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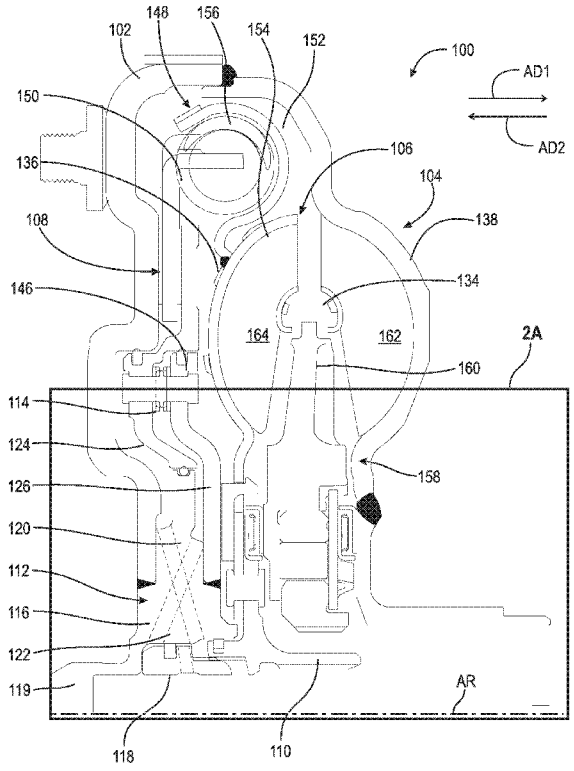


Fig. 2

(57) Abstract: A cover arranged to receive torque from an engine; an impeller; a turbine; an output hub arranged to non-rotatably connect to an input shaft for a transmission; a lockup clutch including an axially displaceable piston plate and arranged to directly connect the cover to the output hub; and a seal system including a pilot portion including first and second channels and a secondary hub non-rotatably connected to the output hub and axially displaceable with respect to the output hub to control flow of pressurized fluid through the first and second channels, or non-rotatably connected to the pilot portion and axially displaceable with respect to the pilot portion to control flow of pressurized fluid through the first and second channels.

WO 2017/019364 A1

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TORQUE CONVERTER WITH A SELECTIVE PRESSURE ACTIVATED SEAL SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under Articles 4 and 8 of the Stockholm Act of the Paris Convention for the Protection of Industrial Property and under 35 U.S.C. §120 of United States Non-provisional Patent Application No. 14/807,964, filed on July 24, 2015, which application is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a torque converter with a selective pressure activated seal system, in particular, a seal system displaced by fluid pressures in a four-pass torque converter during torque converter and lockup modes for the torque converter to assist in lift-off for a piston in a lockup clutch in a release mode for the clutch.

BACKGROUND

[0003] Known four pass torque converter designs include four fluid circuits: two circuits to charge the torus; one circuit to apply the lock up clutch; and one circuit connected to the sump (atmospheric pressure). These designs also use leaf springs to control the lift-off of the piston and insure clutch clearance during clutch release mode operation. Seals used to isolate the various pressure chambers of the clutch system introduce a drag force, acting against the lift-off of the pistons, that can be greater than the force generated by the leaf springs. This drag can prevent the piston from lifting off the clutch to the desired clearance, or in a worst case scenario cause the piston to remain in contact with the clutch plate. Both cases generate undesirable drag in the system and impact torque converter performance.

SUMMARY

[0004] The present disclosure broadly comprises a torque converter, including a cover arranged to receive torque from an engine, an impeller, a turbine, an output hub arranged to non-rotatably connect to an input shaft for a transmission, a lockup clutch including an axially displaceable piston plate and arranged to directly connect the cover to the output hub, and a seal system including a pilot portion including first and second channels and a secondary hub non-rotatably connected to the output hub and axially displaceable with respect to the output hub to control flow of pressurized fluid through the first and second channels, or non-rotatably connected to the pilot portion and axially displaceable with respect to the pilot portion to control flow of pressurized fluid through the first and second channels.

[0005] The present disclosure broadly comprises a torque converter, including a cover arranged to receive torque from an engine, an impeller, a turbine, an output hub arranged to non-rotatably connect to an input shaft for a transmission, a lockup clutch including an axially displaceable piston plate arranged to directly connect the cover to the output hub, a release pressure chamber partially bounded by the piston, an apply pressure chamber partially bounded by the piston, and a seal system including a pilot portion including first and second channels and a secondary hub non-rotatably connected to the output hub and axially displaceable with respect to the output hub to control flow of pressurized fluid through the first and second channels. For a torque converter mode, fluid pressure in the release pressure chamber is arranged to displace the piston in a first axial direction to open the lockup clutch and enable independent rotation of the output hub with respect to the cover. For a lockup mode, fluid pressure in the apply pressure chamber is arranged to displace the piston in a second axial direction, opposite the first axial direction, to close the lockup clutch and non-rotatably connect the cover and the output hub. The first and second channels open to the release pressure chamber and the apply pressure chamber, respectively.

[0006] The present disclosure broadly comprises a torque converter, including a cover arranged to receive torque from an engine, an impeller, a turbine, an output hub arranged to non-rotatably connect to an input shaft for a transmission, a lockup clutch including an axially displaceable piston plate arranged to directly connect the cover to the output hub, a release pressure chamber partially bounded by the piston, an apply pressure chamber partially bounded by the piston, and a seal system including a pilot portion including first and second channels and a secondary hub non-rotatably connected to the pilot portion and axially displaceable with respect to the pilot portion to control flow of pressurized fluid through the first and second channels. For a torque converter mode, fluid pressure in the release pressure chamber is arranged to displace the piston in a first axial direction to open the lockup clutch and enable independent rotation of the output hub with respect to the cover. For a lockup mode, fluid pressure in the apply pressure chamber is arranged to displace the piston in a second axial direction, opposite the first axial direction, to close the lockup clutch and non-rotatably connect the cover and the output hub. The first and second channels open to the release pressure chamber and the apply pressure chamber, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The nature and mode of operation of the present disclosure will now be more fully described in the following detailed description of the present disclosure taken with the accompanying figures, 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 cross-sectional view of a torque converter with a selective pressure activated seal system in a torque converter mode;

Figure 2A is a detailed view of area 2A in Figure 2;

Figure 3 is a cross-sectional view of the torque converter of Figure 2 in a lockup mode;

Figure 3A is a detailed view of area 3A in Figure 3;

Figure 4 is a cross-sectional view of the torque converter of Figure 2 with a resilient element in the selective pressure activated seal system;

Figure 5 is a cross-sectional view of the torque converter of Figure 2 with a resilient element in the selective pressure activated seal system;

Figure 6 is a cross-sectional view of a torque converter with a selective pressure activated seal system in a torque converter mode;

Figure 6A is a detailed view of area 6A in Figure 6;

Figure 7 is a cross-sectional view of the torque converter of Figure 6 in a lockup mode; and,

Figure 7A is a detailed view of area 7A in Figure 7.

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 pertains. 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] 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 present disclosure belongs. It should be appreciated that the term "substantially" is synonymous with terms such as "nearly", "very nearly", "about", "approximately", "around", "bordering on", "close to", "essentially", "in the neighborhood of", "in the vicinity of", etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term "proximate" is synonymous with terms such as "nearby", "close", "adjacent", "neighboring", "immediate", "adjoining", etc., and such terms may be used interchangeably as appearing in the specification and claims.

[0012] 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**.

[0013] 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**.

[0014] Figure 2 is a cross-sectional view of torque converter **100** with a selective pressure activated seal system in a torque converter mode.

[0015] Figure 2A is a detailed view of area 2A in Figure 2. The following should be viewed in light of Figures 2 and 2A. Torque converter **100** includes axis of rotation **AR**, cover **102**, impeller **104**, turbine **106**, lockup clutch **108**, output hub **110**, and pressure activated seal system **112**. The cover is arranged to receive torque from an engine (not shown). Output hub **110** is arranged to non-rotatably connect to input shaft **IS** for a transmission (schematically represented in Figure 2A). The lockup clutch includes axially displaceable piston plate **114** and, as is known in the art, is arranged to directly connect cover **102** to output hub **110**. Seal system **112** includes pilot portion **116** and secondary hub **118**. In an example embodiment, portion **116** is part of pilot **119** and is non-rotatably connected to cover **102**. Portion **116** includes channels **120** and **122**. Hub **118** is non-rotatably connected to output hub **110** and axially displaceable (in opposite axial directions **AD1** and **AD2**) with respect to output hub **110** to control the flow of pressurized fluid through channels **120** and **122**. By "non-rotatably connected" we mean that, whenever hub **110** rotates, hub **118** rotates, and whenever hub **118** rotates, hub **110** rotates. Axial or radial displacement between non-rotatably connected components is possible according to the particular configuration involved.

