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(54) **TORQUE CONVERTER WITH TURBINE INERTIA IN A DAMPER ASSEMBLY**

(75) Inventors: **Jeremy Vanni**, Sterling, OH (US); **Brian C. Zaugg**, Millersburg, OH (US)

(73) Assignee: **Schaeffler Technologies GmbH & Co. KG**, Herzogenaurach (DE)

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(51) **Int. Cl.**
F16H 45/02 (2006.01)

(52) **U.S. Cl.**
USPC **192/3.29**; 192/213.1

(58) **Field of Classification Search**
USPC 464/68.7
See application file for complete search history.

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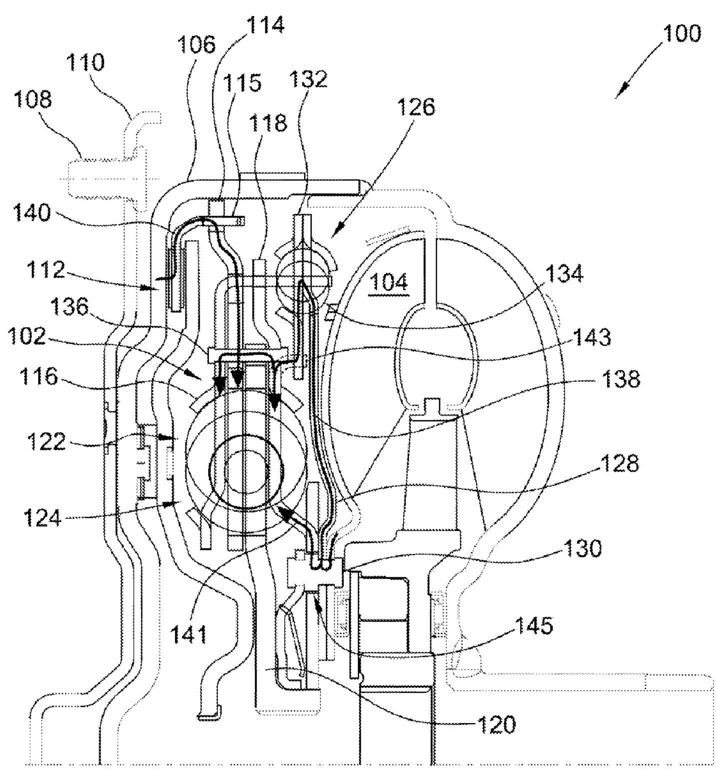
Primary Examiner — Rodney Bonck
(74) *Attorney, Agent, or Firm* — Simpson & Simpson, PLLC

(57) **ABSTRACT**

A torque converter, including: a turbine; a cover; a lock-up clutch engageable with the cover; and a first damper assembly including: a first flange connected to the lock-up clutch so as to rotate in unison with the clutch; at least one side plate; a second flange for connection to an input shaft for a transmission; a first plurality of springs engaged with the first flange and with the at least one side plate; and a second plurality of springs, at least partially circumferentially aligned with the first plurality of springs, and engaged with the at least one side plate and the second flange. The torque converter includes a second damper assembly connected to the first damper assembly and including: a third side plate fixed to the turbine; and a third plurality of springs, radially outside of the first and second pluralities of springs, and engaged with the third side plate.

