(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 217 487 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.09.2017 Bulletin 2017/37

(51) Int Cl.:
H01R 39/08 *(2006.01)* ***H01R 43/10*** *(2006.01)*
H01R 39/10 *(2006.01)*

(21) Application number: **16159221.7**

(22) Date of filing: **08.03.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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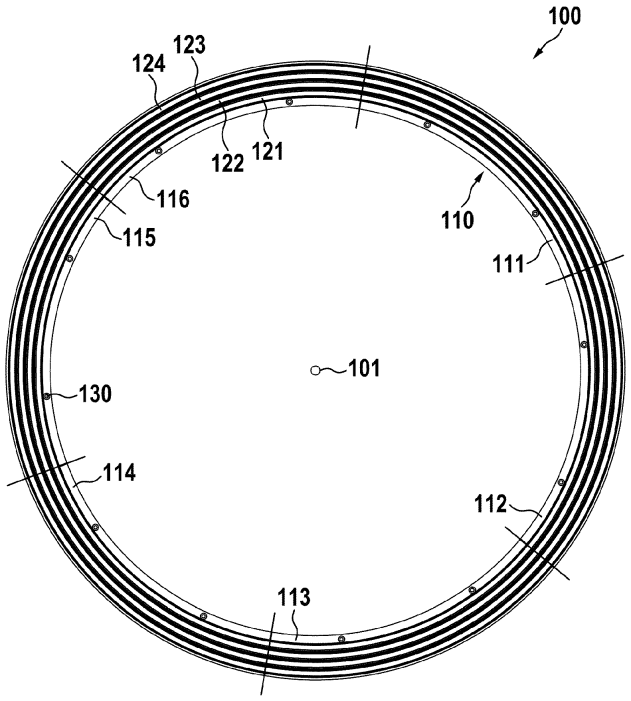
(54) MODULAR SLIP RING SYSTEM

(57) A slipring comprises an insulating body and at least one sliding track. The insulating body further comprises a plurality of body sections, the body sections forming a continuous ring-shaped body, wherein the body sections are connected and/or held together by the at least one sliding track.

Fig. 1



EP 3 217 487 A1

Description

Field of the invention

[0001] The invention relates to sliprings having at least one sliding track of an electrically conductive material held by a body comprising insulating material. It further relates to large sliprings which may be used for computed tomography (CT) scanners.

Description of the related art

[0002] In computed tomography (CT) scanners, usually large sliprings having a diameter of approximately 1 meter or more are required. The sliding tracks must be held at a supporting structure while insulating the sliding tracks from each other and from other machine parts.

[0003] US 5,054,189 discloses a slipring having a body of insulating material with pre-machined grooves into which a conductive sliding track is rolled.

[0004] US 5,734,218 discloses a drum-shaped slipring having a pre-formed insulating body with grooves into which sliding tracks are pressed. The body needs a rigid backing member as mechanical support.

[0005] These embodiments have the disadvantage that they require comparatively solid insulating bodies which further require a significant amount of insulating material or additional rigid backing. Another disadvantage is the comparatively big size of the insulating body which makes handling and manufacturing of the insulating body difficult and expensive.

[0006] US 6,664,697 B2 discloses a slipring apparatus having multiple spaced-apart support structures. The support structures are made of an insulating material to provide the insulation and spacing from a supporting CT scanner gantry. As multiple spaced-apart support structures are used, only a comparatively small amount of insulating material is required, which makes the support structure comparatively inexpensive. The drawback is, that the sliding tracks are only mechanically supported at the location of the spaced-apart support structures. Between the support structures, there is no mechanical support. Therefore, the sliding tracks themselves must have a certain mechanical stability which further requires a significant amount of sliding track material, which compensates or even over-compensates the savings by the support structure. Another drawback of the spaced-apart support structures is that audible noise may be generated when a CT scanner rotates fast due to a discontinuous airflow. Finally, as sections of the sliding tracks are not mechanically supported, mechanical vibrations or oscillations may occur when the device is rotating. Such vibrations of a sliding track may cause contact noise or contact interrupts which have to be avoided at slipring systems, as they lead to signal or power interrupts and excessive sliding track and brush wear due to arcing.

Summary of the invention

[0007] The problem to be solved by the invention is to provide a slipring system which has a simplified manufacturing process and lower manufacturing costs while avoiding the disadvantages mentioned above.

