(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 February 2015 (05.02.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/015320 A2

(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/IB2014/002543

(22) International Filing Date:
16 July 2014 (16.07.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/857,785 24 July 2013 (24.07.2013) US

(71) Applicant: **SCHAEFFLER TECHNOLOGIES GMBH & CO. KG** [DE/DE]; Industriestrasse 1-3, 91074 Herzogenaurach (DE).

(72) Inventors; and
(71) Applicants *(for US only)*: **LEE, Brian**; 108 Felix Lane, York, SC 29745 (US). **OHR, Carsten**; 5136 Quail Canyon Drive, Charlotte, NC 28226 (US).

(74) Agents: **MALISZEWSKI, Chester, Paul** et al.; Simpson & Simpson, PLLC, 5555 Main Street, Williamsville, NY 14221 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2015/015320 A2

(54) Title: DISCONNECT FOR A SWITCHABLE WEDGE CLUTCH

(57) Abstract: A wedge clutch, including: an inner hub; an outer race; and a conical outer race: including a first portion aligned with the outer race in a radial direction orthogonal to an axis of rotation for the wedge clutch and in an axial direction, and a second portion aligned with the outer race in an axial direction parallel to the axis. The conical outer race is axially displaceable with respect to the outer race to bring the first and second portions into contact with the outer race to non-rotatably connect the inner hub and the outer race and to separate the first and second portions from the outer race to enable relative rotation of the inner hub and the outer race. The wedge clutch includes a wedge plate radially located between the inner hub and the conical outer race and engaged with the inner hub and the conical outer race.

DISCONNECT FOR A SWITCHABLE WEDGE CLUTCH

TECHNICAL FIELD

[0001] The present disclosure relates to a wedge disconnect clutch for an all-wheel drive, in particular, a wedge disconnect clutch with cone-shaped outer races, one of which is axially displaceable to connect and disconnect the clutch.

BACKGROUND

[0002] It is known to use wedge plate clutches for switchable clutch applications. Commonly owned U.S. Provisional Patent Application No. 61/715,518 discloses a switchable one way clutch using a two piece outer race. The two pieces are displaceable axially away from each other to open the clutch and the two pieces are displaceable axially toward each other to close the clutch. Active force must be applied to the two pieces to prevent the two pieces from separating due to radially outwardly acting forces from a wedge plate in contact with the two pieces.

SUMMARY

[0003] According to aspects illustrated herein, there is provided a wedge clutch, including: an inner hub; an outer race assembly including a first outer race and a conical outer race including a portion aligned with the first outer race in a radial direction orthogonal to an axis of rotation for the wedge clutch and axially displaceable with respect to the first outer race to open and close the wedge clutch; and a wedge plate radially located between the inner hub and the outer race assembly. In a closed position for the wedge clutch, the wedge plate is non-rotatably connected to the inner hub and the first outer race. In an open position for the wedge clutch, the inner hub and the first outer race are rotatable relative to each other.

[0004] According to aspects illustrated herein, there is provided a wedge clutch, including: an inner hub; an outer race assembly including a first outer race and a conical outer race including a first portion aligned with the first outer race in a radial direction orthogonal to an axis of rotation for the wedge clutch and including a second portion aligned with the first outer race in an axial direction parallel to the axis of rotation; and a wedge plate radially located between the inner hub and the conical outer race and engaged with the inner hub. The conical outer race is axially displaceable with respect to the first outer race: to bring the first and second portions into contact with the first outer race to non-rotatably connect the inner hub, the wedge plate, and the outer race assembly; and to separate the first and second

portions from the first outer race to enable relative rotation between the inner hub and the first outer race.

[0005] According to aspects illustrated herein, there is provided a wedge clutch, including: an inner hub; an outer race assembly including a first outer race and conical outer race including a portion radially inward of the first outer race and aligned with the first outer race in a radial direction orthogonal to the axis of rotation; and a wedge plate engaged with the inner hub and located between the inner hub and the conical outer race in the radial direction. For a closed position of the wedge clutch, the conical outer race is displaceable in a first axial direction, parallel to the axis of rotation, to bring the portion of the conical outer race and the first outer race into contact to non-rotatably connect the inner hub and the first outer race. For an open position of the clutch, the conical outer race is displaceable in a second axial direction, opposite the first axial direction, to separate the portion of the conical outer race from the first outer race so that the inner hub and the first outer race are rotatable relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] 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 an exploded view of a switchable wedge clutch;

Figure 3 is a back view of the switchable wedge clutch of claim 2 in a closed position;

Figure 4A is a cross-sectional view generally along line 4/5-4/5 in Figure 3, showing the switchable wedge clutch of Figure 2 in an open position;

Figure 4Bis a detail of area 4B in Figure 4A;

Figure 5A is a cross-sectional view generally along line 4/5-4/5 in Figure 3, showing the switchable wedge clutch of Figure 2 in a closed position;

Figure 5B is a detail of area 5B in Figure 5A; and,

Figure 6 is a schematic block diagram of the wedge clutch of Figure 2 showing an actuator.

DETAILED DESCRIPTION

[0007] 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.

[0008] 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.

[0009] 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.

[0010] Figure **1A** is a perspective view of cylindrical coordinate system **80** demonstrating spatial terminology used in the present application. The present invention is at least partially described 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**.

[0011] 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.

[0012] 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.

[0013] It should be understood that Figures 2A through 6B are schematic in nature and are not to scale. Further, features in Figures 2A through 6B such as proportions, sizes, lengths, spacing, widths, gaps, and contact surfaces, are not to scale and may be exaggerated or otherwise altered for the sake of clarity.

[0014] Figure 2 is an exploded view of switchable wedge clutch **100**.

[0015] Figure 3 is a back view of switchable wedge clutch **100** of claim 2. The following should be viewed in light of Figures 2 and 3. Clutch **100** includes inner hub **102**, wedge plate **104**, and outer race assembly **106** including conical outer race **108** and outer race **110**. Wedge plate **104** is located between hub **102** and assembly **106** in radial direction **RD** orthogonal to axis of rotation **AX** for clutch **100**. As further described below, in a closed position for wedge clutch **100**, plate **104** is non-rotatably connected to inner hub **102** and outer race assembly **106**. More specifically, in the closed position for clutch **100**, plate **104** is non-rotatably connected to hub **102** and race **108** and race **108** is non-rotatably connected to race **110**. In an open position for the wedge clutch, the inner hub and outer race **110** are rotatable relative to each other.

[0016] Figure 4A is a cross-sectional view generally along line 4/5-4/5 in Figure 3, showing switchable wedge clutch **100** of Figure 2 in an open position.

[0017] Figure 4B is a detail of area 4B in Figure 4A.

