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(54) Title: RIBBON CAGE AND ROLLER ASSEMBLY AND METHOD THEREOF

(57) Abstract: A roller bearing cage, including: an axis of rotation; a body including a plurality of bars, each bar having a length, in a first axial direction parallel to the axis of rotation, a height, in a radial direction orthogonal to the axis of rotation, less than the length and a width, in a circumferential direction, less than the height; and a plurality of spaces, each space circumferentially disposed between a respective pair of circumferentially adjacent bars and arranged to receive a respective roller.

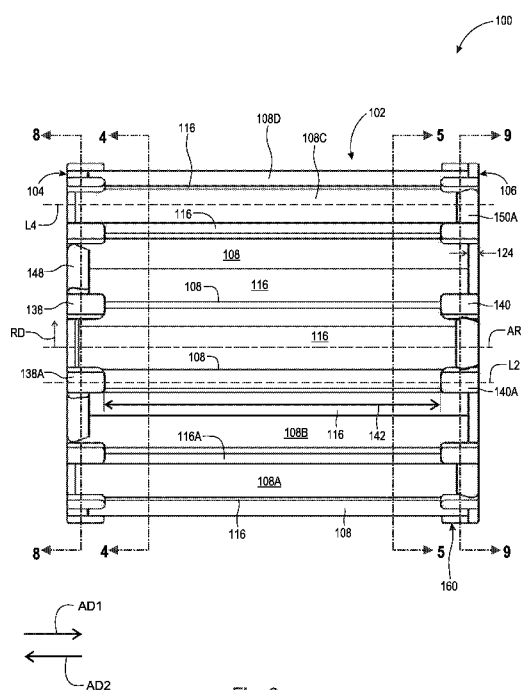


Fig. 2

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RIBBON CAGE AND ROLLER ASSEMBLY AND METHOD THEREOF

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TECHNICAL FIELD

[0001] The present disclosure relates to a roller bearing cage with bars, circumferentially located between spaces arranged to receive rollers, having a circumferential extent less than a radial extent. The present disclosure also relates to a roller bearing assembly including rollers disposed in a roller bearing cage with bars, circumferentially between spaces arranged to receive rollers, having a circumferential extent less than a radial extent. The present disclosure further relates to a method of fabricating a roller bearing cage with bars, circumferentially between spaces arranged to receive rollers, having a circumferential extent less than a radial extent, and of fabricating a roller bearing assembly including the cage.

BACKGROUND

15 [0002] Planetary gear bearings for a transmission typically have a relatively small diameter envelope. Therefore, the diameter of the bearings and number of rollers in the bearings are limited, especially when a cage is used to retain and separate the rollers. A planetary gear bearing must employ a cage to reduce roller friction in high speed applications. The size and number of rollers in a planetary gear bearing determine the load carrying capacity of the bearing. However, known configurations of the cage bars that separate rollers in the cage take-up excessive circumferential space, limiting the size and number of rollers that can be placed in the cage. As a result, the loading bearing capacity of a known planetary gear bearing is similarly limited.

[0003] The torque requirements in modern transmissions are steadily increasing. However, attaining sufficient load bearing capacity in a planetary gear bearing is at times not achievable due to the limitations, noted above, on the number and size of rollers that can be placed in a known cage for a planetary gear bearings.

[0004] Fig. 19 is a perspective view of flat steel strip **300** in an initial stage for a prior art roller bearing cage. Figure 20 is a perspective view of strip **300** in Figure 19 after slots have been punched out to form pockets. Figure 21 is a perspective view of a prior art roller bearing cage formed from the steel strip shown in Figures 19 and 20. Figures 19 through 21 are taken from Figs. 1 through 3, respectively of commonly-owned U.S. Patent No. 6,330,748. Figures 19 through 21 illustrate a known method of fabricating a cage, for example, for a planetary gear bearing. Fig. 19 shows strip **300** of steel, having a thickness **302**. In Fig. 20, slots **304** have

been punched out of strip **300** to form pockets for roller bearings. Bars **306** are formed between openings **304**. Thickness **308** of bars **306** is equal to thickness **302** of strip **300**. Dimension **310** of bars **306**, between openings **304**, is considerably greater than thicknesses **302** and **308**.

[0005] In Fig. 21, strip **300** from Fig. 20 has been wrapped to form cage **312**. Ends E1 and E2 of strip **300** are joined to form cage **312**. Rollers (not shown) are placed in slots **304**. Radial dimension **314** of bars **306** is equal to thicknesses **302** and **308**. Circumferential dimension **316** of bars **306** is considerably greater than dimension **314**. The extent of dimension **316** limits the number and size of rollers usable with cage **308**. U.S. Patents Nos. 1,598,025 and 1,894,595 also illustrate bearing cages having bars between spaces with circumferential dimensions considerably greater than radial dimensions.

[0006] It is not possible to successfully increase the number of rollers in a bearing cage using known production methods. For example, reducing the circumferential extent of the bars to accommodate more rollers drastically reduces cage robustness, which typically leads to premature failure.

SUMMARY

[0007] According to aspects illustrated herein, there is provided a roller bearing cage, including: an axis of rotation; a body including a plurality of bars, each bar having a length, in a first axial direction parallel to the axis of rotation, a height, in a radial direction orthogonal to the axis of rotation, less than the length and a width, in a circumferential direction, less than the height; and a plurality of spaces, each space circumferentially disposed between a respective pair of circumferentially adjacent bars and arranged to receive a respective roller.

[0008] According to aspects illustrated herein, there is provided a roller bearing assembly, including: an axis of rotation; a cage including a body including a plurality of bars and a plurality of end panels, each end panel directly connected to a respective pair of bars adjacent to each other in a circumferential direction; and a plurality of rollers, each roller in the plurality of rollers including an axis of rotation and disposed, in the circumferential direction, between a respective pair of bars. A line, co-linear with the axis of rotation of a first roller, passes through only one single end panel.

[0009] According to aspects illustrated herein, there is provided A method of fabricating a roller bearing cage, including: bending a strip of metal to form a plurality of bars and a plurality of end panels, the strip of metal having first and second oppositely facing sides, each of the first and second sides including a length in a first direction and a width, less than the length, in a second direction orthogonal to the first direction and a thickness, less than the

width, in a third direction, orthogonal to the first and second directions, between the first and second oppositely facing sides; forming the strip of metal about an axis of rotation; forming a first end plate having a plurality of retention tabs and a plurality of pocket tabs; forming a second end plate having a plurality of retention tabs and a plurality of pockets tabs; fixedly
 5 securing the first end plate to a first group of end panels included in the plurality of end panels, such that the axis of rotation passes through the first end plate; fixedly securing the second end plate to a second group of end panels included in the plurality of end panels, such that the plurality of bars are disposed parallel to the axis of rotation and between the first and second end plates; forming a plurality of spaces bounded in a first axial direction, parallel to the
 10 axis of rotation, by the first end panel, bounded in a second axial direction, opposite the first axial direction, by the first group of end panels, and bounded in first and second opposite circumferential directions by the plurality of bars, or bounded in a first axial direction, parallel to the axis of rotation, by the second group of end panels, bounded in a second axial direction, opposite the first axial direction, by the second end panel, and bounded in first and second
 15 opposite circumferential directions by the plurality of bars.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

20 Figure 1 is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

Figure 2 is a side view of a roller bearing cage with bars having a circumferential extent less than a radial extent;

Figure 3 is a side view of a portion of a body for the roller bearing cage in Figure
 25 2;

Figure 4 is a cross-sectional view generally along line 4-4 in Figure 2;

Figure 5 is a cross-sectional view generally along line 5-5 in Figure 2;

Figure 6 is a front view of the roller bearing cage in Figure 2;

Figure 7 is a back view of the roller bearing cage in Figure 2;

30 Figure 8 is a cross-sectional view generally along line 8-8 in Figure 2;

Figure 9 is a cross-sectional view generally along line 9-9 in Figure 2;

Figure 10 is a side view of a roller bearing assembly including a roller bearing cage with bars having a circumferential extent less than a radial extent;

Figure 11 is a cross-sectional view generally along line 11-11 in Figure 10;

Figure 12 is a plan view of a strip of metal for use in fabricating a roller bearing cage;

Figure 13 is a side view of the strip of metal in Figure 12;

5 Figure 14 is a perspective view of the strip of metal in Figure 13 after initial bending;

Figure 15 is a side view of an end plate for a roller bearing cage;

Figure 16 is a side view of an end plate for a roller bearing cage;

10 Figure 17 shows the end plate of Figure 15 in contact with the bars and the first plurality of end panels;

Figure 18 shows the end plate of Figure 16 in contact with the bars and the second plurality of end panels;

Fig. 19 is a perspective view of a flat steel strip in an initial stage for a prior art roller bearing cage;

15 Figure 20 is a perspective view of the strip in Figure 19 after slots have been punched out to form pockets; and,

Figure 21 is a perspective view of a prior art roller bearing cage formed from the steel strip shown in Figures 12 and 13.

DETAILED DESCRIPTION

20 [0011] At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements of the disclosure. It is to be understood that the disclosure as claimed is not limited to the disclosed aspects.

[0012] Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is
25 also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the present disclosure.

[0013] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure belongs. It should be understood that any methods, devices or materials similar or
30 equivalent to those described herein can be used in the practice or testing of the disclosure.

[0014] Figure 1 is a perspective view of cylindrical coordinate system 10 demonstrating spatial terminology used in the present application. The present application is at least partially described within the context of a cylindrical coordinate system. System 10 includes longitudinal axis 11, used as the reference for the directional and spatial terms that follow.

Axial direction **AD** is parallel to axis **11**. Radial direction **RD** is orthogonal to axis **11**. Circumferential direction **CD** is defined by an endpoint of radius **R** (orthogonal to axis **11**) rotated about axis **11**.

[0015] To clarify the spatial terminology, objects **12**, **13**, and **14** are used. An axial surface, such as surface **15** of object **12**, is formed by a plane co-planar with axis **11**. Axis **11** passes through planar surface **15**; however any planar surface co-planar with axis **11** is an axial surface. A radial surface, such as surface **16** of object **13**, is formed by a plane orthogonal to axis **11** and co-planar with a radius, for example, radius **17**. Radius **17** passes through planar surface **16**; however any planar surface co-planar with radius **17** is a radial surface. Surface **18** of object **14** forms a circumferential, or cylindrical, surface. For example, circumference **19** is passes through surface **18**. As a further example, axial movement is parallel to axis **11**, radial movement is orthogonal to axis **11**, and circumferential movement is parallel to circumference **19**. Rotational movement is with respect to axis **11**. The adverbs “axially,” “radially,” and “circumferentially” refer to orientations parallel to axis **11**, radius **17**, and circumference **19**, respectively. For example, an axially disposed surface or edge extends in direction **AD**, a radially disposed surface or edge extends in direction **R**, and a circumferentially disposed surface or edge extends in direction **CD**.

[0016] Figure 2 is a side view of roller bearing cage **100** with bars having a circumferential extent less than a radial extent.

[0017] Figure 3 is a side view of a portion of body **102** for roller bearing cage **100** in Figure 2. The following should be viewed in light of Figures 2 and 3. Cage **100** includes axis of rotation **AR**, body **102**, end plate **104** and end plate **106**. Body **102** includes bars **108**. Each bar **108** has: length **110** in axial direction **AD1**, parallel to axis of rotation **AR**; and height **112** in radial direction **RD**, orthogonal to axis of rotation **AR**. Height **112** is less than length **110**. Body **102** is made of a single piece of material joined at end **E1** and **E2** (shown in Figure 14 below).

[0018] Figure 4 is a cross-sectional view generally along line 4-4 in Figure 2.