[0008] Solutions of the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

[0009] In one embodiment, manufacturing of the insulating body is simplified. The embodiment is based on the fact that a one-piece insulating body is large, heavy, difficult to handle and requires large molding machines. Therefore, the insulating body is divided into a plurality of body sections, preferably having the shape of arc segments. Preferred numbers of body sections are three, four, five, six, seven, eight, twelve or fifteen. Since any number of body segments may be used, the number of segments would be optimized to have as few segments as necessary but profit from lower manufacturing tolerances for smaller segments produced on machines suitable for mass production. Preferably the number of body segments would be between 3 and 15. Each individual body section is significantly smaller than the whole insulating body and therefore may be manufactured by using significantly smaller manufacturing and specifically molding and milling machines. When manufacturing a slipring, first individual body sections are manufactured. Preferably, grooves for holding sliding tracks are provided in the body section. Furthermore, it is preferred if holes or other means which may be required for contacting sliding tracks or mounting the assembled body are provided in at least one of the body sections. It is not necessary, that each body section has holes for contacting a sliding track, as a sliding track may be contacting only once or twice. The same applies to mounting means. On the other hand, it may be beneficial to have only one body section design, such that all body sections are the same and have the same configuration, as this may be cheaper to manufacture. For example, if body sections are manufactured by pressure-molding, they all should look alike, and therefore it may be acceptable if all body sections have holes for contacting sliding tracks and/or mounting means. It is also preferred, if the body sections have mounting holes, mounting surfaces, and interconnecting means for interconnecting neighbored body sections. They may further have mounting holes for other components like transceivers and antennas of contactless data links. Therefore, preferably the body sections are prepared such that after assembling the body sections to an insulating body bearing sliding tracks, no or only a low number of processing steps is required to finish the slipring. Also an encoder tick fence formed as a ring can be assembled in a groove of the assembled slipring. Instead of further sliprings ferrites for an inductive contactless power transmission can be mounted into a groove of the segments. After mounting of the segments together with a slipring track for grounding purposes litz wire may be potted into

the ferrites.

[0010] For assembling a slipring body, a plurality of body sections is assembled to form a continuous ring-shaped body. The sections may be mechanically connected to each other by interconnecting a first end side of a section to a second end side of a neighbored section, by at least one of the connection methods as mentioned below:

A key-and-slot-connection may be used, wherein at least one body section has at least one key and/or at least one slot at a first end side, while at least one second section has at least one corresponding key or slot at a second end side. Key-and-slot-connections may be designed such that the end sides of neighbored sections can be slid in a either axial, radial or tangential direction together.

[0011] Neighboring sections may also be bolted together by bolts and/or screws, which are preferably arranged in tangential direction. The bolts and/or screws may engage with threads which may be integrated into the sections, or with nuts at the sections. Preferably, the bolts and/or screws are arranged in a tangential direction, although it is also possible to use overlapping attachment sections of the body sections which may be screwed together by screws and/or bolted by bolts in any other direction, like radial or axial direction.

[0012] The body sections may also be glued together by using an adhesive, like epoxy or any other adhesive material. Also self-adhesive tapes may be used. They may also be plastics welded.

[0013] It is obvious that the different locking systems mentioned above may be combined. For example, a key-and-slot-connection may be used for a first assembly stage, whereas the body sections are locked together by bolts, while an adhesive cures to give the body the final stability and strength.

[0014] At least one sliding track is mounted to the ring-shaped body, preferably after the body sections have been assembled to a ring-shaped body. The at least one sliding track stabilizes the ring shaped body. Therefore it is preferred, if a larger number of sliding tracks is provided. Preferably, the at least one sliding track is mounted into a groove in the ring-shaped body, or at least close to a protrusion which may act as a barrier. It is further preferred, if the at least one sliding track is mechanically fixed to the ring-shaped body. It is preferred, if the sliding track is fixed by an adhesive, for example by gluing with epoxy or any other suitable material. Most preferably, the at least one sliding track is glued to the ring-shaped body over its whole length, which would result in the highest possible stability and strength. In an alternate embodiment, the at least one sliding track may be glued at multiple locations, whereby it is preferred to keep the distance between the gluing locations small. Furthermore, the sliding track may be fixed by means of bolts which are attached to the sliding track. Such a fixation by bolts is preferably done at multiple positions of the sliding track to give a good stability. The bolts may also serve as terminals to contact the slipring track.

[0015] Fixedly attaching the at least one sliding tracks and most preferably a plurality of sliding tracks, most preferably by an adhesive or glue, results in an enhancement of stability, as the at least one sliding track further stabilizes the ring-shaped body. Therefore, a high stiffness, a high mechanical stability, and a high suppression of potential vibrations is given by fixing the sliding track to the body. Furthermore, less care must be taken about fixing neighboring body sections to each other, as the stability of the whole slipring will be maintained by the sliding tracks.

[0016] By using a sectioned body, drum shaped sliprings can be manufactured easily. Normally, it is not possible to insert ring shaped sliding tracks into grooves of a drum (or cylinder) shaped body. Here, other, comparatively complex methods must be used. By sectioning the body, individual body sections can either be placed from the outside (if the rings are inside the body) or from the inside (if the rings are outside of the body) at the sliding tracks. Alternatively or in addition, split sliding tracks, which may be formed from bar stock can be extended in their diameter, such that they can be moved over the body to their final position.

[0017] Tests have shown, that it is often not necessary to directly fix the body sections as mentioned above together. Instead, it is sufficient to glue a plurality of sliding tracks to or into the body sections. The glued sliding tracks give sufficient stability to the whole assembly and hold the sections together sufficiently strong.

[0018] According to the invention, the sliding tracks are providing a significant function in the mechanical support of the body sections, and therefore, the sliding tracks should have a certain cross-section and mechanical stability. It is preferred, that at least one sliding track has a cross-section in a range of between 5 mm^2 and 100 mm^2, most preferably between 20 mm^2 and 60 mm^2. It is further preferred to have at least three, most preferably five sliding tracks. A higher number of tracks increases stability. It is further preferred to use brass or similar rigid material for the at least one sliding track. Brass has a sufficient stiffness and a sufficiently low resistance to allow the transport of high currents which may be up to several hundred Ampere per track in modern CT scanners. Also different sliding tracks may be made from different materials.