12 Claims, 3 Drawing Sheets



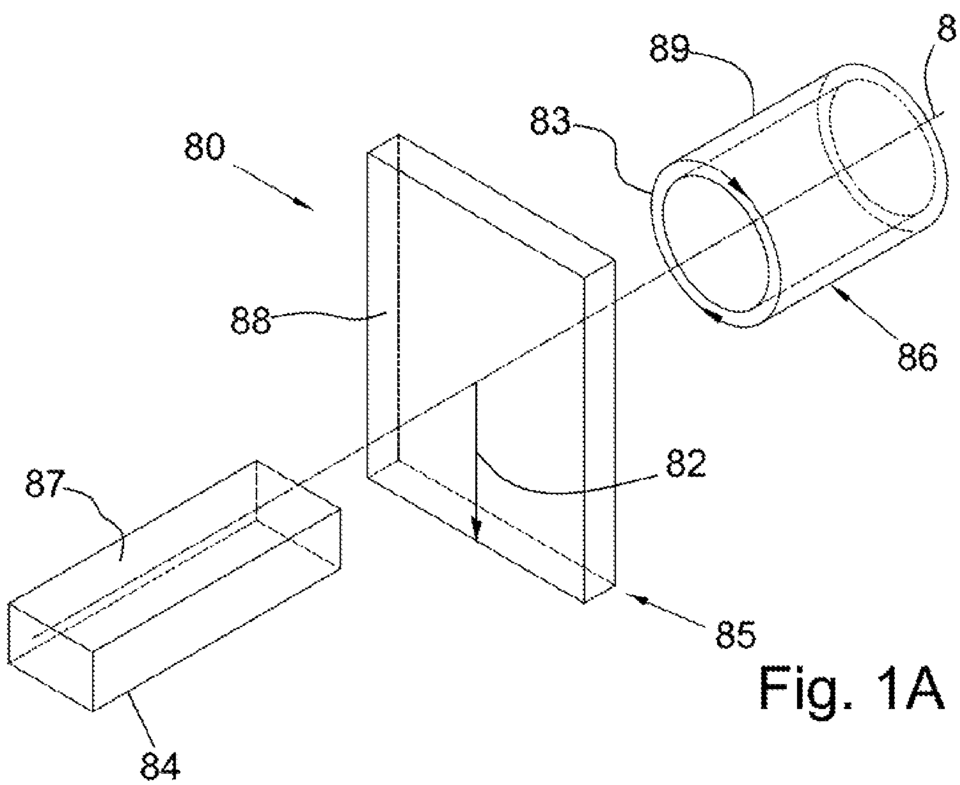


Fig. 1A