[0018] Figure 5 is a cross-sectional view generally along line 4/5-4/5 in Figure 3, showing switchable wedge clutch **100** of Figure 2 in a closed position.

[0019] Figure 5B is a detail of area 5B in Figure 5A. The following should be viewed in light of Figures 2 through 5B. Conical outer race **108** includes radially inner surface **112** and radially outer surface **114**. Outer race **110** includes radially inner surface **116**. Portion **114A** of surface **114** and portion **116A** of surface **116** are aligned in radial direction **RD**. In

an example embodiment, at least some of portion **114A** is aligned with surface **116** in axial direction **AD** parallel to axis **AX**. Portion **108A** of conical outer race **108** is located radially inward of outer race **110** and in alignment with outer race **110** in radial direction **RD**.

[0020] In the open position of Figures 4A and 4B, surfaces **114** and **116** are free of contact, for example, surfaces **114** and **116** are separated by gap **118** along length **120** of surface **114**. Thus, races **108** and **110** are independently rotatable with respect to each other in rotational, or circumferential, directions **CD1** and **CD2** about axis **AX**. In the closed position of Figures 5A and 5B, surfaces **114** and **116** are in contact and non-rotatably connected.

[0021] Surface **114** slopes toward axis **AX** in direction **AD1**, as shown by angle **AGL1**. Surface **116** slopes toward axis **AX** in direction **AD1**, as shown by angle **AGL2**. To switch wedge clutch **100** from the open position of Figures 4A and 4B to the closed position of Figures 5A and 5B, the conical outer race is arranged to displace axial direction **AD1**, such that surface **114**, in particular portion **114A**, contacts and slides across surface **116**. Outer race **110** is radially fixed; therefore, the movement of sloped surface **114** across sloped surface **116** generates radially inward compressive force on outer race **108**, displacing portion **108A** radially inward. The inward displacement of race **108** engages race **108** with the wedge plate. The displacement of race **108** in direction **AD1** also frictionally engages surfaces **114** and **116**. As a result, races **108** and **110** are non-rotatably connected and as further explained below, relative rotation between the inner hub and race **110** causes wedge plate **104** to non-rotatably connect with race **108** and the inner hub.

[0022] To switch wedge clutch **100** from the closed position of Figures 5A and 5B to the open position of Figures 4A and 4B, the conical outer race is arranged to displace in axial direction **AD2**, opposite **AD1**, relieving the radially inward compressive force noted above, separating surface **114** from surface **116**, enabling race **108** to expand radially outward, and creating gap **118**. As further explained below, the radially outward expansion of race **108** enables relative rotation between the inner hub and race **110**.

[0023] In an example embodiment, outer race **110** is fixed with respect to movement in directions **AD1** or **AD2**. In an example embodiment, wedge plate **104** is fixed with respect to movement in directions **AD1** or **AD2** and race **108** displaces in directions **AD1** and **AD2** with respect to the wedge plate.

[0024] Figure 6 is a schematic block diagram of the wedge clutch of Figure 2 showing actuator **122**. Actuator **122** is used to displace race **108** in axial directions **AD1** and **AD2**. Any actuator known in the art, including, but not limited to mechanical, hydraulic, or pneumatic actuators can be used for actuator **122**.

[0025] Returning to Figures 2 through 5B, in an example embodiment, radially outer surface **124** of inner hub **102** includes radially outwardly extending ramps **126**. Wedge plate **104** includes radially inner surface **128** with radially inwardly extending ramps **130**. In the open position for clutch **100**, ramps **126** and **130** are engaged and radially outer surface **132** of wedge plate **104** is free of contact with radially inner surface **134** of race **108**, for example, surfaces **132** and **134** are separated by gap **136**. The inner hub and the wedge plate rotate together and are rotatable with respect to race **108**. Due to gap **118**, race **108** is rotatable with respect to outer race **110**.

[0026] To transit from the open position of clutch **100** to the closed position for clutch **100**, race **108** is axially displaced in direction **AD1** so that surfaces **114** and **116** frictionally engage, non-rotatably connecting races **108** and **110** and displacing race **108** radially inward to engage surface **132** of the wedge plate as described above. The non-rotatable connection of races **108** and **110** and the engagement of wedge plate **104** with race **108** enables relative rotation between wedge plate **104** and inner hub **102**. For example, for relative rotation of wedge plate **104** with respect to the inner hub in circumferential direction **CD1**, ramps **130A** begin to slide along ramps **126A** in direction **CD1**. Thus, the radially inwardly increasing portions of ramps **130** slide across the radially outwardly increasing portions of ramps **126** causing wedge plate **104** to expand radially outward to relieve the force between ramps **126** and **130**. As a result, plate **104** is wedged between the inner hub and race **108**, non-rotatably connecting the inner hub and race **108**.

[0027] For example, for relative rotation of wedge plate **104** with respect to the inner hub in circumferential direction **CD2**, ramps **130B** begin to slide along ramps **126B** in direction **CD2**. Thus, the radially inwardly increasing portions of ramps **130** slide across the radially outwardly increasing portions of ramps **126** causing wedge plate **104** to expand radially outward to relieve the force between ramps **126** and **130**. As a result, plate **104** is wedged between the inner hub and race **108**, non-rotatably connecting the inner hub and race **108**. In an example embodiment, plate **104** includes gap **138** to facilitate radial displacement of plate **104**.

[0028] In an example embodiment, angles **AGL1** and **AGL2** are calculated such that the frictional engagement and non-rotatable connection of surfaces **114** and **116** is self-locking. Thus, outer races **108** and **110** are not pushed apart (race **108** is not displaced in direction **AD2** with respect to race **110**) due to forces from wedge plate **104**, for example, radially directed forces due to a torque load on clutch **100**. As a result, it is not necessary to keep actuator **122** actively engaged to apply pressure to outer race **108**, reducing the energy requirement and increasing the service life for actuator **122**. In another example embodiment, the angles are calculated so that only a minimal force from actuator **122** keeps the clutch engaged and removal of the actuator force disengages the clutch.

[0029] Advantageously, outer race assembly provides a means of opening and closing clutch **100** without the necessity of changing or removing torque loads on the inner hub or outer race **110** and without the necessity of modifying rotation of the inner hub or outer race **110**. Regardless of the torque loads on clutch **100** or relative rotation of components of clutch **100**, outer race **108** can be axially displaced in directions **AD1** and **AD2** to close and open the clutch, respectively.

[0030] Further, since outer races **108** and **110** are not in contact in the open position for clutch **100**, frictional losses associated with operation of clutch **100** in the open mode are eliminated or greatly reduced.