[0019] Figure 5 is a cross-sectional view generally along line 5-5 in Figure 2. The following should be viewed in light of Figures 2 through 5. In the descriptions that follow, the nomenclature “**XXXZ**” is used for certain elements. “**XXX**” is a number referring to each element in a plurality of elements and “**Z**” is a letter referring to a particular element in the plurality of elements. Each bar **108** has width **114**, in circumferential direction **CD1**, less than height **112**. Cage **100** includes spaces **116**. Each space **116** is circumferentially disposed

between a respective pair of circumferentially adjacent bars **108** and is arranged to receive a respective roller (rollers are shown in Figures 10 and 11). For example, space **116A** is between circumferentially adjacent bars **108A** and **108B**. In an example embodiment, height **112** is at least 1.5 times greater than width **114**.

5 **[0020]** Each bar **108** includes opposite axial ends **118** and **120**. For example, ends **118** are a furthest extent of bars **108** in axial direction **AD2**, opposite direction **AD1**, and end **120** are a furthest extent of bars **108** in axial direction **AD1**. Body **102** includes end panels **122**. Each end panel **122** is directly connected to axial ends **118** for a respective pair of circumferentially adjacent bars; or is directly connected to axial ends **120** for a respective pair of circumferentially adjacent bar **108**. For example, end panel **122A** is directly connected to ends **118** of bars **108C** and **108D**, and end panel **122B** is directly connected to ends **120** of bars **108D** and **108E**. Body **102** is a single piece of material.

10 **[0021]** In an example embodiment, each end panel **122** has height **112** in radial direction **RD**, and dimension **124**, in axial direction **AD1**, equal width **114**. Each bar **108** is directly connected to only one end panel **122** at axial end **118** and each bar **108** is directly connected to only one end panel **122** at axial end **120**. For example, end **118** for bar **108D** is directly connected to only end panel **122A** and end **120** for bar **108D** is directly connected to only end panel **122B**.

15 **[0022]** Each bar **108** has sides **126** and **128**, facing in circumferential directions **CD1** and **CD2**, respectively. Direction **CD2** is opposite direction **CD1**. In an example embodiment, line **L1**, orthogonal to axis of rotation **AR**, passes through a bar **108**, for example bar **108B**, and is equidistant from sides **126** and **128** for the bar **108**. Line **L1** can be drawn through any bar **108** to be equidistant from sides **126** and **128** for the bar **108** chosen.

20 **[0023]** Figure 6 is a front view of roller bearing cage **100** in Figure 2.

25 **[0024]** Figure 7 is a back view of roller bearing cage **100** in Figure 2. The following should be viewed in light of Figures 2 through 7. Body **102** includes axial ends **130** and **132**. Ends **130** and **132** are the portions of body **102** furthest in directions **AD2** and **AD1**, respectively. End plates **104** and **106** are fixedly secured to ends **130** and **132**, respectively. End plates **104** and **106** have ring-shaped bodies **134** and **136**, respectively. In an example embodiment, bodies **134** and **136** are perpendicular to axis **AR**.

30 **[0025]** End plate **104** includes retention tabs **138** extending from body **134** in direction **AD1**. End plate **106** includes retention tabs **140** extending from body **136** in direction **AD2**.

Tabs **138** and **140** are radially outward of bars **108** and overlap bars **108** in radial direction **RD**. As further described below, tabs **138** and **140** radially restrain and retain rollers in spaces **116**.

[0026] To illustrate the configuration of body **102**, end plates **104** and **106**, and tabs **138** and **140**, a series of lines are used. Line **L2**, parallel to axis of rotation **AR**, passes through a retention tab **138** and a retention tab **140**, for example, tabs **138A** and **140A**. The retention tabs **138** and **140** through which line **L2** passes are separated by distance **142** in the axial direction **AD1**. Line **L1**, orthogonal to axis of rotation **AR**, passes from axis of rotation **AR**, through a bar, for example bar **108B**, to a tab **138**, for example, tab **138A**. Line **L3**, orthogonal to axis of rotation **AR**, passes from axis of rotation **AR**, through a bar, for example bar **108B**, to a tab **140**, for example, tab **140A**.

[0027] Each retention tab **138** and each tab **140** overlaps a respective bar **108** in circumferential direction **CD1**. For example, tab **138A** extends past bar **108B** in directions **CD1** and **CD2** and tab **140A** extends past bar **108B** in directions **CD1** and **CD2**. Circumferentially adjacent tabs **138** are separated from each other, in direction **CD1**, by space **144** and circumferentially adjacent tabs **140** are separated from each other, in direction **CD1**, by space **146**.

[0028] Figure 8 is a cross-sectional view generally along line 8-8 in Figure 2.

[0029] Figure 9 is a cross-sectional view generally along line 9-9 in Figure 2. The following should be viewed in light of Figures 2 through 9. In an example embodiment, end plates **104** and **106** include pocket tabs **148** and **150**, respectively. Each pocket tab **148** is in contact with circumferentially adjacent bars **108** and a respective end panel **122** connecting the circumferentially adjacent bars. For example, tab **148A** is in contact with end panel **122C** and tab **150A** is in contact with end panel **122D**. Tabs **148** and **150** are circumferentially off-set. Therefore, a line, parallel to axis of rotation **AR**, passes through a pocket tab **148** without passing through a pocket tab **150** or passes through a pocket tab **150** without passing through a pocket tab **148**. For example, line **L4** passes through tab **150A** without passing through a tab **148**.

[0030] In an example embodiment, sides **152** and **154** of tabs **148** and **150**, contact circumferentially adjacent bars **108** to hold the bars **108** at a specified orientation and to separate the bars **108** by a specified circumferential distance. For example, dimension **112** of bars **108** is radially aligned with axis **AR**. For example, side **154** of tab **148A** and side **152** of tab **150B** hold bar **108E**, such that radial line **L5** is equidistant from sides **126** and **128** of bar **108D**. For example, sides **152** and **154** of tab **148A** maintain specified distance **156** between

bars **108E** and **108F**. Distance **156** also is the circumferential dimension for spaces **116**. The radial alignment of bars **108** provides radially inward restraint and retention of rollers (described below) in spaces **116**.

[0031] Cage **100** includes circumferential space **158** between circumferentially adjacent end panels. For example, space **158A** is between end panels **122A** and **122E** and space **158B** is between end panels **122F** and **122G**. End plate **104** blocks, in axial direction **AD1** or **AD2**, spaces **158** at axial end **130** of body **102**. End plate **106** blocks, in axial direction **AD1** or **AD2**, spaces at axial end **132** of body **102**. Thus, end plates **104** and **106**, in conjunction with end panels **122**, define an axial extent of spaces **116**.

[0032] Figure 10 is a side view of a roller bearing assembly **200** including roller bearing cage **100** with bars having a circumferential extent less than a radial extent.

[0033] Figure 11 is a cross-sectional view generally along line 11-11 in Figure 10. The following should be viewed in light of Figures 2 through 11. Roller bearing assembly **200** includes cage **100** and rollers **202**. Each roller **202** has axis of rotation **RAR**. Each roller **202** is disposed, in circumferential direction **CD1**, between a respective pair of bars **108**. An axis of rotation **RAR** for a roller **202**, passes through only one single end panel. For example: axis **RAR** for roller **202A** passes through only end panel **122E** and pocket tab **148B**; and axis **RAR** for roller **202D** passes through only end panel **122H** and pocket tab **150C**. Circumferentially adjacent rollers **202** are off-set, in axial direction **AD1** from each other. For example, roller **202A** extends further in axial direction **AD1** than roller **202B**, and roller **202B** extends further in direction **AD2** than roller **202A**. For example, pocket tab **148B** displaces roller **202A** in direction **AD1**, and pocket tab **150C** displaces roller **202B** in direction **AD2**.

[0034] Each roller **202** is axially located between: end plate **104** (blocking a respective space **158** at axial end **130**) and a respective end panel **122**; or between end plate **106** (blocking a respective space **158** at axial end **132**) and a respective end panel **122**. For example: roller **202A** is between end plate **106**, and end panel **122E** and pocket tab **148B**; and roller **202B** is between end plate **104**, and end panel **122H** and pocket tab **150C**.

[0035] Retention tabs **138** and **140** overlap rollers **202** in radial direction **RD** to restrain movement of rollers **202** radially outward and to retain rollers **202** in desired radial positions. For example, tabs **138A** and **138B** and tabs **140A** and **140B** restrain and retain roller **202C**.

[0036] Figure 12 is a plan view of a strip of metal for use in fabricating a roller bearing cage.

[0037] Figure 13 is a side view of the strip of metal in Figure 12.

[0038] Figure 14 is a perspective view of the strip of metal in Figure 13 after initial bending. The following should be viewed in light of Figures 2 through 9 and 12 through 14. The following describes a method of fabricating a roller bearing cage. Although the method is presented as a sequence of steps for clarity, no order should be inferred from the sequence unless explicitly stated. A first step bends strip of metal **160** to form bars **108** and end panels **122**. Strip **160** has: oppositely facing sides **162** and **164**. Side **162** includes length **166** in direction **D1** and width **168**, less than length **166**, in a direction **D2** orthogonal to direction **D1**. Strip **160** has thickness **170**, less than width **168**, in direction **D3**, orthogonal to directions **D1** and **D2**, between sides **162** and **164**. In an example embodiment, prior to the first step, bend grooves **172** are formed in strip **160** in the areas at which strip **160** is bent to form bars **108** and end panels **122**. A second step forms the strip of metal about axis of rotation **AR** and connects ends **E1** and **E2** of strip **160**.

[0039] Figure 15 is a side view of an end plate for a roller bearing cage.

[0040] Figure 16 is a side view of an end plate for a roller bearing cage.

[0041] Figure 17 shows the end plate of Figure 15 in contact with the bars and the first plurality of end panels.

[0042] Figure 18 shows the end plate of Figure 16 in contact with the bars and the second plurality of end panels. The following should be viewed in light of Figures 2 through 9 and 12 through 18. A third step forms end plate **104** having retention tabs **138** and pocket tabs **148**. A fourth step forms end plate **106** having retention tabs **140** and pocket tabs **150**. A fifth step fixedly secures end plate **104** to a first group of end panels **122** (at end **130**), such that axis **AR** passes through end plate **104**. A sixth step fixedly secures end plate **106** to a second group of end panels **122** (at end **132**) such that bars **108** are disposed parallel to the axis of rotation **AR** and between end plates **104** and **106**. Figures 17 and 18 show end panels **104** and **106**, respectively, in position to be fixed to bars **108** and end panels **122**. A seventh step forms spaces **116**. Spaces **116**: are bounded in axial direction **AD2** by end panel **104**, are bounded in axial direction **AD1**, by the first group of end panels **122**, and are bounded in circumferential directions **CD1** and **CD2** by bars **108**; or, are bounded in axial direction **AD1** by the second group of end panels **122**, are bounded in axial direction **AD2** by end panel **106**, and are bounded in circumferential directions **CD1** and **CD2** by the plurality of bars.

[0043] An eight step positions bars **108** such that each bar **108**: has dimension **114**, in circumferential direction **CD1**, equal to thickness **210** of strip of metal **200**; and has dimension **112**, in radial direction **RD**, equal to width **208** of strip of metal **200**.

[0044] The fifth step includes bending pocket tabs **148** over the first group of end panels **122**. The sixth step includes bending pocket tabs **150** over the second group of end panels **108**. Figures 17 and 4 show tabs **148** before and after bending. Figures 18 and 5 show tabs **150** before and after bending. A ninth step bends tabs **138** at a right angle to end plate **104**. A tenth step bends tabs **140** at a right angle to end plate **106**.

[0045] An eleventh step contacts each bar **108** included in the plurality of bars with a respective pocket tab **148** and with a respective pocket tab **150**. A twelfth step fixes, with the respective pocket tabs **148** and **150**, an orientation for each bar **108** with respect to a respective line orthogonal to axis of rotation **AR**. A thirteenth step fixes, with the respective pocket tabs **148** and **150**, dimension **156**, in circumferential direction **CD1**, for each space **116**. A fourteenth step grinds outer diameter **156** of cage **100**. Note that after grinding tabs **138** and **140** provide the guiding surfaces for cage **100**.

