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(54) Title: ONE WAY WEDGE CLUTCH WITH DISPLACEABLE WEIGHT ELEMENT TO ELIMINATE LOCKUP IN FREEWHEEL MODE

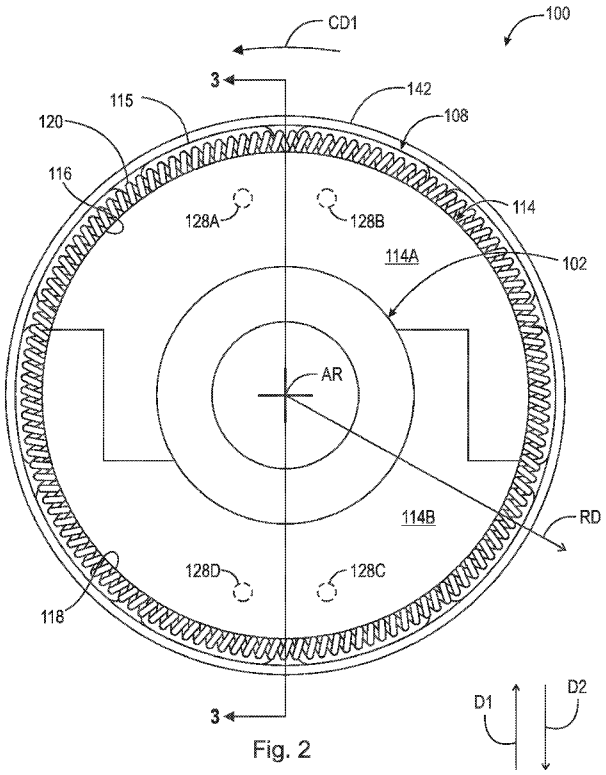


Fig. 2

(57) Abstract: A one-way clutch including: a wedge plate including a first radially innermost circumference with a first plurality of ramps; an inner race including a first radially outermost circumference with a second plurality of ramps and arranged to receive torque and transmit the torque to the wedge plate in a lock-mode for the one-way clutch; and a weighting element engaged with the wedge plate. The weighting element is arranged to displace, in response to rotation of the inner race, to radially contract the wedge plate.

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SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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— *with international search report (Art. 21(3))*

ONE WAY WEDGE CLUTCH WITH DISPLACEABLE WEIGHT ELEMENT TO ELIMINATE LOCKUP IN FREE-WHEEL MODE

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. 62/052,840, filed September 19, 2014, which application is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to a one-way wedge clutch with a displaceable weight element to eliminate lockup in free-wheel mode, in particular, a multi-piece weight element arranged to radially contract a wedge plate while the clutch is in free-wheel mode.

BACKGROUND

[0003] A wedge one-way clutch including an inner race with a plurality of ramps and a wedge plate with a plurality of ramps engaged with the plurality of ramps for the inner race is known. In a free-wheel mode, the inner race and the wedge plate rotate together. If the inner race is the driven component of the clutch and the rotational speed of the inner race is high enough in the free-wheel mode, the rotation of the inner race and wedge plate produces a centrifugal force acting to expand the wedge plate radially outward. If the radially outward expansion is large enough, the outer circumference of the wedge plate can frictionally engage an outer race for the clutch, initiating an undesirable lock-up of the clutch (non-rotatable connection of the inner and outer race).

SUMMARY

[0004] According to aspects illustrated herein, there is provided a one-way clutch, including: a wedge plate including a first radially innermost circumference with a first plurality of ramps; an inner race including a first radially outermost circumference with a second plurality of ramps and arranged to receive torque and transmit the torque to the wedge plate in a lock-mode for the one-way clutch; and a weighting element engaged with the wedge plate. The weighting element is arranged to displace, in response to rotation of the inner race, to radially contract the wedge plate.

[0005] According to aspects illustrated herein, there is provided a one-way clutch, including: a wedge plate including a first radially innermost circumference with a first

plurality of ramps and first and second pluralities of slots; an inner race including a first radially outermost circumference with a second plurality of ramps engaged with the first plurality of ramps and arranged to receive torque and transmit the torque to the wedge plate; a weighting element including first and second components and first and second pluralities of pins. The first and second pluralities of pins are fixed to the first and second components, respectively and disposed in the first and second pluralities of slots, respectively. For rotation of the inner race: the first and second components are arranged to displace away from each other; and to radially contract the wedge plate, the first component is arranged to displace to slide the first plurality of pins in the first plurality of slots and the second component is arranged to displace to slide the second plurality of pins in the second plurality of slots.