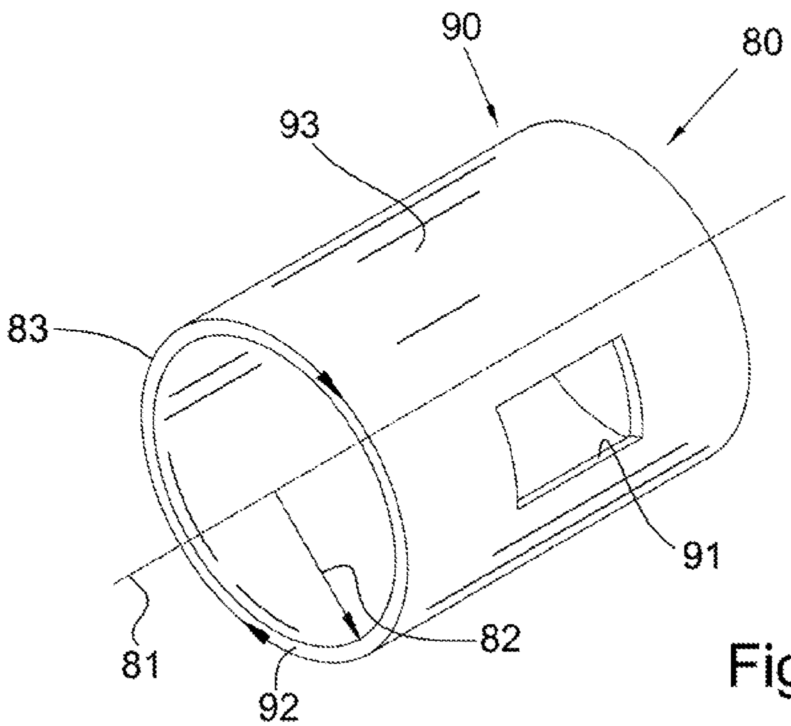
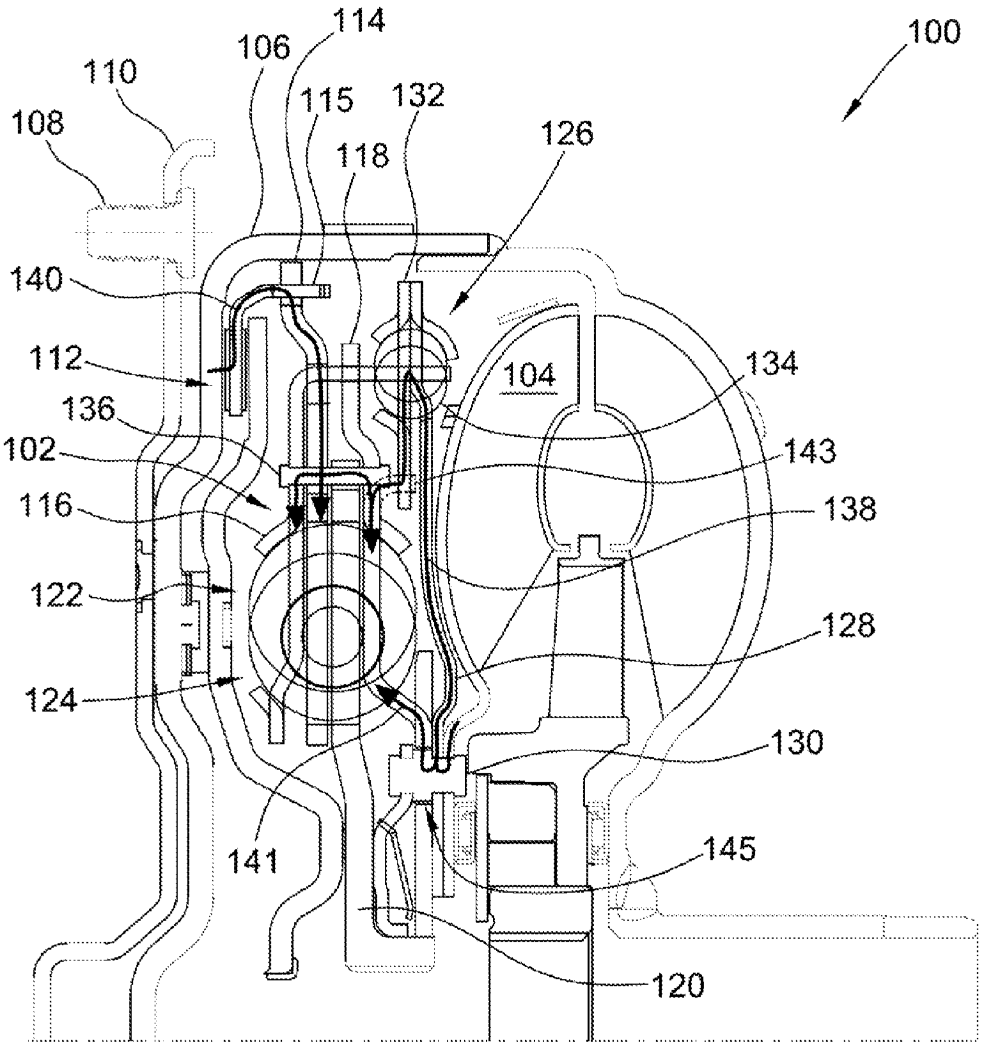


