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(54) Title: ONE-WAY CLUTCH WITH CONICAL STRUT

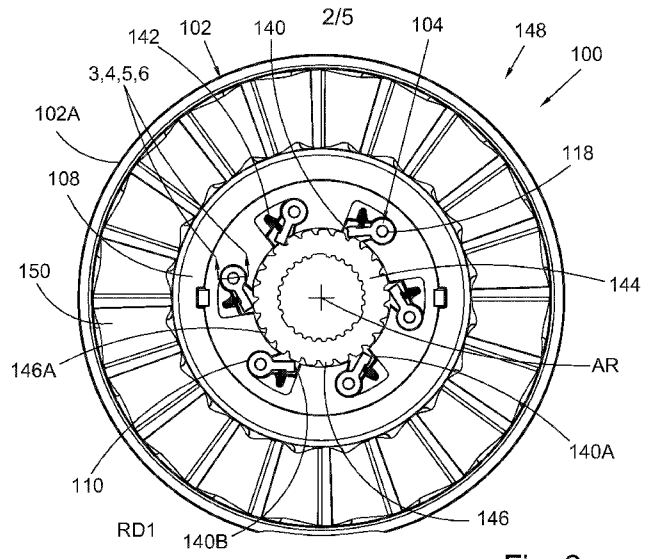


Fig. 2

(57) Abstract: A one-way clutch, including: a housing including a top side and a plurality of indentations in the housing, each indentation including: a respective opening in a portion of the top side; a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the one-way clutch; and a respective side wall. The respective side wall: connects the respective opening and bottom wall and tapers inward from the respective opening to the respective bottom wall. The clutch includes a plurality of struts, each strut including a first segment disposed in a respective indentation and including a respective side surface substantially parallel to the respective side wall. Each strut is pivotable in the respective indentation to enable rotation of the housing in a first rotational direction and to block rotation of the housing in a second rotational direction, opposite the first rotational direction.

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ONE-WAY CLUTCH WITH CONICAL STRUT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 61/818,614, filed May 2, 2013, which application is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a one-way clutch with conical struts, in particular, a one-way clutch for a stator for a torque converter including matingly configured conical struts and indentations for the struts in a housing. The present disclosure also relates to protrusions on the struts, the indentations, or a side plate to minimize drag associated with rotation of the struts in the indentations.

BACKGROUND

[0003] Figure 9 is a plan view of known stator **200** for a torque converter with a side plate removed.

[0004] Figure 10 is a cross-sectional view generally along line 10-10 in Figure 9. The following should be viewed in light of Figures 9 and 10. Stator **200** includes housing **202** with struts **204** in indentations **206**. For rotation of the housing in direction **RD2**, struts **204** engage stator shaft **208** to block further rotation of the housing in direction **RD2**. For rotation of the housing in direction **RD1**, struts **204** slide over the stator shaft, without locking onto the stator shaft, to enable rotation of the housing in direction **RD2**.

[0005] As seen in Figure 10, struts **204** include respective vertical side surfaces **210** and indentations **206** include respective vertical side walls **212**. Both surfaces **210** and walls **212** are parallel to one another and to axis of rotation **R** for the stator. To attain the parallel configuration of walls **212**, an extra step must be performed after the housing is cast. Specifically, the walls must be machined, after the housing is cast, to remove a conical shape of walls **212** necessitated by the casting process (draft angle). The machining step increases the cost, complexity, and time associated with fabrication of housing **202**.

SUMMARY

[0006] According to aspects illustrated herein, there is provided a one-way clutch, including: a housing including a top side and a plurality of indentations in the housing, each indentation including: a respective opening in a portion of the top side; a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the one-way clutch; and a respective side wall. The respective side wall: connects the respective opening and the respective bottom wall and tapers inward from the respective opening to the respective bottom wall. The clutch includes a plurality of struts, each strut including a first segment disposed in a respective indentation and including a respective side surface substantially parallel to the respective side wall. Each strut is pivotable in the respective indentation to enable rotation of the housing in a first rotational direction and to block rotation of the housing in a second rotational direction, opposite the first rotational direction.

[0007] According to aspects illustrated herein, there is provided a stator for a torque converter, including: a housing including a top side and a one-way clutch including: a plurality of indentations in the housing, each indentation including a respective opening in a portion of the top side, a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the stator, and a respective side wall. Each side wall connects the respective opening and the respective bottom wall and tapers inward from the respective opening to the respective bottom wall. The stator includes plurality of struts, each strut including a first segment disposed in a respective indentation and including a respective side surface substantially parallel to the respective side wall. Each strut is pivotable in the respective indentation to enable rotation of the housing in a first rotational direction and to block rotation of the housing in a second rotational direction, opposite the first rotational direction.

[0008] According to aspects illustrated herein, there is provided a one-way clutch, including: a housing including a top side; a side plate including a bottom side engaged with the top side; and a plurality of indentations in the housing, each indentation including a respective opening in the top side, a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the one-way clutch, and a respective side wall. The side wall connects the respective opening and the respective bottom wall and tapers inward from the respective opening to the respective bottom wall. The clutch includes a plurality of struts,

each strut including a respective first segment disposed in a respective indentation, the respective first segment including a respective side surface substantially parallel to the respective side wall a respective top surface facing the respective opening, and a respective bottom surface facing the respective bottom wall. The bottom side of the side plate covers the plurality of indentations. The side plate includes a plurality of protrusions, each protrusion aligned, in the axial direction, with a respective strut in a respective indentation and extending toward the respective strut in the respective indentation, or each strut includes a respective protrusion extending from the respective top surface toward the side plate; or, the respective bottom surface for said each strut includes a respective protrusion extending toward the respective bottom wall of a respective indentation, or the respective bottom wall for said each indentation includes a respective protrusion extending toward the respective bottom surface of a respective strut.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] 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 1A is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

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

Figure 2 is plan view of a one-way clutch with conical struts and with a side plate removed;

Figure 3 is a partial cross-sectional view generally along line 3-3 in Figure 2, with a side plate included;

Figure 4 is a partial cross-sectional view generally along line 4-4 in Figure 2, with a side plate included;

Figure 5 is a partial cross-sectional view generally along line 5-5 in Figure 2, with a side plate included;

Figure 6 is a partial cross-sectional view generally along line 6-6 in Figure 2, with a side plate included;

Figure 7 is a perspective view of the strut in Figures 3 and 5;

Figure 8 is a side view of the strut in Figure 7;

Figure 9 is a plan view of a known stator for a torque converter with a side plate removed; and,

Figure 10 is a cross-sectional view generally along line 10-10 in Figure 9.