[0016] Figure 3 is a cross-sectional view of torque converter **100** with a selective pressure activated seal system in a lockup mode.

[0017] Figure 3A is a detailed view of area 3A in Figure 3. The following should be viewed in light of Figures 2 through 3A. Torque converter **100** includes release pressure chamber **124** and apply pressure chamber **126**, each of which are partially bounded by piston **114**. For a torque converter mode, fluid pressure in release pressure chamber **124** is arranged to displace piston **114** in an axial direction **AD1** to open the lockup clutch and enable independent rotation of output hub **110** with respect to cover **102**. For a lockup mode, fluid pressure in apply pressure chamber **126** is arranged to displace piston **114** in axial direction **AD2** to close the lockup clutch and non-rotatably connect cover **102** and output hub **110**. Channels **120** and **122** open to release pressure chamber **124** and apply pressure chamber **126**, respectively.

[0018] Hubs **110** and **118** are non-rotatably connected by non-rotatable connection **128**, including respective portions of output hub **110** and secondary hub **118**, for example,

teeth, or splines, **130** and **132**, respectively, interleaved in a circumferential direction as is known in the art. For the torque converter mode, fluid pressure in torque converter **100**, for example, in torus **134** or chamber **136**, is arranged to displace secondary hub axial direction **AD2** such that secondary hub **118** blocks fluid flow through channel **122**, and fluid flows through non-rotatable connection **128** and channel **120** to release pressure chamber **124**.

[0019] For example, torus **134** and pressure chamber **136** are axially located between cover **102** and impeller shell **138** and are not included as part of the apply pressure chamber or the release pressure chamber. Pressurized fluid **PF1** is arranged to flow from channel **C1** (formed by stator shaft **SS** and pump hub **138**) into torque converter **100** and pressurized fluid **PF2** is arranged to flow out of torque converter **100** to channel **C2** (formed by shaft **SS** and shaft **IS**). For the torque converter mode, fluid pressure in torus **134** and chamber **136**, via channel **C2**, is arranged to displace secondary hub **118** in axial direction **AD2**. For example, pressurized fluid **PF3** flows past splines **140** on hub **110** (non-rotatably connecting hub **110** to shaft **IS**), and pressurized fluid **PF4** flows through connection **128**. Since torque converter **100** is in the torque converter mode, fluid pressure in channel **C3** in shaft **IS** (which urges hub **118** in direction **AD1**) is lower than fluid pressure in channel **C2**, fluid **PF3** displace hub **118** in direction **AD2** until hub **118** contacts portion **116**, blocking flow from channel **C3** to channel **122**. It should be noted that fluid **PF2**, **PF3**, and **PF4** are the same fluid stream, but are individually labeled to clarify the presentation.

[0020] In the example embodiment of Figures 2 and 3, hub **118** includes channel **142**. For the lockup mode, fluid pressure in torque converter **100** displaces secondary hub **118** in axial direction **AD1** such that pressurized fluid **PF5** flows past the secondary hub into apply pressure chamber **126** via channel **122**, and pressurized fluid **PF6** flows out of release apply chamber **124** through channel **120** to channel **C4** in shaft **IS**. Channel **C4** is connected to a sump and is typically at atmospheric pressure. In lockup mode, fluid **PF5** is at a higher pressure than fluid **PF3**, causing fluid **PF5** to displace hub **118** in direction **AD1**.

[0021] In the example embodiment of Figures 2 and 3 assembly **112** includes dynamic seals **144A** and **144B** sealing hub **118** with respect to portion **116** and enabling relative rotation between hub **118** and portion **116**, and, O-rings **146A** and **146B** are arranged to seal hub **118** against shaft **IS** and separate channels **C3** and **C4** and separate channels **C3** and **142** from fluid **PF3**.

[0022] In the example embodiment of Figures 2 and 3, torque converter **100** includes plate **146** non-rotatably connected to portion **116** and bounding chamber **126**, and torsional vibration damper **148** including input part **150**, output part **152** non-rotatably connected to turbine shell **154**, and at least one spring **156** engaged with parts **152** and **154**. In the lockup mode, piston **114** clamps part **150** to cover **102** to transmit torque from cover **102** to shell **154** via springs **156** and part **152**. Shell **154** is non-rotatably connected to hub **110**.

[0023] In the example embodiment of Figures 2 and 3 torque converter **100** includes stator **158** with at least one stator blade **160**, impeller **104** includes at least one impeller blade **162** connected to shell **138**, and turbine **106** includes at least one turbine blade **164** connected to shell **154**.

[0024] Figure 4 is a cross-sectional view of torque converter **100** of Figure 2 with resilient element **158** in selective pressure activated seal system **112**. In an example embodiment, resilient element **158**, for example, a wave washer, is axially disposed between portion **116** and hub **118**. Element **158** reacts against portion **116** to urge hub **118** in direction **AD1**. The force applied by element **158** helps to overcome pressure applied to hub **118** in direction **AD2** by fluid **PF3**.

[0025] Figure 5 is a cross-sectional view of torque converter **100** of Figure 2 with resilient element **158** in selective pressure activated seal system **112**. In an example embodiment, resilient element **158**, for example, a diaphragm spring, is axially disposed between portion **116** and hub **118**. Element **158** reacts against portion **116** to urge hub **118** in direction **AD1**. The force applied by element **158** helps to overcome pressure applied to hub **118** in direction **AD2** by fluid **PF3**.

[0026] Figure 6 is a cross-sectional view of torque converter **100** with a selective pressure activated seal system in a torque converter mode.

[0027] Figure 6A is a detailed view of area 6A in Figure 6. The following should be viewed in light of Figures 6 and 6A. Torque converter **100** includes axis of rotation **AR**, cover **102**, impeller **104**, turbine **106**, lockup clutch **108**, output hub **110**, and pressure activated seal system **112**. The cover is arranged to receive torque from an engine (not shown). Output hub **110** is arranged to non-rotatably connect to input shaft **IS** for a transmission (schematically represented in Figure 6A). The lockup clutch includes axially displaceable piston plate **114** and, as is known in the art, is arranged to directly connect cover **102** to output hub **110**. Seal system **112** includes pilot portion **116** and secondary hub **118**. In

an example embodiment, portion **116** is part of pilot **119** non-rotatably connected to cover **102**. Portion **116** includes channels **120** and **122**. Hub **118** is non-rotatably connected to portion **116** and axially displaceable (in opposite axial directions **AD1** and **AD2**) with respect to portion **116** to control the flow of pressurized fluid through channels **120** and **122**. In an example embodiment, O-ring **160A** forms a seal between portion **116** and hub **118** and O-ring **160B** forms a partial seal between portion **116** and **118** as further described below.

[0028] Figure 7 is a cross-sectional view of torque converter **100** of Figure 6 in a lockup mode.

[0029] Figure 7A is a detailed view of area 7A in Figure 7. The following should be viewed in light of Figures 6 through 7A. Torque converter **100** includes release pressure chamber **124** and apply pressure chamber **126**, each of which are partially bounded by piston **114**. For a torque converter mode, fluid pressure in release pressure chamber **124** is arranged to displace piston **114** in axial direction **AD1** to open the lockup clutch and enable independent rotation of output hub **110** with respect to cover **102**. For a lockup mode, fluid pressure in apply pressure chamber **126** is arranged to displace piston **114** in axial direction **AD2** to close the lockup clutch and non-rotatably connect cover **102** and output hub **110**. Channels **120** and **122** open to release pressure chamber **124** and apply pressure chamber **126**, respectively.

[0030] Portion **116** and hub **118** are non-rotatably connected by non-rotatable connection **128** including respective portions of portion **116** and secondary hub **118**, for example, teeth, or splines, **130** and **132**, respectively, interleaved in a circumferential direction as is known in the art. For the torque converter mode, fluid pressure torque converter **100**, for example in torus **134** or chamber **136**, is arranged to displace secondary hub **118** axial direction **AD2** such that secondary hub **118** blocks fluid flow through channel **122**, and fluid flows through non-rotatable connection **128** and channel **120** to release pressure chamber **124**.

[0031] For example, pressure chamber **136** is axially located between cover **102** and impeller shell **138** and is not included as part of the apply pressure chamber or the release pressure chamber. For the torque converter mode, pressurized fluid **PF7** in chamber **136** is arranged to displace secondary hub **118** in axial direction **AD2**. Since torque converter **100** is in the torque converter mode, fluid pressure in channel **C3** in shaft **IS** (which urges hub **118** in direction **AD1**) is lower than fluid pressure in chamber **136**, and fluid **PF7** displaces hub

118 in direction AD2 until hub 118 contacts segment 116A of portion 116, and segment 118A of portion 118 blocks flow from channel C3 to channel 122. O-ring 160B is configured to enable a limited amount of fluid flow past O-ring 160B. Therefore, at the same time, pressurized fluid PF8 flows past O-ring 160B and through connection 128 into chamber 124 via channel 120 to increase fluid pressure in chamber 124.