Fig. 1B


100
114
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110
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132
108
118
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140
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104
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136
143
102
116
138
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128
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130
141
145
120

Fig. 2

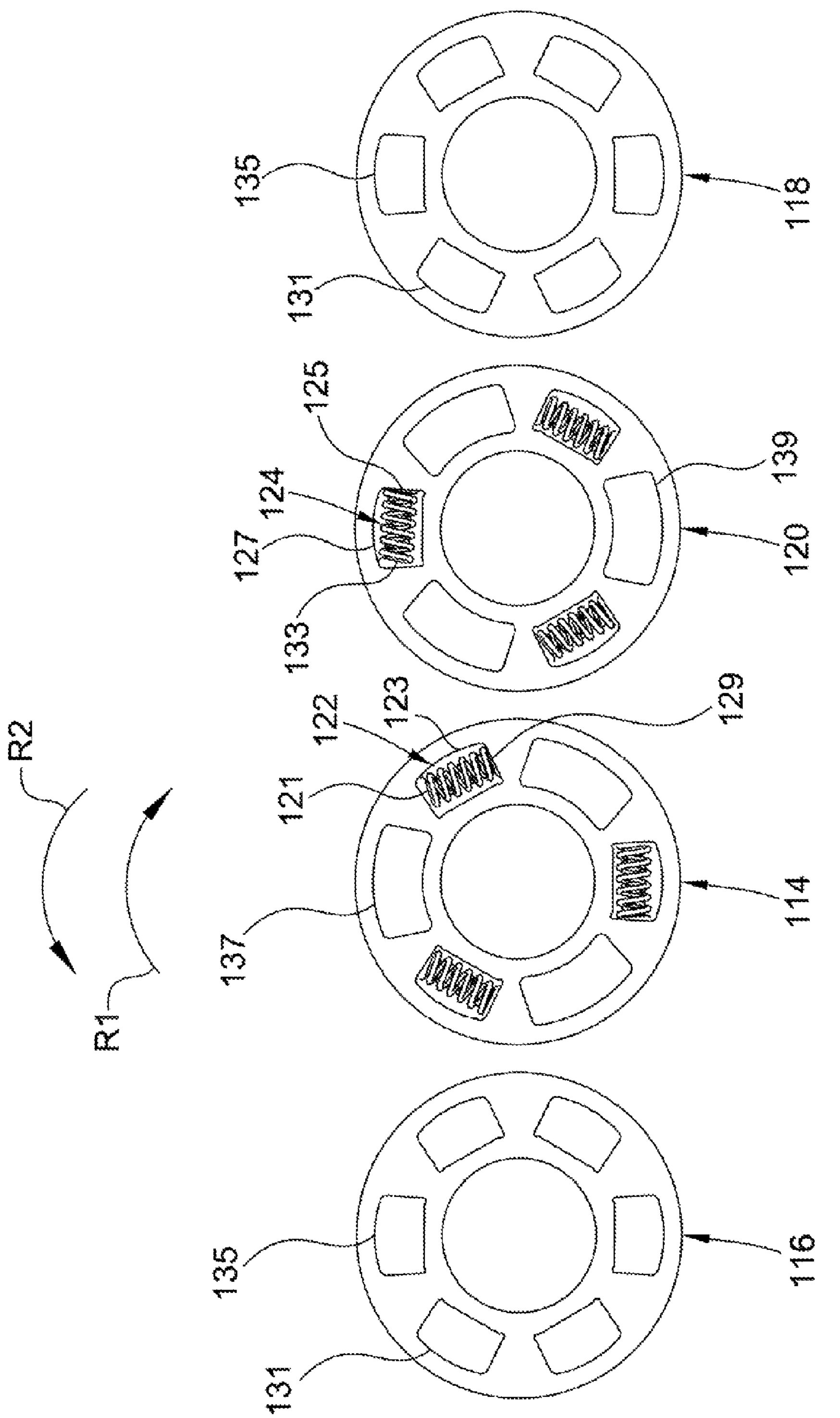
135
131
118
125
124
127
133
139
120
122
123
121
129
137
114
R2
R1
135
131
116

Fig. 3

TORQUE CONVERTER WITH TURBINE INERTIA IN A DAMPER ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. §119 (e) of U.S. Provisional Application No. 61/426,099 filed Dec. 22, 2010, which application is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a torque converter with increased turbine inertia in a damper assembly. In particular, the present disclosure relates to torque converter with a series damper assembly into which additional turbine inertia is introduced via a Tilger damper.

BACKGROUND

Vibration from an engine can be transmitted to a transmission via a torque converter connected to the engine and the transmission. It is known to use a Tilger damper in a torque converter to attenuate vibration transmitted from an engine to a transmission.

SUMMARY

According to aspects illustrated herein, there is provided a torque converter, including: a turbine; a cover arranged to receive torque from an engine; a lock-up clutch engageable with the cover; and a first damper assembly including: a first flange connected to the lock-up clutch so as to rotate in unison with the lock-up clutch; at least one side plate; a second flange for connection to an input shaft for a transmission; a first plurality of springs engaged with the first flange and with the at least one side plate; and a second plurality of springs, at least partially circumferentially aligned with the first plurality of springs, and engaged with the at least one side plate and with the second flange. The torque converter includes a second damper assembly connected to the first damper assembly and including: a third side plate fixed to the turbine; and a third plurality of springs, radially outside of the first and second pluralities of springs, and engaged with the at least one side plate and the third side plate.

According to aspects illustrated herein, there is provided a torque converter, including: a turbine; a cover arranged to receive torque from an engine; a lock-up clutch engageable with the cover plate; a first damper assembly connected to the lock-up clutch, arranged to connect to an input shaft for a transmission, and including at least one side plate and first and second circumferentially aligned pluralities of springs, the first plurality of springs in contact with a component of the first damper assembly with which the second plurality of springs is not in contact; a second damper assembly fixed to the turbine, connected to the first damper assembly, and including a third plurality of springs radially outside of the first and second pluralities of springs. When the lock-up clutch is engaged with the cover the torque converter includes: a drive torque transmission path from the cover through the lock-up clutch to the at least one side plate; and an absorption torque path, separate from the first torque transmission path, from the turbine to the at least one side plate via the second damper assembly. Torque due to inertia of the turbine is transmitted to the at least one side plate via the absorption torque path.