[0006] According to aspects illustrated herein, there is provided a one-way clutch, including: an outer race including a first radially inner circumference; and a wedge plate disposed radially inward of the outer races and including: a second radially innermost circumference with a first plurality of ramps; a first radially outermost circumference; first and second ends connecting the second radially innermost circumference and the first radially outermost circumference; and first and second pluralities of slots. The clutch includes: an inner race including a second radially outer circumference with a second plurality of ramps and arranged to receive torque and transmit the torque to the wedge plate; and a weighting element including a first component including a first plurality of pins fixed to the first component and disposed in the first plurality of slots and a second component including a second plurality of pins fixed to the second component and disposed in the second plurality of slots. For a free-wheel mode for the one-way clutch: the inner race is arranged to rotate in a circumferential direction; the first and second components are arranged to displace away from each other; the first and second pluralities of pins are arranged to slide in the first and second pluralities of slots, respectively, to urge the first and second ends toward each other to radially contract the wedge plate; and the inner race is rotatable with respect to the outer race.

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 front view of one-way wedge clutch with a displaceable weight element to eliminate lockup;

Figure 3 is a cross-sectional view generally along line 3-3 in Figure 2; and,

Figure 4 is a front view of the wedge plate shown in Figure 2.

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 front view of one-way wedge clutch **100** with a displaceable weight element to eliminate lockup.

[0014] Figure 3 is a cross-sectional view generally along line 3-3 in Figure 2.

[0015] Figure 4 is a front view of the wedge plate shown in Figure 2. The following should be viewed in light of Figures 2 through 4.One-way clutch **100** includes: inner race **102** including radially outermost circumference **104** with ramps **106**; wedge plate **108** including radially innermost circumference **110** with ramps **112**; and weighting element **114** engaged with wedge plate **108**. In an example embodiment, inner race **102** is the driven component for clutch **100**, that is, inner race **102** is arranged to receive torque and transmit the torque to wedge plate **108**. For rotation of inner race **102**, weighting element **114** is arranged to displace to radially contract wedge plate **108**. By "radially contract" we mean that at least a portion of radially outermost circumference **115** of wedge plate **108** is drawn closer to axis of rotation **AR** for clutch **100**.

[0016] In an example embodiment, weighting element **114** includes components **114A** and **114B** arranged to displace in opposite directions **D1** and **D2**, respectively, in response to rotation of inner race **102** in circumferential direction **CD2** (free-wheel mode). That is, components **114A** and **114B** displace away from each other. Components **114A** and **114B** include radially outermost circumferences **116** and **118**, respectively. Clutch **100** includes resilient element **120** engaged with circumferences **116** and **118** and urging components **114A** and **114B** in directions **D2** and **D1**, respectively, that is, toward each other.

[0017] In an example embodiment, at least a portion of weighting element **114** is aligned with wedge plate **108** so that line **L1** parallel to axis of rotation **AR** for clutch **100** passes through weighting element **114** and wedge plate **108** as shown in Figure 3. In an example embodiment, at least a portion of weighting element **114** is aligned with inner race **102** so that line **L2** parallel to axis of rotation **AR** passes through weighting element **114** and inner race **102** as shown in Figure 3.

[0018] Circumference **115** extends further direction **RD**, orthogonal to axis of rotation **AR**, than circumferences **116** and **118**.

[0019] In an example embodiment, wedge plate **108** includes slots **126** and weighting element **114** includes pins **128** fixed to the weighting element. Each pin **128** is disposed in a respective slot **126**. In response to rotation of inner race **102** in direction **CD2**, pins **128** are arranged to displace in slots **126** to radially contract wedge plate **108**. In an example embodiment, wedge plate **108** includes ends **130A** and **130B** separated from each other in circumferential direction **CD2**. At least respective portions of ends **130A** and **130B** are aligned with each other so that line **L3** in direction **CD2** passes through ends **130A** and **130B** and space **132**, separating ends **130A** and **130B**.

[0020] Pins **128** are arranged to displace in slots **126** to urge ends **130A** and **130B** toward each other. Specifically, pins **128** are arranged to displace in slots **126** to urge end **130A** in direction **CD2** and to urge end **130B** in circumferential direction **CD1**, opposite direction **CD2**. As ends **130A** and **130B** are drawn toward each other, at least a portion of circumference **115** is drawn closer to axis **AR**.

