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Lindemann et al.

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(54) **TWO PASS MULTI-FUNCTION TORQUE CONVERTER**

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(51) **Int. Cl.**

F16H 45/02	(2006.01)
F16H 41/24	(2006.01)
F16H 45/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F16H 45/02*** (2013.01); ***F16H 41/24*** (2013.01); *F16H 2045/002* (2013.01); *F16H 2045/0205* (2013.01); *F16H 2045/0215* (2013.01); *F16H 2045/0221* (2013.01); *F16H 2045/0257* (2013.01); *F16H 2045/0263* (2013.01); *F16H 2045/0278* (2013.01)

(58) **Field of Classification Search**

CPC F16H 41/24; F16H 2045/0263; F16H 2045/0257; F16H 2045/0205; F16H 2045/0221; F16H 2045/002; F16H 2045/0215; F16H 2045/0278

See application file for complete search history.

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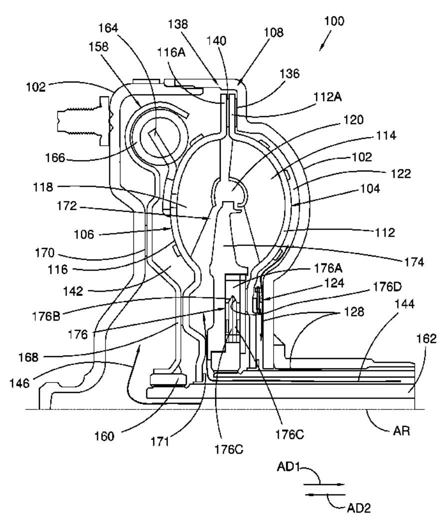
(57) **ABSTRACT**

A torque converter, including: a cover; an impeller including an impeller blade, and an impeller shell with a first surface extending beyond the impeller blade in a radial direction and at an acute angle with respect to a first line in the radial direction; a turbine including a turbine blade, and a turbine shell with a second surface axially aligned with the first surface and at the acute angle with respect to the first line; a turbine clutch including the first and second surfaces and friction material disposed between the first and second surfaces; a torus at least partially enclosed by the impeller and turbine shells; and a pressure chamber at least partially formed by the turbine shell and the cover. For torque converter mode, the turbine and the impeller are independently rotatably with respect to each other. For lock-up mode, the first and second surfaces are non-rotatably connected.

18 Claims, 11 Drawing Sheets



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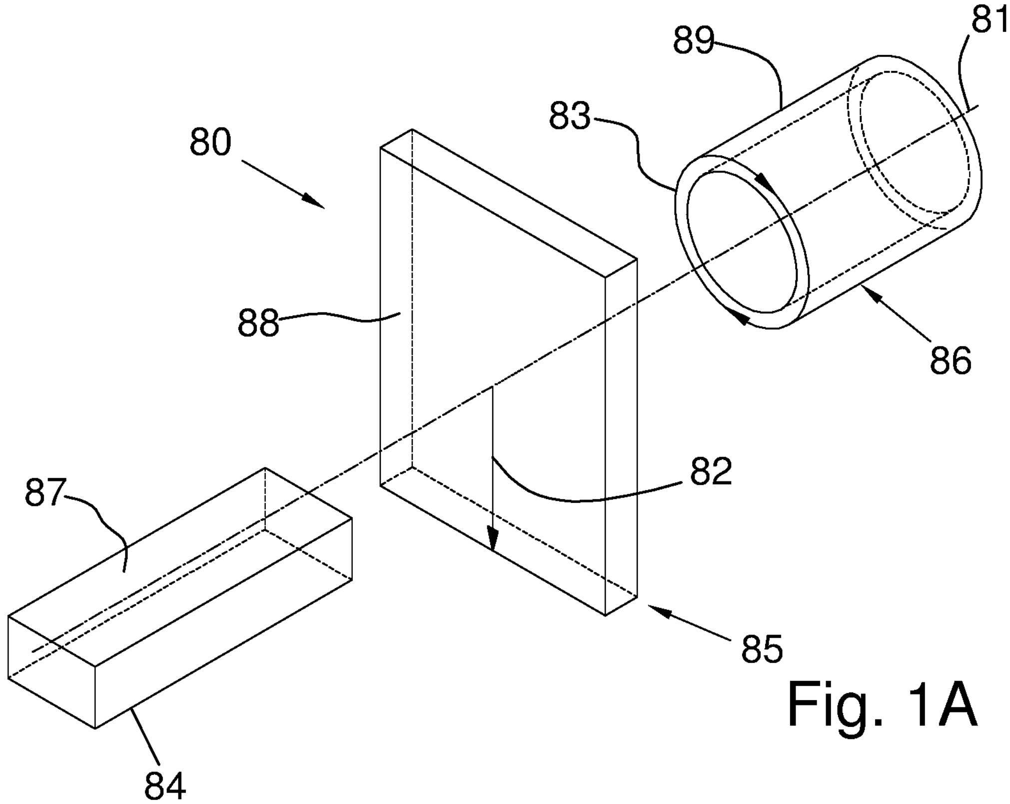