[0032] In the example embodiment of Figures 6 and 7, hub 118 includes channel 142 and hub 110 includes channel 143. For the lockup mode, fluid pressure in torque converter 100 displaces secondary hub 118 in axial direction AD1 such that pressurized fluid PF9 flows past the secondary hub into apply pressure chamber 126 via channel 122, and pressurized fluid PF10 flows out of release apply chamber 124 through channels 120, 142 and 143 to channel C4 in shaft IS. Channel C4 is connected to a sump and is typically at atmospheric pressure. In lockup mode, fluid PF9 is at a higher pressure than fluid PF7, causing fluid PF9 to displace hub 118 in direction AD1.

[0033] In the example embodiment of Figures 6 and 7, assembly 112 includes dynamic seals 144A and 144B sealing hub 118 with respect to portion 116 and enabling relative rotation between hub 118 and portion 116 and, O-rings 146A and 146B are arranged to seal hub 118 against shaft IS and separate channels C3 and C4 and separate channels C3 and 142 from fluid PF3.

[0034] In the example embodiment of Figures 6 and 7, torque converter 100 includes plate 146 non-rotatably connected to portion 116 and bounding chamber 126, and torsional vibration damper 148 including input part 150, output part 152 non-rotatably connected to turbine shell 154, and at least one spring 156 engaged with parts 152 and 154. In the lockup mode, piston 114 clamps part 150 to cover 102 to transmit torque from cover 102 to shell 154 via springs 156 and part 152.

[0035] Advantageously, seal system 112 uses the four fluid circuits in torque converter 100 to reinforce the operation of release chamber 124 and apply chamber 126 during torque converter and lockup mode and address the problems noted above associated with four pass torque converters. For example, supplying pressurized fluid to release chamber 124 while simultaneously draining fluid from apply chamber 126 ensures that sufficient force is applied to piston 114 to enable a desired lift-off of the piston, overcoming the drag force of seals used to isolate the release and apply chambers.

[0036] 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.

What is claimed is:

1. A torque converter, comprising:

a cover arranged to receive torque from an engine;

an impeller;

a turbine;

an output hub arranged to non-rotatably connect to an input shaft for a transmission;

a lockup clutch:

including an axially displaceable piston plate; and,

arranged to directly connect the cover to the output hub; and,

a seal system including:

a pilot portion including first and second channels; and,

a secondary hub:

non-rotatably connected to the output hub and axially displaceable with respect to the output hub to control flow of pressurized fluid through the first and second channels; or,

non-rotatably connected to the pilot portion and axially displaceable with respect to the pilot portion to control flow of pressurized fluid through the first and second channels.

2. The torque converter of Claim 1, further comprising:

a release pressure chamber partially bounded by the piston;

an apply pressure chamber partially bounded by the piston;

for a torque converter mode, fluid pressure in the release pressure chamber is arranged to displace the piston in a first axial direction to open the lockup clutch and enable independent rotation of the output hub with respect to the cover;

for a lockup mode, fluid pressure in the apply pressure chamber is arranged to displace the piston in a second axial direction, opposite the first axial direction, to close the lockup clutch and non-rotatably connect the cover and the output hub; and,

the first and second channels open to the release pressure chamber and the apply pressure chamber, respectively.

3. The torque converter of Claim 2, wherein:

for the torque converter mode a first pressurized fluid in the torque converter, outside of the release and apply pressure chambers, is arranged to displace the secondary hub in the first axial direction such that:

the secondary hub blocks fluid flow through the second channel; and,

the first pressurized fluid flows through the first channel to the release pressure chamber.

4. The torque converter of Claim 3, wherein:

the output hub and the secondary hub are non-rotatably connected by respective portions of the output hub and the secondary hub; and,

for the torque converter mode, the first pressurized fluid is arranged to flow:

between the respective portions of the output hub and the secondary hub;

through the first channel; and,

to the release pressure chamber.

5. The torque converter of Claim 4, further comprising:

a torus enclosed by the impeller and the turbine, wherein:

the second channel is arranged to receive second pressurized fluid from a third channel partially formed by the input shaft; and,

for the torque converter mode:

the first pressurized fluid is arranged to flow:

from the torus; and,

between the respective portions of the output hub and the secondary hub;

the first pressurized fluid flowing between the respective portions of the output hub and the secondary hub is arranged to displace the secondary hub in the first axial direction; and,

the first pressurized fluid flowing between the respective portions of the output hub and the secondary hub is at arranged to be a higher pressure than the second pressurized fluid.

6. The torque converter of Claim 5, wherein:

the secondary hub includes a fourth channel; and,

for the lockup mode:

the first pressurized fluid flowing between the respective portions of the output hub and the secondary hub is arranged to be a lower pressure than the second pressurized fluid;

the second pressurized fluid is arranged to displace the secondary hub in the second axial direction such that:

the second pressurized fluid is able to flow through the second channel to the apply pressure chamber; and,

the fourth channel aligns with the first channel to enable flow from the release pressure chamber to a fifth channel formed in the input shaft.

7. A torque converter, comprising:

a cover arranged to receive torque from an engine;

an impeller;

a turbine;

an output hub arranged to non-rotatably connect to an input shaft for a transmission;

a lockup clutch:

including an axially displaceable piston plate; and,

arranged to directly connect the cover to the output hub;

a release pressure chamber partially bounded by the piston;

an apply pressure chamber partially bounded by the piston; and,

a seal system including:

a pilot portion including first and second channels; and,

a secondary hub non-rotatably connected to the output hub and axially displaceable with respect to the output hub to control flow of pressurized fluid through the first and second channels, wherein:

for a torque converter mode, fluid pressure in the release pressure chamber is arranged to displace the piston in a first axial direction to open the lockup clutch and enable independent rotation of the output hub with respect to the cover;

for a lockup mode, fluid pressure in the apply pressure chamber is arranged to displace the piston in a second axial direction, opposite the first axial direction, to close the lockup clutch and non-rotatably connect the cover and the output hub; and,

the first and second channels open to the release pressure chamber and the apply pressure chamber, respectively.

8. The torque converter of Claim 7, wherein:

for the torque converter mode a first pressurized fluid in the torque converter, outside of the release and apply pressure chambers, is arranged to displace the secondary hub in the first axial direction such that:

the secondary hub blocks fluid flow through the second channel; and,

the first pressurized fluid flows through the first channel to the release pressure chamber.

9. A torque converter, comprising:

a cover arranged to receive torque from an engine;

an impeller;

a turbine;

an output hub arranged to non-rotatably connect to an input shaft for a transmission;

a lockup clutch:

including an axially displaceable piston plate; and,

arranged to directly connect the cover to the output hub;

a release pressure chamber partially bounded by the piston;

an apply pressure chamber partially bounded by the piston; and,

a seal system including:

a pilot portion including first and second channels; and,

a secondary hub non-rotatably connected to the pilot portion and axially displaceable with respect to the pilot portion to control flow of pressurized fluid through the first and second channels, wherein:

for a torque converter mode, fluid pressure in the release pressure chamber is arranged to displace the piston in a first axial direction to open the lockup clutch and enable independent rotation of the output hub with respect to the cover;

for a lockup mode, fluid pressure in the apply pressure chamber is arranged to displace the piston in a second axial direction, opposite the first axial direction, to close the lockup clutch and non-rotatably connect the cover and the output hub; and,

the first and second channels open to the release pressure chamber and the apply pressure chamber, respectively.

10. The torque converter of Claim 9, wherein:

for the torque converter mode a first pressurized fluid in the torque converter, outside of the release and apply pressure chambers, is arranged to displace the secondary hub in the first axial direction such that:

the secondary hub blocks fluid flow through the second channel; and,

the first pressurized fluid flows through the first channel to the release pressure chamber.