[0021] Each slot **126** includes a respective longitudinal axis **LA**. Extent **134** of each slot **126**, parallel to longitudinal axis **LA**, is greater than extent **136** of slot **126** orthogonal to longitudinal axis **LA**. Each longitudinal axis **LA** is at acute angle **AA** with respect to line **R** orthogonal to axis of rotation **AR** for clutch **100**.

[0022] In an example embodiment, slots **126** includes slots **126A-D**. Each respective axis **LA** passes through respective ends **138A** and **138B** of each slot. Ends **138A** are closer to axis **AR** than are ends **138B**. Ends **138A** for slots **126A** and **126B** are closer together in direction **CD1** than are ends **138B** for slots **126A** and **126B**. In like manner, ends **138A** for slots **126C** and **126D** are closer together in direction **CD1** than are ends **138B** for slots **126C** and **126D.** In an example embodiment, slots **126** are symmetrically placed in wedge plate **108**. For example, line **L4** passes through axis of rotation **AR** and slots **126A** and **126D**.

[0023] In an example embodiment, pins **128A** and **128B** are fixed to component **114A** and disposed in slots **126A** and **126B**. Pins **128C** and **128D** are fixed to component **114B** and disposed in slots **126C** and **126D**. Each slot **126** includes a respective edge **140**, for example, parallel to axis **LA**. In response to rotation of inner race **102** in direction **CD2**, pins **128A** and **128B** are arranged to contact edges **140A** and **140B**, respectively, and pins **128C** and **128D** are arranged to contact edges **140C** and **140D**, respectively. Radially outward

displacement of components **114A** and **114B** and contact between pins **128** and edges **140** causes the circumferential displacement of wedge plate **108**, for example, of ends **130A** and **130B**, and concurrent radial contraction of wedge plate **108**.

[0024] Clutch **100** includes outer race **142** located radially outward of wedge plate **108** and including radially innermost circumference **144**. For a free-wheel mode for one-way clutch **100**, in which inner race **102** is rotatable with respect to outer race **142**, inner race **102** rotates in circumferential direction **CD2** with respect to outer race **142** and ramps **112** are arranged to slide down ramps **106**. As is known in the art, as ramps **112** slide down ramps **106**, wedge plate **108**, in particular at least a portion of radially outermost circumference **115**, constricts radially inward to prevent frictional engagement of radially outermost circumference **115** and radially innermost circumference **144** with sufficient force to trigger the lock-up mode of clutch **100**. As noted above, in free-wheel mode, displacement of element **114** causes radial contraction of wedge plate **108**.

[0025] For the lock-up mode for one-way clutch **100**, in which wedge plate **108** is non-rotatably connected to inner race **102** and outer race **142**, inner race **102** rotates in circumferential direction **CD1** with respect to outer race **142** and ramps **112** are arranged to slide up ramps **106**. As is known in the art, as ramps **112** slide up ramps **106**, wedge plate **108**, in particular radially outermost circumference **115**, expands radially outward to frictionally engage radially outermost circumference **115** and radially innermost circumference **144** with sufficient force to trigger the lock-up mode of clutch **100**. Note that the configuration of element **114** and slots **126** is such that the displacement of element **114** does not interfere with implementation of the lock-up mode. During lock-up mode, element **120** urges elements **114A** and **114B** into contact with each other to prevent rattling of elements **114A** and **114B**.

[0026] It should be understood that increasing a speed of rotation of inner race **102** in direction **CD2** causes further displacement of component **114A** and **114B** in directions **D1** and **D2**, respectively. It also should be understood that decreasing a speed of rotation of inner race **102** causes displacement of component **114A** and **114B** in directions **D2** and **D1**, respectively, enabling ends **130A** and **130B** to displace away from each other.

[0027] Advantageously, weighting element **114** prevents the undesirable lock-up during free-wheel mode described above. As noted above, the lock-up is caused by centrifugal force displacing a radially outermost circumference, such as radially outermost

circumference **115**, radially outward far enough to frictionally engage an outer race with sufficient force to trigger a lock-up. For example, cause ramps on a wedge plate to slide up ramps on an inner race. Using the configuration shown in the figures as an example, as inner race **102** and wedge plate **108** rotate, the centrifugal force noted above causes components **114A** and **114B** to displace away from each other in directions **D1** and **D2**, respectively.