[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 I Claim Is:

1. A wedge clutch, comprising:

an inner hub;

an outer race assembly including:

a first outer race; and,

a conical outer race:

including a portion aligned with the first outer race in a radial direction orthogonal to an axis of rotation for the wedge clutch; and,

axially displaceable with respect to the first outer race to open and close the wedge clutch; and,

a wedge plate radially located between the inner hub and the outer race assembly, wherein:

in a closed position for the wedge clutch, the wedge plate is non-rotatably connected to the inner hub and the first outer race; and,

in an open position for the wedge clutch, the inner hub and the first outer race are rotatable relative to each other.

2. The wedge clutch of Claim 1, wherein the conical outer race is displaceable:

in a first axial direction, parallel to an axis of rotation for the wedge clutch, with respect to the first outer race to non-rotatably connect the inner hub and the first outer race; and,

in a second axial direction, opposite the first axial direction, with respect to the first outer race to separate the conical outer race from the first outer race.

3. The wedge clutch of Claim 1, wherein:

the portion of the conical outer race is located radially inward of the first outer race in the radial direction.

4. The wedge clutch of Claim 1, wherein:

the wedge plate includes a radially outer surface;

the conical outer race includes a radially inner surface;

in the open position for the clutch, the radially inner surface and the radially outer surface are free of contact; and,

in the closed position for the clutch, the radially inner surface and the radially outer surface are in contact.

5. The wedge clutch of Claim 1, wherein:

the first outer race includes a first radially inner surface;

the portion of the conical outer race includes a first radially outer surface aligned with the first radially inner surface in the radial direction; and,

the first radially inner surface and the second radially outer surface each slope toward the axis of rotation in a first axial direction parallel to the axis of rotation.

6. The wedge clutch of Claim 5, wherein to switch the wedge clutch from the open position to the closed position the conical outer race is arranged to displace in the first axial direction to slide the first radially outer surface across the first radially inner surface to:

displace the portion of the conical outer race radially inward; and,

bring the conical outer race and the wedge plate into contact.

7. The wedge clutch of Claim 6, wherein:

the inner hub includes a second radially outer surface including a plurality of radially outwardly extending ramps;

the wedge plate includes a second radially inner surface with a plurality of radially inwardly extending ramps;

in the open position for the wedge clutch, the respective pluralities of radially outwardly and inwardly extending ramps are in contact and the inner hub and the wedge plate rotate together; and,

the contact of the wedge plate with the conical outer race is arranged to cause relative rotation between the wedge plate and the inner hub such that:

the plurality of radially inwardly extending ramps slide along the plurality of radially outwardly extending ramps in a circumferential direction; and,

the wedge plate expands radially outward to non-rotatably connect the inner hub with the first outer race.

8. The wedge clutch of Claim 1, wherein the first outer race is fixed with respect to movement parallel to the axis of rotation.

9. The wedge clutch of Claim 1, further comprising:

an actuator arranged to displace the conical outer race, in first and second opposite axial directions parallel to an axis of rotation for the wedge clutch, to switch the wedge clutch between the closed and open positions.

10. The wedge clutch of Claim 1, wherein in the closed position the inner hub and first outer race are rotatable together in one of first or second opposite rotational directions about the axis of rotation for the wedge clutch.

11. A wedge clutch, comprising:

an inner hub;

an outer race assembly including:

a first outer race; and,

a conical outer race:

including a first portion aligned with the first outer race in a radial direction orthogonal to an axis of rotation for the wedge clutch; and,

including a second portion aligned with the first outer race in an axial direction parallel to the axis of rotation; and,

a wedge plate radially located between the inner hub and the conical outer race and engaged with the inner hub, wherein:

the conical outer race is axially displaceable with respect to the first outer race:

to bring the first and second portions into contact with the first outer race to non-rotatably connect the inner hub, the wedge plate, and the outer race assembly; and,

to separate the first and second portions from the first outer race to enable relative rotation between the inner hub and the first outer race.

12. The wedge clutch of Claim 11, wherein:

the wedge plate includes a radially outer surface;

the conical outer race includes a radially inner surface;

in the open position for the clutch, the radially inner surface and the radially outer surface are free of contact; and,

in the closed position for the clutch, the radially inner surface and the radially outer surface are in contact.

13. The wedge clutch of Claim 11, wherein:

the first outer race includes a first radially inner surface;

the first and second portions of the conical outer race include a first radially outer surface aligned with the first radially inner surface in the radial direction; and,

the first radially inner surface and the first radially outer surface each slope toward the axis of rotation in a first axial direction parallel to the axis of rotation.

14. The wedge clutch of Claim 13, wherein to switch the wedge clutch from the open position to the closed position the conical outer race is arranged to displace in a first axial direction, parallel to the axis of rotation, to slide the first radially outer surface across the first radially inner surface to:

displace the first and second portions of the conical outer race radially inward; and,

bring the conical outer race and the wedge plate into contact.

15. The wedge clutch of Claim 14, wherein:

the inner hub includes a second radially outer surface including a plurality of radially outwardly extending ramps;

the wedge plate includes a second radially inner surface with a plurality of radially inwardly extending ramps;

in the open position for the wedge clutch, the respective pluralities of radially outwardly and inwardly extending ramps are in contact and the inner hub and the wedge plate rotate together; and,

the contact of the wedge plate with the conical outer race is arranged to cause relative rotation between the wedge plate and the inner hub such that:

the plurality of radially inwardly extending ramps slide along the plurality of radially outwardly extending ramps in a circumferential direction; and,

the wedge plate expands radially outward to non-rotatably connect the inner hub with the first outer race.

16. The wedge clutch of Claim 11, wherein the first outer race is fixed with respect to movement parallel to the axis of rotation.

17. The wedge clutch of Claim 11, further comprising:

an actuator arranged to axially displace the conical outer race.

18. A wedge clutch, comprising:

an inner hub;

an outer race assembly including

a first outer race; and,

conical outer race including a portion radially inward of the first outer race and aligned with the first outer race in a radial direction orthogonal to the axis of rotation; and,

a wedge plate engaged with the inner hub and the conical outer race and located between the inner hub and the conical outer race in the radial direction, wherein:

for a closed position of the wedge clutch, the conical outer race is displaceable in a first axial direction, parallel to the axis of rotation, to bring the portion of the conical outer race and the first outer race into contact to non-rotatably connect the inner hub and the first outer race; and,

for an open position of the clutch, the conical outer race is displaceable in a second axial direction, opposite the first axial direction, to separate the portion of the conical outer race from the first outer race so that the inner hub and the first outer race are rotatable relative to each other.