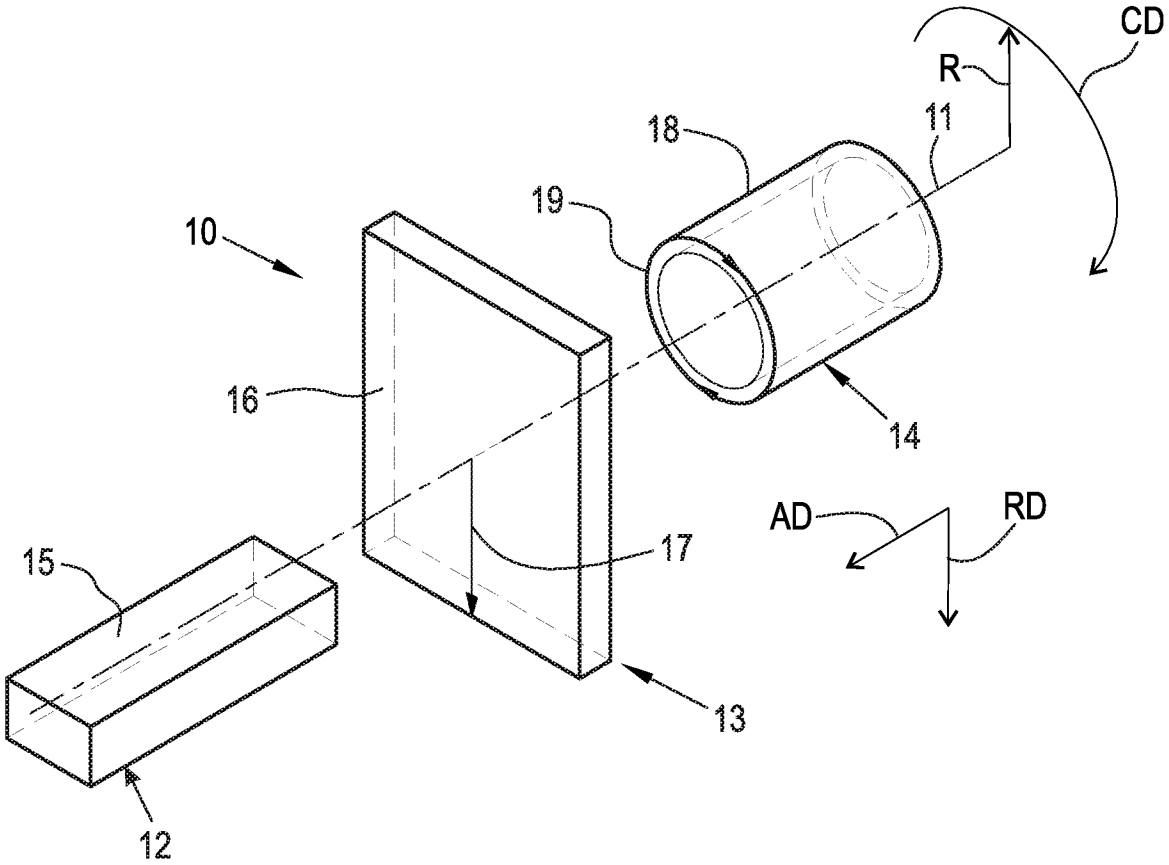


Fig. 1

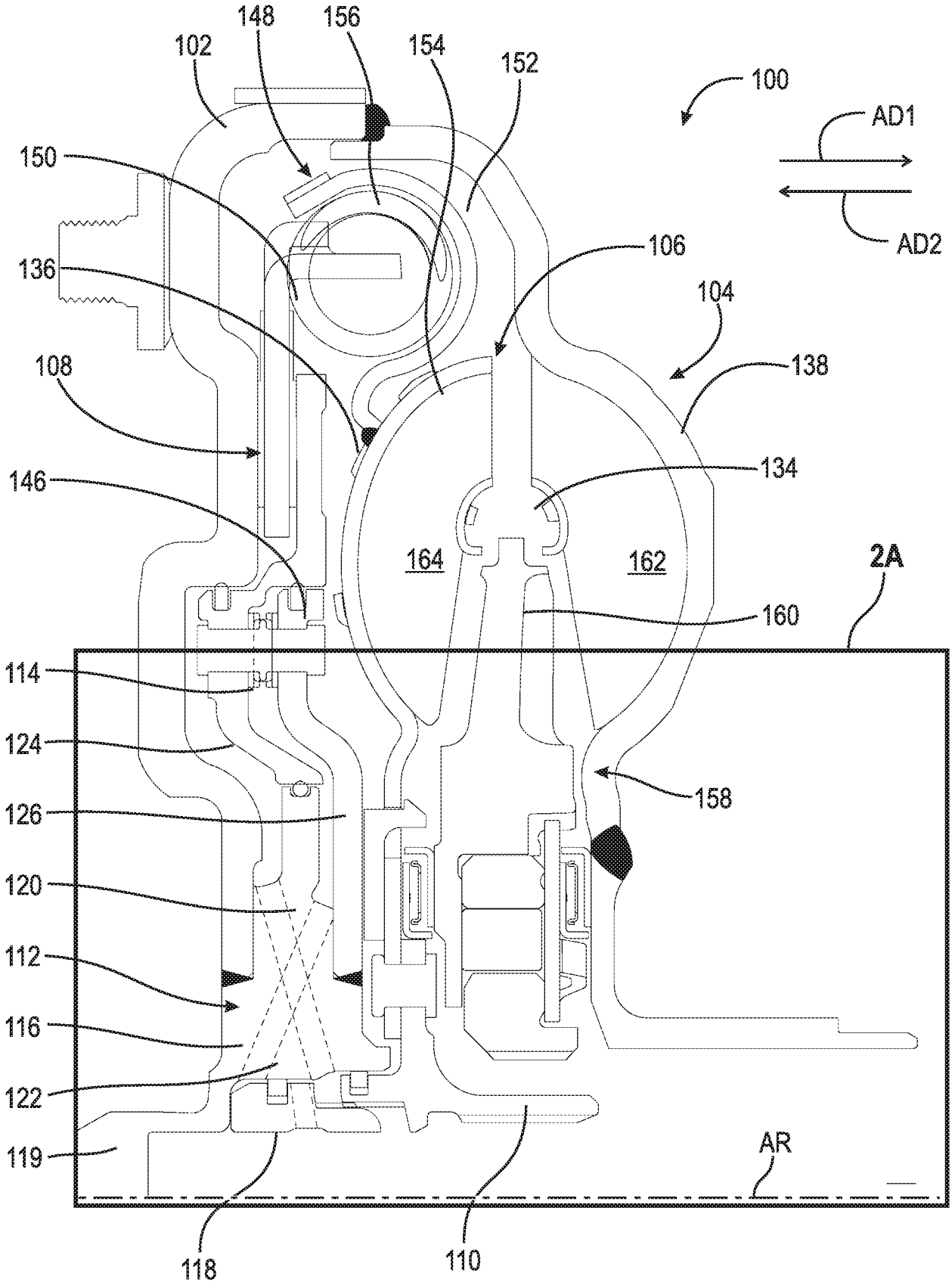

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Fig. 2

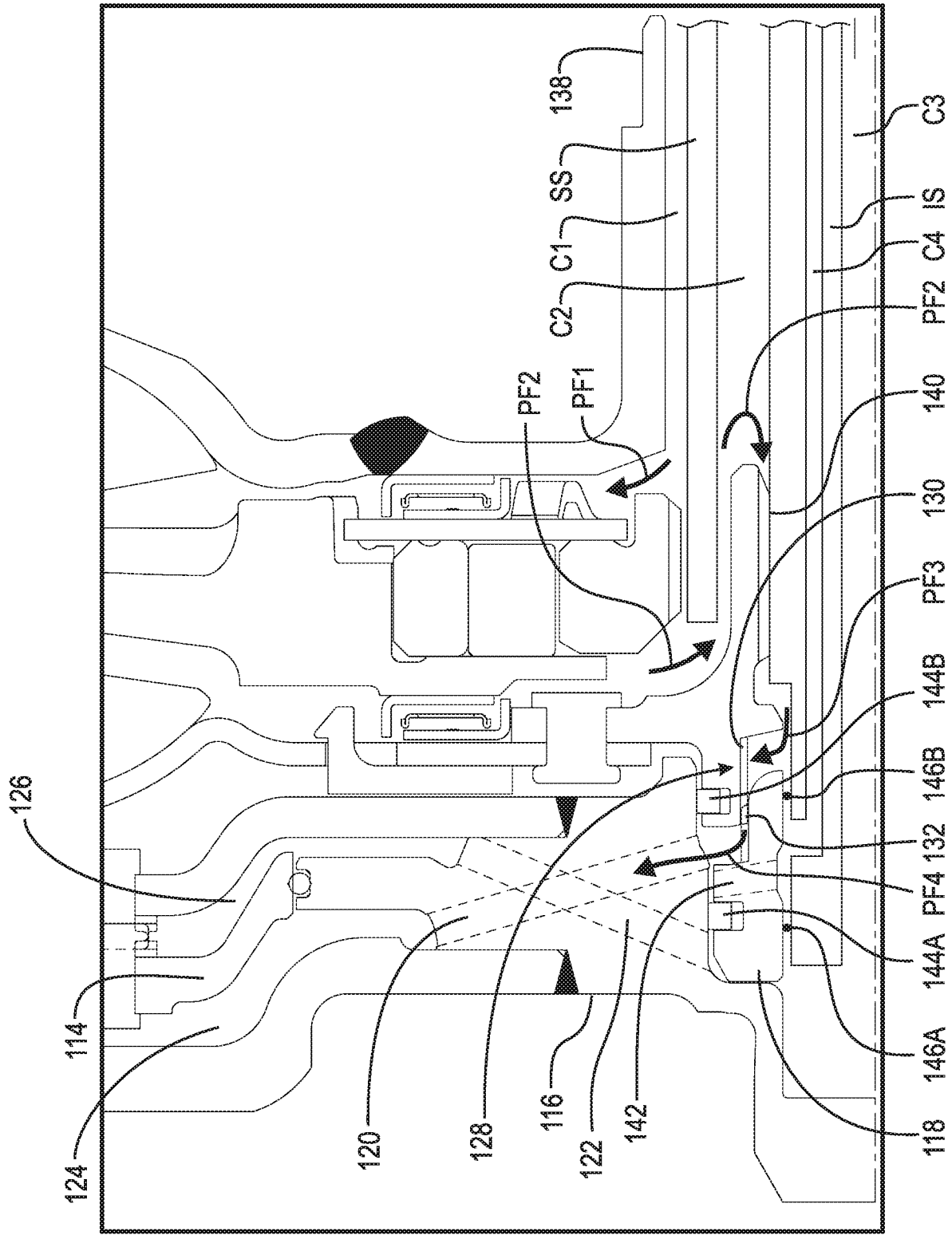

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Fig. 2A