Fig. 1A

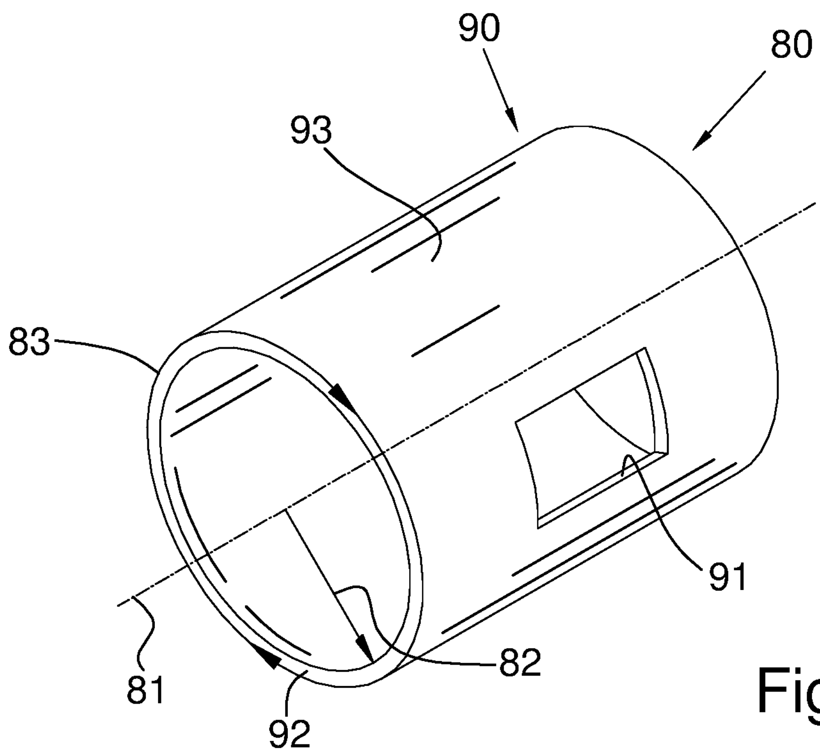


Fig. 1B

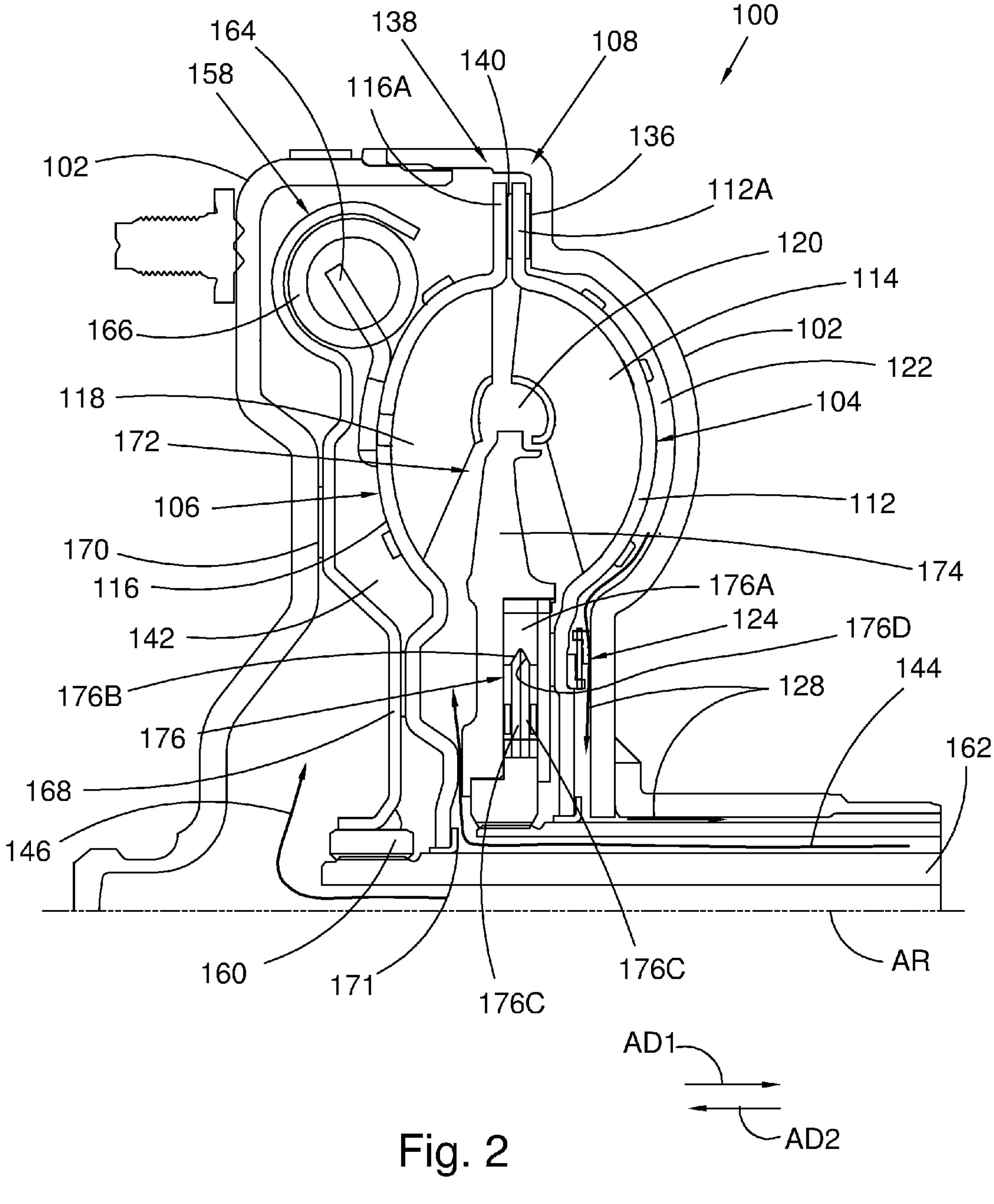
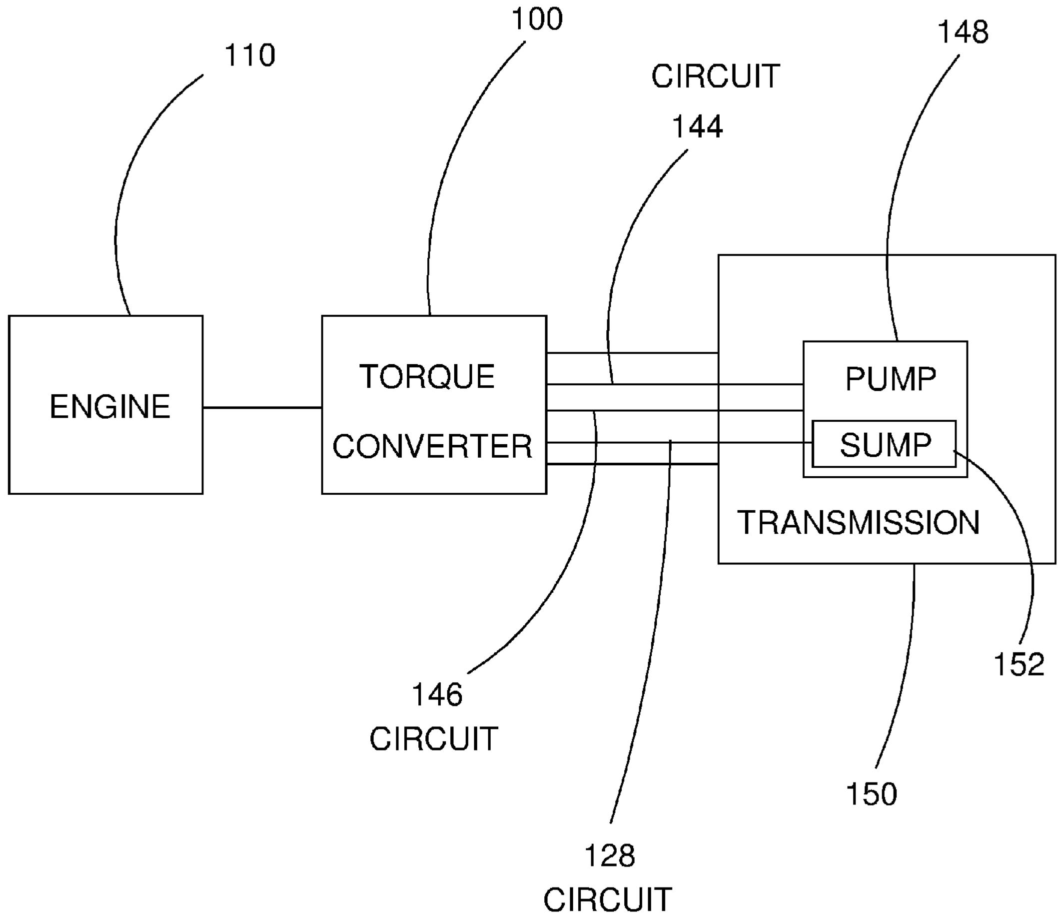

100
164
138
140
108
158
116A
136
102
112A
120
114
166
102
122
118
104
172
106
112
170
174
116
176A
124
142
176D
176B
128
144
176
162
168
146
AR
160
171
176C
176C
AD1
AD2

Fig. 2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100
CIRCUIT
144
148
ENGINE
TORQUE
CONVERTER
PUMP
SUMP
TRANSMISSION
146
CIRCUIT
128
CIRCUIT
150
152

Fig. 3

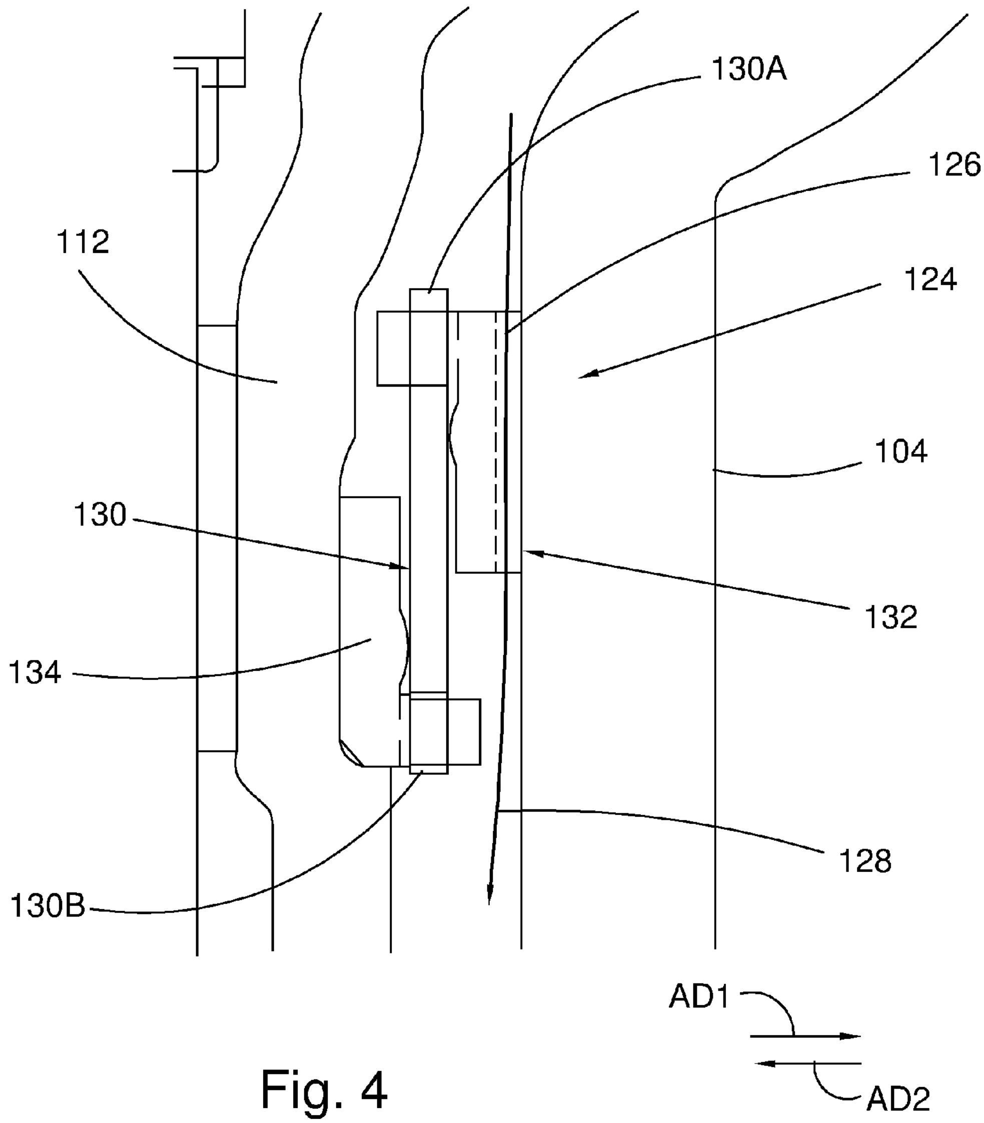
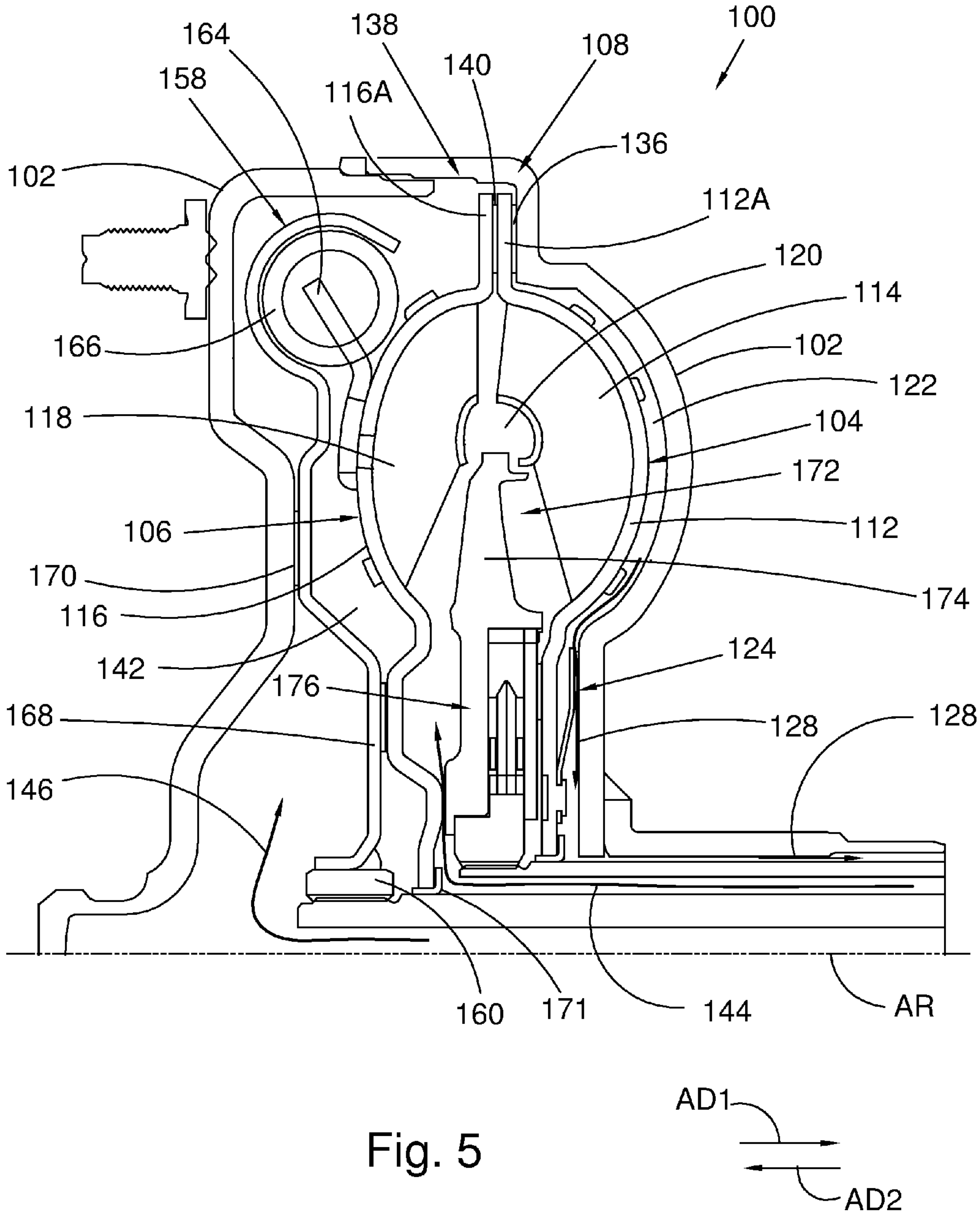


