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(54) CONTACT RING AND CONTACT SYSTEM

(57) The present invention relates to a contact ring (10, 100) for connecting at least a first and a second electrically conductive contact element (1, 2), the contact ring (10, 100, 1000) comprising: a strip (12) comprising electrically conductive material, wherein the strip (12) comprises a plurality of projections (14, 104) on at least one longitudinal side, wherein the projections (14, 104) are configured such that they contact the electrically conductive materials of the contact elements (1, 2) and establish an electrically conductive connection therebetween. The present invention further relates to a contact system composed of a contact ring (100), a ground cylinder (200), and a shielding cylinder (300) with centering projections, where the contact ring is disposed between the two cylinders and where the ground cylinder (200) and the shielding cylinder (300) are connected to one another by a press-fit.

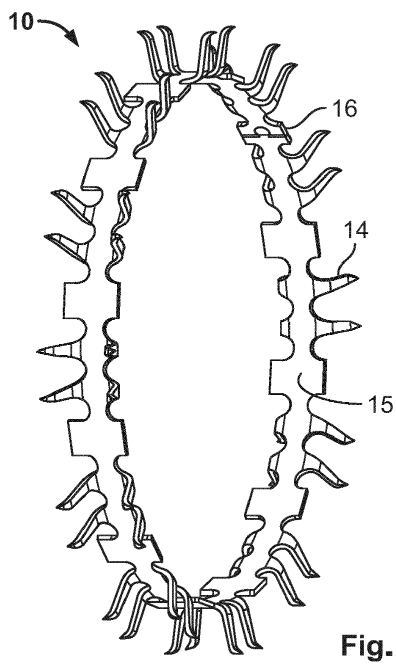

Fig. 2C

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Description

[0001] The present invention relates to a contact ring which connects contact elements in an electrically conductive manner, and a contact system comprising a ground cylinder, a shielding cylinder, and a contact ring which connects the two cylinders in an electrically conductive manner.

[0002] Contact rings are known in the form of compression spring contacts which are made of electrically conductive materials and can therefore establish electrically conductive connections between contact elements. These contact rings are typically flat and have, for example, a wave shape so that they alternately touch the surfaces of the contact elements.

[0003] Figures 1A and 1B illustrate a conventional arrangement of two contact elements 1 and 2 without a connecting member (Figure 1A) and two contact elements with a connecting member 3 (Figure 1B). Connecting member 3 in Figure 1B is a typical contact ring 3 as is known from prior art. Contact ring 3 is flat and wave-shaped and is typically made of spring steel which has good mechanical but poor electrothermal properties, which can also hardly be compensated for by a thick silver plating. The contact sections of the known contact ring are also not able to reliably penetrate electrically insulating surface layers, such as aluminum oxide, with typical contact forces. They are also prone to corrosion.

[0004] Contact elements, though containing electrically conductive materials whose surfaces, however, are made of electrically insulating layers, such as natural oxides, cannot be connected in an adequate electrically conductive manner by the contact elements described in prior art. In addition, the contact elements are not configured to avoid air gaps between the contact elements. The electromagnetic shielding of such a connection is therefore inefficient in the event of high frequencies. There is therefore a need for connecting members that provide electrically conductive connections between contact elements with surfaces made of electrically insulating layers and efficient electromagnetic shielding.

[0005] This problem is solved by the subject matter of the independent claims. Advantageous embodiments of the present invention are presented in the dependent claims.

[0006] For connecting contact elements having an electrically conductive core and an electrically insulating surface layer, the present invention is based on the idea of using a contact member which is made of electrically conductive material and respectively penetrates the electrically insulating surface layers of the contact elements.

[0007] The contact member according to the present invention has the shape of a ring, where the term "ring" in the present application refers to circular ring structures as well as structures that are topologically equivalent to circular ring structures. This includes, for example, non-overlapping polygonal structures. In order to ensure better understanding, only the term "ring" shall be used in the following without further specification. The figures show circular ring structures by way of example, although structures that are topologically equivalent to circular ring structures are also included.

[0008] The ring shape of the contact member enables, in particular, the efficient connection of cylindrical contact elements with a corresponding base area, since the latter has the appropriate architecture for use in a limited ring-shaped installation space. It is created in that a strip of an electrically conductive material, for example, a copper alloy, which can be silver-plated, is closed to form a ring-shaped structure. The use of a copper alloy, which can be silver-plated, is advantageous since it represents a good compromise between mechanical and electrothermal properties.

[0009] The strip comprises projections on at least one longitudinal side. The projections have tips or sharp edges which penetrate the electrically insulating surface layers of the contact elements and thereby establish an electrically conductive connection between the electrically conductive cores of the contact elements. By using a large number of short projections, the contact member according to the present invention benefits from the advantages of multi-contact physics and has favorable electrothermal properties. The projections each establish an electrically conductive contact, whereby a plurality of electrically conductive connections between the contact elements is created, which leads to many short current flows and redundant contacting.

[0010] In contrast to known contact rings, which have planar contact sections for touching the contact elements, the contact sections of the contact ring according to the present invention are very limited and thereby reduce the occurrence of corrosion.

[0011] According to an advantageous embodiment, the strip of the contact ring is arranged in the shape of a cylinder and can therefore be well adapted to cylindrical contact elements.

[0012] The projections of this embodiment taper to a tip and have an S-shaped cross section, so that their tip impacts the surfaces of the contact elements at an obtuse angle. This avoids greater lateral contact or surface contact of the projections with the surfaces of the contact elements. This in turn reduces the occurrence of fretting corrosion.

[0013] At least one pair of adjacent projections has flat segments disposed between the two projections. Said flat segments serve as overstretch protection for the projections during pre-assembly and final assembly between the contact elements. With a coil spring that engages around the cylindrically arranged strip, the contact ring on the cylindrical contact element can optionally be even more stable.

[0014] According to a further advantageous embodiment, the strip is closed to form a ring-shaped structure and is arranged in a flat manner.

[0015] The contact ring according to the second embodiment can be used as part of a contact system which, in addition to the contact ring according to the present invention, comprises a ground cylinder and a shielding cylinder which are shaped such that gap-free assembly with the flat contact ring is possible, thereby creating perfect electromagnetic shielding. The connection is established by a double press fit and is therefore particularly robust. It additionally reduces relative motions and vibrations. Due to this connection, the contact system according to the present invention comprises efficient electromagnetic shielding, in particular in the event of high frequencies, and can advantageously be used in multi-position connectors.

[0016] The shielding cylinder according to the present invention also has three centering projections which enable the efficient centering of the shielding cylinder relative to the ground cylinder and prevent relative motions and vibrations between them, thereby additionally stabilizing the connection.

[0017] A cylinder of the contact system preferably comprises the electrically conductive material aluminum. Other materials are also conceivable.

[0018] According to a third advantageous embodiment, the strip is also closed to form a ring-shaped structure and arranged in a flat manner, but additionally has a meander structure with sections alternatingly facing inwardly and outwardly, wherein the sections facing inwardly are bent upwardly or downwardly from the plane of the ring and form projections for electrically conductive contacting of the contact elements.

[0019] The contact rings according to all embodiments have a high degree of adaptability with regard to the orientation, arrangement, number, and configurations of the projections.

[0020] For better understanding of the present invention, it shall be explained in detail by way of the embodiments illustrated in the figures below. Same elements are there designated with same reference numerals and same component designations. Furthermore, some features or combinations of features from the different embodiments shown and described can also be independent inventive solutions by themselves or solutions according to the invention.

Fig. 1A shows a first and a second contact element.

Fig. 1B shows the two contact elements from Figure 1A connected by a contact ring in a known embodiment.

Fig. 2A shows the strip according to the first embodiment of the present invention.

Fig. 2B shows the optional closure according to the first embodiment of the present invention.

Fig. 2C shows the contact ring according to the first embodiment of the present invention.

Fig. 3 shows the configuration of two contact elements and the contact ring according to the first embodiment of the present invention.

Fig. 4 shows the contact ring according to a second embodiment of the present invention.

Fig. 5 shows the contact system comprising a contact ring according to the second embodiment, a ground cylinder, and a shielding cylinder according to the second embodiment of the present invention.

Fig. 6A shows the contact ring according to the second embodiment and the ground cylinder of the contact system.

Fig. 6B shows a detail of the contact ring of the second embodiment and the ground cylinder of the contact system.

Fig. 7A shows the contact system comprising a shielding cylinder with centering projections according to the second embodiment of the present invention.

Fig. 7B shows a cross section of the contact system comprising a shielding cylinder with centering projections according to the second embodiment of the present invention.

Fig. 7C shows an enlarged detail of the contact system comprising a shielding cylinder with a centering projection according to the second embodiment of the present invention.

Fig. 8 shows the contact ring according to the second embodiment, alternatively with toothing instead of inner projections.

Fig. 9A shows the strip closed in a ring-shaped manner with a meander structure according to the third embodiment of the present invention.

Fig. 9B shows the contact ring according to the third embodiment of the present invention with projections which point in the same direction.

Fig. 9C shows the contact ring according to the third embodiment of the present invention with projections which point in different directions.

Fig. 10 shows a possible application of the contact ring according to the third embodiment.

Fig. 11A shows the contact ring according to the third embodiment with attachment projections having a flat shape.

Fig. 11B shows the contact ring according to the third embodiment with attachment projections having bent-over projections.

Fig. 11C shows the contact ring according to the third embodiment with attachment projections having a flat shape in a second variant.

Fig. 11D shows the contact ring according to the third embodiment with attachment projections having bent-over projections in a second variant.

Fig. 11E shows the contact ring according to the third embodiment with attachment projections having a flat shape in a third variant.

Fig. 11F shows the contact ring according to the third embodiment with attachment projections having bent-over projections in a third variant.

Fig. 12A shows the contact ring according to the third embodiment in an exemplary variation having a flat shape.

Fig. 12B shows the contact ring according to the third embodiment in an exemplary variation having bent-over projections.

Fig. 12C shows the contact ring according to the third embodiment in a further exemplary variation having a flat shape.

Fig. 12D shows the contact ring according to the third embodiment in a further exemplary variation having bent-over projections.

Fig. 13A shows the contact ring according to the third embodiment as part of a contact system in a first variant.

Fig. 13B shows the contact ring according to the third embodiment as part of a contact system in a second variant.

Fig. 13C shows the contact ring according to the third embodiment as part of a contact system in a third variant.

Fig. 13D shows the contact ring according to the third embodiment as part of a contact system in a fourth variant.

[0021] Embodiments of the present invention shall be described hereafter in detail with reference to Figures 2A to 13D.

[0022] Figures 2A to 2C show a contact ring 10 according to a first embodiment of the present invention. As shown in Figure 2A, contact ring 10 comprises a strip 12 made of electrically conductive material. Strip 12 is provided with projections 14 on at least one longitudinal side. Projections 14 taper and form a tip at their end. Figure 2B shows that strip 12 can be equipped at the ends with a closure 16 which allows strip 12 to be closed to form a ring-shaped cylindrically arranged structure, as can be seen in Figure 2C. This structure allows for simple and inexpensive production of contact ring 10 by punching and bending. As shown in Figure 2C, projections 14 are bent outwardly and have an S-shaped cross section.

[0023] A coil spring (not shown) can optionally surround contact ring 10 concentrically so that the connection between contact ring 10 and cylindrical contact element 2 is even more stable.