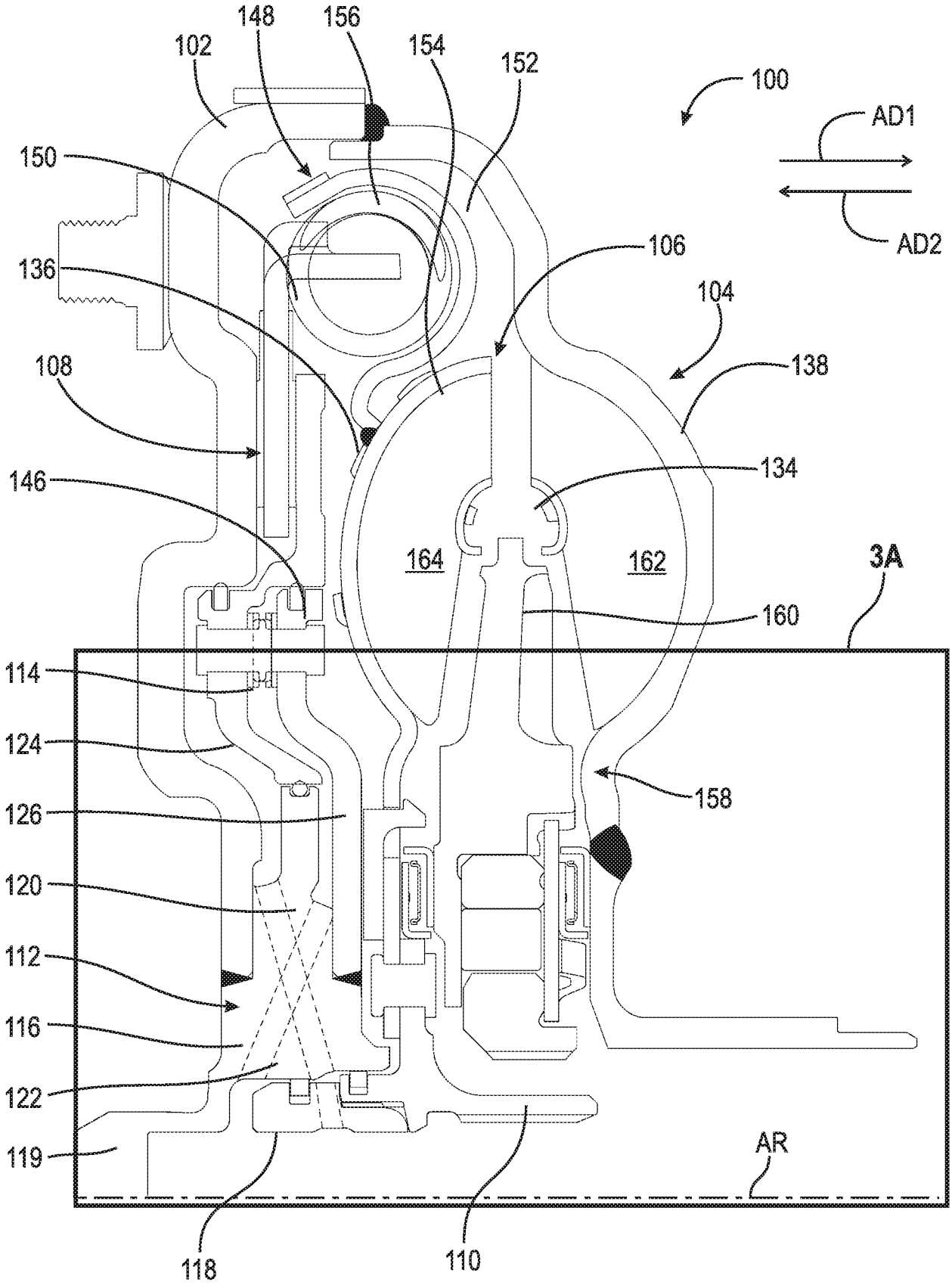

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Fig. 3

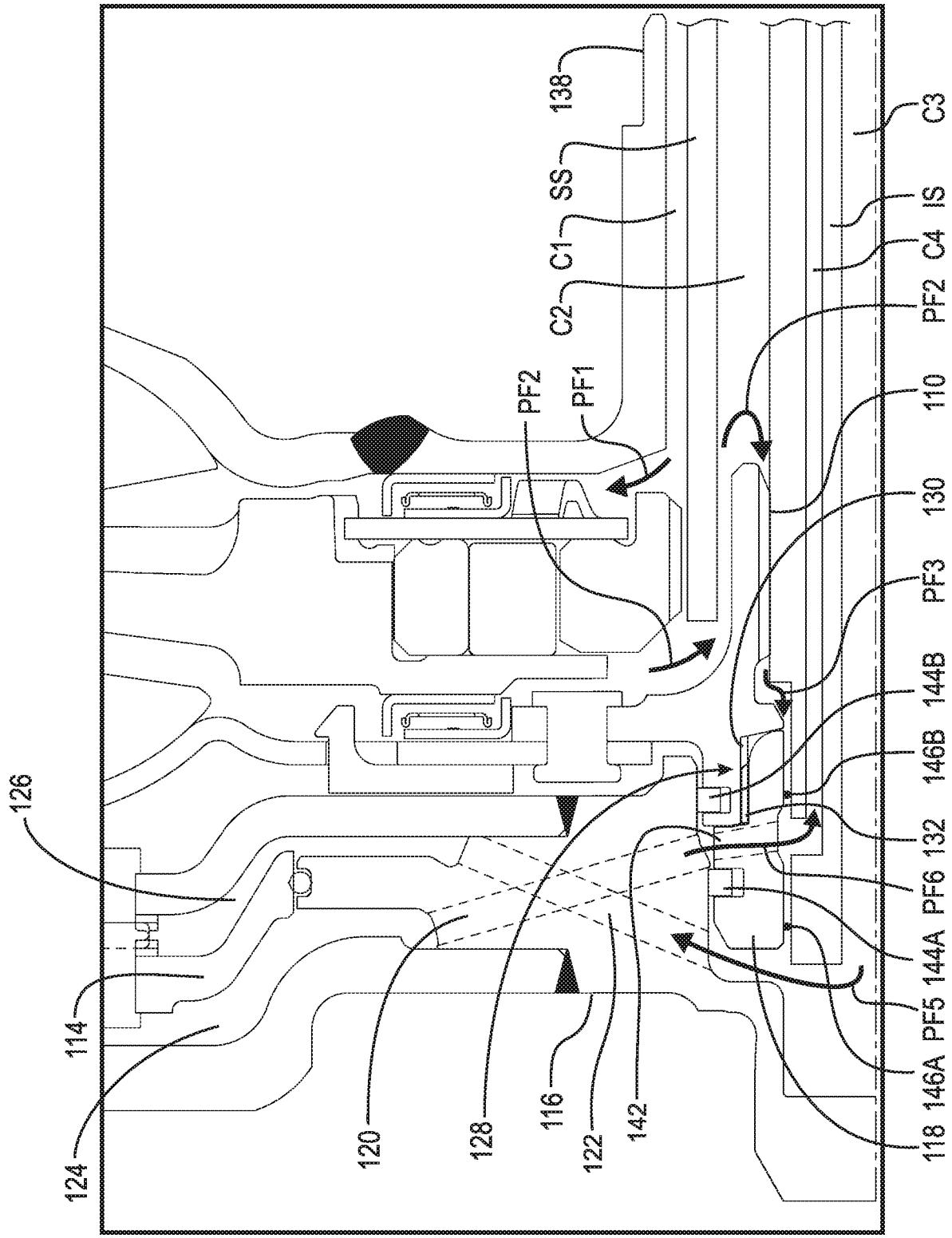

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PF2
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Fig. 3A