[0019] Preferably, the at least one sliding track is a continuous ring of metal. Such continuous rings may be machined from a tube or a drum-shaped body. Machining such ring-shaped bodies is complex and expensive.

[0020] Another embodiment relates to a cheaper method and slipring by using a standard rod-shaped material, like bar stock, and forming ring-shaped sliding tracks thereof. Preferably, the tracks are bent to the sliding track diameter. Forming or bending the sliding tracks may be done by rolling. Such pre-formed circular sliding tracks

may be fixed or glued to the body sections in a later step. It is not desired to roll the sliding track material on or into the body sections similar to the rolling of wires into a solid slipring body, as disclosed in US 5,054,189. Such a direct rolling would assert significant forces to the body sections which may lead to damage thereof. The rolling of the above-mentioned US-disclosure requires a comparatively solid body (which may be avoided by sectioning as mentioned above) and allows only to use comparatively thin or low cross-sectioned sliding tracks. The use of rolled slipring tracks that are preformed but open also allows the retrofit of a slipring in a system where the installations in the axis do not allow to insert a closed slipring.

[0021] The ends of a sliding track made of bar stock may be welded, soldered or molded together to form a continuous ring. It is preferred to omit this manufacturing step and to glue the sliding track having a gap into the ring-shaped body or the body sections. Such sliding tracks can also easily be mounted to a cylindrical body, even without using a sectioned body. It is desired to have both ends of a sliding track made of bar stock at the same height, to avoid an edge. However, due to manufacturing tolerances, an edge can hardly be avoided. Such an edge may be removed by further machining, which is not desirable. Tests have shown that a certain gap is acceptable and would even allow a certain deviation in height of the both ends without leading to increased brush wear. In a preferred embodiment, there is a gap between the ends of the sliding track, which preferably is between 0.5 and 3 mm, most preferably between 1.5 and 2.5 mm, and further preferred at about 2 mm. It is further preferred, if the gap is under an angle to the tangent of the sliding track, which may be in a range between 10 degrees to 90 degrees. It is preferred, if the angle is between 40 and 80 degrees, and most preferred around 60 degrees. To further decrease wear of a brush, the section of the sliding track forming an acute angle is chamfered or preferably rounded at the location of the acute angle.

[0022] In a slipring having multiple gaps, it is preferred to displace the gaps with respect to each other, such that the brushes are moving over the gaps at different times. This would avoid a sudden bump or shock, which may lead to a short contact interrupt or at least some vibration or noise. To improve signal transmission quality and to reduce arcing at the gap, it is preferred to have at least one two sliding tracks with displaced gaps connected together. In a further preferred embodiment, two or more narrower sliding tracks may be used connected parallel instead of a wide sliding track, as multiple narrow sliding tracks are easier to manufacture e.g. easier to bend. It is further preferred, if the sliding tracks are close to each other, such that one brush may run on the multiple sliding tracks contacting the plurality of sliding tracks.

[0023] The sliding tracks disclosed herein may either be used with any standard isolating body or with any sectioned body disclosed herein.

[0024] A further embodiment relates to a CT scanner having at least one of the embodiments disclosed above.

[0025] Further embodiments relate to methods of manufacturing slipring body sections, sectioned sliprings and sliding tracks as disclosed above.

Description of Drawings

[0026] In the following the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Figure 1 shows a top view of a slipring with a sectioned body.

Figure 2 shows a sectional view of the slipring.

Figure 3 shows a simplified sectional view.

Figure 4 shows a rear view of a first embodiment.

Figure 5 shows a detailed view of a first section joint.

Figure 6 shows a first section joint with a locking plate.

Figure 7 shows a first embodiment of a body section.

Figure 8 shows a second embodiment of a body section.

Figure 9 shows a boltable section.

Figure 10 shows a section of a body with sliding tracks.

Figure 11 shows a detailed view of the gaps in the sliding tracks.

[0027] In Figure 1, a top view of a slipring with a sectioned body according to a first embodiment is shown. The slipring 100 has a center of rotation 101, around which it may rotate. The slipring has a body 110 comprising a plurality of sections 111, 112, 113, 114, 115, and 116. In this embodiment, six sections of the same size are shown. Therefore, every section covers an angle of about 60 degrees. It is obvious, that a slipring body may comprise any other number of sections, even in different sizes, as long as the sections form a body. The slipring body 110 holds a plurality of sliding tracks 121, 122, 123, and 124 of an electrically conductive material. It is obvious, that there may be any number of sliding tracks, starting from one sliding track to a large number of sliding tracks. For example in computed tomography (CT) scanners, multiple sliding tracks are required for transmission of various power levels and multiple control signals. It is further obvious, that the sliding tracks may have different sizes, like different heights and different

widths or even different shapes, like batch-shaped or circular. Furthermore, the sliding tracks may be mounted at different distances from each other, whereby preferably the distances are dimensioned according to the isolation requirements and specifically according to the required creeping distances which largely depend on the operational voltage difference between neighbored sliding tracks. Preferably, there is a number of mounting holes 130 which may be used to mount the body to a supporting structure. Preferably, each section has at least one mounting hole, which would result in a better stability. It is further preferred to have a higher number, like two or more mounting holes per section.

