendicular to the parallel grooves (62) and (65). Each of the slots (80) to (86) has

20 an open top end (66) within the side wall top rim (60), parallel first (70) and second (72) sides, and a bottom arch (74) having an apex (76) close to the side wall bottom end (56). The slots divide the side wall into a plurality of side wall segments (90), (92), (94) and (96). In the embodiment illustrated in Figures 1 to 6, the slots (80) to (86) are equally spaced around the circumference of the side wall (48). In other embodiments of the invention, there may be more than four slots

dividing the side wall (48) into more than four sections. As well, there must be at least one groove in the side wall but there may be more than two grooves. Where more than one groove is used then these grooves are equally spaced and located a predetermined distance from the top end of the side wall. In yet a further embodiment not illustrated here, the slots may be spaced in any

5 predetermined pattern or at a predetermined curvature or angle as illustrated in Figures 7, 8 and 9.

The spring is disposed within the hollow tubular damper body so that the bottom of the spring abuts the inside surface of the bottom of the damper body. The spring and damper body are coaxially arranged. The inside surface of the hollow tubular damper body is adapted to frictionally engage the outside surface of the spring thereby damping resonant vibrations of the spring during
10 engine operation.

In Figures 7, 8 and 9 there is shown another embodiment of the spring valve damper hollow comprising tubular body (120) wherein there is a plurality of angled slots (122) within the sidewall (124) of the tubular body (120). The degree of angle (134) is predetermined and may be positive
15 or negative from a vertical axis (135). The slots have an open top end (128) in the rim (130) of the sidewall (124), parallel sides (127) and (129) and an arched bottom (131) having an apex (132) near the bottom of the side wall. The slots divide the side wall (124) into a plurality of side wall sections (133). The top (137) of each side wall section (133) includes a parallelogram-shaped projection (139) having a top flat surface (141) that is even with the top of the side wall section
20 (137) and a bottom flat surface (143). In this embodiment, there is a single circumferential groove (136) having a rectangular cross-section, a flat bottom surface (145) and a flat top surface (143) formed from the flat bottom surface of the projections (139). The groove (136) is adapted to receive a single steel ring (not shown) also having a rectangular cross-section. This embodiment

fits over the bottom of the valve spring with the bottom end of the valve spring abutting against the inside surface (140) of bottom surface (142).

Referring back to Figures 1 to 6, there is further included in that embodiment of the invention (10) biasing steel rings (100) and (101) positioned within the two parallel grooves (62) and (65) respectively. There must be at least one biasing ring. The biasing rings are adapted to exert compressive forces against the outside surface of the side wall (48) so that when the valve spring is in its compressed position and its outside surface (18) is in enhanced frictional contact with the inside surface (54) of the side wall (48). This is described below with reference to Figure 32. The rings maintains side wall integrity during operation of the valve spring damper as well as increasing frictional forces against the outside surface dampening spring to enhance its operation. In another embodiment of the invention, not illustrated here, the side wall has a sufficient thickness (50) so that grooves can have a depth sufficient to completely house the biasing rings so that the outside surface of the side wall remains smooth. In the embodiment illustrated in Figures 1 to 6, the biasing rings (100) and (101) are made from spring steel, have a circular cross-section and a gap (103). In other embodiments of the invention, the rings may be coiled springs such as garter springs having sufficient tension to maintain the integrity of the side wall. The tension of the rings can be varied by removing mass from the ring. As well, the ring, as more fully explained below, may have a plurality of concavo-convex grooves, dimples and other shaped indentations such that the convex projection on the inner surface of the rings enhance the frictional contact between the inside surface of the damper body and the outside surface of the ring adjacent the location of the convex projections.

The dynamic forces exerted on the valve spring damper necessitate that it be manufactured from material capable of withstanding heat and frictional wear. In the preferred embodiment, the valve spring damper is moulded from a high strength, heat resistant and resilient polymer.

5 Figures 10, 11 and 12 illustrate another embodiment of the invention (160) wherein the grooves (162) and (164) have a rectangular cross-section and the biasing rings (166) and (168) also have a rectangular cross-section. All other components of the valve spring damper embodiment (160) are the same as the embodiment (10) illustrated in Figures 1 to 6.

10 Referring to Figures 13, 14 and 15 there is shown another embodiment of the invention comprising a valve spring damper (180) adapted for placement over the bottom end of a valve spring (182). The valve spring has an untensioned length (184), an outside surface (186), an inside diameter (188) and an outside diameter (190). The valve spring damper comprises a hollow tubular body (192) comprising: an inside diameter (194), an outside diameter (196), a height (198)

15 and an axis (200). The hollow tubular further comprises a bottom (202) having an aperture (206) co-axial with the axis (200), an inside surface (210), an inside rim (212) and a side wall (222). The side wall (222) has a thickness (224), an outside surface (226), an inside surface (228) and a top end (232). Within the side wall there is a plurality of radially disposed spaced slots. In the illustrated embodiment there are four such slots (236), (238), (240) and (242). In other

20 embodiments there may be more slots but there are always at least four slots. The spaced slots are parallel to the axis (200). Each of the spaced slots has an open top end (244) within the side wall top, parallel first (246) and second (248) sides, and a bottom arch (250) having an apex (252). In the embodiment illustrated, the slots are equally spaced but they may be spaced in a predetermined

pattern in other embodiments. As well, the slots may be curved or angled in a positive or negative direction away from a vertical as illustrated in Figures 7, 8 and 9.

The slots divide the side wall into a plurality of side wall segments (260), (262), (264) and
 5 (266). In the illustrated embodiment there are four spaced slots and four side wall segments but in other embodiments there may be additional spaced slots creating additional side wall segments. Encircling the outside surface of the side wall is a biasing ring (268). The ring is adapted to exert compressive forces against the outside surface of the side wall. In this embodiment the biasing ring has a rectangular cross-section, is made from spring steel and may have a gap. The top end
 10 (232) outside surface of each of the sidewall segments (260) to (266) includes a left (280) and a right (282) generally square projection. A typical projection shown within circle (281) is expanded at (283). Each projection has a bottom surface (284), a top surface (286), a left side surface (288) and a right side surface (290). The top surface (286) of each of the generally square projections is even with the top end (234) of the side wall and the left side surface (288) of each of the generally
 15 square projections is even with each of the slot first sides (246). The right side (290) of each of the generally square projections is even with each of the slot second sides (248). The bottom end outside surface of each of the side wall segments further includes a centrally disposed generally square projection (292) having a bottom surface (294), a top surface (296), a left side surface (298) and a right side surface (300). The bottom surface (294) is even with the bottom (202) of the
 20 tubular hollow body, and the top surface (296) is generally even with the apex (252) of slot arch (250). The bottom surface (284) of the left and right generally square projections and the top surface (296) of the centrally disposed generally square projection act cooperatively as a ring guide so that the bottom surface (270) of the ring is adjacent to the top surface of the centrally disposed

generally square projection and the top surface (272) of the ring is adjacent to the bottom surface (284) of the left and right generally square projections.

Referring to Figures 16, 17 and 18, there is shown yet another embodiment of the invention

5 comprising a valve spring damper (300) adapted for placement over the bottom end of a valve spring (302). The valve spring has an untensioned length (304), an outside surface (306), an inside diameter (308) and an outside diameter (310). The valve spring damper (300) comprises a hollow tubular body (312) comprising an inside diameter (314), an outside diameter (316), a height (318) and an axis (320). The valve spring damper (300) further comprises a bottom (322) having an

10 aperture (326) co-axial with the axis, an inside surface (330), an inside rim (332), an open top end (334) and a concentric bottom outside rim (336). The hollow tubular body (312) has side wall (337). The side wall has a thickness (338), an outside surface (340), an inside surface (342), a bottom end (344) contiguous with the concentric outside rim and a top end (346). Within the side wall (336) there is a plurality of radially disposed spaced slots (350), (352), (354) and (356). The

15 slots are parallel to the axis (320). Each of the slots has an open top end (358) within the side wall top rim. As with the slots described in previous embodiments herein, each slot has a parallel first and second side, and a bottom arch having an apex (366). In the embodiment illustrated, the slots are equally spaced but they may be spaced in a predetermined pattern in other embodiments. As well, the slots may be curved or angled in a positive or negative direction away from a vertical as

20 illustrated in Figures 7, 8 and 9. The slots divide the side wall into a plurality of side wall segments (370), (372), (374) and (376). In the illustrated embodiment there are four spaced slots and four side wall segments but in other embodiments there may be additional spaced slots creating additional side wall segments. Encircling the outside surface of the side wall is a single groove (378) having a rectangular cross-section that is adapted to accept a single biasing ring (380) also

having a rectangular cross-section. The ring is adapted to exert compressive forces against the outside surface of the sidewall axis.

Referring to Figures 19 to 24 there is shown still another embodiment of the invention

5 comprising a valve spring damper (400) adapted for placement over the bottom end of a valve spring (402). The valve spring has an untensioned length (404), an outside surface (406), an inside diameter (408) and an outside diameter (410). The valve spring damper (400) comprises a hollow tubular body (412) comprising an inside diameter (414), an outside diameter (416), a height (418) and an axis (420). The hollow tubular further comprises a bottom (422) having an aperture (426)
10 co-axial with the axis (420), an inside surface (430), an inside rim (432), an open top (436) and a side wall (438). In this embodiment there is a central tubular sleeve (440) rising from the inside rim (432). The sleeve has a top portion (441) having flat top end (443). The top portion (441) comprises sealing means (445) to seal the annulus between the valve stem (not shown) and the inside surface (444). The hollow tubular body (412) includes a side wall (450) having a thickness
15 (452), an outside surface (454), an inside surface (456) and a top rim (460). Within the side wall is a plurality of spaced slots (462), (464), (466) and (468) disposed radially. The slots are parallel to the axis (420). The slots have an open top end (470) within the side wall top rim (460), parallel first (472) and second (474) sides and an apex (476). The slots divide the side wall into a plurality of side wall segments (480), (482), (484) and (486). In the embodiment shown the slots are equally
20 spaced. In other embodiments, there may be more or fewer slots and the slots may be spaced in a predetermined pattern and they may be curved or angled at a predetermined angle as shown in Figures 7, 8 and 9.

In Figures 19, 20 and 21 there is a biasing ring (488) disposed around the side wall outside surface (454). The biasing ring (488) has a bottom surface (490) and a top surface (492) and is adapted to exert compressive forces against the outside surface of the side wall. This embodiment of the invention is also moulded from a high strength, heat resistant and resilient polymer. The
 5 biasing ring has a rectangular cross-section, is made from spring steel and may include a gap.

The top end outside surface of each of the plurality of sidewall segments includes a left (500) and a right (502) generally square projection. Each projection has a top surface (504), a bottom surface (506), a left side surface (510) and a right side surface (508). The top surface (504)
 10 of each projection is even with the top end of the side wall and the left side surface of each projection is even with each of the second (474) sides of the slots. The right side of each projection is even with each of the slot first sides (472). In addition, this embodiment illustrates the inclusion of a centrally disposed generally square projection (512) on the bottom end outside surface of each of the sidewall segments. These centrally disposed projections have a bottom surface (514), a top
 15 surface (516), a left side surface (518) and a right side surface (520). The bottom surface (514) is even with the bottom of the tubular hollow body and the top surface (516) is close to even with the apex (476) of the slots. When the ring (488) is placed around the side wall, the bottom surfaces (506) of the left and right projections and the top surface (516) of the centrally disposed projection act cooperatively as a ring guide.

20 Refer now to the embodiments of the invention illustrated in Figures 6, 15, 18 and 21. The valve spring damper of these embodiments is adapted for placed over the bottom end of the valve spring. The dampening operation of the damper is similar for all of these embodiments. Figure 6 is exemplary. The rings ensure that the outside surface of the spring is in continual frictional

contact with the inside surface of the dampening body so that the resonant vibration of the spring is dampened.

The dampening effect of the valve spring damper can be adjusted by varying the number of grooves (62) and hence the number of rings (100)/(101) interposed within them. As well as further explained below the performance characteristics of the rings may be altered by imparting various grooves, notches, dimples indentations and apertures in the ring that have the effect of either reducing the mass of the spring and hence its tension qualities or the contact areas between the damper body and the spring outside surface.

Referring now to Figures 25 to 30 there is shown yet another embodiment of the invention in which the valve spring damper (600) is adapted for placement within the centre of a valve spring (602) having an untensioned length (604), an inside surface (606), an inside diameter (608) and an outside diameter (610). The valve spring damper (600) comprises a hollow tubular body (610) comprising an inside diameter (612), an open top (614), an outside diameter (616), a height (618) and an axis (620). The hollow tubular body (610) further comprises a bottom ring (622) having a contiguous flange (624) an aperture (626) co-axial with the axis (620) having a diameter (612) equal to the inside diameter of the hollow tubular body (616) and an outside diameter (632). The flange has a bottom surface (636) a top surface (638) and a thickness (640).

The hollow tubular body further comprises a side wall (644). The side wall has an outside surface (646), an inside surface (648), a bottom end (650) fixed to the flange and a top end (652). There is also at least one circumferential concave groove (655) located within the side wall inside surface (648). The side wall further comprises a plurality of radially spaced slots (650), (652),

(654) and (656). These slots are parallel to the axis (620). Each of the radially spaced slots has an open top end (658), parallel first (660) and second (662) sides, and a bottom apex (667) adjacent to the top surface of the flange. The slots divide the side wall into a plurality of side wall segments (670), (672), (674) and (676). The slots are equally spaced in this embodiment but they may be spaced in a predetermined pattern and they may be curved or angled at a predetermined angle as illustrated in Figures 7, 8 and 9. In this embodiment, there is shown four slots dividing the side wall into four segments. A person skilled in the art would understand that there may be more than four slots and four side wall segments in alternate embodiments of the invention. The embodiment illustrated includes a spring steel biasing ring (680) positioned within the at least one groove (655). The biasing element is adapted to exert radial forces against the inside surface of the sidewall away from the axis.

The hollow tubular body of this embodiment is preferably moulded from a high strength, heat resistant and resilient polymer. The at least one groove (655) within the inside surface of the side wall is located a predetermined distance from the top end of the side wall. In an alternative embodiment of the invention, the at least one concave groove has a depth sufficient to enclose said biasing element.

In the illustrated embodiment, the valve spring (602) has a first compressed state and a second tensioned state. The ring ensures that there is continual frictional contact between the inside surface of the valve spring (606) and the outside surface (646) of the side wall sufficient to dampen the resonant vibration of the spring.

Figure 31 illustrates the effectiveness of the present invention (New Pac) in reducing valve spring harmonic vibrations. The present invention, in the embodiment wherein the valve spring is situated within the plastic valve spring damper body, reduces vibrations significantly over prior art steel valve spring dampers.

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Referring to Figure 32 there is shown a diagram which illustrates the manner in which the ring affects the performance of the valve spring damper. When the ring is placed on the outside of the valve body the tension of the ring exerts compressive forces against the valve damper body. This intern exerts pressure against the outside surface of the valve spring. The amount of tension
10 exerted by the ring against the valve damper body will affect the overall performance of the damper. It has been found that the amount of tension exerted by the ring can be determined by removing mass from the ring itself.

Figure 33 illustrates a preferred embodiment of the ring comprising a steel ring (700)
15 having a top surface (702) and bottom surface (704). This embodiment of the ring is shown around the valve damper body in Figure 19. The ring (700) has an inside surface (708) and an outside surface (706) a first end (710) and a second end (712). There is a linear gap (714) between the first and second end. As depicted in Figure 32 the ring is in tension and so will compress the body of the valve damper so that the inside surface of the body of the valve damper is in frictional contact
20 with the outside surface of the valve spring. As the valve spring moves up and down with the motion of the valve, the point of contact (693) in Figure 32 will increase resistance to the motion of the valve spring and therefore affect the overall performance of the valve spring.

Figure 34 shows a second preferred embodiment of the “linear gap” ring (720). It is known that reducing the mass of the ring by removing material will reduce the tension of the ring and therefore the performance of the valve spring damper. In this embodiment there is a void (722) in the ring where a mass has been removed so that the loading of the valve spring is modified. As well there is shown a first notch (724) and a second opposite notch (726) symmetrically placed above and below the void. These notches are adapted to facilitate assembly of the valve spring damper and they also modify the loading of the valve spring by the ring.

Figure 35 illustrates yet another embodiment of the “linear gap” ring (730) in which there is a plurality of concave indentations (732) in the outside surface of the ring causing a series of convex dimples (734) on the inside surface of the ring. These dimples are equally spaced circumferentially around the ring in a first (736) and second (738) train. The convex side of the dimples have the effect of exerting enhanced frictional contact between the inside wall of the damper body and the outside surface of the valve spring whenever the outside surface of the valve body passes over the inside surface of the damper body.

Figure 36 illustrates another embodiment of the “linear gap” ring (740) in which there is a single groove (742) disposed circumferentially in the centre of the ring. The groove has a concave outside surface (746) and a convex inside surface (744). The convex inside surface of the groove acts to enhance the frictional contact point (693) in Figure 32 so that there is additional friction resisting the motion of the valve spring thereby modifying the performance of the spring.

Figure 37 illustrates yet another embodiment of the “linear gap” ring (750) in which there are two grooves (752) and (754) disposed circumferentially in the ring providing two enhanced friction points against the motion of the spring.

5 Figure 38 illustrates still another embodiment of the “linear gap” ring (756) in which there is a void (758) removed from the ring to modify its tension. Additionally this embodiment includes a linear gap (760) and a plurality of indentations (762) machined within the ring and spaced radially about the circumference of the ring and parallel to the linear gap. The indentations have a concave outer surface (764) and a convex inner surface (766) adapted to exert pressure
10 against the outside surface of the damper body and enhance the adjacent frictional contact of the inside surface of the damper body with the outside surface of the valve spring. Each of the indentations has a void (768) removed to reduce the mass of the ring and so modify its performance characteristics.

15 Figure 39 illustrates another embodiment of the “linear gap” ring (770) which is identical to the embodiment shown in Figure 38 except that the plurality of indentations (772) does not have voids.

 Figure 40 illustrates another embodiment of the “linear gap” ring (774) including a single
20 train of a plurality of circular indentations (776) each having a concave outer surface (780) and a convex inner surface (782). The convex inner surface is adapted to press against the outside surface of the damper body thereby creating enhances points of frictional contact between the inside surface of the valve body and the outside surface of the valve spring. Each of the plurality

of indentations has a void (784) thereby removing mass from the ring and modifying its tension properties.

Figure 41 illustrates another embodiment of the “linear gap” ring (786) including a single
 5 train of a plurality of circular indentations (788) having a concave outer surface (790) and a convex inner surface (792). The convex surfaces of the indentations are adapted to create enhanced points of frictional contact between the inside wall of the damper body and the outside surface of the valve spring.

10 Referring to Figure 42 there is show yet another embodiment of the “linear gap” ring (794) having three parallel trains of dimples (796) each having a concave outer surface (798) and a convex inner surface (800). Each of the plurality of dimples has a void (802) at their centres.

Referring to Figure 43 there is shown another embodiment of the “linear gap” ring (804)
 15 which is identical to the embodiment shown in Figure 42 except that there are only two parallel trains of dimples (806).

Shown in Figure 44 is an ring embodiment (808) of the ring as shown in Figure 41 save that
 there are three evenly spaced parallel trains of dimples (810) circumferentially disposed about the
 20 outside of the ring.

Referring now to Figure 45 there is shown another preferred embodiment of the ring (812) having a first end (814) and a second end (816) The first end has a first finger (818) which is interdigitized between fingers (820) and (822) of the second end (816). The gap (824) between the

fingers permits flexure of the ring as the valve damper operates, that is, the ring will under go cycles of expansion and release as the valve spring moves up and down within the body of the damper. Void (826) is adapted to fine tune the tension of the ring and therefore the performance of the valve spring damper during operation. Material removed from the void has the effect of

5 reducing tension in the band and the loading on the valve spring. Notches (828) and (830) are adapted to permit easy assembly of the ring over the valve damper body. There are a variety of other embodiments of this “finger” design of steel ring shown in following diagrams.

Referring to Figure 46 there is shown another preferred embodiment (832) of the “finger” design of Figure 45. Ring (832) includes a groove (834) which as a concave outer surface (836) and a convex inner surface (838). Referring back to Figure 32, the convex inner surface of the groove is adapted engage the valve spring outside surface at point (693) and increases the pressure of the frictional contact with the outside surface of the valve spring. This in turn affects the performance of the valve spring damper.

Referring to Figure 47 there is yet another preferred embodiment (840) of the “finger” design of Figures 45 and 46. In this embodiment there are two grooves (842) and (844) adapted to engage the valve spring outside surface on their inner convex surfaces.

Referring to Figure 48 there is shown another preferred embodiment (846) of the “finger” design of figure 45. Rather than one or two circumferential grooves about the ring there is a plurality of oval indentations (848) circumferentially spaced radially about the ring. Each of the plurality of indentations has a convex outer surface (850) and a concave inner surface (852). The convex inner surface of each indentation is adapted to press against the outside wall of the damper

body thereby exerting compressive forces against the valve spring outer surface at each contact point between the surface (852) and spring outer surface.

Referring to Figure 49 there is shown yet another preferred embodiment (854) of the “finger” design ring. In this embodiment there is a plurality of dimples (856) forced into the outer surface of the ring that are arranged in a single train around the circumference of the ring. The dimples have a concave outer surface (858) and a convex inner surface (860). The purpose of the dimples has been described above in respect of previous embodiments of the ring.

Referring to Figure 50 there is shown another preferred embodiment (862) of the ring which is the same as the embodiment shown in Figure 49 except that there are two parallel trains (864) and (868) of dimples disposed about the outer circumference of the ring.

Referring to Figure 51 there is shown another preferred embodiment (870) of the ring as in Figures 49 and 50 save that there are three parallel trains (872), (874) and (876) of dimples disposed about the outer circumference of the ring.

Referring to Figure 52 there is shown another preferred embodiment of the ring (878) wherein there is a single train (880) of dimples (882) spaced circumferentially about the ring and having a concave outer surface (884) and a concave inner surface (886). The center (888) of each dimple is apertured to remove mass from the ring and therefore tune its characteristics.

Referring to Figure 53 there is shown yet another embodiment of the ring (890) wherein there are two trains (892) and (894) of apertured dimples (896) circumferentially spaced around the ring.

5 Referring to Figure 54 there is shown another embodiment of the ring (898) wherein there are three trains (900), (902) and (904) of dimples circumferentially spaced around the ring.

Referring to Figure 55 there is shown still another preferred embodiment of the ring (906) wherein there is a plurality of indentations (908) radially spaced around the circumference of the
10 ring. The indentations have a concave outer surface (910) and a convex inner surface (912). Each of the plurality of indentations includes an aperture (914).

Referring to Figure 56 there is shown one preferred embodiment of the ring (916) having a single gap (918) and notches (920) and (922). Included in the ring is an “S” shaped gap (924).
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Referring to Figure 57 there is shown another embodiment of the ring (926) as shown in Figure 56 save that the ring includes a single groove (928) imposed on the outer surface ring circumference. The groove has a concave outside surface (930) and a convex inner surface (932). The convex surface is adapted to press against the wall of the damper body and modify the
20 performance of the spring damper.

Referring to Figure 58 there is shown one embodiment of the ring (934) as in Figure 57 save that there are two grooves (936) and (938).

Referring to Figure 59 there is shown another embodiment of the ring (940) as shown in Figure 56 including a first (942) and second (944) trains of convexo-concave dimples circumferentially placed around the ring.

5 Referring to Figure 60 there is shown another embodiment (946) of the same ring as in Figure 59 save that there are three trains (948), (950) and (952) of dimples around the ring.

Referring to Figure 61 there is shown another embodiment of the ring (954) having the “S” shaped gap (956) and including a single train of apertured dimples (958) similar to those shown in
10 Figure 52.

Referring to Figure 62 there is shown another embodiment of the ring (960) identical to the embodiment in Figure 61 save that there are two trains of apertured dimples (962) and (964).

15 Referring to Figure 63 there is shown another embodiment of the ring (966) having the “S” shaped gap (968) and including a plurality of evenly spaced indentations (970) on the outside surface of the ring. Each indentation has a concave outer surface (972) and a convex inner surface (974).

20 Referring now to Figure 64 there is shown an embodiment of the ring (974) having an “S” shaped gap (976) in which the indentations (978) each have an aperture (980) therein.

Figure 65 illustrates another preferred embodiment of the ring (975) as shown in Figure 56 save that the gap (977) is chevron-shaped.

Figure 66 illustrates the same embodiment of the ring (982) in which the gap (984) is chevron-shaped. The ring includes an aperture (986) and a first notch (988) and a second notch (990). There is included a single groove (992) having a concave outer surface (994) and a convex inner surface (996).

Referring to Figure 67 there is illustrated another embodiment of the ring (998) in which there are two grooves (1000) and (1002).

Referring to Figure 68 there is shown another embodiment of the ring (1006) having a plurality of indentations (1008) spaced circumferentially around the outside of the ring. The indentations have a concave outer surface (1010) and a convex inner surface (1012).

Referring to Figure 69 there is shown the same embodiment of the ring (1014) as shown in Figure 68 except that each of the indentations (1016) has an aperture (1018).

Figure 70 illustrates a ring (1020) in the same embodiment as Figure 65 except there is included a single train of concavo-convex dimples (1022) disposed circumferentially around the ring.

Figure 71 illustrates a ring (1024) of the same embodiment of Figure 70 in which there are two parallel trains (1026) and (1028) of concavo-convex dimples disposed circumferentially around the ring.

Figure 72 illustrates the same ring (1030) as Figure 72 with three parallel trains (1032), (1034) and (1036) of concavo-convex dimples disposed circumferentially around the ring.

Figure 73 illustrates the same ring (1038) as Figure 70 except that each dimple (1040) of the single train of concavo-convex dimples is apertured (1042).

Figure 74 illustrates the same ring (1044) as shown in Figure 71 except that each dimple (1046) is apertured (1048).

Figure 75 illustrates the same ring (1050) as shown in Figure 73 except that each dimple (1052) is apertured (1054).

Figure 76 shows another preferred embodiment of the ring (1056) having an aperture (1058) and first (1060) and second (1062) notch. The ring also includes a gap (1064) in the ring that is set at a predetermined angle (1066).

Figure 77 shows one embodiment of the ring (1068) except that there is one groove (1070) set into the outside surface of the ring. The groove has a concave outside surface (1072) and a convex inside surface (1074).

Figure 78 shows the same embodiment of the ring (1076) as shown in Figure 77 except that there are two grooves (1078) and (1080).

Figure 79 shows another embodiment of the ring (1082) in which there are a plurality of indentations (1084) disposed circumferentially around the outside surface of the ring. The indentations have a concave outside surface (1086) and a convex inside surface (1088).

5 Figure 80 illustrates the same embodiment of the ring (1090) in which each of the plurality of concavo-convex indentations includes an aperture (1092) therein.

 Figure 81 illustrates the same embodiment of the ring (1094) as show in the embodiment of Figure 76 except that there is included a single train (1096) of dimples disposed circumferentially
10 around the outside of the ring. Each of the dimples in the train has a concave outside surface(1098) and a convex inside surface (1100).

 Figure 82 illustrates the same embodiment of the ring (1102) as show in the embodiment of Figure 81 except that there are two parallel trains (1104) and (1106) of concavo-convex dimples
15 disposed circumferentially around the outside surface of the ring.

 Figure 83 illustrates the same embodiment of the ring (1108) as show in the embodiment of Figure 81 except that there are three parallel trains (1110), (1112) and (1114) of concavo-convex dimples disposed circumferentially around the outside surface of the ring.

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 Figure 84 illustrates the same embodiment of the ring (1116) as shown in Figure 81 except that each of the concavo-convex dimples (1118) includes an aperture (1120).

Figure 85 illustrates the same embodiment of the ring (1122) except that each of the concavo-convex dimples includes an aperture (1124).

Figure 86 illustrates the same embodiment of the ring (1126) except each of the concavo-convex dimples includes an aperture (1128).

By varying the number of rings around the valve spring damper body and by varying the number of morphology of the grooves, apertures, indentations and dimples within the body of the ring the dampening properties of the valve spring damper can be precisely tuned to meet the needs of a particular application.

It is apparent from the foregoing description that the present invention and its preferred embodiments are improvements over the known art valve spring dampers. The invention disclosed herein is easy and inexpensive to manufacture because it can be moulded from a suitable polymer having resistance to frictional heating and wear.

Although this description contains much specificity, these should not be construed as limiting the scope of the invention by merely providing illustrations of some of the embodiments of the invention. Thus the scope of the invention should be determined by the appended claims and their legal equivalents rather than by the examples given.

CLAIMS

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A valve spring damper for dampening a valve spring in an engine, said valve spring having an axis, a bottom surface, an inside surface and an outside surface, said valve spring damper comprising a hollow tubular body comprising an axis, a sidewall and a bottom, said sidewall comprising an inside surface and an outside surface, said bottom having an inside surface and an outside surface, wherein said valve spring is co-axially disposed within said hollow tubular body so that said bottom surface of the valve spring abuts said inside surface of said hollow tubular body bottom, and further wherein said hollow tubular body inside surface is adapted to frictionally engage said valve spring outside surface thereby damping resonant vibrations thereof during engine operations.
2. The damper of Claim 1 further comprising at least one spring steel ring wrapped around said outside surface of the hollow tubular body, wherein said at least one spring steel ring is adapted to compress the sidewall of the hollow tubular body thereby enhancing said frictional engagement between the outside surface of the spring steel ring and the inside surface of the sidewall.
3. The damper of Claim 2 wherein said at least one spring steel ring comprises one spring steel ring.
4. The damper of Claim 2 wherein said at least one spring steel ring comprises two steel rings.

5. The damper of Claims 3 and 4 wherein the performance of the damper may be modified by adjusting the amount and placement of frictional engagement between the hollow tubular body inside surface and the valve spring outside surface.
6. The damper of Claim 5 wherein said amount of frictional engagement is adjusted by varying the tension in the spring steel ring and wherein the placement of frictional engagement on the inside surface of the hollow tubular body is adjusted by the placement of a plurality of concavo-convex dimples in the spring steel ring.
7. The damper of Claim 6 wherein said tension in the spring steel ring is varied by removing mass there from.
8. The damper of claim 7 wherein said mass is removed from the spring steel ring by introducing at least one aperture therein.
9. A valve spring damper for dampening a valve spring in an engine, said valve spring having an axis, a bottom surface, an inside surface and an outside surface, said valve spring damper comprising a hollow tubular body comprising an axis, a sidewall and a bottom, said sidewall comprising an inside surface, an outside surface and a plurality of slots therein, said bottom having an inside surface and an outside surface, wherein said valve spring is co-axially disposed within said hollow tubular body so that said bottom surface of the valve spring abuts said inside surface of said hollow tubular body bottom, and further wherein said hollow tubular body inside surface is adapted to frictionally engage said valve spring outside surface thereby damping resonant vibrations thereof during engine operations.
10. The damper of claim 9 wherein said plurality of slots is parallel to said axis of the hollow tubular body.

11. The damper of claim 9 wherein the plurality of slots are disposed at a predetermined angle to the axis of the tubular body.
12. The damper of Claims 10 and 11 wherein the plurality of slots comprises at least four slots.
13. The damper of Claims 10 and 11 wherein the plurality of slots comprises four slots.
14. The damper of Claims 12 and 13 wherein the sidewall outside surface further comprises at least one groove disposed circumferentially therein.
15. The damper of Claim 14 wherein said at least one groove has a rectangular cross-section.
16. The damper of Claim 15 wherein said at least one groove has a concave cross-section.
17. The damper of Claims 15 and 16 further comprising at least one spring steel ring disposed in said at least one groove, wherein said at least one spring steel ring has a cross-section compatible with the at least one groove, and wherein the at least one spring steel spring is adapted to compress the sidewall of the hollow tubular body thereby enhancing said frictional engagement between the inside surface of the hollow tubular body and the outside surface of the valve spring.
18. The damper of Claim 17 wherein the damper may be modified to adjust the amount and location of frictional engagement between the hollow tubular body inside surface and the valve spring outside surface.
19. The damper of Claim 18 wherein said amount of frictional engagement is adjusted by varying the tension in the spring steel ring, and wherein said location of frictional engagement on the inside surface of the hollow tubular body is adjusted by the placement of a plurality of concavo-convex features on the spring steel ring.

20. The damper of Claim 19 wherein said tension in the spring steel ring is varied by removing mass there from.
21. The damper of claim 20 wherein said mass is removed from the spring steel ring by introducing at least one aperture therein.
22. A valve spring damper for dampening a valve spring in an engine, said valve spring having, an axis, an inside surface, an outside surface and a bottom surface, said valve spring damper comprising a hollow tubular body comprising an axis, a sidewall and a bottom flange, said sidewall comprising a height, an inside surface and an outside surface, said bottom flange comprising a top surface and a bottom surface, wherein said hollow tubular body is co-axially disposed within said valve spring so that said spring bottom surface abuts said bottom flange top surface, and wherein said hollow tubular body outside surface is adapted to frictionally engage said valve spring inside surface thereby damping resonant vibrations thereof during the operation of said engine.
23. The damper of claim 22 wherein the sidewall further comprises a plurality of slots disposed therein, said plurality of slots parallel to said hollow tubular body axis, wherein the plurality of slots is adapted to enhance the flexure of the sidewall during engine operation.
24. The damper of claim 23 wherein the plurality of slots comprises four slots equally spaced around the sidewall.
25. The damper of Claims 23 and 24 wherein the hollow tubular body sidewall inside surface further includes at least one groove circumferentially disposed therein.
26. The damper of Claim 25 wherein said at least one groove has a rectangular cross-section.
27. The damper of claim 25 wherein said at least one groove has a concave cross-section.

28. The damper of Claims 26 and 27 further including at least one spring steel ring having an outside surface and a groove-matching cross-section disposed within said at least one groove, said at least one spring steel ring adapted to exert biasing forces radially against said groove thereby enhancing said frictional engagement between the outside side surface of the hollow tubular body and the inside surface of the valve spring.
29. The damper of Claim 28 wherein said amount of frictional engagement is adjusted by varying the tension in the spring steel ring.
30. A valve spring damper for dampening a valve spring in an engine, said valve spring having an axis, an outside surface, an inside surface and a bottom surface, said valve spring damper comprising a hollow tubular body having an axis, a sidewall and a bottom surface having an aperture having a rim, said side wall having an outside surface and an inside surface, said bottom having an outside surface and an inside surface, wherein said hollow tubular body further includes an inside tubular sleeve rising from said rim co-axial with the hollow tubular body.
31. The damper as claimed in Claim 30 wherein the damper is adapted for placement over the bottom of the valve spring so that said bottom surface of the valve spring abuts against said inside surface of the hollow tubular body bottom, and wherein said inside tubular sleeve is disposed within the valve spring, and further wherein said outside surface of the valve spring is in frictional contact with said inside surface of the hollow tubular body thereby dampening resonant vibrations thereof during engine operation.
32. The damper of claim 31 wherein the sidewall further comprises a plurality of slots disposed therein, said plurality of slots parallel to said hollow tubular body axis, wherein the plurality of slots is adapted to enhance the flexure of the sidewall during engine operation.

33. The damper of claim 32 wherein the plurality of slots comprises four slots equally spaced around the sidewall.
34. The damper of Claims 32 and 33 wherein the hollow tubular body sidewall outside surface further includes at least one groove circumferentially disposed therein.
35. The damper of Claim 34 wherein said at least one groove has a rectangular cross-section.
36. The damper of Claim 35 further including at least one spring steel ring having an inside surface and a groove-matching cross-section disposed within said at least one groove, said at least one spring steel ring adapted to exert biasing forces radially against said groove thereby enhancing said frictional engagement between the inside surface of the hollow tubular body and the outside surface of the valve spring.
37. The damper of Claim 36 wherein the damper may be modified to adjust the amount and location of frictional engagement between the hollow tubular body inside surface and the valve spring outside surface.
38. The damper of Claim 37 wherein said amount of frictional engagement is adjusted by varying the tension in the spring steel ring, and wherein said location of frictional engagement on the inside surface of the hollow tubular body is adjusted by the placement of a plurality of concavo-convex features on the spring steel ring.
39. The damper of Claim 38 wherein said tension in the spring steel ring is varied by removing mass there from.
40. The damper of Claims 2, 17, 28 and 36 wherein the spring steel ring comprises a first end, a second end, a smooth inside surface, a smooth outside surface, a top, a bottom, a middle and a gap between said first end and said second end wherein said gap permits placement of said spring steel ring over the damper hollow tubular body.

41. The spring steel ring as claimed in Claim 40 further including an oval-shaped aperture disposed opposite the gap, wherein said aperture reduces the mass of the ring thereby modifying its tension characteristics.
42. The spring steel ring as claimed in claim 41 further including a first notch and a second notch disposed respectively over and under the oval-shaped aperture, said first and second notch adapted to facilitate manufacture of the ring.
43. The spring steel ring as claimed in claim 42 further comprising a single train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring wherein each of said plurality of dimples has a concave side on the outside surface of the ring and a convex side on the inside surface of the ring so that said convex side of each dimple is in compressing contact with the outside surface of the sidewall of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite each dimple.
44. The spring steel ring as claimed in claim 43 further comprising a first and a second train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
45. The spring steel ring as claimed in claim 43 further comprising a first, second and third train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
46. The spring steel ring as claimed in Claims 43, 44 and 45 wherein each dimple of the plurality of concavo-convex dimples is apertured at their centres thereby reducing the mass and tension properties of the ring.