DETAILED DESCRIPTION

[0010] 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.

[0011] 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.

[0012] 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.

[0013] Figure 1A is a perspective view of cylindrical coordinate system **80** demonstrating spatial terminology used in the present application. The present disclosure is at least partially cast within the context of a cylindrical coordinate system. System **80** has a longitudinal axis **81**, used as the reference for the directional and spatial terms that follow. The adjectives "axial," "radial," and "circumferential" are with respect to an orientation parallel to axis **81**, radius **82** (which is orthogonal to axis **81**), and circumference **83**, respectively. The adjectives "axial," "radial" and "circumferential" also are regarding orientation parallel to respective planes. To clarify the disposition of the various planes, objects **84**, **85**, and **86** are used. Surface **87** of object **84** forms an axial plane. That is, axis **81** forms a line along the surface. Surface **88** of object **85** forms a radial plane. That is, radius **82** forms a line along the surface. Surface **89** of object **86** forms a circumferential plane. That is, circumference **83** forms a line along the surface. As a further example, axial movement or disposition is parallel to axis **81**, radial movement or disposition is parallel to radius **82**, and circumferential movement or disposition is parallel to circumference **83**. Rotation is with respect to axis **81**.

[0014] The adverbs "axially," "radially," and "circumferentially" are with respect to an orientation parallel to axis **81**, radius **82**, or circumference **83**, respectively. The adverbs "axially," "radially," and "circumferentially" also are regarding orientation parallel to respective planes.

[0015] Figure 1B is a perspective view of object **90** in cylindrical coordinate system **80** of Figure 1A demonstrating spatial terminology used in the present application. Cylindrical object **90** is representative of a cylindrical object in a cylindrical coordinate system and is not intended to limit the present invention in any manner. Object **90** includes axial surface **91**, radial surface **92**, and circumferential surface **93**. Surface **91** is part of an axial plane, surface **92** is part of a radial plane, and surface **93** is a circumferential surface.

[0016] Figure 2 is plan view of one-way clutch **100** with conical struts and with a side plate removed.

[0017] Figure 3 is a partial cross-sectional view generally along line 3-3 in Figure 2, with a side plate included. The following should be viewed in light of Figures 2 and 3. One-way clutch **100** includes housing **102** and struts **104**. Housing **102** includes top side **106** including portion **108** substantially orthogonal to axis of rotation **AR** for the stator. Clutch **100** includes indentations **110** in portion **108**. Each indentation includes opening **112** in portion **108**, bottom wall **114** opposite opening **112** in axial direction **AD1** parallel to axis of rotation **AR**, and respective side wall **116**. Side wall **116** connects opening **112** and the respective bottom wall **114**, tapers inwardly, that is, in a cone shape, from opening **112** to bottom wall **114**. For example, diameter **D** of side wall **116** (with respect to axis **A** parallel to axis **AR**) diminishes as the point of measurement for **D** moves in direction **AD1**. In a cross-section orthogonal to axis **A**, for example the configuration shown in Figure 2, side wall **116** forms a portion of a circle.

[0018] Each strut **104** includes segment **118** disposed in a respective indentation **110**. Segment **118** includes side surface **120** substantially parallel to side wall **116**. That is, surface **120** has a taper paralleling the taper of side wall **116**. In a cross-section orthogonal to axis **A**, for example the configuration shown in Figure 2, segment **118** forms a portion of a circular disc. Gap **122** is present between side surface **120** and side wall **116** to enable pivoting of strut **104** about axis **A** while in indentation **110**. Gap **122** is exaggerated for purposes of illustration. Each strut **104** is pivotable in a respective indentation **110** to enable rotation of the housing in

rotational direction **RD1** (free-wheel mode) and to block rotation of the housing in a rotational direction **RD2** (locking mode), as further described below.

[0019] Each strut **104** includes top surface **124**. One-way clutch **100** includes side plate **126** including bottom side **128** engaged with portion **108** of the top side and covering indentations **110**. For example, side **128** is in contact with portion **108** and covers indentations **110**. Top surface **124** faces plate **126** in direction **AD2**.

[0020] Figure 4 is a partial cross-sectional view generally along line 4-4 in Figure 2, with a side plate included. The following should be viewed in light of Figures 2 through 4. In an example embodiment, as shown in Figures 3 and 4, bottom wall **114** includes protrusion **130** extending from bottom wall **114** toward bottom wall **132** of strut **104**. That is, protrusion **130** extends, in direction **AD2**, from portion **114A** of wall **114**. As further described below, protrusion **130**, having a smaller area than wall **114** as a whole, reduces drag between strut **104** and wall **114** as strut pivots in indentation **110** while protrusion **130** and surface **132** are in contact. In an example embodiment, bottom surface **132** is substantially planar.

[0021] Figure 5 is a partial cross-sectional view generally along line 5-5 in Figure 2, with a side plate included. The following should be viewed in light of Figures 2 through 5. In an example embodiment, as shown in Figures 3 and 5, strut **104** includes protrusion **134** extending from top surface **124** toward side plate **126**. That is, protrusion **134** extends, in direction **AD2**, from portion **124A** of surface **124**. As further described below, protrusion **134**, having a smaller area that surface **124** as a whole, reduces drag between strut **104** and side plate **126** as strut pivots in indentation **110** while protrusion **134** and plate **126** are in contact. In an example embodiment, portion **128A** of bottom side **128**, aligned with indentation **110** in direction **AD2**, is substantially planar.

[0022] Figure 6 is a partial cross-sectional view generally along line 6-6 in Figure 2, with a side plate included. The following should be viewed in light of Figures 2 through 6. In an example embodiment, for example as shown in Figures 4 and 6, plate **126** includes protrusions **136** extending from bottom side **128**, in particular, portion **128A**. Each protrusion **136** extends toward respective top surface **124** of each strut **104** in direction **AD1**. As further described below, protrusion **136**, having a smaller area that portion **128A** as a whole, reduces drag between

strut **104** and plate **126** as strut pivots in indentation **110** while protrusions **136** and struts **104** are in contact. In an example embodiment, surface **124** is substantially planar.