Fig. 4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158
116A
136
102
112A
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114
166
102
122
118
104
172
106
112
170
174
116
142
124
176
168
128
128
146
160
171
144
AR
AD1
AD2

Fig. 5

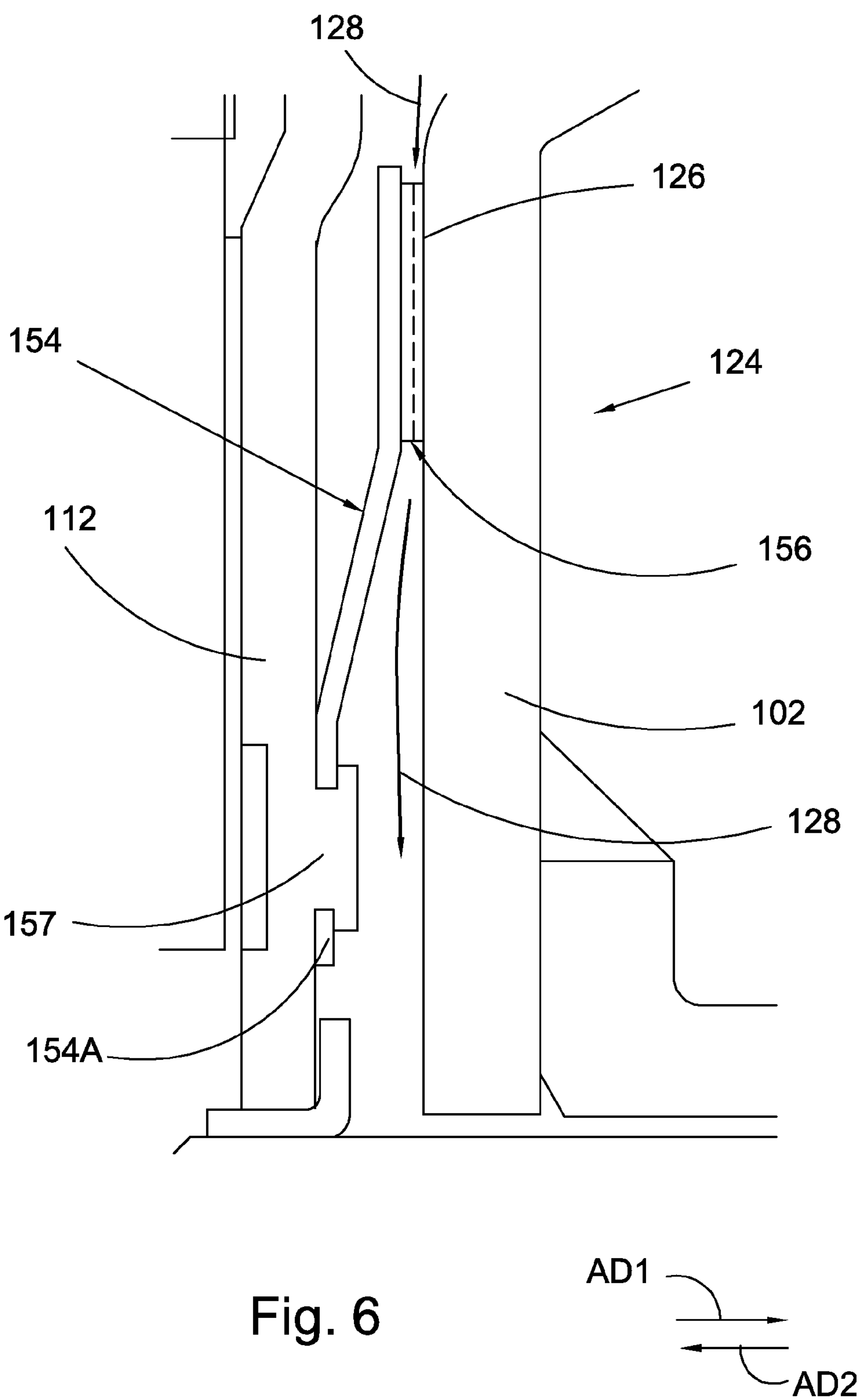
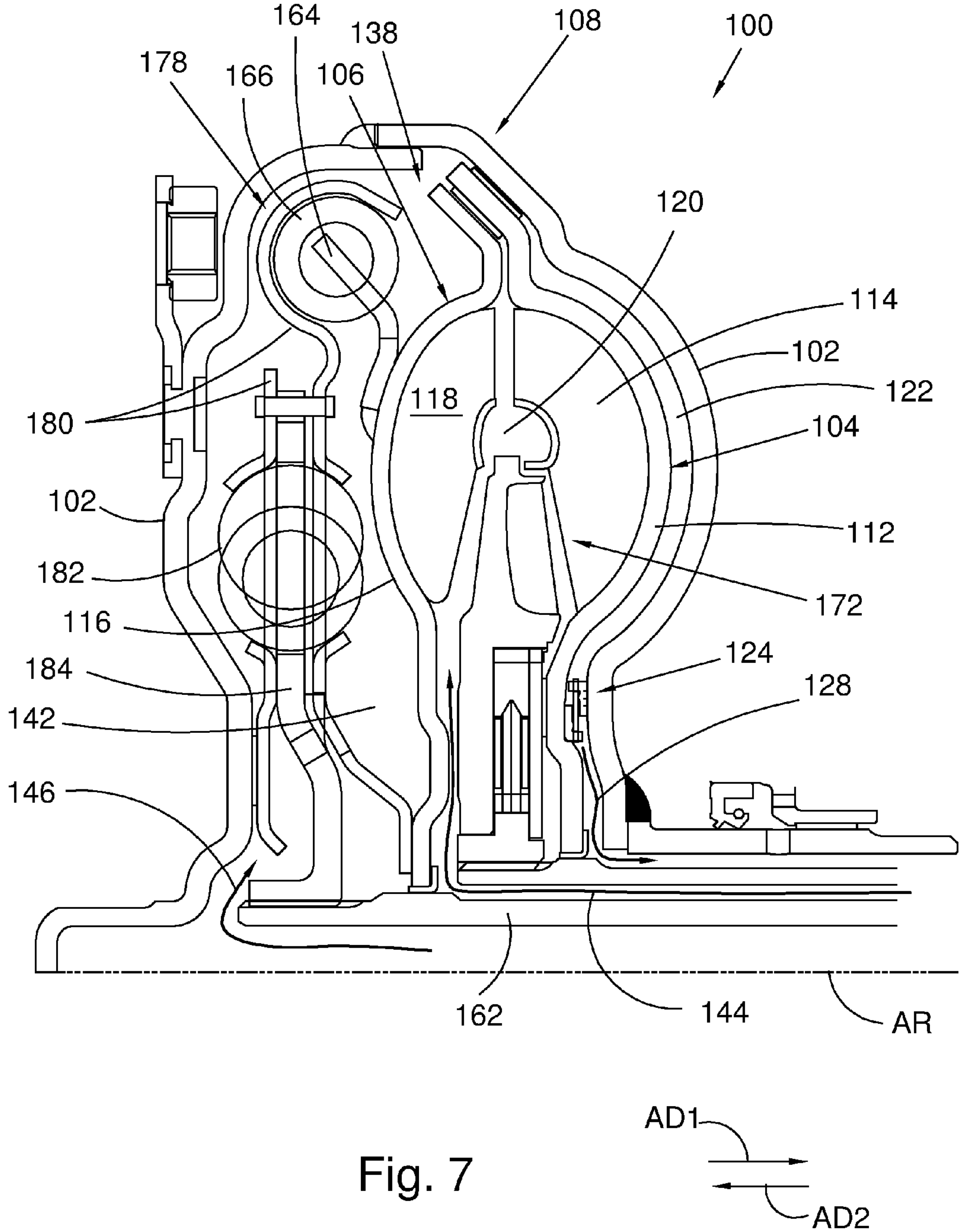
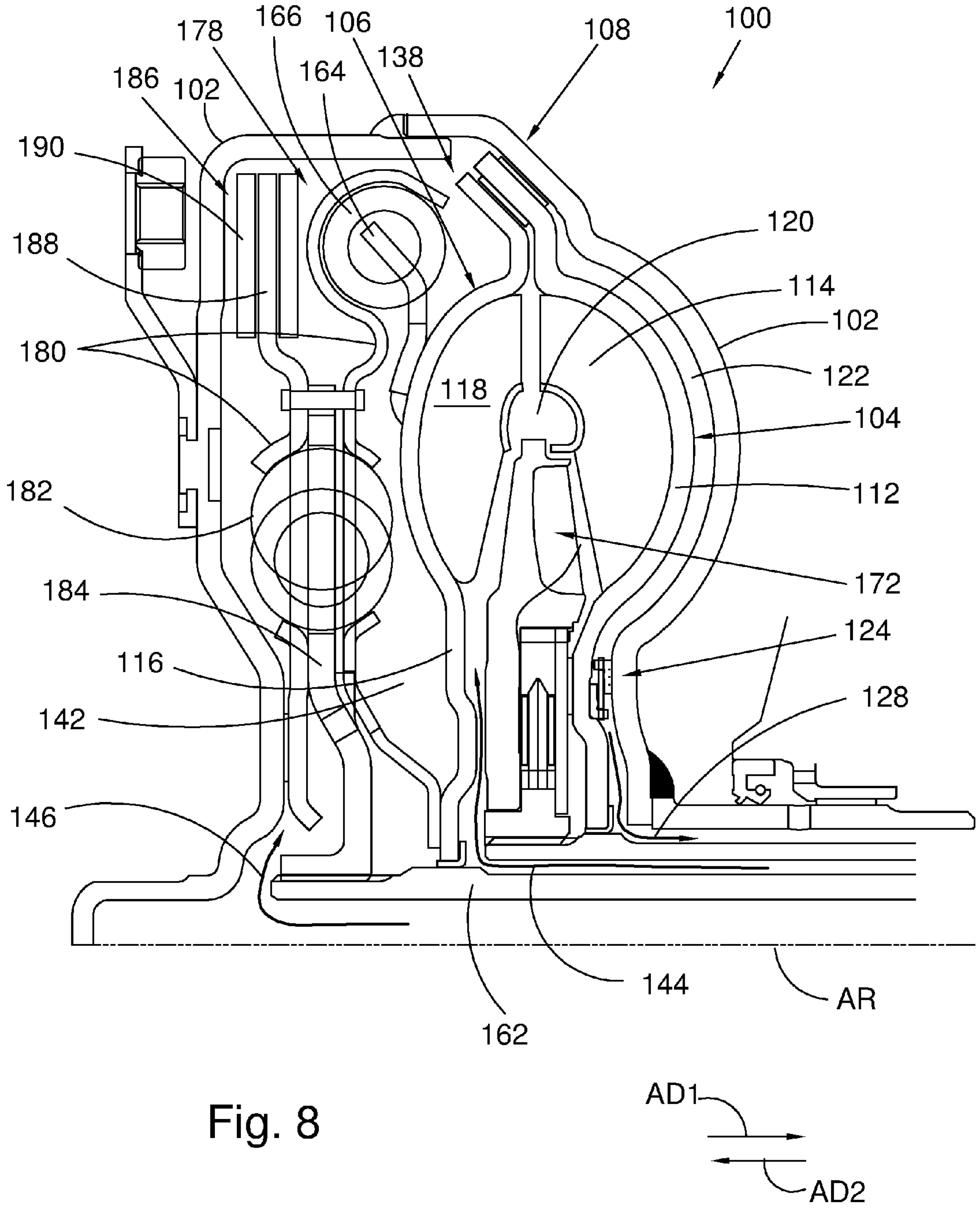


