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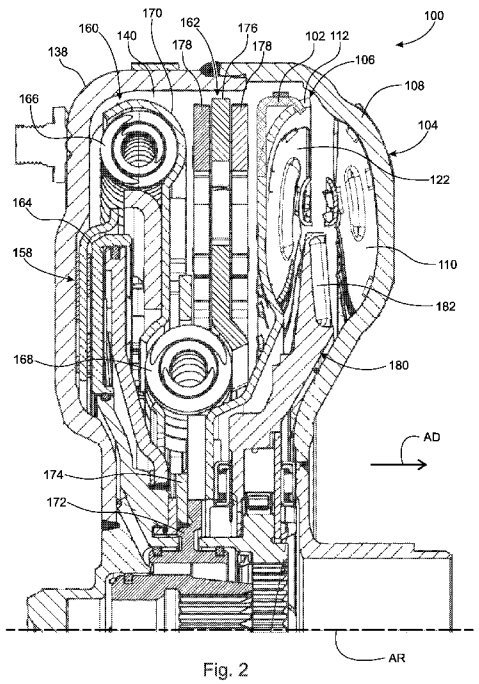


Fig. 2

(57) Abstract: A torque converter, including: an impeller arranged to receive torque and including an impeller shell and at least one impeller blade fixed to the impeller shell; and a turbine including a turbine shell including a slot with an open end circumferentially located between first and second radially outermost portions of the turbine shell and at least one turbine blade fixed to the turbine shell; and an inertia ring fixed to the turbine shell and including a tab with a segment located in the slot.

WO 2018/097914 A1

TORQUE CONVERTER WITH A FINGER-TABBED BRAZED INERTIA RING

TECHNICAL FIELD

[0001] The present disclosure relates to a torque converter with an inertia ring, in particular, an inertia ring fixed to the turbine shell by tabs in slots in a radially outer portion of the turbine shell and by fingers in openings in the turbine shell radially inward of the slots.

BACKGROUND

[0002] An inertia ring is desired on the turbine of a torque converter to improve efficiency and certain noise, vibration and harshness (NVH) characteristics. A durable attachment method is necessary, and brazing is preferred in conjunction with current turbine blade assembly methodology. An inner surface of the turbine, turbine blades and a core ring face up during brazing operations securing the turbine blades to the inner surface and securing the core ring to the turbine blades. Holding the inertia ring in place against an outer surface of the turbine shell (facing downwards) while the inner surface faces up is essential for a durable attachment. Multiple fixtures on a brazing furnace belt could be used to hold the inertia ring in place; however, many problems and considerable costs would be associated with the use of multiple fixtures.

[0003] For U.S. Patent No. 4,844,216 A, a mass is connected to a damper, not to a turbine. Therefore, the mass provides a damper inertia, not a direct inertia. U.S. Patent No. 5,195,621 welds an inertial mass to a turbine shell. However, welding weakens brazed turbine blade joints and reduces turbine blade durability. Further, the mass is relatively large and the large size of the mass results in a slower take-off. U.S. Patent No. 6,648,112 uses welding to attach an inertial mass to a turbine shell for a torque converter to increase inertia of the turbine. However, welding weakens brazed turbine blade joints and reduces turbine blade durability. Further, the mass is relatively large, which results in a slower take-off. U.S. Patent No. 6,789,446 B2 uses welding to attach a ring gear to a cover for a torque converter to increase inertia of the cover. As a result, inertia from the ring gear acts in different modes than a ring on only the turbine. U.S. Patent No. 8,763,775 adds mass to the intermediate mass in the damper and not to turbine (which would add mass to the transmission input shaft). Thus, the mass

provides a different mode for NVH and efficiency. U.S. Patent Application Publication No. 2004/0226794 adds mass (inertia) to the intermediate mass in the damper and not to the turbine (which would add mass directly to the transmission input shaft). Thus, the mass provides a different mode for NVH and efficiency.

SUMMARY

[0004] According to aspects illustrated herein, there is provided a torque converter, including: an impeller arranged to receive torque and including an impeller shell and at least one impeller blade fixed to the impeller shell; a turbine including a turbine shell including a slot with an open end circumferentially located between first and second radially outermost portions of the turbine shell, and at least one turbine blade fixed to the turbine shell; and an inertia ring fixed to the turbine shell and including a tab with a segment located in the slot.

[0005] According to aspects illustrated herein, there is provided a torque converter, including: a cover arranged to receive torque; an impeller including an impeller shell non-rotatably connected to the cover and at least one impeller blade fixed to the impeller shell; a turbine including a turbine shell and an inertia ring. The turbine shell includes: an outer surface; an inner surface; an opening connecting the inner and outer surfaces of the turbine shell; and at least one turbine blade fixed to the inner surface of the turbine shell. The inertia ring is fixed to the outer surface of the turbine shell and includes a finger with a radially innermost surface of the inertia ring, and a segment located in the opening.

[0006] According to aspects illustrated herein, there is provided a torque converter, including: a cover arranged to receive torque; an impeller including an impeller shell non-rotatably connected to the cover and at least one impeller blade fixed to the impeller shell; a turbine; and an inertia ring. The turbine includes: a turbine shell including an inner surface and an outer surface, at least one turbine blade connected to the inner surface, a slot, and an opening connecting the inner and outer surfaces and located radially inward of the slot. The includes: a tab with a segment located in the slot; and a finger including a radially innermost surface of the inertia ring and with a segment located in the opening.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] 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:

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

Figure 2 is a partial cross-sectional view of an example embodiment of a torque converter with a finger-tabbed brazed inertia ring;

Figure 3 is a detail of a portion of Figure 2, showing the impeller and turbine of Figure 2;

Figure 4 is a partial front view of the inertia ring and turbine shell in Figure 2;

Figure 5 is a partial plan view detail of the inertia ring and turbine shell in Figure 2;

Figure 6 is a partial cross-sectional view of an example embodiment of a torque converter with a finger-tabbed brazed inertia ring;

Figure 7 is a detail of a portion of Figure 6, showing the impeller and turbine of Figure 6;

Figure 8 is a partial front view of the inertia ring and turbine shell in Figure 6; and,

Figure 9 is a partial plan view detail of the inertia ring and turbine shell in Figure 6.

DETAILED DESCRIPTION

[0008] 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.

[0009] 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 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.

[0010] 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 equivalent to those described herein can be used in the practice or testing of the disclosure.

[0011] 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**.

[0012] 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**.