[0023] In an example embodiment, for example as shown in Figures 5 and 6, strut **104** includes protrusion **138** extending from bottom surface **132** toward bottom wall **114**. That is, protrusion **138** extends, in direction **AD1**, from portion **132A** of surface **132**. As further described below, protrusion **138**, having a smaller area that bottom surface **132** as a whole, reduces drag between strut **104** and wall **114** as strut pivots in indentation **110** while strut **104** and wall **114** are in contact. In an example embodiment, wall **114** is substantially planar.

[0024] Figure 3 shows an example configuration with protrusions **130** and **134** in conjunction. Figure 4 shows an example configuration with protrusions **130** and **134** in conjunction. Figure 5 shows an example configuration with protrusions **134** and **138** in conjunction. Figure 6, shows an example configuration with protrusions **136** and **138** in conjunction.

[0025] Figure 7 is a perspective view of strut **104** in Figures 3 and 5.

[0026] Figure 8 is a side view of strut **104** in Figure 7. The following should be viewed in light of Figures 2 through 8. In an example embodiment, strut **104** includes segment **140** and resilient elements **142**. Segment **140** extends from portion **118**. Elements **142** are engaged with segments **140** and urge segments **140** radially inward so that at least some of struts **104** lockingly engage non-rotatable shaft, or inner hub, **144**. For the free-wheel mode, for example, rotation of housing **102** in direction **RD1**, at lower rotational speed, portions **140A** of the struts slide across ramps **146** without locking with the ramps. As the rotational speed increases, centrifugal force urges segment **140** radially outward until segments **140** no longer engage ramps **146**. In the locking mode, for example, rotation in direction **RD2**, respective portions **140B** of segments **140** for at least some of struts **104** lockingly engage with ramps **146**. In particular, portions **140B** engage faces **146A** to block further rotation of housing **102**.

[0027] Thus, proper operation of one-way clutch **100** requires that struts **104** be able to pivot as needed to switch between free-wheel and locking modes. In an example embodiment, axial length **L1** between plate **126** and wall **114** is greater than axial length **L2** of strut **104**. When one-way clutch **100** is at rest or is rotating at lower speed in the free-wheel mode, surface **132** may be in contact with wall **114**. As noted above, protrusions **130** and **138** advantageously

reduce drag when surface **132** and wall **114** are in contact, which facilitates the desired pivoting of strut **104**.

[0028] As noted above, casting of housing **102** requires a conical shape for walls **120** (draft angle). Advantageously, because side surfaces **116** have a complimentary conical shape, struts **104** can be used in the indentations with the draft angle (conical shape for walls **120**) intact. Thus, the step of machining walls **120** to remove the conical shape is not required, reducing the cost, time, and complexity associated with fabricating one-way clutch **100**.

[0029] However, the complimentary conical shapes of walls **116** and **120** noted above creates a problem that is solved by the use of protrusions **134** and **136**. Namely, force applied to portions **140B** causes struts **104** "ride up" sloped wall **116** in reaction to the force. Thus, struts **104** displace in direction **AD2** such that top surfaces **124** of the struts are in contact with side **128** of plate **126**. The contact of surfaces **124** with side **128** produces drag, which resists the desired motion of struts **124**. However, protrusions **134** and **136** advantageously reduce the area of contact between struts **104** and side **128**, and hence the drag associated with the contact of struts **104** and **128**, overcoming the problem noted above and enabling the desired motion of struts **104**.

[0030] In an example embodiment, clutch **100** is part of torque converter stator **148** and housing **102** includes radially outer portion **102A** and blades **150** connected to outer portion **102A**. In example embodiments, clutch **100** is used in: any torque transmitting device known in the art, such as a transmission; a seat adjuster; or a parking brake.

[0031] 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.

CLAIMS

What Is Claimed Is:

1. A one-way clutch, comprising:

a housing including a top side;

a plurality of indentations in the housing, each indentation including:

a respective opening in a portion of the top side;

a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the one-way clutch; and,

a respective side wall:

connecting the respective opening and the respective bottom wall; and,

tapering inward from the respective opening to the respective bottom wall; and,

a plurality of struts, each strut including a first segment disposed in a respective indentation and including a respective side surface substantially parallel to the respective side wall, wherein:

said each strut is pivotable in the respective indentation to enable rotation of the housing in a first rotational direction and to block rotation of the housing in a second rotational direction, opposite the first rotational direction.

2. The one-way clutch of claim 1, wherein:

said each strut includes a respective top surface facing the respective opening, the one-way clutch further comprising:

a side plate including a bottom side engaged with the portion of the top side and covering the plurality of indentations,

wherein:

the side plate includes a plurality of protrusions, each protrusion:

aligned, in the axial direction, with a respective strut; and,

extending toward a respective strut in the respective indentation; or,

wherein:

said each strut includes a respective protrusion extending from the respective top surface toward the side plate.

3. The one-way clutch of claim 2, wherein:

a gap, in the axial direction, is present between said each protrusion from the plurality of protrusions for the side plate and the respective strut; or,

a gap, in the axial direction, is present between the respective protrusion for said each strut and the side plate.

4. The one-way clutch of claim 1, wherein:

said each strut includes a respective bottom surface facing the respective bottom wall of a respective indentation; and,

the respective bottom surface includes a respective protrusion extending toward the respective bottom wall; or,

wherein the respective bottom wall includes a respective protrusion extending toward the respective bottom surface of a respective strut.

5. The one-way clutch of claim 4, further comprising:

a side plate including a bottom side engaged with the surface and covering the plurality of indentations, wherein:

a gap, in the axial direction, is present between said each strut and the side plate.

6. The one-way clutch of claim 1, wherein:

said each strut includes a respective second segment extending from the respective first segment;

the one-way clutch includes a plurality of resilient elements;

each resilient element is engaged with the respective second segment for a respective strut from the plurality of struts;

said each resilient element urges the respective second segment radially inward; and,

the respective second segment is arranged to engage a stator shaft to block rotation of the stator housing in the second rotational direction.

7. The one-way clutch of claim 1, wherein the respective side walls form respective partial circles in a cross-section orthogonal to the axis of rotation for the one-way clutch.

8. The one-way clutch of claim 1, wherein the respective first segments form respective partial circular discs in a cross-section orthogonal to the axis of rotation for the one-way clutch.