Fig. 6



164
138
108
100
178
166
106
120
114
102
122
180
118
104
102
112
182
172
116
124
184
128
142
146
162
144
AR
AD1
AD2

Fig. 7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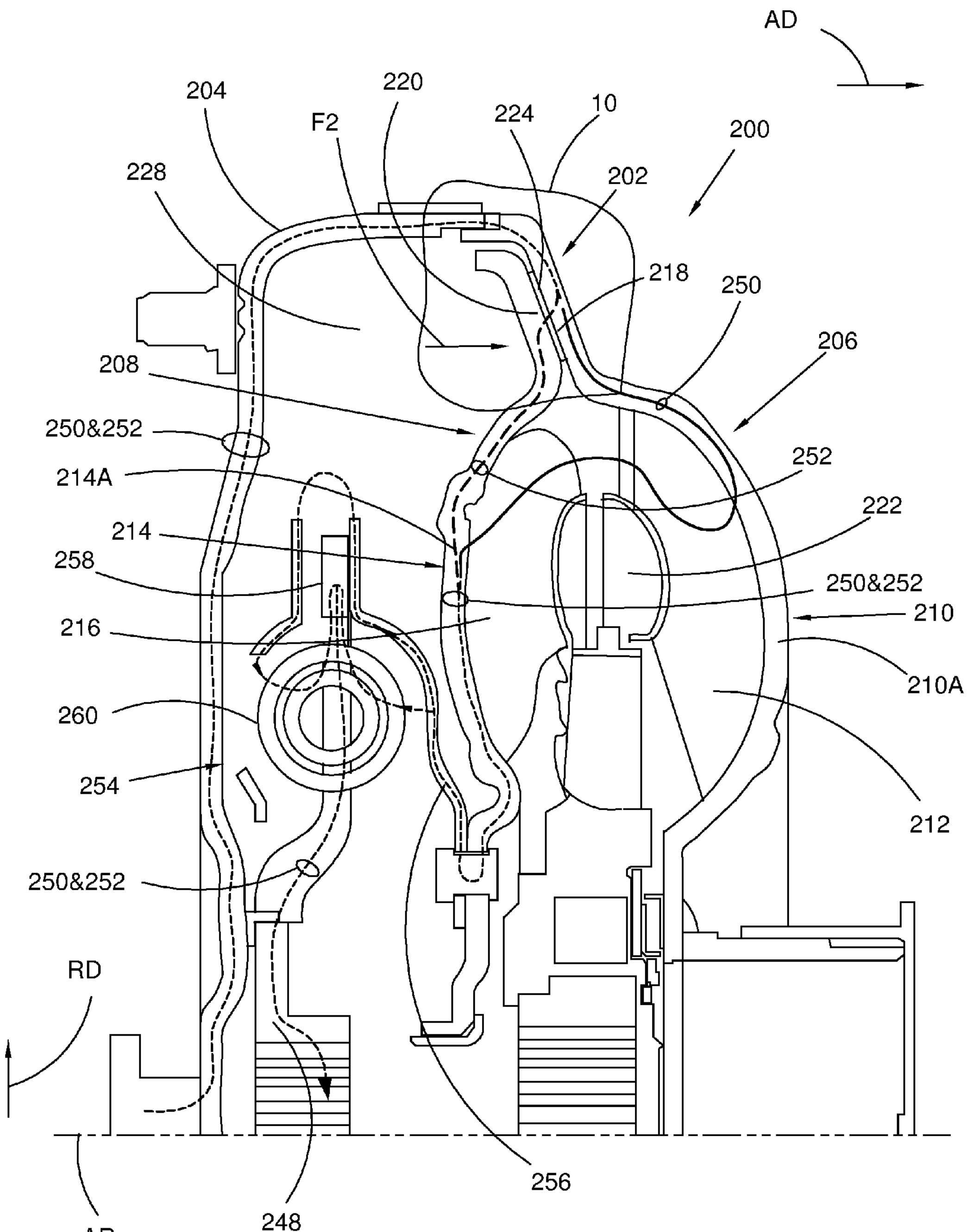
102
122
104
112
172
124
128
144
AR
162
AD1
AD2