47. The spring steel ring as claimed in Claim 42 further including a single concave groove disposed about the middle of the ring wherein the outside concave surface of the groove corresponds to an adjacent convex projection about the middle of the inside surface of the ring, said convex projection in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projection.
48. The spring steel ring as claimed in claim 47 wherein there is a first and a second concave groove disposed around the middle of the ring respectively above and below the aperture.
49. The spring steel ring as claimed in claim 42 further comprising a plurality of concave indentations equally spaced about the circumference of the ring and parallel to the axis thereof, wherein each concave indentation of said plurality of indentations on the outside surface of the ring corresponds to a convex projection on the inside surface of the ring, and further wherein each of said convex projections is in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projections.
50. The spring steel ring as claimed in Claim 49 wherein each of the indentations is apertured thereby reducing the mass and tension properties of the ring.
51. The spring steel ring as claimed in Claims 2, 17, 28 and 36 wherein the steel ring comprises a top, a bottom, a middle, a flat outside surface, a flat inside surface, a first end and a second end, wherein said first end includes a single finger projecting from the middle thereof, and wherein said second end includes two fingers projecting

respectively from the top and bottom thereof so said first end finger is inter-digitized between said second end fingers.

52. The spring steel ring as claimed in Claim 51 further including an oval-shaped aperture disposed opposite the gap, wherein said aperture reduces the mass of the ring thereby modifying its tension characteristics.
53. The spring steel ring as claimed in claim 52 further including a first notch and a second notch disposed respectively over and under the oval-shaped aperture, said first and second notch adapted to facilitate manufacture of the ring.
54. The spring steel ring as claimed in claim 53 further comprising a single train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring wherein each of said plurality of dimples has a concave side on the outside surface of the ring and a convex side on the inside surface of the ring so that said convex side of each dimple is in compressing contact with the outside surface of the sidewall of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite each dimple.
55. The spring steel ring as claimed in claim 54 further comprising a first and a second train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
56. The spring steel ring as claimed in claim 55 further comprising a first, second and third train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.

57. The spring steel ring as claimed in Claims 54, 55 and 56 wherein each dimple of the plurality of concavo-convex dimples is apertured at their centres thereby reducing the mass and tension properties of the ring.
58. The spring steel ring as claimed in Claim 53 further including a single concave groove disposed about the middle of the ring wherein the outside concave surface of the groove corresponds to an adjacent convex projection about the middle of the inside surface of the ring, said convex projection in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projection.
59. The spring steel ring as claimed in claim 58 wherein there is a first and a second concave groove disposed around the middle of the ring respectively above and below the aperture.
60. The spring steel ring as claimed in claim 59 further comprising a plurality of concave indentations equally spaced about the circumference of the ring and parallel to the axis thereof, wherein each concave indentation of said plurality of indentations on the outside surface of the ring corresponds to a convex projection on the inside surface of the ring, and further wherein each of said convex projections is in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projections.
61. The spring steel ring as claimed in Claim 60 wherein each of the indentations is apertured thereby reducing the mass and tension properties of the ring.

62. The damper of Claims 2, 17, 28 and 36 wherein the spring steel ring comprises a first end, a second end, a smooth inside surface, a smooth outside surface, a top, a bottom, a middle and an "S"-shaped gap between said first end and said second end wherein said gap permits placement of said spring steel ring over the damper hollow tubular body.
63. The spring steel ring as claimed in Claim 62 further including an oval-shaped aperture disposed opposite the gap, wherein said aperture reduces the mass of the ring thereby modifying its tension characteristics.
64. The spring steel ring as claimed in claim 63 further including a first notch and a second notch disposed respectively over and under the oval-shaped aperture, said first and second notch adapted to facilitate manufacture of the ring.
65. The spring steel ring as claimed in claim 64 further comprising a single train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring wherein each of said plurality of dimples has a concave side on the outside surface of the ring and a convex side on the inside surface of the ring so that said convex side of each dimple is in compressing contact with the outside surface of the sidewall of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite each dimple.
66. The spring steel ring as claimed in claim 65 further comprising a first and a second train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
67. The spring steel ring as claimed in claim 66 further comprising a first, second and third train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.

68. The spring steel ring as claimed in Claims 65, 66 and 67 wherein each dimple of the plurality of concavo-convex dimples is apertured at their centres thereby reducing the mass and tension properties of the ring.
69. The spring steel ring as claimed in Claim 68 further including a single concave groove disposed about the middle of the ring wherein the outside concave surface of the groove corresponds to an adjacent convex projection about the middle of the inside surface of the ring, said convex projection in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projection.
70. The spring steel ring as claimed in claim 69 wherein there is a first and a second concave groove disposed around the middle of the ring respectively above and below the aperture.
71. The spring steel ring as claimed in claim 70 further comprising a plurality of concave indentations equally spaced about the circumference of the ring and parallel to the axis thereof, wherein each concave indentation of said plurality of indentations on the outside surface of the ring corresponds to a convex projection on the inside surface of the ring, and further wherein each of said convex projections is in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projections.
72. The spring steel ring as claimed in Claim 71 wherein each of the indentations is apertured thereby reducing the mass and tension properties of the ring.

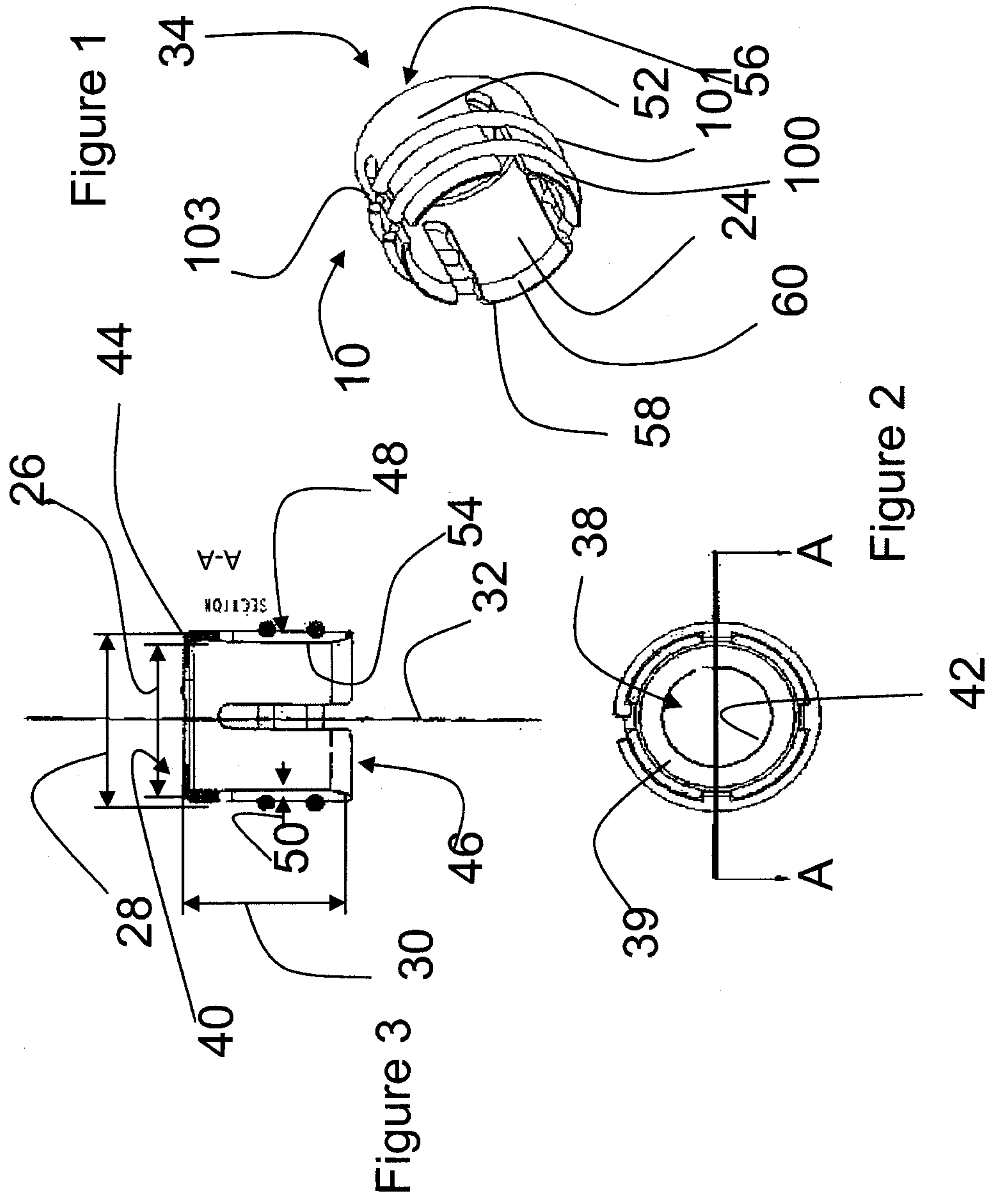
73. The spring steel ring as claimed in Claims 2, 17, 28 and 36 wherein the steel ring comprises a top, a bottom, a middle, a flat outside surface, a flat inside surface, a first end and a second end, wherein there is a chevron-shaped gap between first end and said second end.
74. The spring steel ring as claimed in Claim 73 further including an oval-shaped aperture disposed opposite the gap, wherein said aperture reduces the mass of the ring thereby modifying its tension characteristics.
75. The spring steel ring as claimed in claim 74 further including a first notch and a second notch disposed respectively over and under the oval-shaped aperture, said first and second notch adapted to facilitate manufacture of the ring.
76. The spring steel ring as claimed in claim 75 further comprising a single train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring wherein each of said plurality of dimples has a concave side on the outside surface of the ring and a convex side on the inside surface of the ring so that said convex side of each dimple is in compressing contact with the outside surface of the sidewall of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite each dimple.
77. The spring steel ring as claimed in claim 76 further comprising a first and a second train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
78. The spring steel ring as claimed in claim 77 further comprising a first, second and third train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.

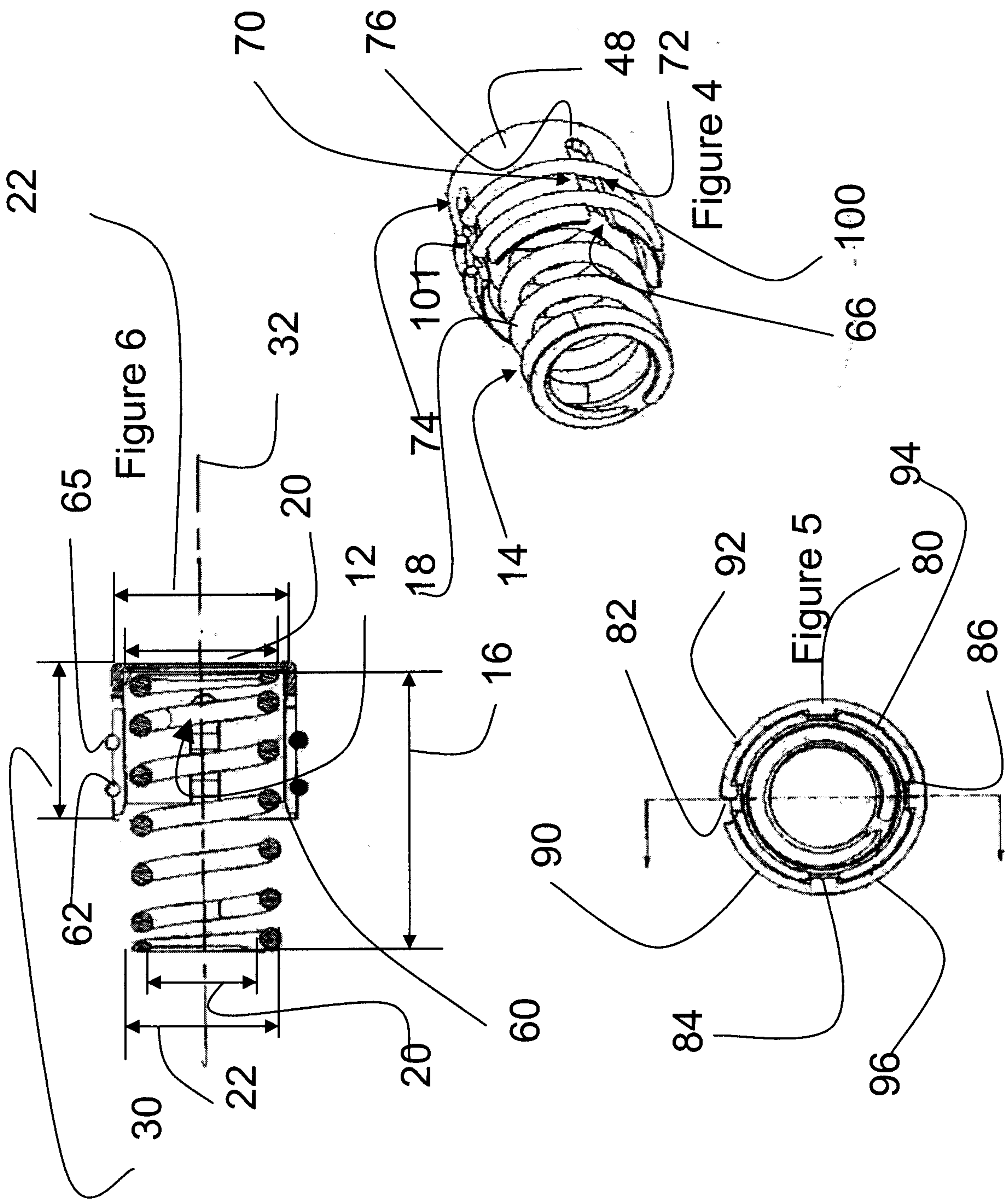
79. The spring steel ring as claimed in Claims 76, 77 and 78 wherein each dimple of the plurality of concavo-convex dimples is apertured at their centres thereby reducing the mass and tension properties of the ring.
80. The spring steel ring as claimed in Claim 79 further including a single concave groove disposed about the middle of the ring wherein the outside concave surface of the groove corresponds to an adjacent convex projection about the middle of the inside surface of the ring, said convex projection in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projection.
81. The spring steel ring as claimed in claim 80 wherein there is a first and a second concave groove disposed around the middle of the ring respectively above and below the aperture.
82. The spring steel ring as claimed in claim 81 further comprising a plurality of concave indentations equally spaced about the circumference of the ring and parallel to the axis thereof, wherein each concave indentation of said plurality of indentations on the outside surface of the ring corresponds to a convex projection on the inside surface of the ring, and further wherein each of said convex projections is in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projections.
83. The spring steel ring as claimed in Claim 82 wherein each of the indentations is apertured thereby reducing the mass and tension properties of the ring.

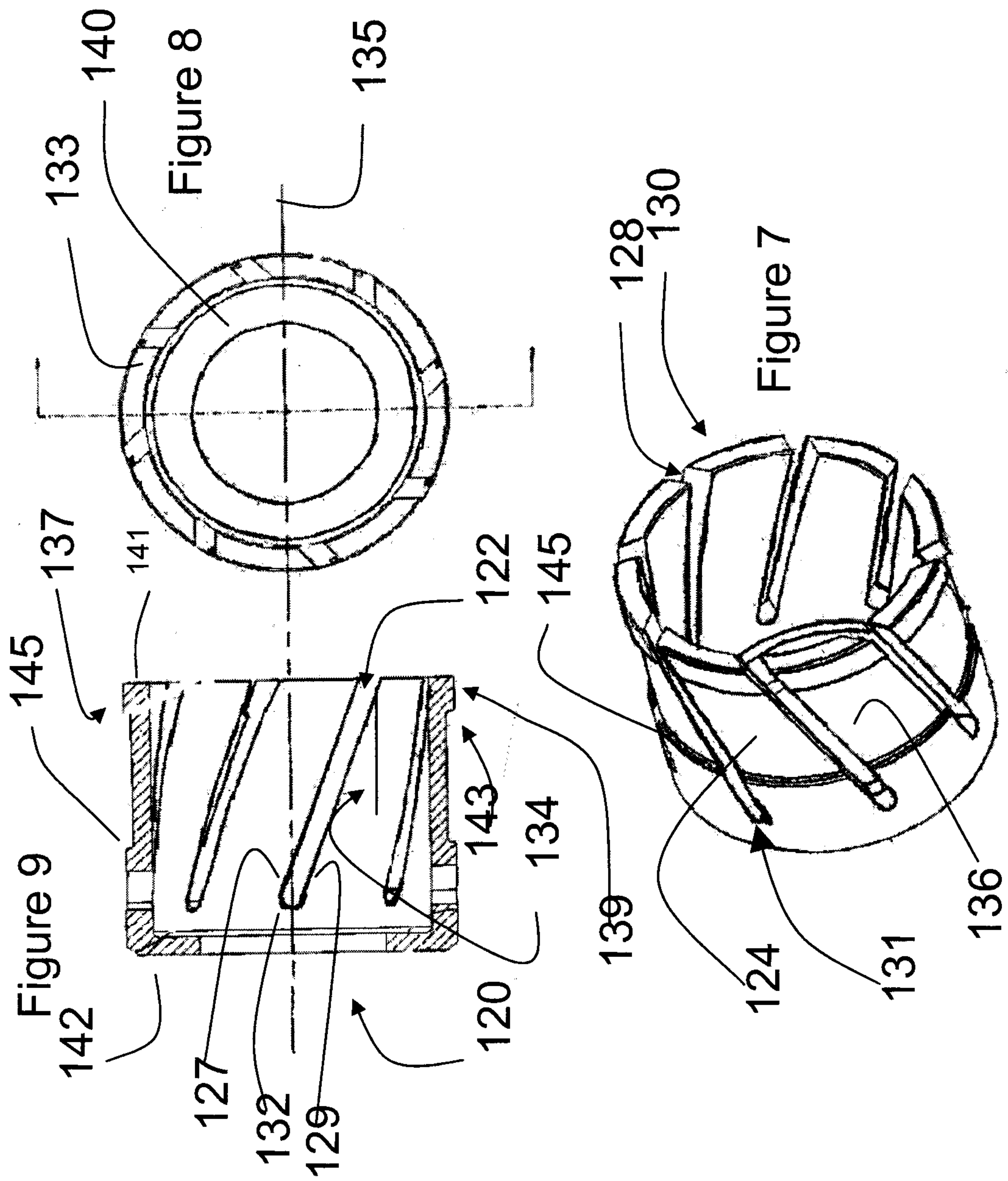
84. The damper of Claims 2, 17, 28 and 36 wherein the spring steel ring comprises a first end, a second end, a smooth inside surface, a smooth outside surface, a top, a bottom, a middle and an inclined gap at a predetermined angle between said first end and said second end wherein said gap permits placement of said spring steel ring over the damper hollow tubular body.
85. The spring steel ring as claimed in Claim 84 further including an oval-shaped aperture disposed opposite the gap, wherein said aperture reduces the mass of the ring thereby modifying its tension characteristics.
86. The spring steel ring as claimed in claim 85 further including a first notch and a second notch disposed respectively over and under the oval-shaped aperture, said first and second notch adapted to facilitate manufacture of the ring.
87. The spring steel ring as claimed in claim 86 further comprising a single train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring wherein each of said plurality of dimples has a concave side on the outside surface of the ring and a convex side on the inside surface of the ring so that said convex side of each dimple is in compressing contact with the outside surface of the sidewall of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite each dimple.
88. The spring steel ring as claimed in claim 87 further comprising a first and a second train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.

89. The spring steel ring as claimed in claim 88 further comprising a first, second and third train of a plurality of concavo-convex dimples disposed circumferentially around the middle of the ring.
90. The spring steel ring as claimed in Claims 87, 88 and 89 wherein each dimple of the plurality of concavo-convex dimples is apertured at their centres thereby reducing the mass and tension properties of the ring.
91. The spring steel ring as claimed in Claim 90 further including a single concave groove disposed about the middle of the ring wherein the outside concave surface of the groove corresponds to an adjacent convex projection about the middle of the inside surface of the ring, said convex projection in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projection.
92. The spring steel ring as claimed in claim 91 wherein there is a first and a second concave groove disposed around the middle of the ring respectively above and below the aperture.
93. The spring steel ring as claimed in claim 92 further comprising a plurality of concave indentations equally spaced about the circumference of the ring and parallel to the axis thereof, wherein each concave indentation of said plurality of indentations on the outside surface of the ring corresponds to a convex projection on the inside surface of the ring, and further wherein each of said convex projections is in compressed contact with the outside surface of the damper hollow tubular body resulting in enhanced frictional contact between the inside surface of the damper hollow tubular body and outside surface of the valve spring opposite the convex projections.

94. The spring steel ring as claimed in Claim 93 wherein each of the indentations is apertured thereby reducing the mass and tension properties of the ring.







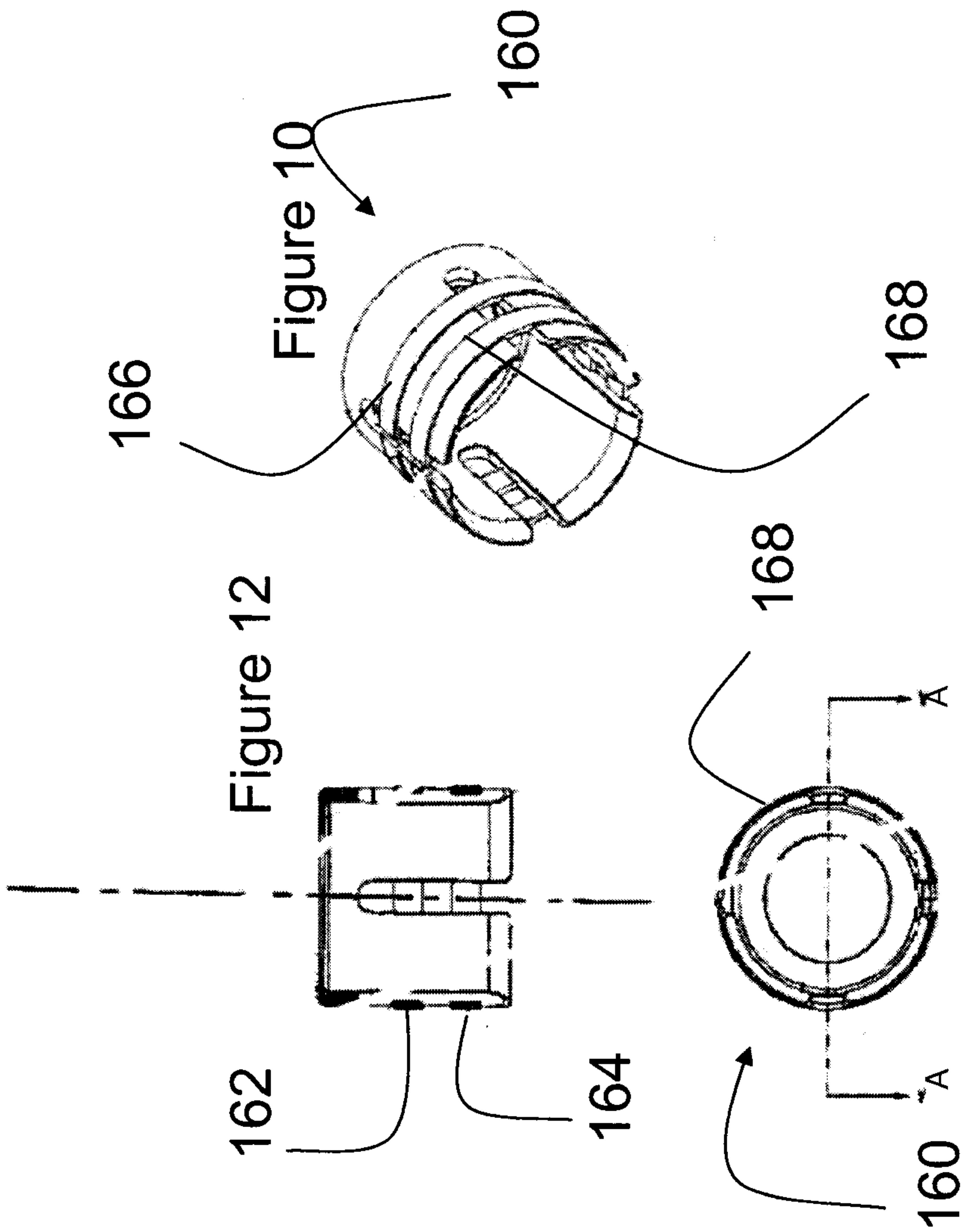
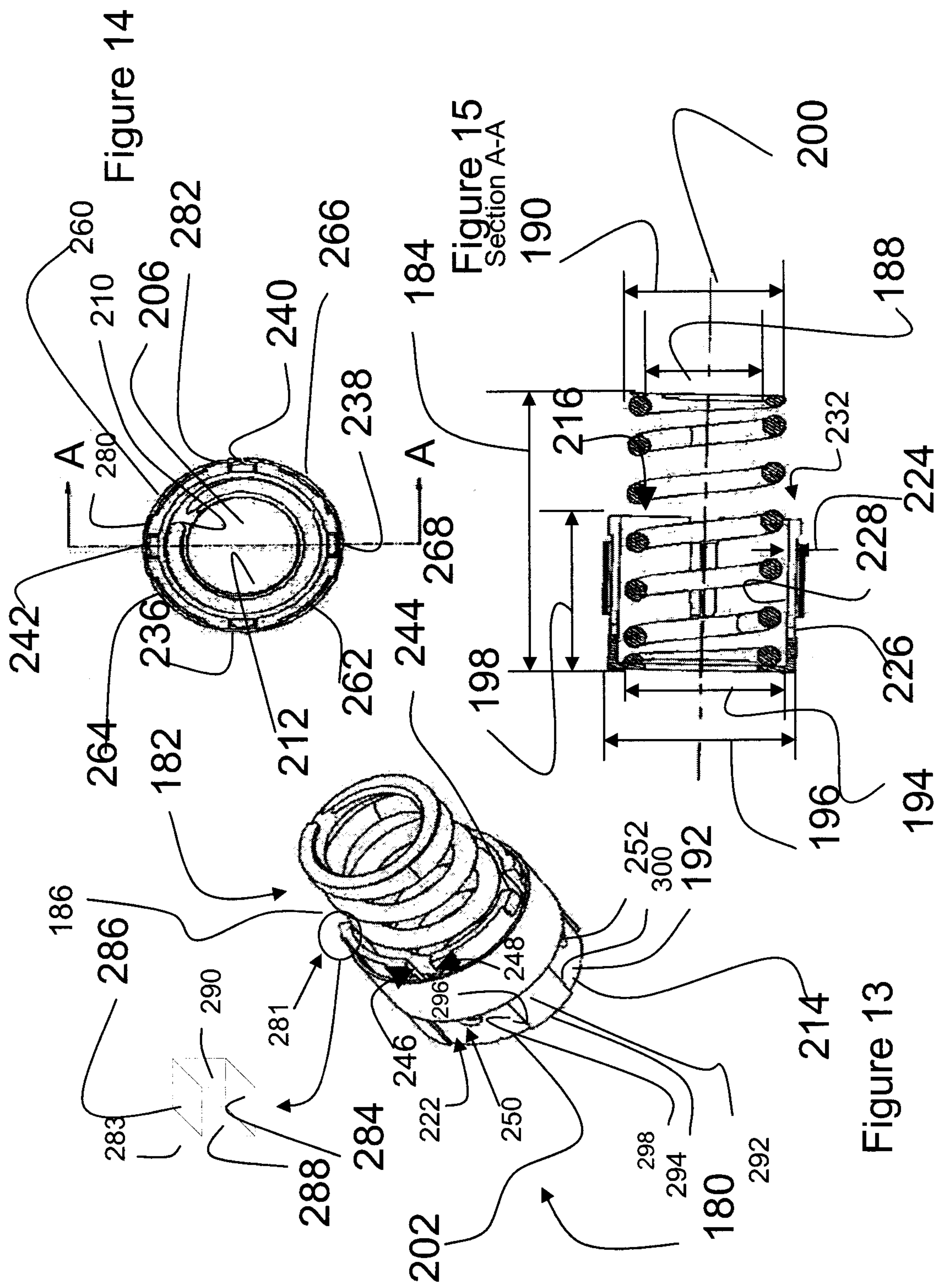
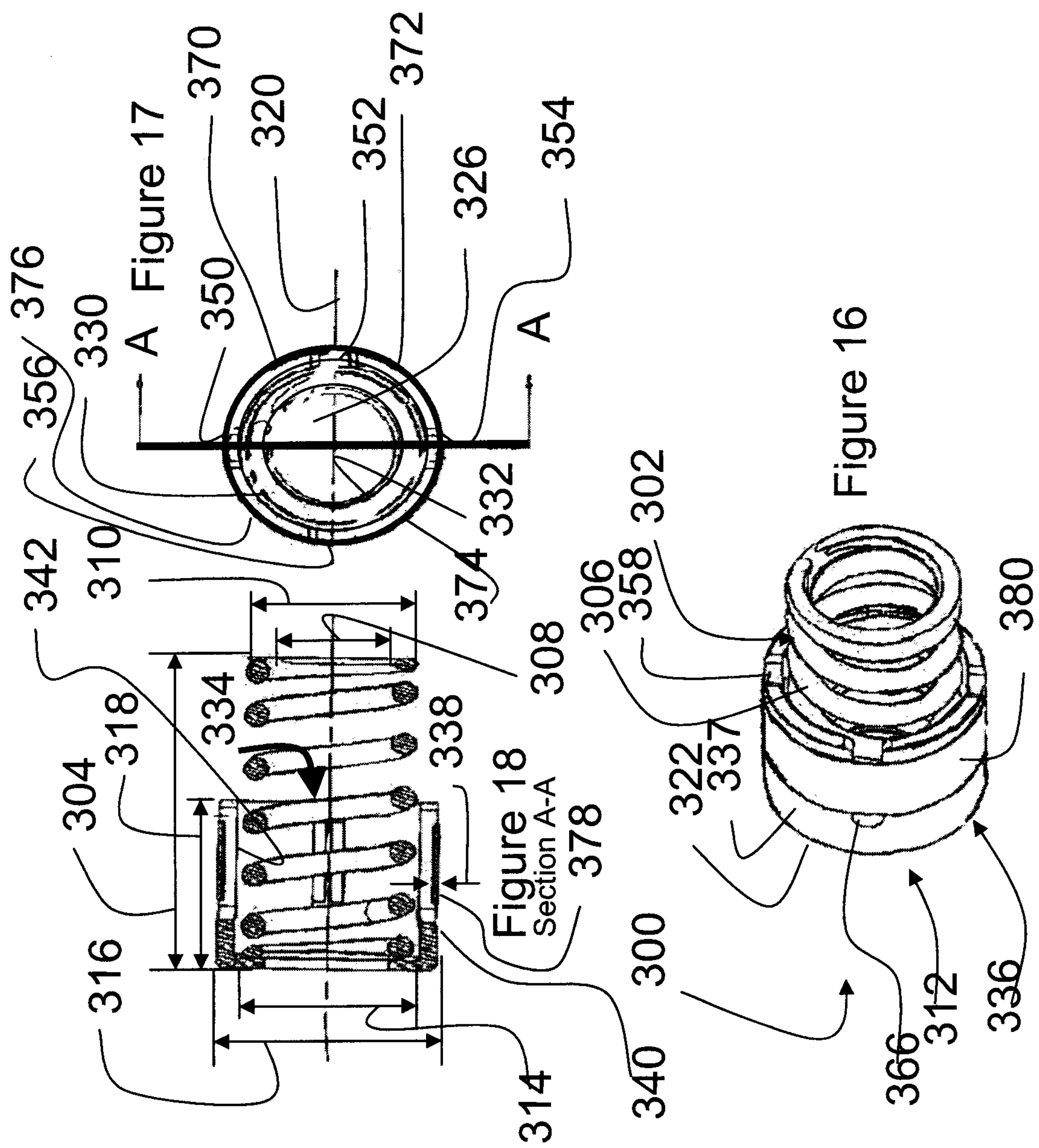
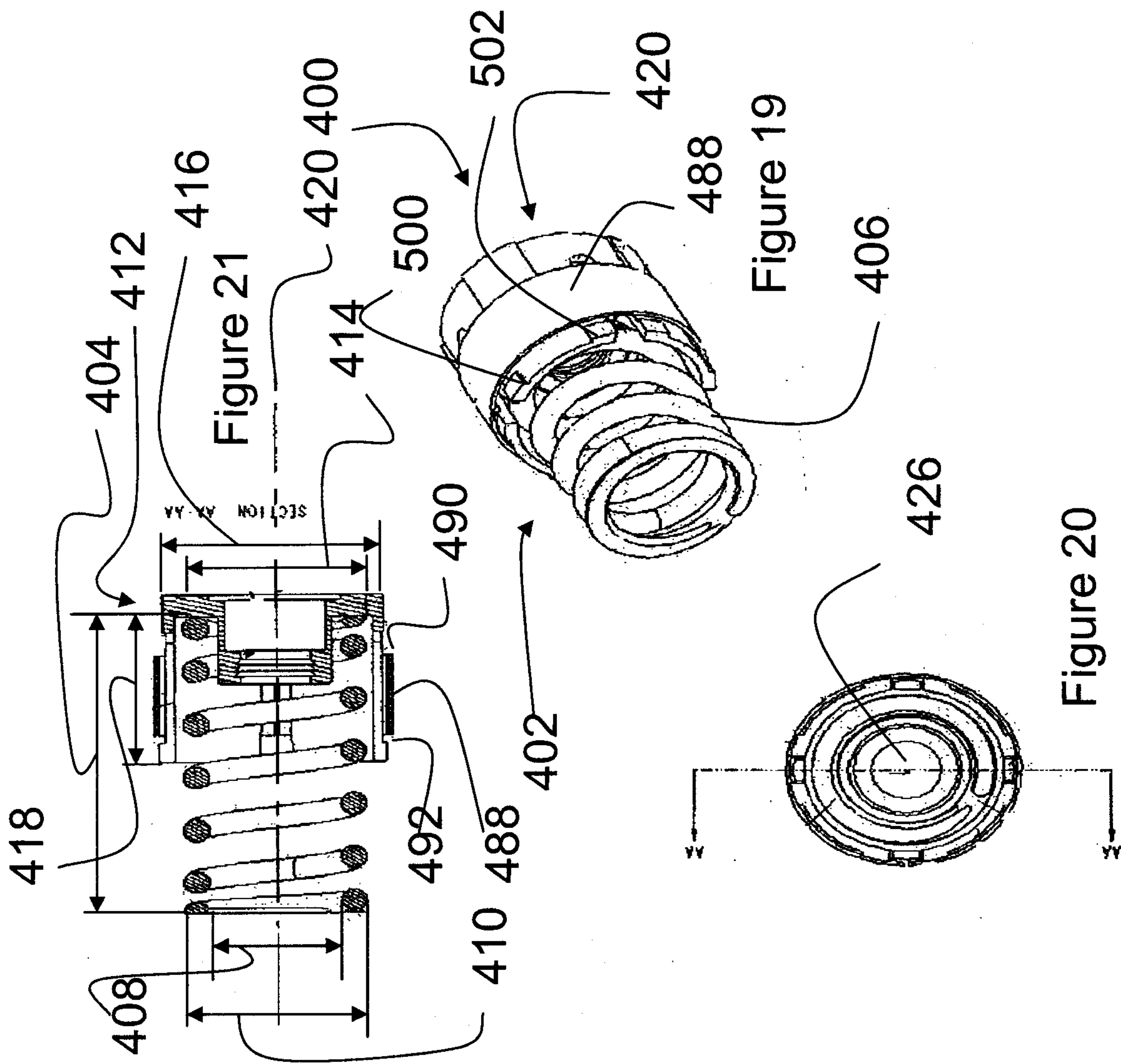
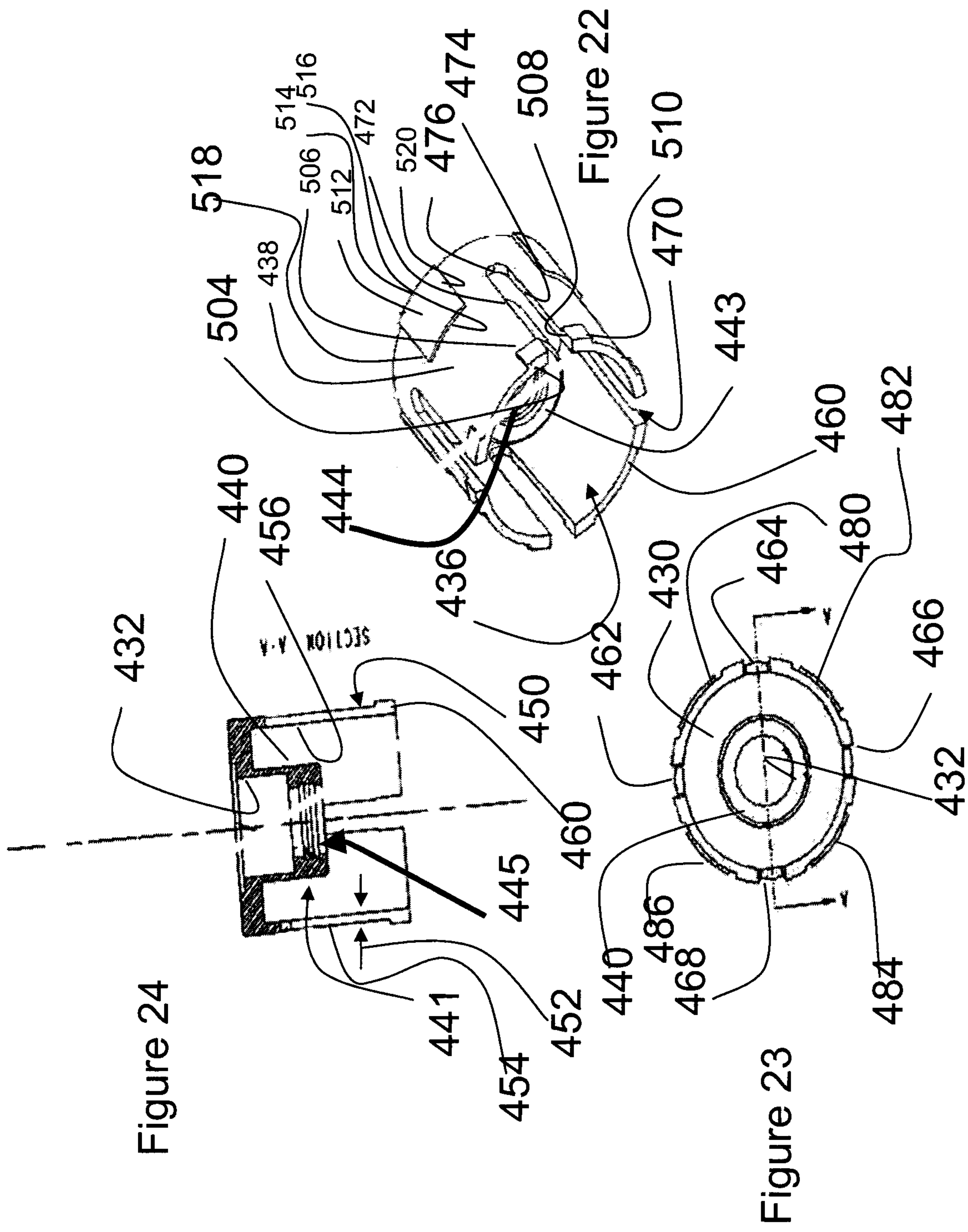