[0046] As noted above, known roller bearing cages have bars between rollers have a circumferential extent greater than a radial extent. This configuration limits the number of roller spaces that can be formed in the cages. Also as noted above, it is not possible to successfully increase the number of rollers in a bearing cage using known production methods. For example, reducing the circumferential extent of the bars to accommodate more rollers drastically reduces cage robustness, which typically leads to premature failure.

[0047] Advantageously, cage **100** and the method of fabricating cage **100** provide a solution that increases the number of rollers in a given size of bearing cage without reducing the robustness and durability of the roller cage. Specifically: bars **108** have a reduced circumferential dimension **114**, equal to a thickness of a strip of metal used to fabricate cage **100**, which creates room for additional rollers; and bars **108** have a radial dimension **112**, equal to a width of the strip of metal, which provides the desired robustness and durability. For example, a prior art roller bearing cage with particular outer dimensions accommodates 11 rollers. Cage **100** with the same outer dimensions accommodates 14 rollers. The configuration of cage **100** results in a greater than 20% increase in load bearing capacity for a prior art cage having the same outer dimensions. Further, the axial off-set of rollers **202** spread load distribution over a larger area, reducing stress. In addition, the axial off-set reduces possible gear bore tilt.

[0048] It will be appreciated that various of the above-disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which
5 are also intended to be encompassed by the following claims.

List of Reference Characters:

	100	roller bearing cage
	102	body
5	AR	axis of rotation
	104	end plate
	106	end plate
	108	bars
	108A-F	bars
10	110	length of bar
	AD1	axial direction
	112	height of bar
	RD	radial direction
	114	width of bar
15	CD1	circumferential direction
	116	space
	116A	space
	118	axial end of bar
	120	axial end of bar
20	122	end panels
	122A-H	end panels
	122	height of end panel
	124	dimension of end panel
	126	side of bar
25	128	side of bar
	CD1	circumferential direction
	CD2	circumferential direction
	L1-L5	lines
	130	axial end of body
30	132	axial end of body
	134	ring-shaped body of end plate 104
	136	ring-shaped body of end plate 106
	138	retention tabs

	138A,B	retention tabs
	140	retention tabs
	140A,B	retention tabs
	142	distance
5	144	space
	146	space
	148	pocket tabs
	148A,B	pocket tab
	150	pocket tabs
10	150A-C	pocket tabs
	152	side of tab 148
	154	side of tab 150
	156	distance
	158	circumferential spaces
15	158A,B	circumferential spaces
	200	roller bearing assembly
	202	rollers
	202A-C	rollers
	RAR	roler axis of rotation
20	160	sheet of metal
	162	side of sheet 160
	164	side of sheet 160
	166	length of sides 162/164
	168	width of sides 162/164
25	170	thickness of sheet 160
	172	bend grooves
	D1-D3	directions

CLAIMS

1. A roller bearing cage, comprising:
an axis of rotation;
5 a body including a plurality of bars, each bar having:
a length, in a first axial direction parallel to the axis of rotation,;
a height, in a radial direction orthogonal to the axis of rotation, less than the
length; and,
a width, in a circumferential direction, less than the height; and,
10 a plurality of spaces, each space:
circumferentially disposed between a respective pair of circumferentially
adjacent bars; and,
arranged to receive a respective roller.
- 15 2. The roller bearing cage of claim 1, wherein the height is at least 1.5 times greater than
the width.
3. The roller bearing cage of claim 1, wherein:
said each bar includes first and second opposite axial ends;
20 the body includes a plurality of end panels, each end panel directly connected to:
the first axial ends for a respective pair of circumferentially adjacent bars; or,
the second axial ends for a respective pair of circumferentially adjacent bars;
each end panel has the height in the radial direction and a dimension, in the first axial
direction, equal to the width; and,
25 said each bar is directly connected to only one end panel at the first axial end.
4. The roller bearing cage of claim 1, wherein:
a first bar has first and second sides facing in first and second circumferential directions,
respectively; and,
30 a line orthogonal to the axis of rotation passes through the first bar and is equidistant
from the first and second sides.

5. The roller bearing cage of claim 1, wherein the body includes first and second axial ends, the roller bearing cage further comprising:

a first end plate fixedly secured to the first axial end and including:

a ring-shaped body; and,

5 a plurality of retention tabs extending in the first axial direction from the ring-shaped body; and,

a second end plate fixedly secured to the second axial end and including:

a ring-shaped body; and,

10 a plurality of retention tabs extending in the second axial direction from the ring-shaped body for the second end plate.

6. The roller bearing cage of claim 5, wherein:

a line parallel to the axis of rotation passes through a retention tab for the first end plate and a retention tab for the second end plate; and,

15 the retention tab for the first end plate and the retention tab for the second end plate are separated by a distance in the first axial direction.

7. The roller bearing cage of claim 5, wherein:

20 a first line orthogonal to the axis of rotation passes from the axis of rotation through a bar to a retention tab for the first end plate;

a second line orthogonal to the axis of rotation passes from the axis of rotation through a bar to a retention tab for the second end plate; and,

each retention tab for the first or second axial end plate overlaps a respective bar in the circumferential direction.

25

8. The roller bearing cage of claim 5, wherein circumferentially adjacent tabs for the first end plate are separated from each other, in the circumferential direction, by a space.

9. The roller bearing cage of claim 1, further comprising:

30 a first end plate fixedly secured to a first axial end of the body and including a plurality of pocket tabs; and,

a second end plate fixedly secured to a second axial end of the body and including a plurality of pocket tabs, wherein a pocket tab for the first end plate is in contact with first and

second circumferentially adjacent bars and an end plate connecting the first and second circumferentially adjacent bars.

10. The roller bearing cage of claim 9, wherein a line, parallel to the axis of rotation, passes
5 through a pocket tab for the first end plate without passing through a pocket tab for the second end plate.

11. A roller bearing assembly, comprising:
an axis of rotation;
10 a cage including:
a body including:
a plurality of bars; and,
a plurality of end panels, each end panel directly connected to a
respective pair of bars adjacent to each other in a circumferential direction; and,
15 a plurality of rollers, each roller in the plurality of rollers:
including an axis of rotation; and,
disposed, in the circumferential direction, between a respective pair of bars,
wherein a line, co-linear with the axis of rotation of a roller included in the plurality of rollers,
passes through only one single end panel.

20

12. The roller bearing assembly of claim 11, wherein each bar includes:
a length in an axial direction parallel to the axis of rotation for the roller bearing
assembly;
a height, less than the length, in a radial direction orthogonal to the axis of rotation for
25 the roller bearing assembly; and,
a width, in the circumferential direction, less than the height.

13. The roller bearing assembly of claim 11, wherein:
the body includes first and second axial ends; and,
30 the cage includes:
a first end plate fixedly secured to the first axial end and including a plurality of
retention tabs overlapping the plurality of rollers in a radial direction orthogonal to the axis of
rotation for the roller bearing assembly; and,

a second end plate fixedly secured to the second axial end and including a plurality of retention tabs overlapping the plurality of rollers in the radial direction.

14. The roller bearing cage of claim 11, wherein a first roller is off-set, in an axial direction,
5 parallel to the axis of rotation for the roller bearing assembly, from a second roller.

15. The roller bearing assembly of claim 11, wherein:
the cage includes first and second end plates with respective pluralities of pocket tabs;
each pocket tab includes first and second sides in contact with respective first and
10 second bars, respectively, adjacent to each other in the circumferential direction; and,
a line, co-linear with the axis of rotation for a roller, passes through a pocket tab for one
of the first or second end plates without passing through a pocket tab for the other of the first
or second end plates.

15 16. The roller bearing assembly of claim 15, further comprising:
a circumferential space between first and second circumferentially adjacent end panels,
wherein:
the first end plate contacts the first and second circumferentially adjacent end
panels and blocks the space in an axial direction parallel to the axis of rotation for the roller
20 bearing assembly; and,
a roller is axially located between the first end plate and a third end panel.

17. A method of fabricating a roller bearing cage, comprising:
bending a strip of metal to form a plurality of bars and a plurality of end panels, the
25 strip of metal having:
first and second oppositely facing sides, each of the first and second sides
including a length in a first direction and a width, less than the length, in a second direction
orthogonal to the first direction; and,
a thickness, less than the width, in a third direction, orthogonal to the first and
30 second directions, between the first and second oppositely facing sides;
forming the strip of metal about an axis of rotation;
forming a first end plate having a plurality of retention tabs and a plurality of pocket
tabs;

forming a second end plate having a plurality of retention tabs and a plurality of pockets tabs;

fixedly securing the first end plate to a first group of end panels included in the plurality of end panels, such that the axis of rotation passes through the first end plate;

5 fixedly securing the second end plate to a second group of end panels included in the plurality of end panels, such that the plurality of bars are disposed parallel to the axis of rotation and between the first and second end plates; and,

forming a plurality of spaces:

10 bounded in a first axial direction, parallel to the axis of rotation, by the first end panel, bounded in a second axial direction, opposite the first axial direction, by the first group of end panels, and bounded in first and second opposite circumferential directions by the plurality of bars; or,

bounded in a first axial direction, parallel to the axis of rotation, by the second group of end panels, bounded in a second axial direction, opposite the first axial direction, by the second end panel, and bounded in first and second opposite circumferential directions by the plurality of bars.

18. The method of claim 17, further comprising:

positioning the plurality of bars such that each bar:

20 has a first dimension, in the first circumferential direction, equal to the thickness of the strip of metal; and,

has a second dimension, in a radial direction orthogonal to the axis of rotation, equal to the width of the strip of metal.

25 19. The method of claim 17, wherein:

fixedly securing the first end plate to the first group of end panels includes bending the plurality of pocket tabs for the first end plate over the first group of end panels; and,

fixedly securing the second end plate to the second group of end panels includes bending the plurality of pocket tabs over the second group of end panels, the method further comprising:

30 bending the plurality of retention tabs for the first end plate at a right angle to the first end plate; and,

bending the plurality of retention tabs for the second end plate at a right angle to the second end plate.

20. The method of claim 17, further comprising:

5 contacting each bar included in the plurality of bars with a respective pocket tab for the first end plate and with a respective pocket tab for the second end plate:

fixing, with the respective pocket tab for the first end plate and with the respective pocket tab for the second end plate, an orientation of said each bar with respect to a respective line orthogonal to the axis of rotation; and,

10 fixing, with the respective pocket tab for the first end plate and with the respective pocket tab for the second end plate, a dimension, in the first circumferential direction, for each space included in the plurality of spaces.