9. A stator for a torque converter, comprising:

a housing including a top side; and,

a one-way clutch including:

a plurality of indentations in the housing, each indentation including:

a respective opening in a portion of the top side;

a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the stator; and,

a respective side wall:

connecting the respective opening and the respective bottom wall; and,

tapering inward from the respective opening to the respective bottom wall; and,

a plurality of struts, each strut including a first segment disposed in a respective indentation and including a respective side surface substantially parallel to the respective side wall, wherein:

said each strut is pivotable in the respective indentation to enable rotation of the housing in a first rotational direction and to block rotation of the housing in a second rotational direction, opposite the first rotational direction.

10. The stator of claim 9, wherein:

said each strut includes a respective top surface facing the respective opening, the stator further comprising:

a side plate including a bottom side engaged with the portion of the top side and covering the plurality of indentations,

wherein:

the side plate includes a plurality of protrusions, each protrusion:

aligned, in the axial direction, with a respective strut; and,

extending toward a respective strut in the respective indentation; or,

wherein:

said each strut includes a respective protrusion extending from the respective top surface toward the side plate.

11. The stator of claim 10, wherein:

a gap, in the axial direction, is present between said each protrusion from the plurality of protrusions for the side plate and the respective strut; or,

a gap, in the axial direction, is present between the respective protrusion for said each strut and the side plate.

12. The stator of claim 9, wherein:

said each strut includes a respective bottom surface facing the respective bottom wall of a respective indentation; and,

the respective bottom surface includes a respective protrusion extending toward the respective bottom wall; or,

wherein the respective bottom wall includes a respective protrusion extending toward the respective bottom surface of a respective strut.

13. The stator of claim 12, further comprising:

a side plate including a bottom side engaged with the surface and covering the plurality of indentations, wherein:

a gap, in the axial direction, is present between said each strut and the side plate.

14. The stator of claim 8, wherein:

said each strut includes a respective second segment extending from the respective first segment;

the one-way clutch includes a plurality of resilient elements;

each resilient element is engaged with the respective second segment for a respective strut from the plurality of struts;

said each resilient element urges the respective second segment radially inward; and,

the respective second segment is arranged to engage a stator shaft to block rotation of the stator housing in the second rotational direction.

15. The stator of claim 9, wherein the housing includes:

a radially outer portion; and,

a plurality of blades connected to the radially outer portion.

16. The stator of claim 9, wherein with the portion of the top side is substantially orthogonal to the axis of rotation for the stator.

17. A one-way clutch, comprising:

a housing including a top side;

a side plate including a bottom side engaged with the top side;

a plurality of indentations in the housing, each indentation including:

a respective opening in the top side;

a respective bottom wall opposite the respective opening in an axial direction parallel to an axis of rotation for the One-way clutch; and,

a respective side wall:

connecting the respective opening and the respective bottom wall; and,

tapering inward from the respective opening to the respective bottom wall; and,

a plurality of struts, each strut including a respective first segment disposed in a respective indentation, the respective first segment including:

a respective side surface substantially parallel to the respective side wall;

a respective top surface facing the respective opening; and,

a respective bottom surface facing the respective bottom wall,

wherein:

the bottom side of the side plate covers the plurality of indentations; and,

wherein:

the side plate includes a plurality of protrusions, each protrusion:

aligned, in the axial direction, with a respective strut in a respective indentation; and,

extending toward the respective strut in the respective indentation; or,

said each strut includes a respective protrusion extending from the respective top surface toward the side plate; or,

wherein:

the respective bottom surface for said each strut includes a respective protrusion extending toward the respective bottom wall of a respective indentation; or,

the respective bottom wall for said each indentation includes a respective protrusion extending toward the respective bottom surface of a respective strut.

18. The one-way clutch of claim 17, wherein:

a gap, in the axial direction, is present between said each strut and the side plate.

19. The one-way clutch of claim 17, wherein:

said each strut includes a respective second segment extending from the respective first segment;

the one-way clutch includes a plurality of resilient elements;

each resilient element is engaged with the respective second segment for a respective strut from the plurality of struts;

said each resilient element urges the respective second segment radially inward; and,

the respective second segment is arranged to engage a stator shaft to block rotation of the stator housing in the second rotational direction.

20. The one-way clutch of claim 17, wherein the housing includes:

a radially outer portion; and,

a plurality of blades connected to the radially outer portion.