Figure 11









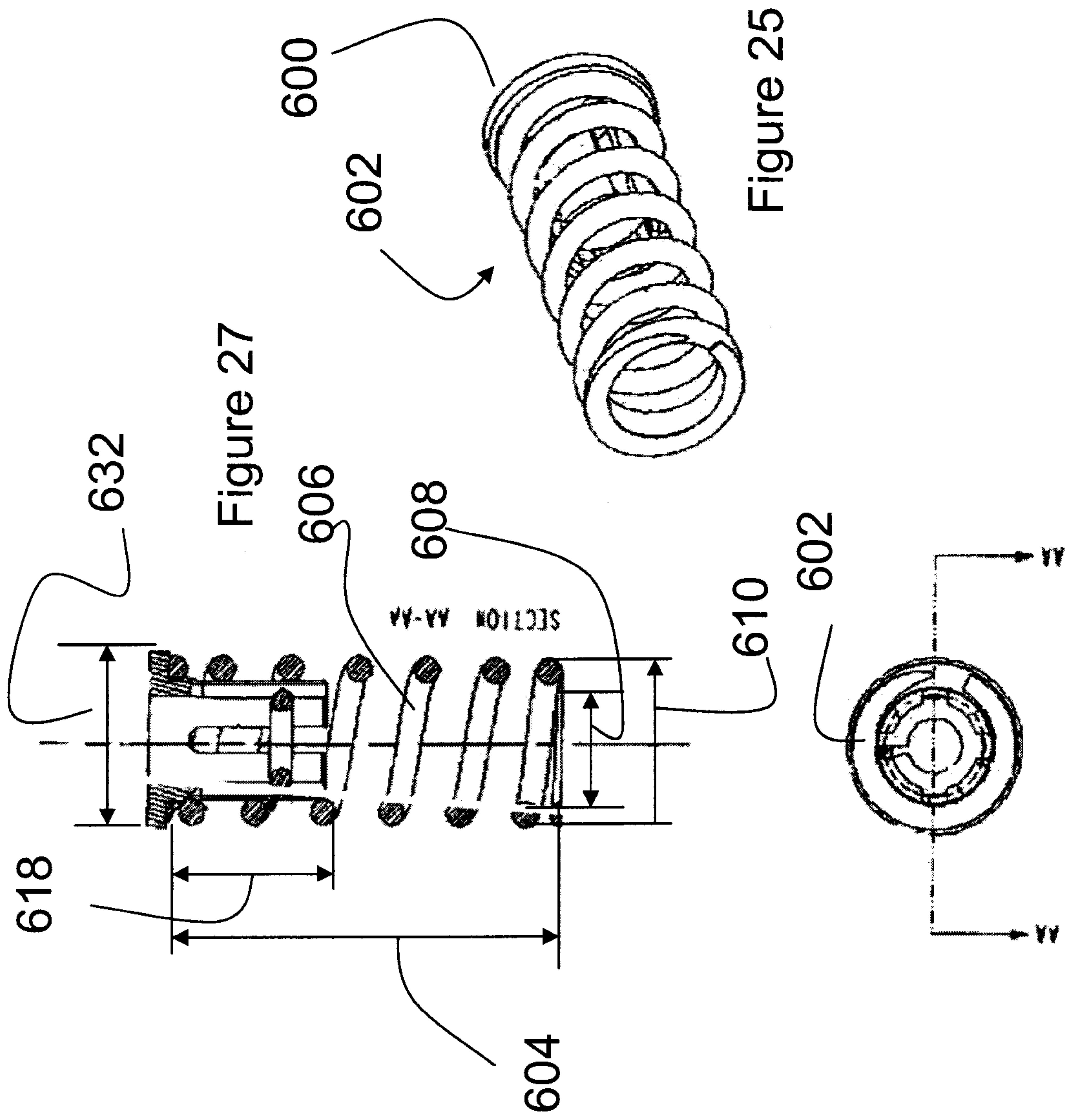


Figure 26

Figure 25

Figure 27

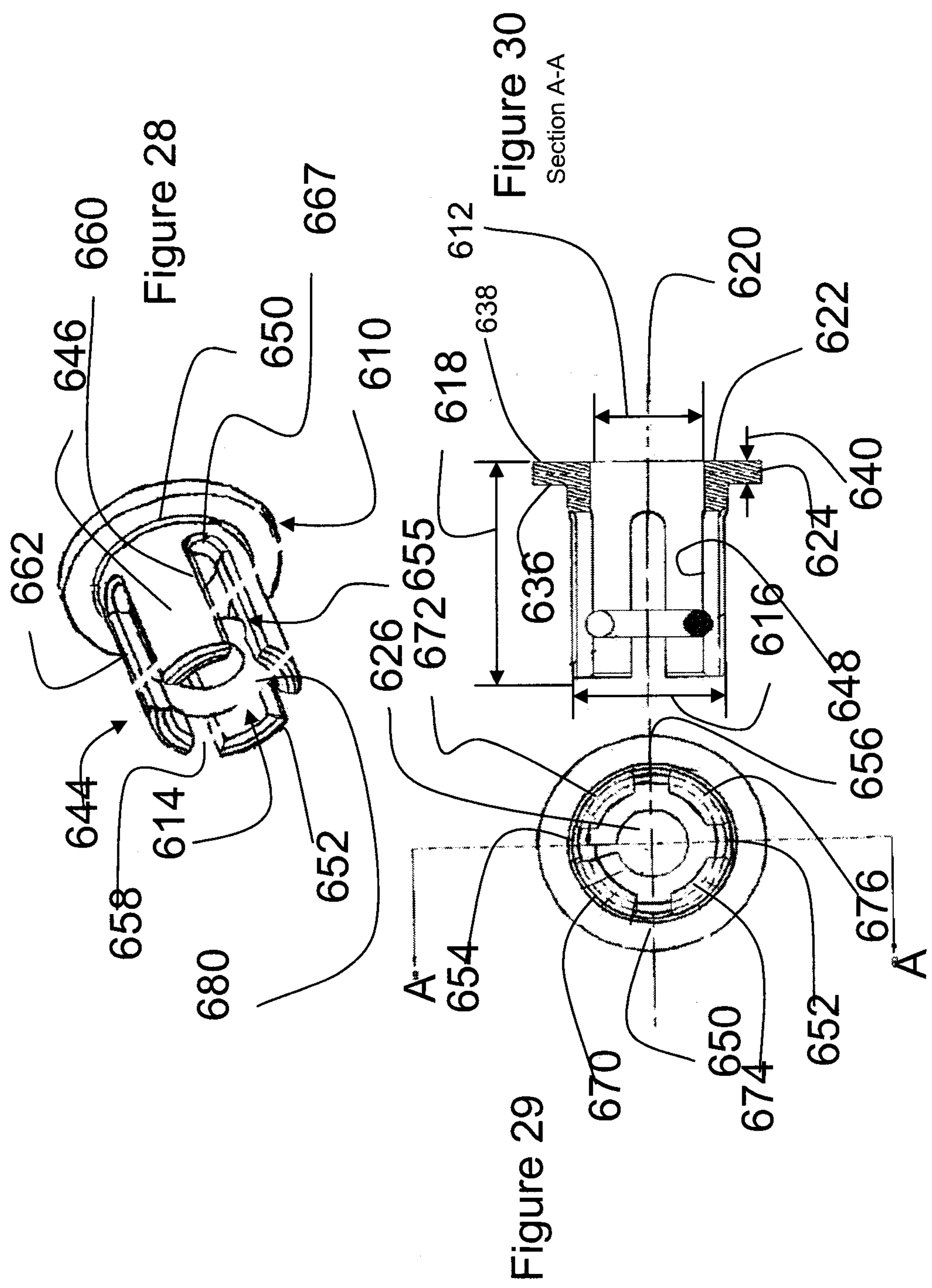
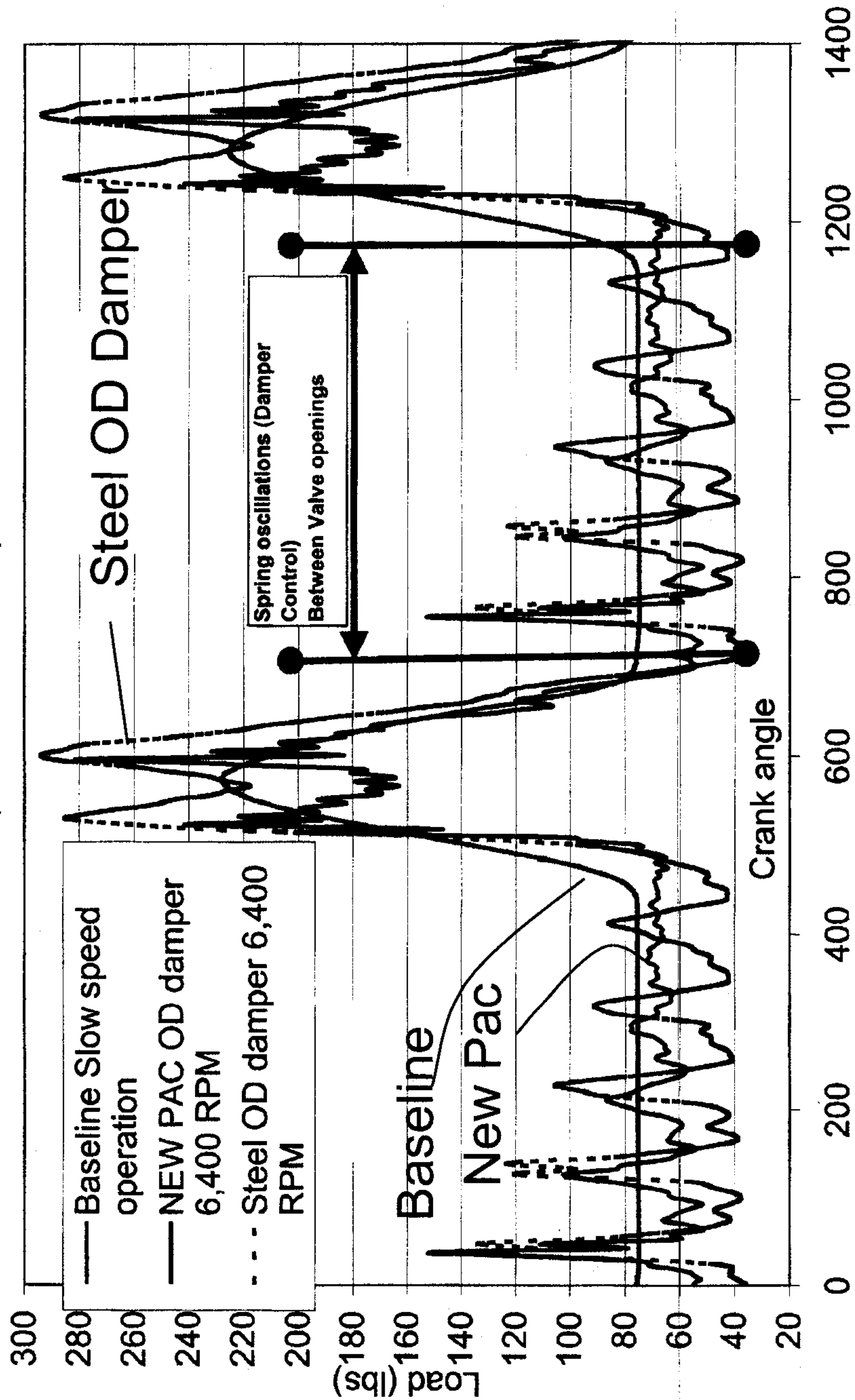


Figure 31
STEEL O.D. damper Vs. New design OD damper (oil temp 180 (F))
(INTAKE SPRING)



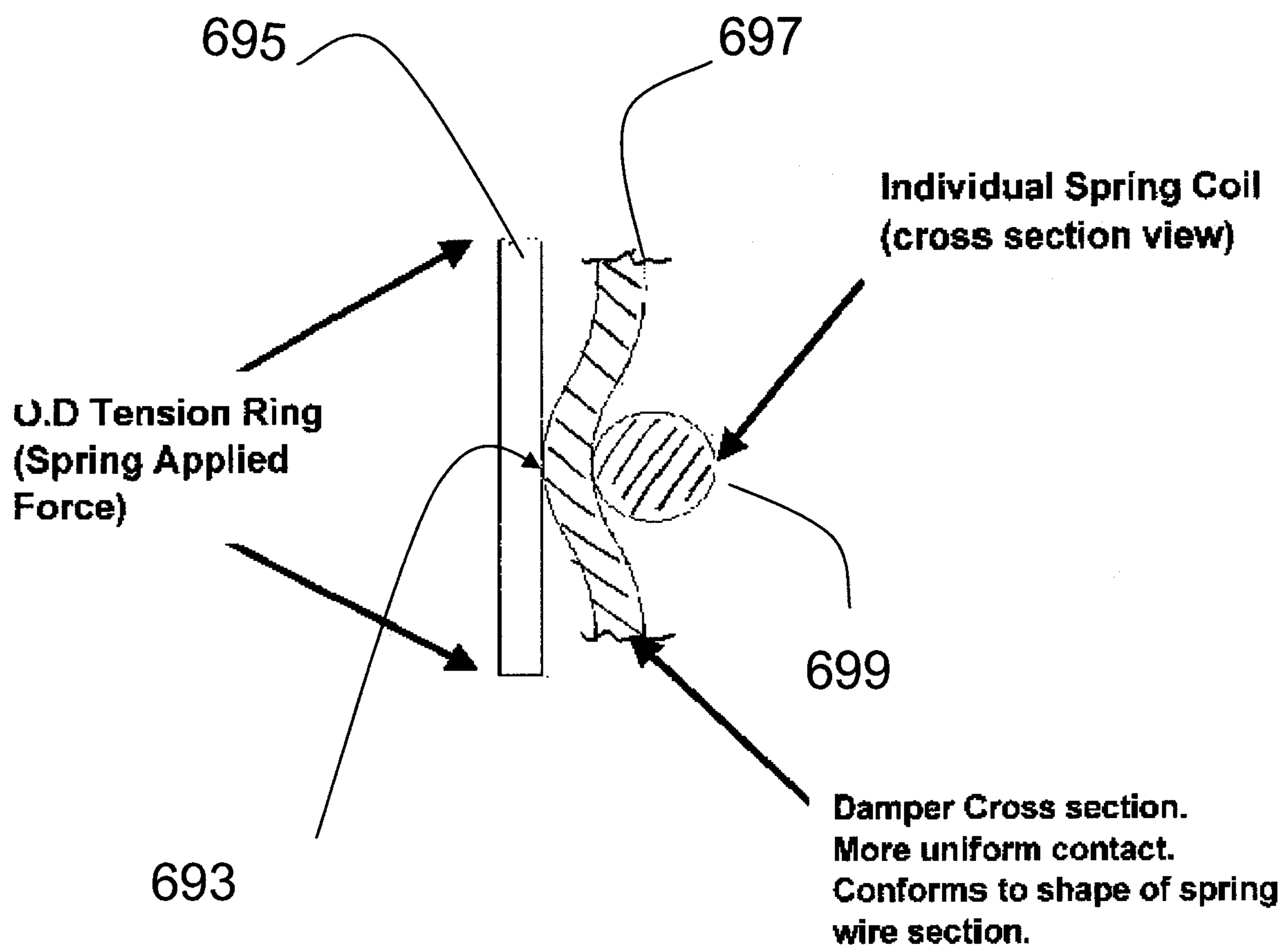
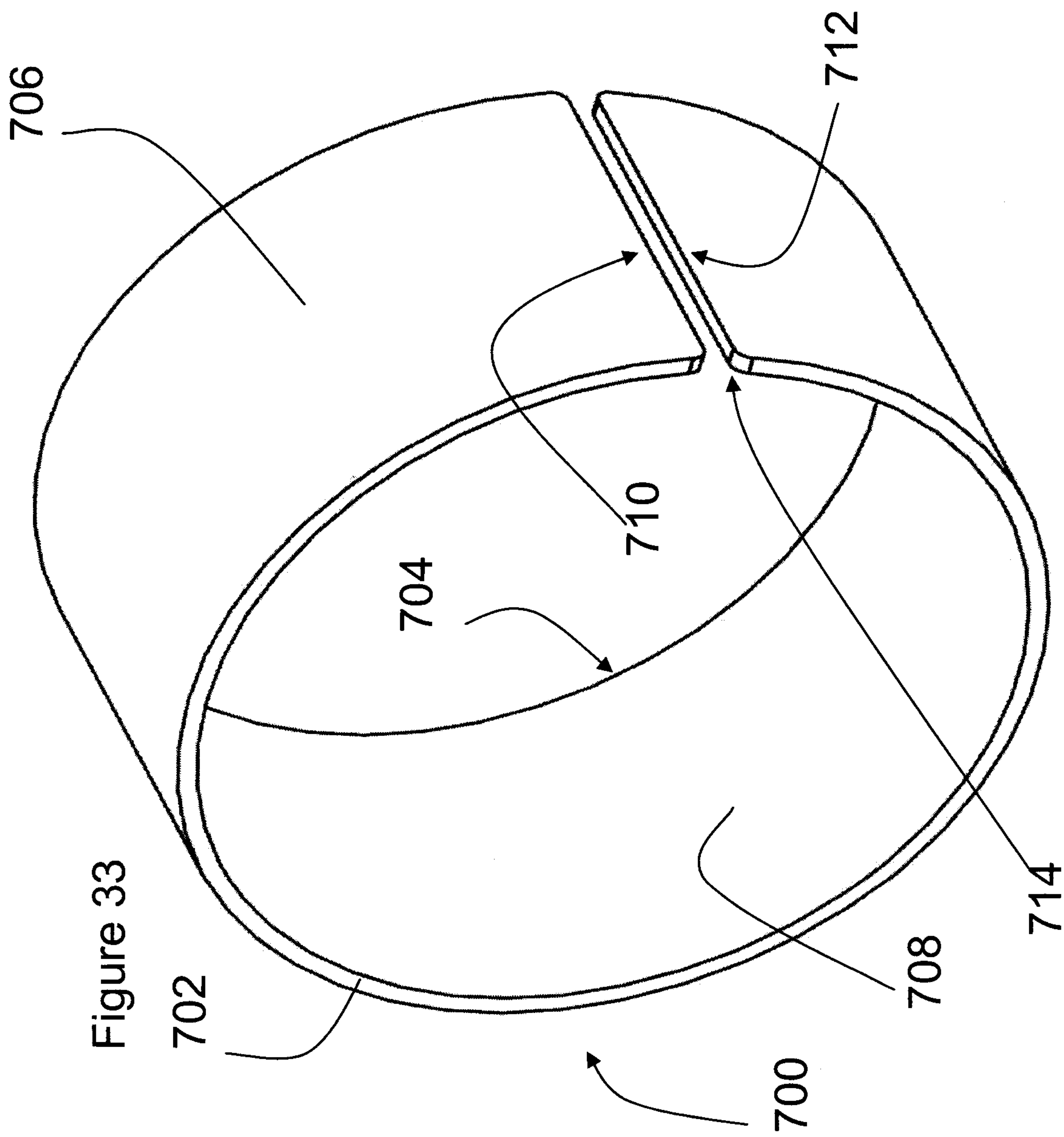


Figure 32



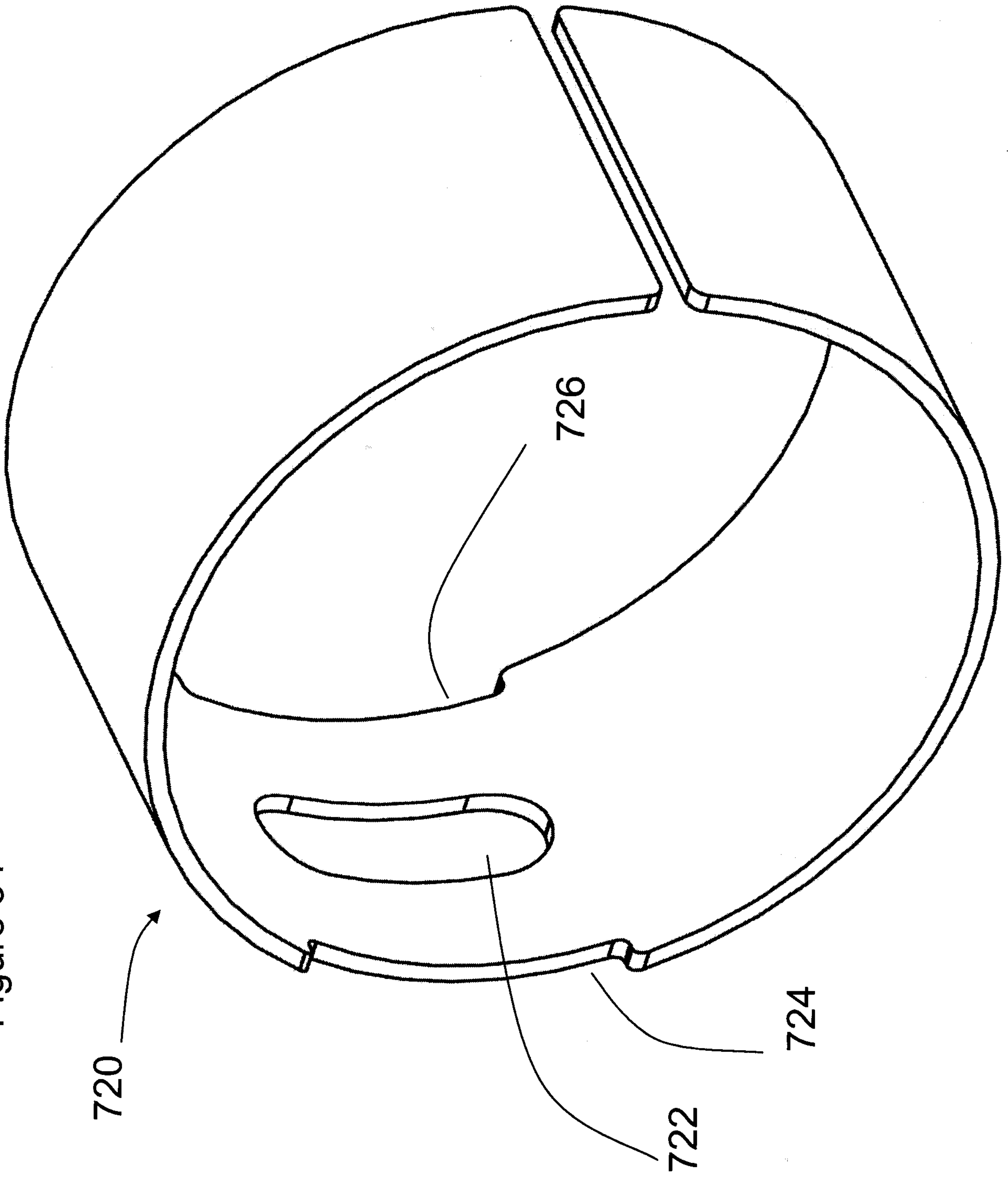
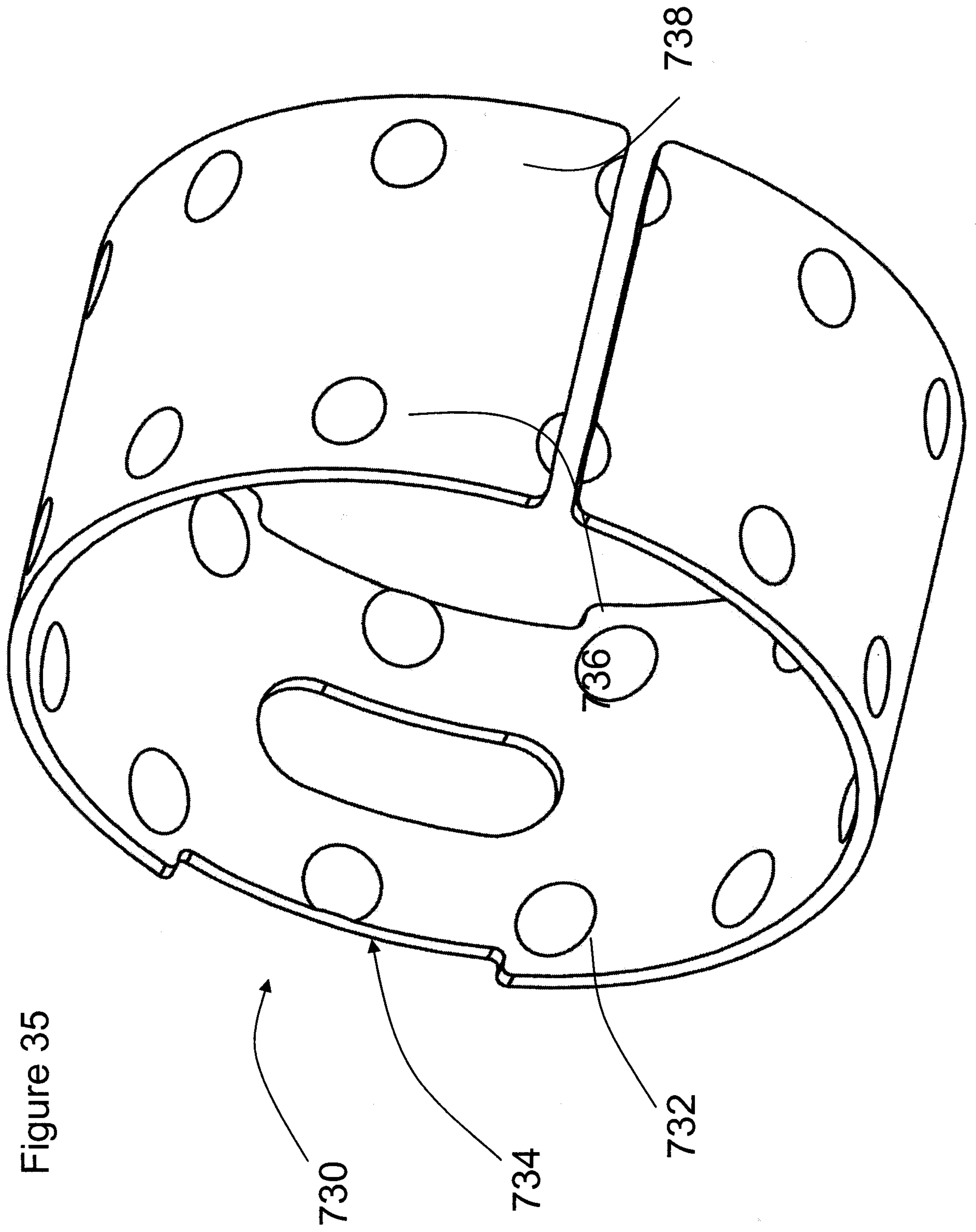


Figure 34



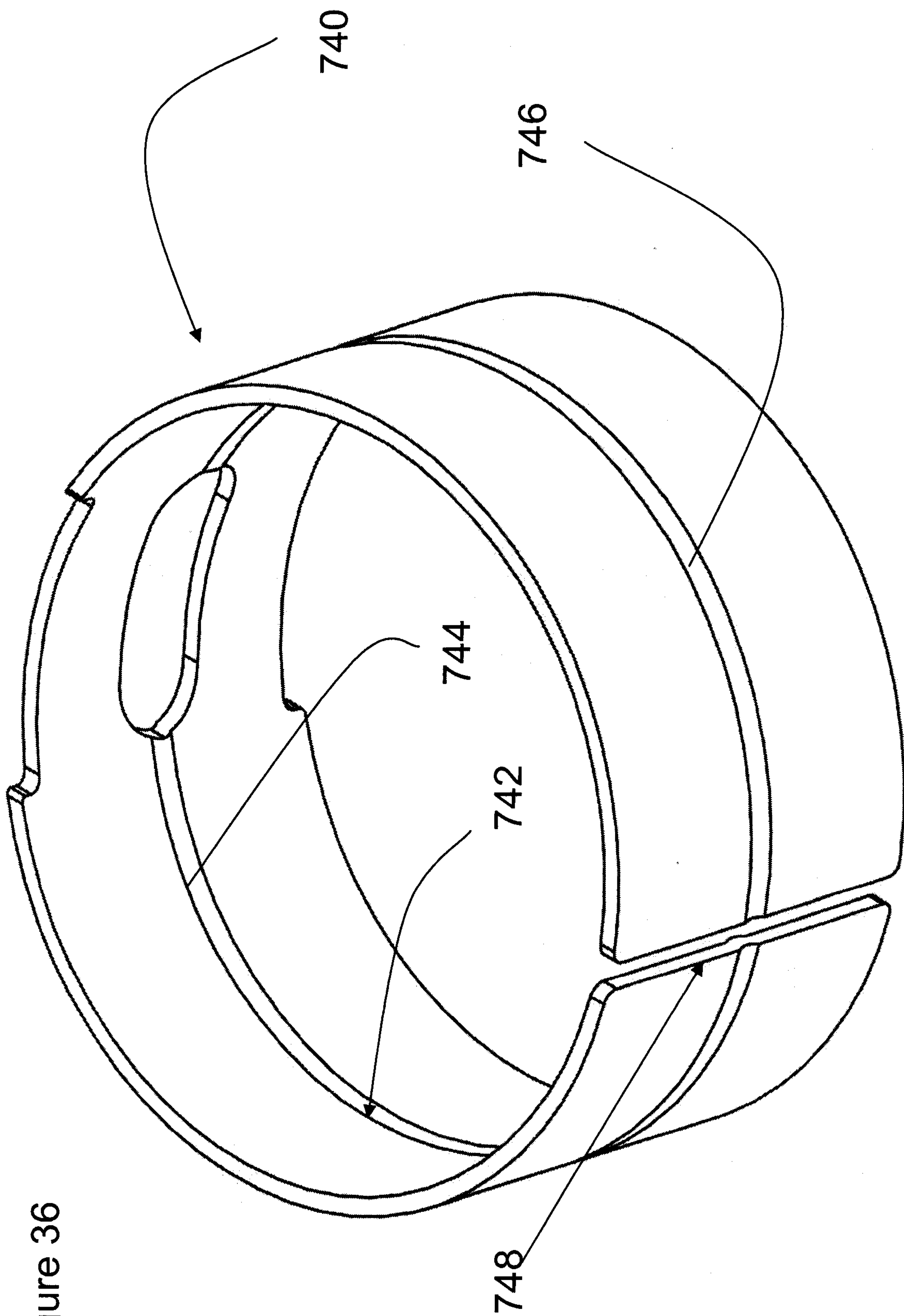
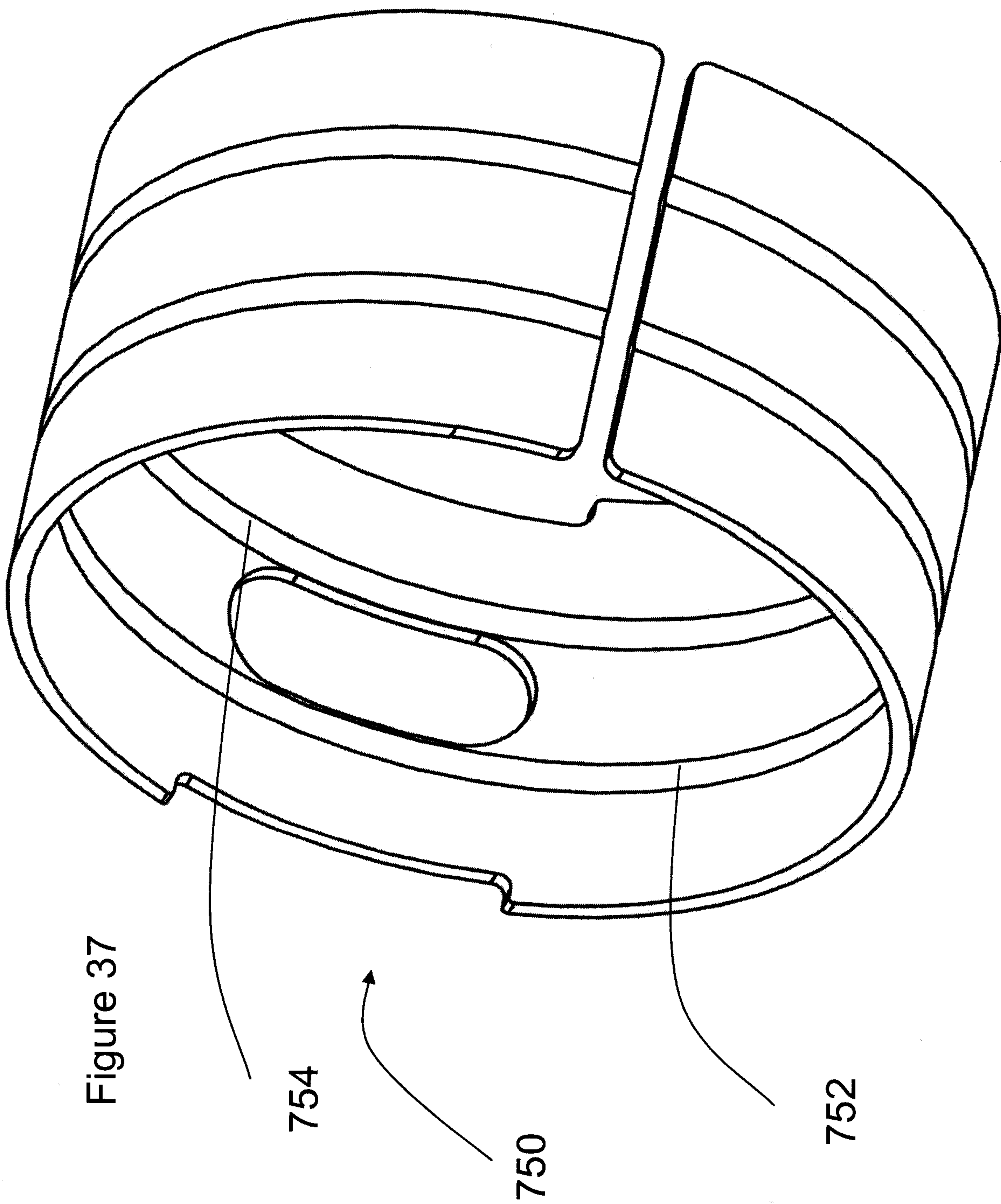
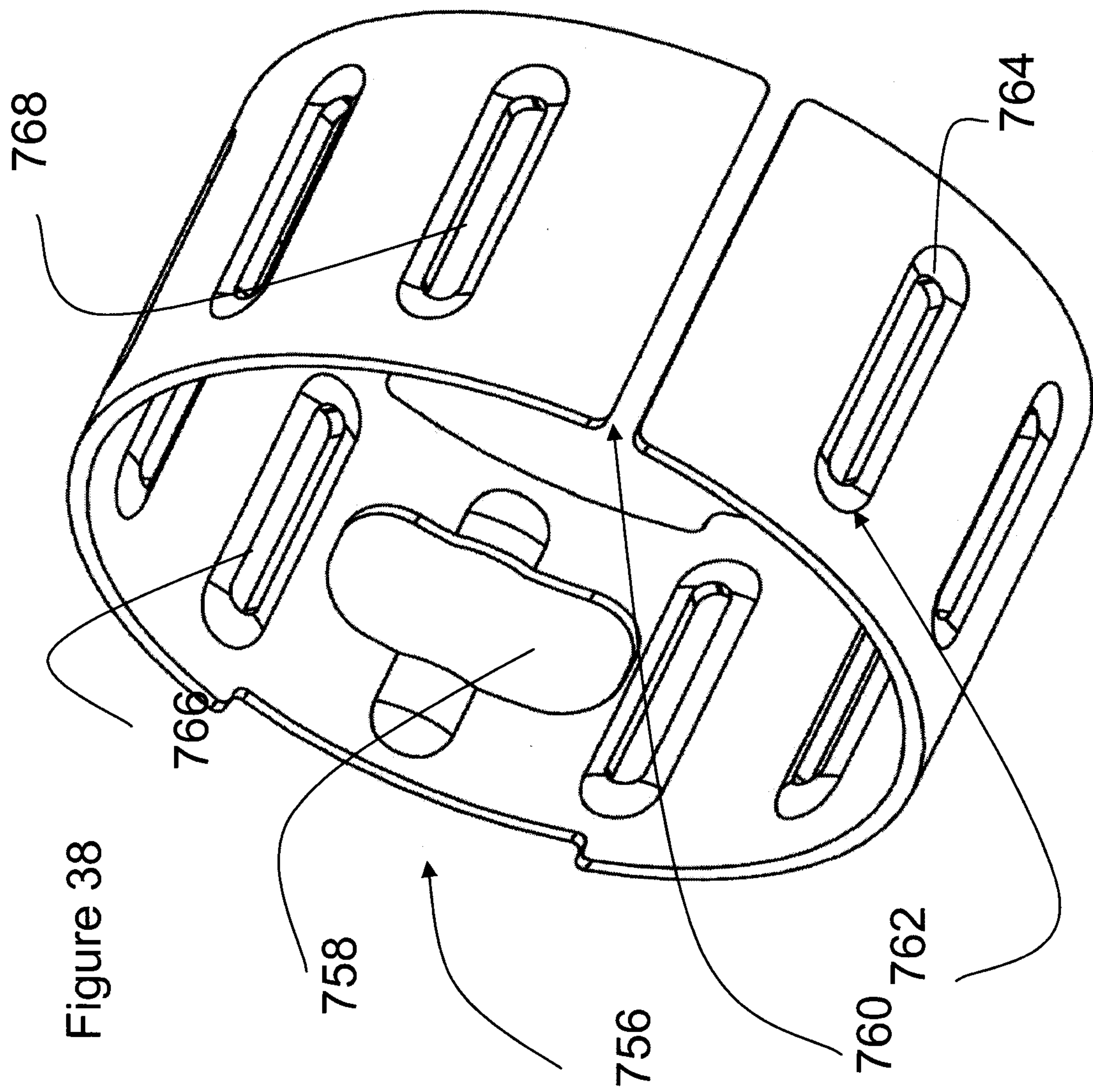
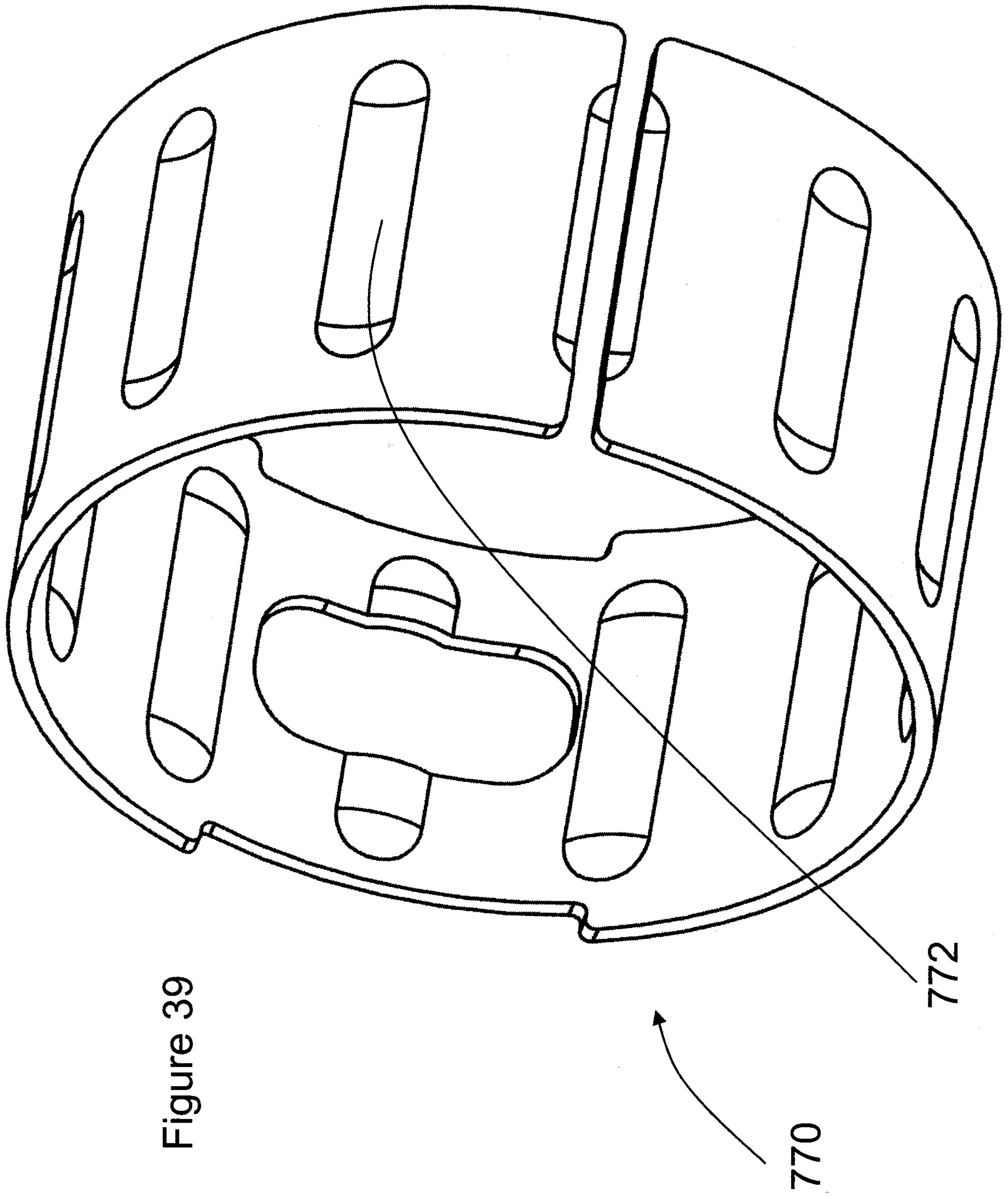