According to aspects illustrated herein, there is provided a torque converter, including: a turbine; a cover arranged to receive torque from an engine; a lock-up clutch engageable with the cover plate; a first damper assembly connected to the lock-up clutch, arranged to connect to an input shaft for a transmission, and including at least one side plate and first and second circumferentially aligned pluralities of springs, the first plurality of springs in contact with a component of the first damper assembly with which the second plurality of springs is not in contact; and a second damper assembly fixed to the turbine, connected to the first damper assembly, and including a third plurality of springs radially outside of the first and second pluralities of springs. When the lock-up clutch is engaged with the cover, the torque converter includes: a drive torque transmission path from the cover through the lock-up clutch to the at least one side plate; and an absorption torque path, separate from the drive torque transmission path, from the turbine to the at least one side plate via the second damper assembly. Torque due to inertia from the cover is transmittable, along the drive torque transmission path, to the at least one side plate via the lock-up clutch. Torque due to inertia of the turbine, is transmittable via the absorption torque path. A spring constant for springs in the third plurality of springs is selected so that, at a first frequency, the respective torques from the drive torque transmission path and the absorption torque path urge the at least one side plate in respective opposite rotational directions.

These and other objects and advantages of the present disclosure will be readily appreciable from the following description of the invention and from the accompanying drawings and claims.

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 a partial cross-sectional view of a torque converter with increased turbine inertia in a damper assembly; and,

FIG. **3** is a front unstacked view of the flanges, side plates, and springs shown for the series damper shown in FIG. **2**.

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 a partial cross-sectional view of torque converter **100** with turbine inertia introduced into damper assembly **102**. Torque converter **100** includes turbine **104**, cover **106** arranged to receive torque from an engine (not shown), for example, via studs **108** and drive plate **110**, and lock-up clutch **112** engageable with the cover. Damper assembly **102** includes flange **114** connected to the lock-up clutch via plate **115** of the lock-up clutch so as to rotate in unison with the lock-up clutch, at least one side plate, and flange **120** for connection to an input shaft (not shown) for a transmission (not shown). In an example embodiment, the at least one side plate is side plates **116** and **118**. Damper assembly **102** includes plurality of springs **122** engaged with flange **114** and with the side plates, and plurality of springs **124**, at least partially circumferentially aligned with plurality of springs **122**, and engaged with the side plates and with the flange **120**.

FIG. **3** is a front unstacked view of the flanges, side plates, and springs shown for the series damper shown in FIG. **2**. The following should be viewed in light of FIGS. **2** and **3**. For purposes of illustration, we assume that torque is delivered to plate **114** from clutch **112** in clockwise direction R**1**. In FIG. **3**, springs **122** are shown only engaged with side plate **114** and springs **124** are shown only engaged with flange **120**, for example, ends **121** of springs **122** are engaged with openings **123** in plate **114** and ends **125** of springs **124** are engaged with openings **127** in flange **120**. It should be understood that ends **129** of springs **122** are engaged with side plates **116** and **118** in openings **131** and that ends **133** of springs **124** are engaged with openings **135** in side plates **116** and **118**. Springs **124** are partially disposed in openings **137** of plate **114**, but do not contact the edges of the openings. Springs **122** are partially disposed in openings **139** of flange **120**, but do contact the edges of the openings. That is, openings **137** and **139** supply clearance for the axial stacking of plates **114**, **116**, and **118**, and flange **120**.

The torque converter also includes damper assembly **126**, otherwise known as a Tilger damper, connected to damper assembly **102** and including side plate **128** fixed to the turbine, for example, by rivet **130**, side plate **132** fixed to side plate **128** and plurality of springs **134**. Plurality of springs **134** is radially outside of pluralities of springs **122** and **124** and is engaged with plates **128** and **132**. In an example embodiment, side plates **116** and **118** are fixed to each other, for example, by rivet **136**, and side plate **116** is engaged with plurality of springs **134**. Rivet **130** also connects plate **118** to the turbine. Rivet **130** passes through slot **145** in plate **118** so that relative rotation between the rivet and plate **118** is possible. In general, the slot has a relatively small circumferential extent. That is, rivet **130** has a circumferential clearance to side plate **118** allowing proper operation of damper **126** in lockup mode.