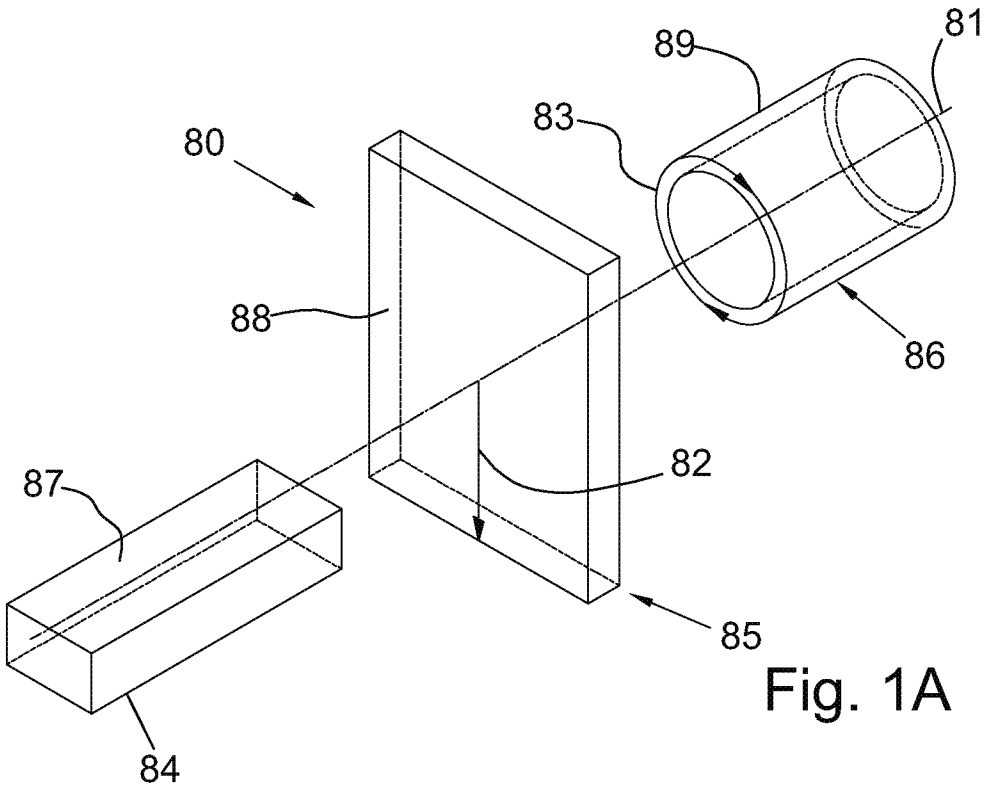


Fig. 1A

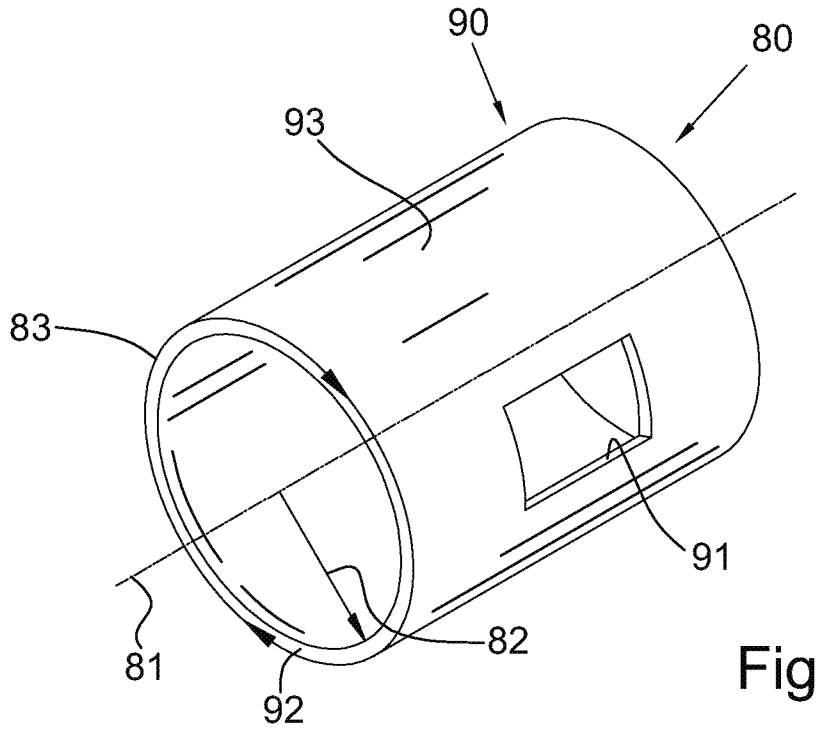


Fig. 1B

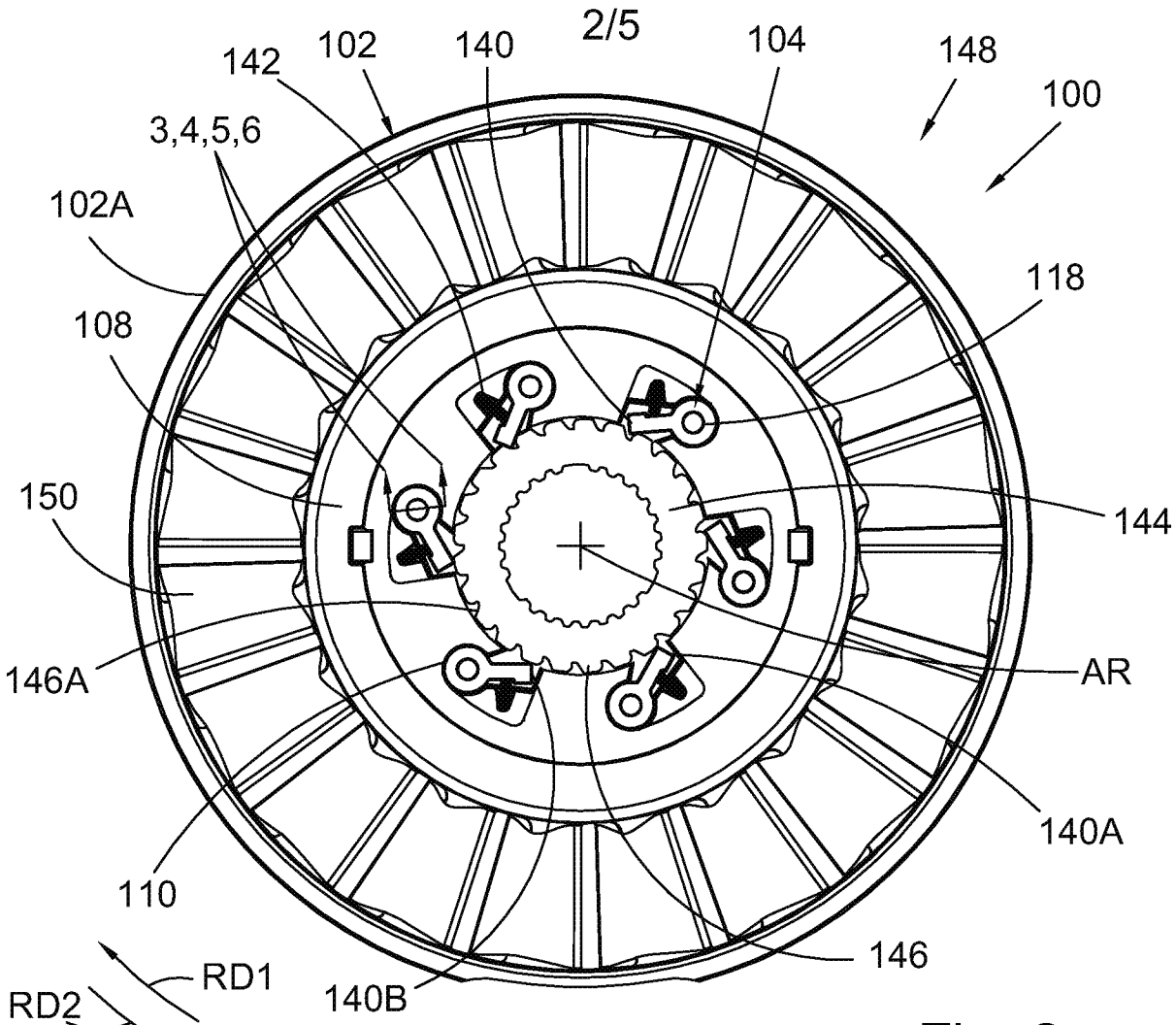

142
102
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148
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3,4,5,6
102A
118
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150
144
146A
AR
140A
110
146
RD1
RD2
140B