Figure 36







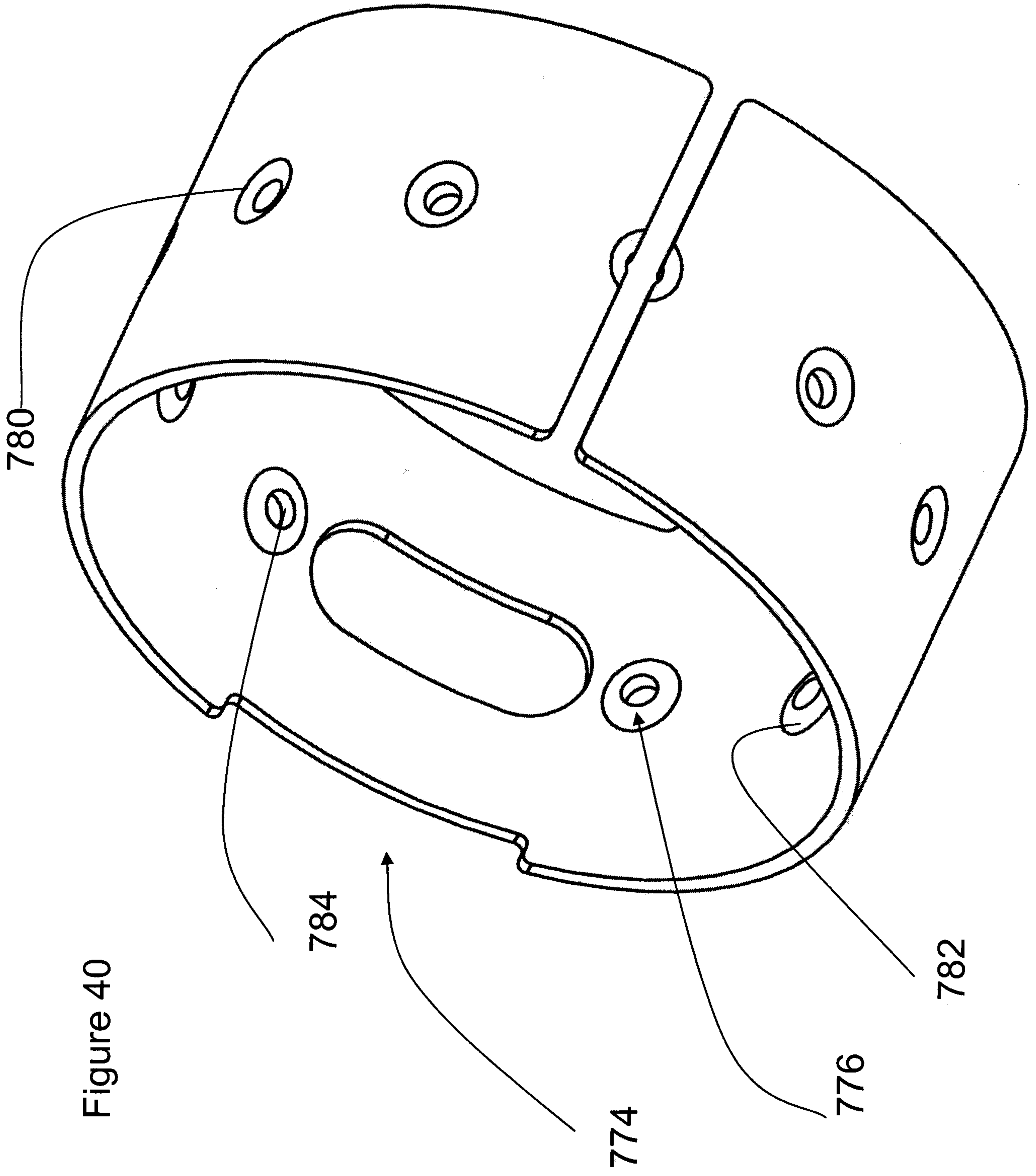
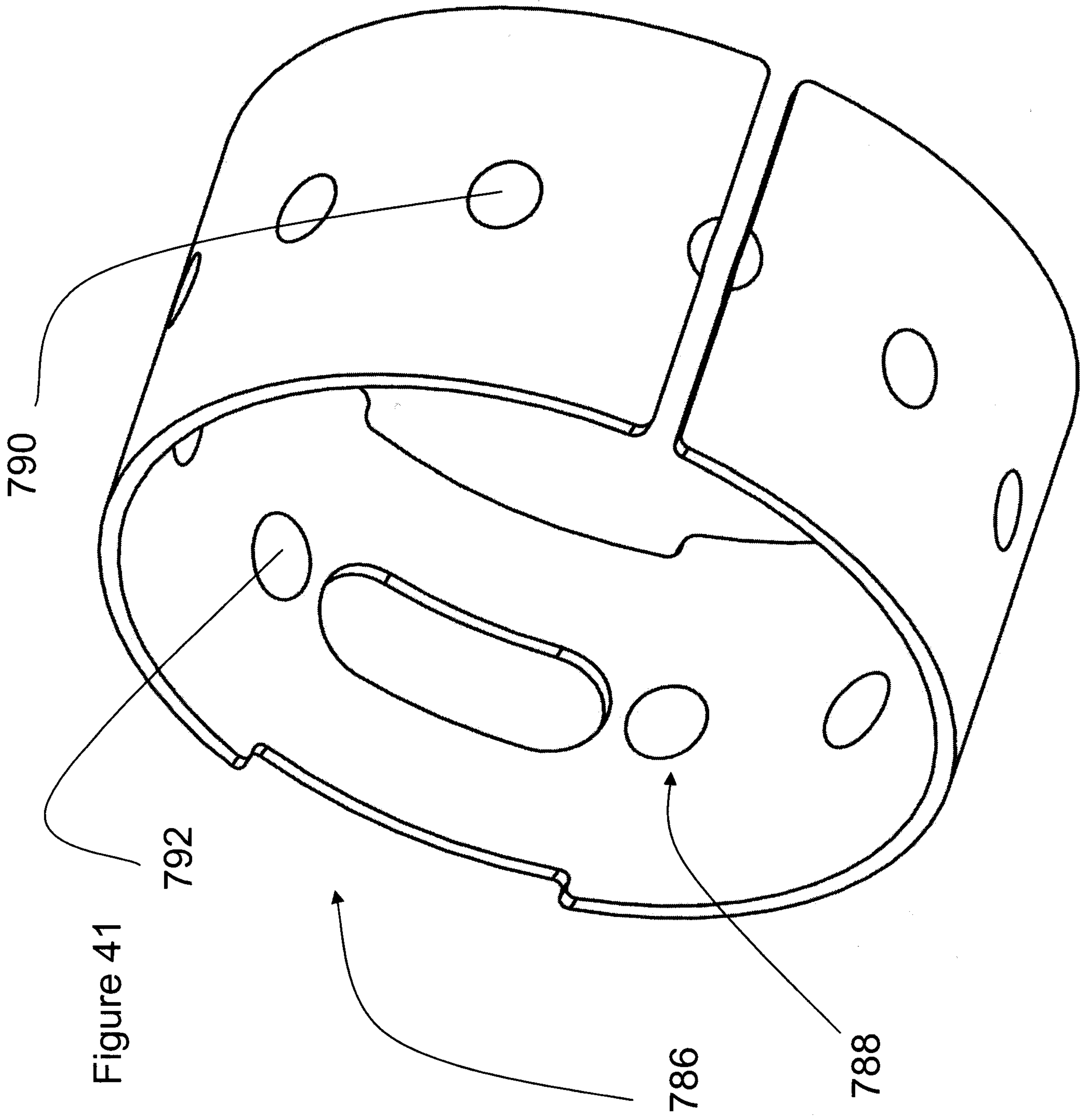
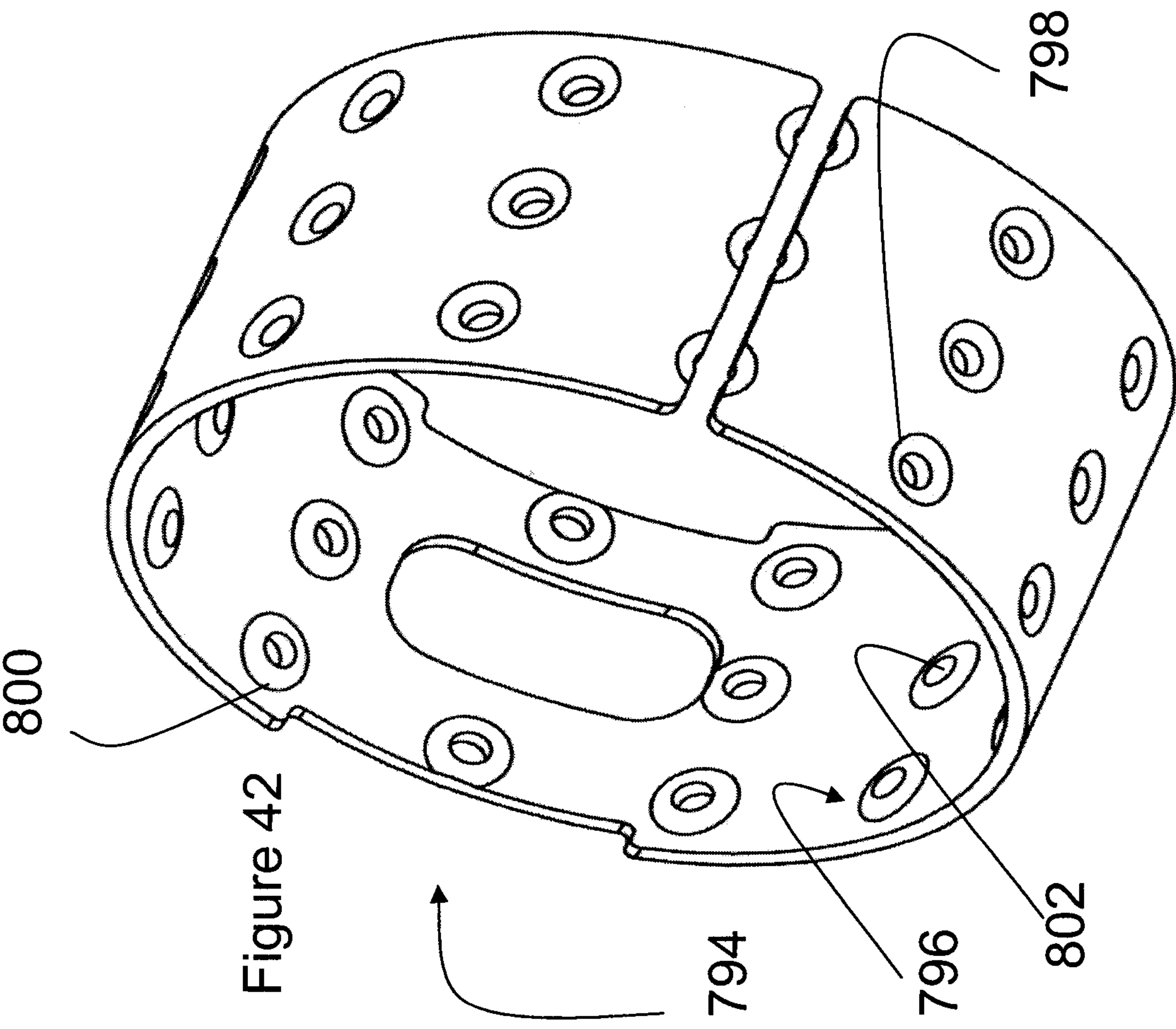
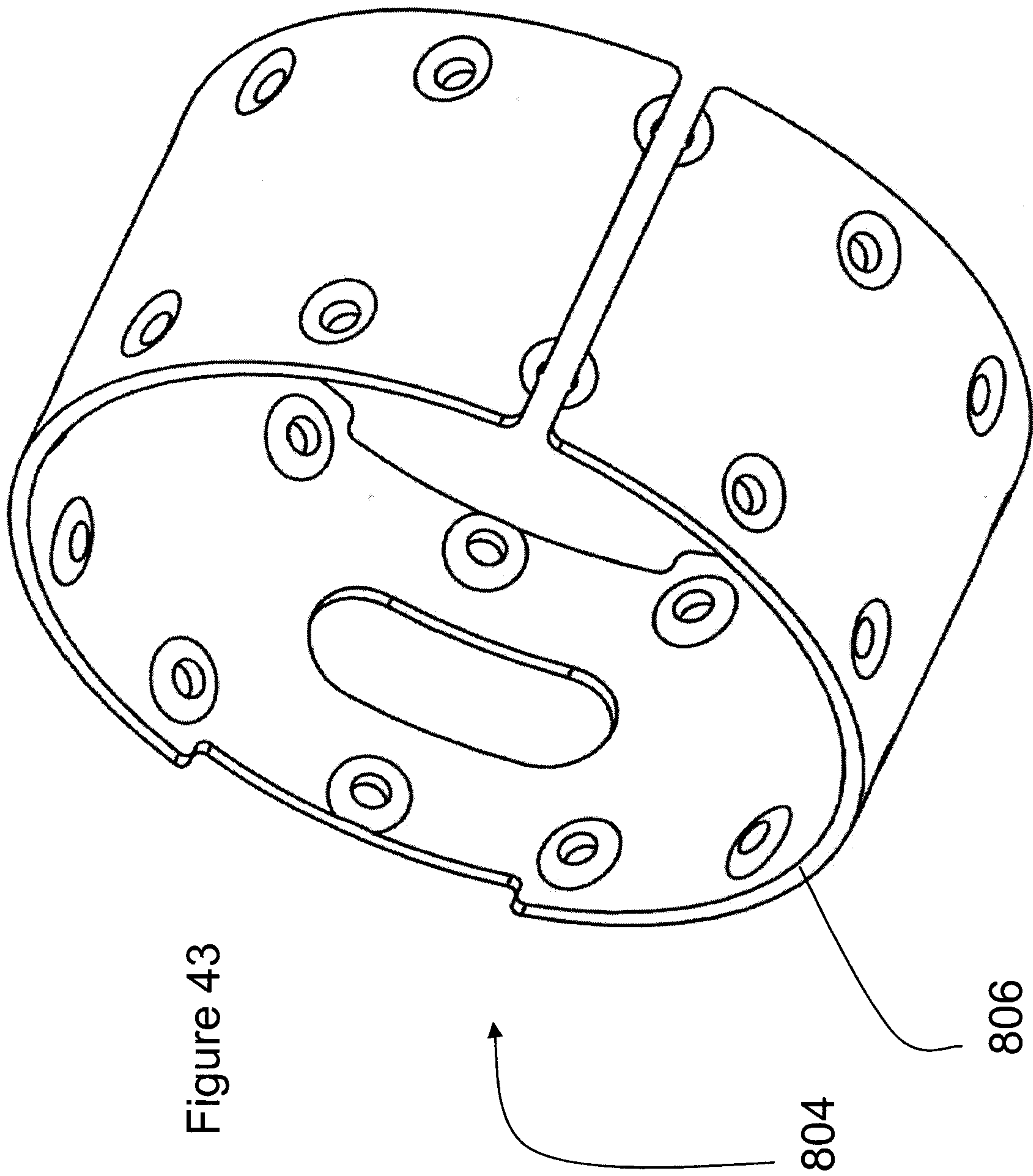
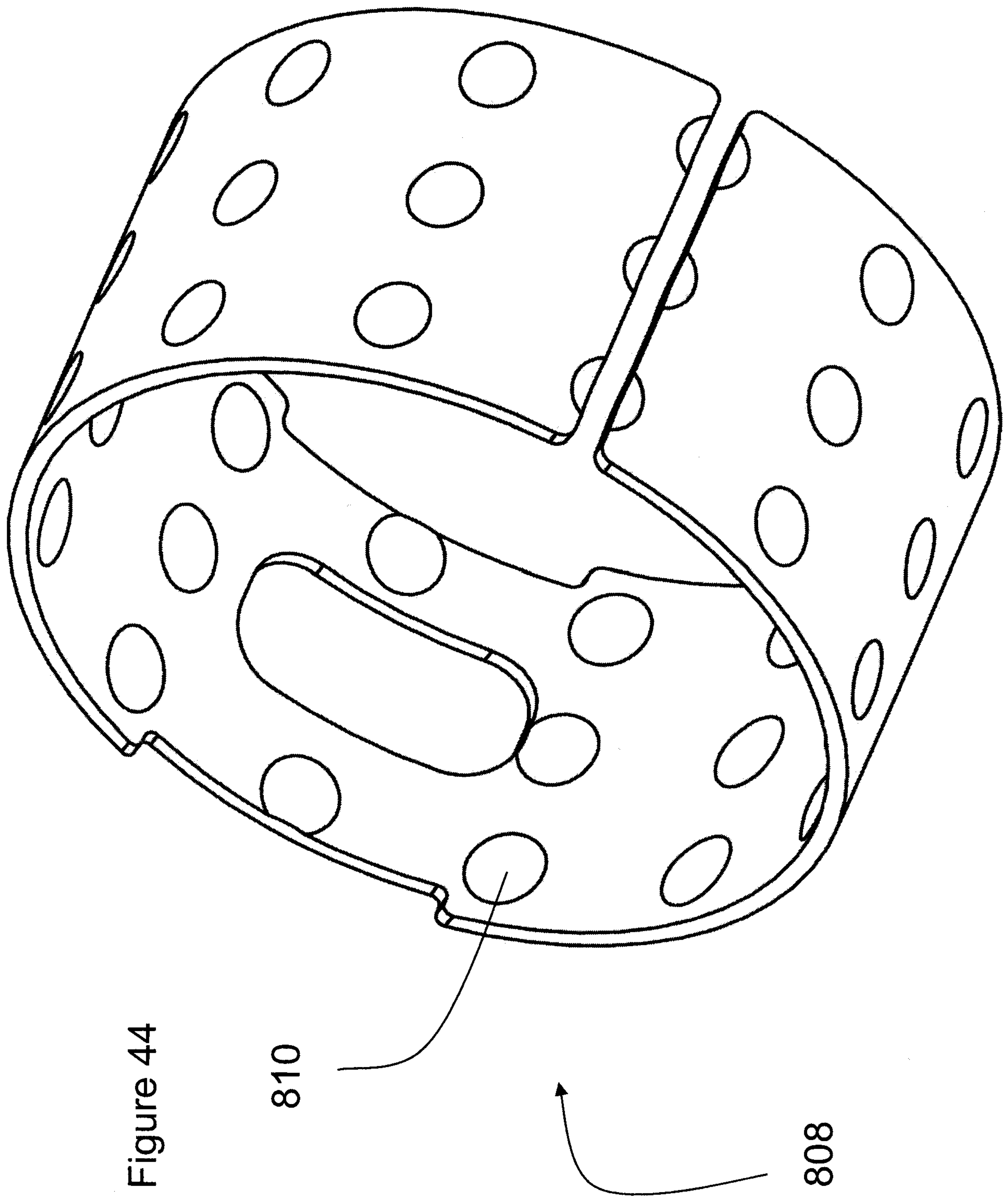