Fig. 8



AD
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220
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F2
228
202
218
250
206
208
250&252
252
214A
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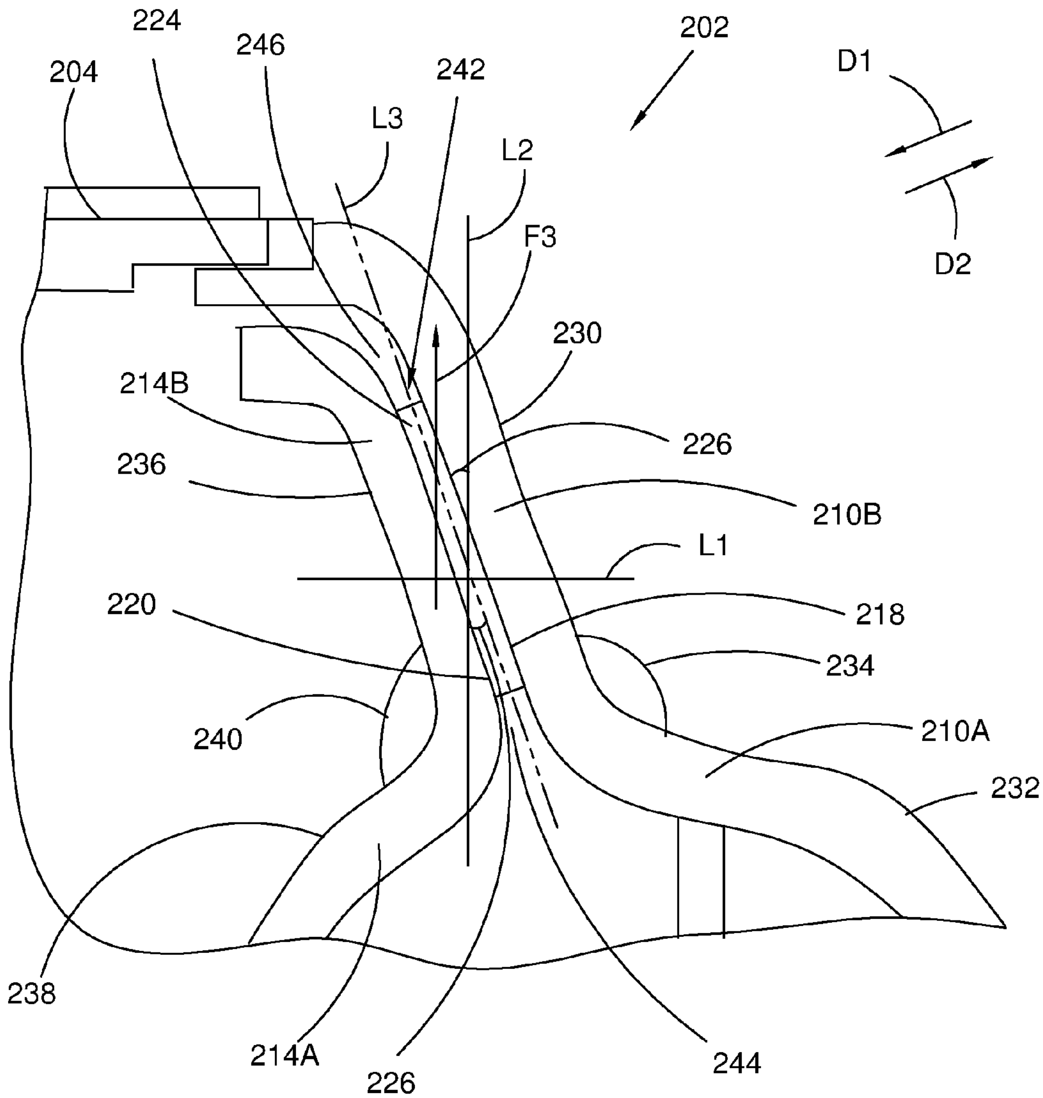
214
258
250&252
210
216
210A
260
254
212
250&252
RD
256
AR
248

Fig. 9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L3
L2
F3
D2
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210A
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238
214A
226
244

Fig. 10

Prior Art

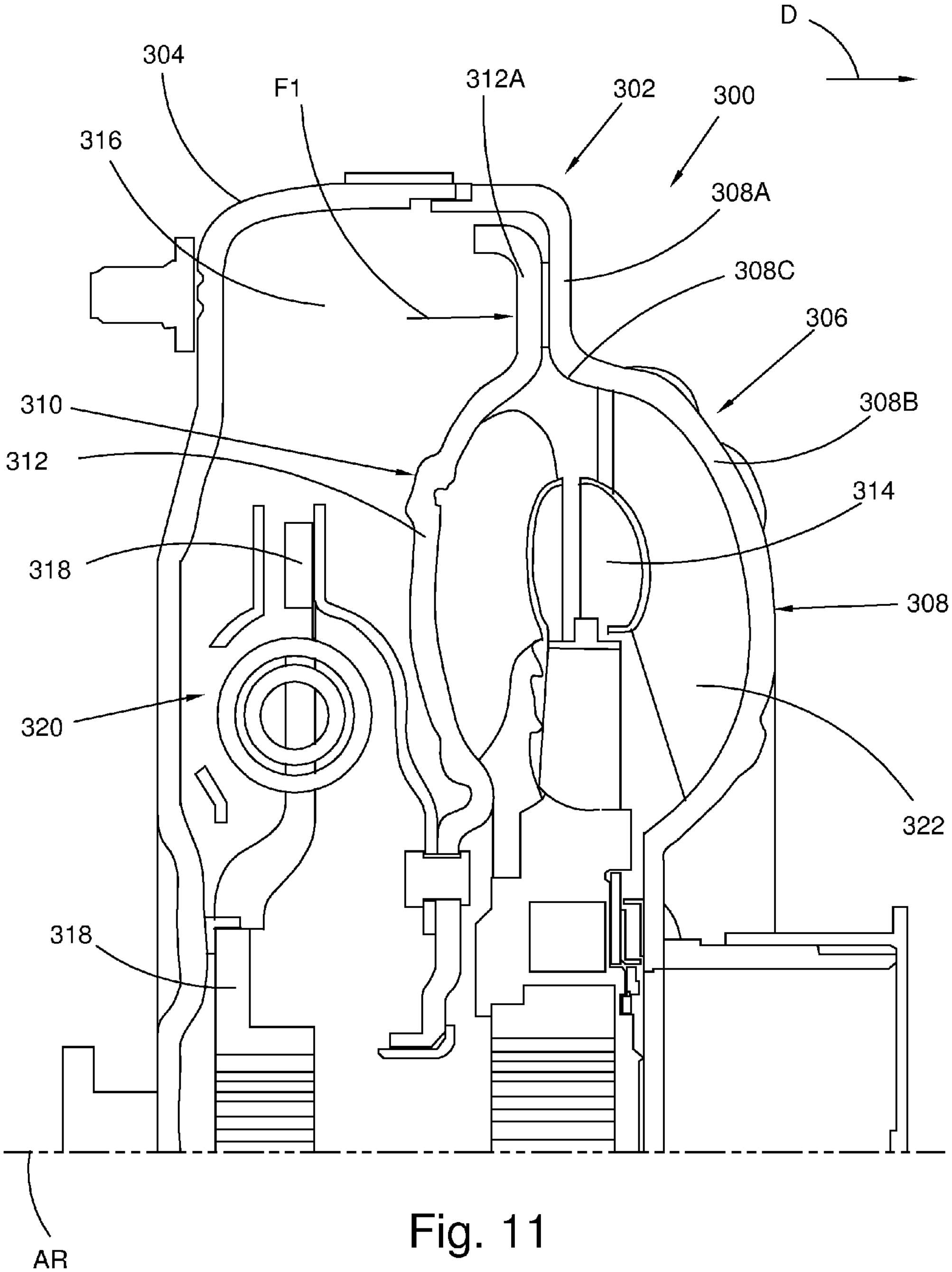

Fig. 11

TWO PASS MULTI-FUNCTION TORQUE CONVERTER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional patent application filed under 35 U.S.C. §§120 and 121 based on U.S. patent application Ser. No. 14/334,309, filed Jul. 17, 2014, which application is incorporated by reference to its entirety. U.S. patent application Ser. No. 14/334,309 claims the benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 61/856,282, filed Jul. 19, 2013, which application is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to a two pass multi-function torque converter with a resilient element for opening an impeller clutch.

BACKGROUND

A multi-function torque converter with an impeller clutch to substantially non-rotatably connect an impeller to a cover for the torque converter, and a torque converter clutch to connect a turbine to the cover is known. It is know to use three controllable fluid circuits (three-pass) to provide pressurized fluid to and to drain fluid from the torus and two pressure chambers to control operation of the impeller and torque converter clutches. A pump in a transmission is typically used to provide pressurized fluid for the torque converter and to drain fluid from the torque converter. However, most known transmissions can only provide two controllable fluid circuits making the three-pass design unusable with these transmissions.

For a multi-function torque converter with only two controllable fluid circuits (two-pass), it is known to close the impeller clutch and then to close the torque converter clutch in series. For example, to use the same fluid circuit to provide apply pressure to close both the impeller clutch and the torque converter clutch. However, this process reduces the pressure bandwidth for both clutches. Further, the torque converter clutch apply pressure for known multi-function torque converters typically starts at a higher level than in a conventional torque converter. As a result, there is need for higher pressure in the circuit and increased pump capacity, and efficiency of the hydraulic system decreases. In addition, with a two-pass design it is difficult to control the closing of the impeller clutch, for example, the impeller clutch typically closes too abruptly causing an uncomfortable sensation for the driver of the vehicle including the torque converter.

FIG. **11** is a partial cross-sectional view of prior art torque converter **300** with turbine clutch **302**. Torque converter **300** includes cover **304**, impeller **306** with impeller shell **308**, and turbine **310** including turbine shell **312**. Clutch **302** acts as a lock-up clutch for converter **300**. For example, for torque converter mode, pressure in torus **314**, formed by impeller **306** and turbine **308**, is greater than pressure in chamber **316** at least partially formed by cover **304** and turbine shell **312**, and clutch **302** is open. Torque flows from the cover to output hub **318** via impeller **306**, the turbine **310**, and torsional damper **320**.

In lock-up mode, pressure in chamber **316** is greater than pressure in torus **314**, closing clutch **302** and non-rotatably connecting impeller shell **308** and turbine **310**. Torque flows from cover **304** to hub **318** via shell **308**, shell **312**, and damper **320**.