[0013] Figure 2 is a partial cross-sectional view of an example embodiment of torque converter **100** with finger-tabbed brazed inertia ring **102**

[0014] Figure 3 is a detail of a portion of Figure 2, showing the impeller and turbine of Figure 2.

[0015] Figure 4 is a partial front view of inertia ring **102** and the turbine shell in Figure 2.

[0016] Figure 5 is a partial plan view detail of inertia ring **102** and the turbine shell in Figure 2. The following should be viewed in light of Figures 2 through 5. Torque converter **100** includes axis of rotation **AR**, ring **102**, impeller **104**, and turbine **106**. Impeller **104** is arranged to

receive torque and includes impeller shell **108** and at least one impeller blade **110** fixed to impeller shell **108**, for example by brazing. Turbine **106** includes turbine shell **112** including slot **114** with open end **116** circumferentially located between radially outermost portions **118** and **120** of turbine shell **112**. Turbine **106** includes at least one turbine blade **122** fixed to turbine shell **112** by brazing. Inertia ring **102** is fixed to turbine shell **112** and includes tab **124** with segment **126** located in slot **114**.

[0017] Turbine shell **112** includes inner surface **128** and outer surface **130**. In an example embodiment, turbine blade **122** is in contact with inner surface **128** and inertia ring **102** is in contact with outer surface **130**. In an example embodiment, portions **118** and **120** include radially outermost edges **132** and **134**, respectively, of shell **112**, and open end **116** is circumferentially disposed between edges **132** and **134**.

[0018] Inertia ring **102** includes body **136**. In an example embodiment, body **136** is L shaped in a radial cross-section. For example, body **136** is L shaped in Figures 2 and 3. Tab **124** extends from body **136** in direction **AD** and then bends radially inward along direction **AD**. Line **CL**, in circumferential direction **CD**, pass through in sequence, portion **118**, segment **126**, and portion **120**.

[0019] Torque converter **100** includes: cover **138** arranged to receive torque and non-rotatably connected to impeller shell **108**; and space **140** formed in part by cover **138**, shell **108** and shell **112**. Inertia ring **102** is disposed in space **140**.

[0020] In an example embodiment, tab **124** includes notch **142** connecting body **136** with segment **126** of tab **124**. Notch **142** is in contact with turbine shell **112**. Segment **126** extends past notch **142** toward the impeller shell, for example in direction **AD**, and radially inward from notch **142**.

[0021] Torque converter **100** includes space **144** bounded in part by impeller shell **108** turbine shell **112**. Space **144** does not extend radially outward of turbine shell **112**. Blades **110** and **122** are located in space **144**. Tab **124**, for example segment **126**, forms a portion of a boundary for space **144**. That is, tab **124** is in communication with space **144**.

[0022] Turbine shell **112** includes opening **146** connecting surfaces **128** and **130** of turbine shell **112**, and wholly surrounded by material forming shell **112**. Inertia ring **102** includes finger **148** with segment **150** located in opening **146**. Finger **148** extends radially inward from

body **136**. Segment **150** includes surface **152**. In an example embodiment, surface **152** is a radially innermost surface of inertia ring **102**.

[0023] In an example embodiment, torque converter **100** includes brazing material **154** in contact with finger **148** and shell **112** and fixing finger **148** (and ring **102**) to shell **112**. In an example embodiment, finger **148** forms a portion of the boundary for space **144**. That is, finger **148**, for example segment **150**, is in communication with space **144**. In the example embodiment of Figures 2 through 5, end **155** of segment **126** extends into space **144**.

[0024] In an example embodiment, space **156** is formed between ring **102** and turbine shell **112**, for example, between body **136** and surface **130**.

[0025] In an example embodiment, torque converter **100** includes lockup clutch **158**, torsional vibration damper **160**, and pendulum vibration absorber **162**. Clutch **158** includes axially displaceable piston **164**. Damper **160** includes at least one spring **166** and at least one spring **168**, located radially inward of spring **166**. Clutch **158**, when closed, is arranged to transmit torque from cover **138** to damper **160**, in particular springs **166**, in a lockup mode for torque converter **100**. Cover plate **170** is arranged to transmit torque from spring **166** to spring **168** and spring **168** is arranged to transmit torque to output hub **172** via flange **174**. Hub **172** is arranged to connect to an input shaft (not shown) for a transmission (not shown). Turbine shell **112** is non-rotatably connected to hub **172**. By "non-rotatably connected" components, we mean that whenever one of the components rotates all of the components rotate, that is, none of the components is rotatable with respect to any of the other components. Absorber **162** includes flange **176** non-rotatably connected to flange **174** and includes pendulum masses **178** connected to flange **176**.

[0026] Torque converter **100** includes stator **180** with blades **182** disposed between impeller **104** and turbine **106**.

[0027] In the example embodiment of Figures 2 through 5, turbine shell **112** includes a plurality of openings **146**, and ring **102** includes a plurality of fingers **148**. Torque converter **100** is not limited to any particular number of openings **146** or fingers **148**. In an example embodiment (not shown), shell **112** includes multiple slots **114** and ring **102** includes multiple tabs **124**.

[0028] Figure 6 is a partial cross-sectional view of an example embodiment of torque converter **100** with finger-tabbed brazed inertia ring **102**.

[0029] Figure 7 is a detail of a portion of Figure 6, showing the impeller and turbine of Figure 6.

[0030] Figure 8 is a partial front view of inertia ring **102** and the turbine shell in Figure 6.

[0031] Figure 9 is a partial plan view detail of inertia ring **102** and the turbine shell in Figure 6. The following should be viewed in light of Figures 2 through 9. The discussion for and description of torque converter **100** in Figures 2 through 5 is applicable to torque converter **100** in Figures 5 through 7 except as noted in the following discussion and description. Segment **126** does not extend into space **144** and portion **185** of body **136** is radially outward of turbine **106**. In the example embodiment of Figures 6 through 9, length **186** of finger **148** is larger than in the example embodiment of Figures 2 through 5 and thus finger 148 in Figures 6 through 9 generates more inertia than finger 148 in Figures 2 through 5.

[0032] The following discussion is applicable to Figures 2 through 9. A durable attachment method is necessary for attaching an inertia ring to a turbine, and brazing is preferred in conjunction with the current turbine blade assembly methodology. Advantageously, the configuration of ring **102** and shell **112** enables ring **102** to be brazed to turbine shell **112** without the use of multiple fixtures or other costly modifications to existing methods of brazing turbine blades to a turbine shell. For example, tab **124** is inserted in slot **114** and segment **126** is bent radially inward. In the example embodiment of Figures 2 through 5, notch **142** contacts edge **188** of shell **112** and tab **124** wraps partially about surfaces **130** and **190** of shell **112**. Finger **148** is inserted in opening **146**. In the example embodiment of Figures 6 through 9, surface **192** of tab **124** contacts surface **190**. Finger **148** is inserted in opening **146**.