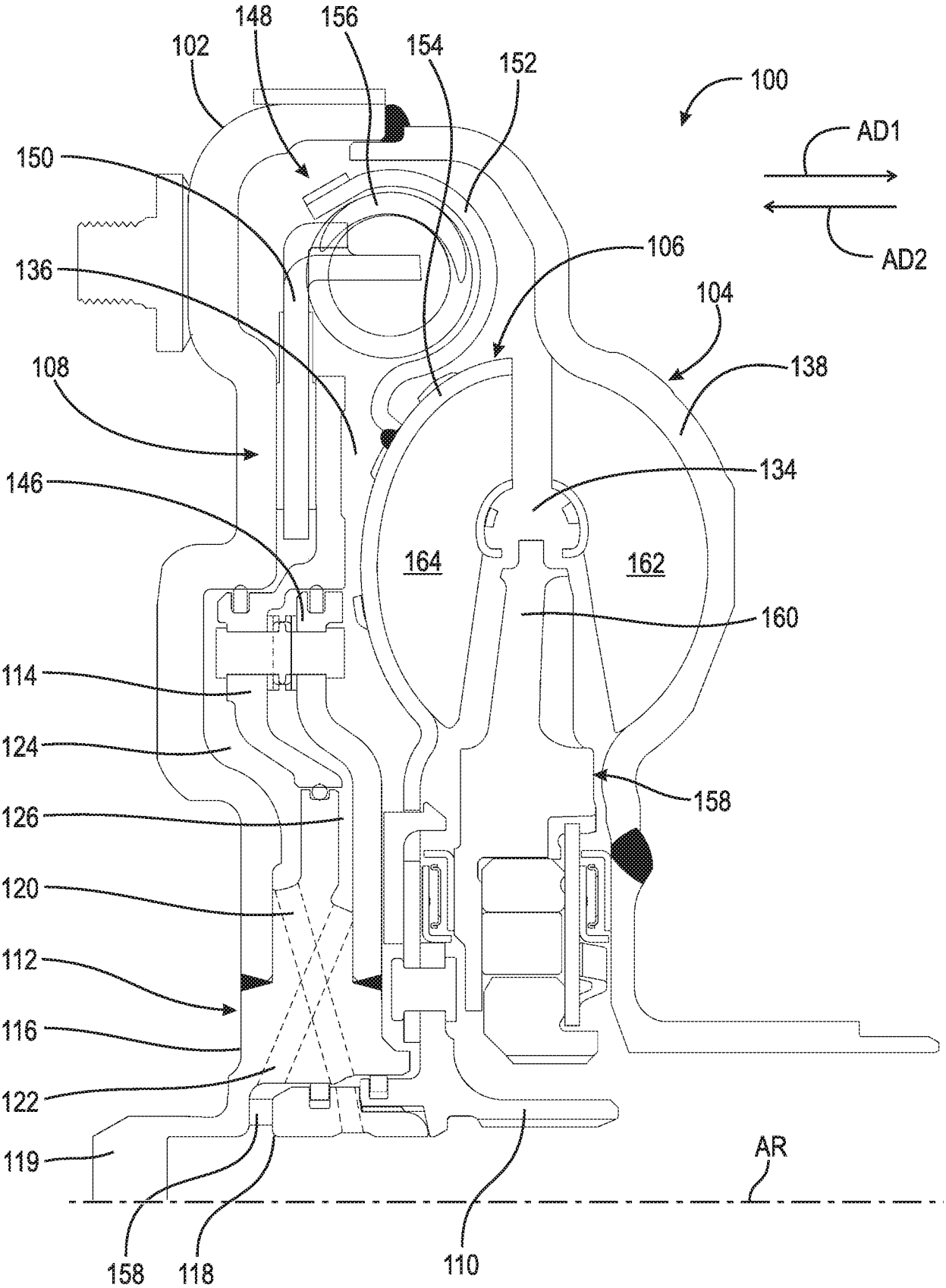

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Fig. 4

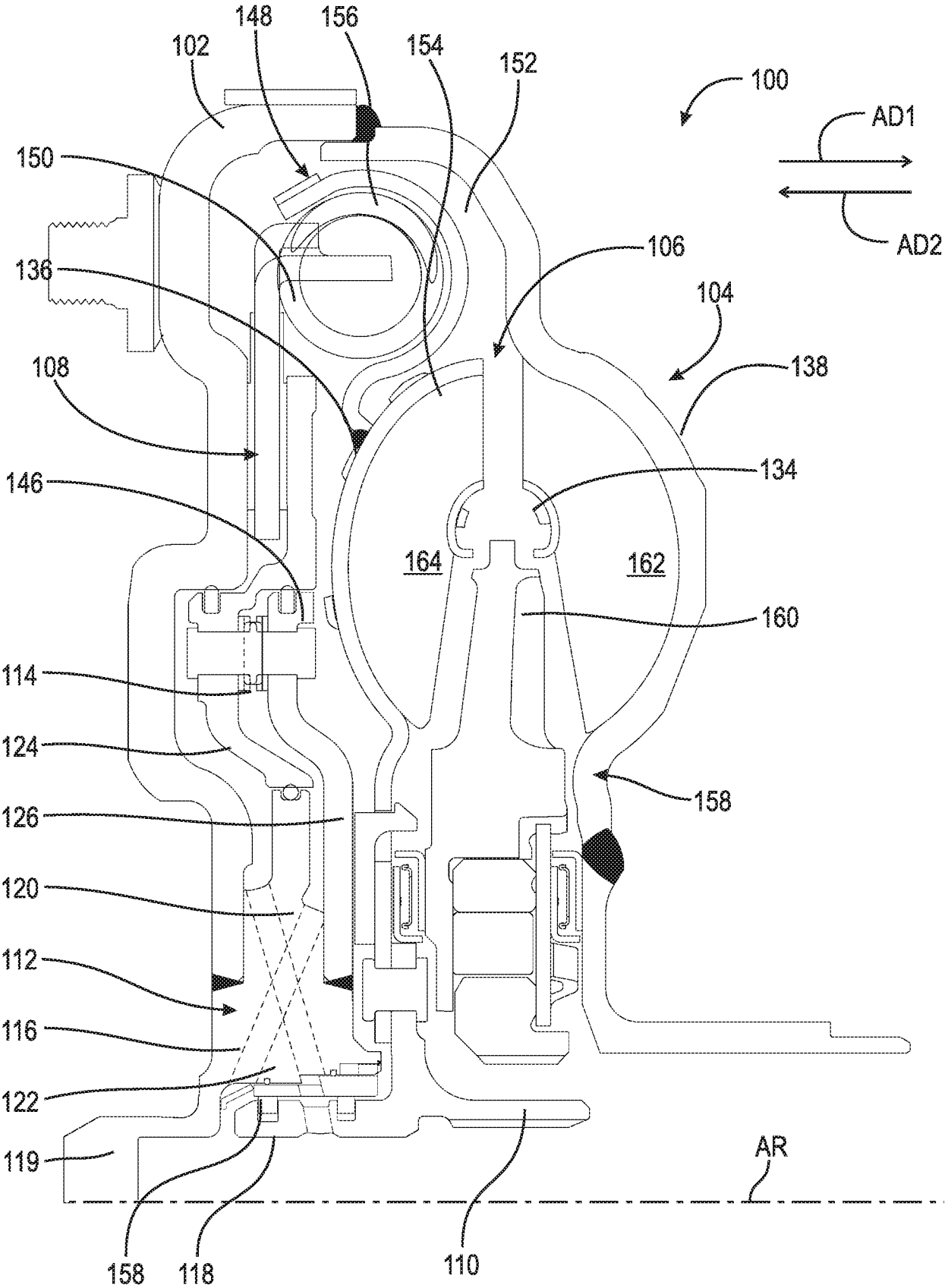

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Fig. 5

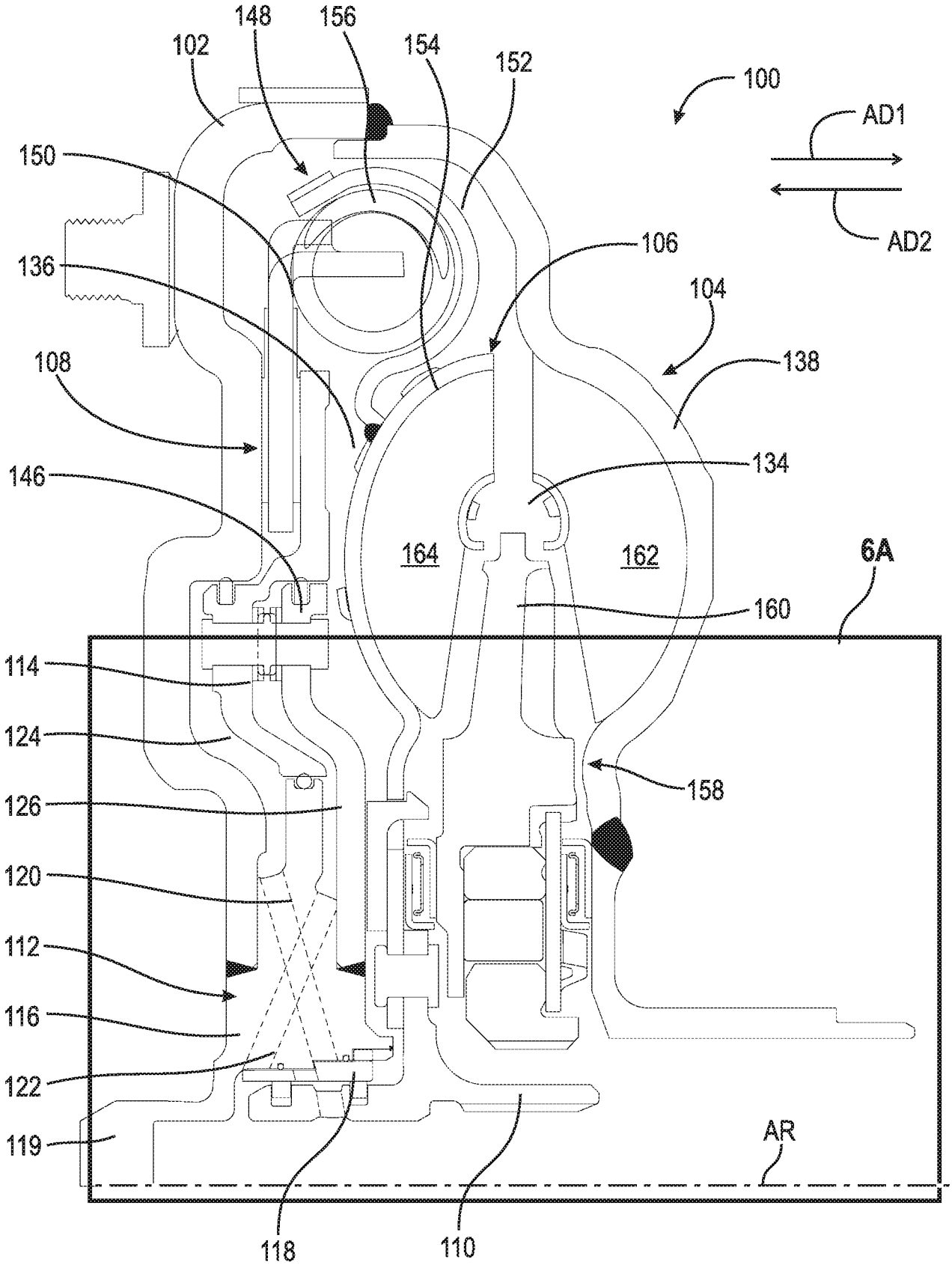

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Fig. 6

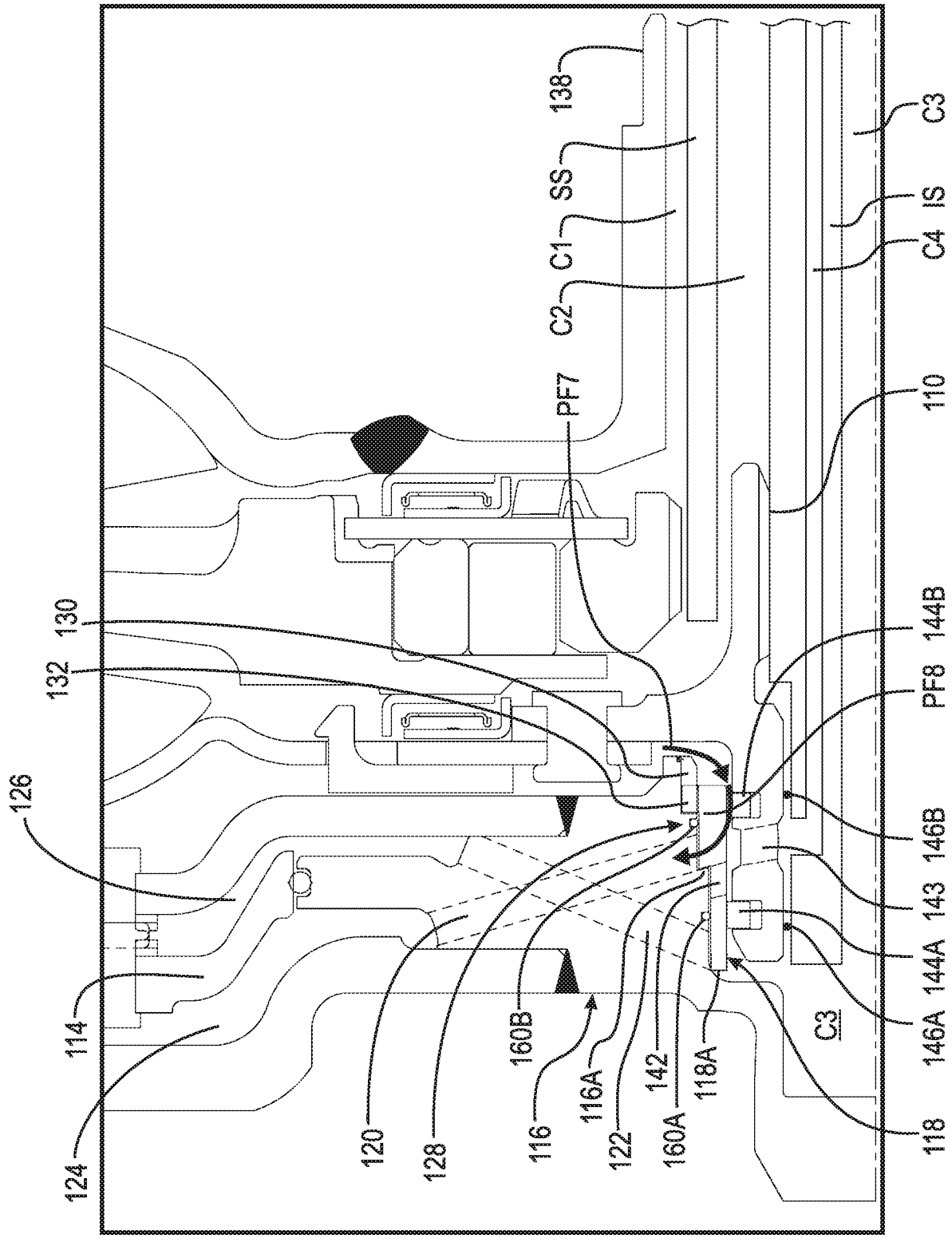

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Fig. 6A

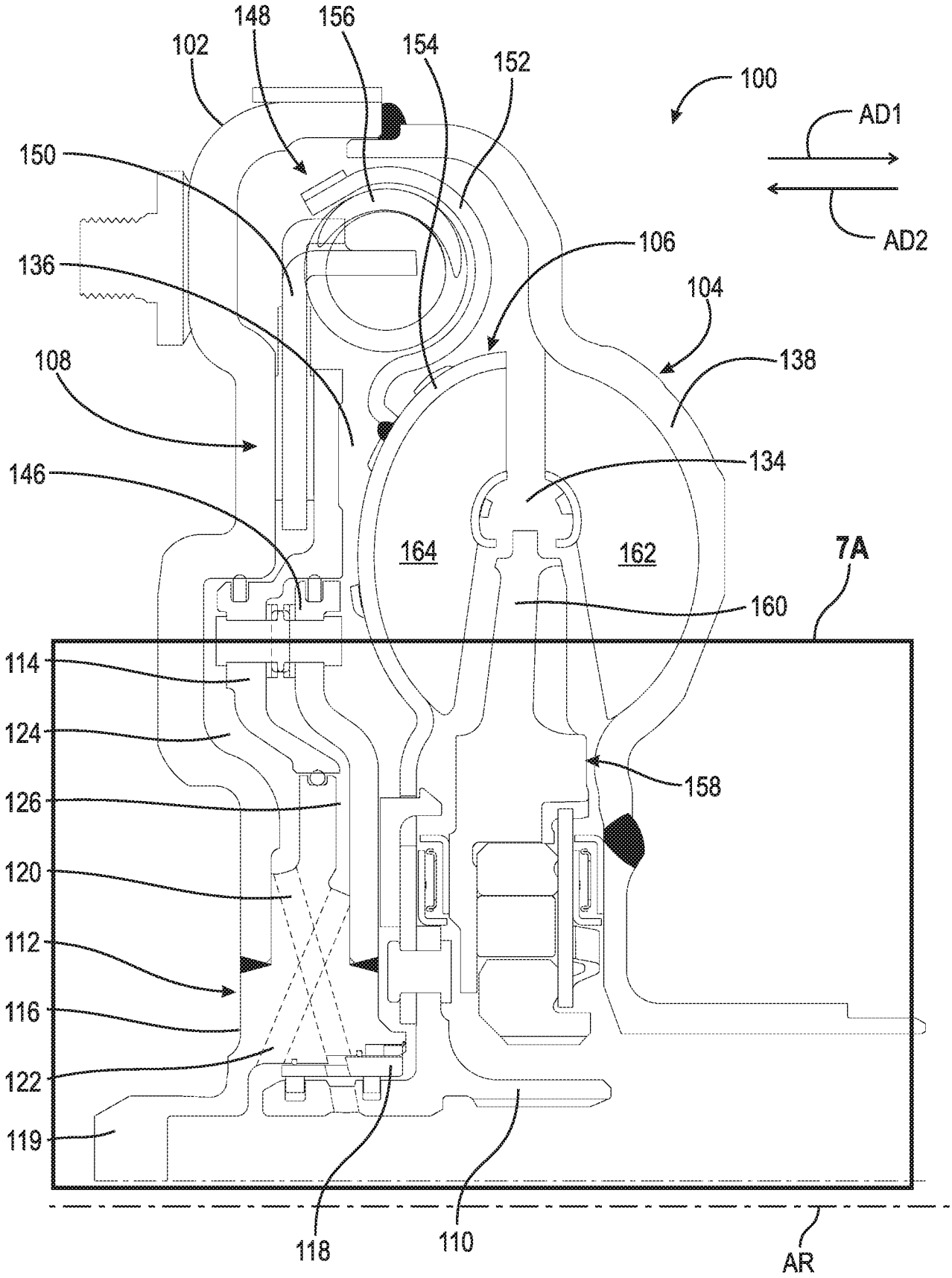

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Fig. 7

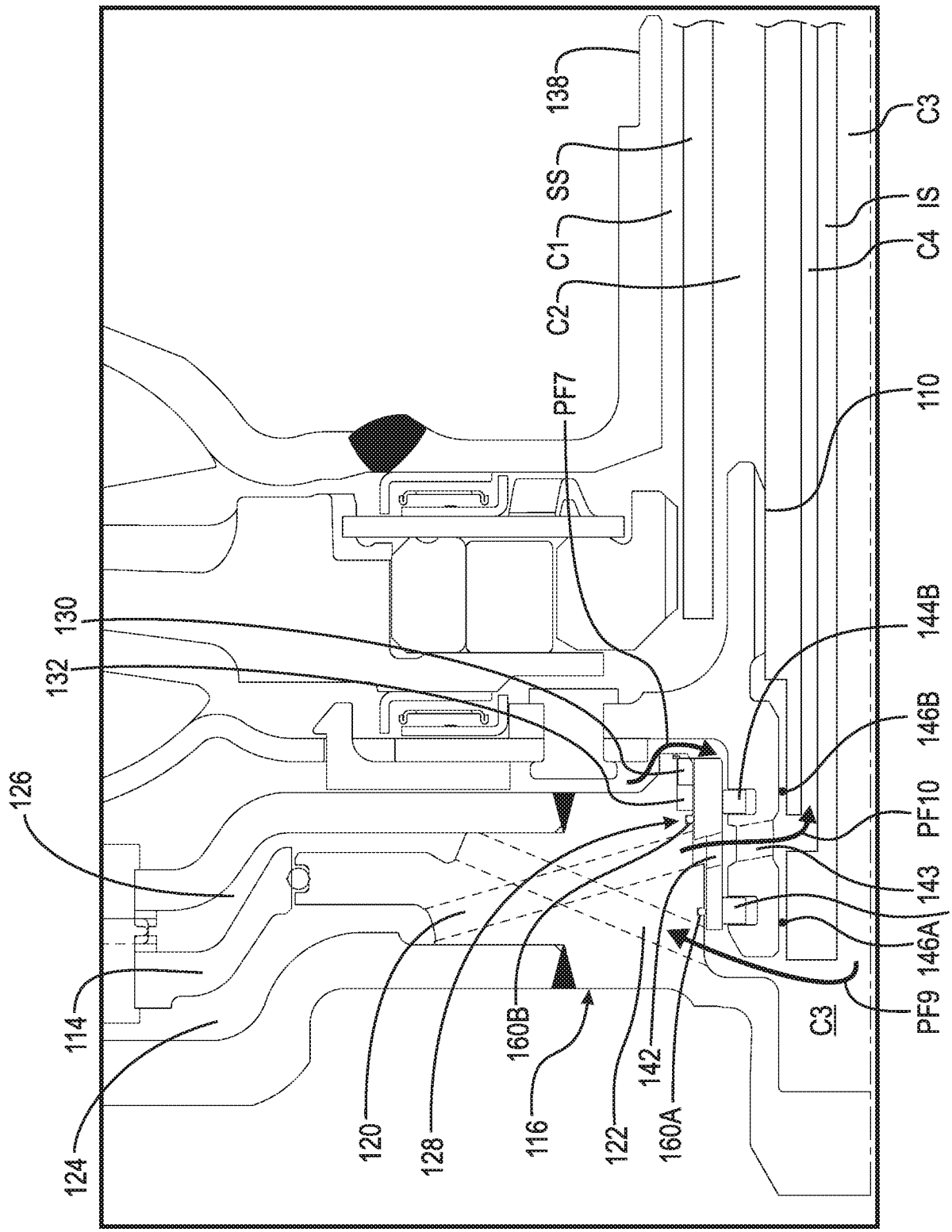

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Fig. 7A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/042801

A. CLASSIFICATION OF SUBJECT MATTER

F16H 41/24(2006.01)i, F16H 41/26(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H 41/24; F16D 33/18; F16H 61/62; F16H 45/02; F16F 15/134; F16D 47/06; F16H 41/26

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: torque converter, lockup, piston, chamber, fluid passage, hub, axial movement