[0028] In Figure 2, a sectional view from one side of the slipring is shown. Here, the sliding tracks 121, 122, 123, and 124 can be seen protruding from the slipring body 110. This view is a partial sectional view, where the slipring body 110 is shown from a side view and the sliding tracks from a sectional view.

[0029] In Figure 3, a simplified sectional view is shown. The body 110 bears the sliding tracks 121, 122, 123, and 124 in corresponding grooves.

[0030] In Figure 4, a rear side view of a first embodiment is shown. In this embodiment, the body sections are held together by bolts. This Figure shows a first section joint 310 and a second section joint 320 which are slightly different and are explained later in detail. Preferably, there is such a section joint between each two neighbored sections.

[0031] In Figure 5, a detailed view of a first section joint 310 is shown. There is a first cutout 311 in a first section which may be section 111 in this Figure. Furthermore, there is a second cutout 312 in an adjacent or neighboring body section, which may be section 112 in this example. There is a first holder 313 in the first cutout 311 and a second holder 314 in the second cutout 312. Furthermore, there is a bolt 315 which preferably has a thread and which is locked by a nut 316. The bolt connects the first holder and the second holder and may be tightened by rotating the nut 316 such that the first holder and the second holder are pulled together, locking the body sections together. Tightening the nut applies a tensile force between the two neighboring body sections. There may be a hole or a cutout in the body sections, interconnecting the first cutout and the second cutout, and which allows placing of the bolt therein.

[0032] In Figure 6, a second section joint 320 with a locking plate is shown. This section joint 320 is an improvement of the previous section joint 310. Here, a locking plate 321 has been added, which is preferably held by a plurality of bolts 322. Most preferably, two bolts are provided in each of the body sections which have to be held together. For holding the bolts, preferably holes 323 are provided in the body sections, as shown in Figure 5. As the plate has non- (V shape) parallel slots, by pushing the plate towards the rotating axis a compressive force is applied. By turning the bolt the plate is fixed.

[0033] In Figure 7, a first embodiment 210 of a body section as a molded section is shown. This body section preferably comprises a plurality of grooves 261, 262, 263, and 264 for holding sliding tracks. There may be contacting holes 271, 272, 273, and 274 for contacting the sliding tracks from a bottom side. The section has a first gluing surface 211 and a second gluing surface 212 which may have further grooves 213. The gluing surfaces 211 and 212 of adjacent sections overlap each other and are held together by a glue or an adhesive. The grooves 213 may be provided as overflow cavities into which excess adhesive may flow.

[0034] In Figure 8, a second embodiment of a body section is shown, which for example may be machined from a plastic material. This body section basically has the same features as the previous body section, although it is made of a somewhat thicker material.

[0035] In Figure 9, a further embodiment of a boltable section is shown. This is a section similar to the sections forming a whole body in Figures 4, 5, and 6. Each boltable section 230 has a first interface section 231 and a second interface section 232, whereby a first interface section of a first body section is bolted to a second interface section of a second body section. Thus, multiple body sections bolted together form a slipring body.

[0036] In Figure 10, a section of a body with sliding tracks is shown. Here, the sliding tracks 121, 122, 123, and 124 are mounted, for example by gluing into grooves of body sections 111 and 112. It is obvious that these exemplary body sections may be any other body sections. The sliding tracks preferably cover a gap 117 between neighboring body sections, and therefore further stabilize the body formed of body sections. Although not necessary, the sliding tracks may have gaps 281, 282, 283, and 284, which preferably are under an angle to the center of the sliding tracks. It is preferred, if the gaps in the sliding tracks are distant from the gaps 117 between neighboring sections. As explained above, the sliding tracks may also be continuous without gaps.

[0037] In Figure 11, a detailed view of the gaps in the sliding tracks is shown. The gaps may have a distance or gap width 285, which are under an angle 286 to the center of the sliding track 288. It is preferred if the angle of the gap is in a range between 10° to 90°, most preferably between 40° and 80°. The best results have been achieved with a 60° angle. This angle is defined between the gap and the tangent to the sliding track or the center of the sliding track, which usually is parallel to the tangent of the sliding track. The gap preferably has a width in a range between 0.5 and 3 mm, more preferably between 1.5 and 2.5 mm, and most preferably at about 2 mm. The gaps preferably have chamfered or rounded edges 287.

List of reference numerals

[0038]

100	slipring
101	center of rotation

110	slipring body
111-116	body sections
117	gap between body sections
121-124	sliding tracks
130	mounting hole
210	molded section
211	first gluing surface
212	second gluing surface
213	groove
220	section with gluing surfaces
221	first gluing surface
222	second gluing surface
223	groove
230	boltable section
231	first interface section
232	second interface section
271-274	track contacting holes
261-264	groves for sliding tracks
281-284	sliding track gaps
285	gap width
286	gap angle
287	edge
288	center of sliding track
310	first section joint
311	first cutout
312	second cutout
313	first holder
314	second holder
315	bolt
316	nut
320	first section joint with locking plate
321	locking plate
322	bolt

Claims

1. Slipring comprising an insulating body and at least one sliding track, **characterized in that**
the insulating body comprises a plurality of body sections, the body sections forming a continuous ring-shaped body, wherein the body sections are connected and/or held together by the at least one sliding track.

2. Slipring according to claim 1,
characterized in that
the at least one sliding track is glued to each of the body sections.