[0033] As noted above, turbine **106** is then tipped so that inner surface **128**, turbine blade **122** and core ring **192** face up for brazing operations to secure turbine blade **122** to inner surface **128** and to secure core ring **192** to turbine blade **122**. In the tipped position, tab **124** holds inertia ring **102** in place against outer surface **130** (facing downwards) while inner surface **128** faces up. In the example embodiment of Figures 2 through 5, the interface of notch **142**, edge **188** and surface **190** provides a large part of the force holding ring **102** in place during brazing operations. In the example embodiment of Figures 6 through 6, the interface of surfaces **190** and

192 provides a large part of the force holding ring **102** in place during brazing operations. Holding ring **102** in place ensures a durable attachment of ring **102** to shell **112**. Brazing material **154** flows into opening **146** to secure ring **102** to turbine **106**.

[0034] 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 are also intended to be encompassed by the following claims.

List of Reference Characters

100	**torque converter**
102	**finger-tabbed brazed inertia ring**
AR	**axis of rotation**
102	**ring**
104	**impeller**
106	**turbin**
108	**impeller shell**
110	**impeller blade**
112	**turbine shell**
114	**slot**
116	**open end**
118	**radially outermost portion of turbine shell**
120	**radially outermost portion of turbine shell**
122	**turbine blade**
124	**tab**
126	**segment**
128	**inner surface of turbine shell**
130	**outer surface of turbine shell**
132	**radially outermost edge of surface 128**
134	**radially outermost edge of surface 130**
136	**body**
AD	**axial direction**
CL	**line**
CD	**circumferential direction**
138	**cover**
140	**space**
42	**notch**
144	**space**
146	**opening**

List of Reference Characters Continued (P160789-00US):

148	**finger**
150	**segment of finger**
152	**surface of finger segment**
154	**brazing material**
155	**end of segment 126**
156	**space**
158	**lock-up clutch**
160	**torsional vibration damper**
162	**pendulum vibration absorber**
164	**pendulum vibration absorber**
166	**spring**
168	**spring**
170	**cover plate**
172	**output hub**
174	**flange**
176	**flange**
178	**pendulum masses**
180	**stator**
182	**stator blades**
184	**portion of body 136**
186	**length of finger 148 i**
188	**edge of shell 122**
190	**surface of shell 122**
192	**surface of tab 124**

CLAIMS

1. A torque converter, comprising:

an axis of rotation;

an impeller arranged to receive torque and including an impeller shell and at least one impeller blade fixed to the impeller shell;

a turbine including:

a turbine shell including a slot with an open end circumferentially located between first and second radially outermost portions of the turbine shell; and,

at least one turbine blade fixed to the turbine shell; and,

an inertia ring fixed to the turbine shell and including a tab with a segment located in the slot.

2. The torque converter of claim 1, wherein:

the inertia ring includes an L shaped body in a radial cross-section; and,

the tab extends from the L shaped body:

toward the impeller shell in an axial direction; and,

radially inward.

3. The torque converter of claim 1, wherein a line in a circumferential direction passes through, in sequence:

the first radially outermost portion of the turbine shell;

the tab; and,

the second radially outermost portion of the turbine shell.

4. The torque converter of claim 1, further comprising:

a cover arranged to receive torque and non-rotatably connected to the impeller shell; and,

a space bounded in part by the cover, the impeller shell and the turbine shell, wherein the inertia ring is disposed in the space.

5. The torque converter of claim 1, wherein:

the inertia ring includes an L shaped body in a radial cross-section;

the tab extends from the L shaped body:

toward the impeller shell in an axial direction; and,

radially inward; and,

the tab includes a notch:

connecting the L shaped body and the segment of the tab; and,

in contact with the turbine shell.

6. The torque converter of claim 5, wherein the segment of the tab extends:

past the notch toward the impeller shell; and,

radially inward from the notch.

7. The torque converter of claim 1, further comprising:

a space bounded in part by the impeller shell and the turbine shell, wherein:

the space does not extend radially outward of the turbine shell;

the at least one impeller blade and the at least one turbine blade are located in the space; and,

the tab forms a portion of a boundary for the space.

8. The torque converter of claim 1, wherein:

the turbine shell includes an inner surface and an outer surface;

the at least one turbine blade is fixed to the inner surface of the turbine shell;

the turbine shell includes an opening connecting the inner and outer surfaces of the turbine shell; and,

the inertia ring includes a finger with a segment located in the opening.

9. The torque converter of claim 8, wherein:

the finger includes a radially innermost surface of the inertia ring;

the inertia ring includes an L shaped body in a cross-section formed by a plane parallel to the axis of rotation and passing through the axis of rotation; and,

the finger extends radially inward from the L shaped body.

10. The torque converter of claim 1, wherein:

the inertia ring includes an L shaped body in a radial cross-section; and,

a portion of the L shaped body is located radially outward of the turbine shell.