[0024] In addition, it is also possible for the strip to be open at the ends without a closure. In this case, the coil spring can optionally hold the strip together. Another possibility is for the strip to be a little longer without a closure and comprises an overlap at the ends.

[0025] The material of contact ring 10 preferably comprises a copper alloy which can be silver-plated. In contrast to spring steel, this material has good mechanical as well as good electrothermal properties.

[0026] Figure 3 shows an application example of contact ring 10. Contact ring 10 is arranged between two contact elements 1 and 2 such that it touches the oppositely disposed surfaces of contact elements 1 and 2 with the tips of S-shaped projections 14. If contact elements 1 and 2 are pressed against one another, then the tips of projections 14 penetrate electrically insulating surface layers such as a layer of aluminum oxide which naturally forms on the surface of a contact element made of electrically conductive aluminum.

[0027] An electrically conductive connection can thus be established with the aid of contact ring 10 between the electrically conductive core of first contact element 1 and the electrically conductive core of second contact element 2, even if contact elements 1 and 2 comprise insulating surfaces that electrically separate them from one another. A large number of projections 14, for example 24, like in Figure 2C, on both sides of contact ring 10 has a physically positive effect on the electrothermal properties of the connection between the two contact elements 1 and 2.

[0028] The structure of contact ring 10 with its pointed projections 14 for touching contact elements 1 and 2 also minimizes the area of the contact sections in which a protective surface of contact elements 1 and 2 is damaged. Corrosion of contact elements 1 and 2 can thereby be counteracted.

[0029] Figure 4 shows a contact ring 100 according to a second embodiment of the present invention. This contact ring 100 comprises a flat ring made of electrically conductive material. The flat ring is provided with projections 104 on the two narrow sides. Projections 104 taper towards their end. Projections 104 are bent such that they point out of the plane spanned by ring 100, wherein projections 104 on the outer side of ring 100 and projections 104 on the inner side of ring 100 point in opposite directions. Projections 104 are preferably, but not necessarily, arranged with regular spacings, where internal projections 104 can also have individual greater spacings.

[0030] Projections 104 on the outer side of ring 100 have an S-shaped cross section. They are oriented such that they surround a common inscribed circle that they touch with one flat side. Projections 104 on the inner side of ring 100 are oriented such that they each touch a common inscribed circle with an edge. This edge is sharp and therefore able to penetrate insulating surfaces. Projections 104 on the outer side of the ring can also optionally be oriented such that they each touch a common inscribed circle with an edge that is sharp and can therefore penetrate insulating surfaces.

[0031] Like contact ring 10 according to the first embodiment, the material of contact ring 100 according to the second embodiment preferably comprises a copper alloy which can be silver-plated and which has good mechanical as well as good electrothermal properties.

[0032] The structure of contact ring 100 can be created in a simple and inexpensive manner as a reel-to-reel strip by punching and bending.

[0033] Figure 5 shows how contact ring 100 according to the second embodiment can be arranged in a contact system 400 together with a ground cylinder 200 and a shielding cylinder 300. Projections 104 on the outer side of the ring engage around shielding cylinder 300. Projections 104 on the inner side of the ring are spread apart from the inside against ground cylinder 200. The connection is established by press-fitting, so that contact ring 100, ground cylinder 200, and shielding cylinder 300 touch each other without any air gaps therebetween.

[0034] As shown in Figures 6A and 6B, contact ring 100 contacts ground cylinder 200 with a sharp edge of projections 104 on the inner side of the ring. As a result of the pressure of the press fit, the sharp edges penetrate the surface of ground cylinder 200. As described in relation to contact ring 10 according to the first embodiment, this creates an electrically conductive connection between contact ring 100 and the electrically conductive core of ground cylinder 200. Due to the expansion of the contact section between contact ring 100 and ground cylinder 200, corrosion is additionally reduced.

[0035] As shown in Figures 7A to 7C, shielding cylinder 300 comprises three centering projections 302. Shielding cylinder 300 is connected to contact ring 100 in such a way that centering projections 302 are each positioned where contact ring 100 comprises internal projections 104 with greater spacings. As a result, centering projections 302 can be bent around contact ring 100 so that they touch ground cylinder 200 from the inside without being obstructed by a projection 104 of contact ring 100.

[0036] Centering projections 302 hold shielding cylinder 300 firmly at ground cylinder 200. As a result, they facilitate the centering of shielding cylinder 300 relative to ground cylinder 200 and stabilize contact system 400. Centering projections 302 and the press-fit of contact system 400 thereby ensure that the connection composed of contact ring 100, ground cylinder 200, and shielding cylinder 300 does not have any air gaps nor any relative motions and vibrations of the components. As a result, efficient electromagnetic shielding can be ensured, in particular in the event of high frequencies.

[0037] As shown in Figure 8, contact ring 100 according to the second embodiment can alternatively comprise a toothing 106 instead of internal projections 104. This alternative of contact ring 100 according to the second embodiment can be produced in a simple and inexpensive manner by deep drawing, punching, and bending.

[0038] Figure 9 shows a contact ring 1000 according to a third embodiment of the present invention. Like contact ring 100 of the second embodiment, contact ring 1000 consists of a strip which is closed to form a flat, ring-shaped structure. In addition, contact ring 1000 of the third embodiment has a meander structure with sections alternately pointing inwardly 1008 and outwardly 1009. This arises from the strip being provided with cutouts 1010 and 1011 which alternately start out from the inner and outer edge of the strip and extend into the interior of the strip (see Figure 9A). The meanders pointing inwardly are bent out of the plane of the ring and in this manner form projections 1004 for the electrically conductive contacting of the contact elements. Projections 1004 can point in the same direction, as shown in Figure 9B, or in different directions, as shown in Figure 9C.

[0039] Figure 10 shows a possible application of contact ring 1000 according to the third embodiment for connecting two contact elements 1 and 2. Due to its structure, contact ring 1000 is elastic in several directions of expansion. On the one hand, the angle between outer 1009 and bent-over inner sections 1008 and therefore the expansion of contact ring 1000 out of the plane of the ring can be varied by moving contact elements 1 and 2 towards or away from one another. On the other hand, the radius of contact ring 1000 can be varied by expanding or compressing the meander structure, thereby increasing or reducing the circumference of contact ring 1000. In the example of contact element 1 shown in Figure 10, this property allows the radially elastic contact ring 1000 to be pulled over a latching step 1012 which is provided with a ramp 1014 on one side. In the target position, contact ring 1000 rests on a retaining ring 1015 and is prevented from slipping off contact element 1 by latching step 1012.

[0040] The meander structure according to the third embodiment allows for a mechanically advantageous connection of the contact elements since they can be effectively decoupled and vibrations can thus be reduced. The configuration is also very variable and can be easily adapted to the given spatial conditions. For example, Figures 11A to 11F show a variation of contact ring 1000 according to the third embodiment which comprises an additional section of outer meanders 1016 pointing out of the plane of the ring and is therefore suitable for the attachment to cylindrical contact elements. The length and shape of the cutouts pointing inwardly and outwardly can then be varied and the spatial elastic properties of contact ring 1000 can thereby be adapted to the respective conditions. Figures 12A to 12D also show variations with attachment projections which can be connected to a contact element, for example, by welding.

[0041] As shown in Figures 13A to 13D, contact ring 1000 according to the third embodiment can also be used as part of a contact system for connecting a ground cylinder 200 and a shielding cylinder 300.

List of reference characters

[0042]

1, 2	contact element
3	contact ring in a known embodiment
10, 100, 1000	contact ring
12	strip
14, 104, 1004	projection
15	flat segment
16	closure
18	coil spring
102	increased spacing
106	toothing
200	ground cylinder
300	shielding cylinder
302	centering projection
400	contact system
1007	attachment projection
1008	section facing inwardly
1009	section facing outwardly
1010	cutout facing inwardly
1011	cutout facing outwardly
1012	latching step
1013	inner ramp
1014	outer ramp
1015	retaining ring
1016	section of the outer sections pointing out of the plane of the ring

Claims

1. Contact ring (10, 100, 1000) for connecting at least a first and a second electrically conductive contact element (1, 2), the contact ring (10, 100, 1000) comprising:

   a strip (12) comprising electrically conductive material,

   wherein said strip (12) comprises a plurality of projections (14, 104, 1004) on at least one longitudinal side,

   wherein said projections (14, 104, 1004) are configured such that they contact the electrically conductive materials of said contact elements (1, 2) and establish an electrically conductive connection therebetween.

2. Contact ring (10, 100, 1000) according to claim 1, wherein said projections (14, 104, 1004) penetrate electrically insulating surface layers of said contact elements, and/or wherein each projection (14, 104) comprises tapering end sections which can be connected to contact elements (1, 2).

3. Contact ring (10, 100, 1000) according to one of the preceding claims, wherein said strip (12) is closed to form a circular ring structure or a structure that is topologically equivalent thereto, and/or wherein at least one of said projections (14, 104, 1004) is bent in order to form a spring contact.

4. Contact ring (10, 100, 1000) according to one of the preceding claims, wherein the material of said contact ring (10, 100, 1000) comprises a copper alloy.

5. Contact ring (10) according to one of the preceding claims, wherein said strip (12) is closed to form a circular ring structure or a structure that is topologically equivalent thereto and is arranged in a cylindrical shape.

6. Contact ring (10) according to claim 5, wherein said contact ring (10) comprises 24 projections on each side.

7. Contact ring (10) according to one of the claims 5 or 6, wherein said projections (14) have an S-shaped cross section.

8. Contact ring (10) according to one of the claims 5 to 7 additionally comprising a coil spring (18) which engages around said strip.

9. Contact ring (100, 1000) according to one of the claims 1 to 4, wherein said strip is closed to form a circular ring structure or a structure that is topologically equivalent thereto and is arranged at least in part in a flat manner.

10. Contact ring (100, 1000) according to claim 9, where said projections (104, 1004) have edge sections with sharp edges.

11. Contact ring (100) according to one of the claims 9 or 10, where said contact ring (100) comprises 15 projections (104) with sharp edges on one side.

12. Contact system comprising a contact ring (100) according to one of the claims 9 to 11, a ground cylinder (200), and a shielding cylinder (300), wherein said contact ring is disposed between said two cylinders and wherein said ground cylinder (200) and said shielding cylinder (300) are connected to one another by a press-fit.

13. Contact system according to claim 12, wherein said shielding cylinder (300) comprises three centering projections (302) for centering said shielding cylinder (300) with respect to said ground cylinder (200).

14. Contact system according to one of the claims 12 or 13, wherein at least one of said cylinders comprises the electrically conductive material aluminum.

15. Contact ring (1000) according to one of the claims 9 or 10, wherein said strip has a meander structure with sections alternatingly pointing inwardly and outwardly, wherein the sections pointing inwardly are bent upwardly or downwardly from the plane of the ring and form said projections (1004).