19. The wedge clutch of Claim 18, wherein:

the portion of the conical outer race includes a radially outer surface sloping toward the axis of rotation in the first axial direction;

the first outer race includes a radially inner surface sloping toward the axis of rotation in the first axial direction;

for the closed position of the wedge clutch, the conical outer race is displaceable in the first axial direction to bring the radially inner surface and the radially outer surface into contact to non-rotatably connect the inner hub and the first outer race; and,

for the open position of the wedge clutch, the conical outer race is displaceable in the second axial direction to separate the radially inner surface and the radially outer surface to enable relative rotation of the inner hub and the first outer race.

20. The wedge clutch of Claim 19, wherein:

in the open position for the wedge clutch, the conical outer race and wedge plate are free of contact; and,

to switch the wedge clutch from the open position to the closed position the conical outer race is arranged to displace in the first axial direction to slide the radially outer surface across the radially inner surface to:

displace the portion of the conical outer race radially inward;

bring the conical outer race and the wedge plate into contact; and,

cause relative rotation between the wedge plate and the inner hub.

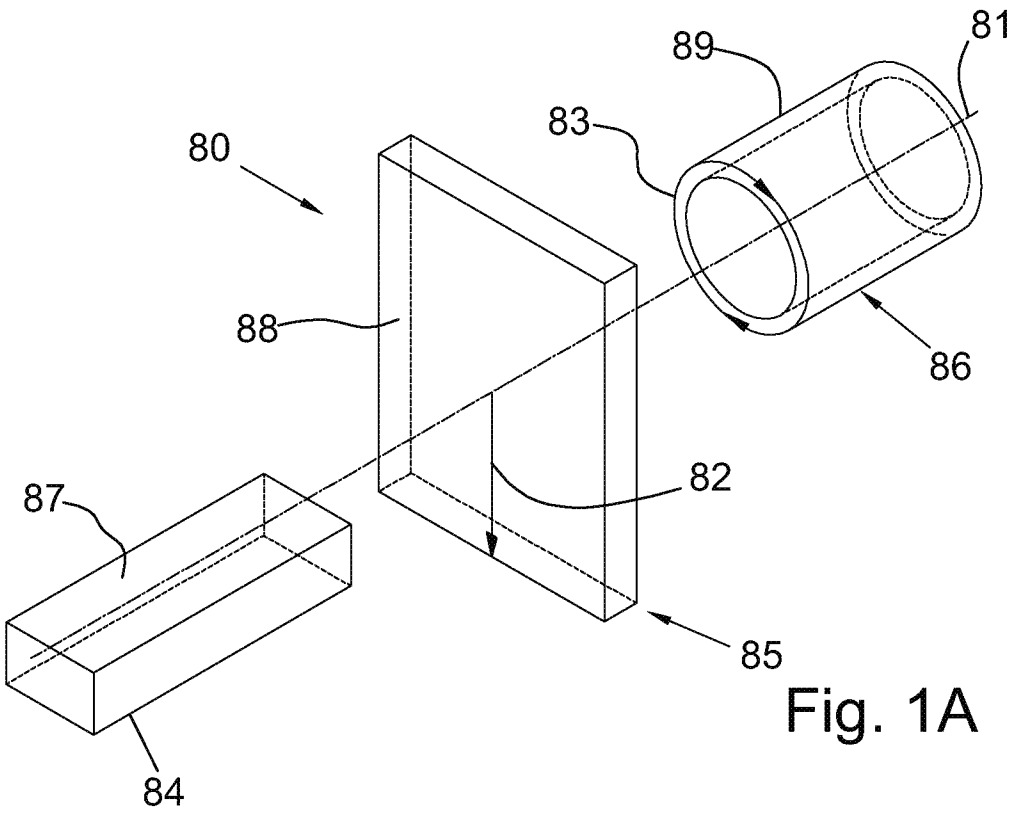


Fig. 1A

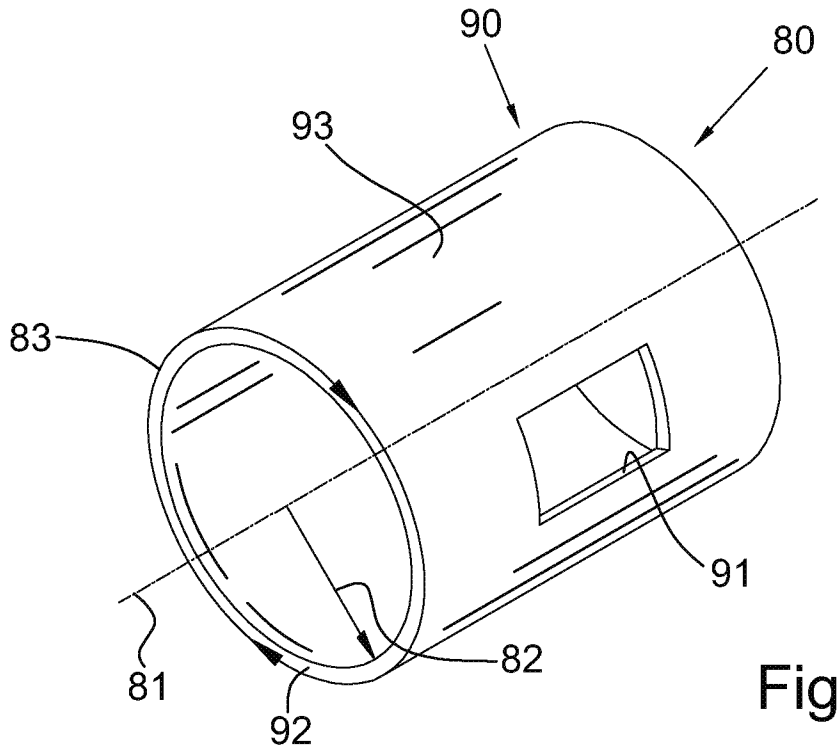


Fig. 1B

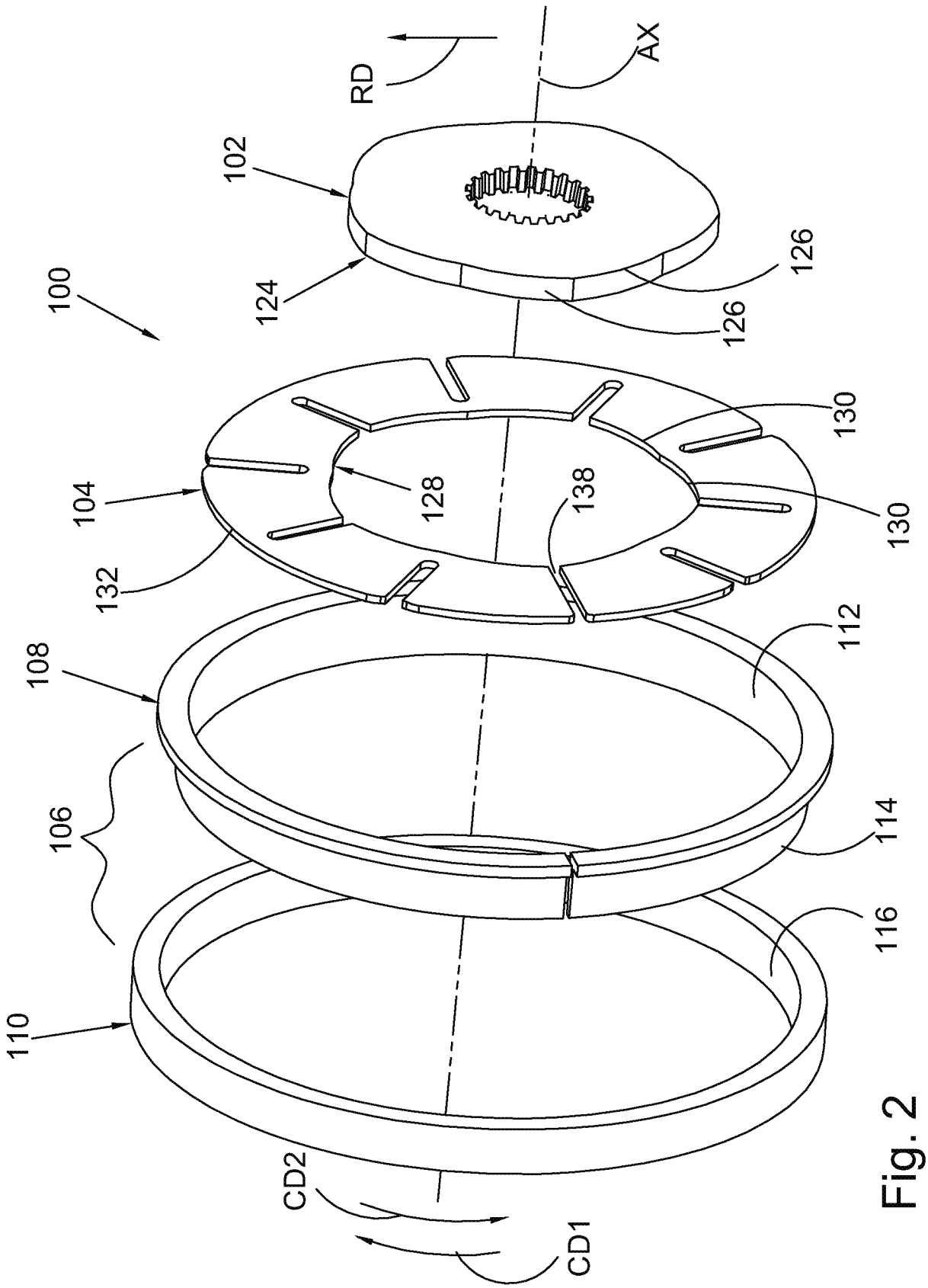

RD
AX
102
100
124
126
126
130
104
128
138
130
132
112
108
106
114
116
110
CD2