3. Slipring according to claim 1,
characterized in that
the at least one sliding track is bolted to at least one of the body sections.

4. Slipring according to any one of the preceding claims,
characterized in that
the at least one sliding track is held in a groove in the body sections.

5. Slipring according to any one of the preceding claims,
characterized in that
at least one body section is connected by a first end side to a second end side of a neighboring second body section.

6. Slipring according to claim 5,
characterized in that
the first end side and the second end side have a key-and-slot-connection.

7. Slipring according to claim 5,
characterized in that
the first end side and the second end side are connected by at least one bolt.

8. Slipring according to claim 5,
characterized in that
the first end side and the second end side are glued and/or plastics welded together.

9. Slipring according to any one of the preceding claims,
characterized in that
the at least one sliding track is a continuous ring.

10. Slipring according to any one of the preceding claims,
characterized in that
the at least one sliding track is a ring formed from bar stock.

11. Slipring according to any one of the preceding claims,
characterized in that
the at least one sliding track has a gap, wherein the gap preferably is under an angle between 10 degrees and 90 degrees to the tangent of the sliding track, and/or preferably the section of the sliding track forming an acute angle is rounded or chamfered at the acute angle.

12. Slipring according to claim 11,
characterized in that
at least two gaps are displaced with each other and preferably at least two sliding tracks with displaced gaps are electrically connected together.

13. CT scanner comprising a slipring according to any one of the previous claims.

14. Method of manufacturing a slipring comprising an insulating body and at least one sliding track by, assembling a plurality of body sections, the body sec-

tions forming a continuous ring-shaped body, wherein the body sections are connected and/or held together by the at least one sliding track.

15. Method of manufacturing a sliding track for a slipring by using sections of bar stock of a conductive material and bending the sections preferably by rolling to the sliding track diameter.