In lock-up mode, that is, when the lock-up clutch is engaged, the torque converter includes absorption torque path **138** from the turbine to plates **116** and **118** via rivet **130**, plates **128** and **132**, and springs **134**. The torque converter also includes drive torque converter path **140** from cover **104** to plates **116** and **118** via plates **115** and **114** and springs **122**. During torque converter mode (lock-up clutch unengaged, or open), torque path **141** from the turbine to flange **120** is formed via rivet **130**, plates **116** and **118**, and springs **124**. In an example embodiment, torque is transmitted from the turbine via rivet **130**, plates **128** and **132**, and tab **143** to plates **116** and **118**. Tab **143** has a circumferential clearance to plate **132**, that is a nominal amount of relative rotation of the tab and plate **132** is possible. If torque from turbine **104** exceeds the torque capacity of damper **126** (i.e., maximum torque before springs are damaged), torque from plates **128** and **132** may be transmitted directly to plate **118** through tab **143**. Similarly, when turbine torque exceeds the torque capacity of damper **102**, torque from plates **116** and **118** may be transmitted directly to flange **120** through rivets **136**.

As noted supra, undesirable vibrations can be transmitted from an engine to a transmission via a torque converter connected to the engine and the transmission. For example, engine vibration can be transmitted along path **140** to the transmission. Damper assembly **126** can be used to introduce beneficial torque due to inertia, or mass, from a turbine in the torque converter to a damper assembly, for example, series damper **102**, to counteract undesirable vibration.

Torque along torque transmission path **140**, for example, due to the cover and the engine when the cover is connected to an engine, urges plates **116** and **118** in one rotational direction, for example, R**1**. Torque along the torque transmission path **138**, for example, due to the turbine and plates **128** and **132**, urges plates **116** and **118** in an opposite rotational direction, for example, R**2**. Thus, the vibration associated with the inertia of the engine and the cover along path **140** is counteracted by torque due to the inertia of the turbine and plates **128** and **132** via a force applied by springs **134** to plate **116**. Thus, via a path outside of drive torque transmission path **140**, torque due to the inertia of the turbine and damper assembly **126** is introduced to damper assembly **102** advantageously dampening undesirable vibration associated with operation of the engine.

It should be understood that torque along path **140** can shift directions according to the acceleration and deceleration of the cover and engine. For example, as the engine fires, the cover accelerates in one direction and after firing, the cover decelerates in an opposite direction. Torque transmitted along path **138** oscillates accordingly to oppose the torque from path **140**. In an example embodiment, a spring constant for springs **134** is selected so that, for a natural frequency for damper assembly **102**, the cover and the turbine oscillate 180 degrees out of phase. That is, respective torques along paths **140** and **138** are in opposition at plates **116** and **118**, optimizing dampening of undesirable engine vibration.

The location of assembly **126** radially outside of damper **102**, or at least radially outside of springs **122** and **124**, increases the radial extent and desirable inertia of plates **128** and **132**. In addition, the extension of plate **128** to rivet **130** increases the inertia of plate **128**.

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 we claim is:

1. A torque converter, comprising:
a turbine;
a cover arranged to receive torque from an engine;
a lock-up clutch engageable with the cover;
a first damper assembly including:
a first flange connected to the lock-up clutch so as to rotate in unison with the lock-up clutch;
a first side plate;
a second flange for connection to an input shaft for a transmission;
a second side plate non-rotatable connected to the first side plate and located between the first and second flanges and the cover in an axial direction;
a first plurality of springs engaged with the first flange, the first side plate, and the second side plate; and,
a second plurality of springs, at least partially circumferentially aligned with the first plurality of springs, and engaged with the first side plate, the second side plate and, the second flange;
a second damper assembly connected to the first damper assembly and including:
a third side plate fixed to the turbine;
a fourth side plate; and,
a third plurality of springs:
radially outside of the first and second pluralities of springs; and,
engaged with the second, third, and fourth side plates.

2. The torque converter of claim **1** wherein:
the first and second side plates are fixed to rotate in unison.

3. The torque converter of claim **1** further comprising, when the lock-up clutch is closed:
a drive torque transmission path from the cover to the first and second side plates via the first flange and the first plurality of springs; and,
an absorption torque path from the turbine to the first and second side plates via the second damper assembly, wherein:
torque from inertia of the cover is transmitted to the first and second side plates via the drive torque transmission path; and,
torque from inertia of the turbine and the third plate is transmitted to the first and second side plates via the absorption torque path.