15

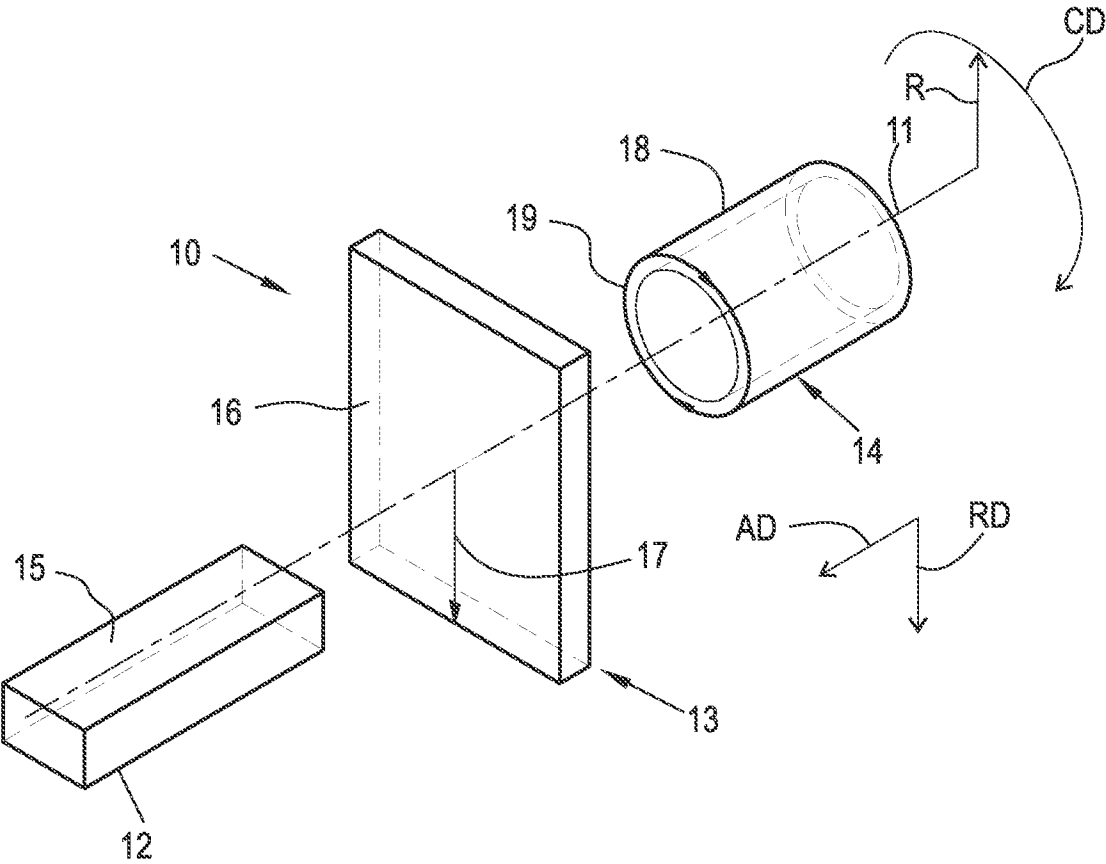
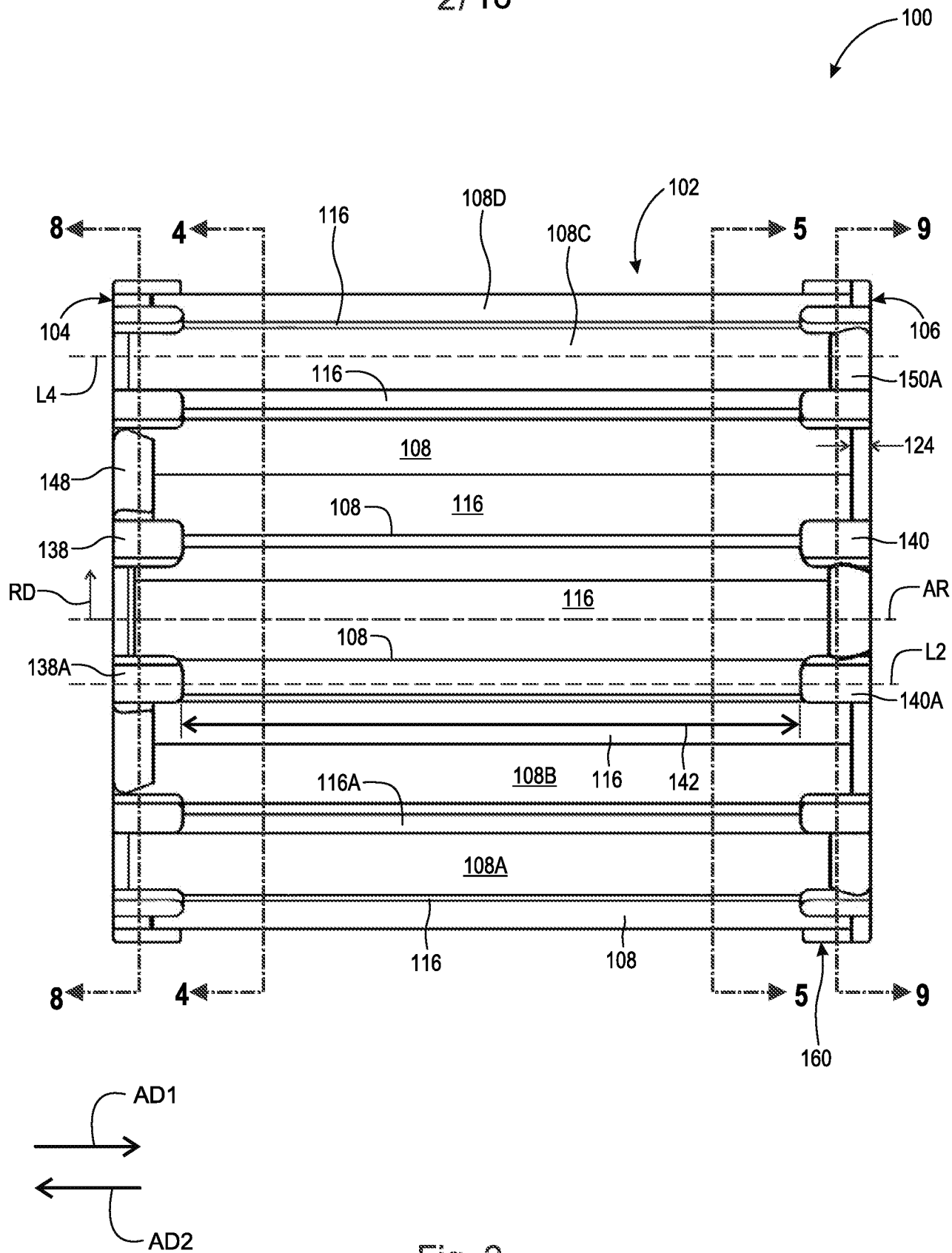


Fig. 1

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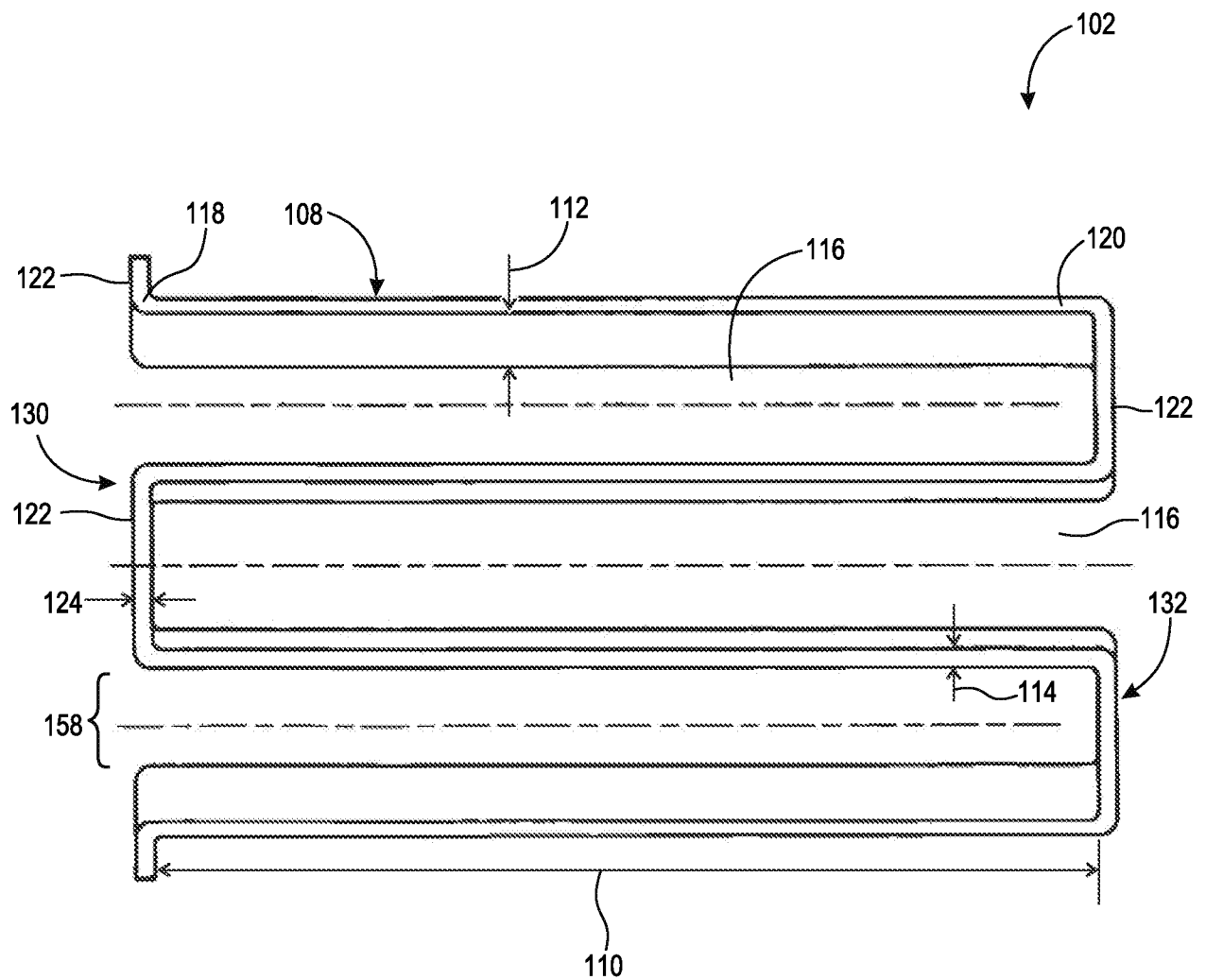


Fig. 3

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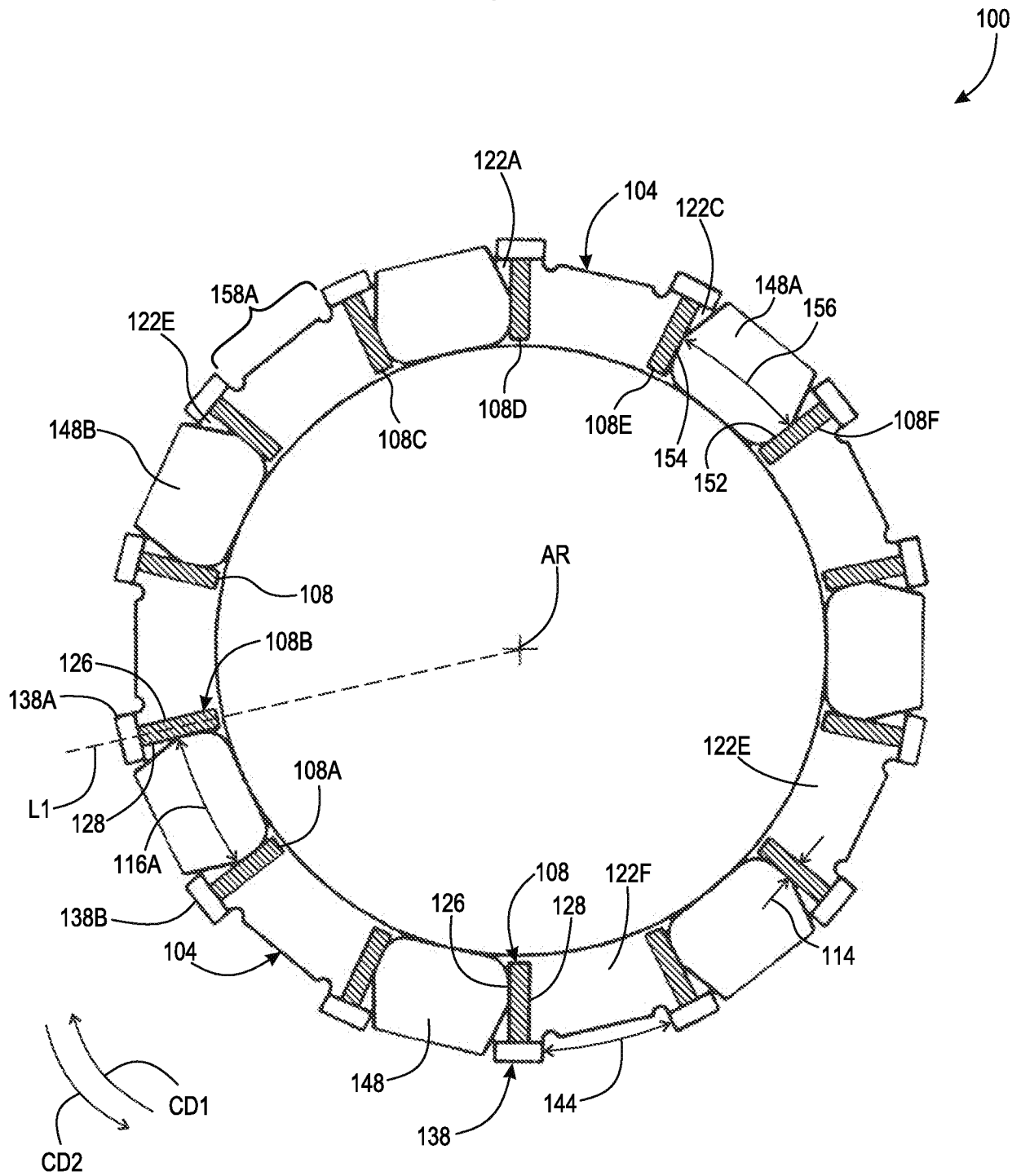