Fig. 1

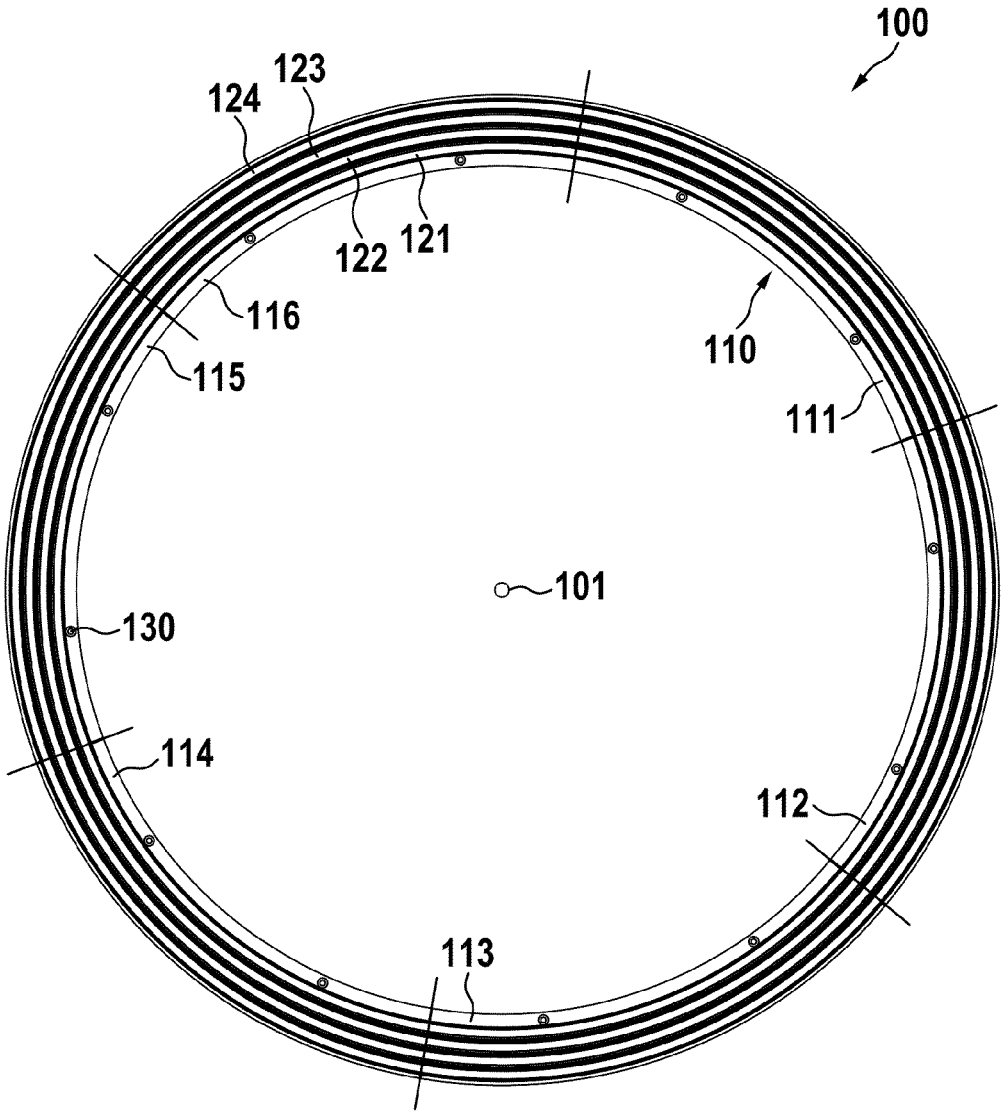

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Fig. 2

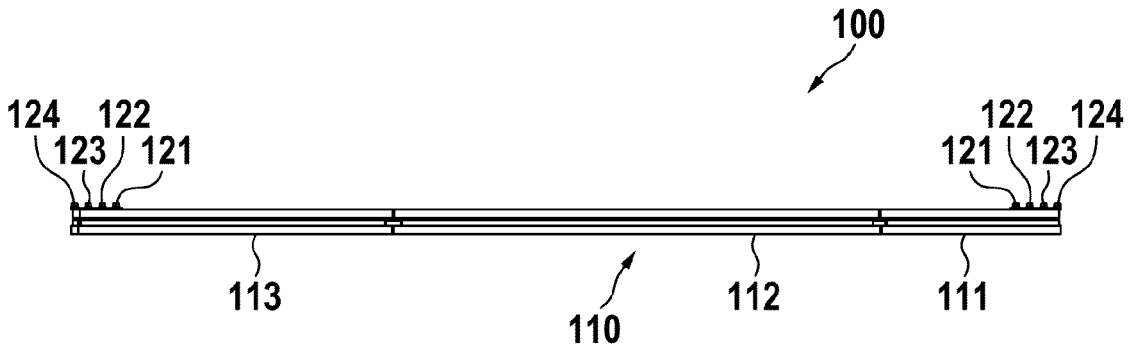
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Fig. 3