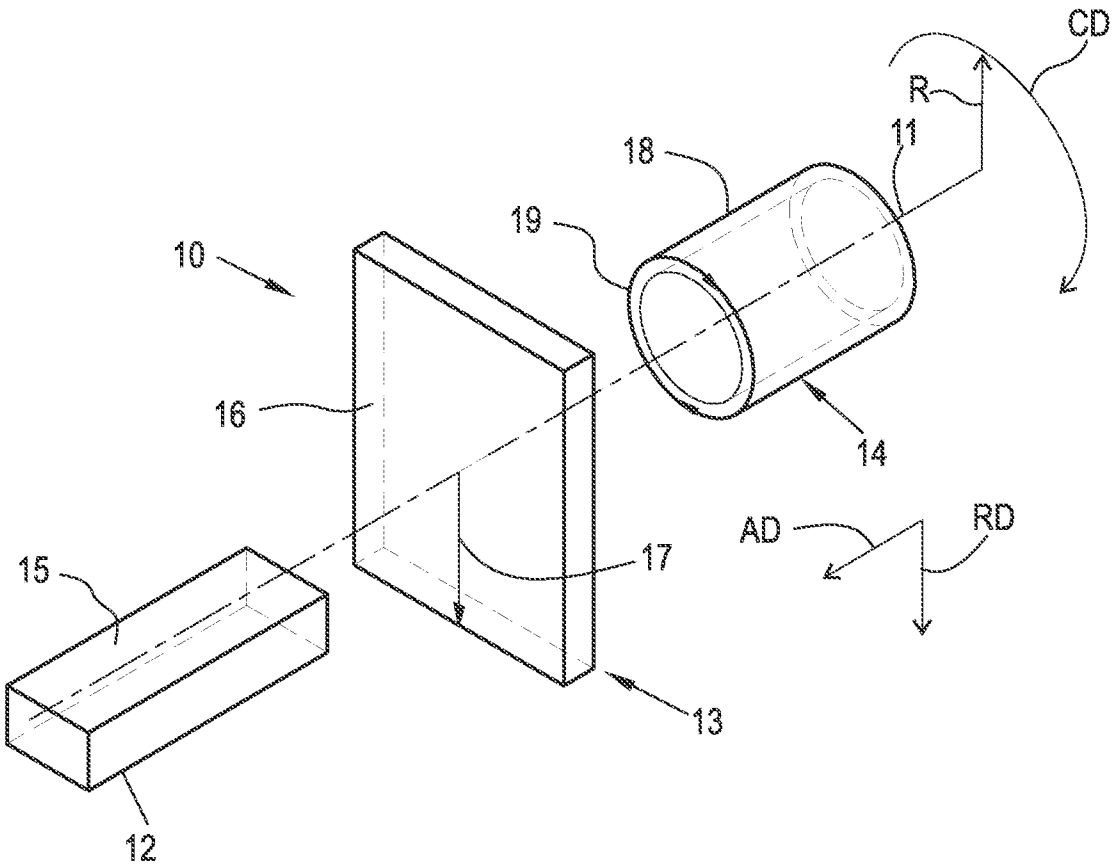


Fig. 1

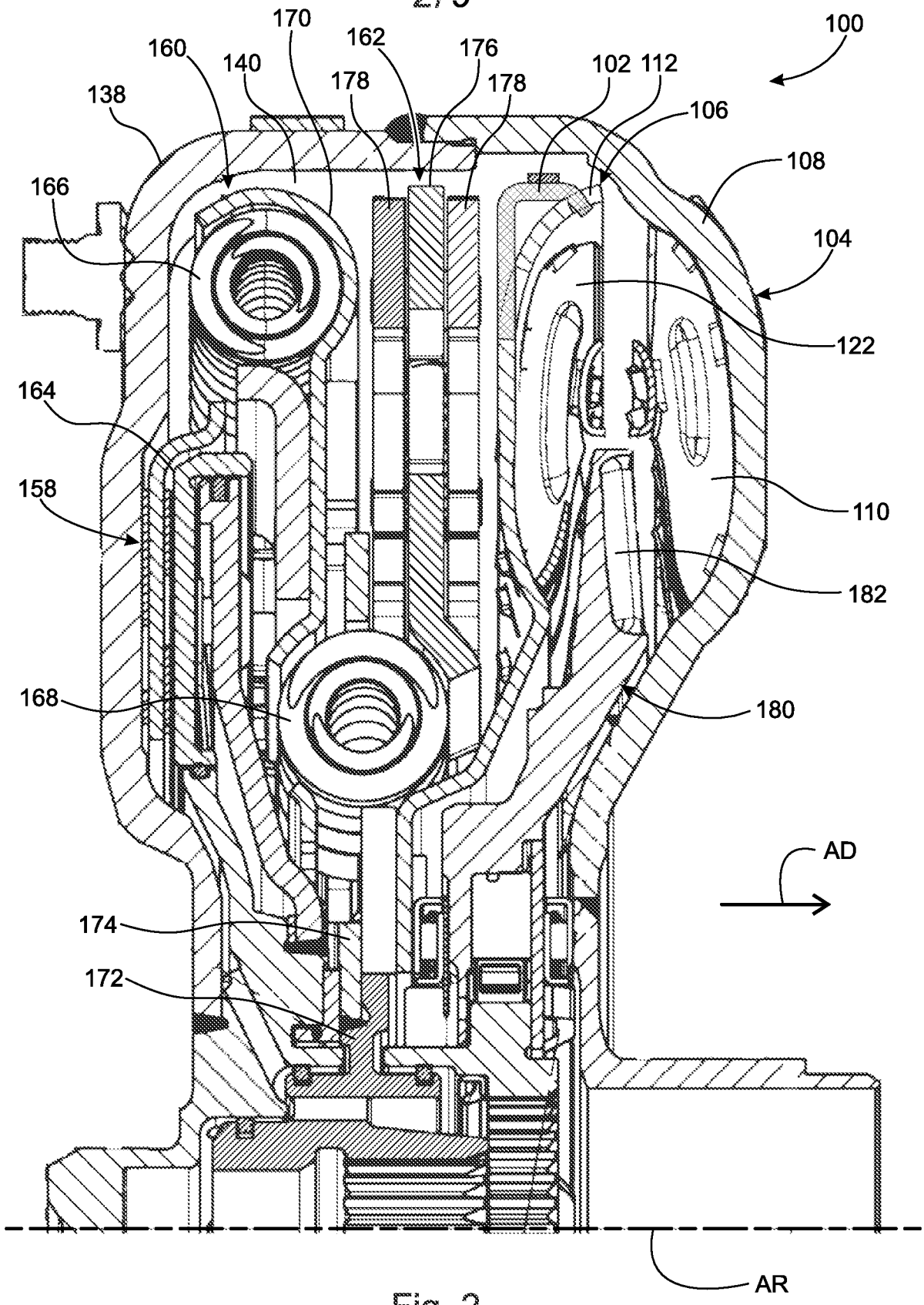

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Fig. 2

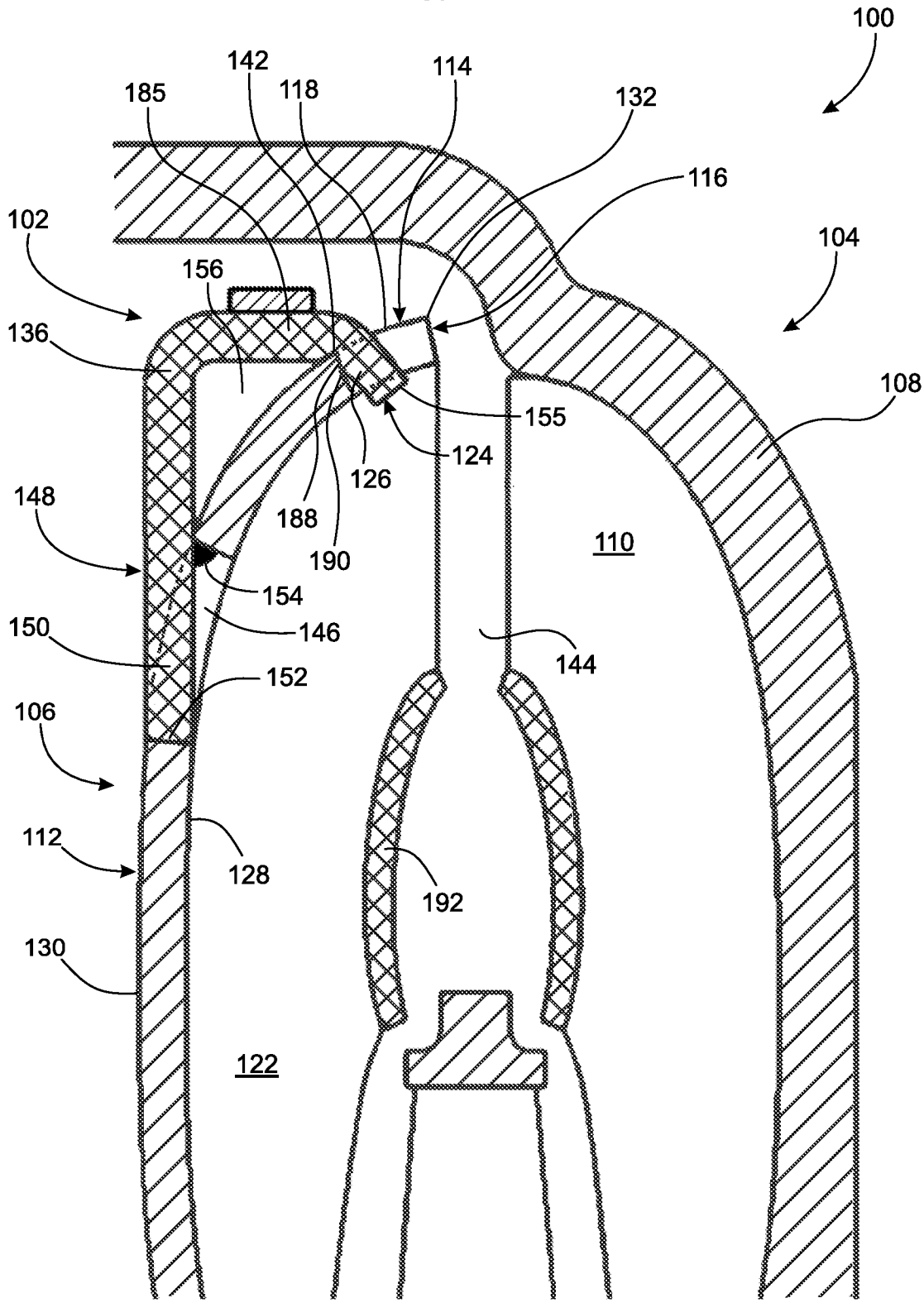

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Fig. 3

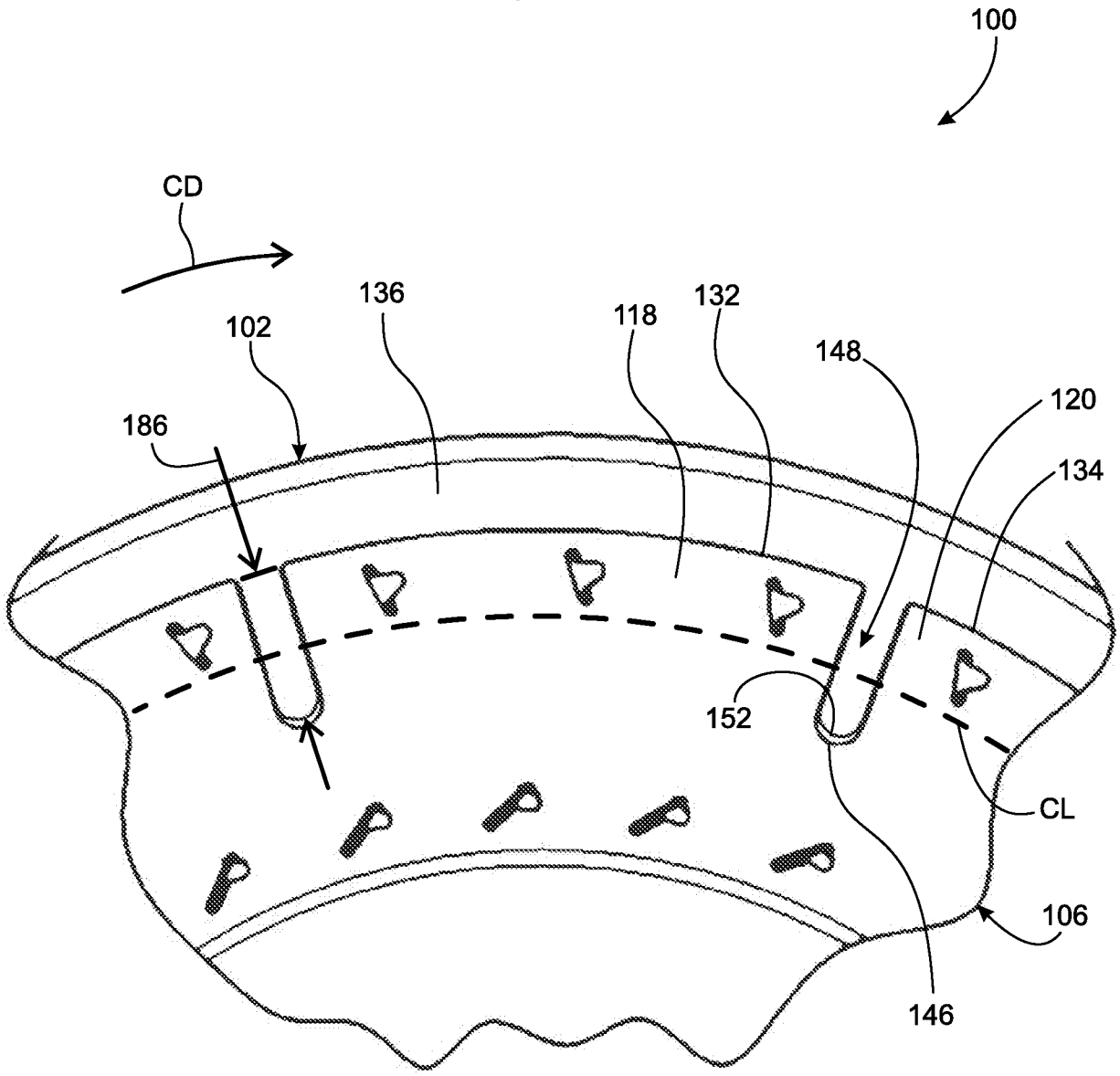


Fig. 4

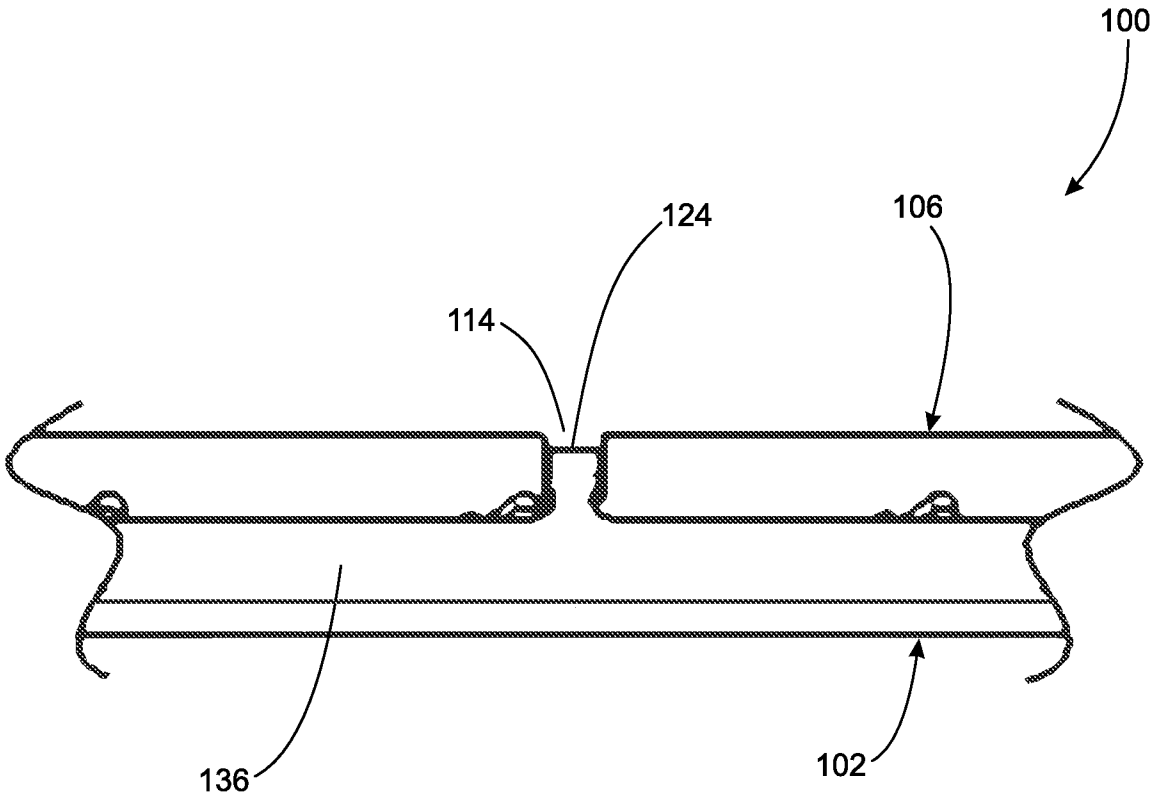


Fig.5

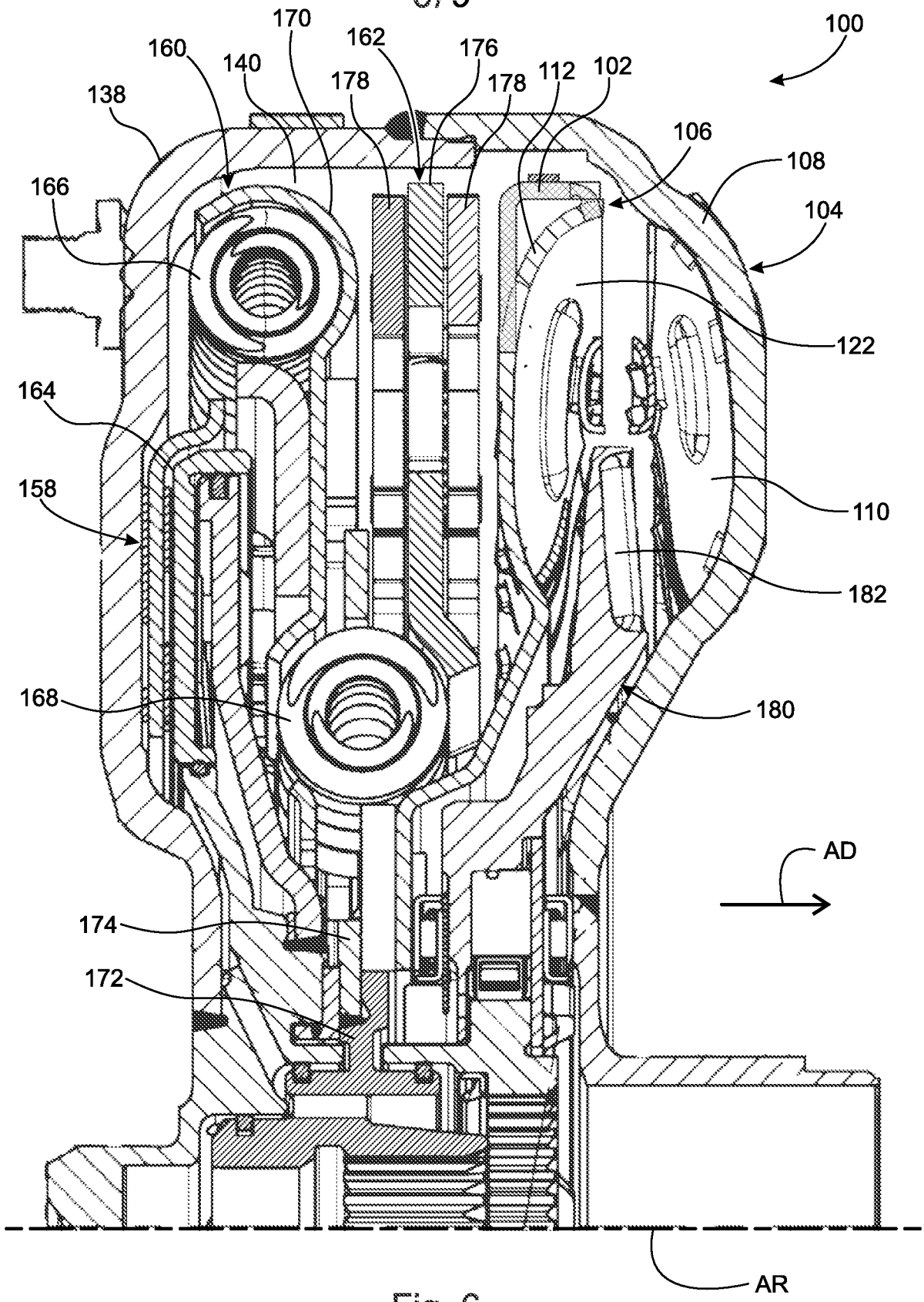