Fig. 4

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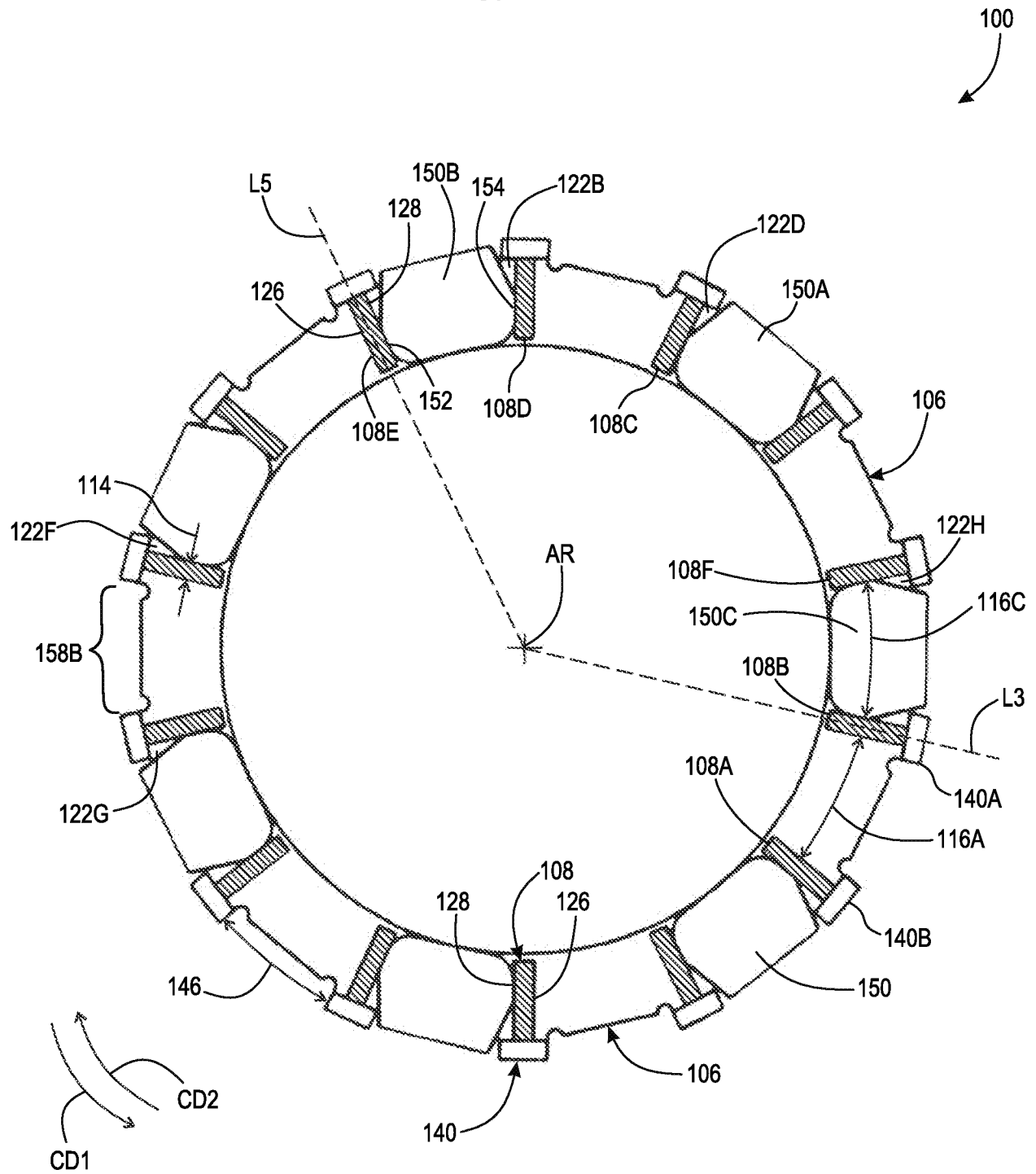


Fig. 5

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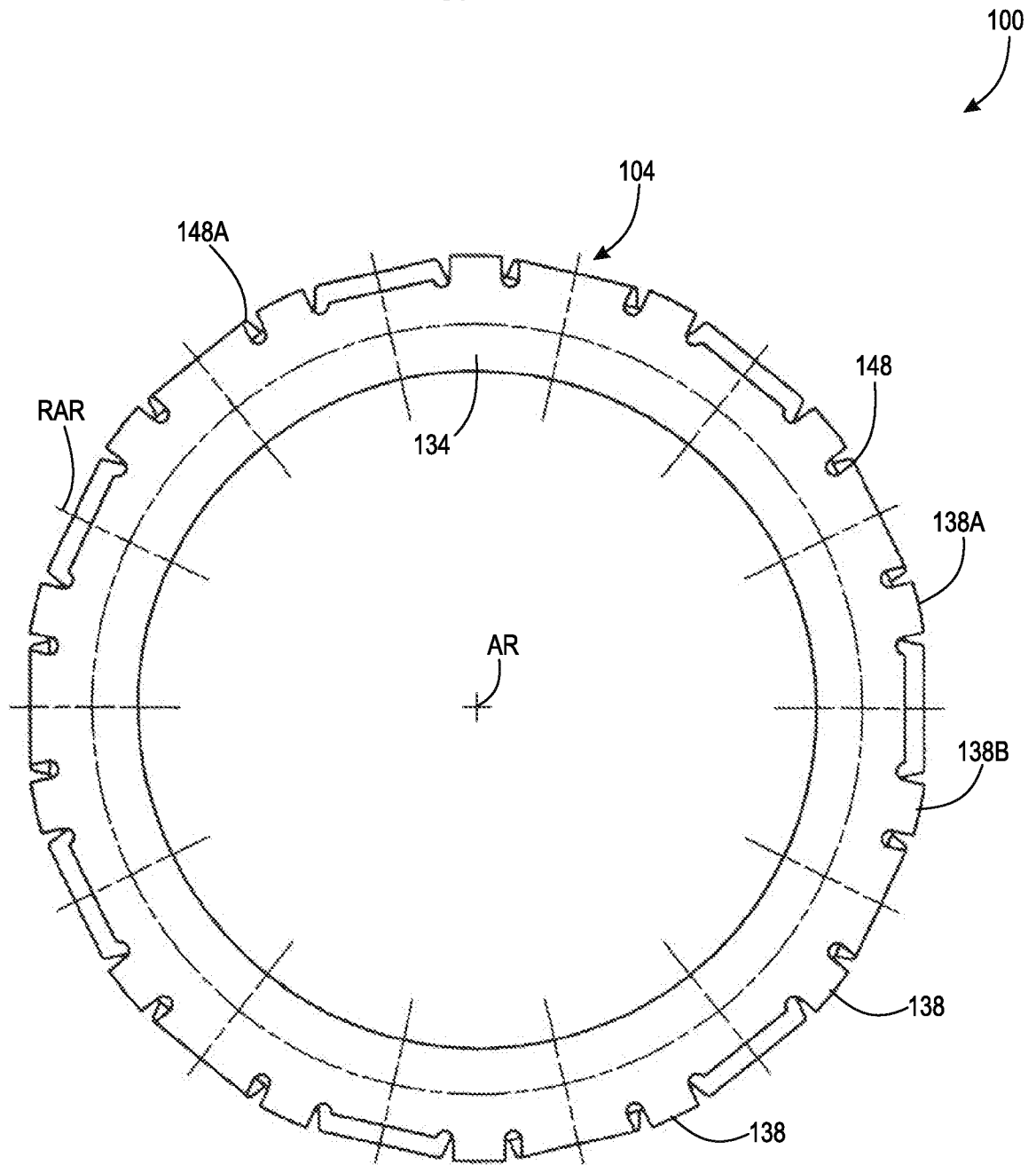


Fig. 6

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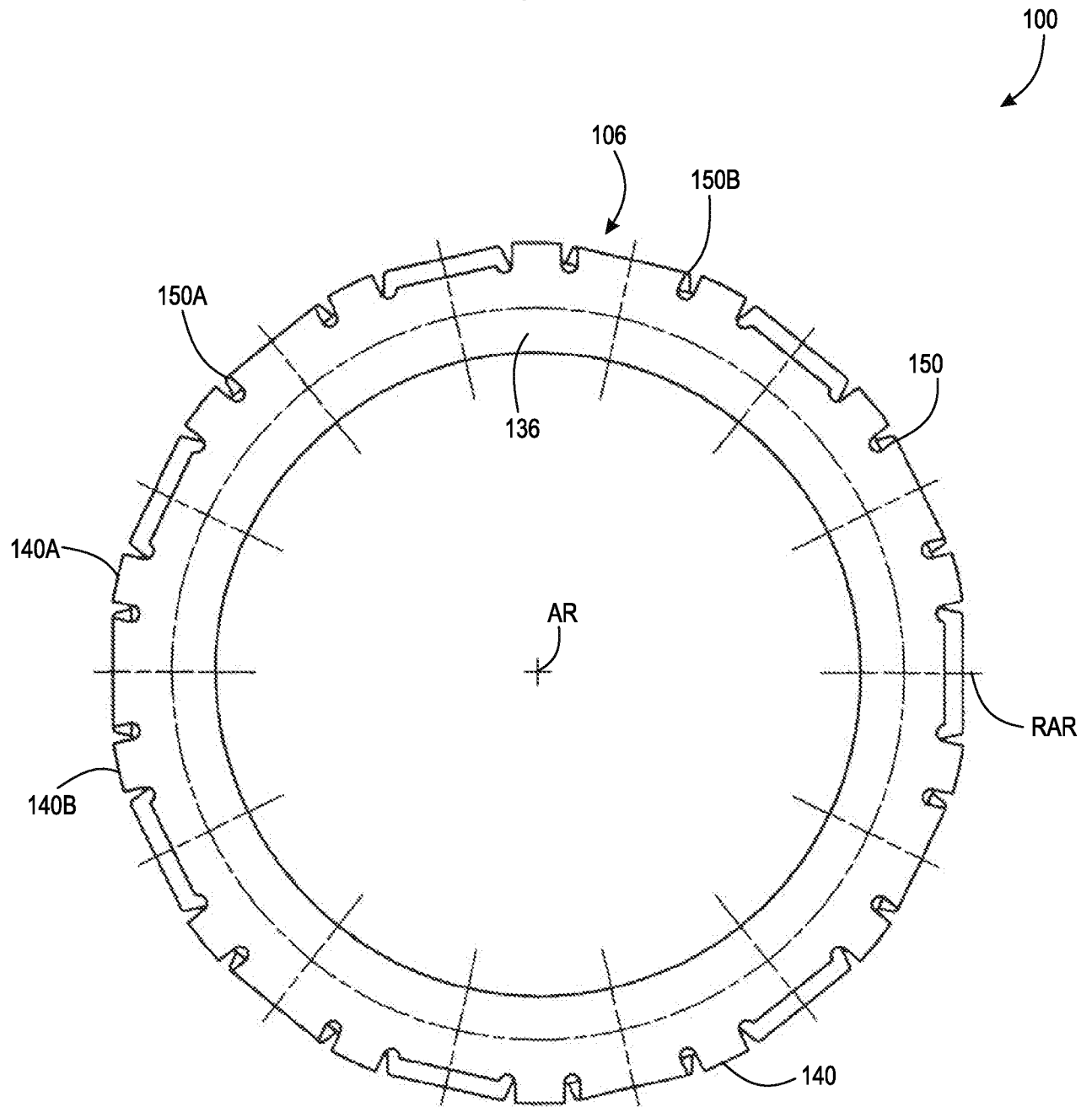