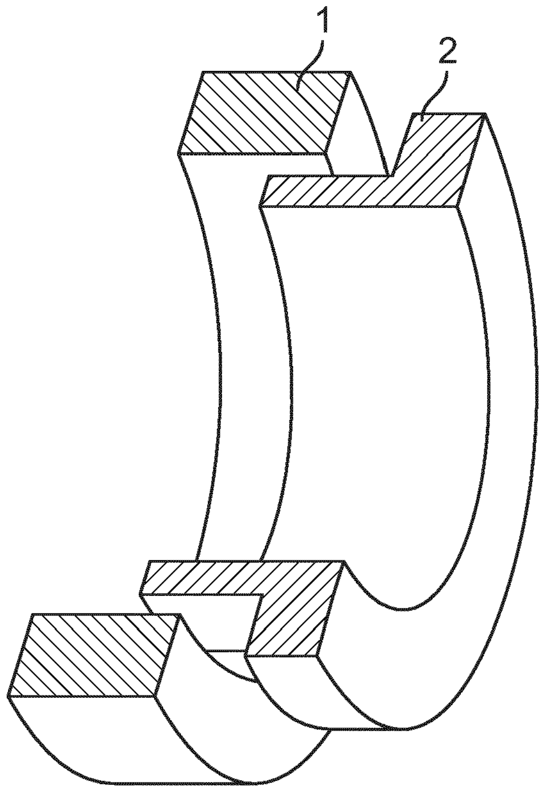

Fig. 1A

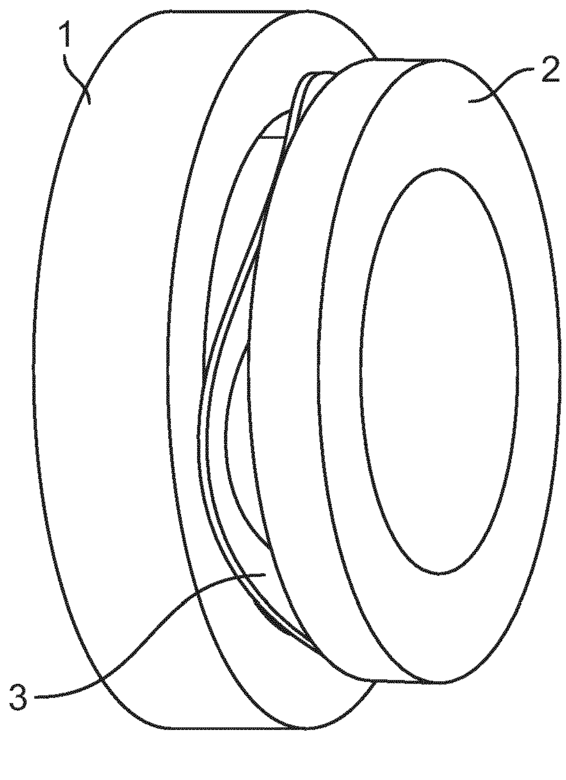

Fig. 1B

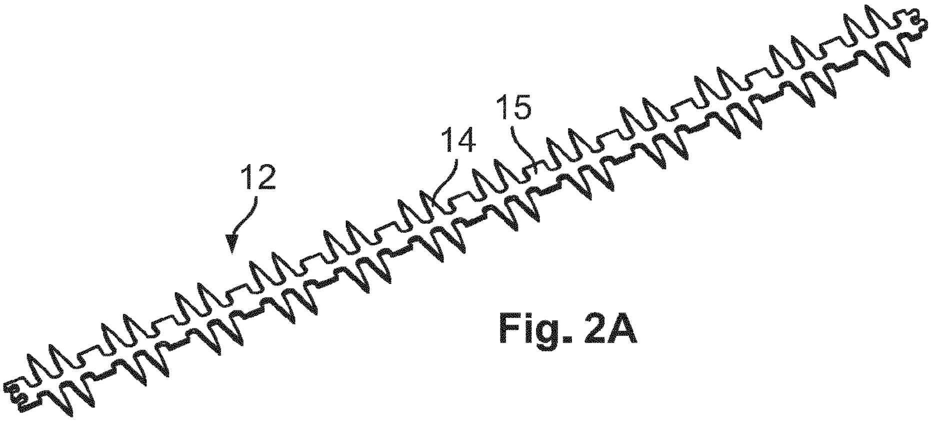

Fig. 2A

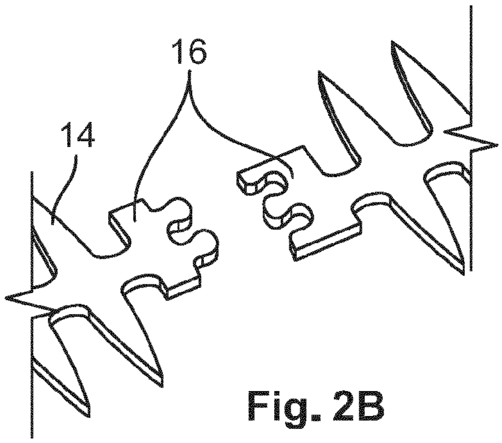

Fig. 2B

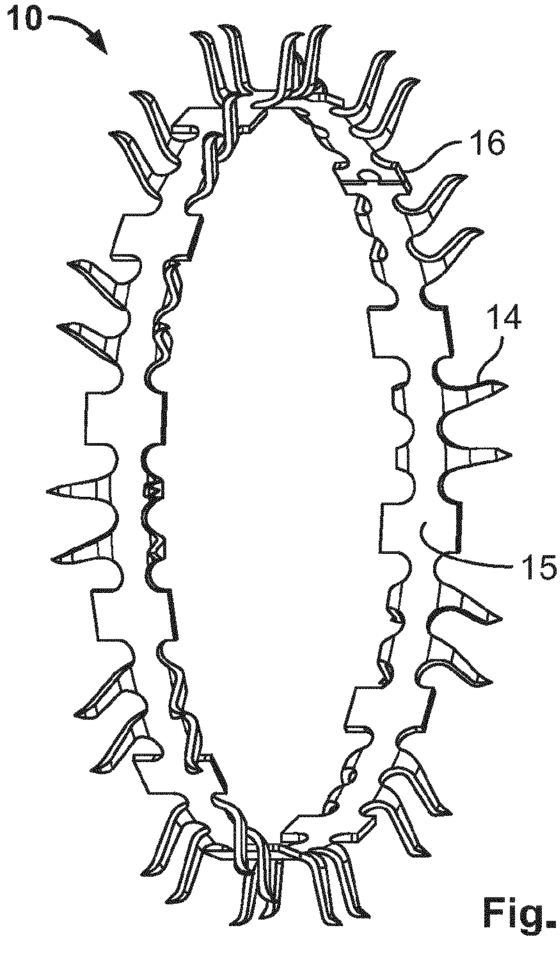

Fig. 2C

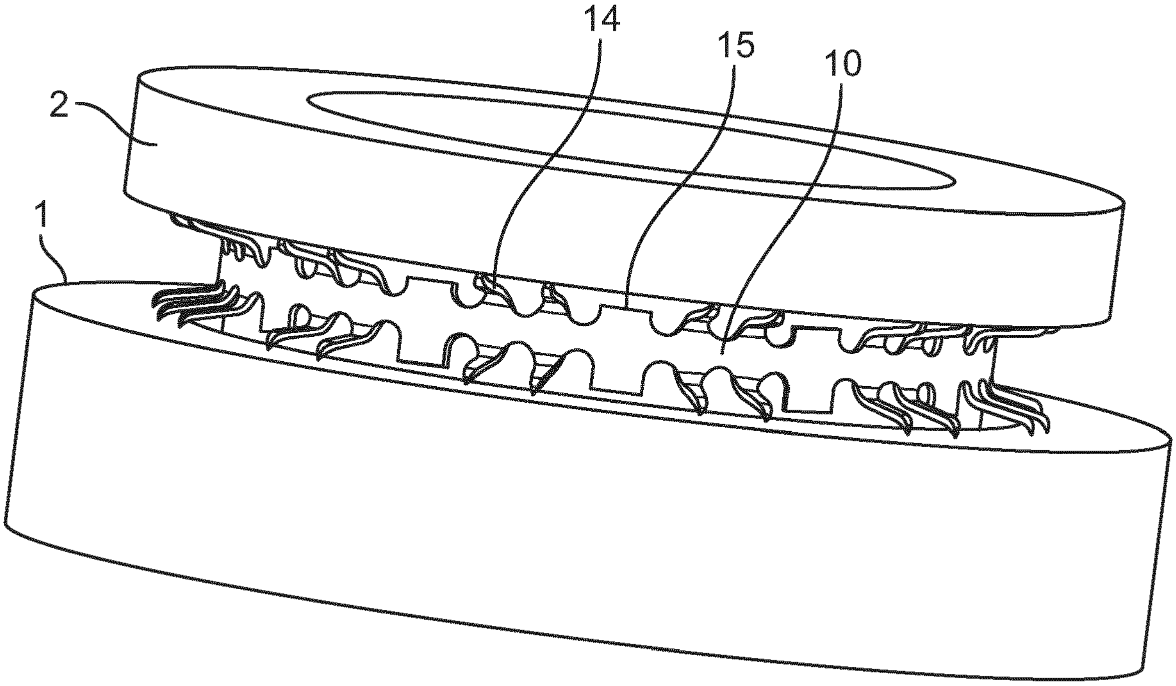

Fig. 3

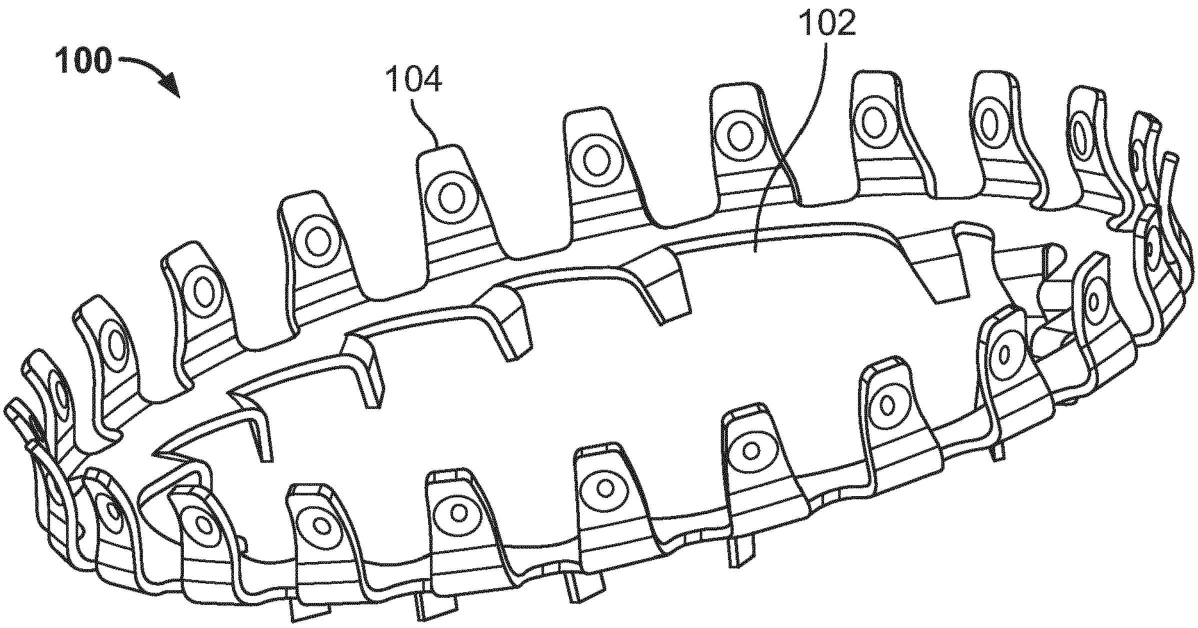

Fig. 4