[0028] Because slots **126** are angled, in particular because slots **126A** and **126B** and slots **126C** and **126D**, respectively, taper toward each other in a radially inward direction, as pins **128** contact edges and displace in directions **D1** and **D2**, respectively, ends **130A** and **130B** are forced together to accommodate the motion of pins **128** along edges **140**. Pushing ends **130A** and **130B** toward each other radially contracts wedge plate **108**, in particular, at least a portion of radially outermost circumference **115** is drawn closer to axis **AR**, preventing the undesirable engagement of wedge plate **108** and outer race **142**.

[0029] Wedge plate **108** is flexible in circumferential directions **CD1** and **CD2**, while components **114A** and **114B** are displaceable only in directions **D1** and **D2.** Therefore, the flexibility of wedge plate **108** and the displacement of ends **130A** and **130B** are able to accommodate the displacement of components **114A** and **114B** in directions **D1** and **D2**, respectively.

[0030] In an example embodiment (not shown), wedge plate **108** is circumferentially continuous. In this case, circumferential and radial contraction and expansion of wedge plate **108** is enable by radial slots, such as slots **146**.

[0031] It should be understood that clutch **100** is not limited to the configuration shown in the figures. For example, the circumferential orientation of ramps **106** and **112** can be reversed.

[0032] 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 wedge plate including a first radially innermost circumference with a first plurality of ramps;

an inner race including a first radially outermost circumference with a second plurality of ramps and arranged to:

receive torque; and,

transmit the torque to the wedge plate in a lock-mode for the one-way clutch; and,

a weighting element engaged with the wedge plate, wherein the weighting element is arranged to displace, in response to rotation of the inner race, to radially contract the wedge plate.

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

the weighting element includes first and second components arranged to displace in first and second opposite directions, respectively, in response to the rotation of the inner race.

3. The one-way clutch of claim 2, wherein the first and second components include respective radially outermost circumferences, the one-way clutch further comprising:

a resilient element engaged with the respective radially outermost circumferences and urging the first and second components in the second and first directions, respectively.

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

the wedge plate includes a plurality of slots;

the weighting element includes a plurality of pins fixed to the weighting element;

each pin in the plurality of pins is disposed in a respective slot included in the plurality of slots; and,

in response to the rotation of the inner race, the plurality of pins are arranged to displace in the plurality of slots to radially contract the wedge plate.

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

the wedge plate includes first and second ends separated from each other in a first circumferential direction;

at least respective portions of the first and second ends are aligned with each other so that a line in the first circumferential direction passes through the first and second ends and a space separating the first and second ends; and,

the plurality of pins is arranged to displace in the plurality of slots to urge the first and second ends toward each other.

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

each respective slot includes a respective longitudinal axis;

an extent of said each slot, parallel to the respective longitudinal axis, is greater than an extent of said each slot orthogonal to the respective longitudinal axis; and,

the respective longitudinal axis is at an acute angle with respect to a line orthogonal to an axis of rotation for the one-way clutch.

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

the plurality of slots includes first, second, third, and fourth slots;

the respective longitudinal axis passes through respective first and second longitudinal ends for said each respective slot;

the respective first longitudinal ends are closer to the axis of rotation than the respective second longitudinal ends;

the respective first longitudinal ends of the first and second slots are closer together in the first circumferential direction than the respective second longitudinal ends of the first and second slots; and,

the respective first longitudinal ends of the third and fourth slots are closer together in the first circumferential direction than the respective second longitudinal ends of the third and fourth slots.

8. The one-way clutch of claim 1, further comprising:

an outer race located radially outward of the wedge plate and including a second radially innermost circumference, wherein:

the wedge plate includes a second radially outermost circumference; and,

for a free-wheel mode for the one-way clutch:

the inner race rotates in a first circumferential direction with respect to the outer race:

the first plurality of ramps is arranged to slide down the second plurality of ramps; and,

the inner race is rotatable with respect to the outer race.

9. A one-way clutch, comprising:

a wedge plate including:

a first radially innermost circumference with a first plurality of ramps; and,

first and second pluralities of slots;

an inner race including a first radially outermost circumference with a second plurality of ramps engaged with the first plurality of ramps and arranged to:

receive torque; and,

transmit the torque to the wedge plate;

a weighting element including:

first and second components; and,

first and second pluralities of pins:

fixed to the first and second components, respectively; and,

disposed in the first and second pluralities of slots, respectively, wherein:

for rotation of the inner race:

the first and second components are arranged to displace away from each other; and,

to radially contract the wedge plate:

the first component is arranged to displace to slide the first plurality of pins in the first plurality of slots; and,

the second component is arranged to displace to slide the second plurality of pins in the second plurality of slots.