Fig. 7

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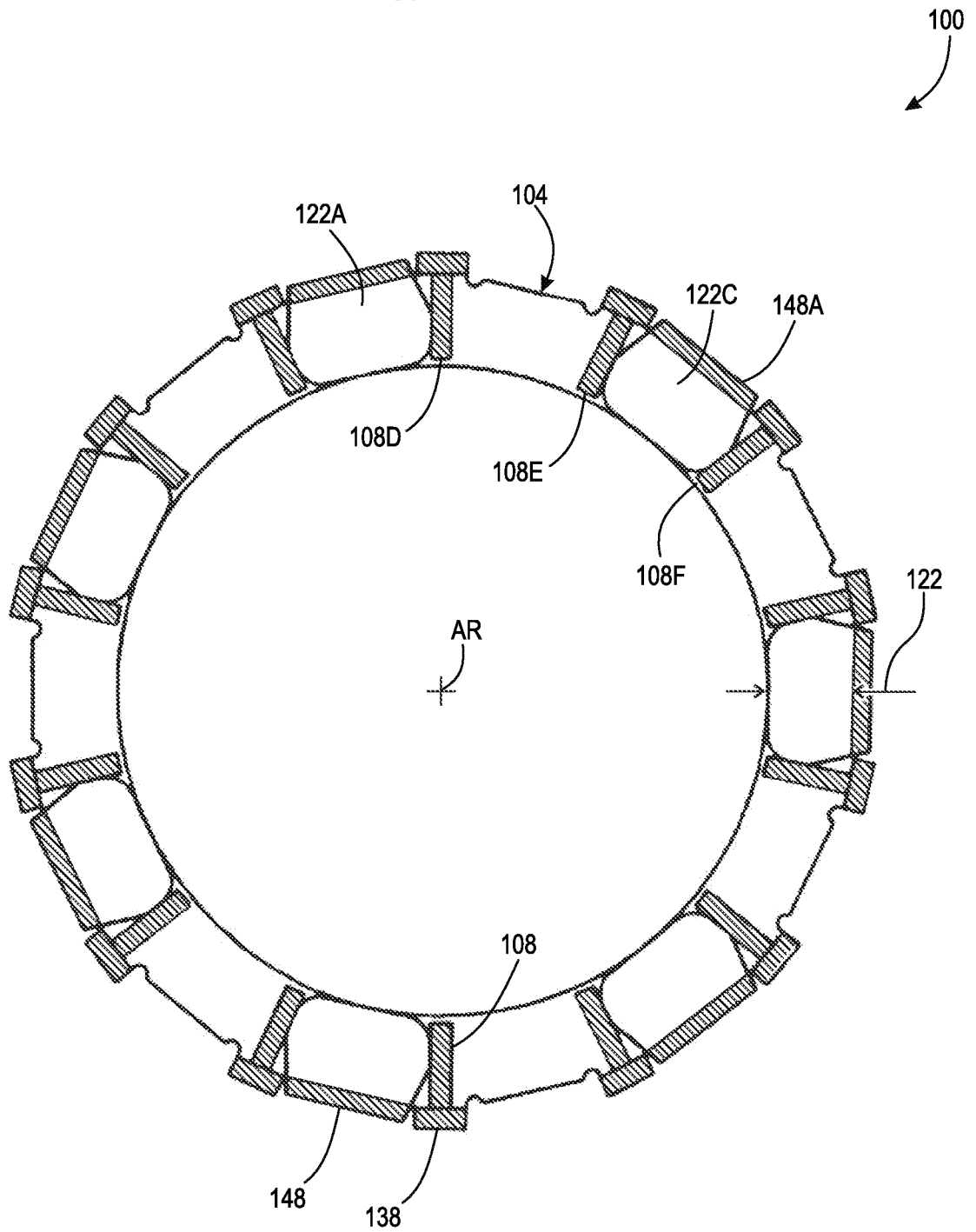


Fig. 8

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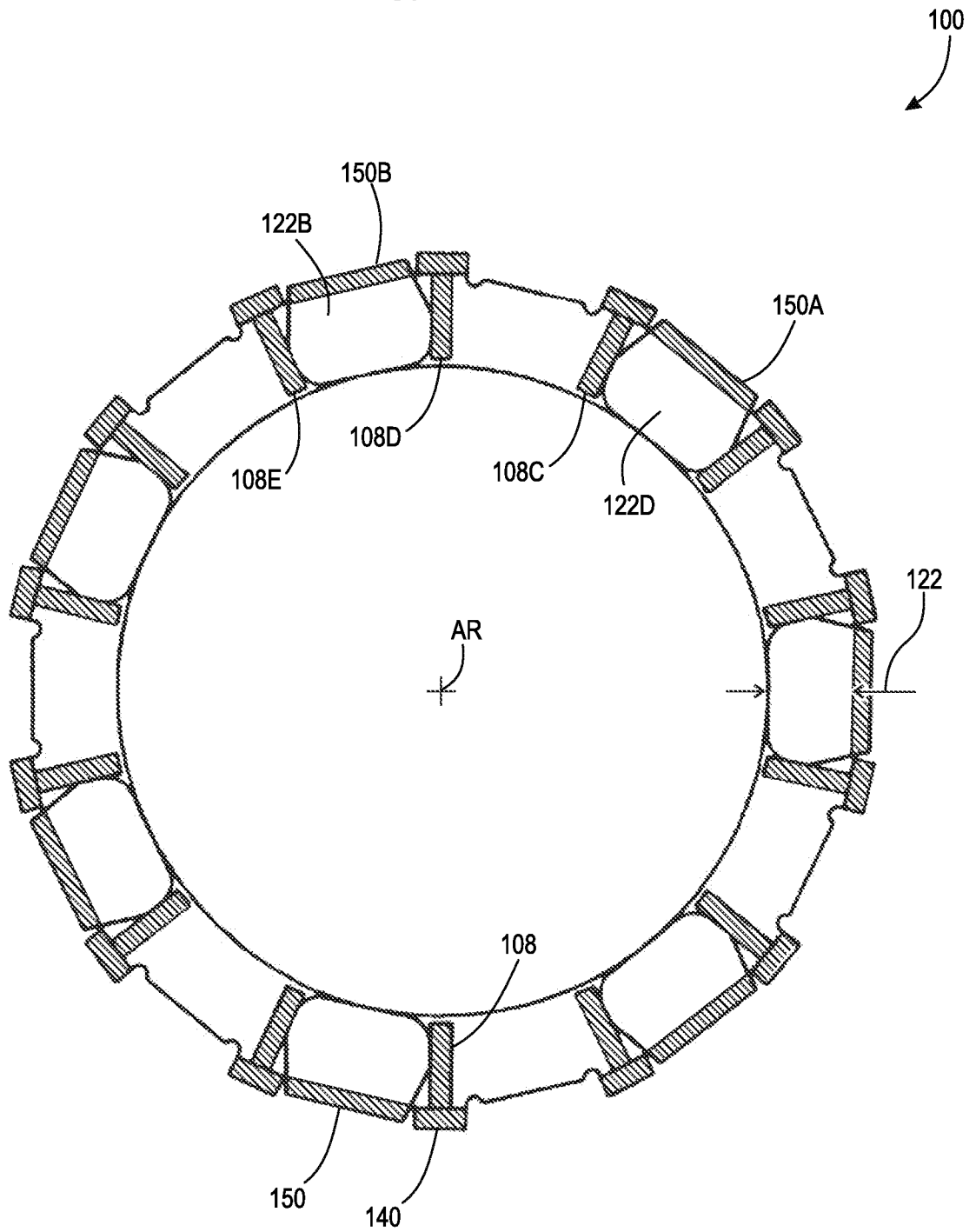


Fig. 9

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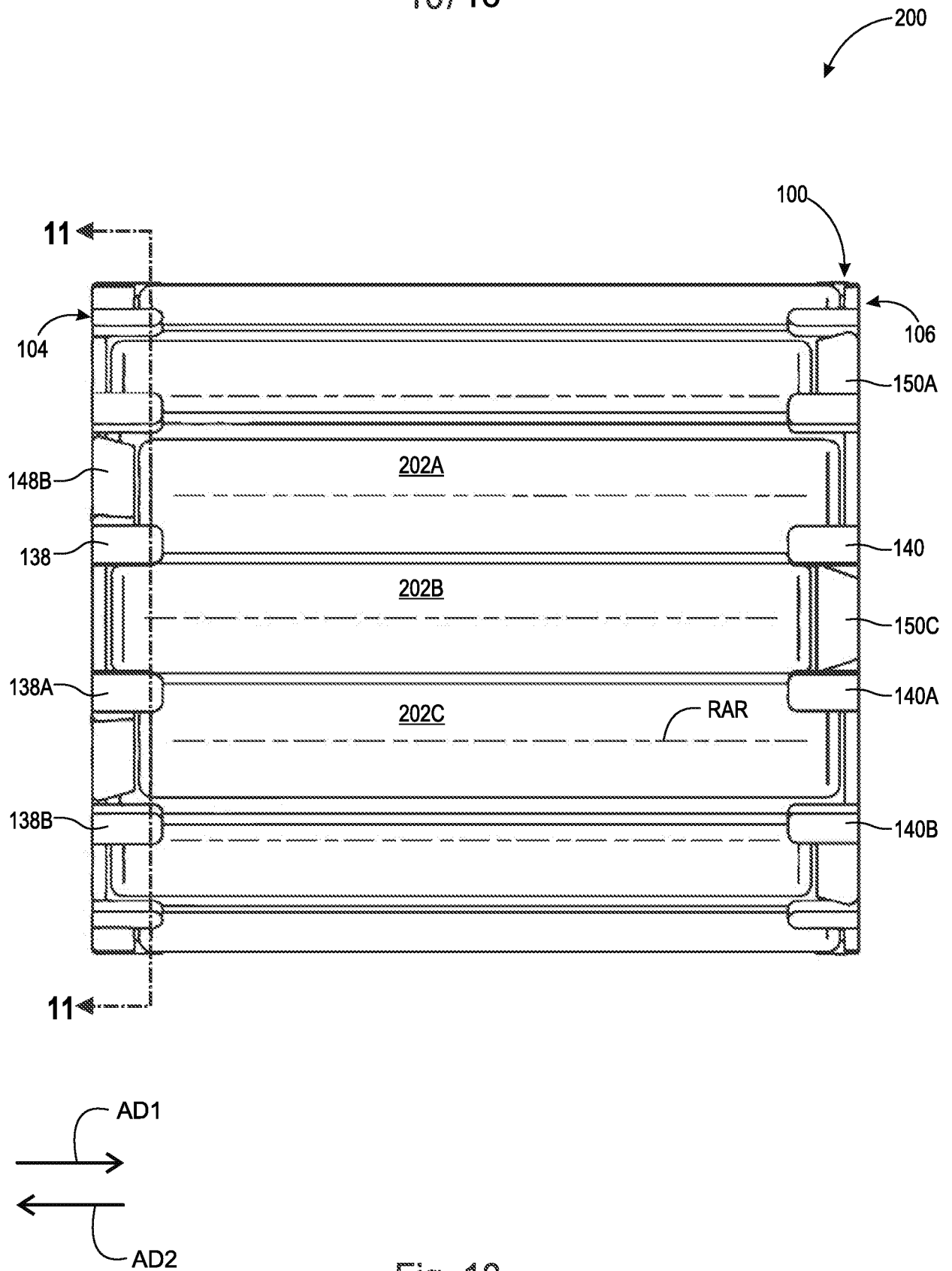