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Fig. 6

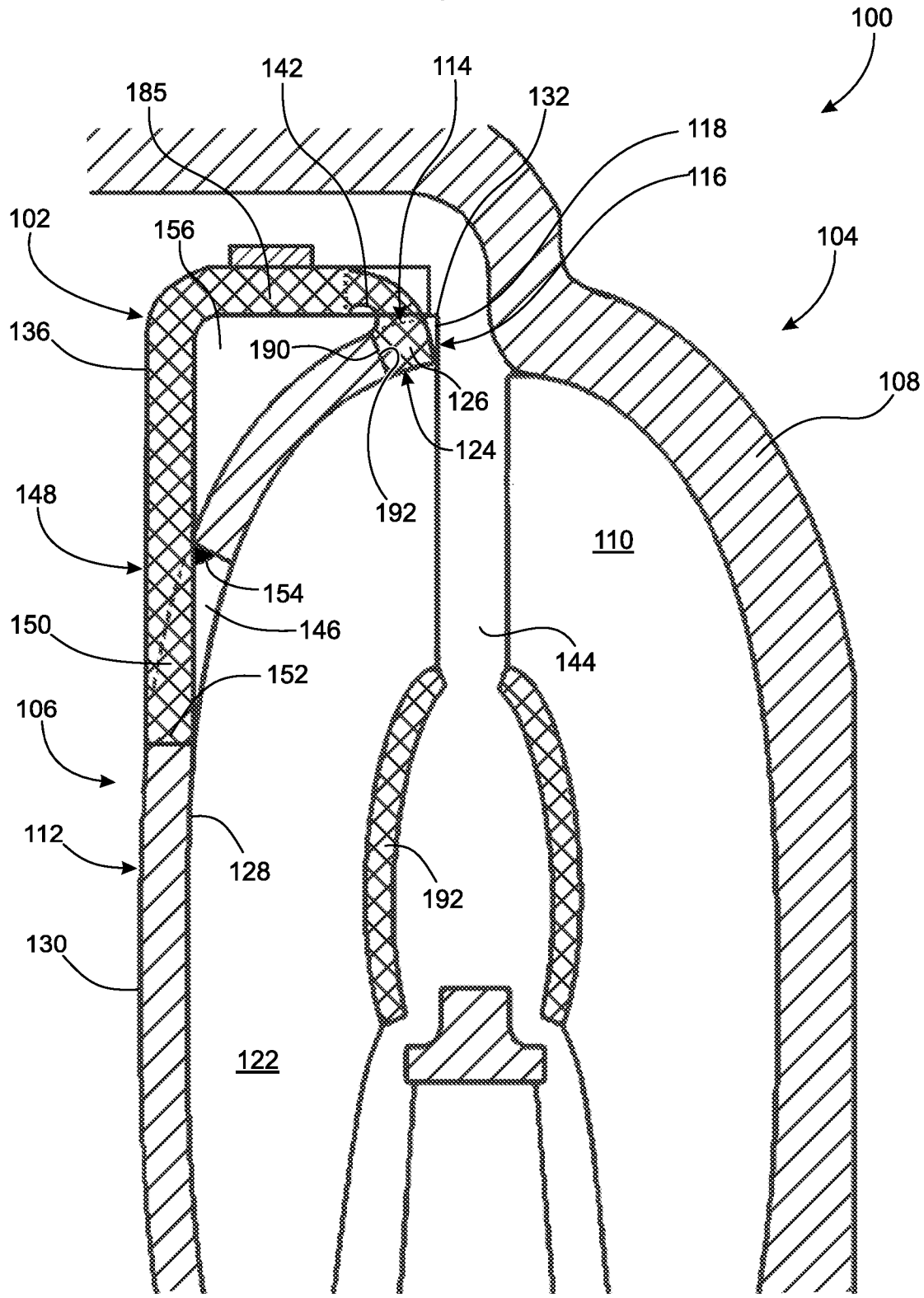

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Fig. 7

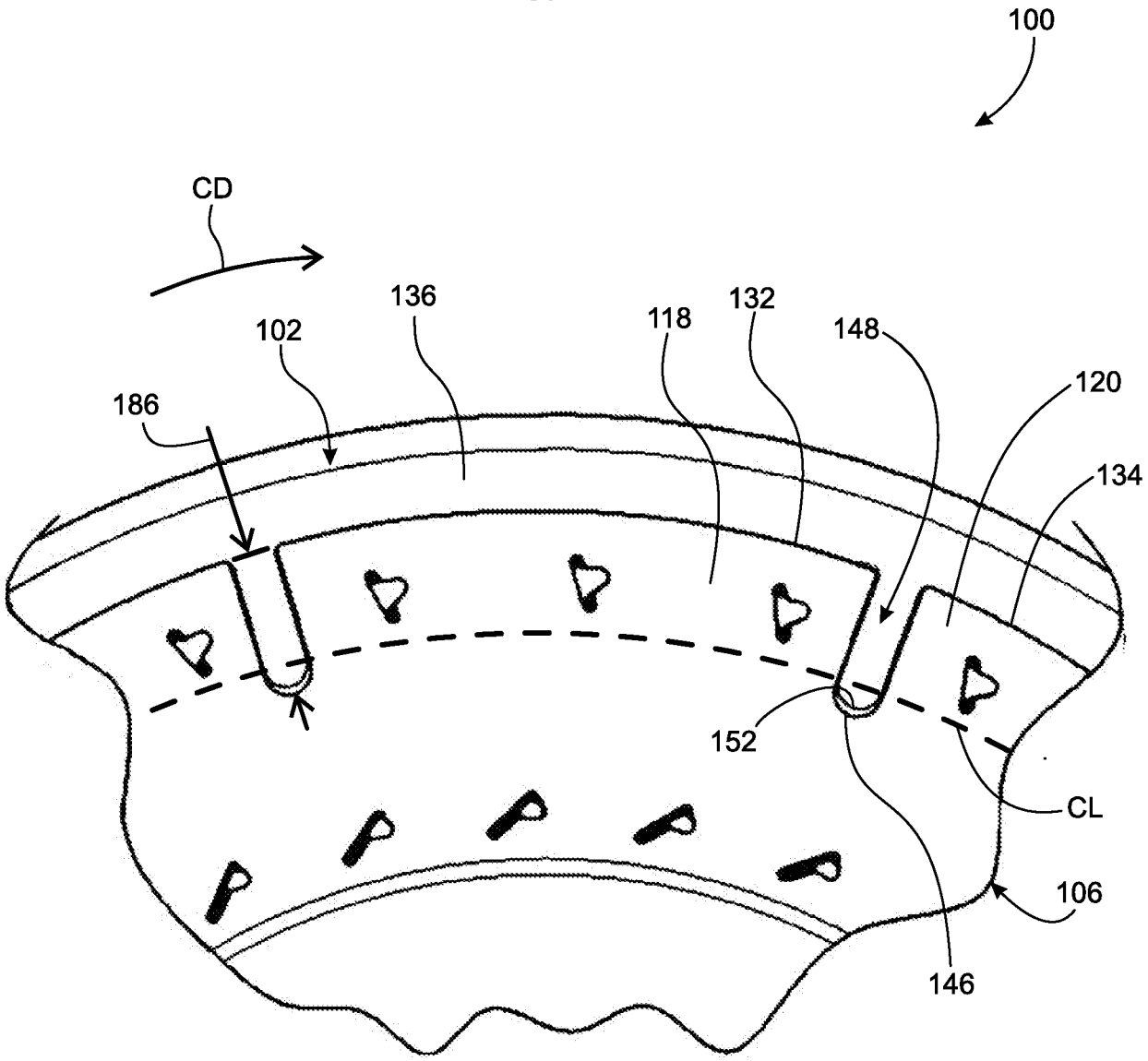


Fig.8

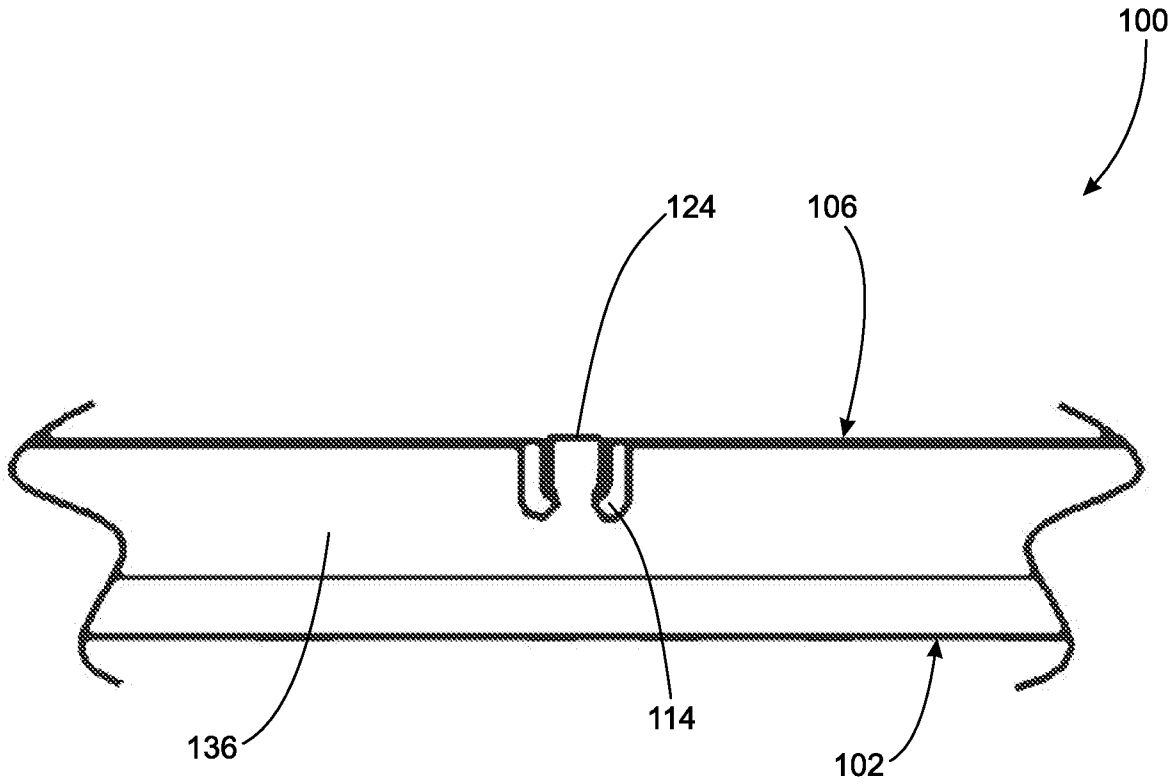


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/057639

A. CLASSIFICATION OF SUBJECT MATTER

F16H 41/24(2006.01)i, F16F 15/22(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H 