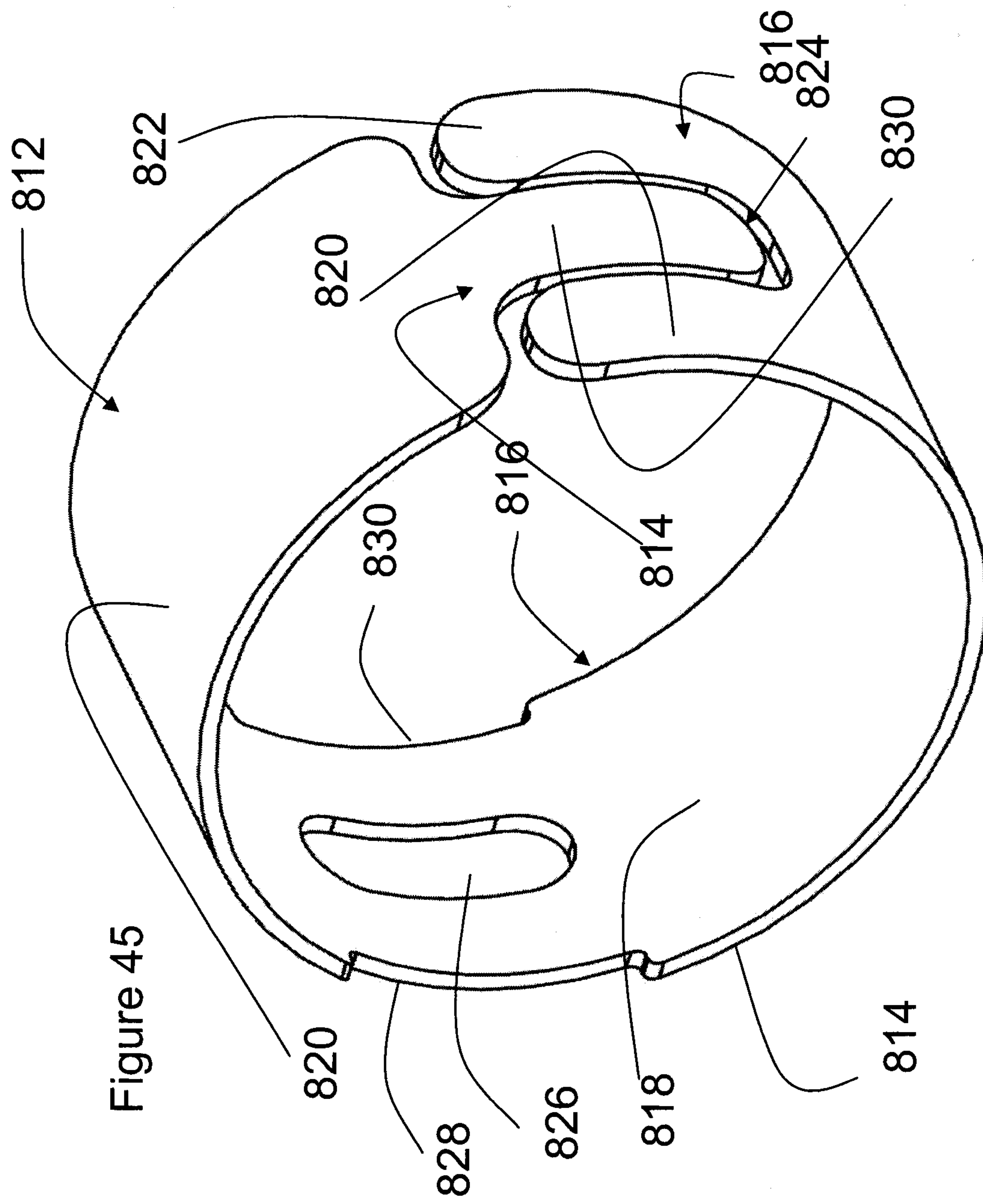
Figure 40











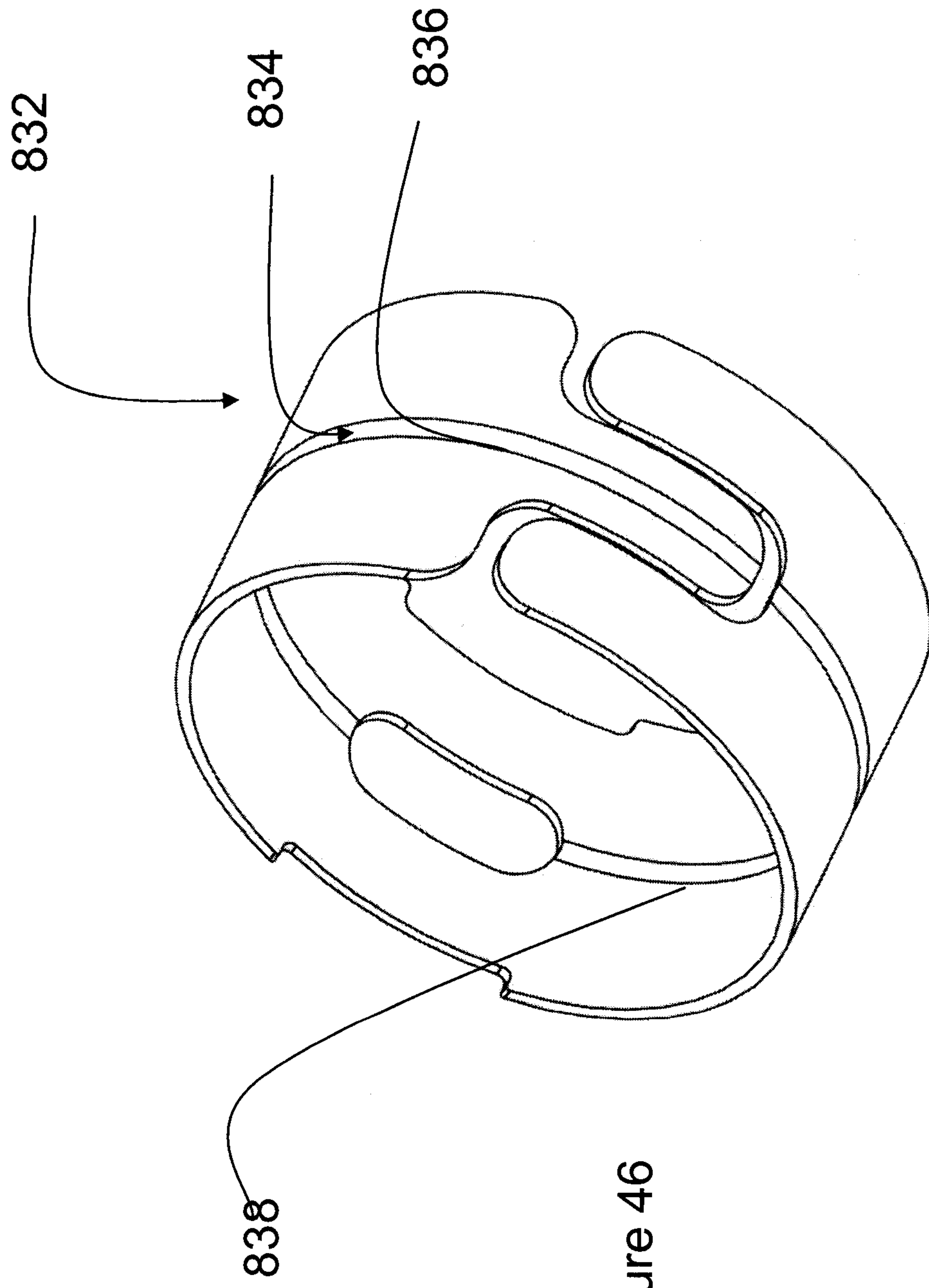


Figure 46

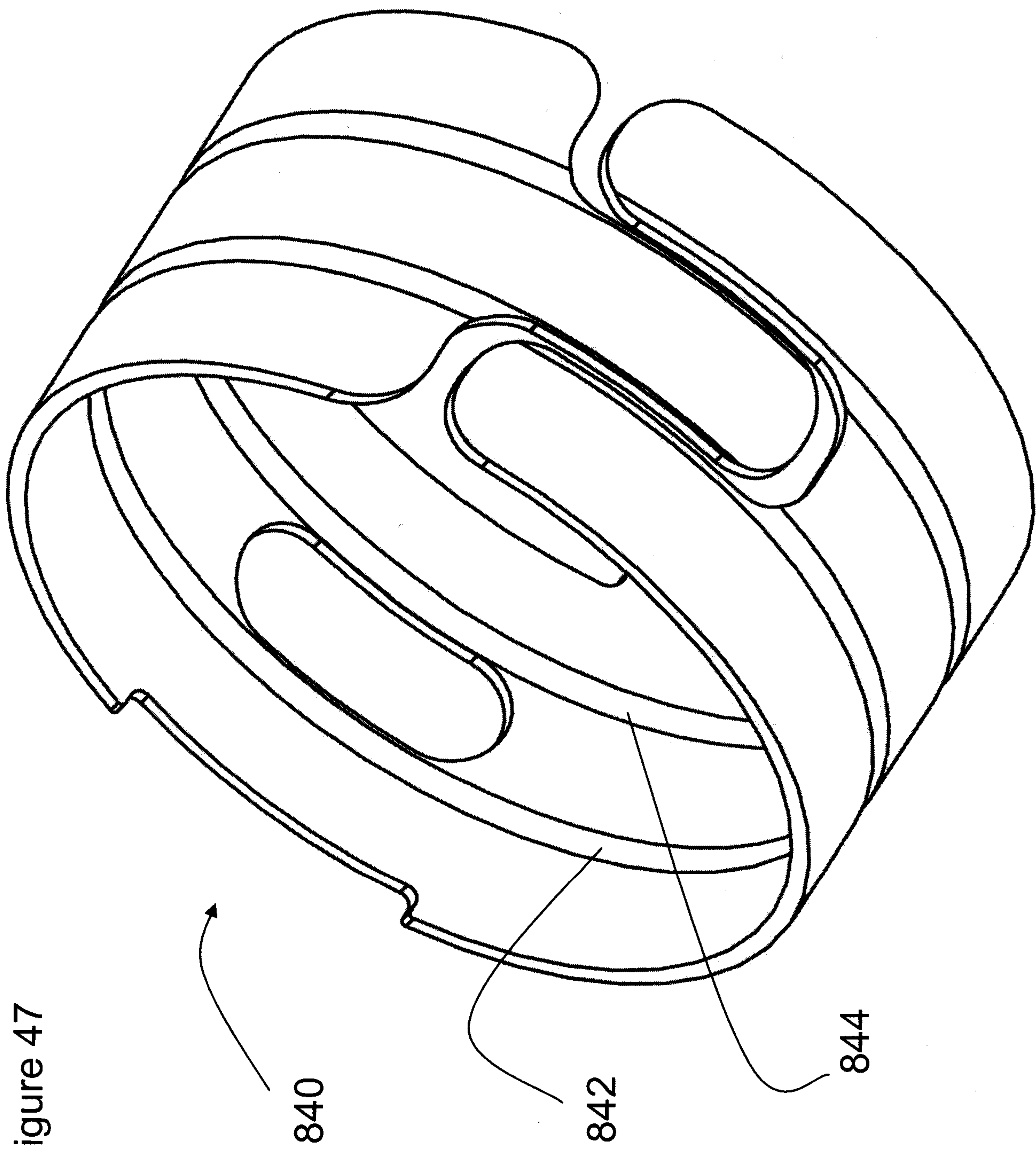
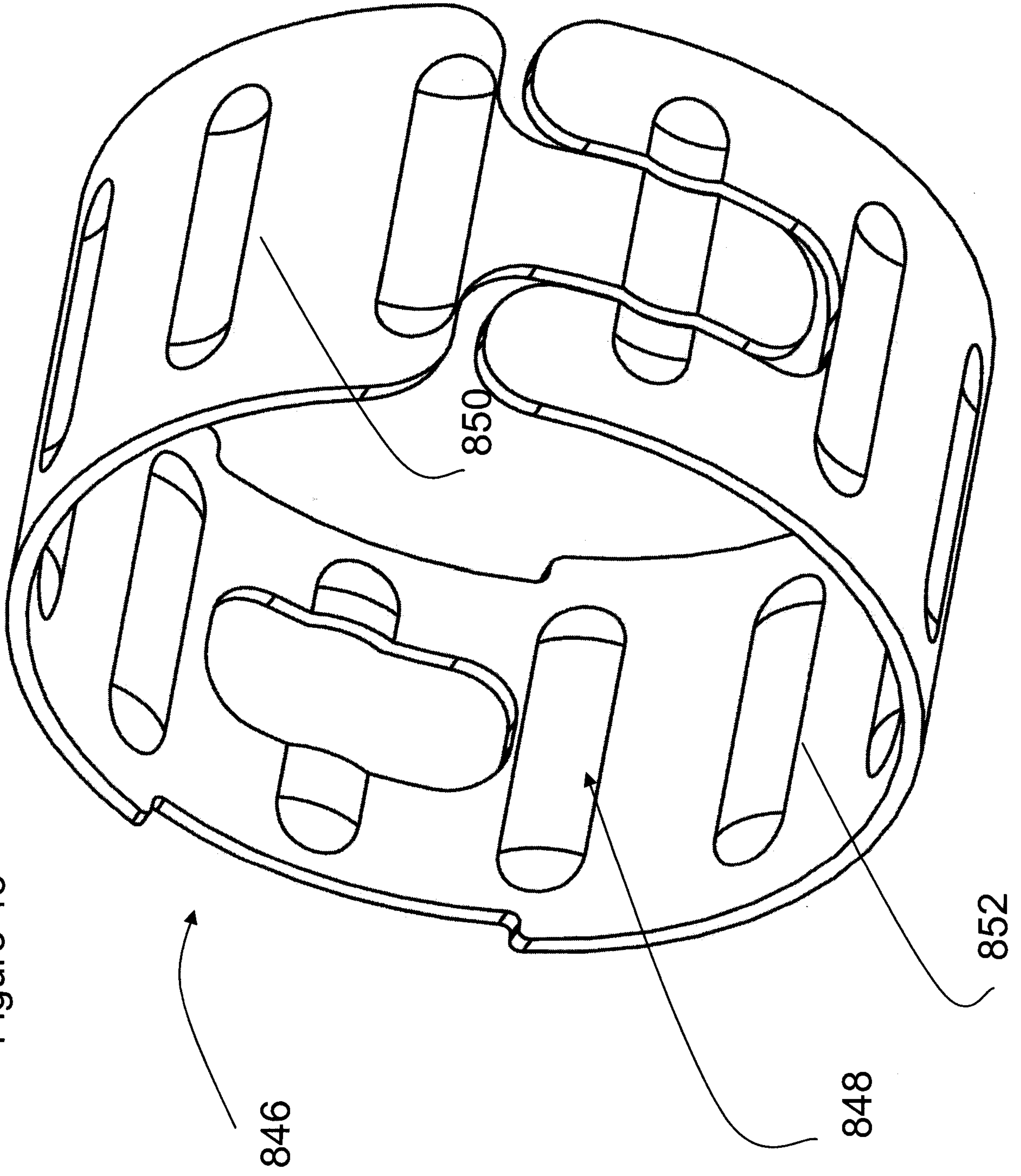
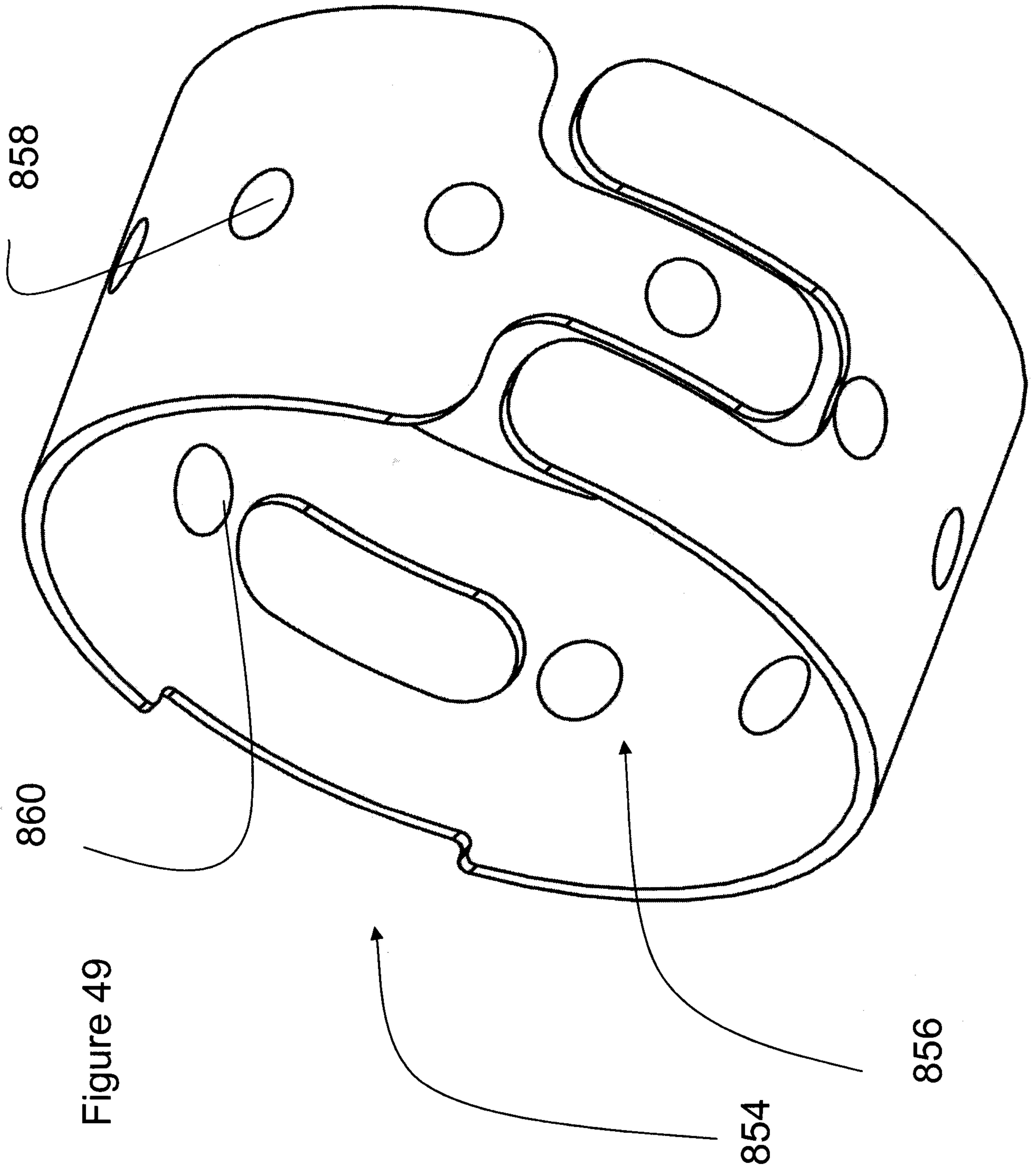
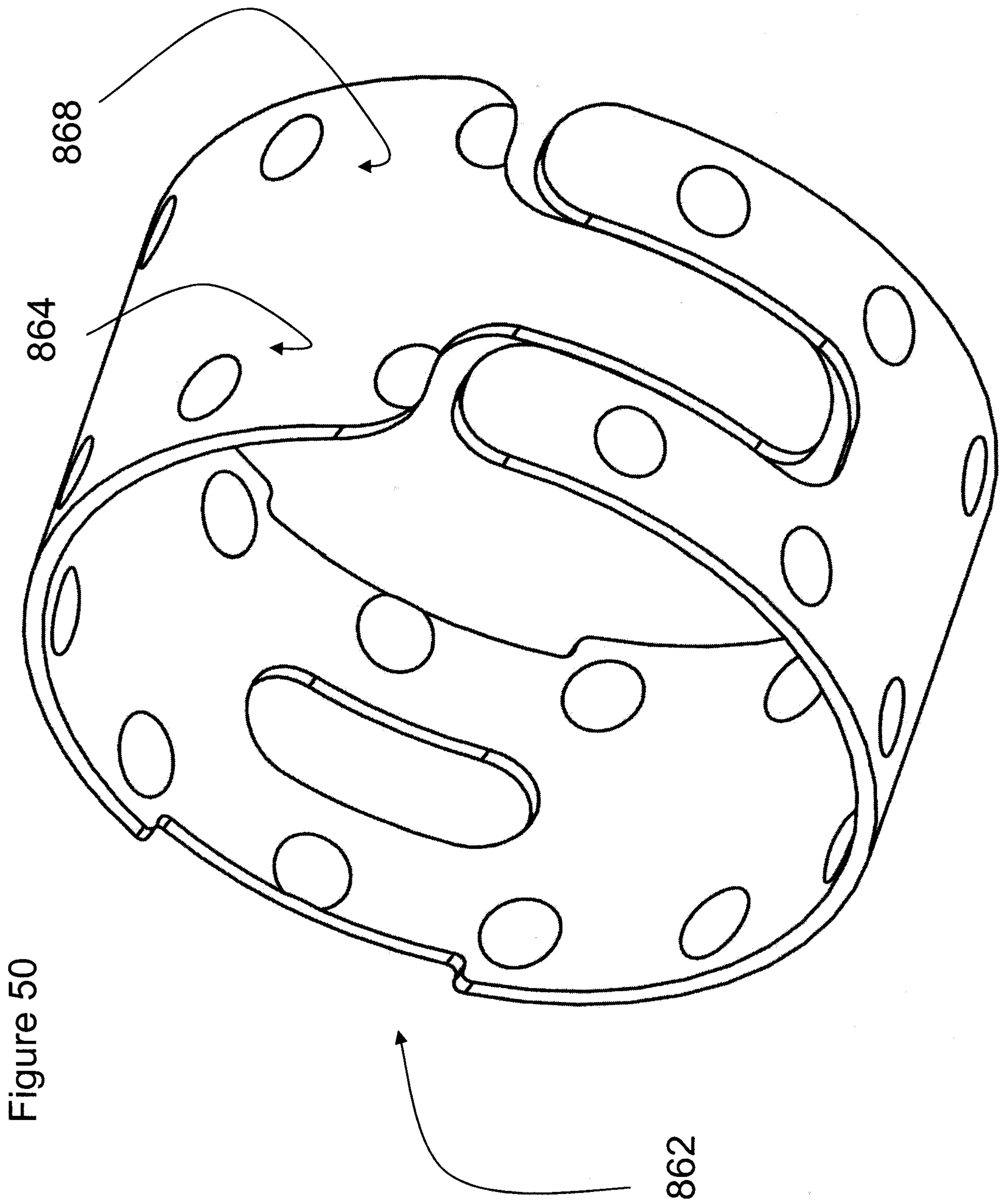
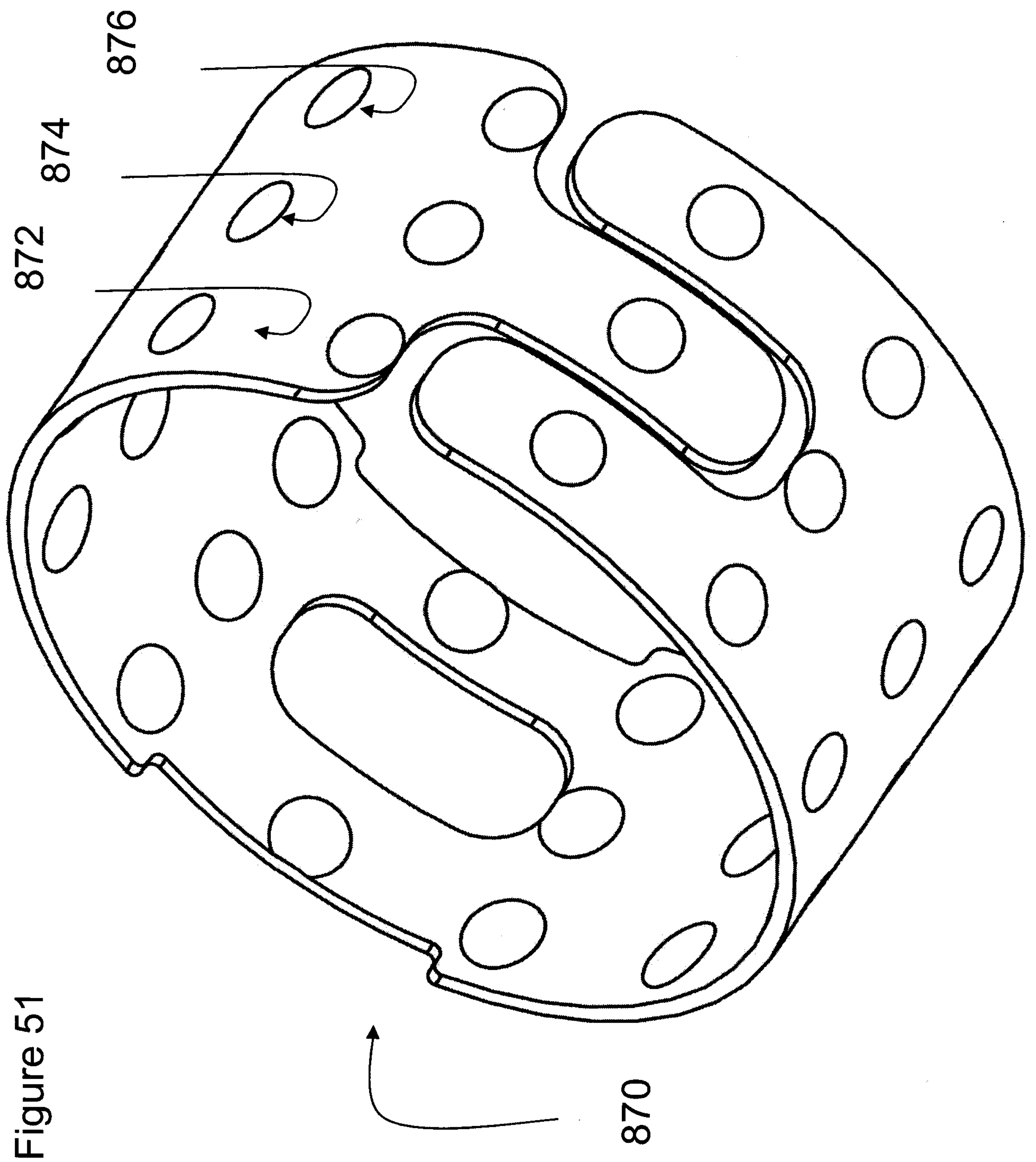


Figure 48









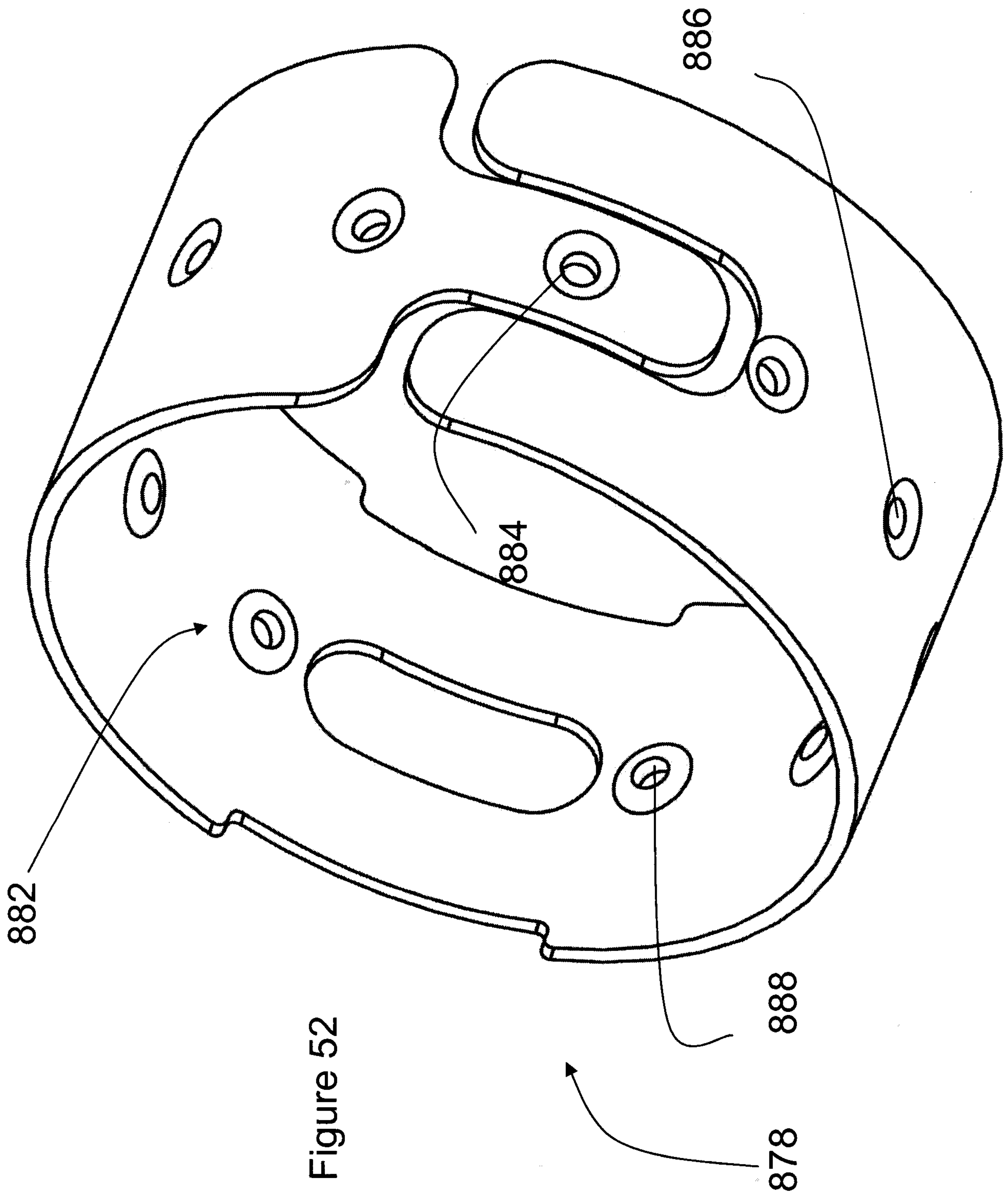
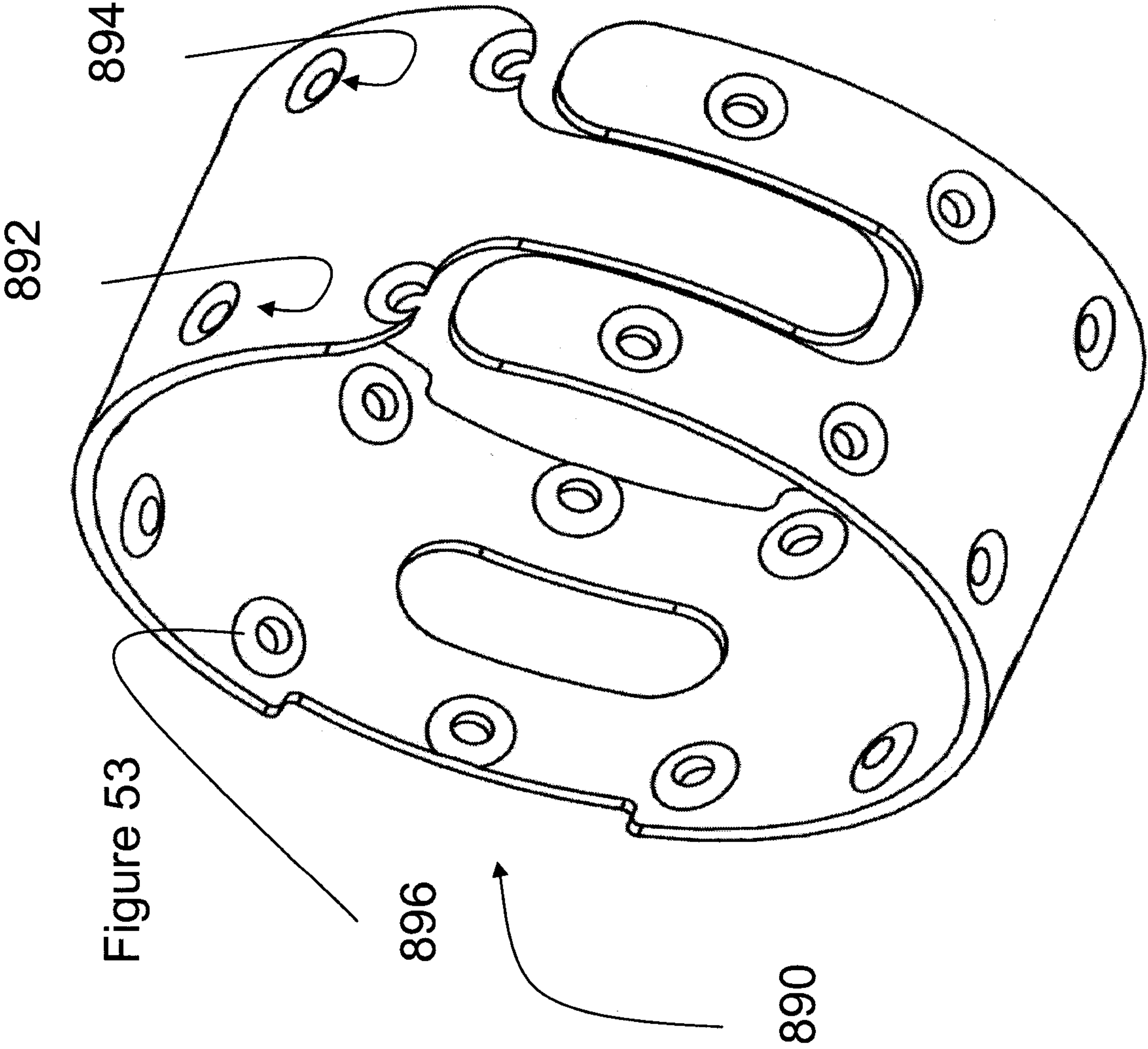
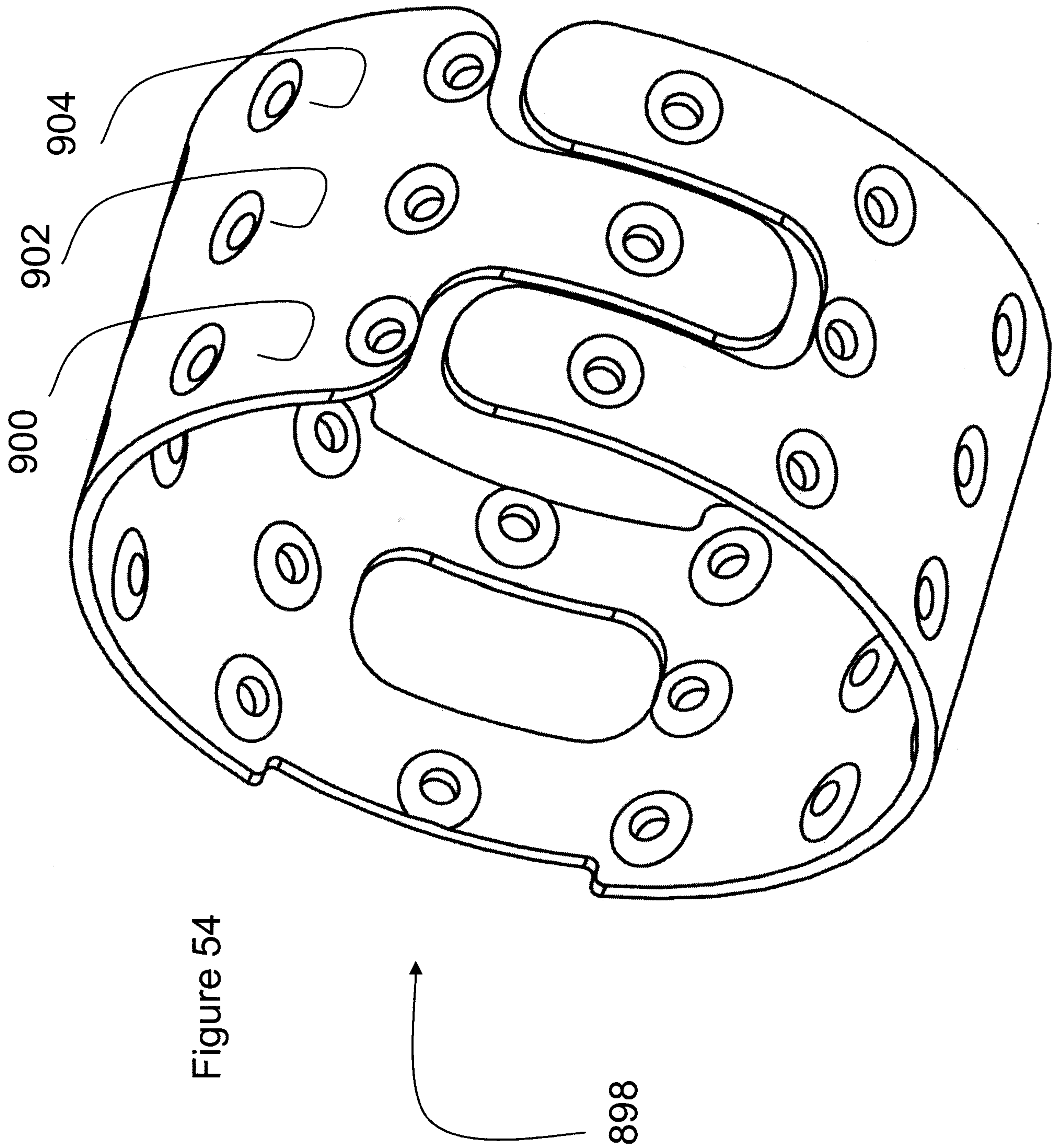


Figure 52





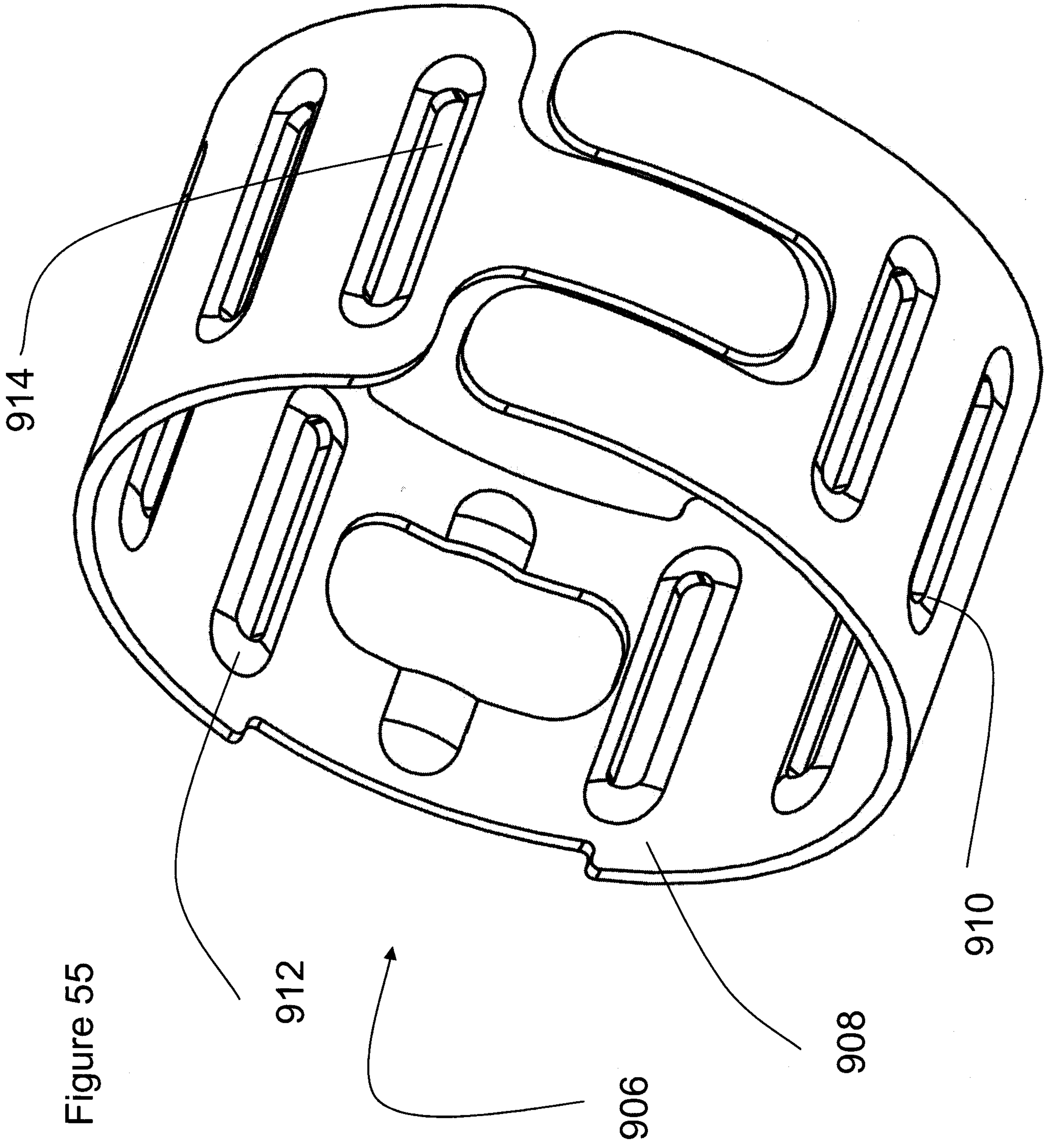
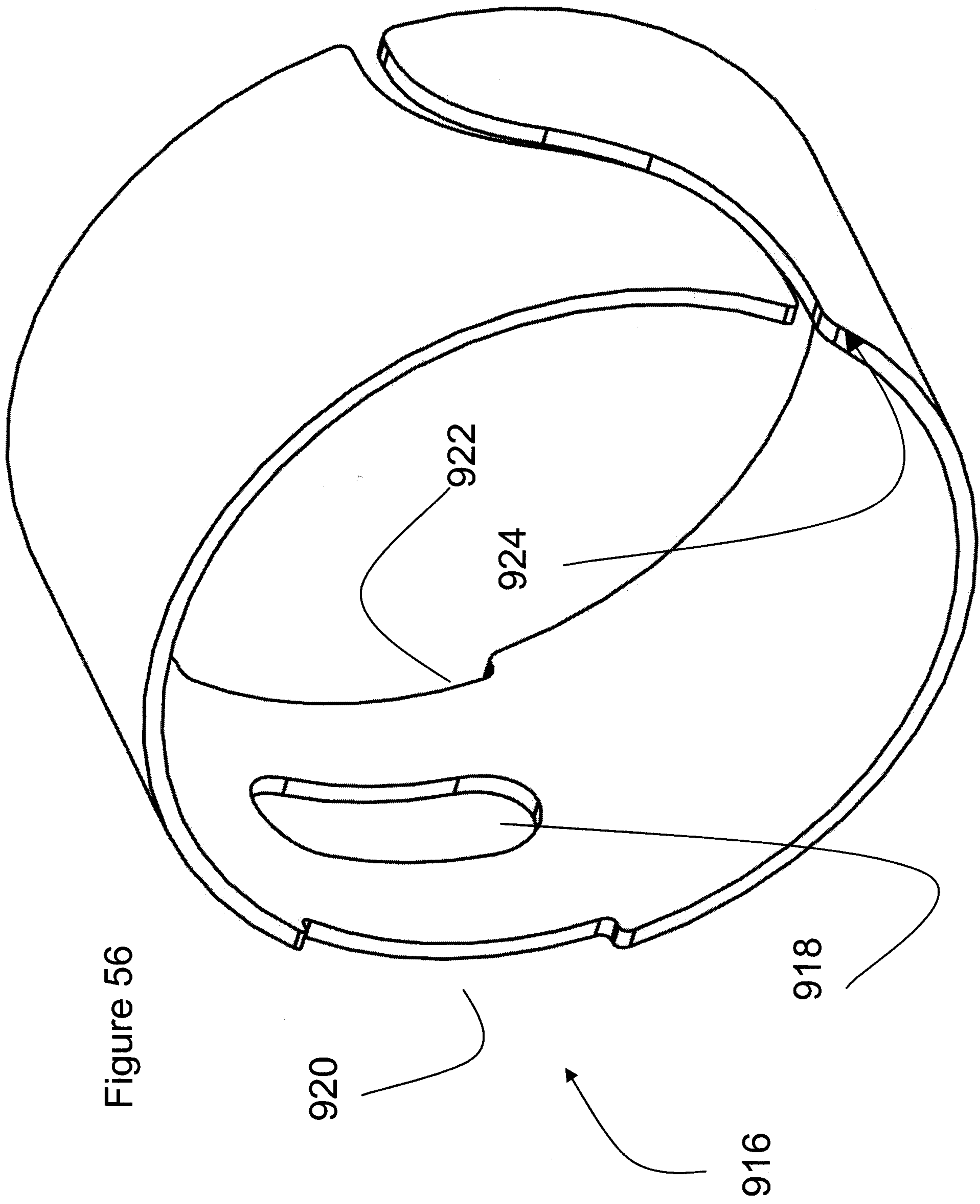