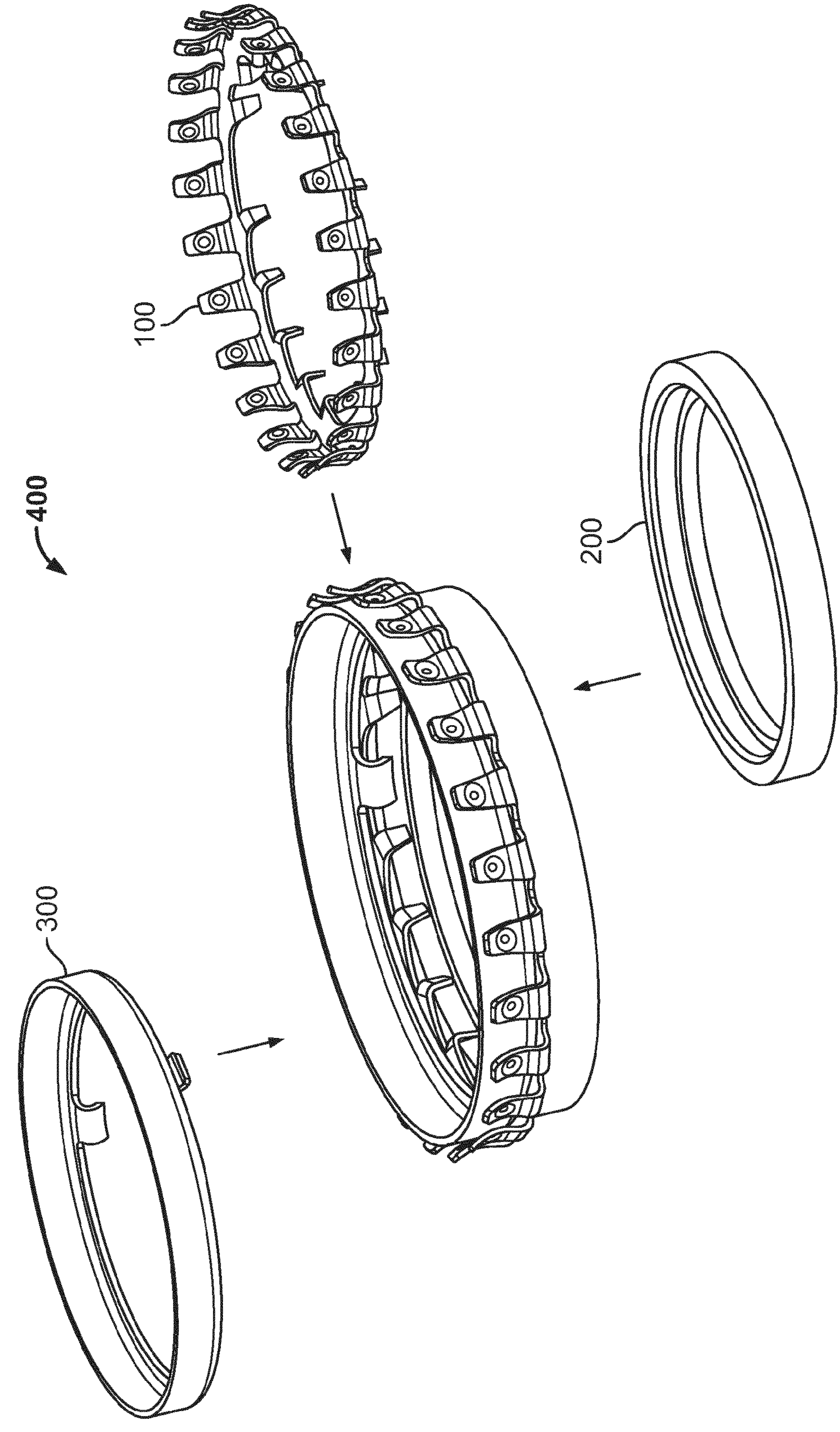

Fig. 5

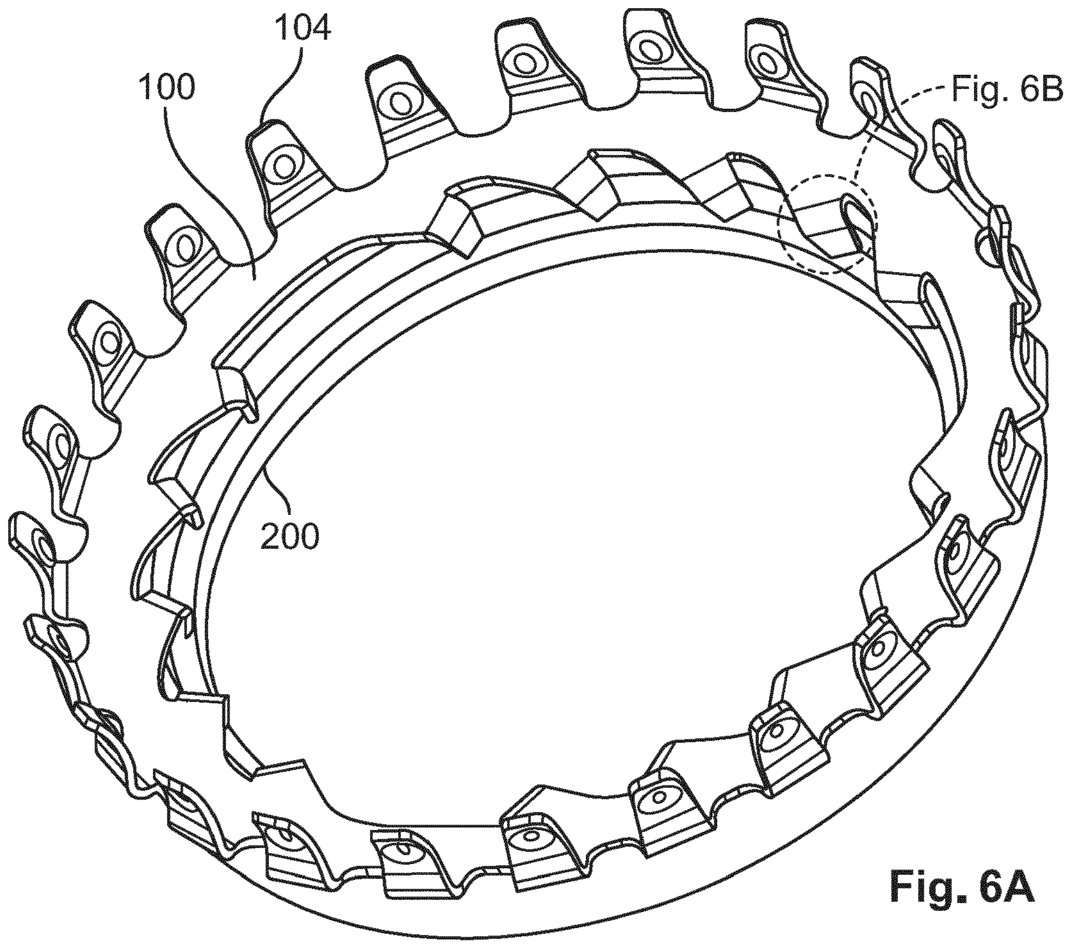

Fig. 6A

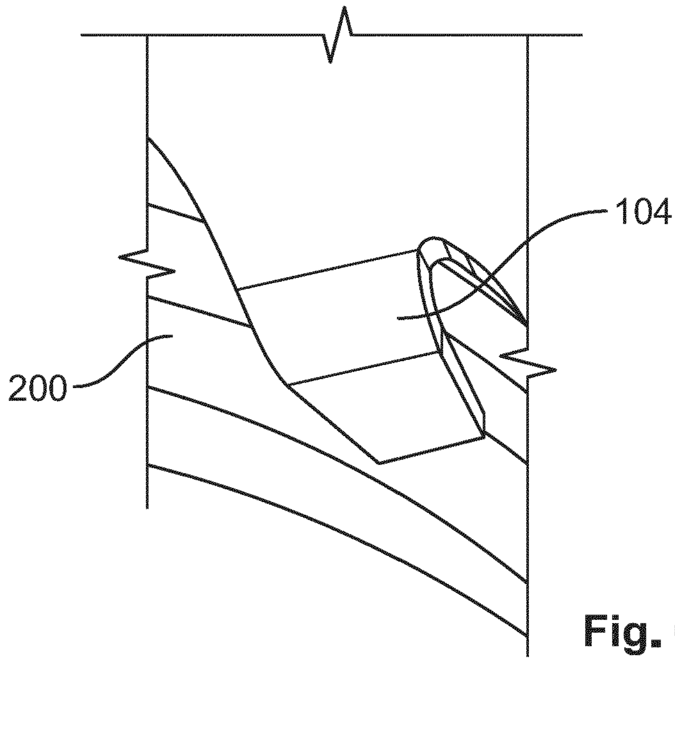

Fig. 6B

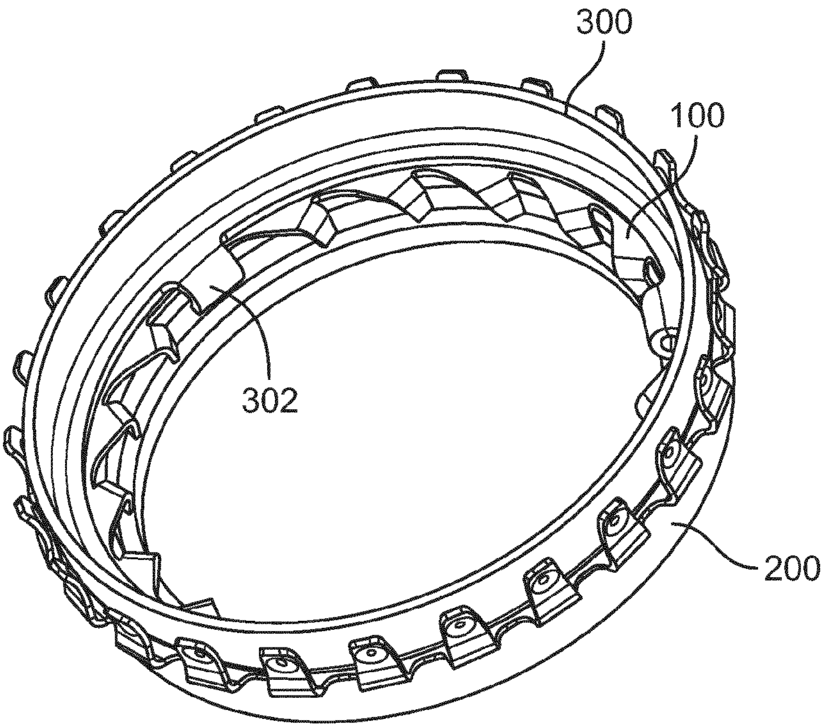

Fig. 7A

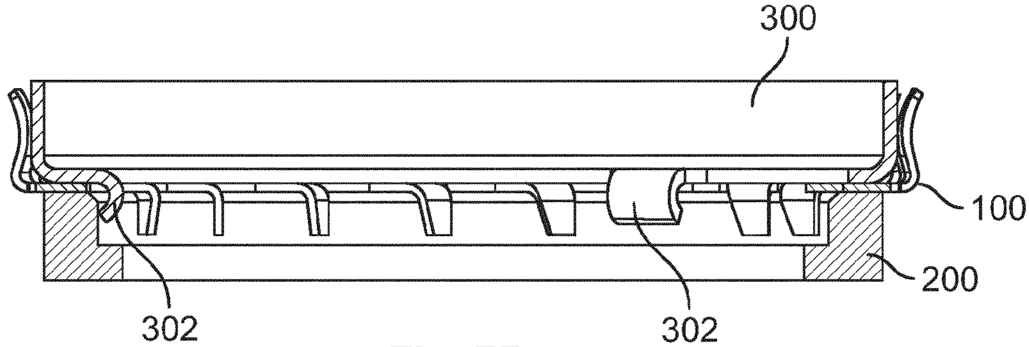

Fig. 7B

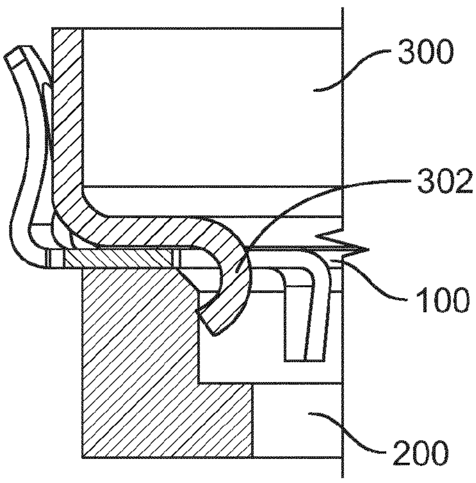

Fig. 7C

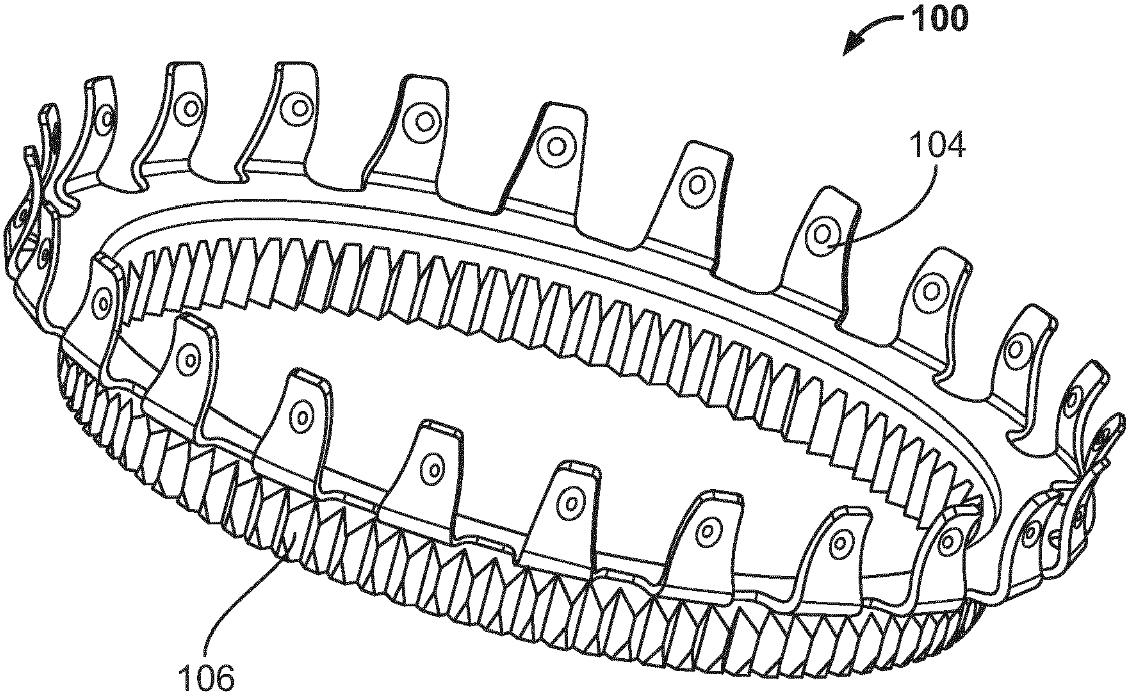

Fig. 8