In lock-up mode, high pressure in chamber **316** is needed to close clutch **302**. This pressure results in force F**1** in direction D on portions **312**A and **308**A of turbine shell **312** and impeller shell **308**, respectively. Portion **308**B of shell **308** is relatively thick and buttressed by blades **322** for the impeller. Portion **308**A is relatively flexible compared to portion **308**B. Therefore, in response to force F**1**, portion **308**B remains stable and portion **308**A flexes in direction D. As a result of the flexing of portion **308**A, stress and strain is placed on corner **308**C of shell **308** decreasing the service life of shell **308** and increasing the likelihood of failure of shell **308**.

SUMMARY

According to aspects illustrated herein, there is provided a multi-function torque converter, including: a cover arranged to receive torque; an impeller including an impeller shell and at least one impeller blade connected to the impeller shell; a turbine including a turbine shell and at least one turbine blade connected to the turbine shell; a torus at least partially enclosed by the impeller and turbine shells; a first pressure chamber at least partially formed by the impeller shell and the cover; in impeller clutch including a portion of the impeller shell; and a resilient element assembly located in the first pressure chamber. Pressure in the torus is arranged to displace the impeller shell in a first direction to substantially non-rotatably connect the portion of the impeller shell to the cover for a closed mode for the impeller clutch. The resilient element assembly urges, with a first force, the impeller shell in a second direction opposite the first direction.

According to aspects illustrated herein, there is provided a multi-function torque converter, including: a cover arranged to receive torque; an impeller including an impeller shell and at least one impeller blade connected to the impeller shell; a turbine including a turbine shell and at least one turbine blade connected to the turbine shell; a torus at least partially enclosed by the impeller and turbine shells; a first pressure chamber at least partially formed by the impeller shell and the cover; an impeller clutch including a portion of the impeller shell; and a resilient element assembly located in the first pressure chamber. Fluid pressure in the torus is arranged to exert a first force on the impeller shell to displace the impeller shell in a first direction to substantially non-rotatably connect the portion of the impeller shell to the cover for a closed mode for the impeller clutch. The resilient element assembly applies a second force to the impeller shell in a second direction opposite the first direction. When the second force is greater than the first force, the resilient element assembly is arranged to displace the impeller shell in the second direction to disengage the impeller shell and cover for an open mode for the impeller clutch.

According to aspects illustrated herein, there is provided a multi-function torque converter, including: a cover arranged to receive torque; an impeller including an impeller shell and at least one impeller blade connected to the impeller shell; a turbine including a turbine shell and at least one turbine blade connected to the turbine shell; a torus at least partially enclosed by the impeller and turbine shells; a first pressure chamber at least partially formed by the impeller shell and the cover; a second pressure chamber at least partially formed by the turbine shell and the cover; an impeller clutch including a portion of the impeller shell; a resilient element assembly located in the first pressure chamber and urging the impeller shell in a first direction with a first force; and a turbine clutch including a portion of the turbine shell. When a second force, produced by fluid pressure in the torus, in a second direction opposite the first direction is greater than the first force, the second force is arranged to displace the impeller shell in the second direction to substantially non-rotatably connect the portion of the impeller shell and the cover for a closed mode for the impeller clutch. When the first force is greater than the second force, the resilient element assembly is arranged to displace the impeller shell in the first direction to disengage the impeller shell and cover for an open mode for the impeller clutch. A difference the fluid pressure in the torus and fluid pressure in the second chamber is arranged to displace the turbine shell in the first or second direction to disengage or engage, respectively, the portion of the turbine shell with the portion of the impeller shell.

According to aspects illustrated herein, there is provided a torque converter, including: a cover arranged to receive torque; an impeller including at least one impeller blade, and an impeller shell with a first surface extending beyond the at least one impeller blade in a radial direction orthogonal to an axis of rotation for the torque converter and at an acute angle with respect to a first line in a radial direction orthogonal to an axis of rotation for the torque converter; a turbine including at least one turbine blade, and a turbine shell with a second surface aligned with the first surface so that a second line parallel to the axis of rotation passes through the first and second surfaces and at the acute angle with respect to the first line; a turbine clutch including the first and second surfaces and friction material disposed between the first and second surfaces; a torus at least partially enclosed by the impeller and turbine shells; and a first pressure chamber at least partially formed by the turbine shell and the cover. For a torque converter mode, the turbine and the impeller are independently rotatably with respect to each other. For a lock-up mode, the first and second surfaces are non-rotatably connected.

BRIEF DESCRIPTION OF THE DRAWINGS

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:

FIG. **1**A is a perspective view of a cylindrical coordinate system demonstrating spatial terminology used in the present application;

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

FIG. **2** is partial cross-sectional view of a multi-function torque converter with a resilient element assembly for an impeller clutch;

FIG. **3** is a schematic block diagram of the multi-function torque converter of FIG. **2** in a vehicle drive train.

FIG. **4** is a detail of the resilient element assembly in the multi-function torque converter of FIG. **2**;

FIG. **5** is partial cross-sectional view of a multi-function torque converter with a resilient element assembly for an impeller clutch;

FIG. **6** is a detail of the resilient element assembly in the multi-function torque converter of FIG. **5**;

FIG. **7** is a partial cross-sectional view of a multi-function torque converter with a series damper and a resilient element assembly for an impeller clutch;

FIG. **8** is a partial cross-sectional view of a multi-function torque converter with a series damper, a vibration absorber and a resilient element assembly for an impeller clutch;

FIG. **9** is a partial cross-sectional view of a torque converter with a conical turbine clutch;

FIG. **10** is a detail of portion **10** in FIG. **9** with clutch **202** closed; and,

FIG. **11** is a partial cross-sectional view of a prior art torque converter with a turbine clutch.

DETAILED DESCRIPTION

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.

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.

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.

FIG. **1**A 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**.

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.

FIG. **1**B is a perspective view of object **90** in cylindrical coordinate system **80** of FIG. **1**A 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.

FIG. **2** is partial cross-sectional view of multi-function torque converter **100** with a resilient element assembly for an impeller clutch.

FIG. **3** is a schematic block diagram of multi-function torque converter **100** of FIG. **2** in a vehicle drive train. The following should be viewed in light of FIGS. **2** and **3**. Multi-function torque converter **100** includes axis of rotation AR, cover **102**, impeller **104**, turbine **106**, and impeller clutch **108**. Cover **102** is arranged to receive torque, for example from engine **110**. Impeller **104** includes impeller shell **112** and at least one impeller blade **114** connected to the impeller shell. Turbine **106** includes turbine shell **116** and at least one turbine blade **118** connected to the turbine shell. Converter **100** includes torus **120**, at least partially enclosed by the impeller and turbine shells, pressure chamber **122** at least partially formed by the impeller shell and the cover, and resilient element assembly **124** located in pressure chamber **122**. Impeller clutch **108** includes portion **112**A of the impeller shell. Pressure in the torus is arranged to displace the impeller shell in direction AD**1**, parallel to axis AR, to substantially non-rotatably connect portion **112**A of the impeller shell to the cover for a closed mode for impeller clutch **108**. By "substantially non-rotatably connect" or "substantially non-rotatably connected" we mean that some nominal relative rotation of components of the clutch in question, for example in the form of slip associated with normal operation of the clutch in question in the closed mode, may be possible for the clutch in question. In the closed mode, clutch **108** transmits torque from cover **102** to impeller **104**.

Resilient element assembly **124** applies a force to the impeller shell in direction AD**2**, opposite direction AD**1**, that is, resilient element assembly **124** urges the impeller shell in direction AD**2** with the force from resilient element assembly **124**. When the force produced by fluid pressure in the torus is less than the force exerted by resilient element assembly **124** on the impeller shell, the resilient element assembly is arranged to displace the impeller shell in direction AD**2** to disengage the impeller shell and cover for an open mode for the impeller clutch. In the open mode for clutch **108**, impeller shell **112** and cover **102** are substantially independently rotatable, that is, there is at most only negligible contact between cover **102** and impeller shell **112**.

FIG. **4** is a detail of resilient element assembly **124** in FIG. **2**. The following should be viewed in light of FIGS. **2** through **4**. Resilient element assembly **124** includes at least one groove **126**. Radially inward flow of fluid out of pressure chamber **122**, for example, fluid circuit **128**, is at least partly through groove **126**. In an example embodiment, the entirety of the radially inward flow is through groove(s) **126**. In an example embodiment, resilient element assembly **124** includes diaphragm spring **130** with fingers **130**A and **130**B engaged with washers **132** and **134**, respectively. Washer **132** is in contact with cover **102** and washer **134** is in contact with shell **112**. In an example embodiment, washers **132** and **134** are plastic washers. Spring **130** reacts against washer **134** and cover **102** to apply force to washer **134** and shell **112** in direction AD**2**. One or both of washers **132** and **134** are slideable along cover **102** and shell **112**, respectively, to enable relative rotation between cover **102** and shell **112**. It should be understood that groove(s) **126** can be formed in washer **134** or that groove(s) **126** can be formed in each of washers **132** and **134**.

Clutch **108** includes friction material **136**. Portion **112**A is radially outward from blade **114** and material **136** is between portion **112**A and cover **102** in direction AD**1**. In the closed position for clutch **108**, portion **112**A, material **136** and cover **102** are substantially non-rotatably connected.

Converter **100** includes turbine clutch **138**. In an example embodiment, clutch **138** includes portion **116**A of the turbine shell and friction material **140**. Portion **116**A is located radially outward of turbine blade **118** and material **140** is between portion **116**A and portion **112**A in direction AD**1**. In the closed position for clutch **138**, portions **112**A and **116**A and material **140** are substantially non-rotatably connected. In an open mode for clutch **138**, impeller shell **114** and turbine shell **116** are substantially independently rotatable, that is, there is at most only negligible contact between impeller shell **114** and turbine shell **116**.