Fig. 10

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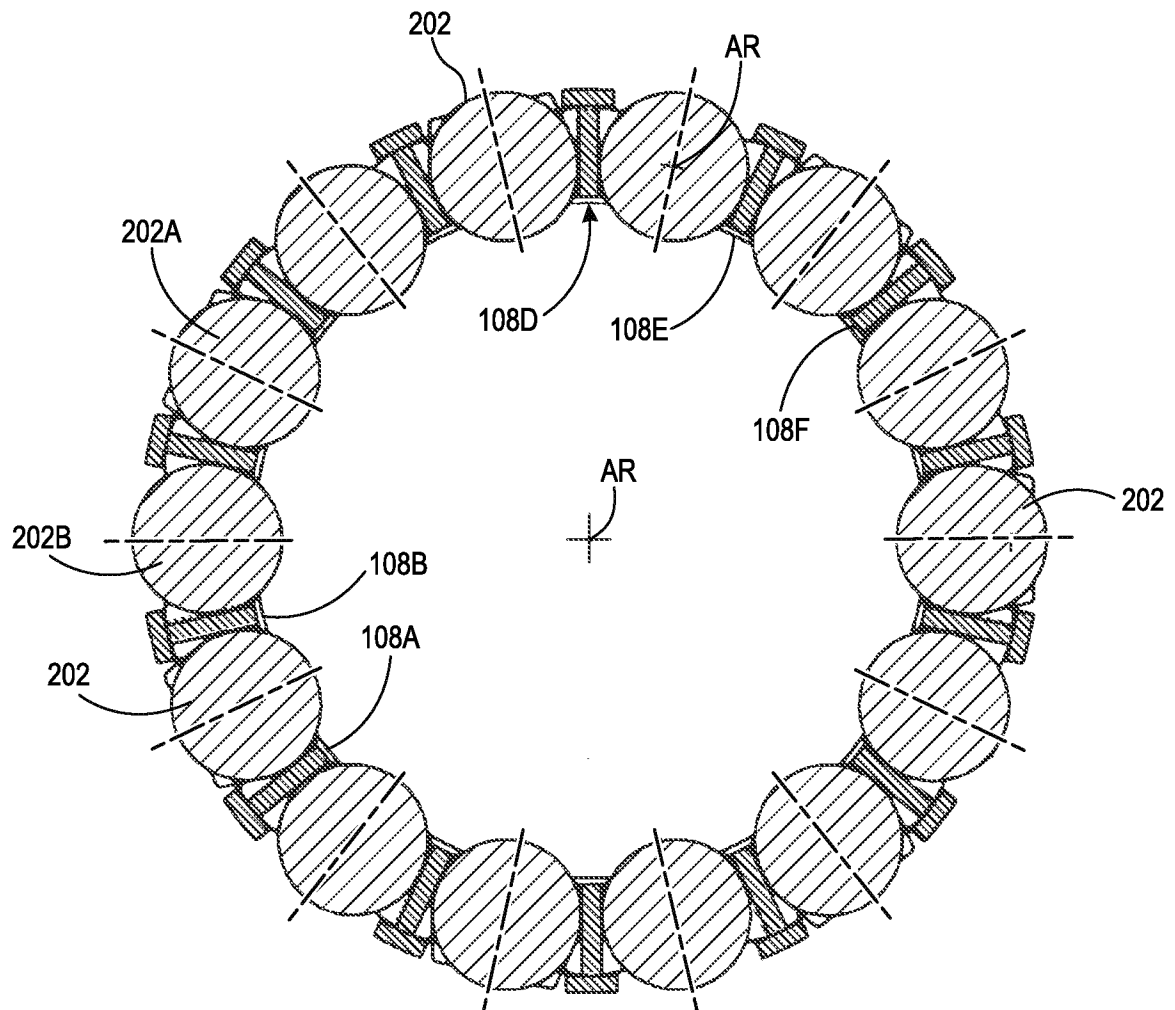
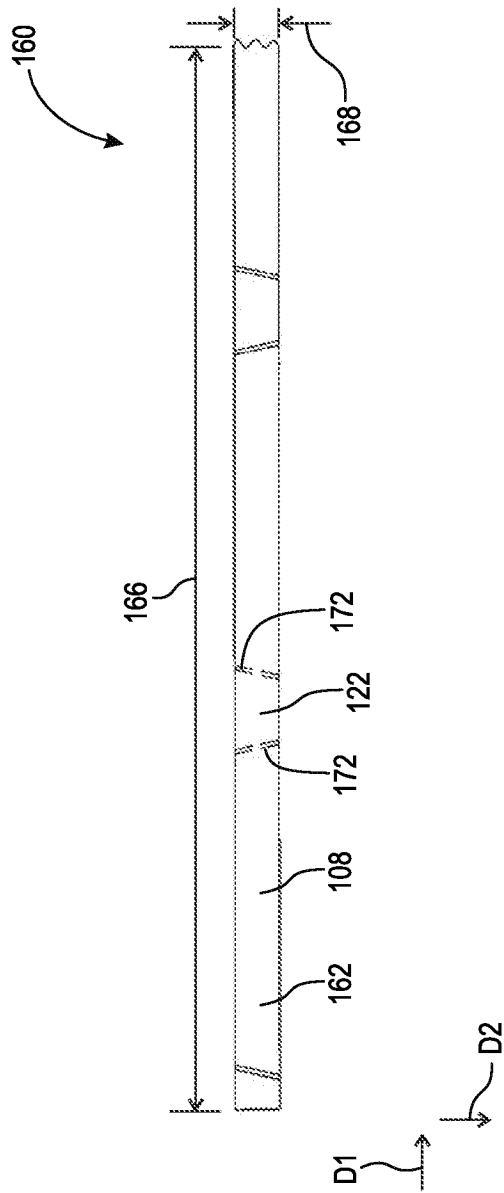
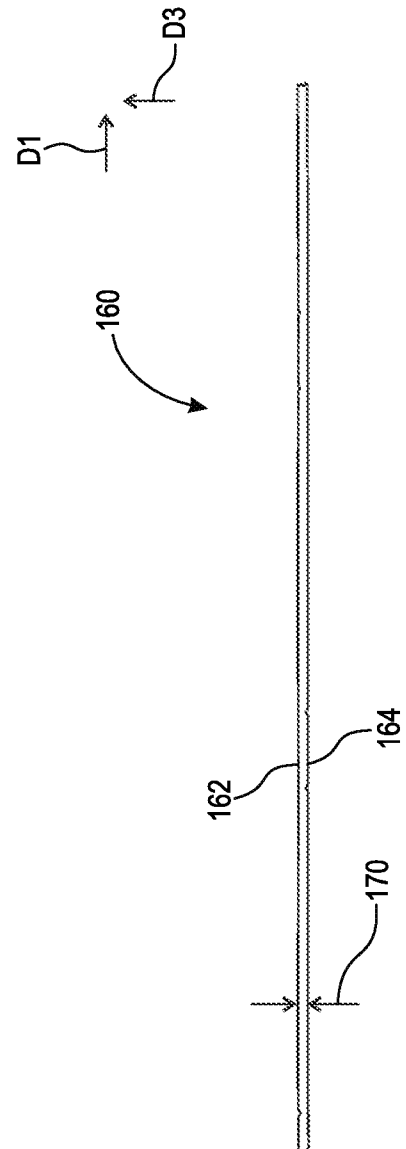


Fig. 11

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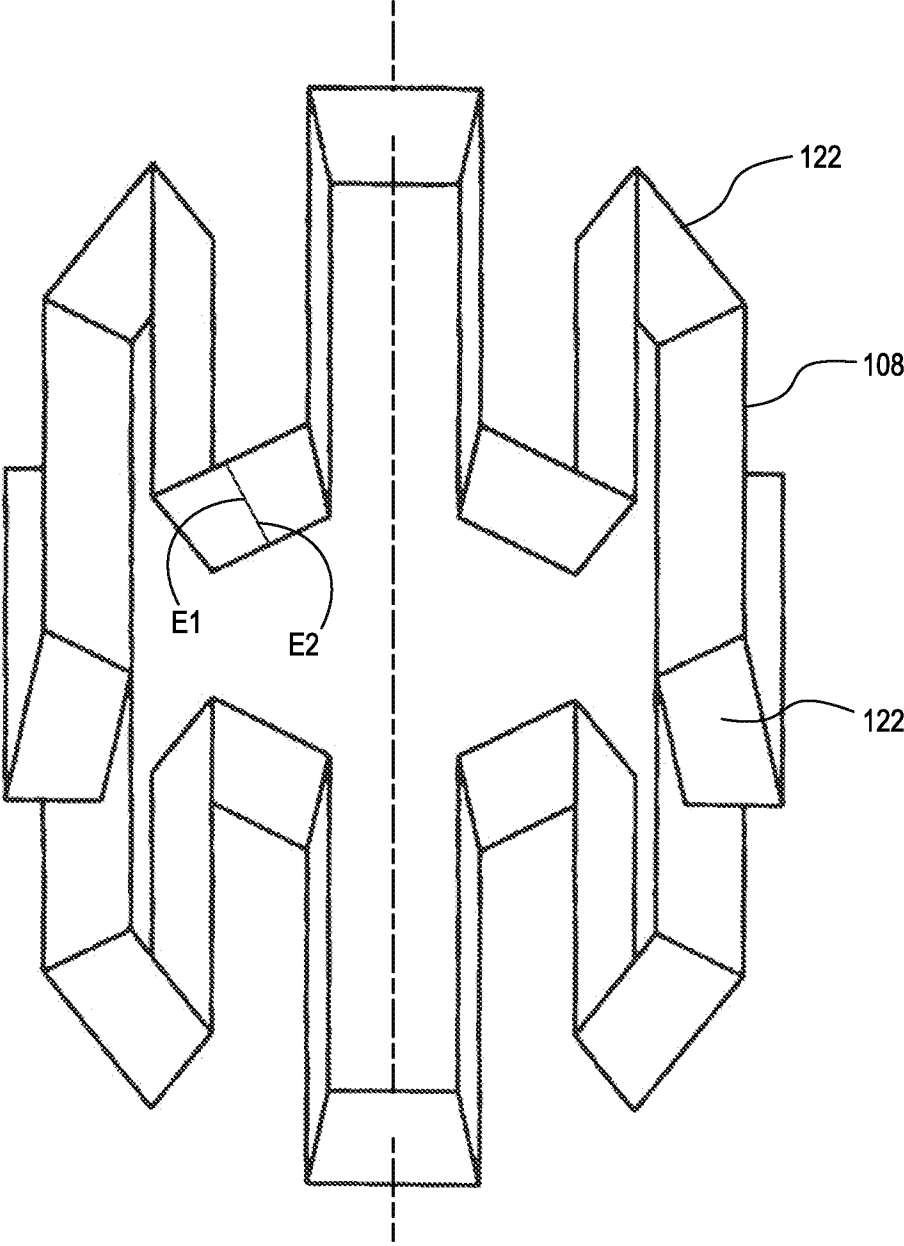