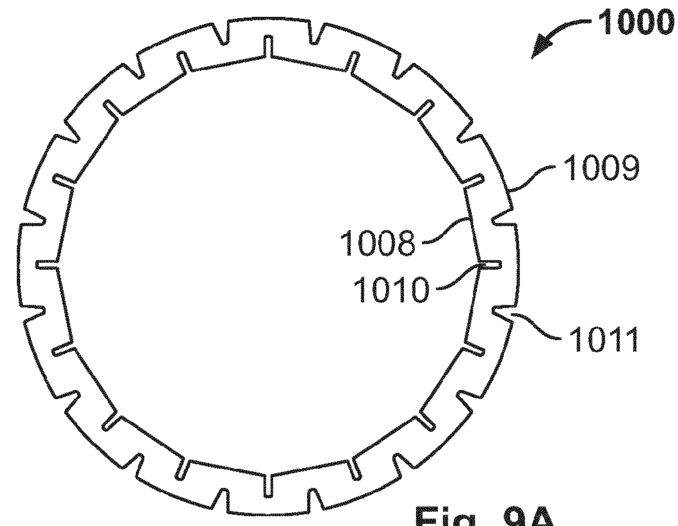

Fig. 9A

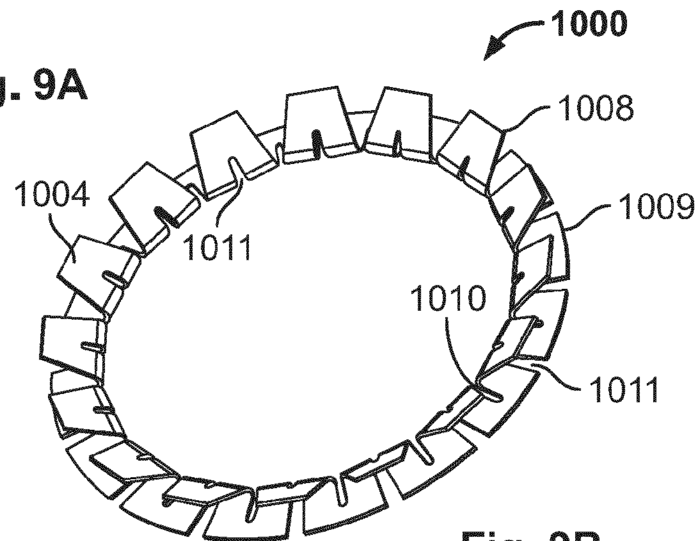

Fig. 9B

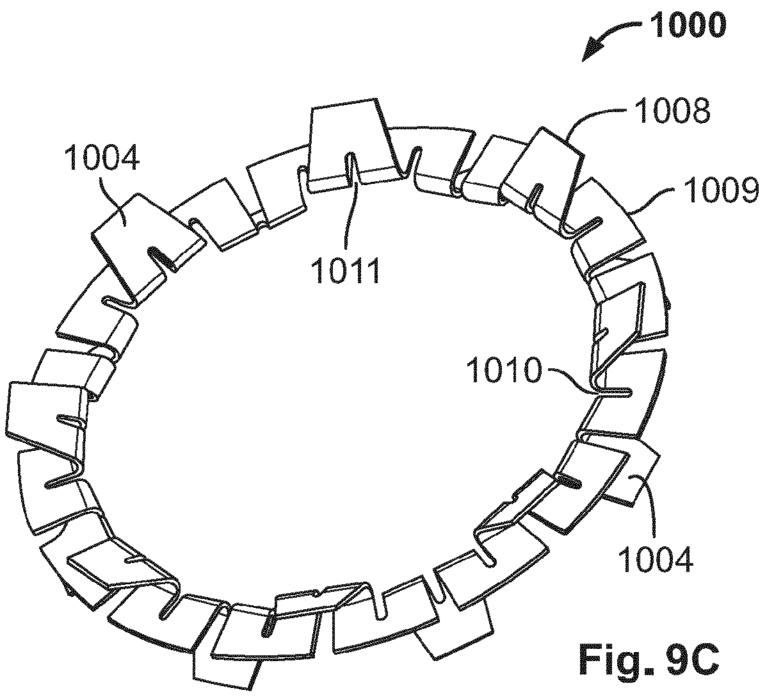

Fig. 9C

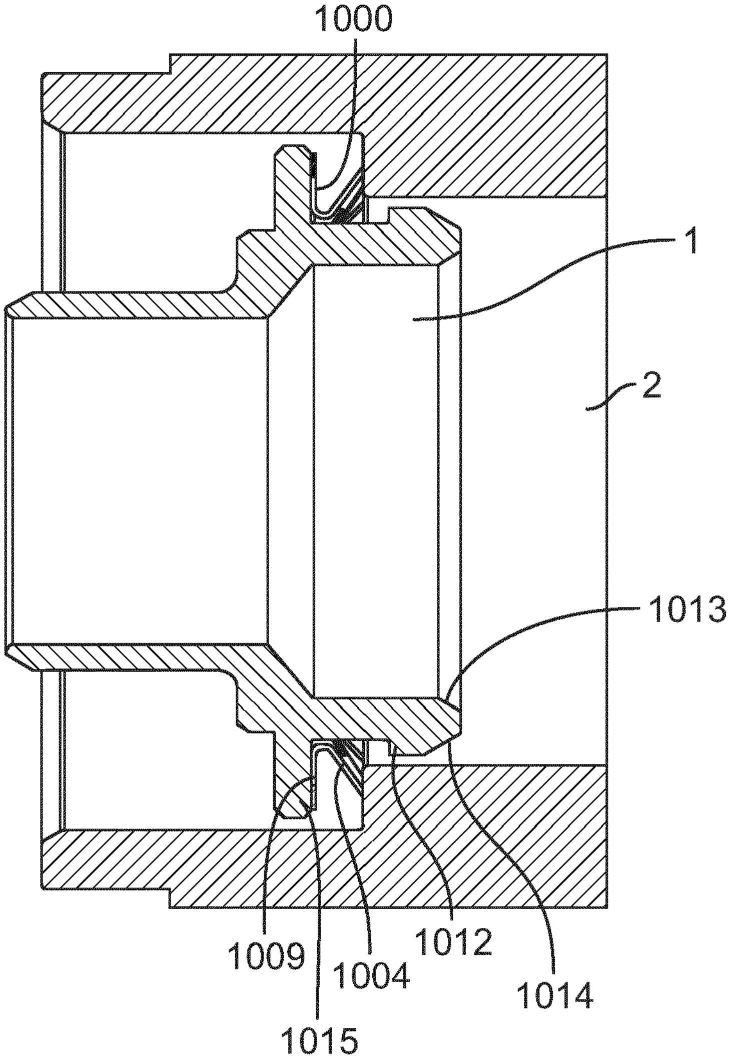

Fig. 10

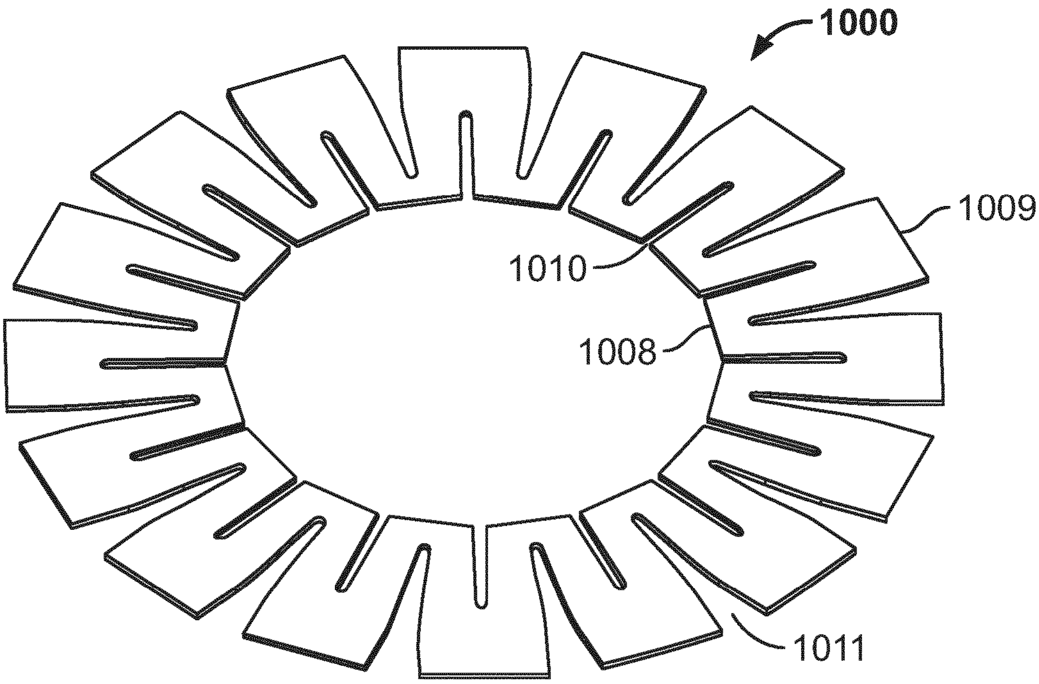

Fig. 11A

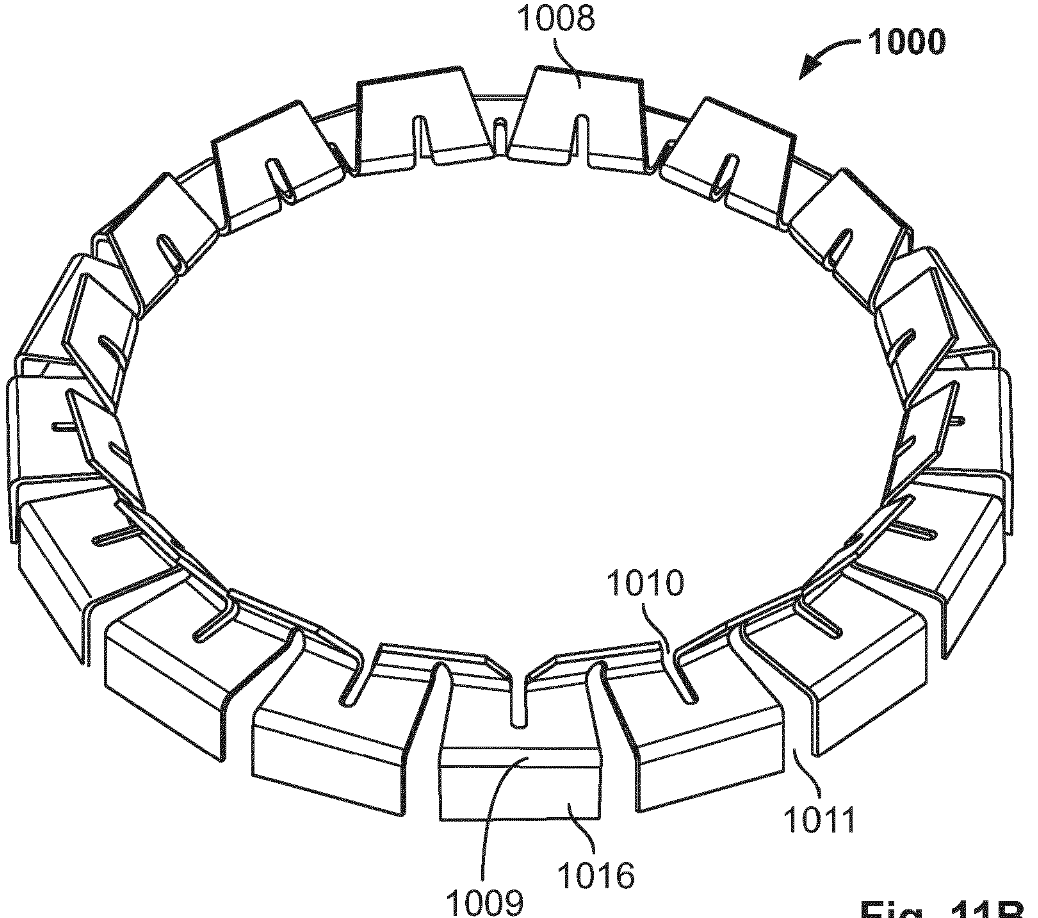

Fig. 11B

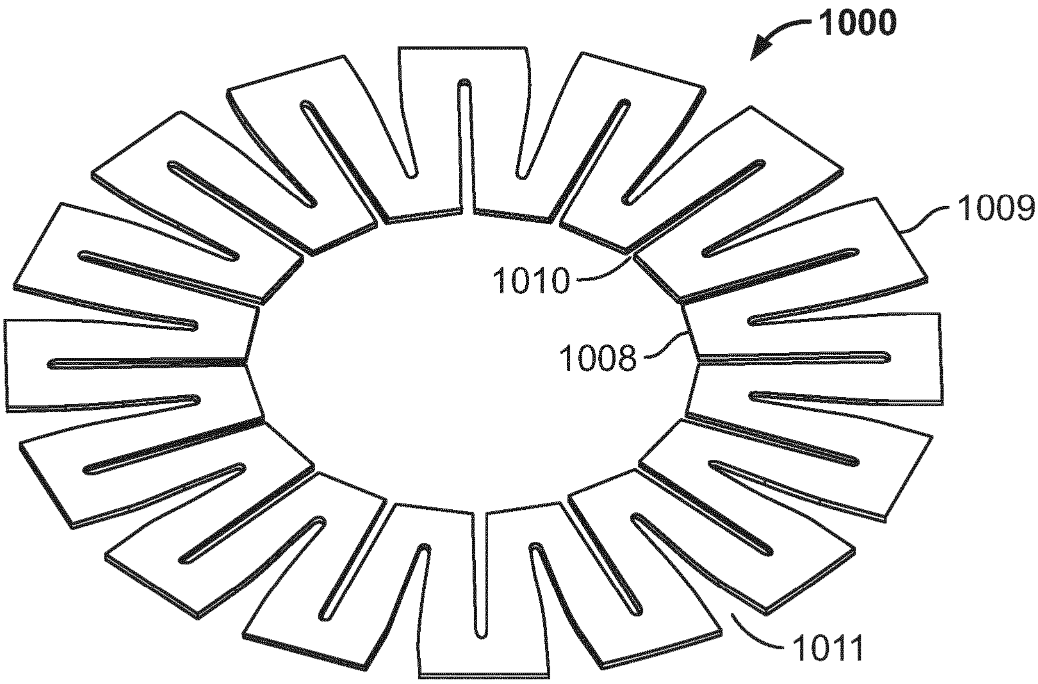

Fig. 11C