Fig. 2

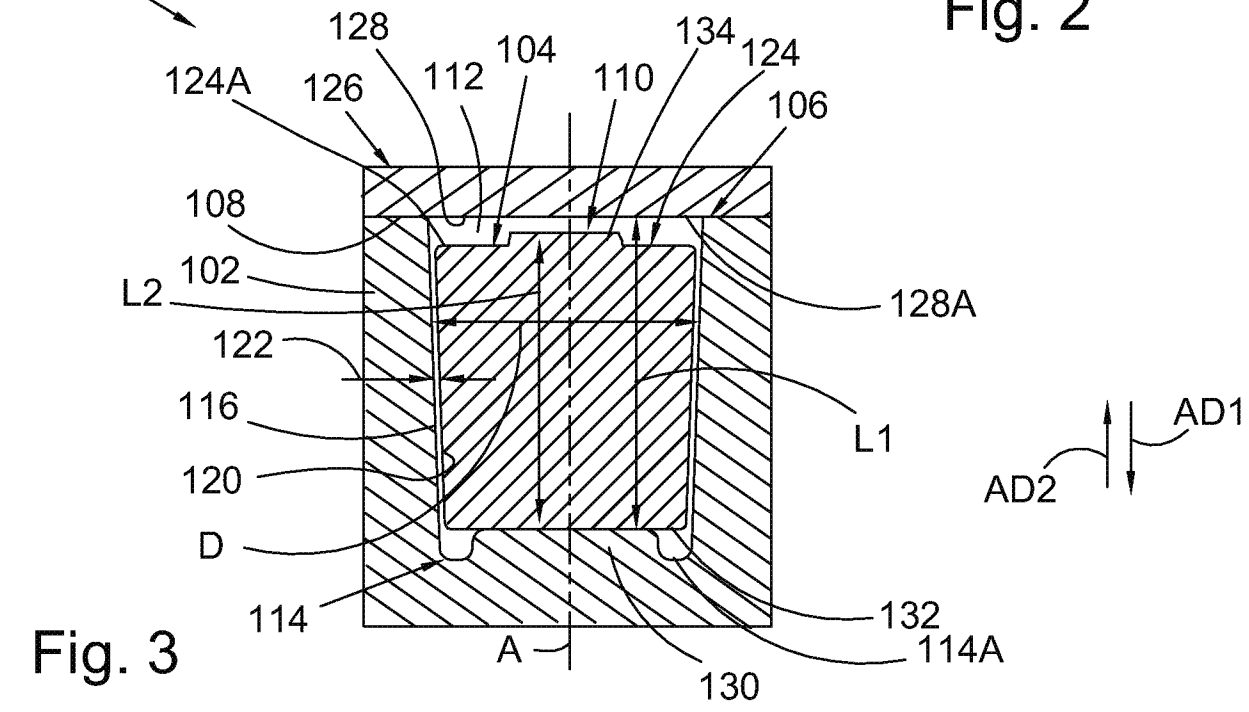

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L1
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D
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132
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114A
130
AD1
AD2