Clutch **138** closes (closed mode) when fluid pressure in chamber **142**, at least partially formed by cover **102** and shell **116**, is sufficiently greater than fluid pressure in the torus, which displaces turbine shell **116** in direction AD**1**. Clutch **138** opens (open mode) when fluid pressure in torus **120** is sufficiently greater than fluid pressure in chamber **142**, which displaces turbine shell **116** in direction AD**2**. Converter **100** includes fluid circuits **144** and **146**. As further described below, only circuits **144** and **146** are actively controlled, that is, converter **100** is a two-pass converter. Circuit **144** is used to controllably provide pressurized fluid to the torus from pump **148** in transmission **150** and circuit **146** is used to controllably provide pressurized fluid to chamber **142** from pump **148**. Circuits **144** and **146** are controlled to provide specified fluid pressures in chamber **142** and the torus to operate clutch **108** and **138**.

Circuit **128** is connected to sump **152** of pump **148**. There is no active control of circuit **128**, for example, there is no control of back pressure between chamber **122** and the sump. Fluid passively drains from chamber **122** to the sump, for example, when shell **112** displaces in direction AD**1** to close clutch **108**. Fluid is replaced in chamber **122** by flow from chamber **142** and/or the torus. By "passively drains" we mean that the circuit from chamber **122** does not contain active elements, such as valves, to control the flow from chamber **122** to the sump.

FIG. **5** is partial cross-sectional view of multi-function torque converter **100** with a resilient element assembly for an impeller clutch.

FIG. **6** is a detail of the resilient element assembly in the multi-function torque converter of FIG. **5**. The following should be viewed in light of FIGS. **2** through **6**. The descriptions in FIGS. **2** through **4** of torque converter **100** are applicable to torque converter **100** in FIG. **5** except as noted. In an example embodiment, resilient element assembly **124** includes "S" shaped diaphragm spring **154** including friction material **156** in contact with cover **102**. End **154**A of spring **154** is non-rotatably connected to shell **112**, for example, by rivet **157**, and material **156** is slideable along cover **102** (rotates with shell **112**) to enable relative rotation of cover **102** with respect to shell **112**. Spring **154** reacts against friction material **156** and cover **102** to apply force to shell **112** in direction AD**2**. It should be understood that the configuration of spring **154** can be reversed, for example, end **154**A can be fixedly secured to cover **102** and material **156** can be in contact with shell **112**.

Advantageously, the two-pass (controlled fluid circuits **144** and **146**) design of torque converter **100** eliminates the problems noted above for two-pass and three-pass multi-function torque converters. For example, since converter **100** is a two-pass design, converter **100** is usable with commonly-used and widely available two-pass transmissions. Converter **100** eliminates the need for a third controllable fluid circuit through the use resilient element assembly **124**. Rather than supplying pressurized fluid to chamber **122** through circuit **128**, force from resilient element assembly **124** is used to displace impeller shell **112** in direction AD2 to open clutch **108**.

Further, resilient element assembly **124** and grooves **126** eliminate the harsh closing of the impeller clutch noted above. To close clutch **108**, fluid pressure in the torus is increased to overcome the force applied by resilient element assembly **124**, displacing shell **112** in direction AD**1**. The displacement of shell **112** in direction AD1 reduces the volume of chamber **122**. In addition, fluid in the torus leaks between portion **112**A and cover **102** until firm contact is made between portion **112**A, friction material **136**, and cover **102**. The reduction of the volume of chamber **122** and the flow from the torus to chamber **122** urge fluid in chamber **122** to drain more quickly than desired for a smooth closing of clutch **108**. Advantageously, grooves **126** restrict the flow of fluid out of chamber **122**, leaving sufficient fluid in the chamber to slow the displacement of shell **112** and cushion the closing of clutch **108**.

In an example embodiment, torque converter **100** includes torsional vibration damper **158** non-rotatably connected to output hub **160**, which in turn is arranged to non-rotatably connect to transmission input shaft **162**. In an example embodiment, at least one tab **164** of damper **158** is non-rotatably connected to shell **116** and engaged with at least one spring **166**. Spring **166** is engaged with output flange **168**, which is non-rotatably connected to the output hub. In an example embodiment, bushing **170** is located between cover **102** and flange **168** and bushing **171** forms a seal between chamber **142** and the torus.

In an example embodiment, torque converter **100** includes stator **172** with at least one blade **174** and one-way clutch **176**. In an example embodiment, clutch **176** is a wedge clutch one-way clutch with outer race **176**A including cone-shaped indent **176**B, and wedge plates **176**C with cone-shaped outer circumferential surfaces **176**D.

FIG. **7** is partial cross-sectional view of multi-function torque converter **100** with a resilient element assembly for an impeller clutch and a series damper. The descriptions of torque converter **100** in FIGS. **2** through **4** are applicable to torque converter **100** in FIG. **7** except as noted. In an example embodiment, converter **100** includes series damper **178** including at least one tab **164** and at least one spring **166**. Spring **166** is engaged with intermediate plates **180**, which are in turn engaged with at least one spring **182**. Spring **182** is engaged with output flange **184**, which is arranged for non-rotatable connection to input shaft **162**. Torque converter **100** in FIG. **7** includes resilient element assembly **124** described in FIGS. **2** and **4**.

FIG. **8** is partial cross-sectional view of multi-function torque converter **100** with a centrifugally actuated impeller clutch in a closed position, a series damper, and a vibration absorber. The descriptions of torque converter **100** in FIGS. **2** through **4** and **7** are applicable to torque converter **100** in FIG. **8** except as noted. In an example embodiment, converter **100** includes damper **178** and vibration absorber **186** with plate **188** non-rotatably connected to plates **180** and with pendulum masses **190** connected to plate **188**, but swivelable with respect to plate **188**.

In an example embodiment, materials **136** and **140** are fixed to portion **112**A.

It should be understood that torque converter **100** is not limited to the damper, series damper, stator, or vibration absorber configurations shown.

FIG. **9** is a partial cross-sectional view of torque converter **200** with conical turbine clutch **202**. Torque converter **200** includes cover **204** arranged to receive torque, impeller **206**, and turbine **208**. Impeller **206** includes impeller shell **210** and at least one impeller blade **212** (hereinafter referred to as impeller blade **212**) directly connected to portion **210**A of shell **210**. Turbine **208** includes turbine shell **214** and at least one turbine blade **216** (hereinafter referred to as turbine blade **216**) directly attached to portion **214**A of shell **214**. Shell **210** includes surface **218** extending beyond impeller blade **212** in radial direction RD orthogonal to axis of rotation AR for torque converter **200**. Shell **214** includes surface **220** extending beyond turbine blade **216** in radial direction RD. Torque converter **200** includes torus **222** at least partially enclosed by shells **210** and **214**.

FIG. **10** is a detail of portion **10** in FIG. **9** with clutch **202** closed. The following should be viewed in light of FIGS. **9** and **10**. Turbine clutch **202** includes surfaces **218** and **220** and friction material **224** disposed between surfaces **218** and **220**. Surface **220** is aligned with surface **218** so that line L1, parallel to axis AR, passes through surfaces **220** and **218**. Surfaces **218** and **220** are at acute angle **226** with respect to line L2 in radial direction RD. Pressure chamber **228** is at least partially formed by turbine shell **214** and cover **204**. For a torque converter mode, turbine **208** and impeller **206** are independently rotatably with respect to each other. Stated otherwise, in the torque converter mode, clutch **202** is open. For a lock-up mode, surfaces **218** and **220** are non-rotatably connected. Stated otherwise, clutch **202** is closed and surfaces **218** and **220** are non-rotatably connected with the possible exception of slip associated with normal operation of a closed clutch.

Surface **218** faces direction D**1**. Shell **210** includes portion **210**B including surface **218** and surface **230** facing direction D**2**, opposite direction D**1**. Portion **210**A includes surface **232** facing away from impeller blade **212**. Surface **230** is at obtuse angle **234** with respect to surface **232**.

Shell **214** includes portion **214**B including surface **220** and surface **236** facing direction D**1**. Portion **214**A includes surface **238** facing away from turbine blade **216**. Surface **236** is at obtuse angle **240** with respect to surface **236**.

Surface **220** faces direction D**2**. Clutch **202** includes space **242** between surfaces **218** and **220**. Space **242** includes end **244** and end **246** radially outward of end **244**. End **244** opens to torus **222**. Friction material **224** is disposed in space **242**. Line L**3**, at acute angle **226** passes through ends **244** and **246** and friction material **224** without intersecting surface **218** or surface **220**. For example, line L**3** is orthogonal to directions D**1** and D**2**.

Torque converter **200** includes output hub **248** arranged to non-rotatably connect to a transmission input shaft (not shown). In the torque converter mode, torque path **250** is formed from cover **204** to output hub **248**. Path **250** passes through in order: portion **210**B, portion **210**A, and portion **214**A. Path **250** by-passes portion **214**B. In the lock-up mode, torque path **252** is formed from cover **204** to output hub **248**. Path **252** passes through in order: portion **210**B, portion **214**B, and portion **214**A. Path **252** by-passes portion **210**A.

In an example embodiment, converter **200** includes torsional vibration damper **254** including input part **256**, output part **258** non-rotatably connected to hub **248**, and at least one resilient element **260** engaged with parts **256** and **258**.