Figure 55



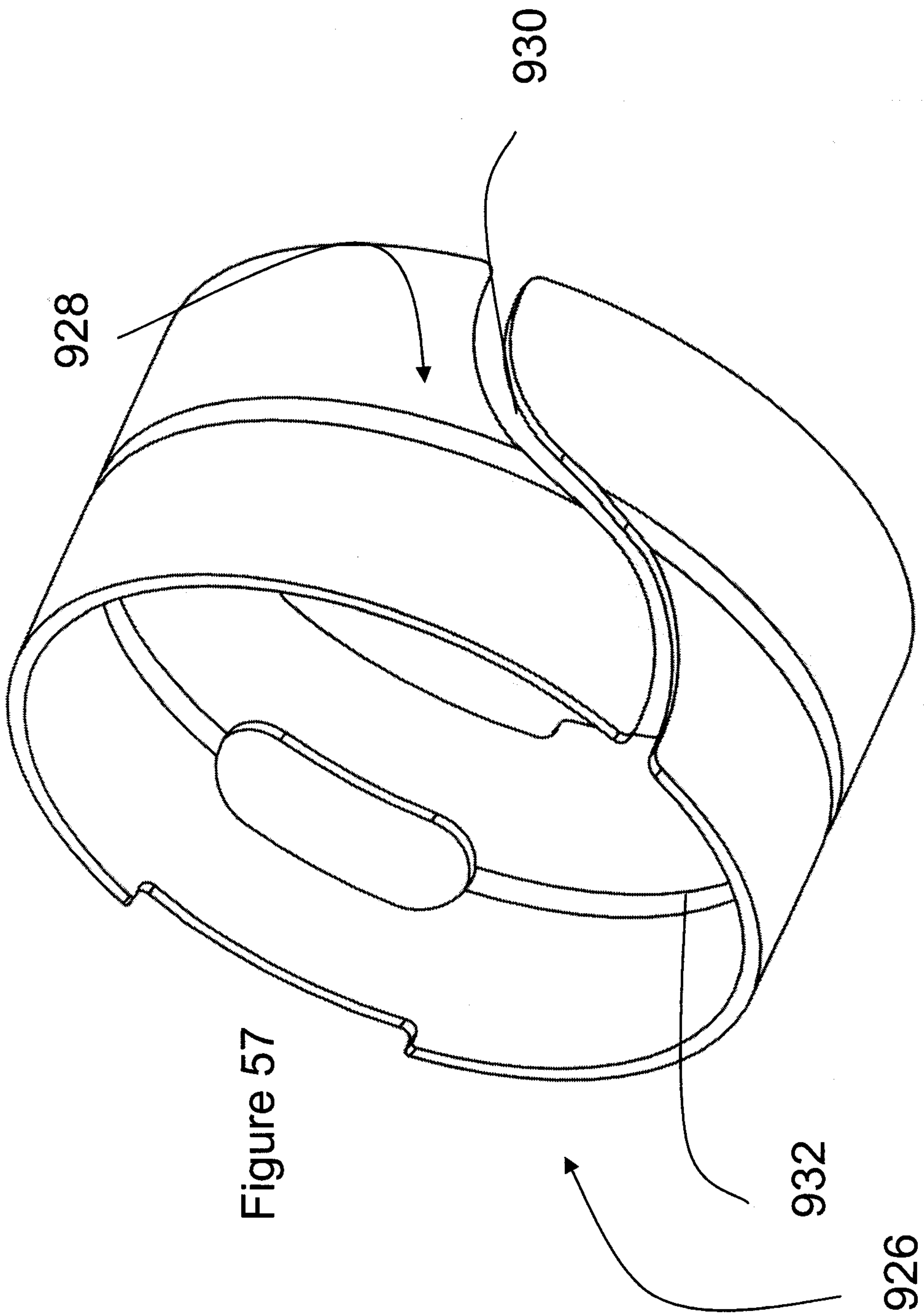
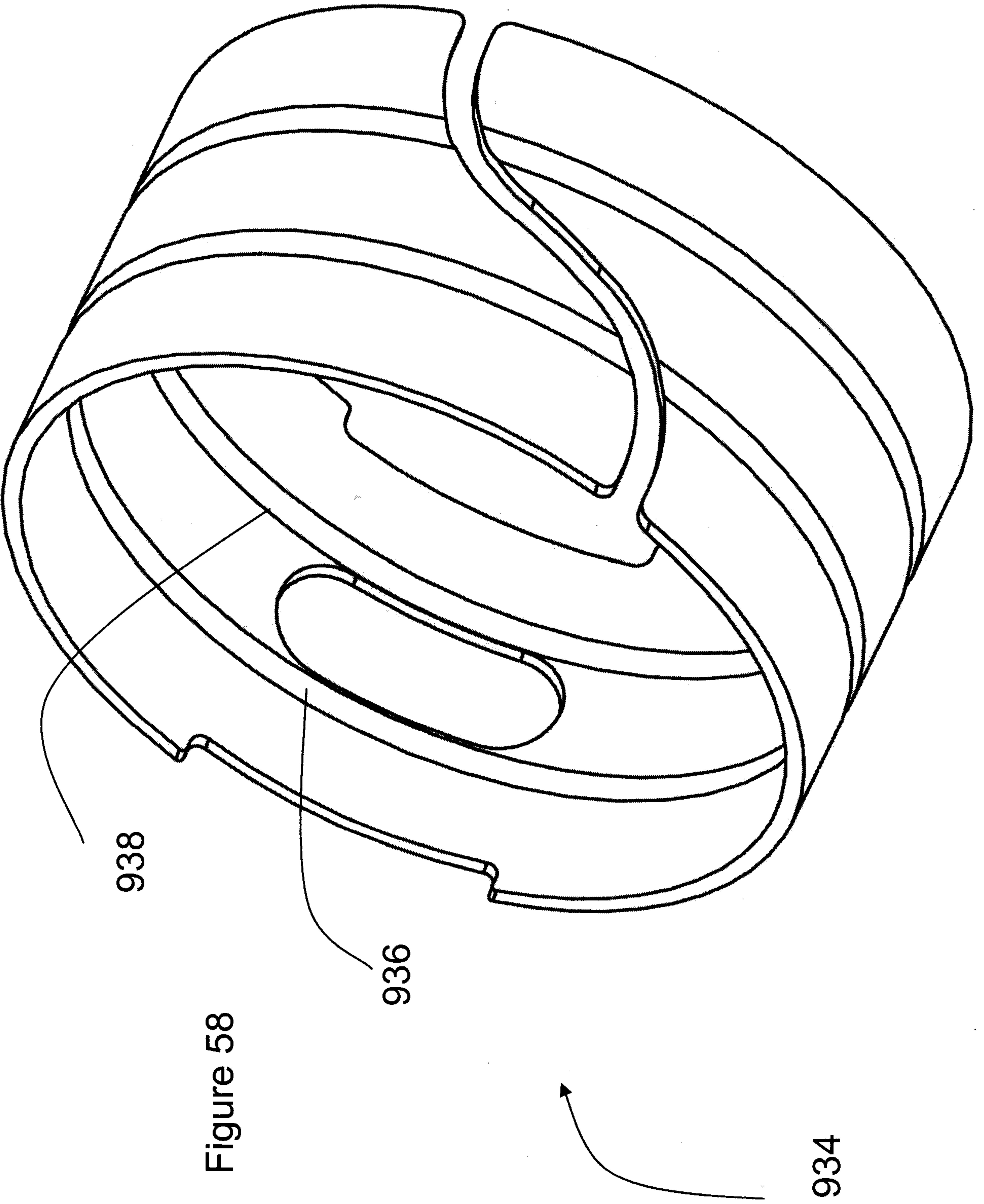
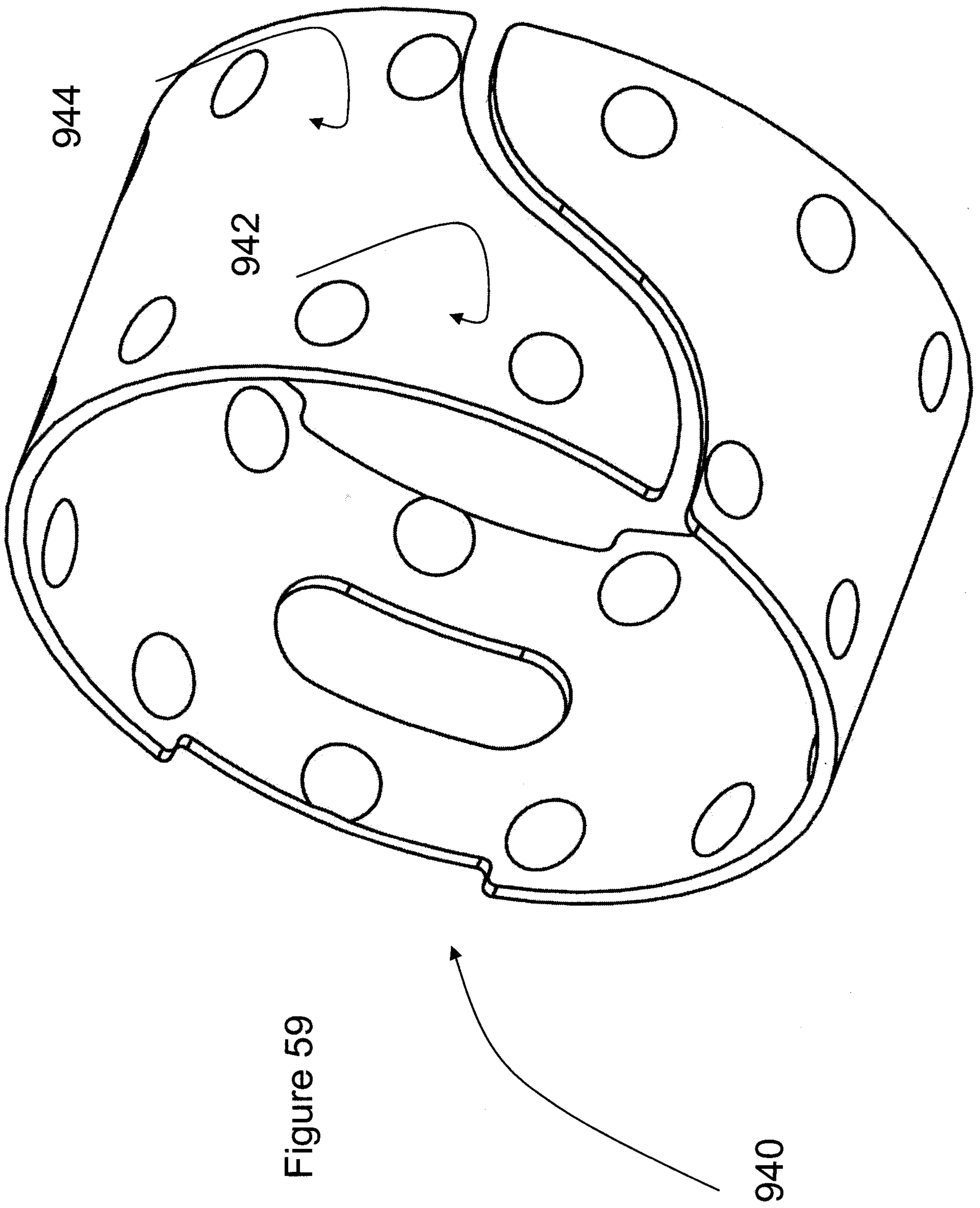
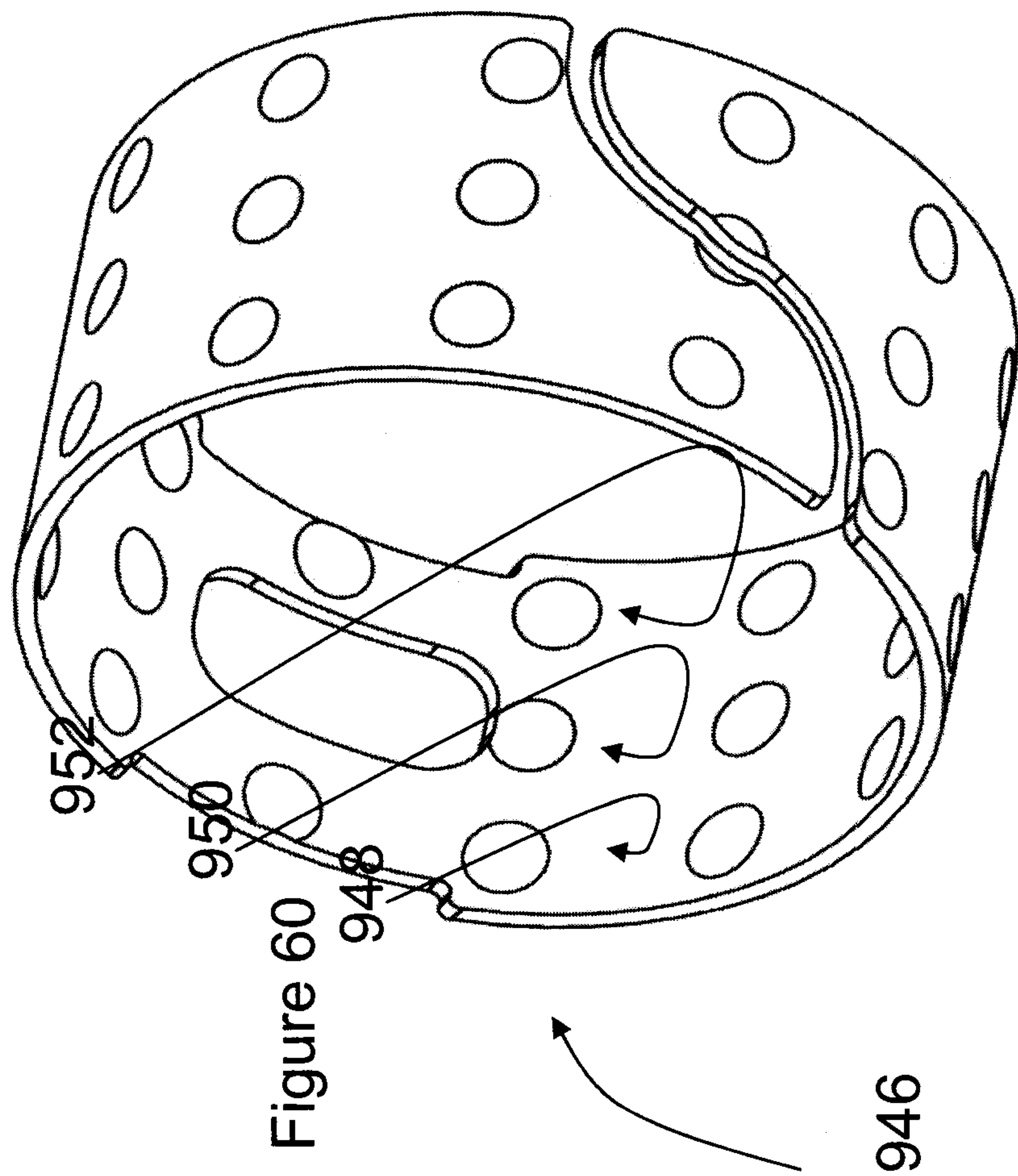
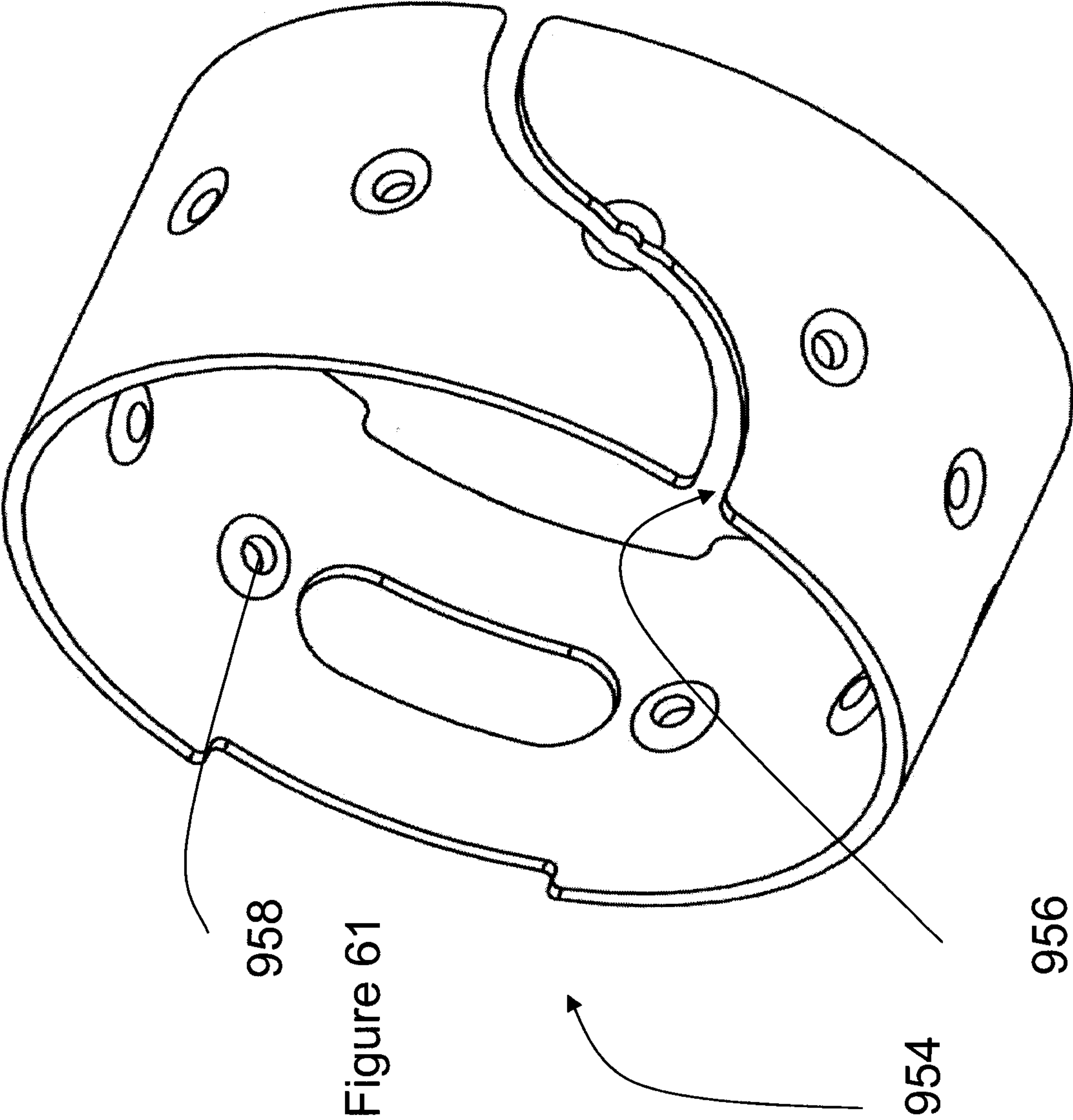


Figure 57









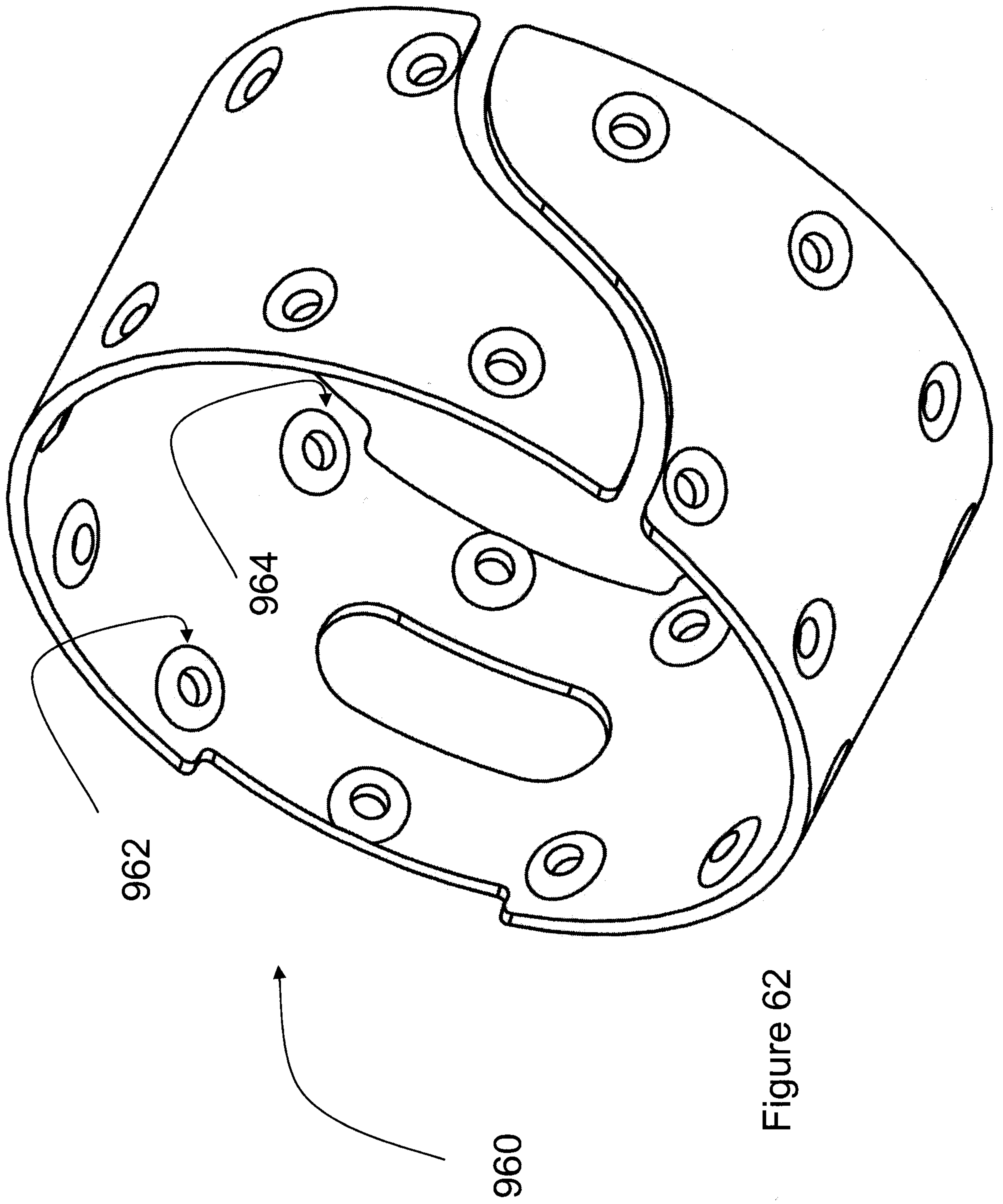
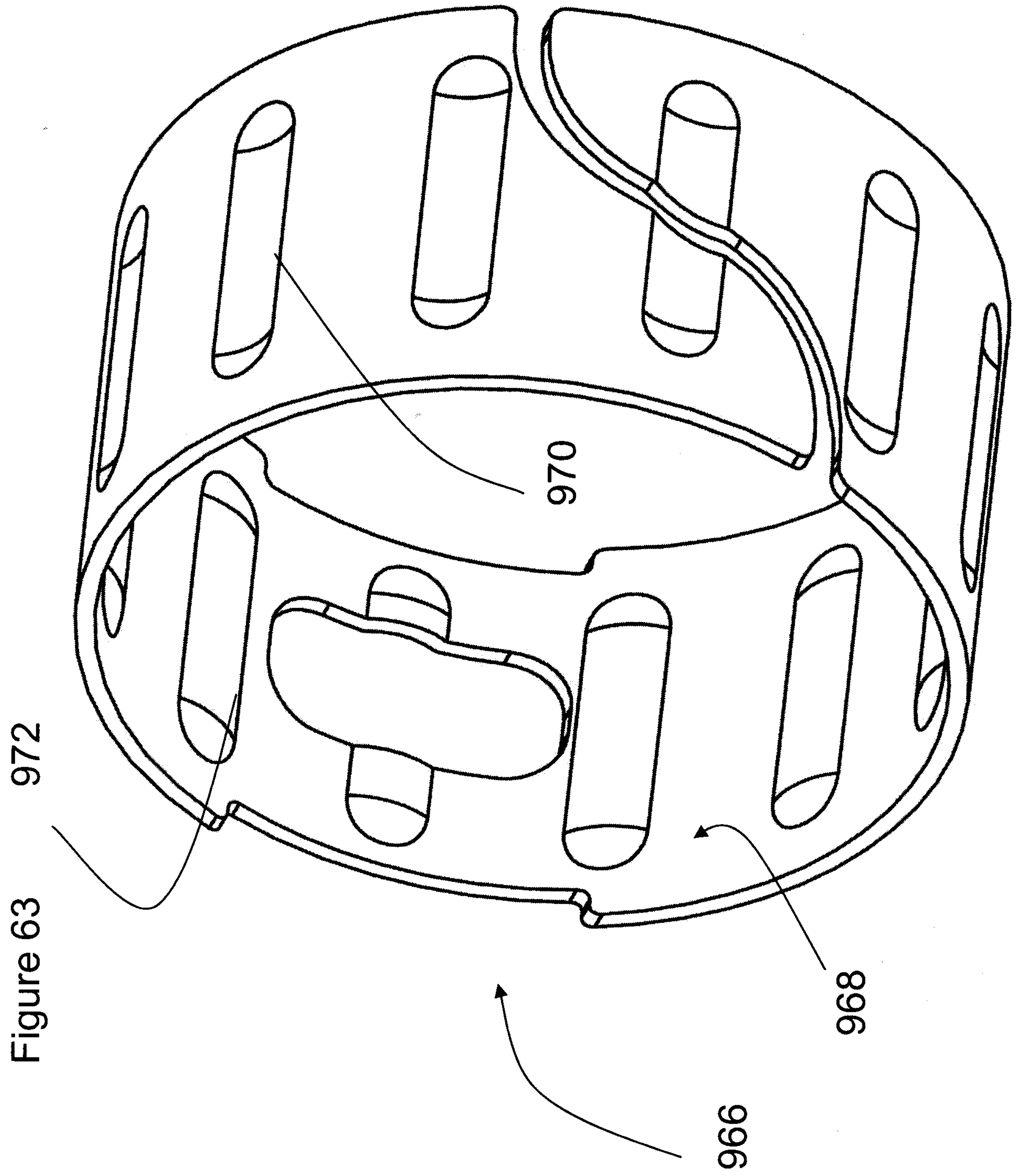
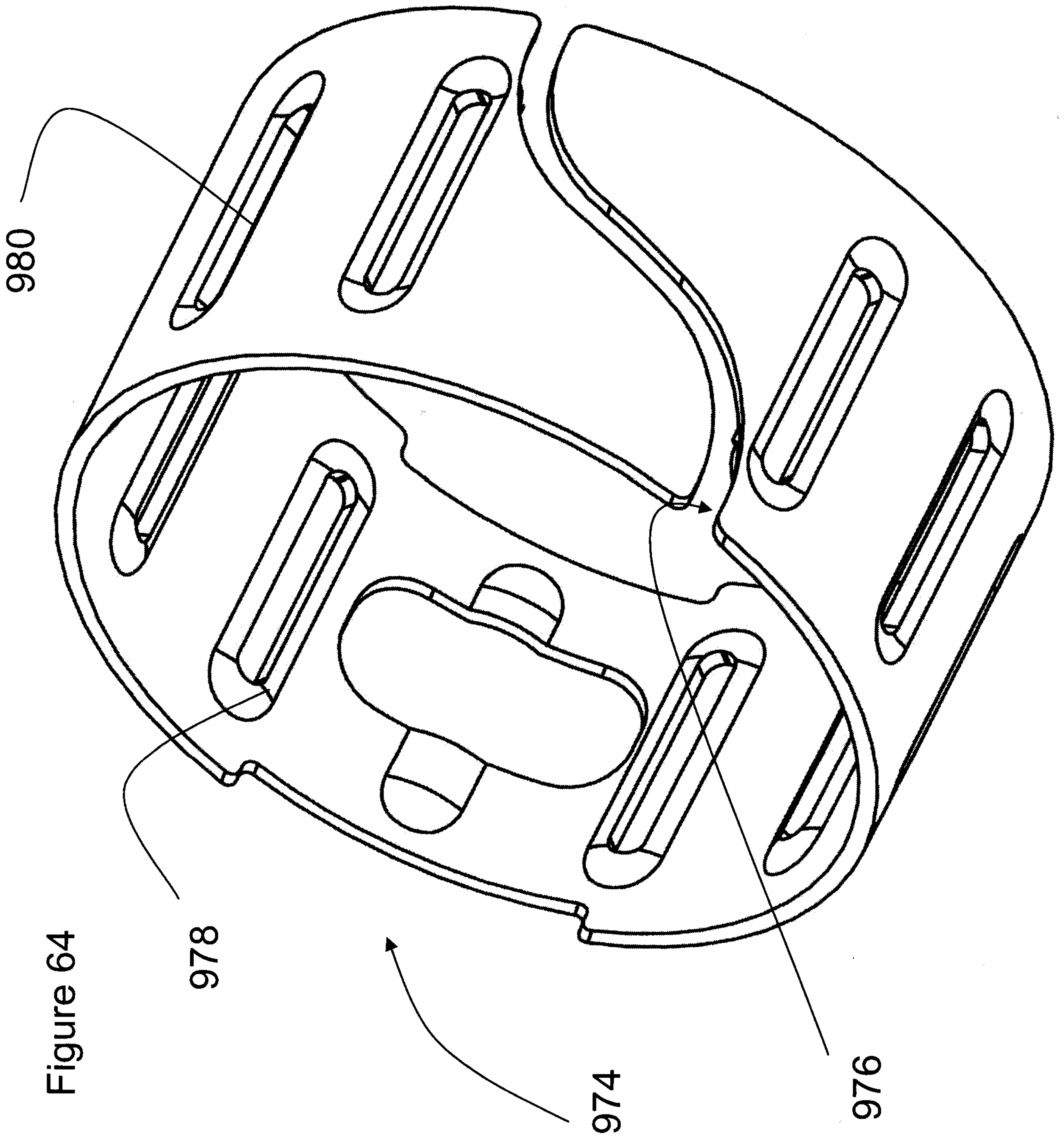
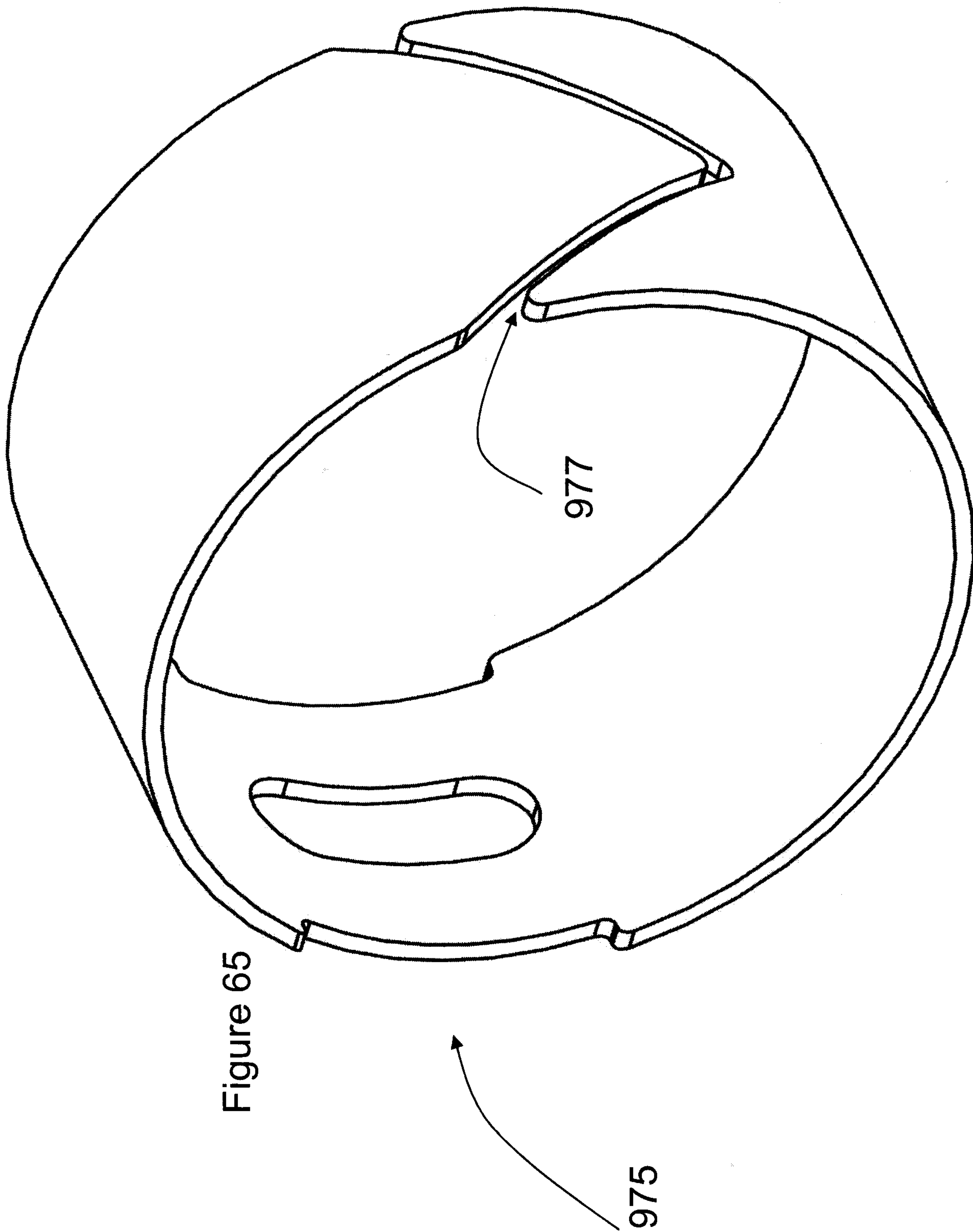
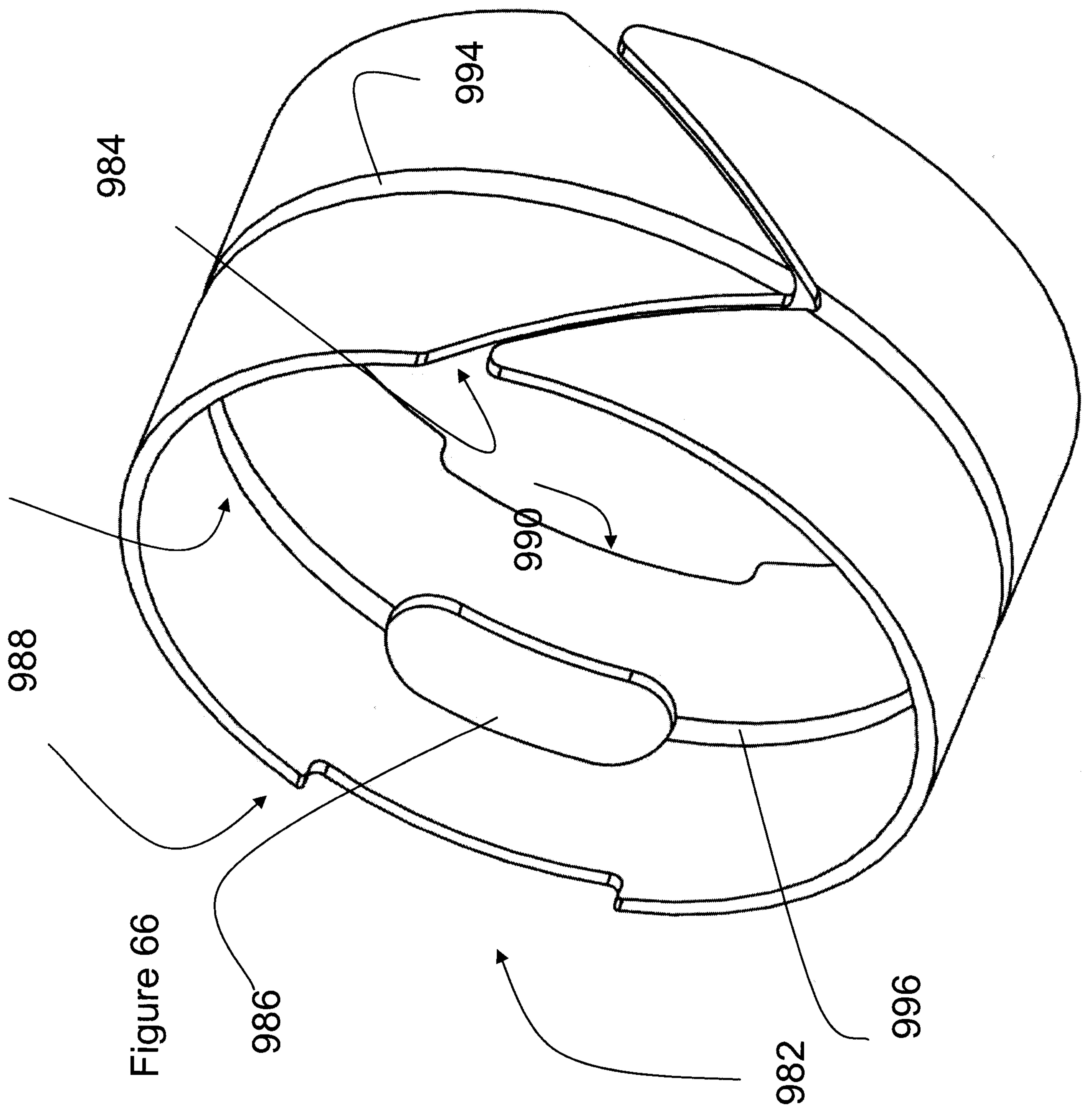