10. A one-way clutch, comprising:

an outer race including a first radially inner circumference;

a wedge plate disposed radially inward of the outer races and including:

a second radially innermost circumference with a first plurality of ramps;

a first radially outermost circumference;

first and second ends connecting the second radially innermost circumference and the first radially outermost circumference; and,

first and second pluralities of slots;

an inner race including a second radially outer circumference with a second plurality of ramps and arranged to:

receive torque; and,

transmit the torque to the wedge plate; and,

a weighting element including:

a first component including a first plurality of pins fixed to the first component and disposed in the first plurality of slots; and,

a second component including a second plurality of pins fixed to the second component and disposed in the second plurality of slots, wherein for a free-wheel mode for the one-way clutch:

the inner race is arranged to rotate in a circumferential direction;

the first and second components are arranged to displace away from each other;

the first and second pluralities of pins are arranged to slide in the first and second pluralities of slots, respectively, to urge the first and second ends toward each other to radially contract the wedge plate; and,

the inner race is rotatable with respect to the outer race.

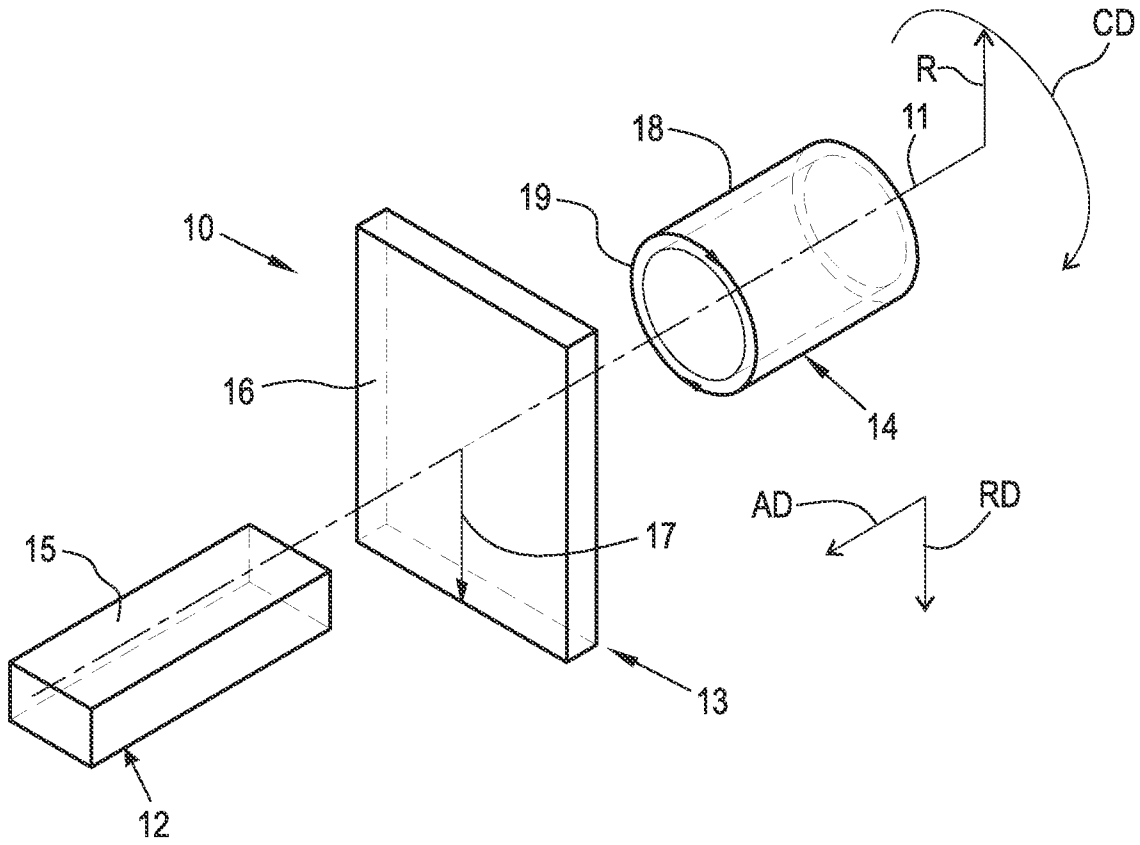


Fig.1

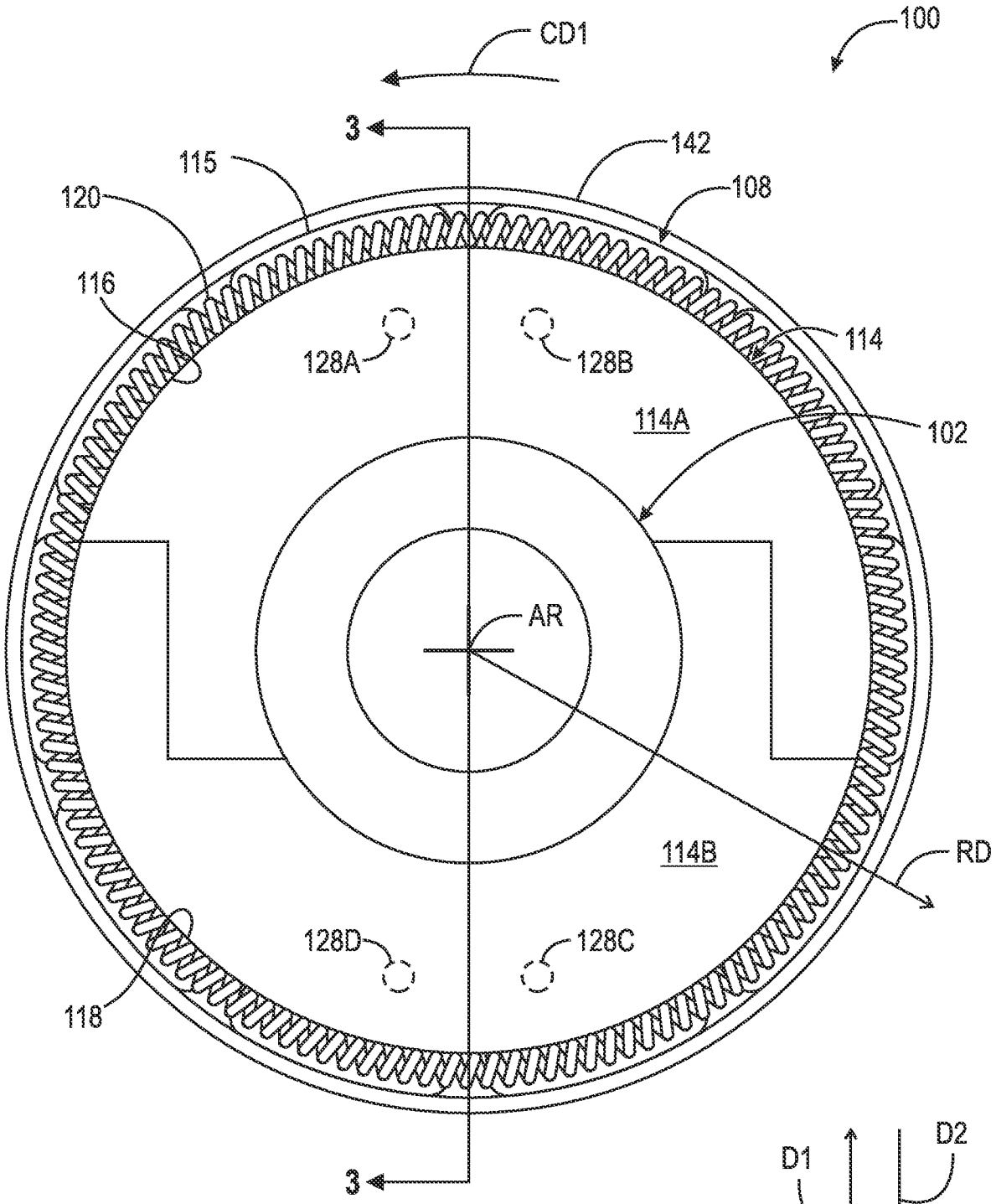