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014-0262666 A1 (EXEDY CORPORATION) 18 September 2014 See paragraphs [0036], [0037], [0042]-[0044], [0049], [0055], [0076], [0081] and figures 1, 2, 5, 7.	1-10
A	JP 2013-217452 A (EXEDY CORPORATION) 24 October 2013 See paragraphs [0024], [0025], [0032], [0039], [0052], [0054], [0055] and figures 1-3.	1-10
A	US 5699887 A (KUNDERMANN, WOLFGANG) 23 December 1997 See column 4, line 51 - column 5, line 43 and figure 1a.	1-10
A	US 2014-0076680 A1 (MATSUOKA, YOSHIHIRO) 20 March 2014 See paragraphs [0034]-[0058] and figure 2.	1-10
A	US 2011-0132709 A1 (FUKUNAGA et al.) 09 June 2011 See paragraphs [0059], [0060] and figure 1.	1-10

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

☒ See patent family annex.

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

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2016 (20.10.2016)	**21 October 2016 (21.10.2016)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/042801

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014-0262666 A1	18/09/2014	CN 103975179 A	06/08/2014
		JP 2013-117282 A	13/06/2013
		JP 5258952 B2	07/08/2013
		US 9267555 B2	23/02/2016
		WO 2013-084637 A1	13/06/2013
JP 2013-217452 A	24/10/2013	CN 104204616 A	10/12/2014
		DE 112013002023 T5	12/03/2015
		JP 5584249 B2	03/09/2014
		KR 10-2014-0144678 A	19/12/2014
		US 2015-0008086 A1	08/01/2015
		US 9303747 B2	05/04/2016
		WO 2013-154065 A1	17/10/2013
US 5699887 A	23/12/1997	DE 19508613 A1	12/09/1996
		FR 2731487 A1	13/09/1996
		FR 2731487 B1	28/05/1999
US 2014-0076680 A1	20/03/2014	CN 103547835 A	29/01/2014
		CN 103547835 B	18/05/2016
		DE 112012002380 T5	27/02/2014
		JP 2012-251649 A	20/12/2012
		JP 5222979 B2	26/06/2013
		KR 10-2014-0037098 A	26/03/2014
		US 2015-0337935 A1	26/11/2015
		US 9285025 B2	15/03/2016
		WO 2012-169243 A1	13/12/2012
US 2011-0132709 A1	09/06/2011	CN 102124252 A	13/07/2011
		DE 112009001985 T5	28/03/2013
		JP 2010-048316 A	04/03/2010
		JP 4684321 B2	18/05/2011
		KR 10-1317747 B1	15/10/2013
		KR 10-2011-0034663 A	05/04/2011
		WO 2010-021243 A1	25/02/2010