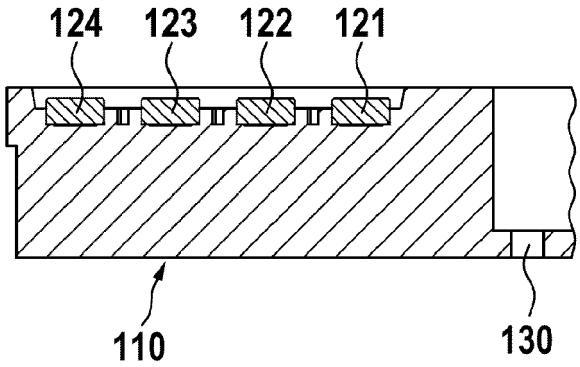

Fig. 4

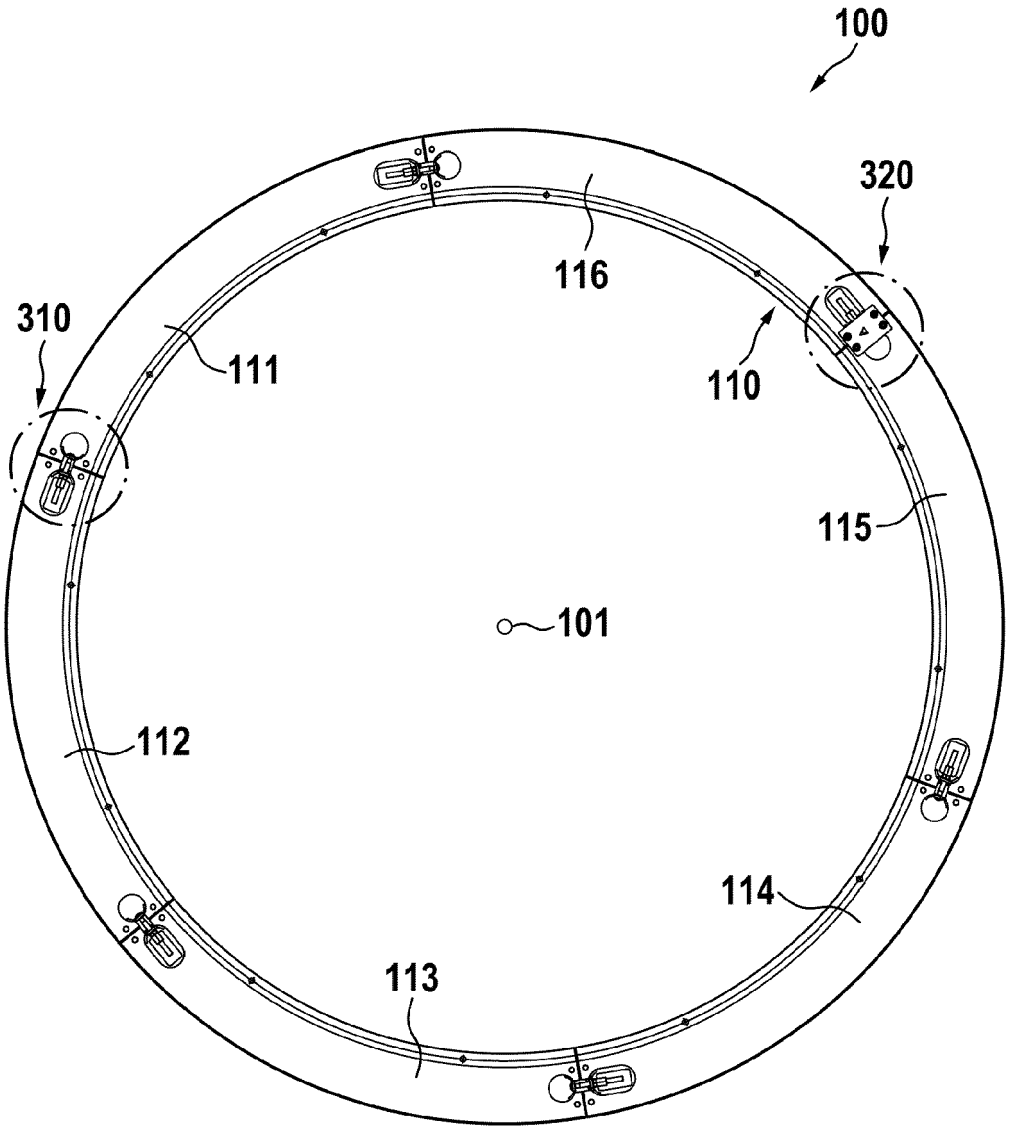

Fig. 5

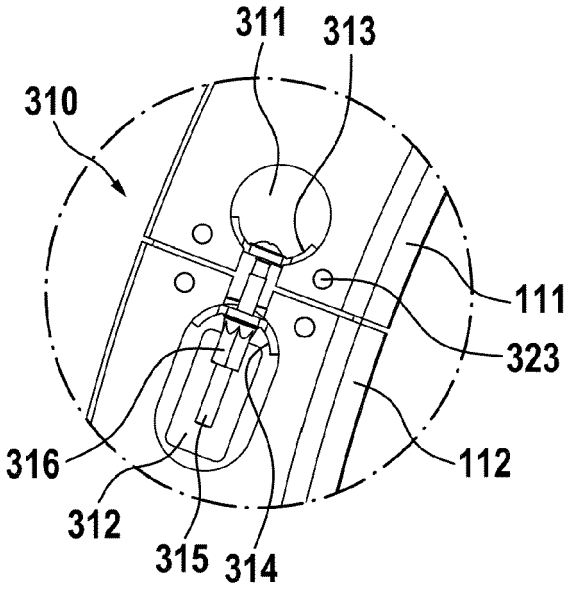
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Fig. 6

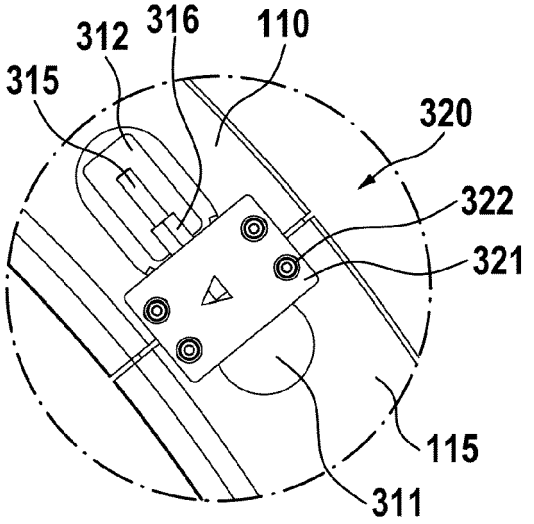
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Fig. 7