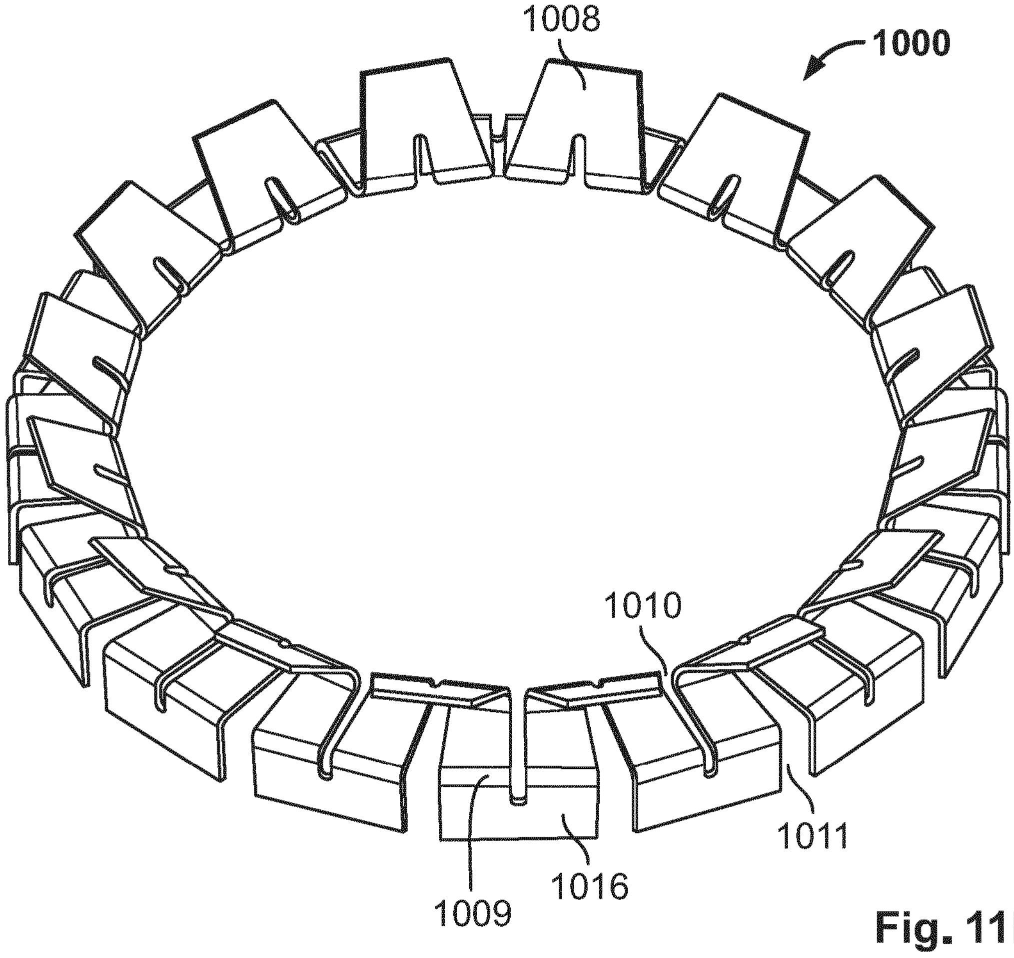

Fig. 11D

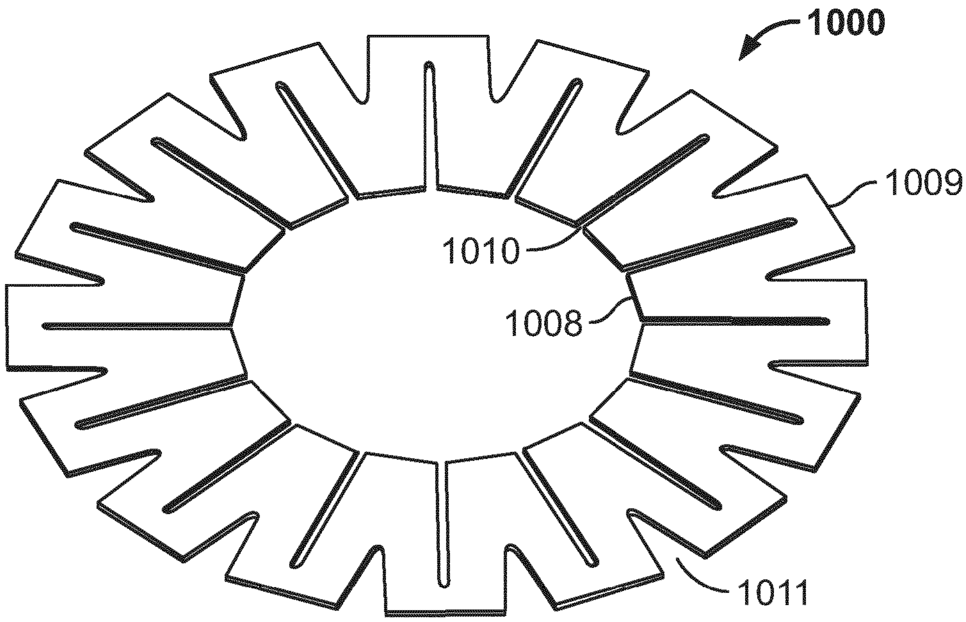

Fig. 11E

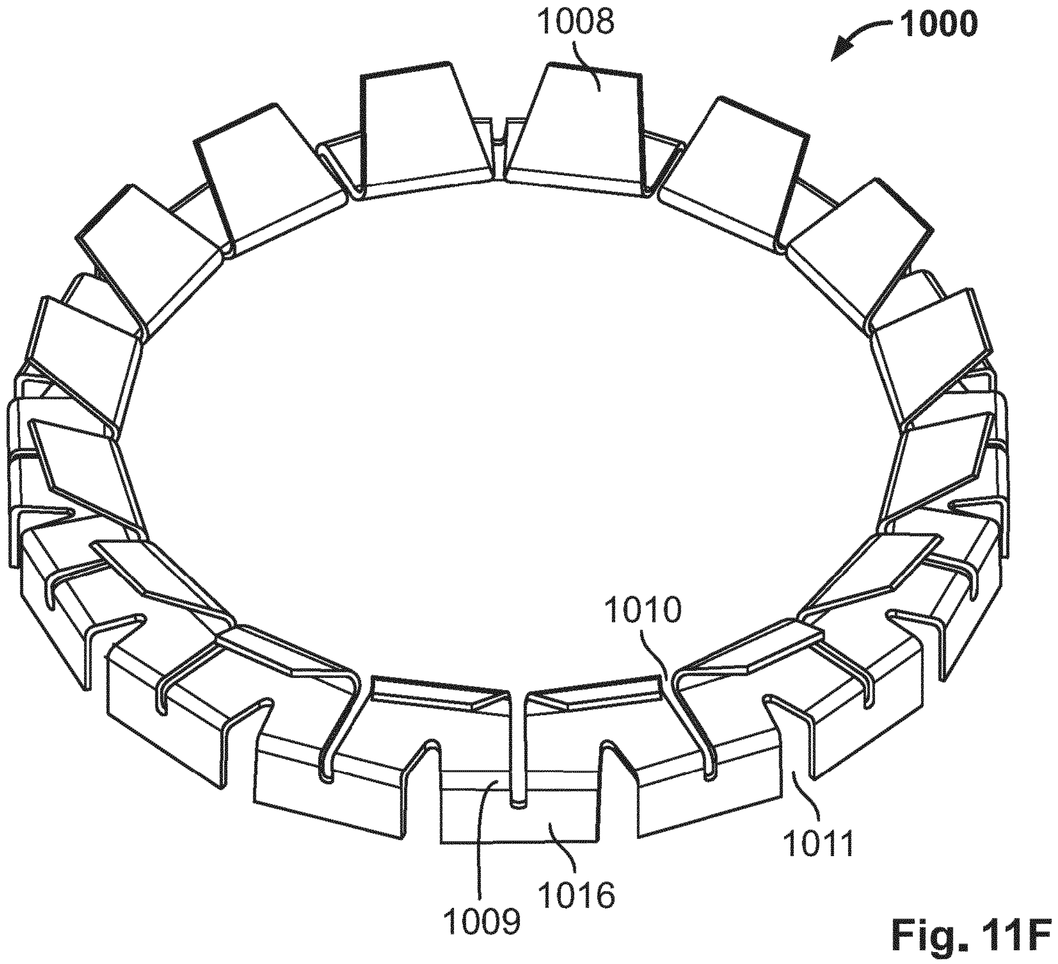

Fig. 11F

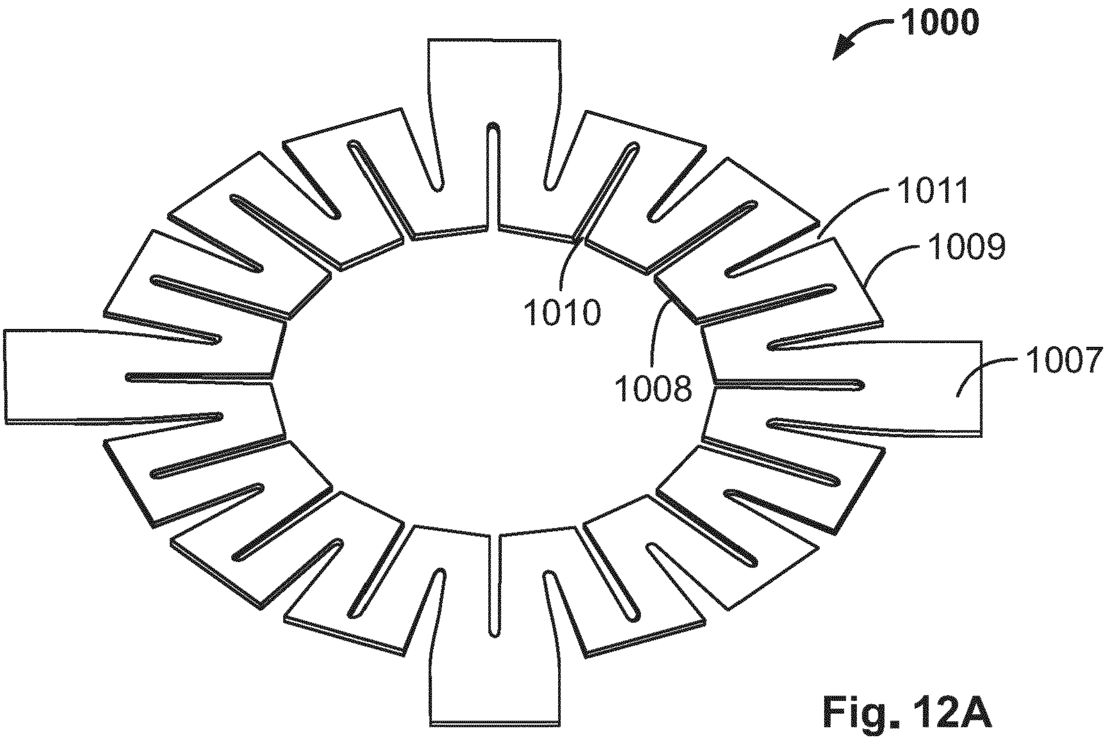

Fig. 12A

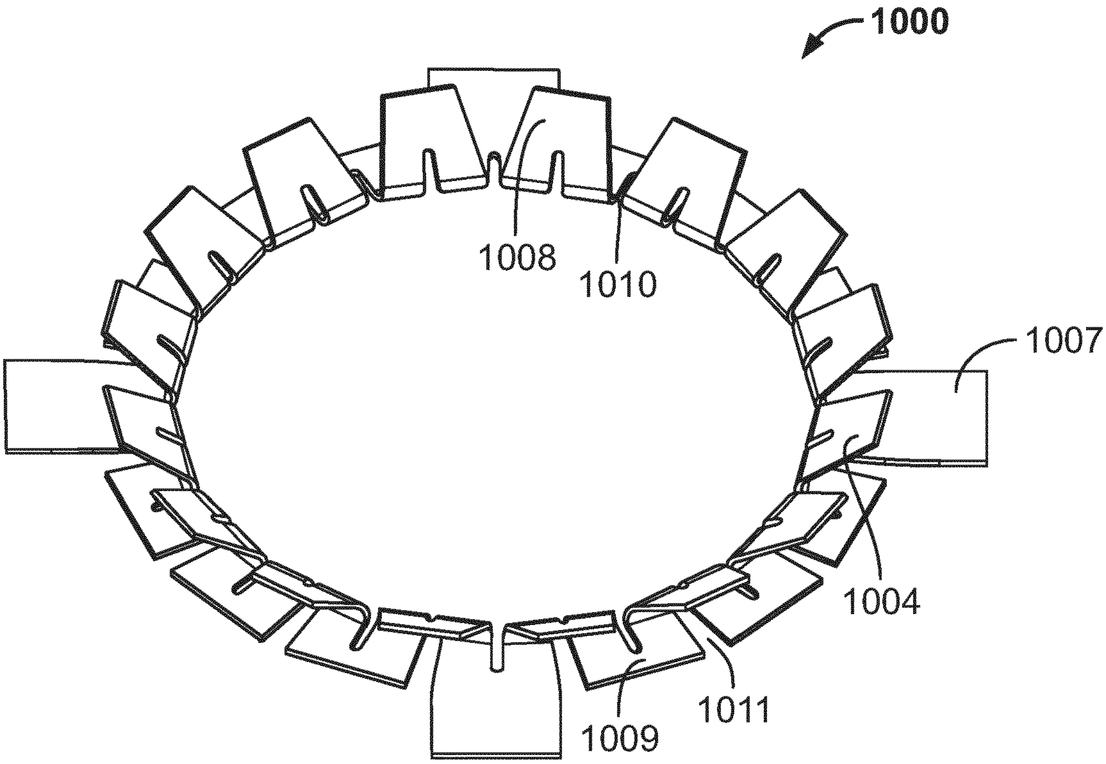

Fig. 12B

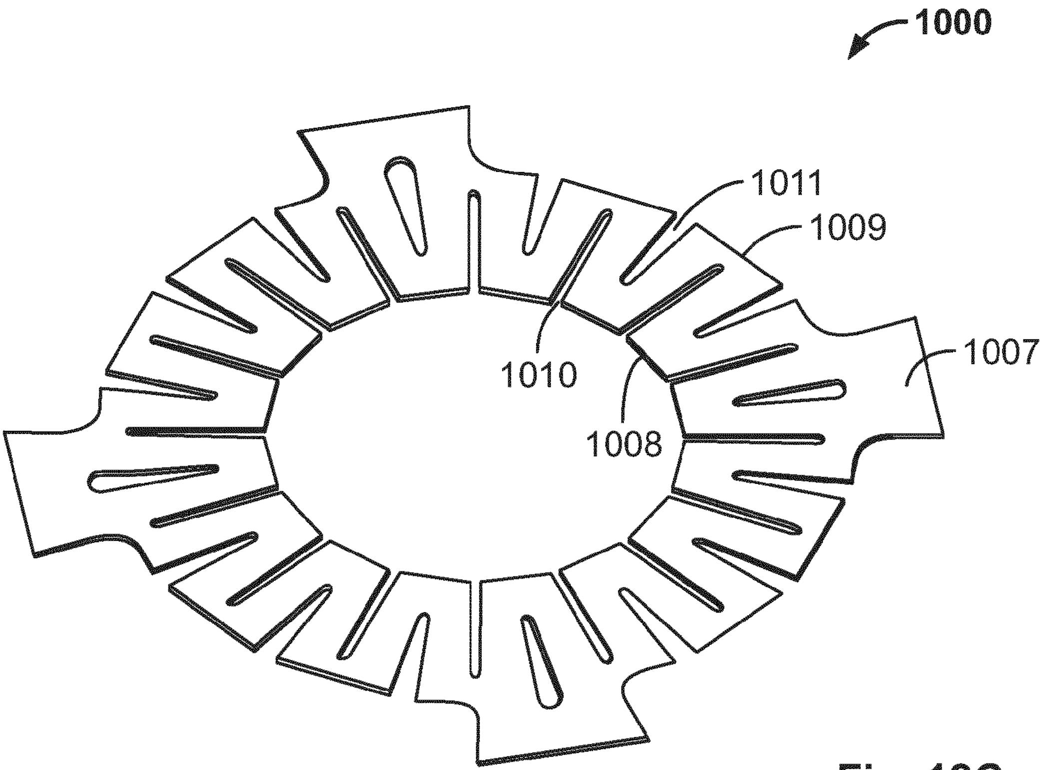

Fig. 12C

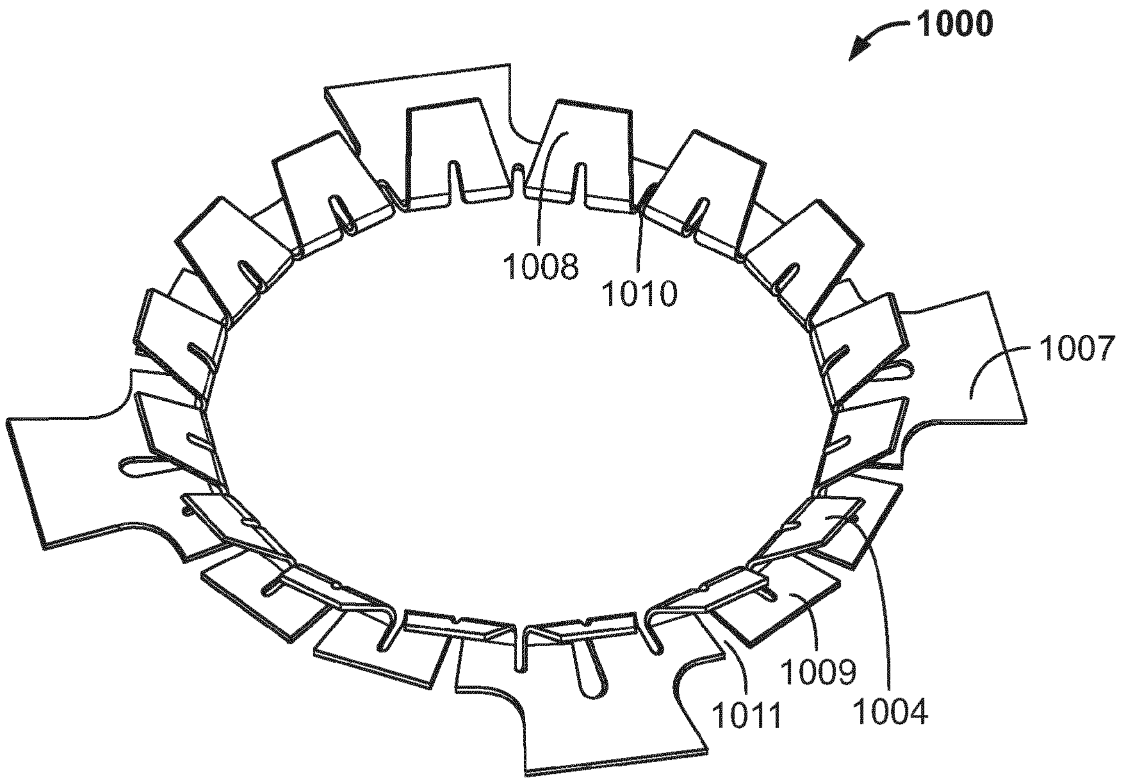

Fig. 12D