4. The torque converter of claim **3** wherein a spring constant for springs in the third plurality of springs is selected so that, for a first frequency, for movement of the first and second side plates in a first rotational direction due to torque along the drive torque transmission path, torque along the absorption torque path urges the first and second side plates in a second rotational direction, opposite the first rotational direction.

5. The torque converter of claim **4** wherein:
the torque transmitted along the absorption torque path is due to the inertia of the turbine and the third side plate and the inertia of the fourth side plate.

6. A torque converter, comprising:
a turbine;
a cover arranged to receive torque from an engine;
a lock-up clutch engageable with the cover;
a first damper assembly connected to the lock-up clutch, arranged to connect to an input shaft for a transmission, and including at least one side plate and first and second circumferentially aligned pluralities of springs, the first plurality of springs in contact with a component of the first damper assembly with which the second plurality of springs is not in contact; and
a second damper assembly, connected to the first damper assembly, and including:
a first side plate fixed to the turbine and non-rotatably connected to the at least one side plate; and,
a third plurality of springs radially outside of the first and second pluralities of springs and engaged with the first side plate, wherein:
when the lock-up clutch is engaged with the cover:
a drive torque transmission path is formed from the cover through the lock-up clutch to the at least one side plate;
an absorption torque path, separate from the first torque transmission path, is formed from the turbine to the at least one side plate via the first side plate and the second damper assembly;
torque due to inertia of the turbine is transmitted to the at least one side plate via the absorption torque path; and,
the absorption torque path bypasses the third plurality of springs for sufficient relative rotation between the at least one side plate and the first side plate.

7. The torque converter of claim **6** wherein:
torque along the drive torque transmission path urges the at least one side plate in a first rotational direction; and,
inertia along the absorption torque path urges the at least one side plate in a second rotational direction, opposite the first rotational direction.

8. The torque converter of claim **6** wherein:
the second damper assembly includes a second side plate engaged with the third plurality of springs; and,
the torque transmitted along the absorption torque path is from the inertia of the turbine and inertia of the first and second side plates.

9. The torque converter of claim **6** wherein a spring constant for springs in the third plurality of springs is selected so that, for a first frequency, the cover and the turbine oscillate 180 degrees out of phase.

10. The torque converter of claim **6** wherein:
the at least one side plate includes second and third side plates;
the first damper assembly includes:
a first flange connected to the lock-up clutch so as to rotate in unison with the lock-up clutch; and,
a second flange for connection to the input shaft for a transmission;

the first plurality of springs is engaged with the first flange and with the second and third side plates;

the second plurality of springs is engaged with the second and third side plates and with the second flange; and,

the second and third plates are engaged with the third plurality of springs.

11. The torque converter of claim **10** wherein:

the second damper assembly includes a fourth side plate engaged with the third plurality of springs;

and,

the fourth plate is engagable with the first damper assembly.

12. A torque converter, comprising:

a turbine;

a cover arranged to receive torque from an engine;

a lock-up clutch engageable with the cover;

a first damper assembly including:

a first flange connected to the lock-up clutch so as to rotate in unison with the lock-up clutch;

a first side plate;

a second side plate;

a second flange for connection to an input shaft for a transmission;

a first plurality of springs engaged with the first flange, the first side plate, and the second side plate; and,

a second plurality of springs, at least partially circumferentially aligned with the first plurality of springs, and engaged with the first side plate, the second side plate and, the second flange; and,

a second damper assembly connected to the first damper assembly and including:

a third side plate fixed to the turbine;

a fourth side plate rotatable for a limited degree with respect to the second side plate; and,

a third plurality of springs:

radially outside of the first and second pluralities of springs; and,

engaged with the first, third and fourth side plates, wherein:

when the lock-up clutch is engaged with the cover:

a first drive torque transmission path is formed from the cover through the lock-up clutch to the first and second side plates; and,

an absorption torque path, separate from the first drive torque transmission path, is formed from the turbine to the first and second side plates via the second damper assembly:

torque due to inertia from the cover is transmittable, along the first drive torque transmission path, to the first and second side plates via the lock-up clutch;

torque due to inertia of the turbine is transmittable via the absorption torque path; and

when the lock-up clutch is unengaged with the cover and the fourth side plate has rotated, with respect to the second side plate, beyond the limited degree, the absorption torque path by-passes the third plurality of springs.

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