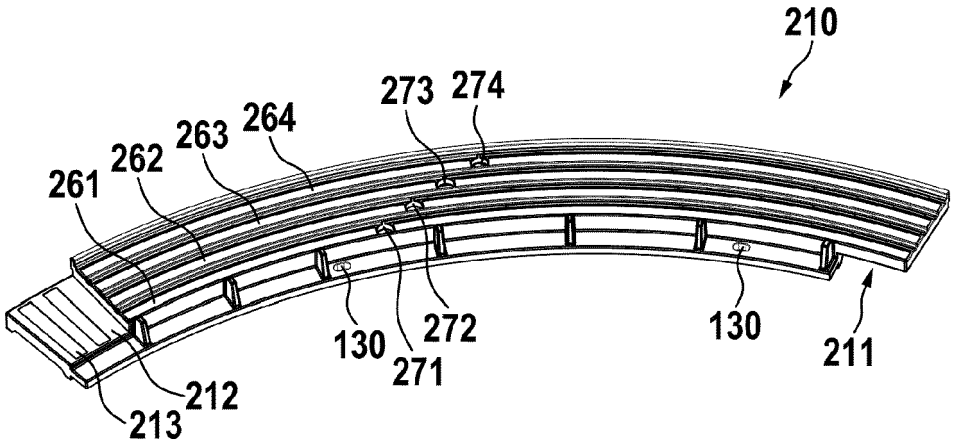

Fig. 8

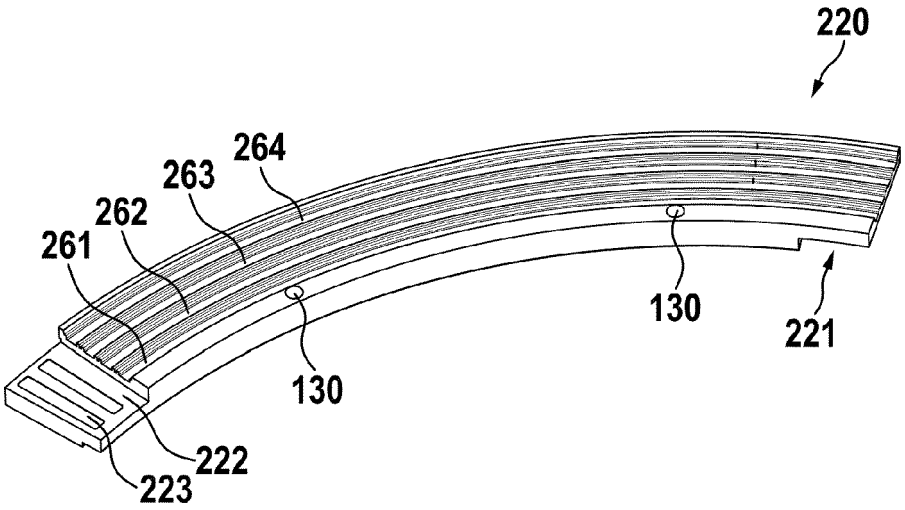

Fig. 9

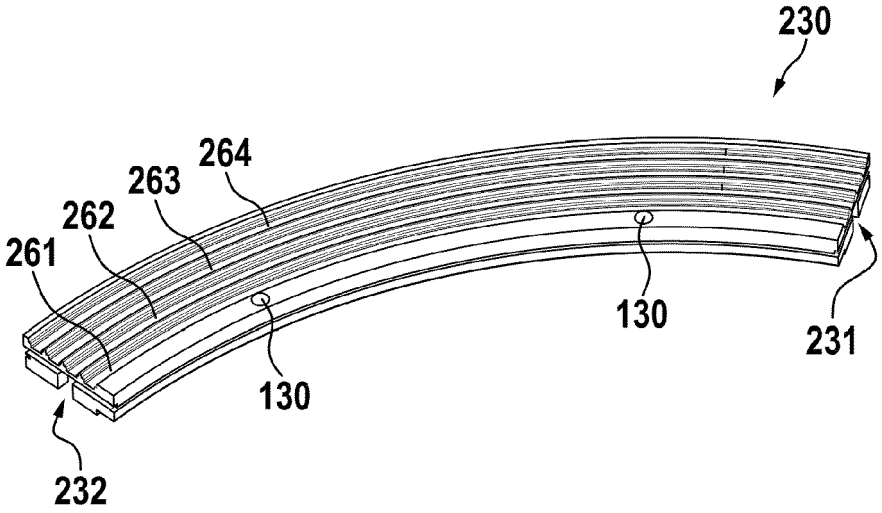

Fig. 10

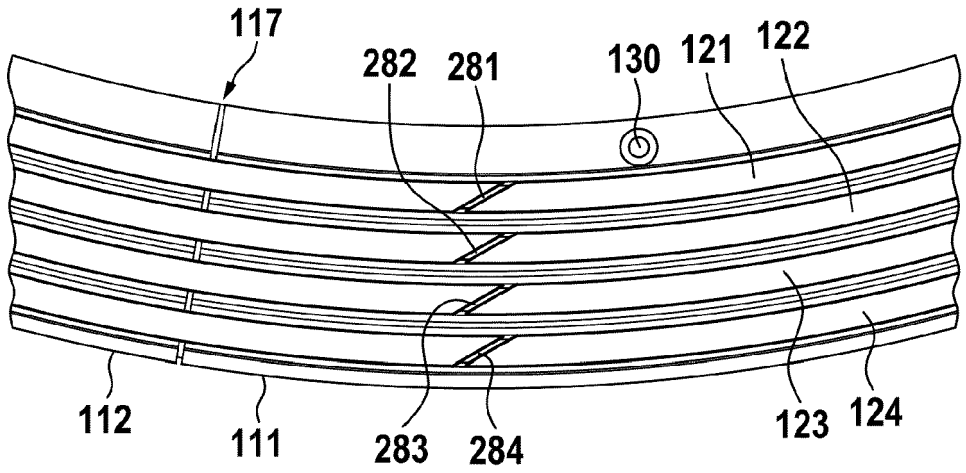
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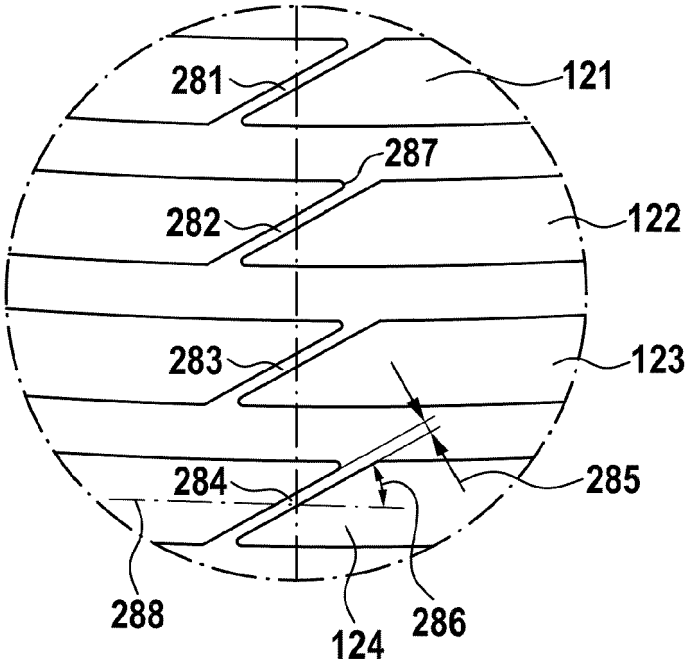
Fig. 11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Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 16 15 9221

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
The Hague	25 August 2016	Georgiadis, Ioannis

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L : document cited for other reasons

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