Advantageously, angling portions **210**B and **214**B addresses the stress and strain problems noted above. Pressure in chamber **228** is increased to be greater than pressure in the torus to displace turbine shell **214** in direction AD, parallel to axis AR, to close clutch **202**. Increasing the pressure in chamber **228** generates force F**2**, in direction AD, on portion **214**B. As clutch **202** closes, force F**2** is transferred to portion **210**B. Advantageously, since portion **210**B is at angle **226**, portion **210**B is able to withstand greater force F**2** without flexing, avoiding stress and strain on shell **210**, in particular in portion **210**C connecting portions **210**A and **210**B. In particular, stress and strain on interior portion **260** of portion **210**C is reduced.

Further, the angling of surfaces **218** and **220** increases the torque bearing capacity of clutch **202**. For example, if surfaces **218** and **220** are substantially orthogonal to axis AR and force F**2** is applied to close the clutch, axial force F**2** is substantially acting alone against shear forces to keep clutch **202** closed. However, by angling surfaces **218** and **220**, a wedge effect is created, augmenting axial force and adding force F**3** in direction RD, to maintain the non-rotatable connection of surfaces **218** and **220**. As a result, and in comparison to a configuration with surfaces **218** and **220** substantially orthogonal to axis of rotation AR: to attain a same torque bearing capacity for clutch **202**, force F**2** can be reduced with surfaces **218** and **220** at acute angle **226**; or for a same force F**2**, the torque bearing capacity of clutch **202** is increased with surfaces **218** and **220** at acute angle **226**.

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.

We claim:

1. A multi-function torque converter, comprising:
- a cover arranged to receive torque;
- an impeller including an impeller shell and at least one impeller blade connected to the impeller shell;
- a turbine including a turbine shell and at least one turbine blade connected to the turbine shell;
- a torus at least partially enclosed by the impeller and turbine shells;
- a first pressure chamber at least partially formed by the impeller shell and the cover;
- an impeller clutch including a portion of the impeller shell; and,
- a resilient element assembly located in the first pressure chamber, the resilient element assembly includes at least one groove and radially inward flow of fluid out of the first pressure chamber is at least partly through the at least one groove;

wherein:
- pressure in the torus is arranged to displace the impeller shell in a first direction to substantially non-rotatably connect the portion of the impeller shell to the cover for a closed mode for the impeller clutch; and,
- the resilient element assembly urges, with a first force, the impeller shell in a second direction opposite the first direction.

2. The multi-function torque converter of claim **1**, wherein:
- when a second force in the first direction, produced by pressure in the torus, is less than the first force, the resilient element assembly is arranged to displace the impeller shell in the second direction to disengage the impeller shell and cover for an open mode for the impeller clutch.

3. The multi-function torque converter of claim **1**, wherein:
- the entirety of the radially inward flow of fluid out of the first pressure chamber is through the at least one groove.

4. The multi-function torque converter of claim **1**, wherein:
- the resilient element assembly includes friction material in contact with the cover; and,
- the at least one groove is formed in the friction material.

5. The multi-function torque converter of claim **1**, wherein the resilient element assembly includes:
- a diaphragm spring;
- a first plastic washer non-rotatably connected to a first end of the diaphragm spring, in contact with the cover, and including the at least one groove; and,
- a second plastic washer non-rotatably connected to a second end of the diaphragm spring and in contact with the impeller shell.

6. The multi-function torque converter of claim **1**, wherein:
- the impeller clutch includes:
  - the portion of the impeller shell located radially outward of the at least one impeller blade;
  - first friction material located between the portion of the impeller shell and the cover in the first direction; and,
- in the closed mode for the impeller clutch, the portion of the impeller shell, the first friction material, and the cover are substantially non-rotatably engaged.

7. The multi-function torque converter of claim **6**, wherein:
- to transition the impeller clutch from an open mode, in which the impeller shell is rotatable with respect to the cover, to the closed mode, fluid in the first pressure chamber is arranged to drain from the first pressure chamber to a sump without control of a back pressure of the fluid.

8. The multi-function torque converter of claim **6**, further comprising:
- a turbine clutch including:
  - a portion of the turbine shell located radially outward of the at least one turbine blade; and,
  - second friction material located between the portion of the impeller shell and the portion of the turbine shell in the first direction, wherein:
    - in an open mode for the turbine clutch, the portion of the turbine shell is rotatable with respect to the portion of the impeller shell; and,
    - in a closed mode for the turbine clutch, the portion of the turbine shell, the second friction material, and the portion of the impeller shell are substantially non-rotatably connected.

9. The multi-function torque converter of claim **1**, further comprising:
- a turbine clutch; and,
- a second pressure chamber at least partially formed by the turbine shell and the cover, wherein:
- for fluid pressure in the second pressure chamber greater than fluid pressure in the torus, the turbine shell is arranged to displace in the first direction to substantially non-rotatably connect to the impeller shell; and,
- for fluid pressure in the torus greater than the fluid pressure in the second chamber, the turbine shell is arranged to displace in the second direction so that the turbine shell is rotatable with respect to the impeller shell.

10. The multi-function torque converter of claim 9, further comprising:

a first fluid circuit arranged to control flow of pressurized fluid to the torus;

a second fluid circuit arranged to control flow of pressurized fluid to the second pressure chamber; and,

a third fluid circuit arranged to passively drain fluid from the first pressure chamber.

11. A multi-function torque converter, comprising:

a cover arranged to receive torque;

an impeller including an impeller shell and at least one impeller blade connected to the impeller shell;

a turbine including a turbine shell and at least one turbine blade connected to the turbine shell;

a torus at least partially enclosed by the impeller and turbine shells;

a first pressure chamber at least partially formed by the impeller shell and the cover;

an impeller clutch including a portion of the impeller shell; and,

a resilient element assembly located in the first pressure chamber, the resilient element assembly includes at least one groove and radially inward flow of fluid out of the first pressure chamber is at least partly through the at least one groove;

wherein:

fluid pressure in the torus is arranged to exert a first force on the impeller shell to displace the impeller shell in a first direction to substantially non-rotatably connect the portion of the impeller shell to the cover for a closed mode for the impeller clutch;

the resilient element assembly applies a second force to the impeller shell in a second direction opposite the first direction; and,

when the second force is greater than the first force, the resilient element assembly is arranged to displace the impeller shell in the second direction to disengage the impeller shell and cover for an open mode for the impeller clutch.

12. The multi-function torque converter of claim 11, wherein:

the portion of the impeller shell is located radially outward of the at least one impeller blade;

the impeller clutch includes first friction material located between the portion of the impeller shell and the cover in the first direction; and,

in the closed mode for the impeller clutch, the portion of the impeller shell, the first friction material, and the cover are substantially non-rotatably engaged.

13. The multi-function torque converter of claim 12, wherein:

to transition the impeller clutch from the open mode in which the impeller shell is rotatable with respect to the cover to the closed mode, fluid in the first pressure chamber is arranged to drain from the first pressure chamber to a sump without control of a back pressure of the fluid.

14. The multi-function torque converter of claim 12, further comprising:

a turbine clutch including:

a portion of the turbine shell located radially outward of the at least one turbine blade; and,

second friction material located between the portion of the turbine shell and the portion of the impeller shell in the first direction, wherein:

in an open mode for the turbine clutch, the portion of the turbine shell is rotatable with respect to the portion of the impeller shell; and,

in a closed mode for the turbine clutch, the portion of the turbine shell, the second friction material, and the portion of the impeller shell are substantially non-rotatably engaged.

15. The multi-function torque converter of claim 11, further comprising:

a turbine clutch; and,

a second pressure chamber at least partially formed by the turbine shell and the cover, wherein:

when fluid pressure in the second pressure chamber is greater than the fluid pressure in the torus, the turbine shell is arranged to displace in the first direction to substantially non-rotatably connect to the impeller shell; and,

when the fluid pressure in the second pressure chamber is less than the fluid pressure in the torus, the turbine shell is arranged to displace in the second direction so that the turbine shell is rotatable with respect to the impeller shell.

16. The multi-function torque converter of claim 15, further comprising:

a first fluid circuit arranged to control flow of first pressurized fluid to the torus;

a second fluid circuit arranged to control flow of second pressurized fluid to the second pressure chamber; and,

a third fluid circuit arranged to passively drain fluid from the first pressure chamber.

17. A multi-function torque converter, comprising:

a cover arranged to receive torque;

an impeller including an impeller shell and at least one impeller blade connected to the impeller shell;

a turbine including a turbine shell and at least one turbine blade connected to the turbine shell;

a torus at least partially enclosed by the impeller and turbine shells;

a first pressure chamber at least partially formed by the impeller shell and the cover;

a second pressure chamber at least partially formed by the turbine shell and the cover;

an impeller clutch including a portion of the impeller shell;

a resilient element assembly located in the first pressure chamber and urging the impeller shell in a first direction with a first force, the resilient element assembly includes at least one groove and radially inward flow of fluid out of the first pressure chamber is at least partly through the at least one groove; and,

a turbine clutch including a portion of the turbine shell, wherein:

when a second force, produced by fluid pressure in the torus, in a second direction opposite the first direction is greater than the first force, the second force is arranged to displace the impeller shell in the second direction to substantially non-rotatably connect the portion of the impeller shell and the cover for a closed mode for the impeller clutch;

when the first force is greater than the second force, the resilient element assembly is arranged to displace the impeller shell in the first direction to disengage the impeller shell and cover for an open mode for the impeller clutch; and,

a difference in the fluid pressure in the torus and fluid pressure in the second chamber is arranged to displace the turbine shell in the first or second direction to disengage or engage, respectively, the portion of the turbine shell with the portion of the impeller shell.

18. The multi-function torque converter of claim **17**, further comprising:

a first fluid circuit arranged to control flow of first pressurized fluid to the torus;

a second fluid circuit arranged to control flow of second pressurized fluid to the second pressure chamber; and,

a third fluid circuit arranged to passively drain fluid from the first pressure chamber.

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