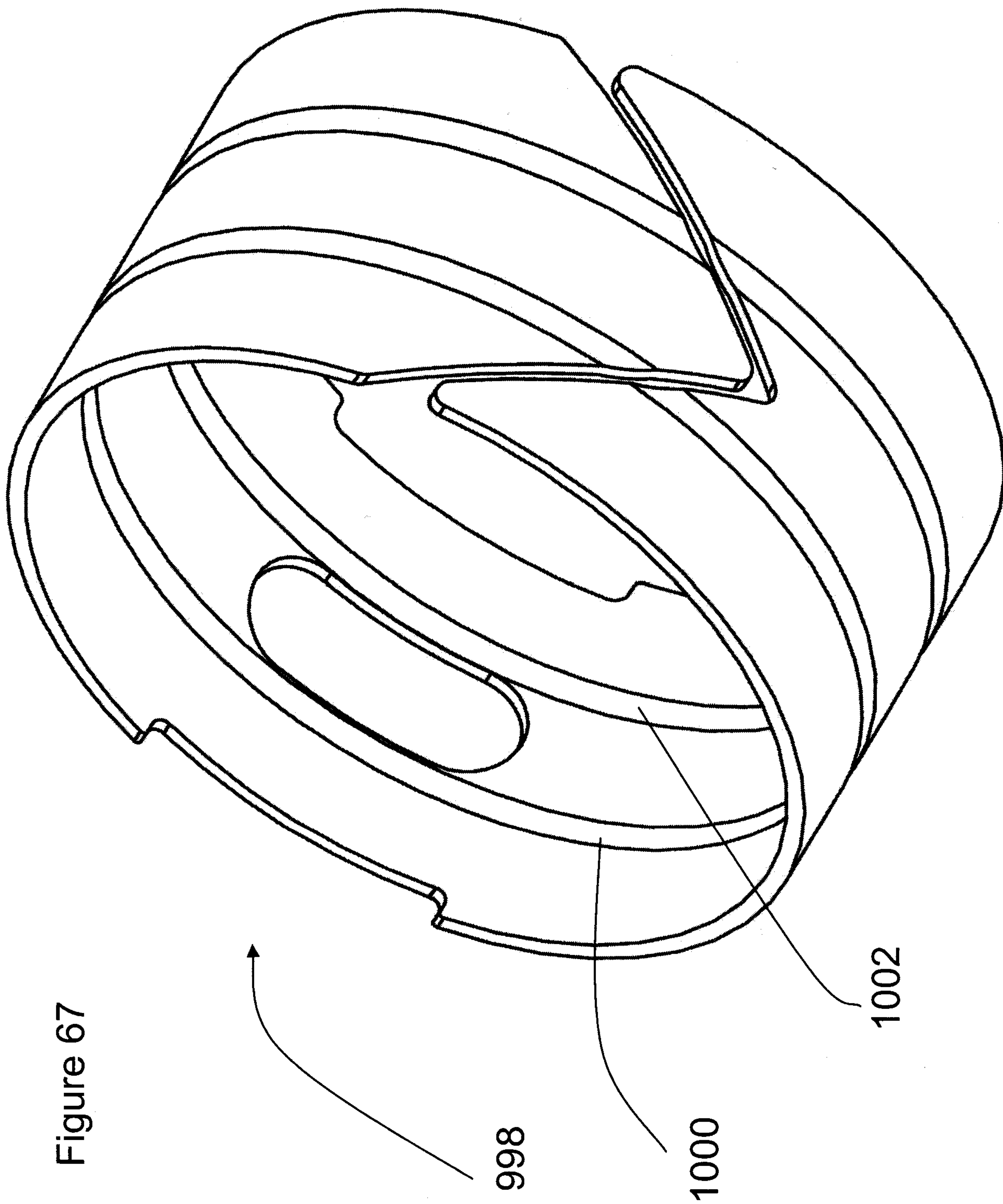
Figure 62

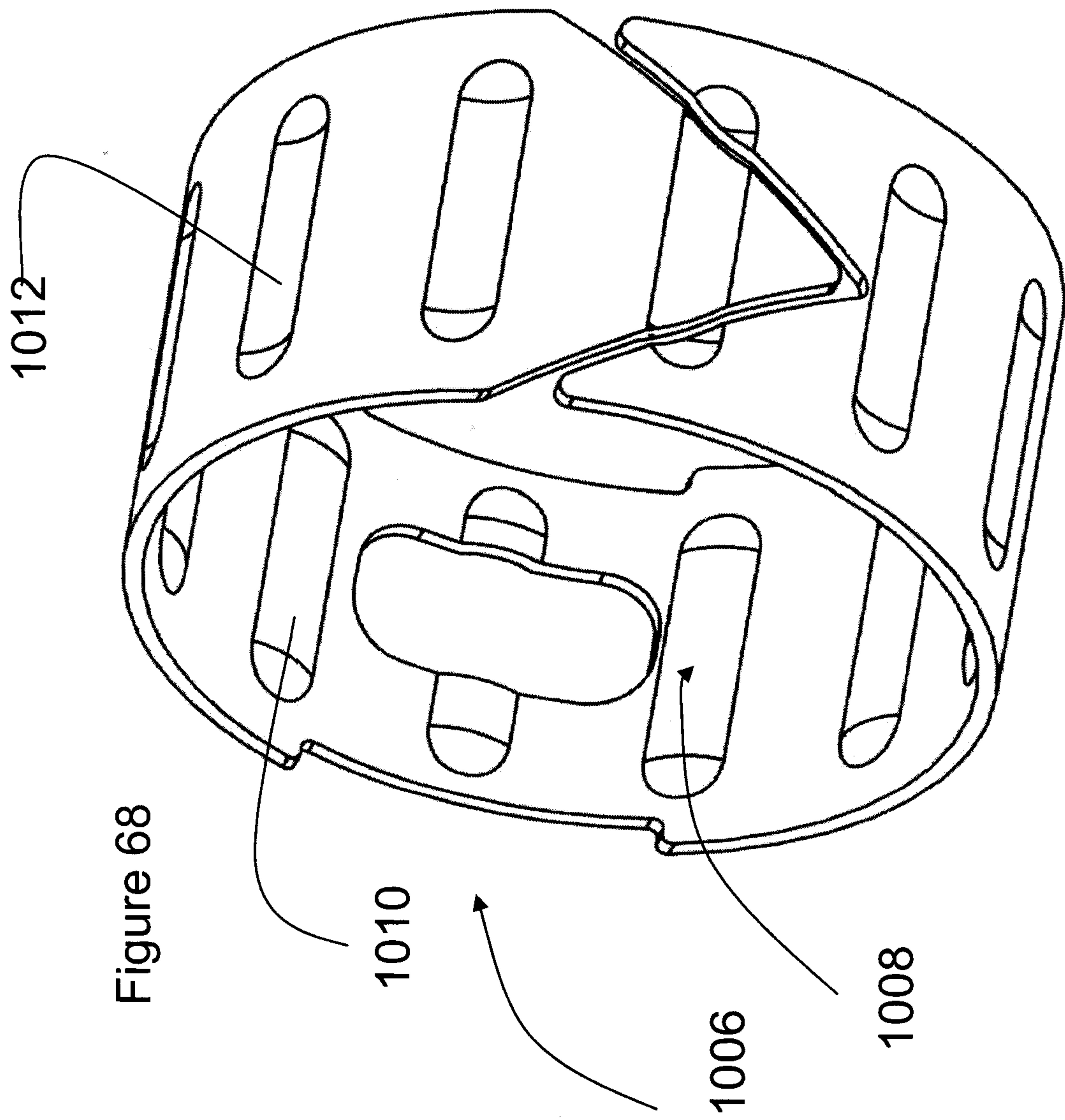


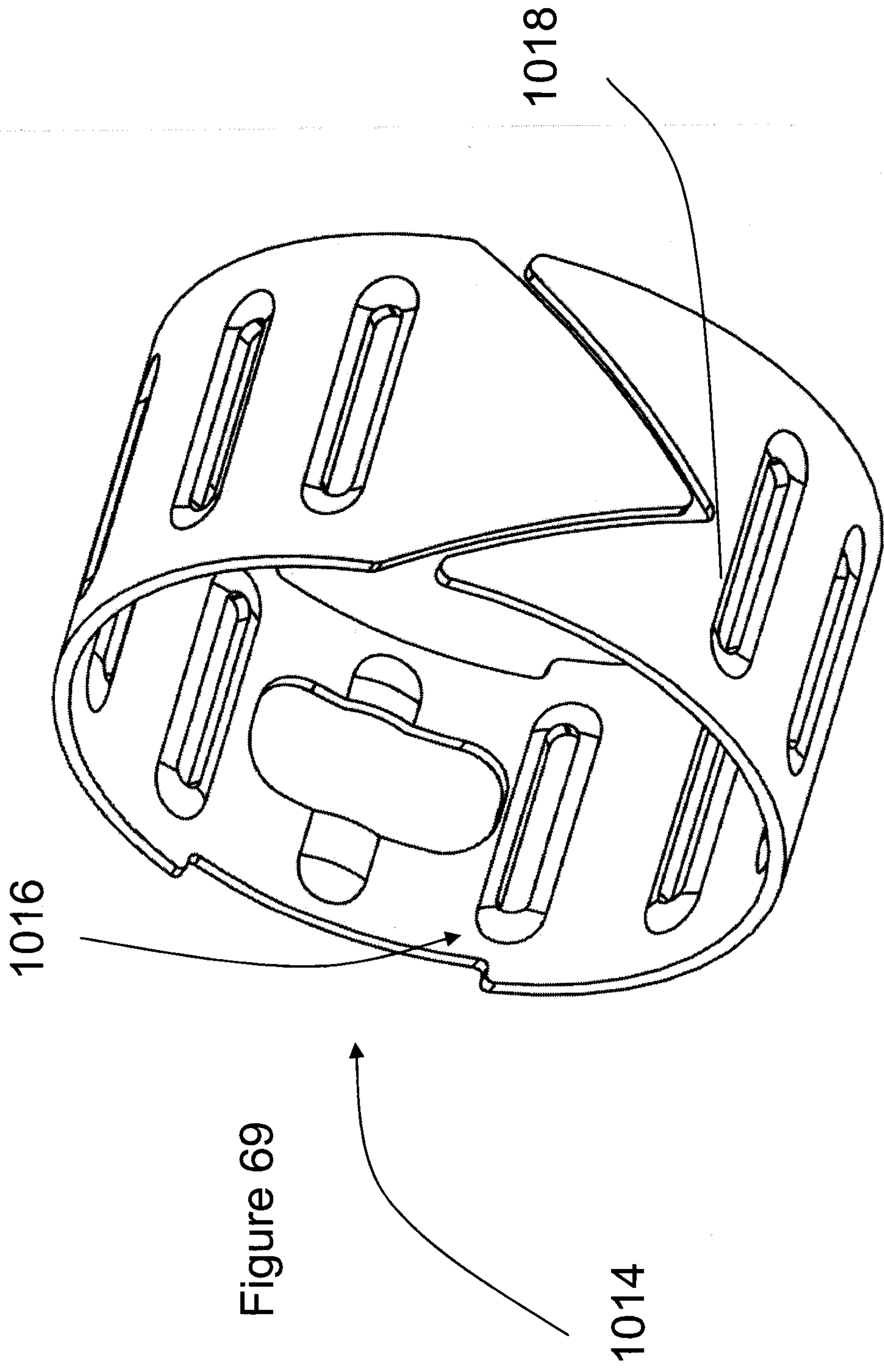












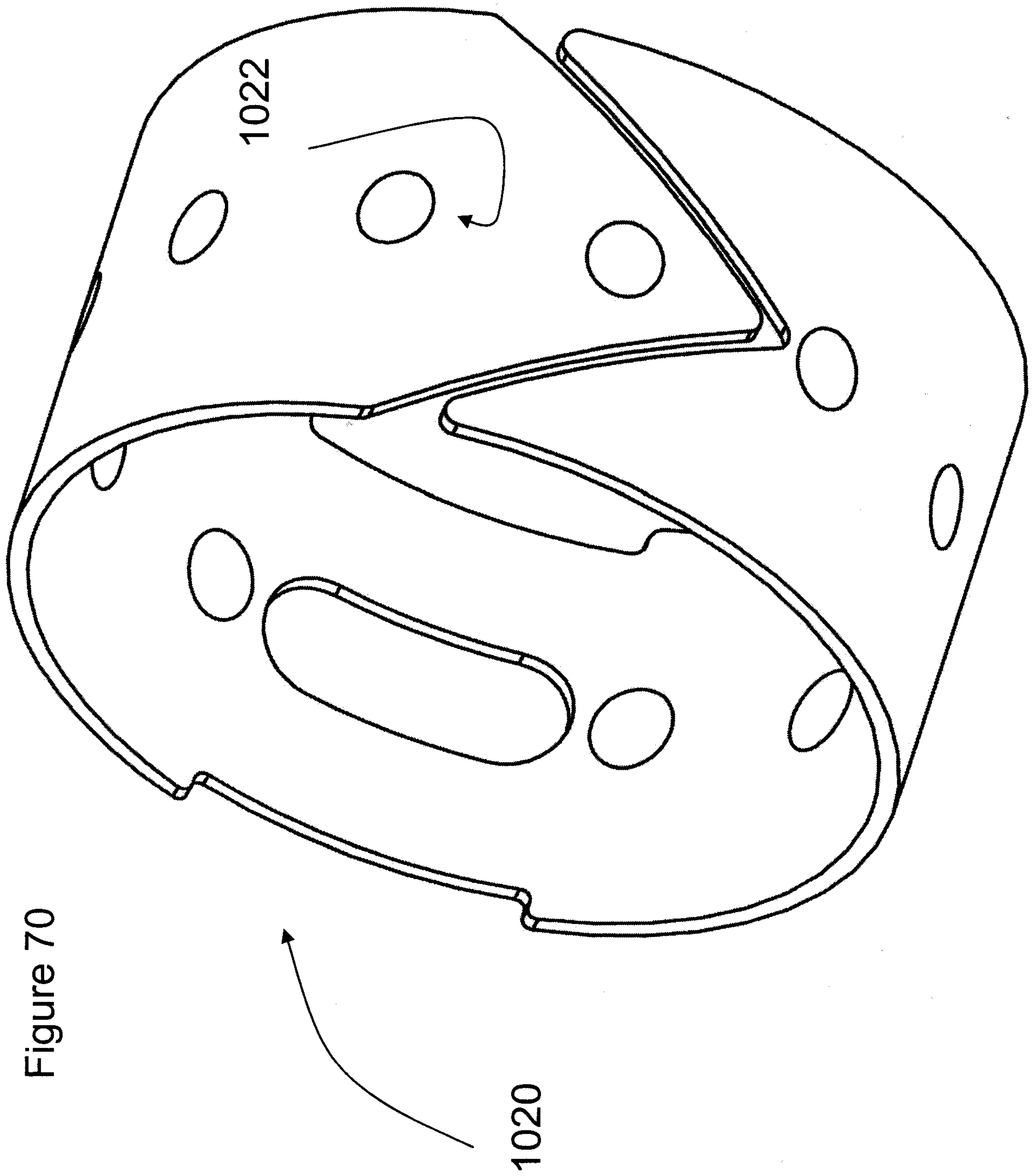
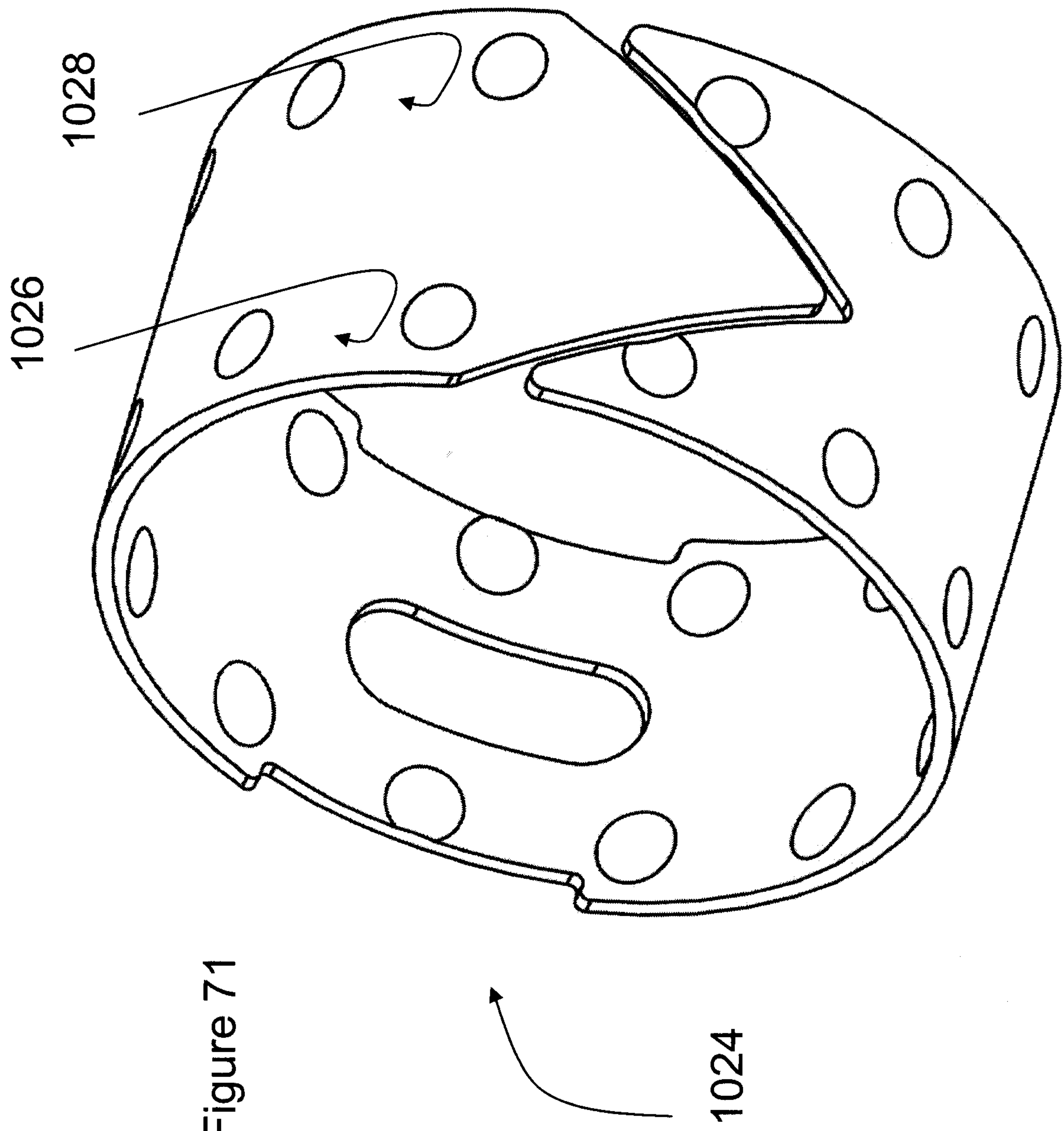


Figure 70



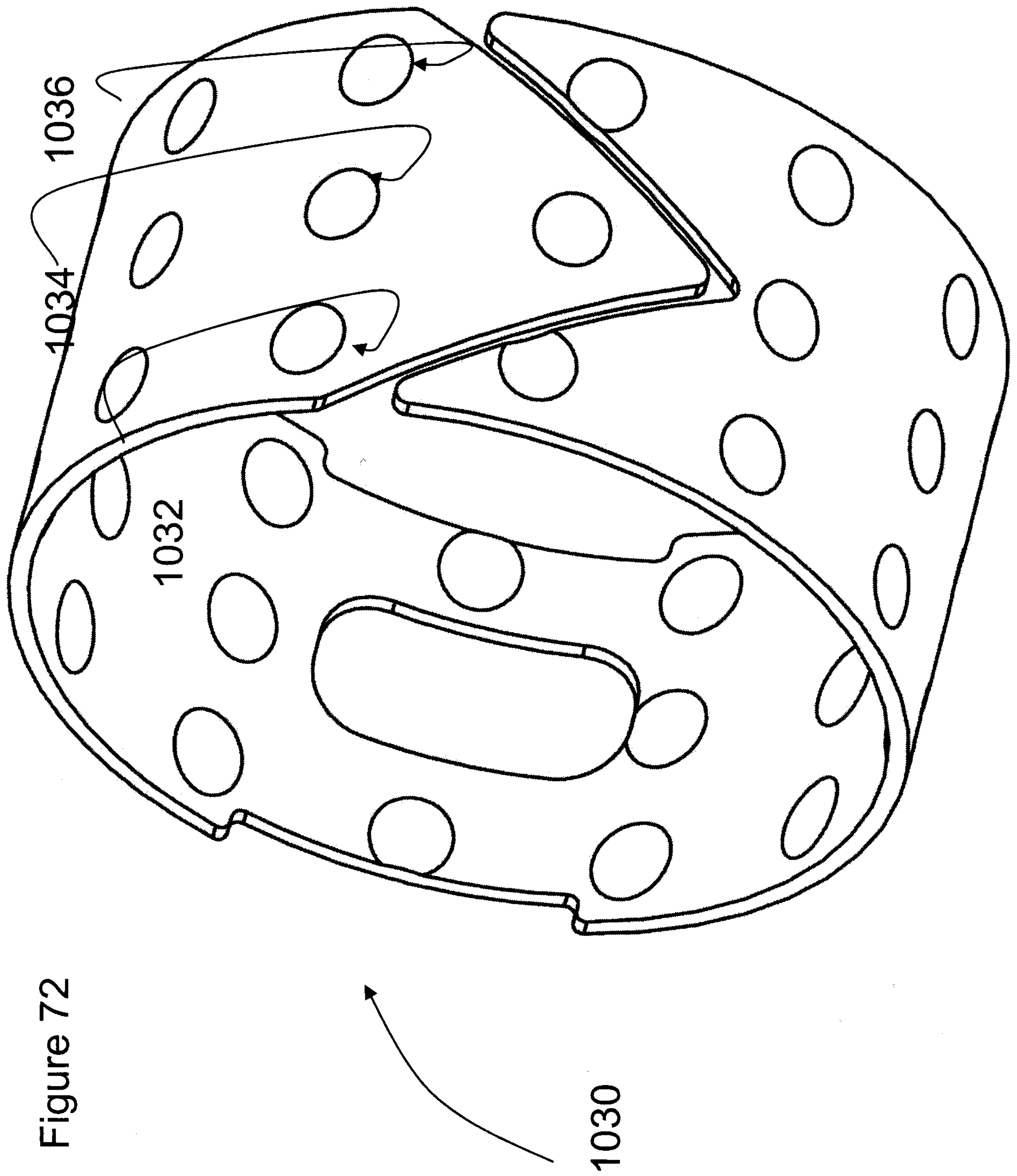
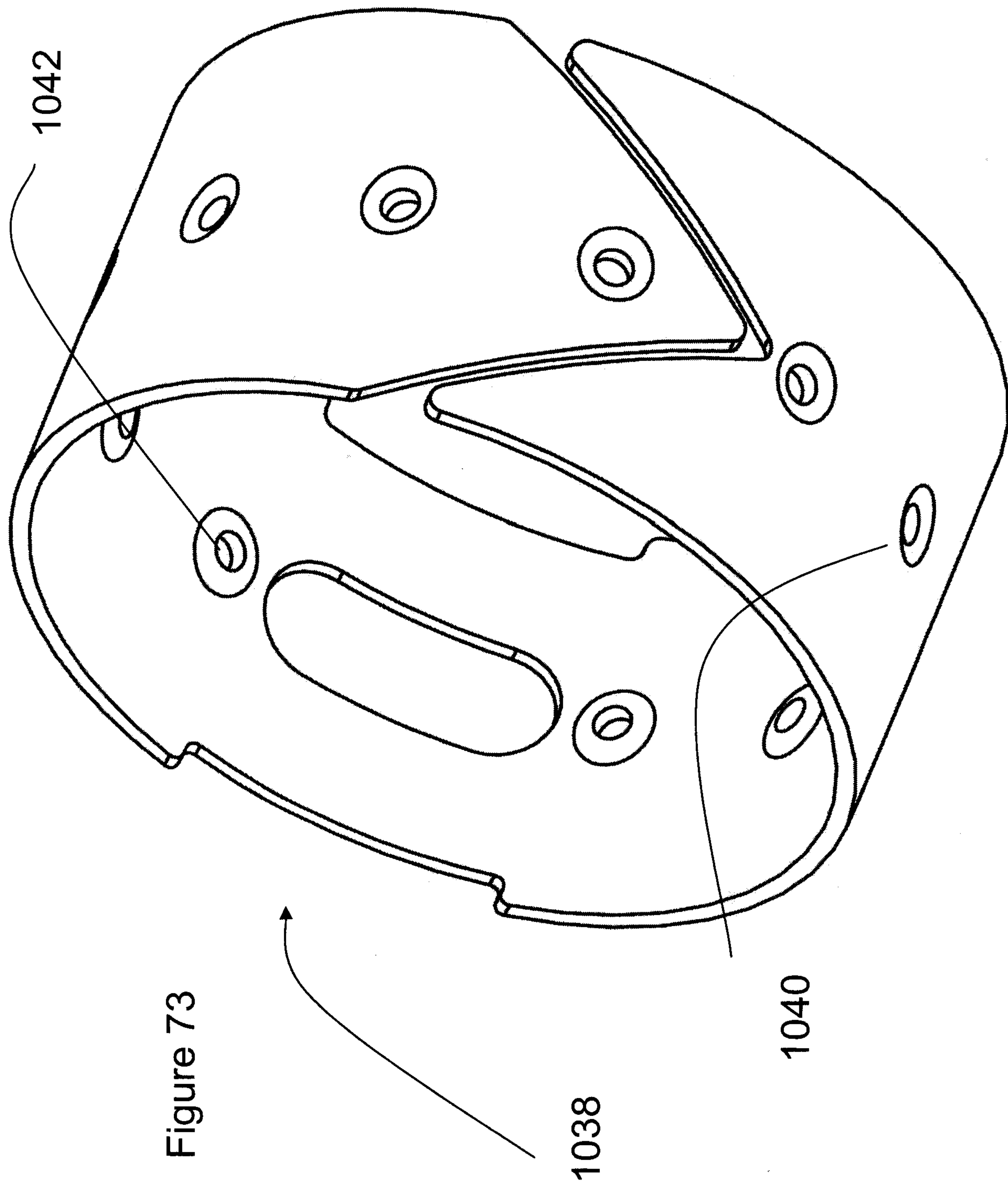
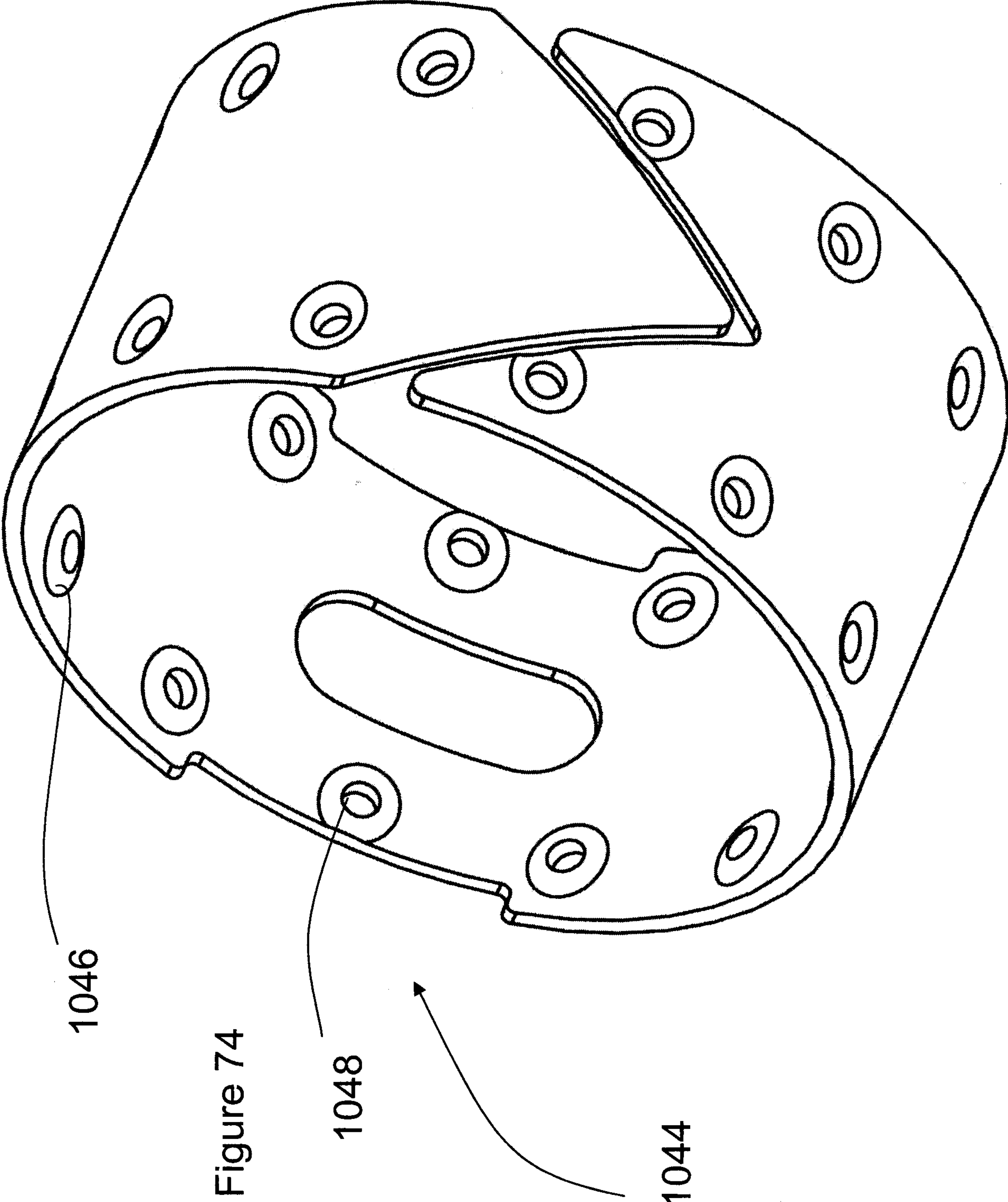
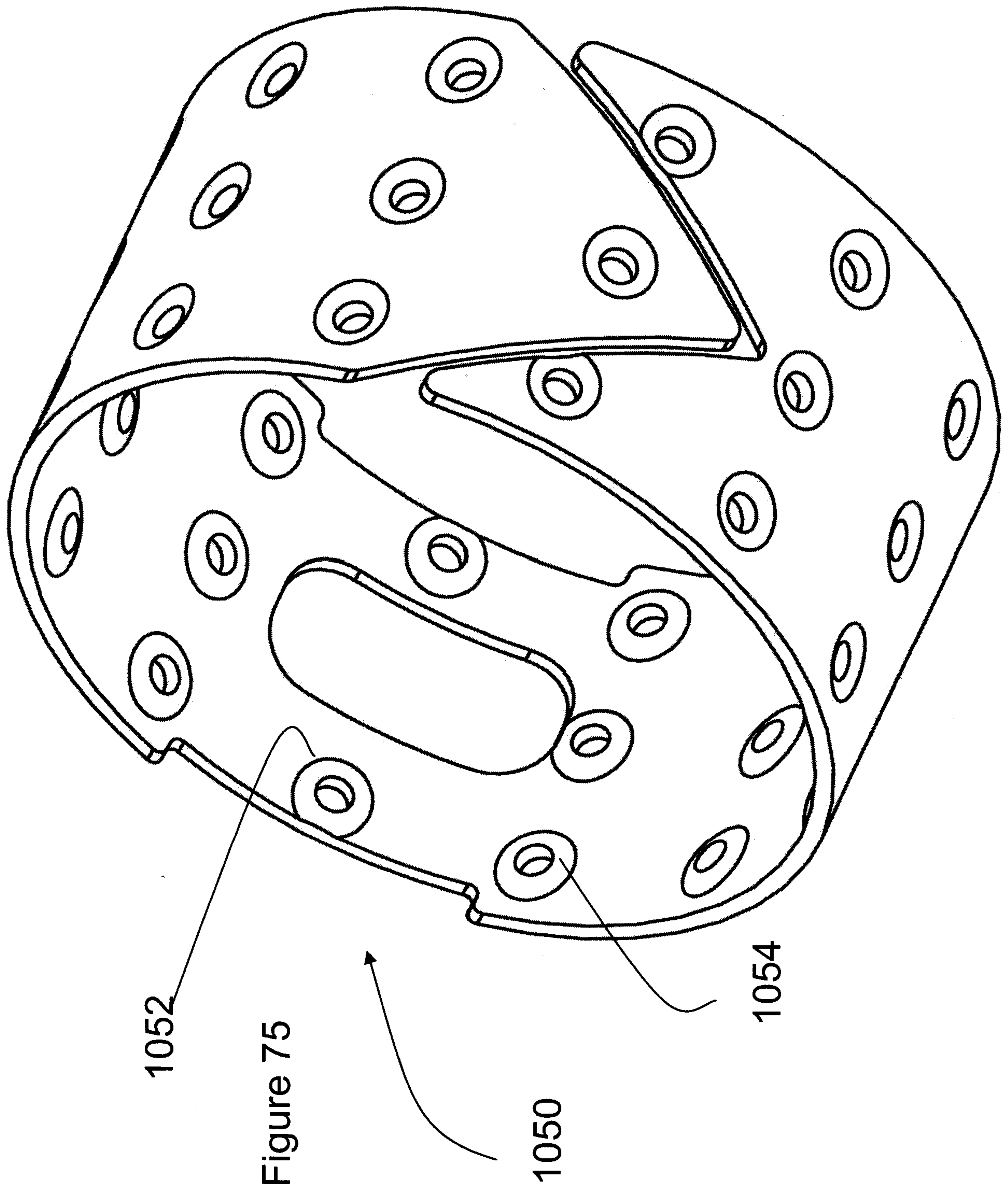
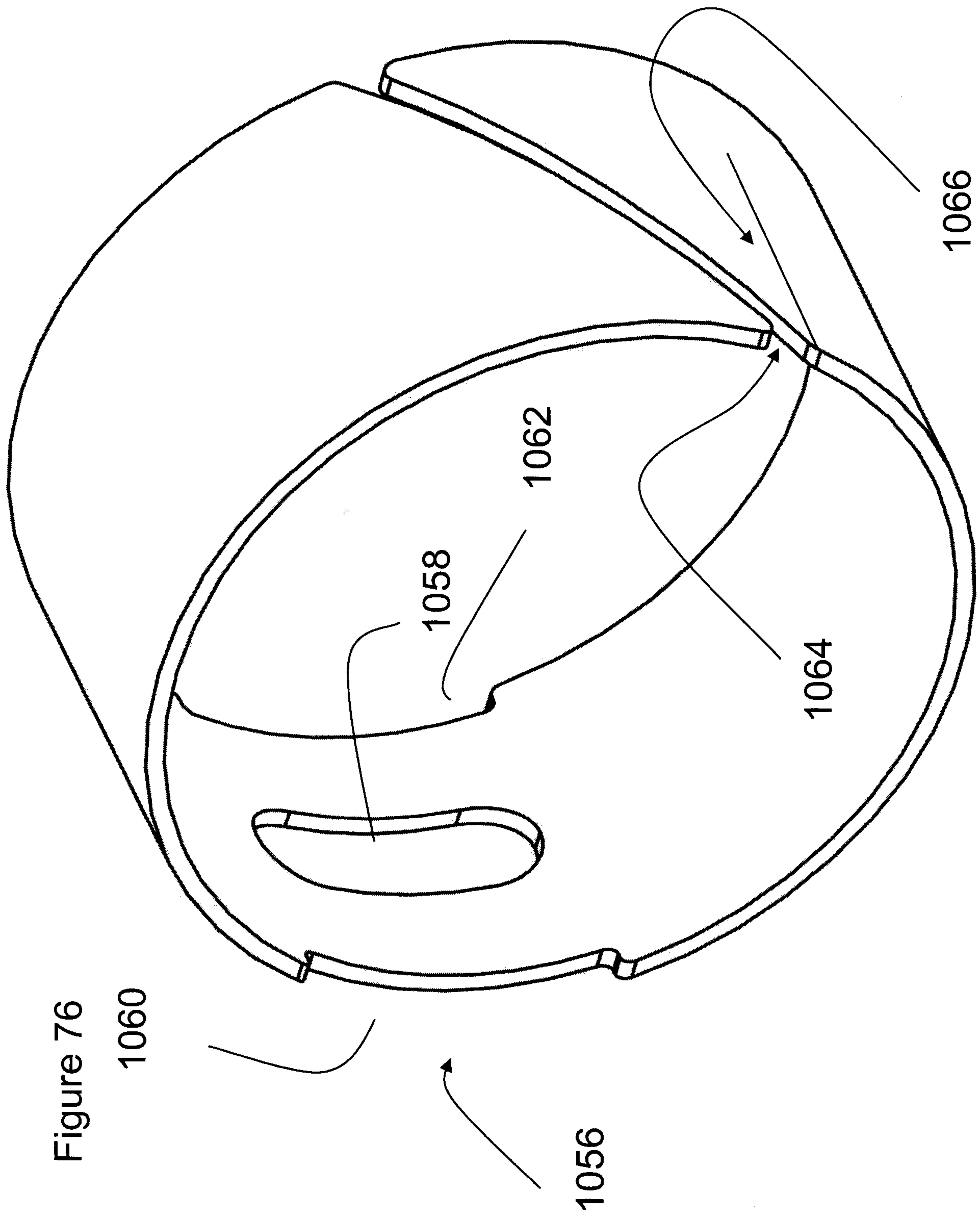