Fig. 14

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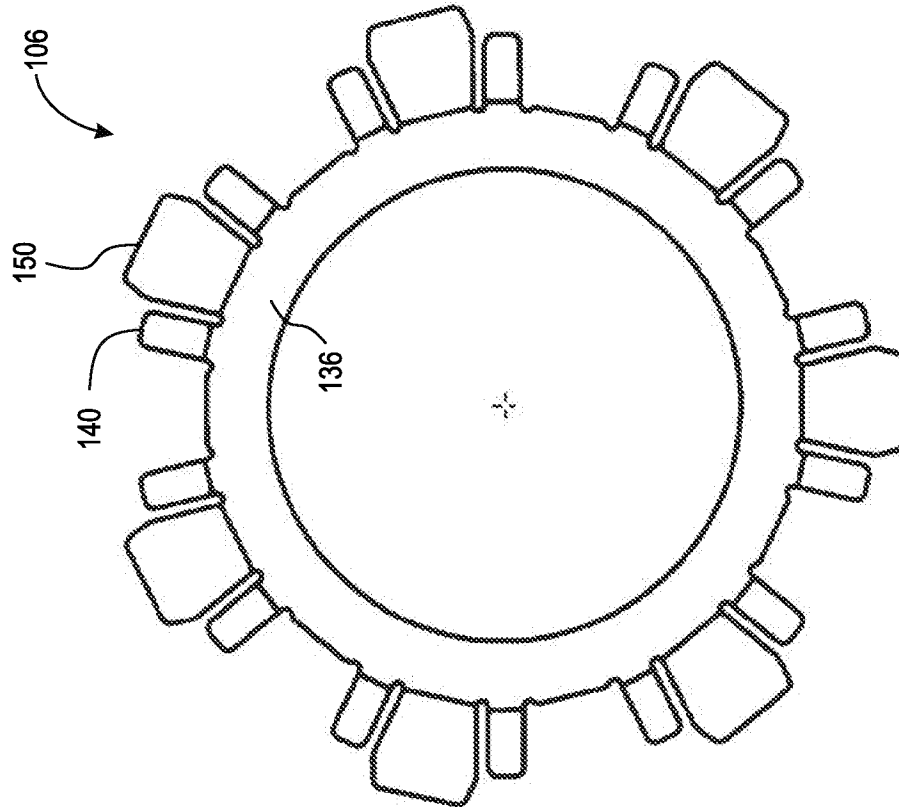


Fig. 15

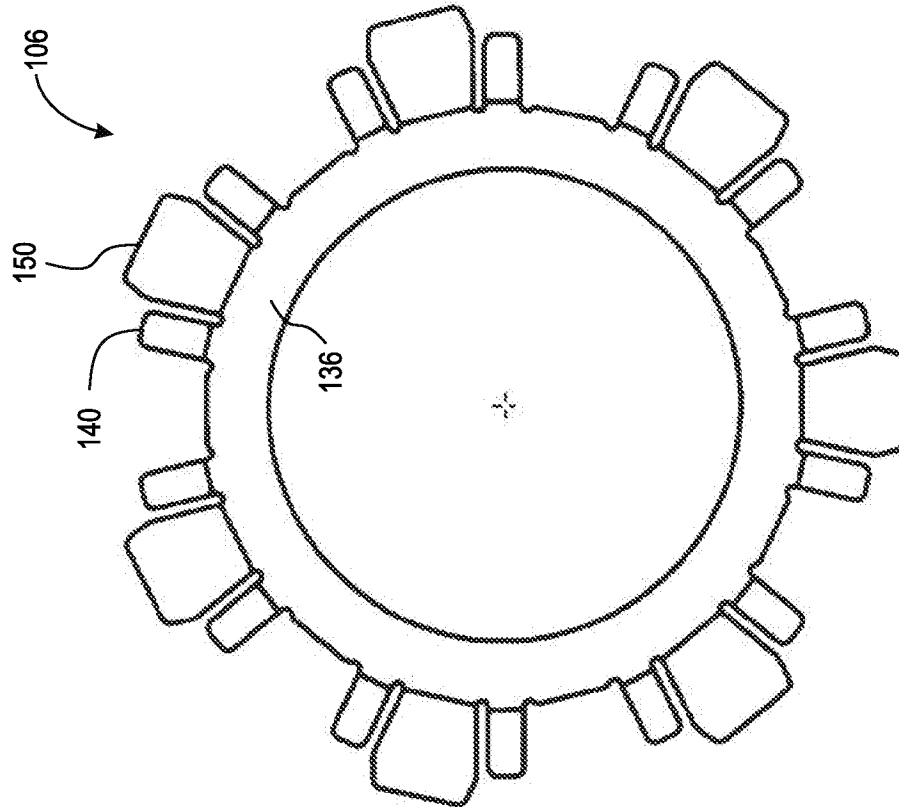


Fig. 16

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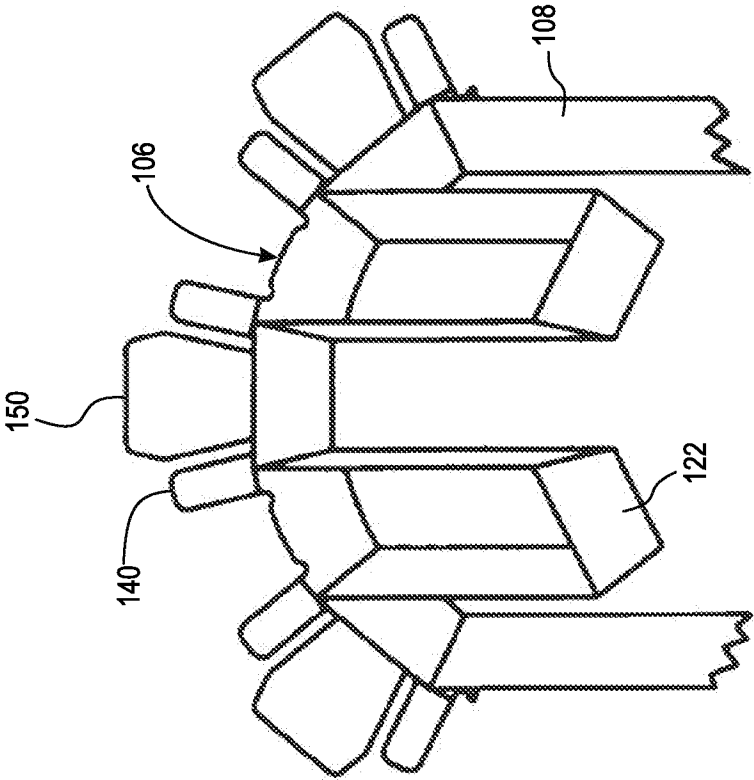


Fig. 18

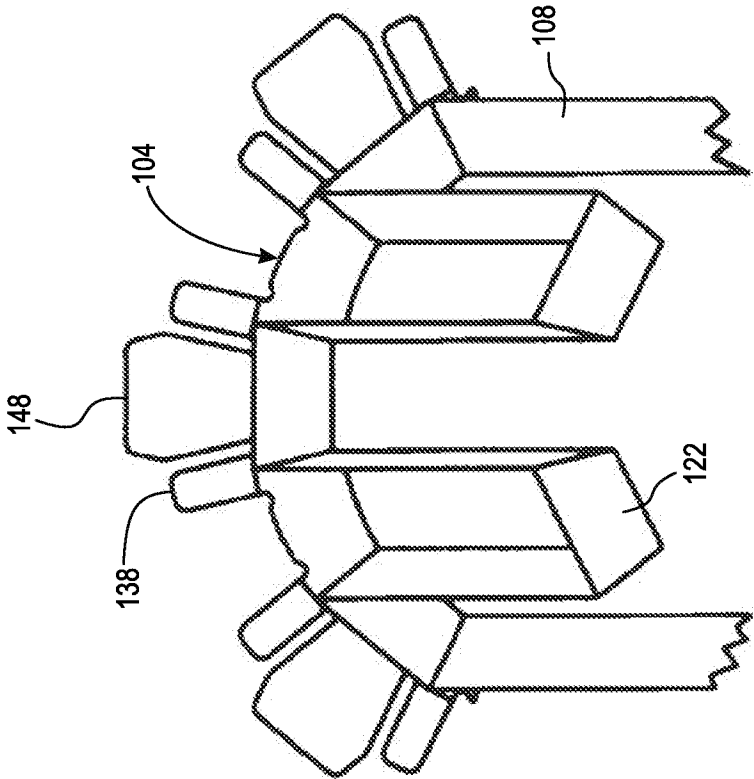


Fig. 17

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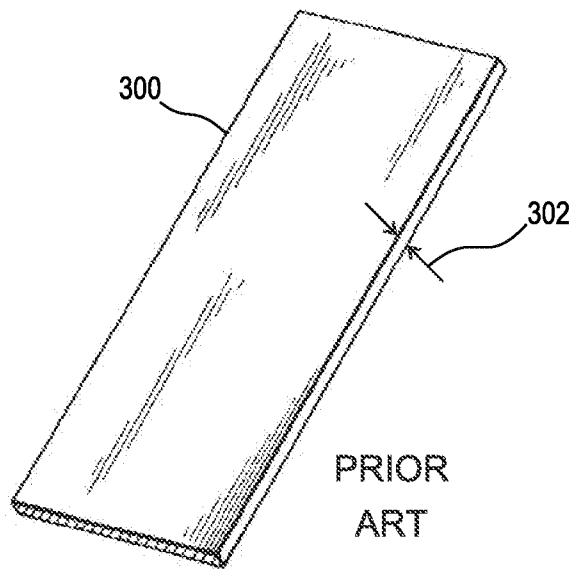


Fig. 19

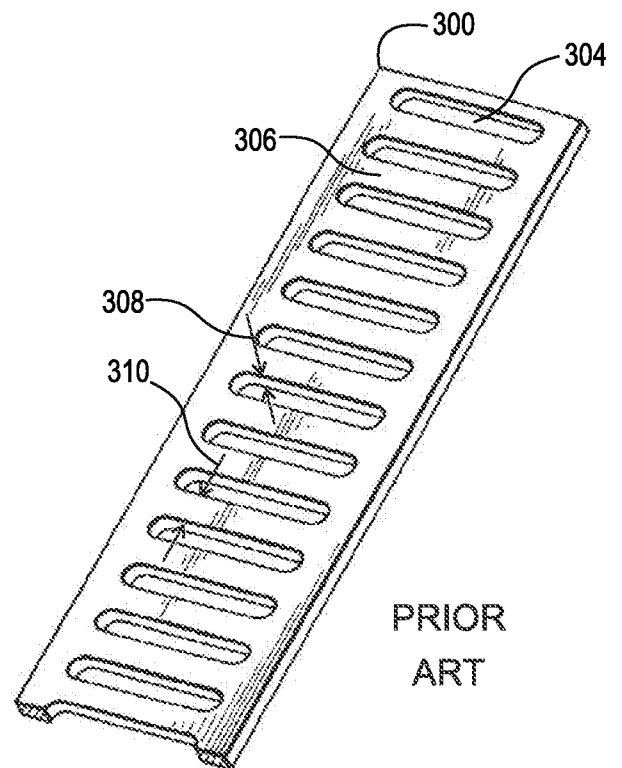


Fig. 20

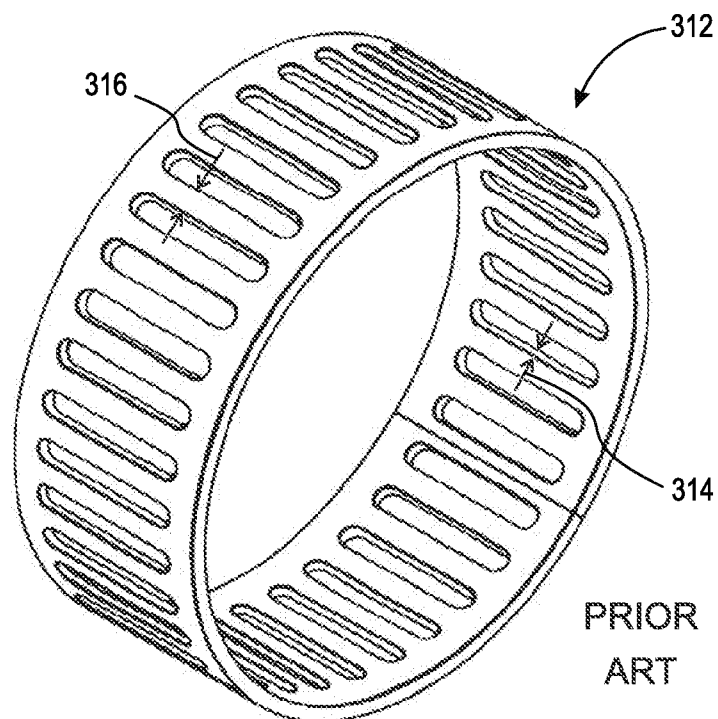


Fig. 21