CD1
100
3
142
115
108
120
116
128A
128B
114
114A
102
AR
RD
114B
128D
128C
118
3
D1
D2

Fig. 2

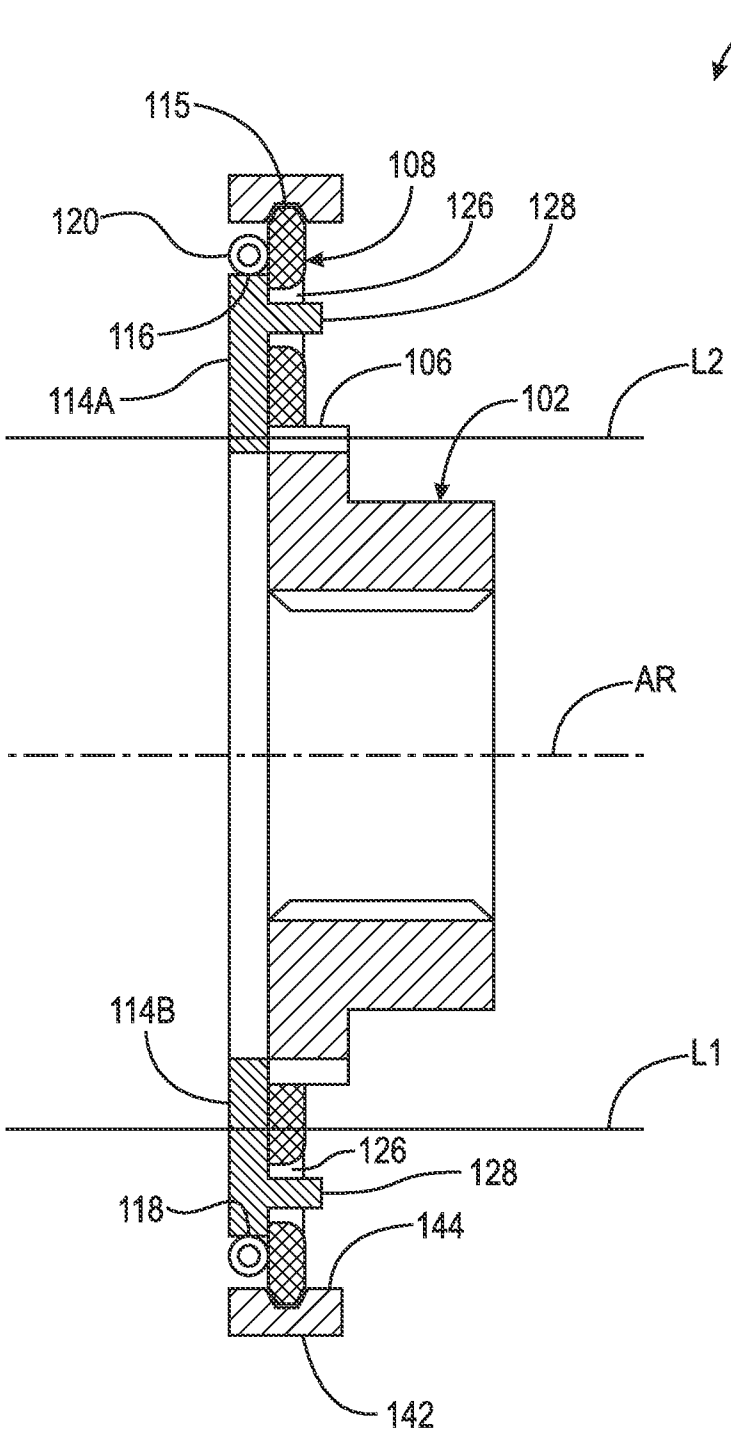

100
115
108
126
128
120
116
106
L2
114A
102
AR
114B
L1
126
128
118
144
142

Fig. 3

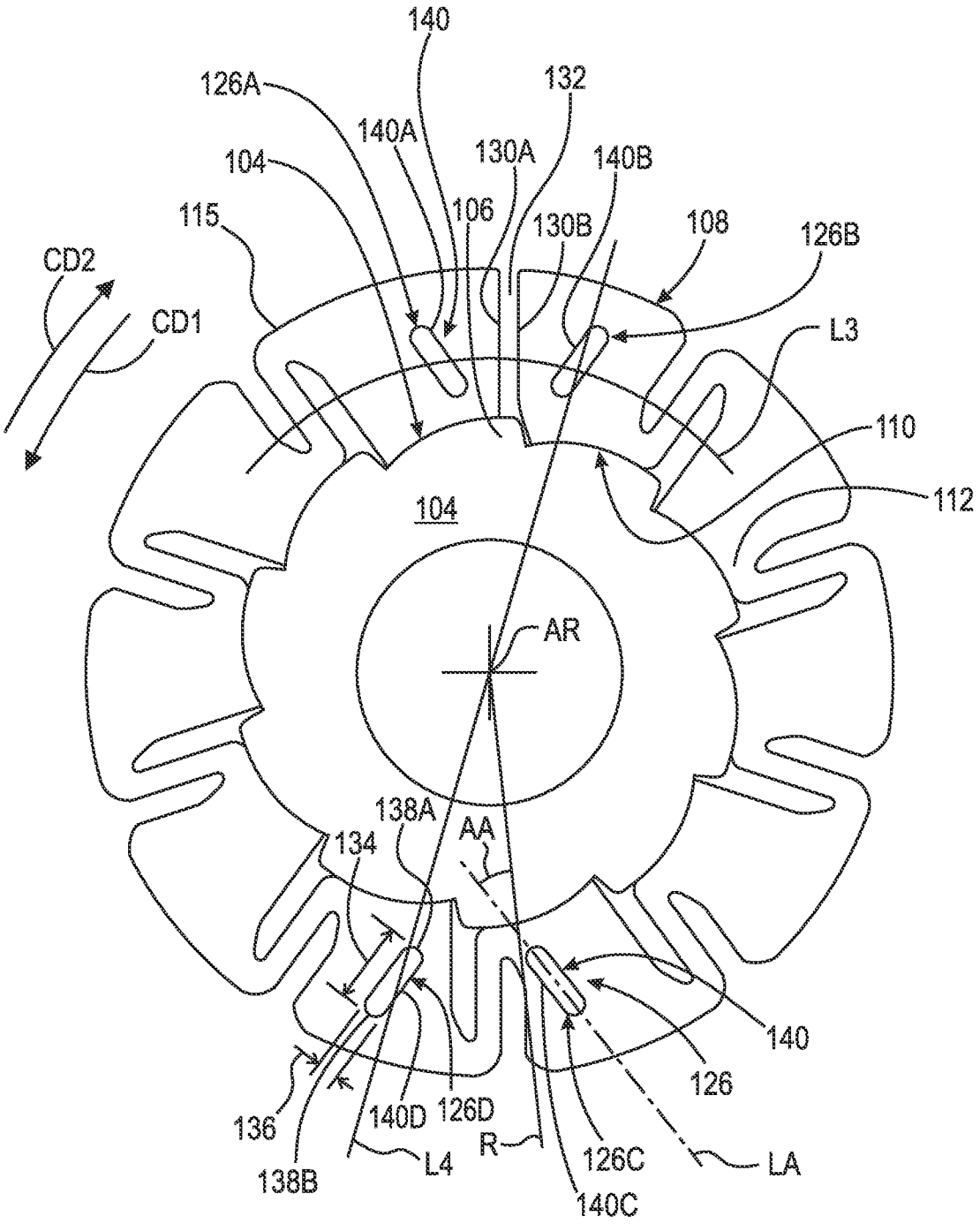

140
126A
132
140A
130A
140B
104
106
115
130B
108
126B
CD2
CD1
L3
110
112
104
AR
138A
AA
134
140
126
136
140D
126D
R
126C
LA
138B
L4
140C

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/039991

A. CLASSIFICATION OF SUBJECT MATTER

F16D 41/063(2006.01)i, F16D 41/07(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 41/063; F16F 15/10; F02B 67/06; F16D 41/06; F16D 41/07

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, weight, centrifugal force, inner race, outer race, and wedge plate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014-0014454 A1 (SCHAEFFLER TECHNOLOGIES AG. & CO., KG.) 16 January 2014 See paragraphs [0025]-[0030] and figures 2-4.	1-10
A	US 2008-0093189 A1 (WIESNETH et al.) 24 April 2008 See paragraph [0028] and figure 4.	1-10
A	US 2006-0021837 A1 (KIMES et al.) 02 February 2006 See paragraphs [0030], [0046] and figures 1, 7.	1-10
A	JP 2006-077921 A (NTN CORP.) 23 March 2006 See paragraphs [0025]-[0028] and figure 2.	1-10
A	US 2009-0159390 A1 (DAVIS, MICHAEL C.) 25 June 2009 See paragraphs [0029]-[0032] and figure 2.	1-10

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

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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