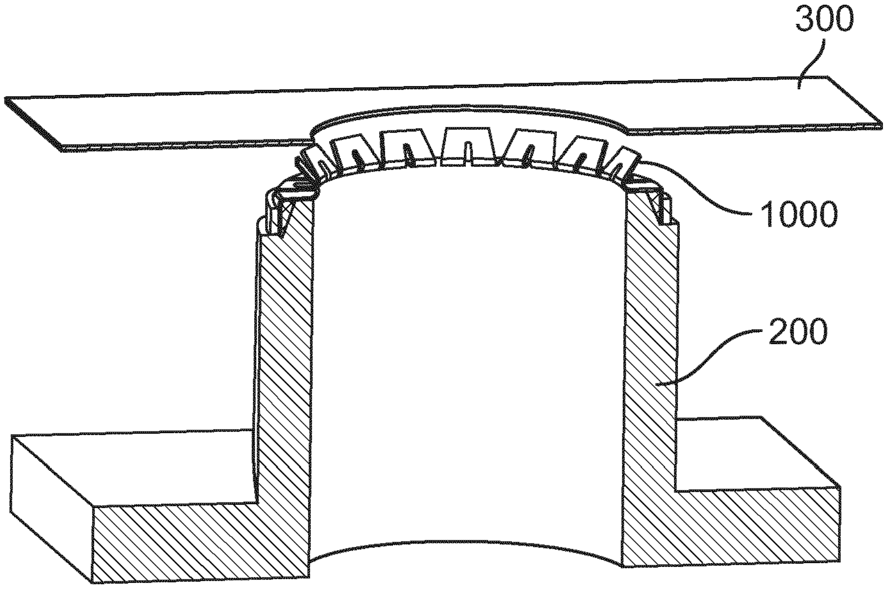

Fig. 13A

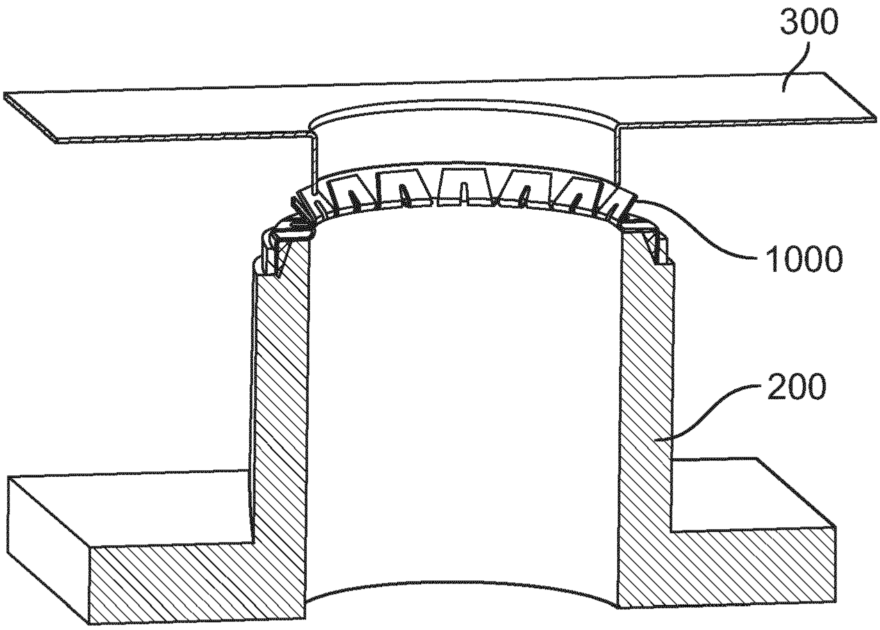

Fig. 13B

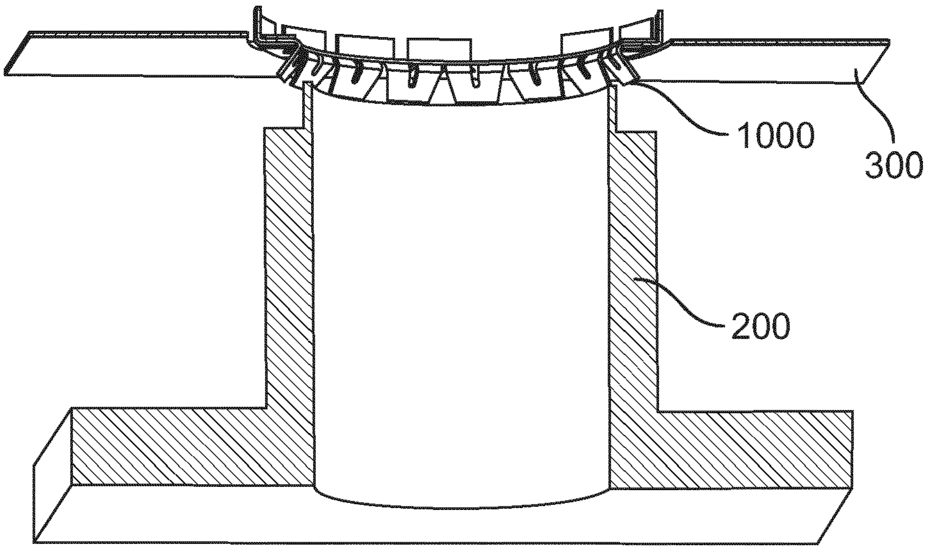

Fig. 13C

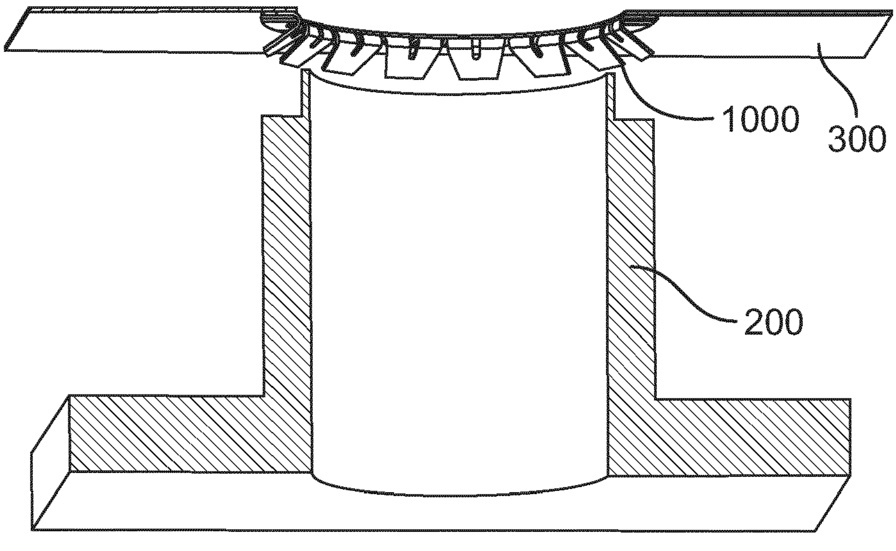

Fig. 13D

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EUROPEAN SEARCH REPORT

Application Number
EP 21 17 0828

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X A	US 2015/099397 A1 (LISTING MARTIN [DE] ET AL) 9 April 2015 (2015-04-09) * paragraphs [0016] - [0042]; figures 1-6 *	1-12,14 13	INV. H01R13/15 H01R13/6583 H01R4/26
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			H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 September 2021	López García, Raquel

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