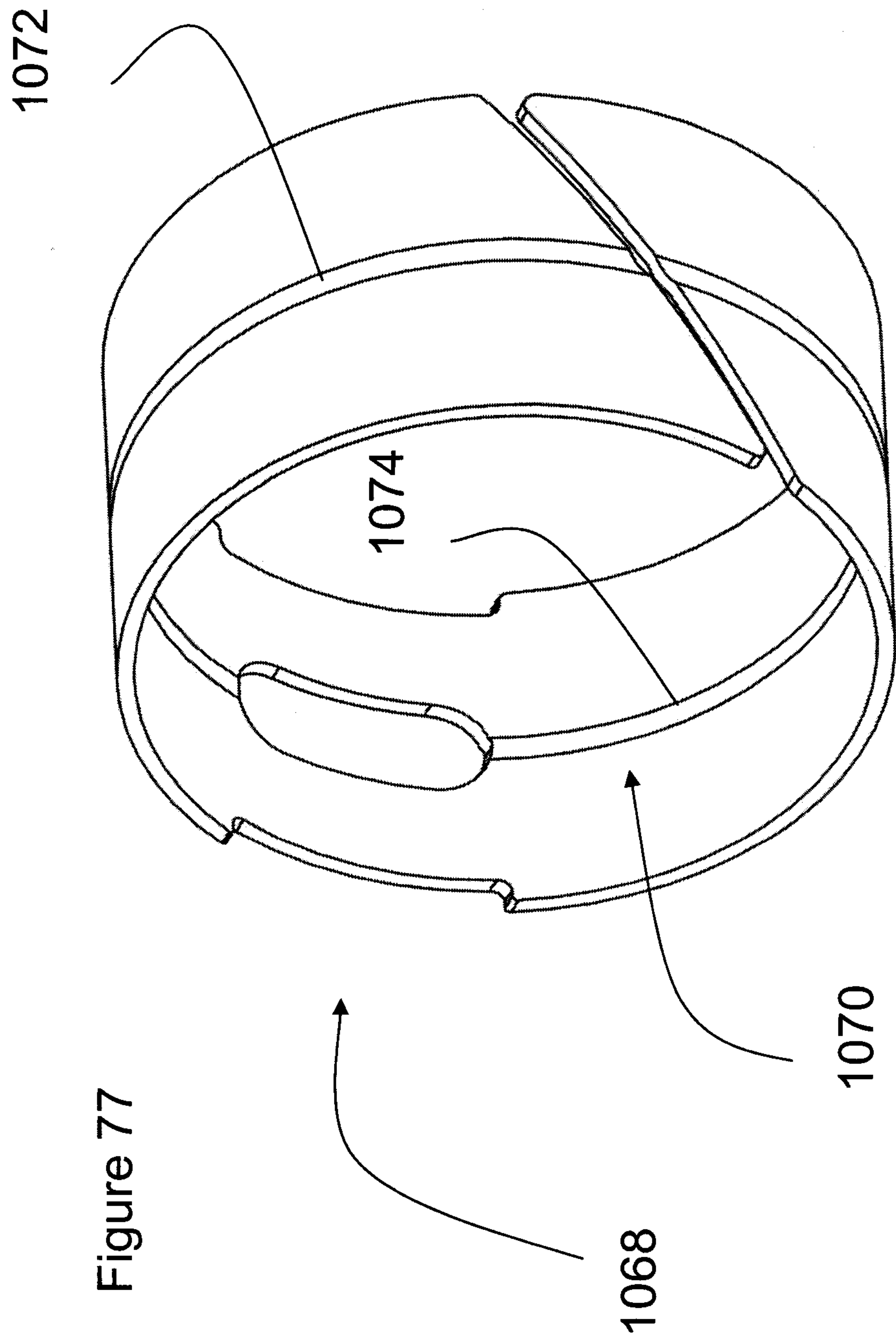
Figure 72

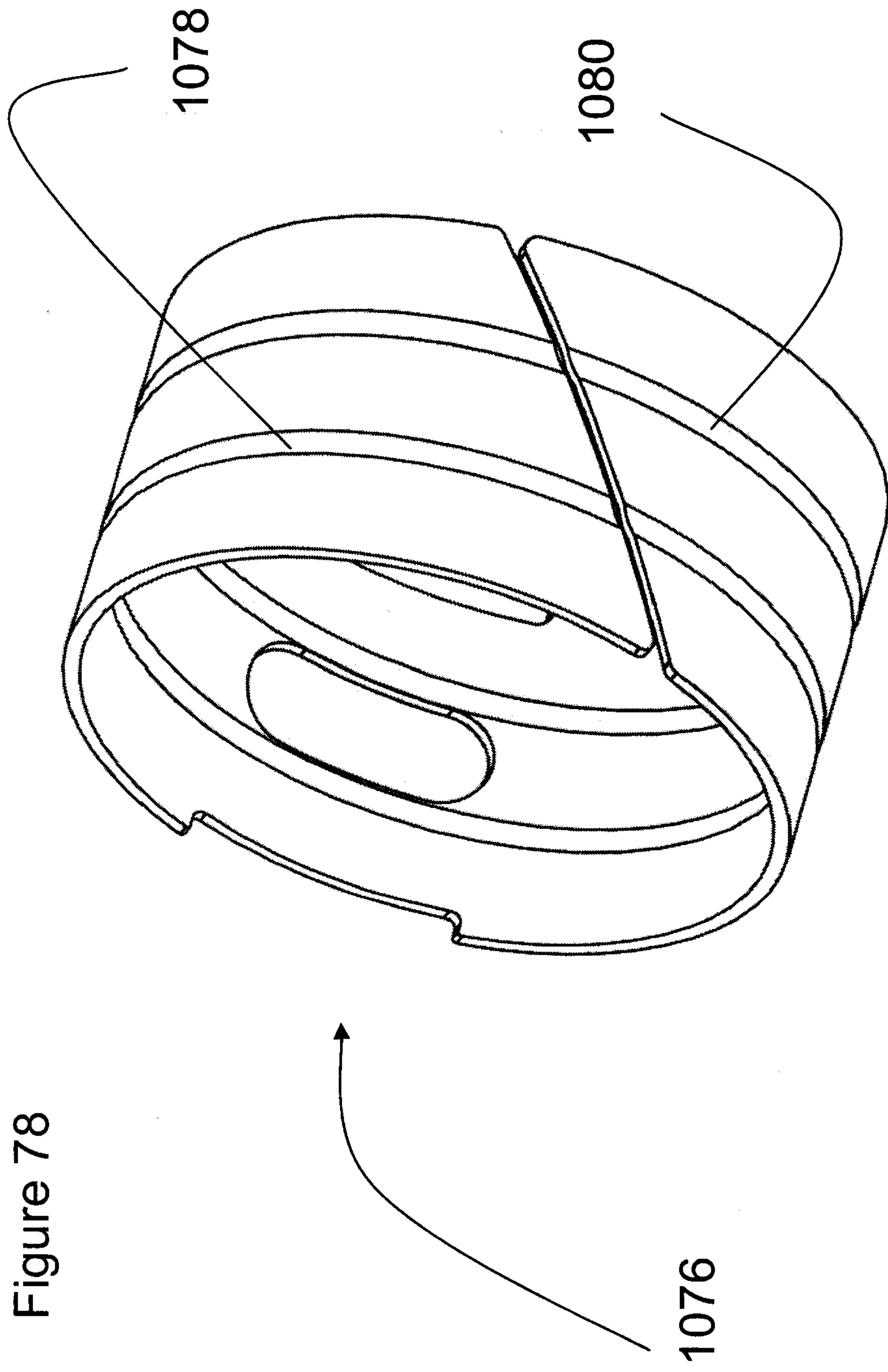












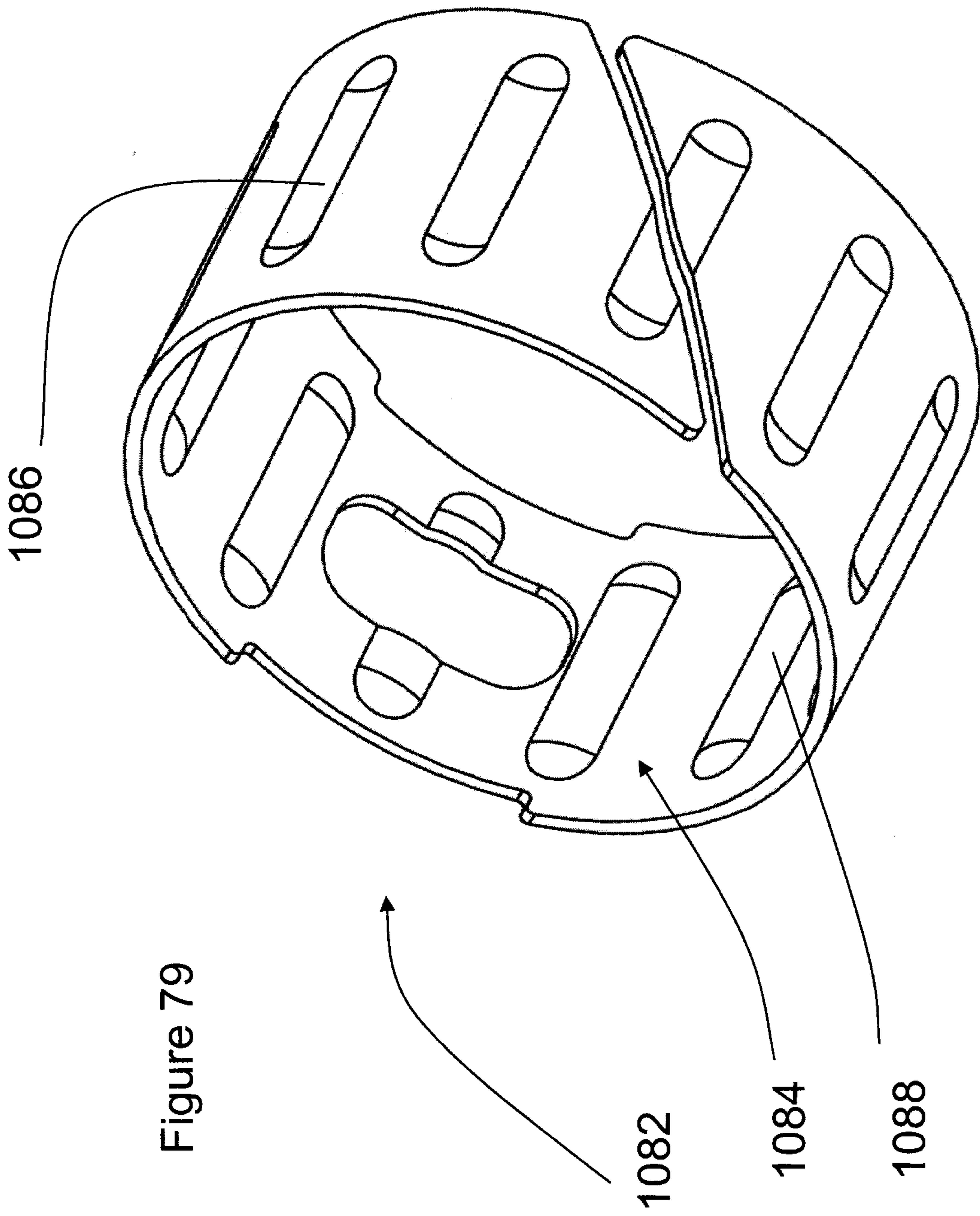
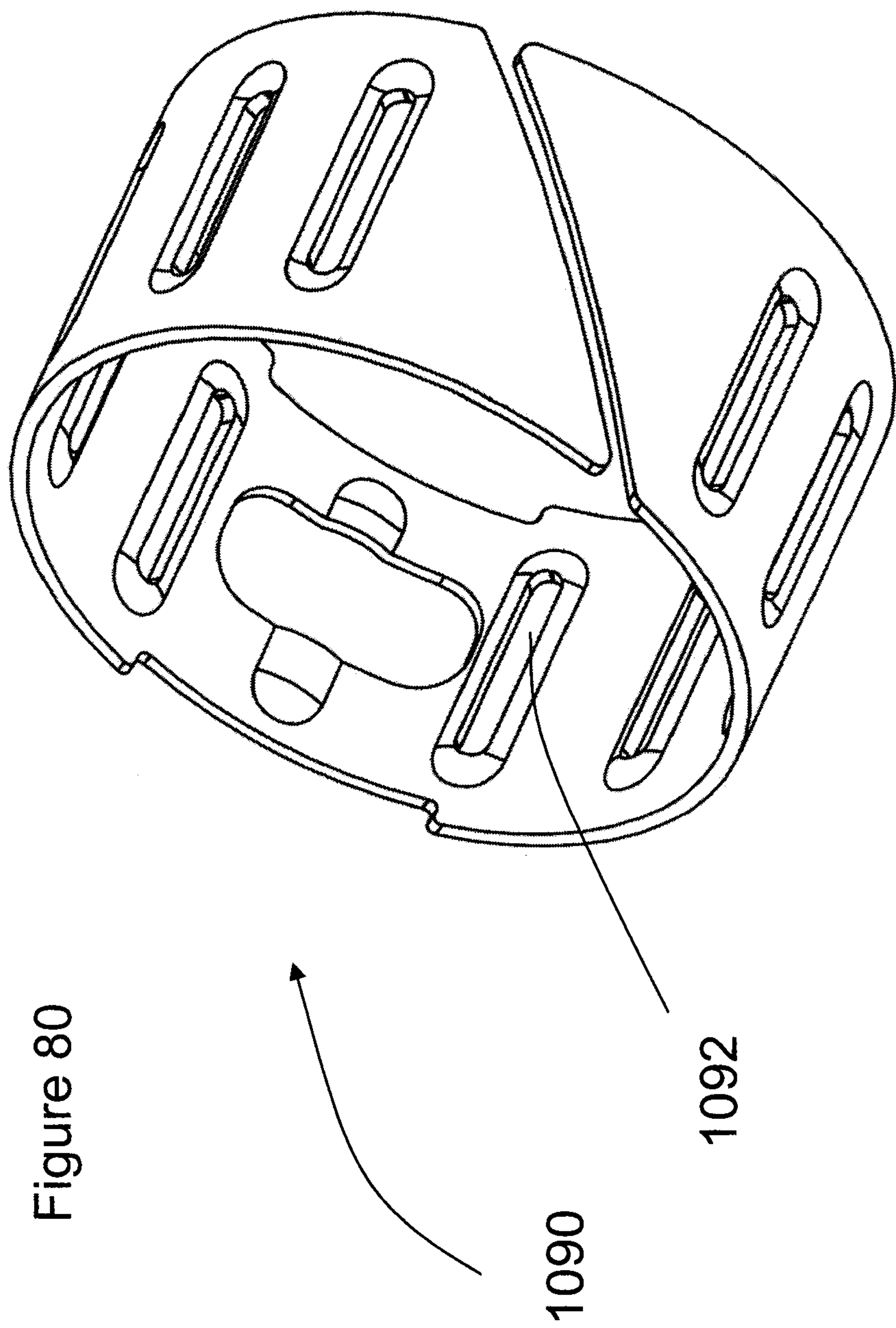
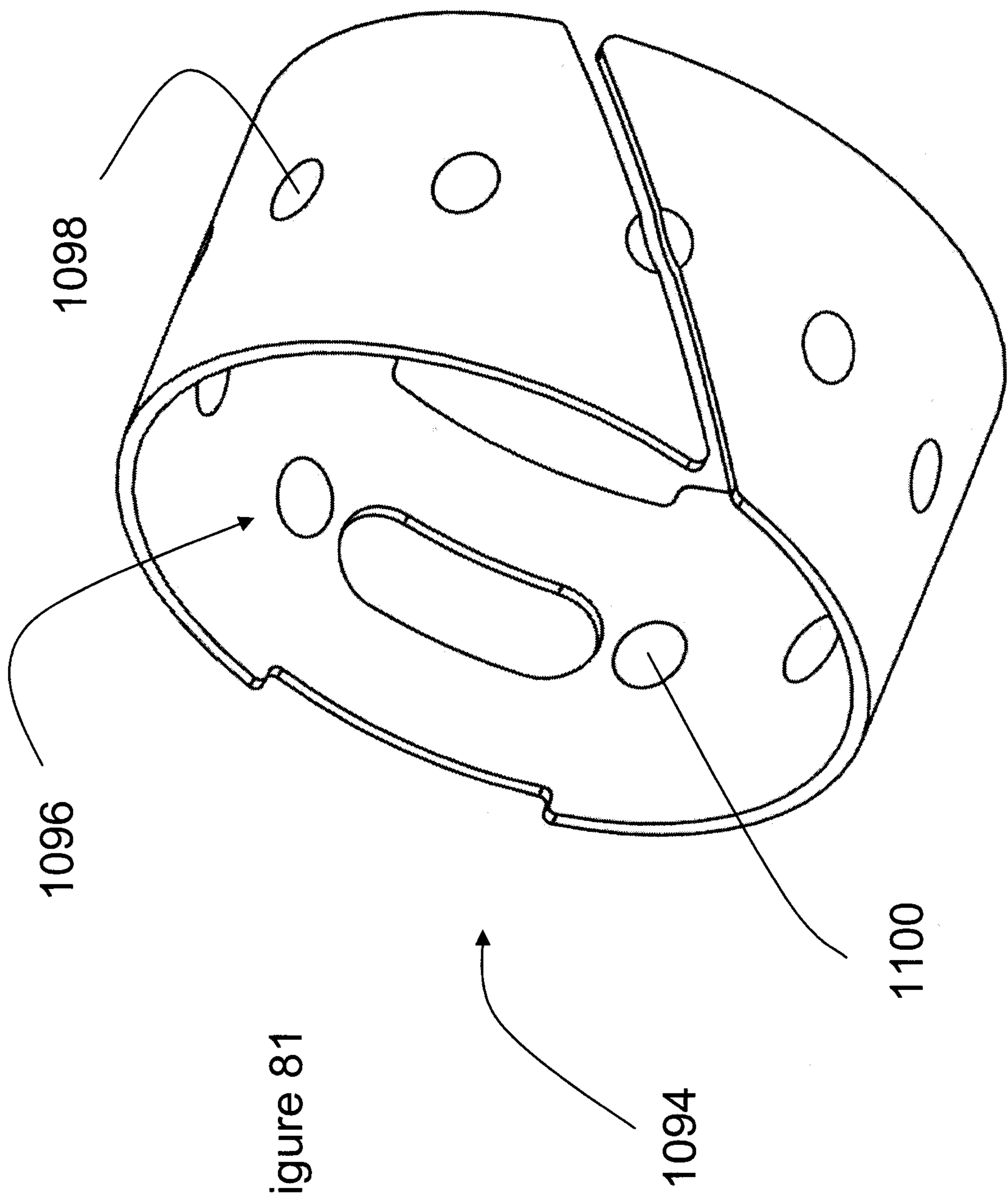


Figure 79





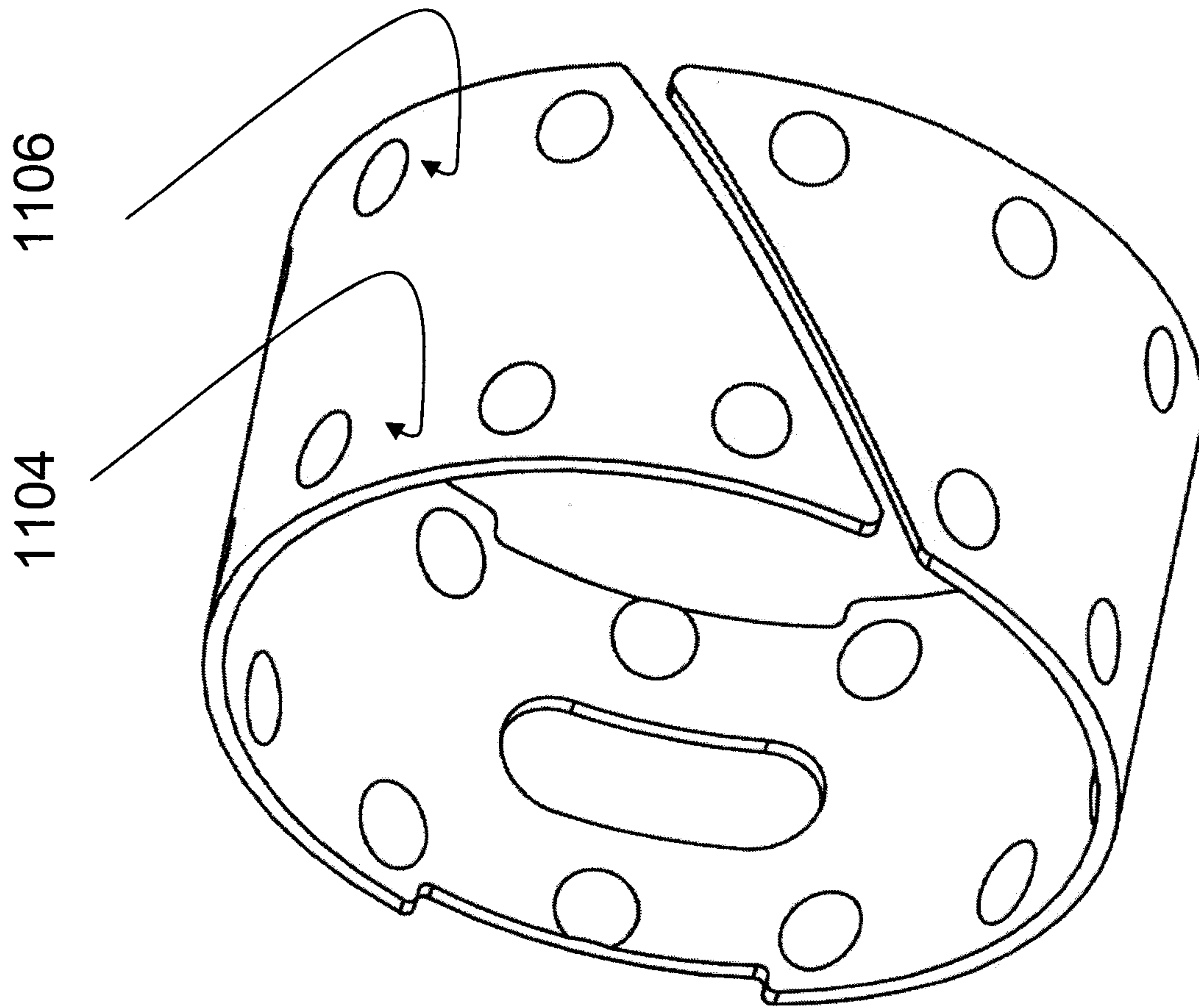
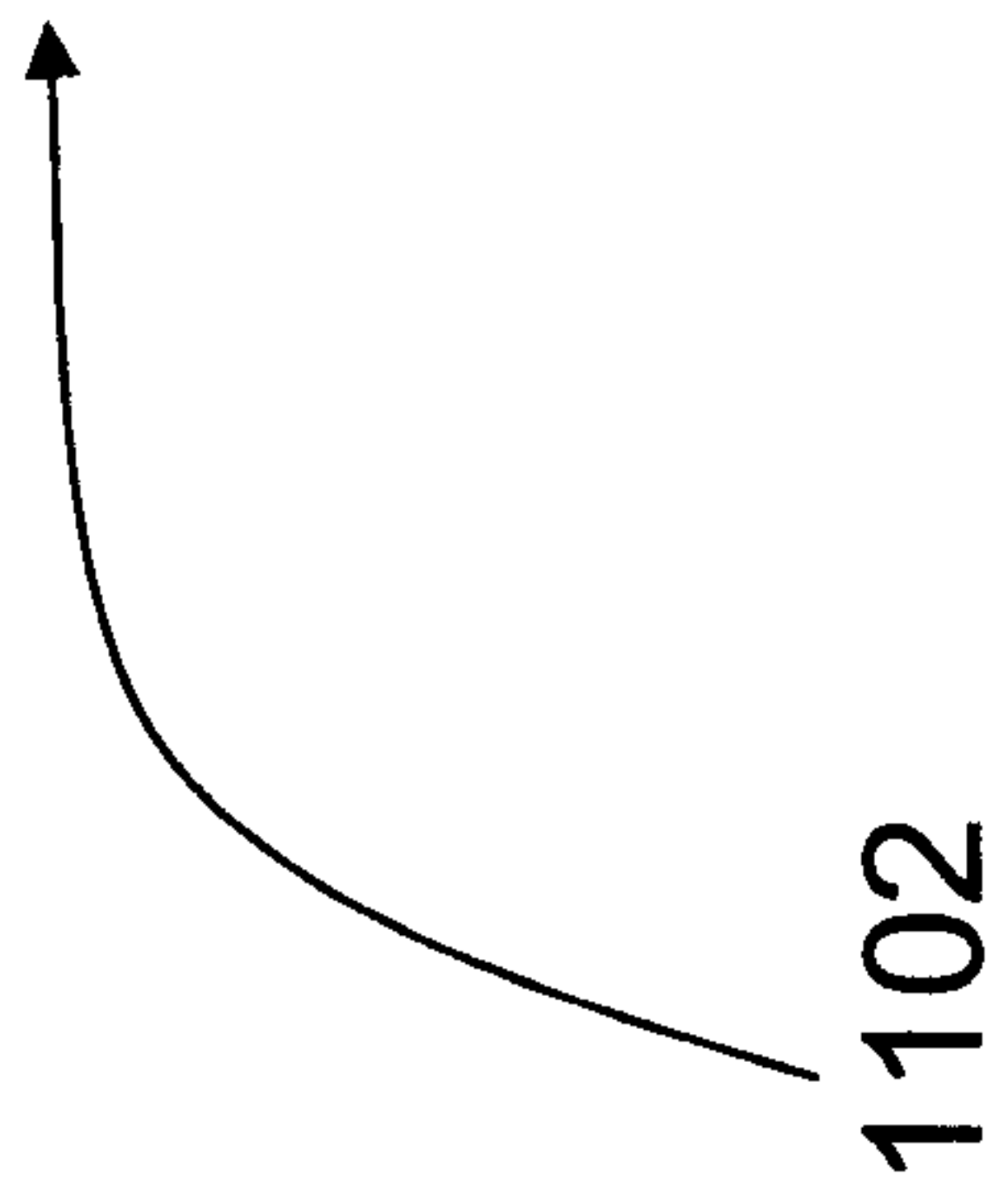


Figure 82



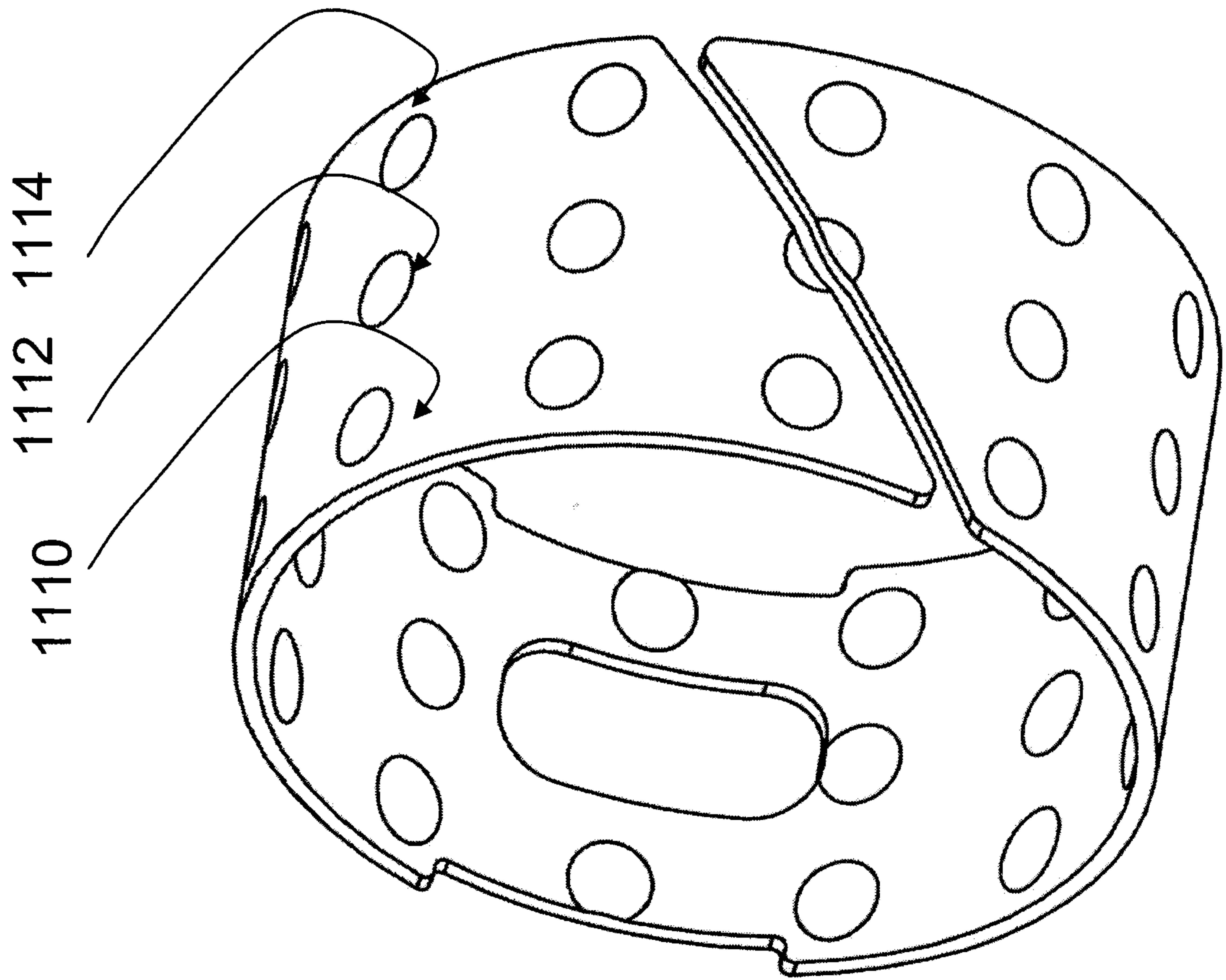
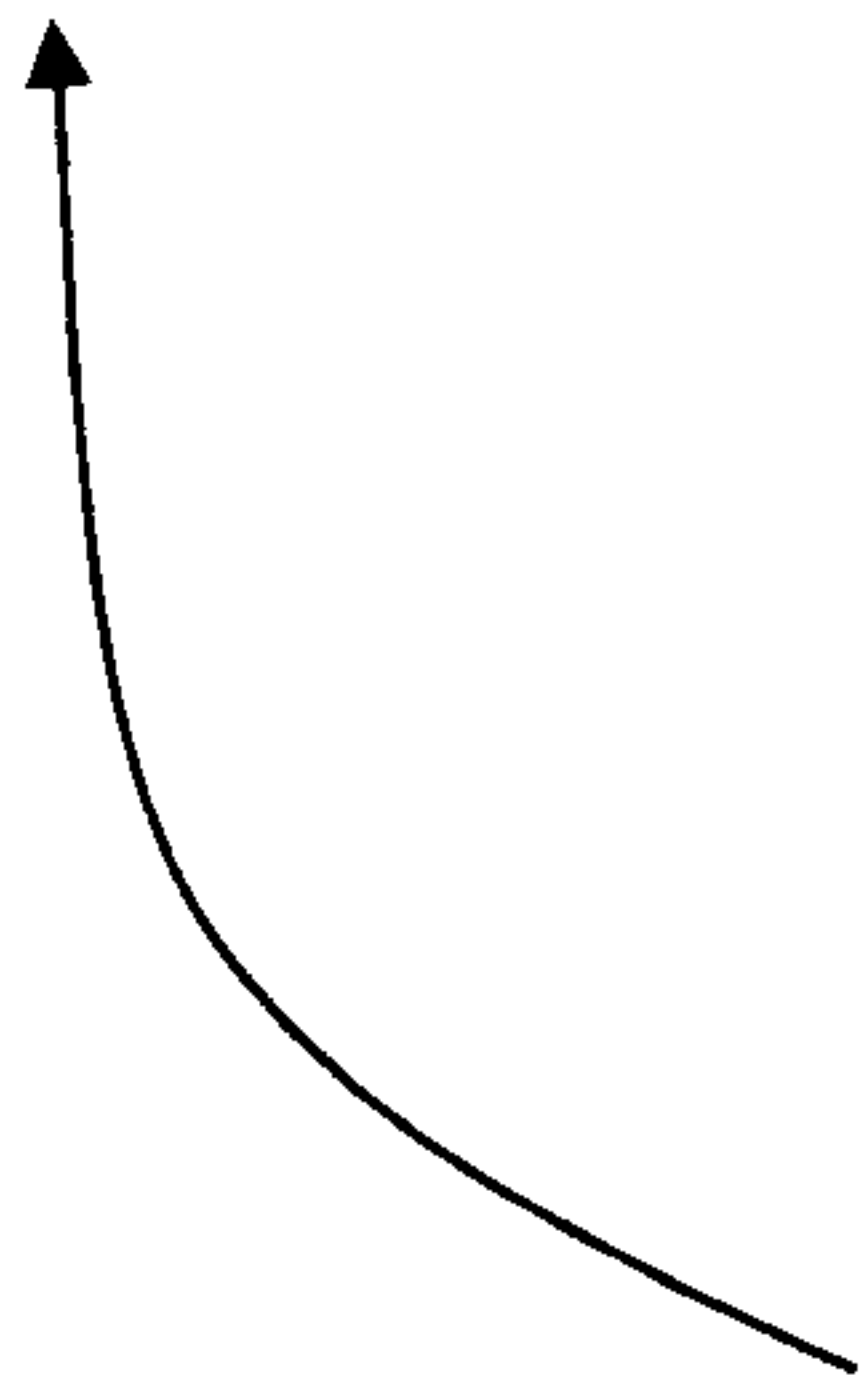
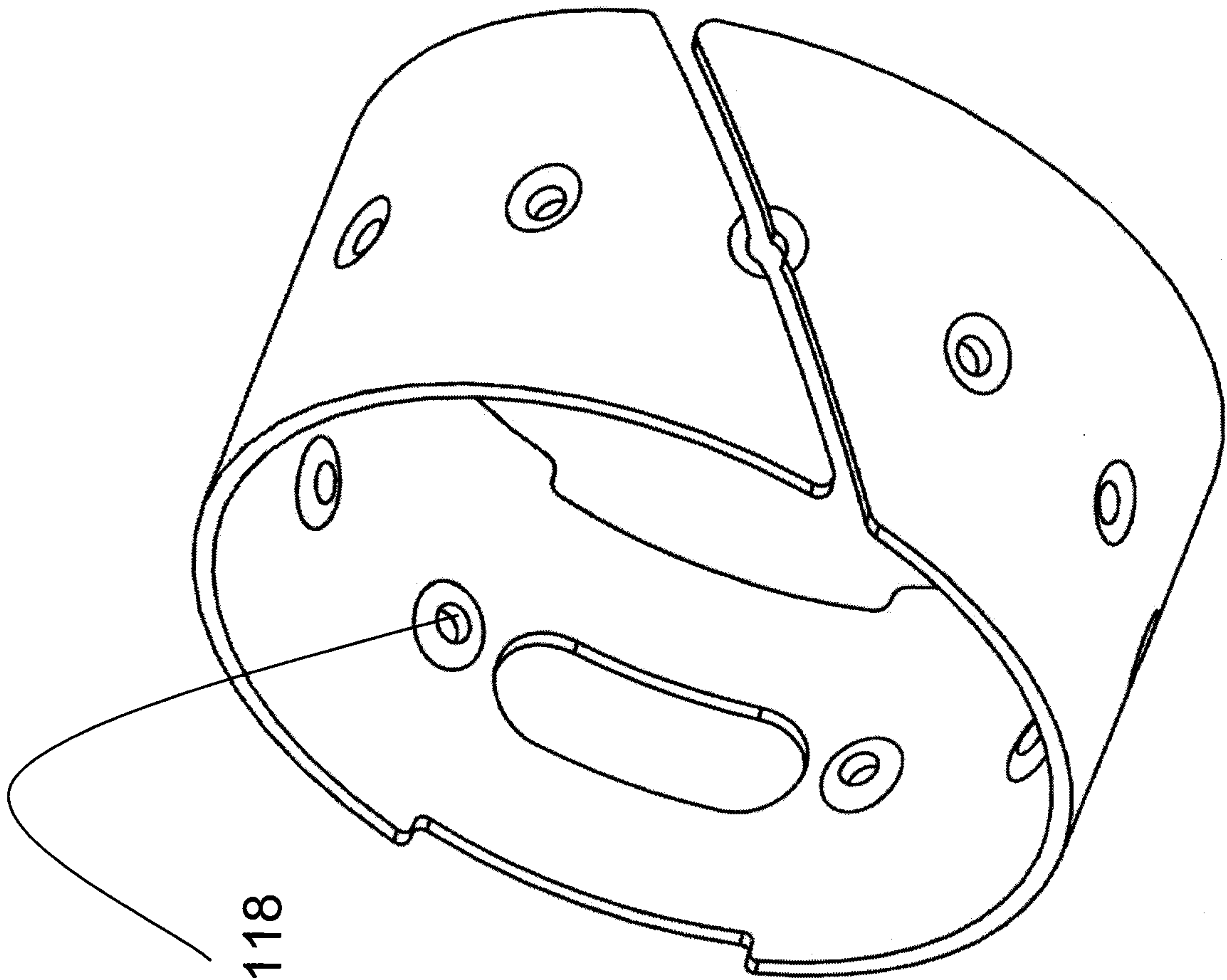


Figure 83



1108



1118

Figure 84

1116

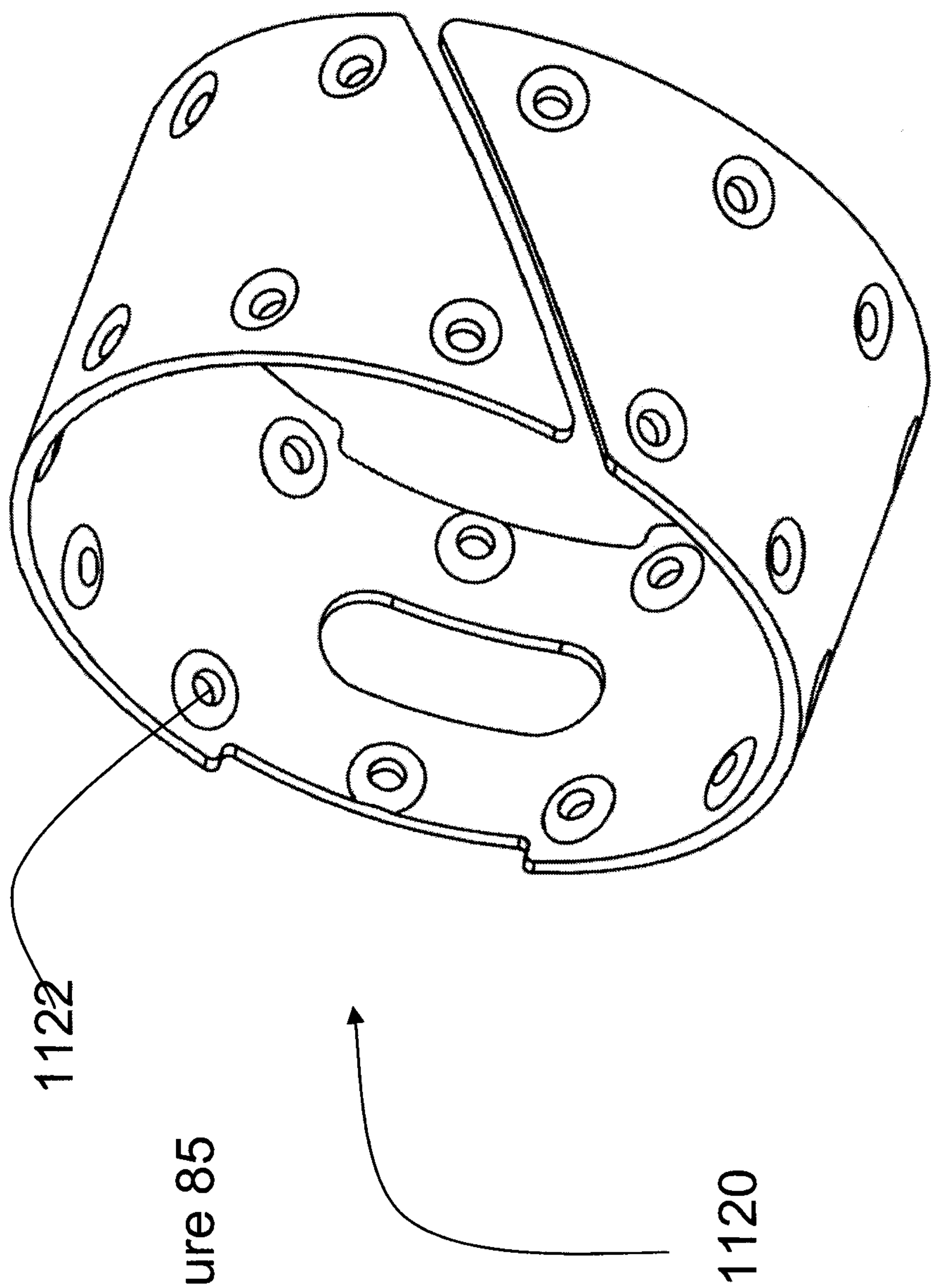


Figure 85