41/24; F16D 33/00; F16H 45/02; F16H 41/28; F16F 15/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:
torque converter, impeller, turbine, inertia ring, tab, slot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3275108 A (GENERAL et al.) 27 September 1966 See column 1, line 10 - column 4, line 75; claim 1; and figures 1-3.	1,3-4,7
Y		2,5-6,10
A		8-9
Y	US 5195621 A (DULL et al.) 23 March 1993 See column 1, line 6 - column 5, line 25; and figure 1.	2,5-6,10
A	US 2014-0021000 A1 (SCHAEFFLER TECHNOLOGIES AG & CO. KG) 23 January 2014 See paragraphs [0001]-[0042]; and figures 2-12.	1-10
A	US 2008-0149440 A1 (STURGIN, TODD) 26 June 2008 See paragraphs [0002]-[0073]; and figures 1-6, 8-12.	1-10
A	EP 0997666 A2 (KUBOTA IRON WORKS CO., LTD. et al.) 03 May 2000 See paragraphs [0001]-[0063]; and figures 1-3, 4A-4H, 5-6, 8, 10.	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 January 2018 (19.01.2018)	**22 January 2018 (22.01.2018)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2017/057639

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3275108 A	27/09/1966	None	
US 5195621 A	23/03/1993	EP 0571008 A2	24/11/1993
US 2014-0021000 A1	23/01/2014	US 9625023 B2	18/04/2017
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