Fig. 3

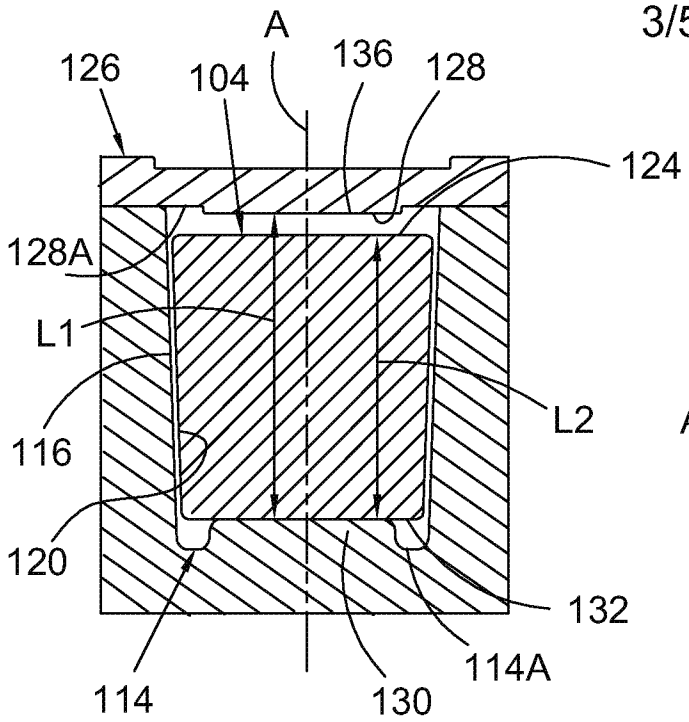


Fig. 4

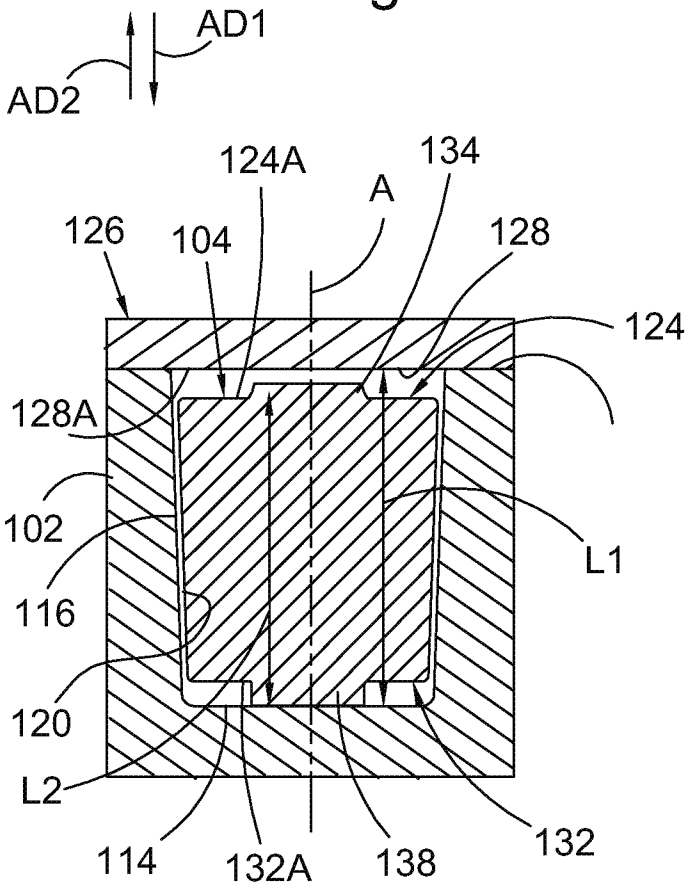


Fig. 5

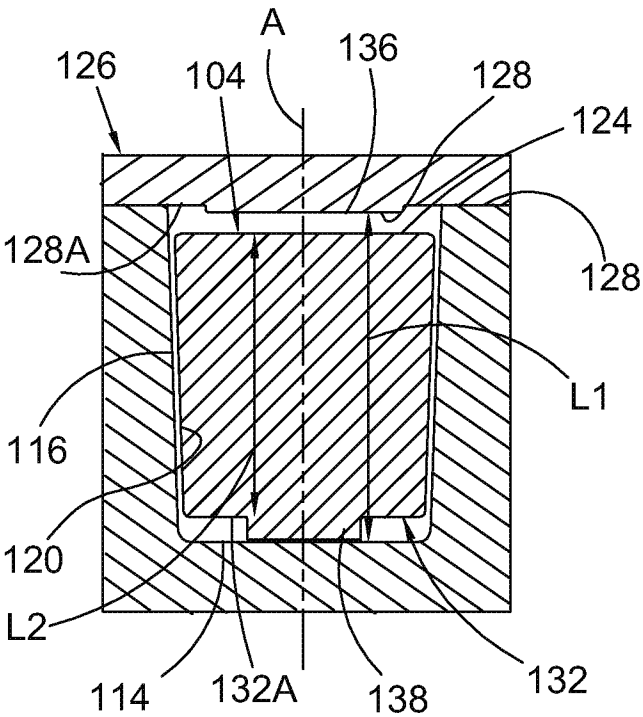


Fig. 6

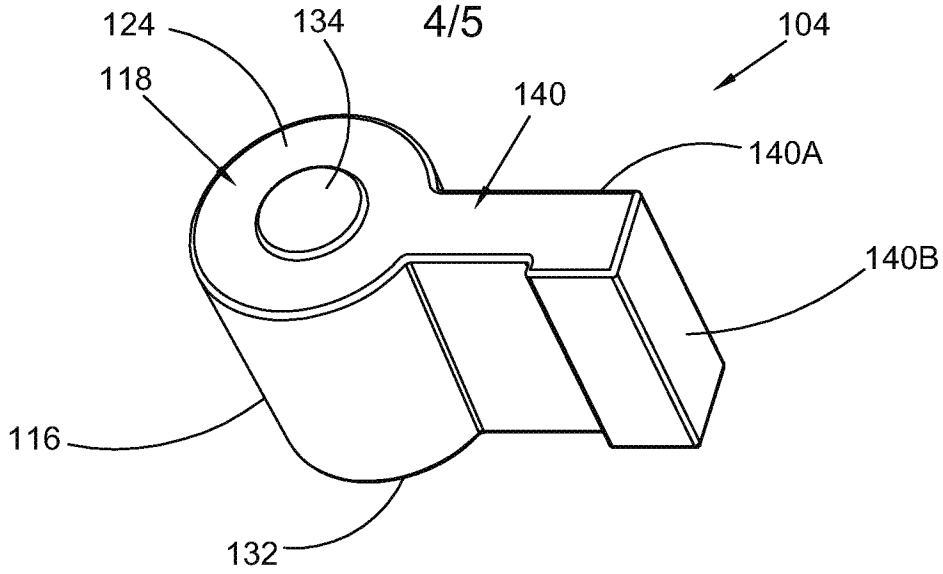

124
134
118
104
140
140A
140B
116
132

Fig. 7

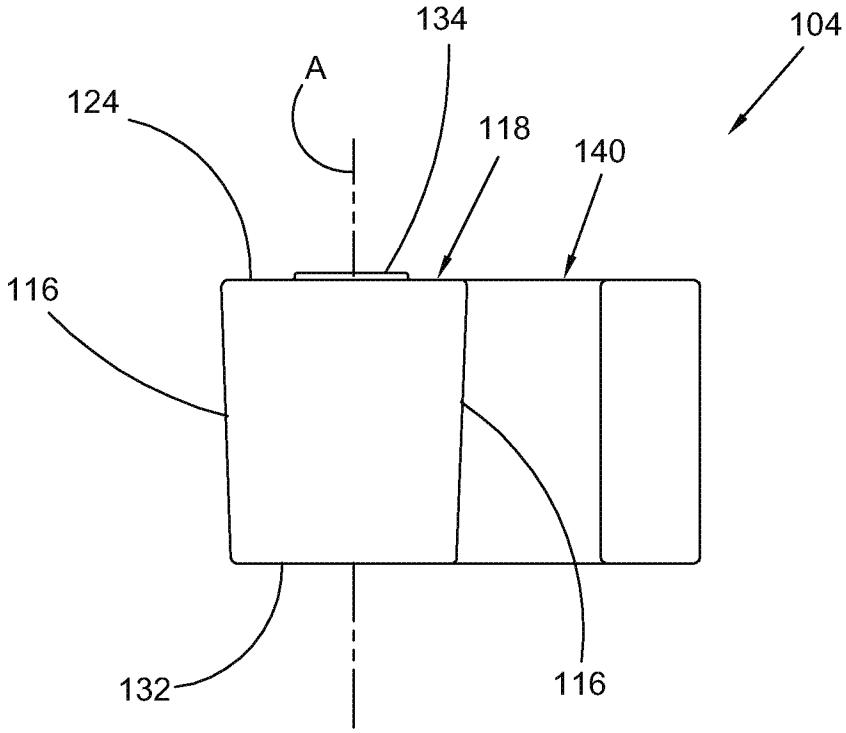

134
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118
140
116
132
116

Fig. 8

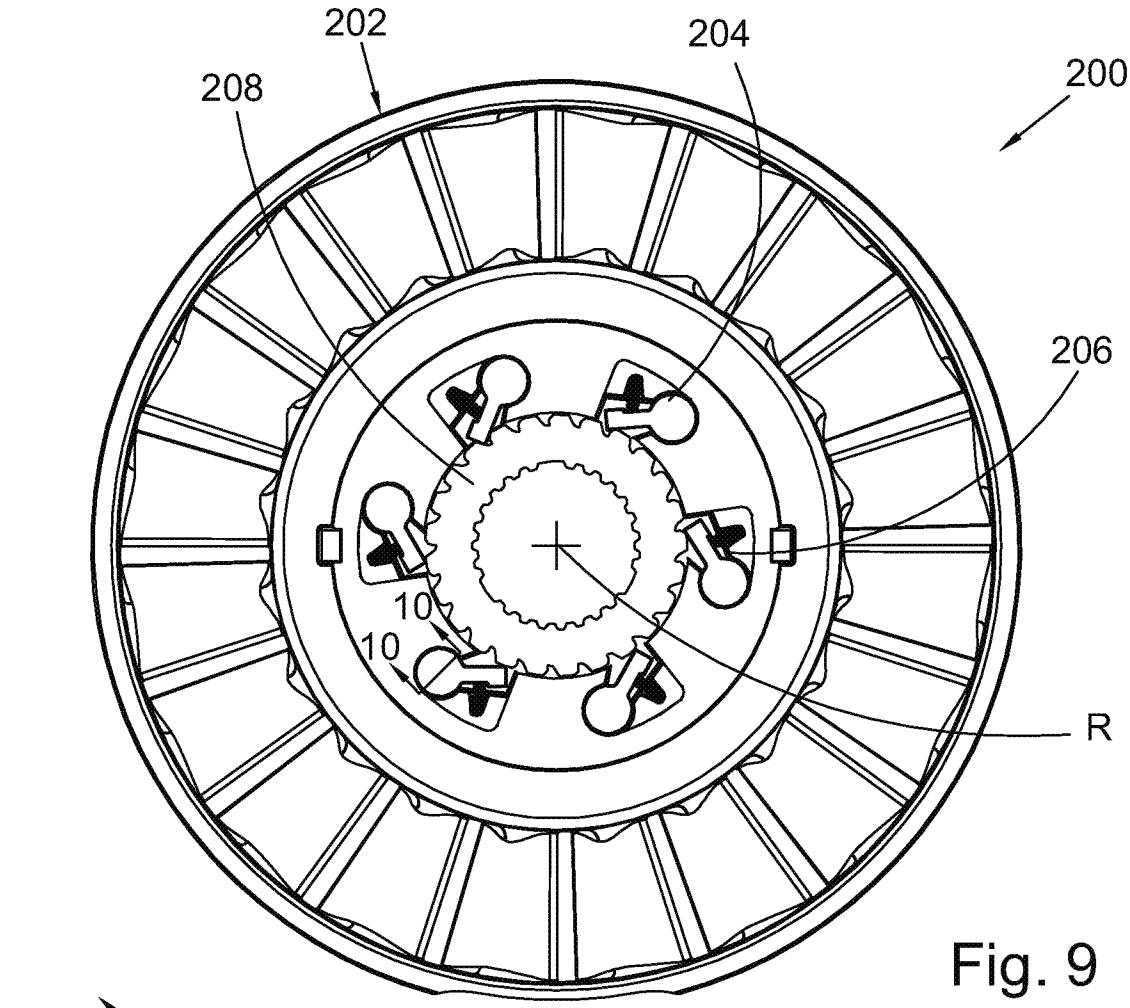


Fig. 9
PRIOR ART

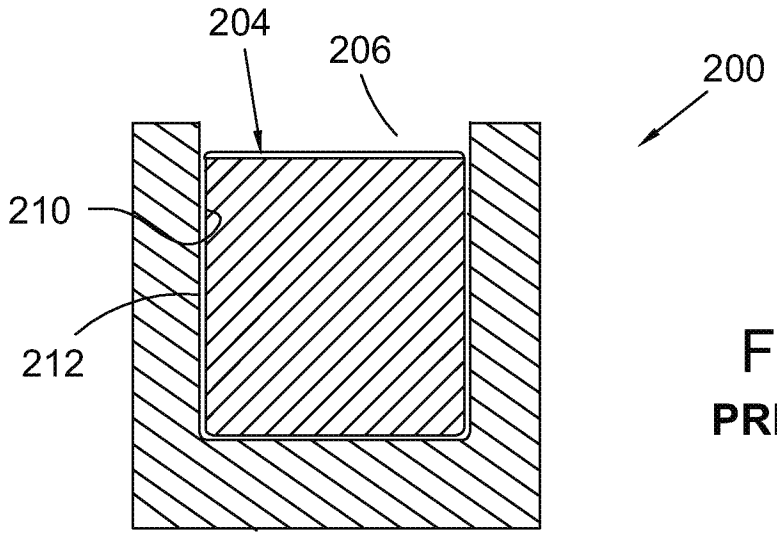


Fig. 10
PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/035066

A. CLASSIFICATION OF SUBJECT MATTER

F16D 41/06(2006.01)i, F16D 41/066(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)
F16D 41/06; F16D 33/00; B23P 6/00; F02N 15/02; F16D 41/00; F16D 41/12; F16D 41/066

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: one-way clutch, draft, cast, pivot, and spring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 202811904 U (KUN TENG INDUSTRY CO., LTD.) 20 March 2013 See paragraphs [0038],[0040],[0041],[0044],[0045],[0047]; and figures 3,6.	1,6-9,14-16
A		2-5,10-13,17-20
Y	KR 10-2010-0026376 A (HYUNDAI MOTOR COMPANY et al.) 10 March 2010 See paragraph [0027]; and figures 1,2.	1,6-9,14-16
Y	US 2007-0220877 A1 (GEORGE et al.) 27 September 2007 See paragraphs [0026],[0027]; and figure 1.	15
A	JP 2002-155841 A (HONDA MOTOR CO., LTD.) 31 May 2002 See paragraph [0012]; and figure 3.	1-20
A	US 2012-0111687 A1 (PETERSON, JODY A.) 10 May 2012 See paragraph [0022]; and figure 2.	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"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
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"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
08 August 2014 (08.08.2014)	**18 August 2014 (18.08.2014)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2014/035066

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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JP 2002-155841 A	31/05/2002	None	
US 2012-0111687 A1	10/05/2012	None	