CD1

Fig. 2

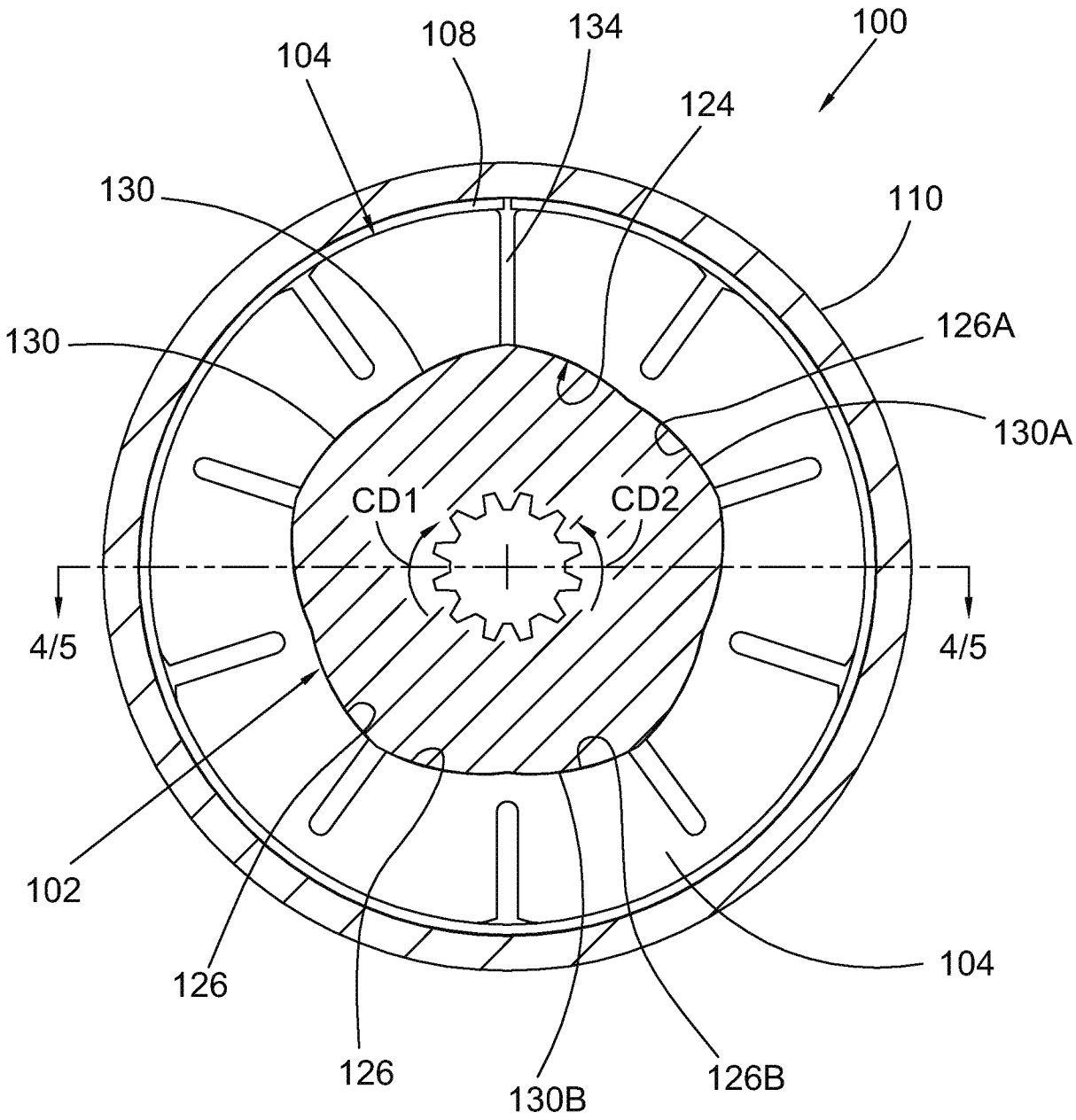

100
104
108
134
124
130
110
130
126A
130A
CD1
CD2
4/5
4/5
102
126
126
130B
126B
104

Fig. 3

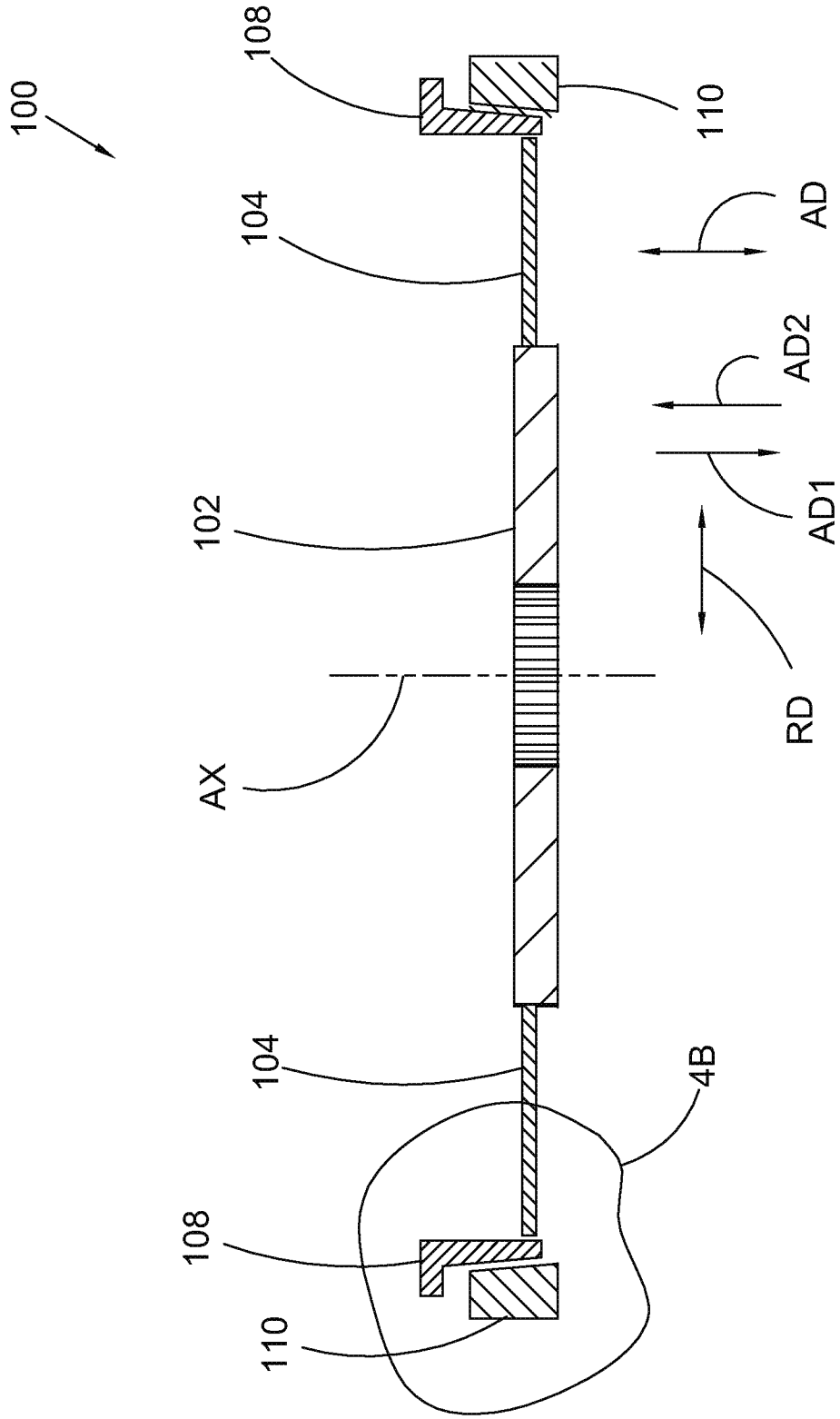


Fig. 4A

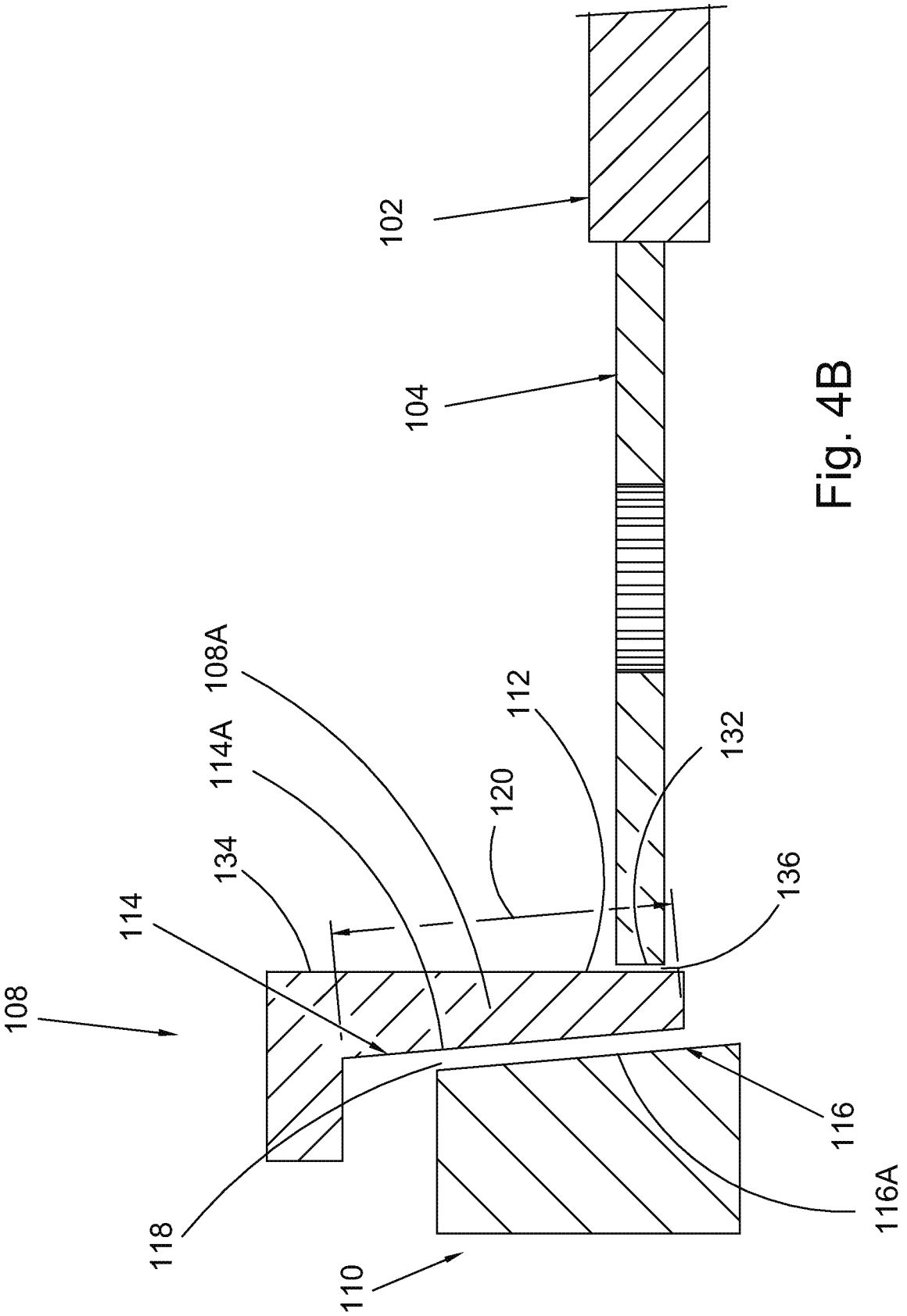


Fig. 4B

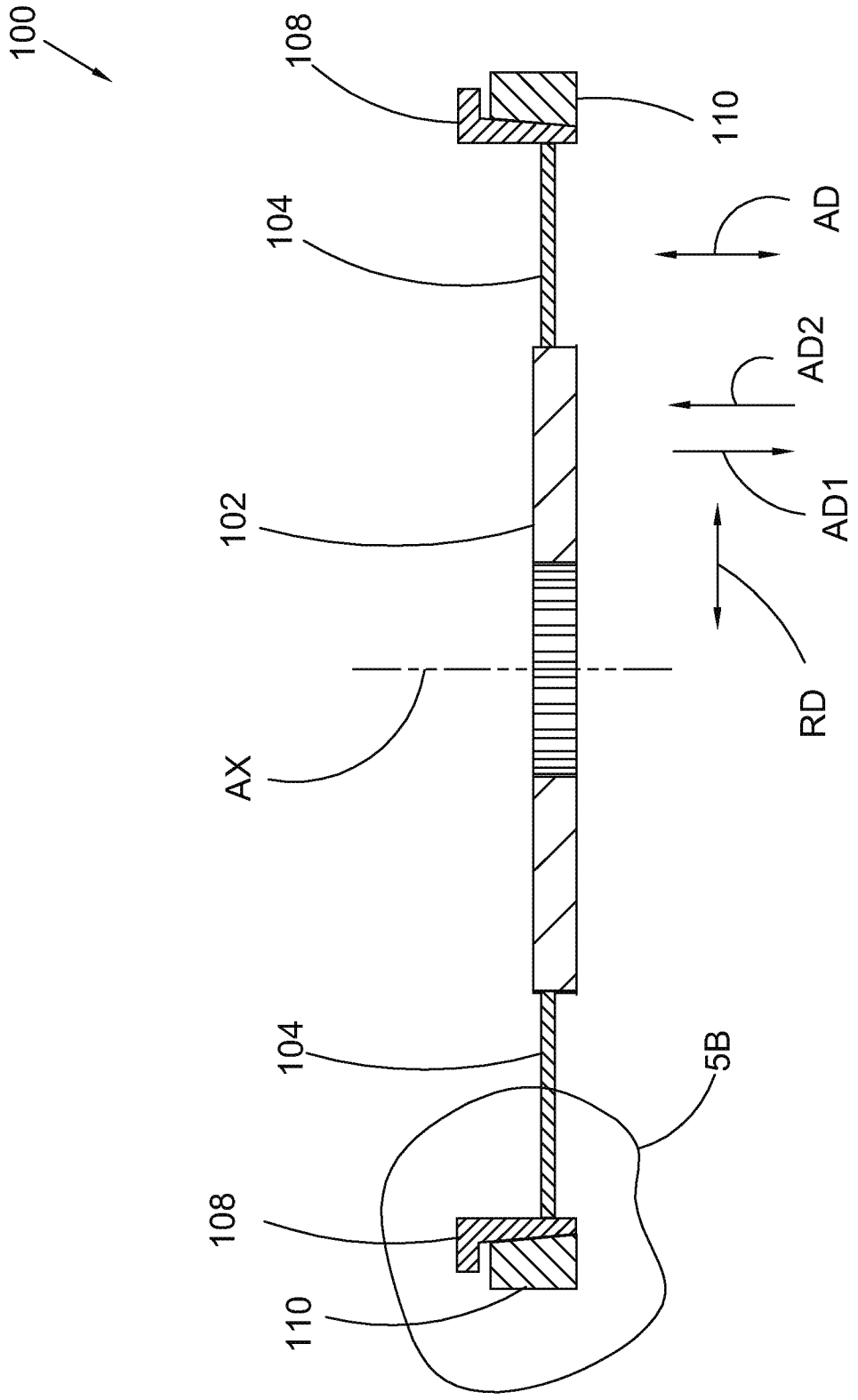


Fig. 5A

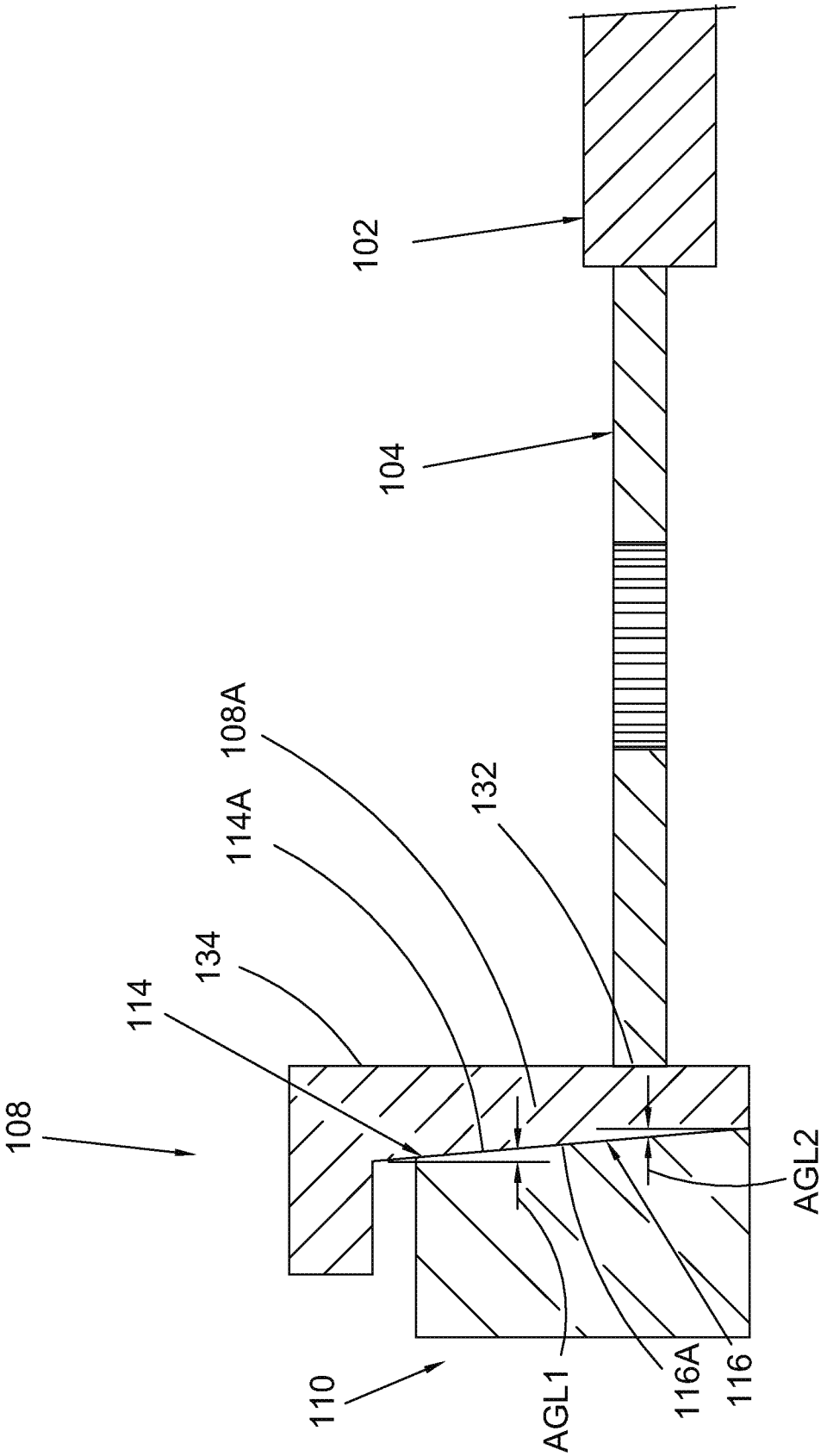


Fig. 5B

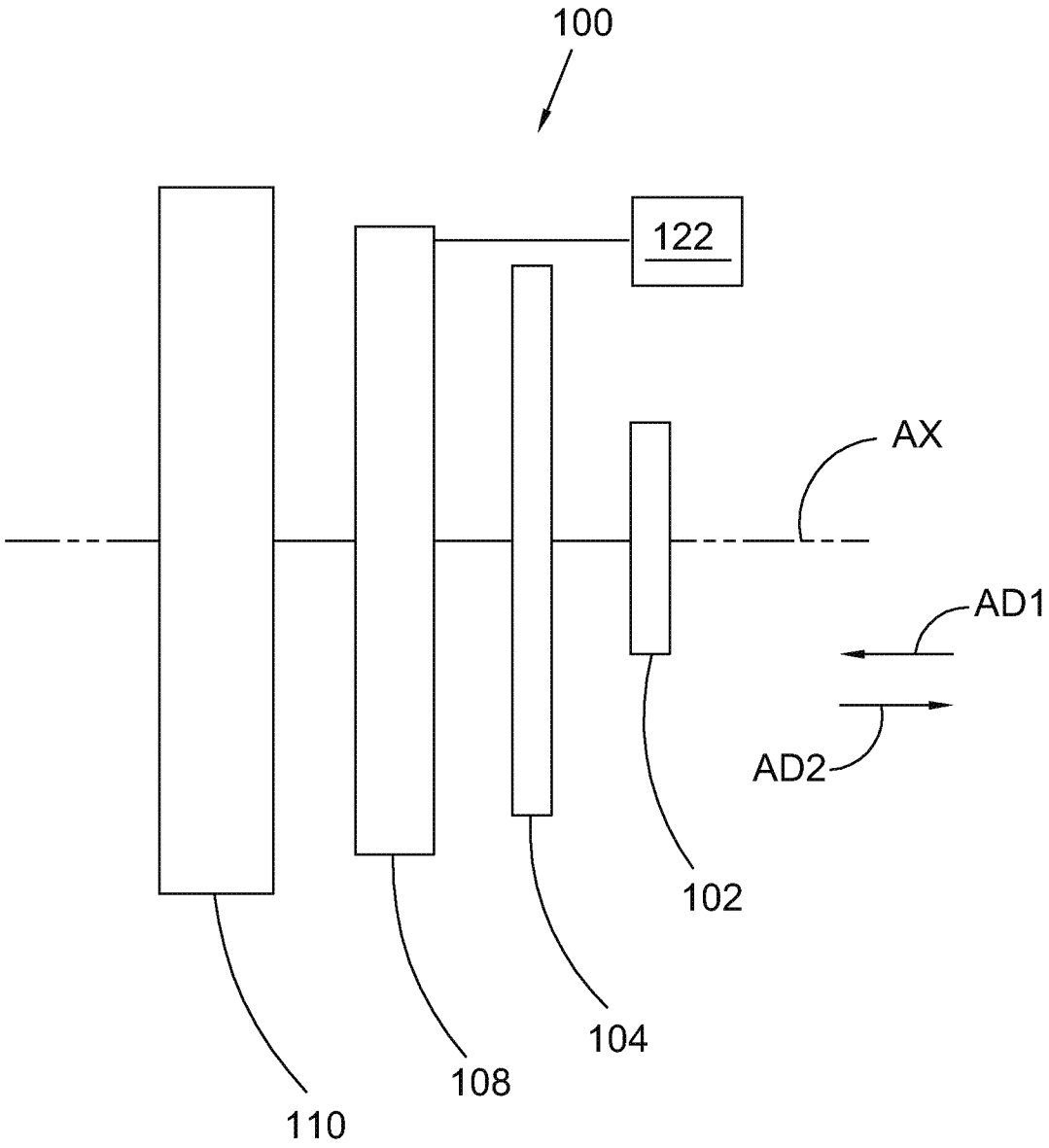


Fig. 6