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

(71) Applicant (*for PH only*): **SCHAEFFLER GROUP USA, INC.** [US/US]; 308 Springhill Farm Road, Fort Mill, South Carolina 29715 (US).

(72) Inventors: **SIMON, Timothy**; 1006 E Hutton Rd, Wooster, Ohio 44691 (US). **BURKY JR., David**; 2580 Urbana

Ave SE, Massillon, Ohio 44646 (US). **MÜLLER, Rolf**; 875 Pepperwood Dr., Wooster, Ohio 44691 (US). **GURNEY, Nigel**; 5505 Millbrook Road, Wooster, Ohio 44691 (US). **SMITH, Matthew**; 1069 Mindy Lane, Apartment 3D, Wooster, Ohio 44691 (US).

(74) Agent: **MEHALL, Clint**; Davidson, Davidson & Kappel, LLC, 589 Eighth Avenue, 16th Floor, New York, New York 10018 (US).

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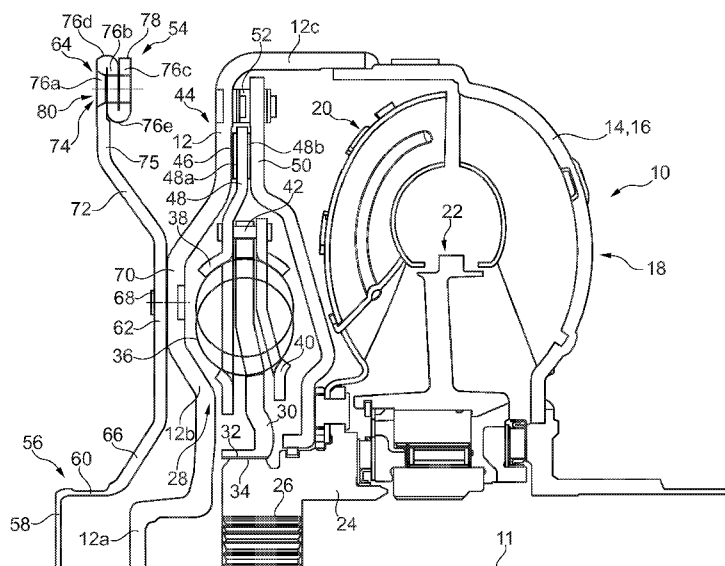


Fig. 1

(57) Abstract: A method of forming a drive plate for a torque converter is provided. The method includes folding a portion of the drive plate into a plurality of sections stacked to form aligned layers and providing a hole through the layers to form a lug for connecting the drive plate to an engine. A torque converter is also provided. The torque converter includes a front cover and a drive plate connected to the front cover and configured for connecting to an engine. The drive plate includes a plurality of sections stacked to form aligned layers and the layers includes a hole passing therethrough.



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TORQUE CONVERTER DRIVE PLATE

[0001] The present disclosure relates generally to torque converters and more specifically to drive plates of torque converters.

BACKGROUND

[0002] U.S. Pub. No. 2013/0272779 discloses a stamped, folded lug with circumferential tabs (or wings) for attachment to the cover.

[0003] U.S. Patent No. 6,561,330 discloses various embodiments of a torque converter including a driving section of the housing.

SUMMARY OF THE INVENTION

[0004] A method of forming a drive plate for a torque converter is provided. The method includes folding a portion of the drive plate into a plurality of sections stacked to form aligned layers and providing a hole through the layers to form a lug for connecting the drive plate to an engine.

[0005] A torque converter is also provided. The torque converter includes a front cover and a drive plate connected to the front cover and configured for connecting to an engine. The drive plate includes a plurality of sections stacked to form aligned layers and the layers includes a hole passing therethrough.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The present invention is described below by reference to the following drawings, in which:

[0007] Fig. 1 schematically shows a cross-sectional side view of a torque converter according to an embodiment of the present invention;

[0008] Figs. 2a to 2c illustrate a method of forming one of lugs in accordance with a first embodiment of the present invention;

[0009] Figs. 3a to 3d illustrate a method of forming one of lugs in accordance with a second embodiment of the present invention;

[0010] Fig. 4 illustrates a method of forming a lug in accordance with a third embodiment of the present invention;

[0011] Fig. 5 illustrates a method of forming a lug in accordance with a fourth embodiment of the present invention; and

[0012] Fig. 6 illustrates a method of forming a lug in accordance with fifth embodiment of the present invention.

DETAILED DESCRIPTION

[0013] The disclosure provides methods of making drive plate tabs thicker by folding two stamped circumferential sides attached to tab, and an optional third outer diameter portion. The two sides (and option third portion) are folded in to form the thicker tab, and threads are rolled for increased thread engagement. The methods may also reduce blank size.

[0014] Fig. 1 shows a cross-sectional side view of a torque converter 10 in accordance with an embodiment of the present invention. Torque converter 10 is rotatable about a center axis 11 and includes a front cover 12 for connecting to a crankshaft of an internal combustion engine and a rear cover 14 forming a shell 16 of an impeller or pump 18. The terms radially, axially and circumferentially are used herein with respect to center axis 11. Front cover 12 includes a pilot 12a centered on center axis 11, a radially extending section 12b extending radially outward from pilot 12a and an axially extending section 12c extending axially from the radially outer end of radially extending section 12b toward rear cover 14. Torque converter 10 also includes a turbine 20, which is positioned opposite impeller 18 and a stator 22 axially between impeller 18 and turbine 20.

[0015] A radially inner end of turbine 20 is riveted to a hub section 24, which includes an circumferential surface 26 splined for connecting to a transmission input shaft. A damper assembly 28 is connected to hub section 24 for rotation with hub section 24. More specifically, a drive flange 30 of damper assembly 28 includes a splined inner circumferential surface 32 configured for connecting to an splined outer circumferential

surface 34 of hub section 24. Drive flange 30 includes a plurality of circumferentially spaced slots for receiving circumferentially spaced springs 36, which are supported axially between a first cover plate 38 and a second cover plate 40. Cover plates 38, 40 are fixed together by sheet metal rivets 42.

[0016] Torque converter 10 also includes a lockup clutch 44 formed by an inner radially extending surface 46 of radially extending section 12b of front cover 12, a clutch plate 48 and a piston 50. Clutch plate 48 is formed at a radially outer end of first cover plate 38 and includes friction material 48a, 48b on both axial surfaces thereof. A first friction material 48a is configured for contacting inner radially extending surface 46 and a second friction material 48b is configured for contacting piston 50. Piston 50 is fixed to radially extending section 12b of front cover 12 by a leaf spring 52 such that piston 50 is axially movable with respect to radially extending section 12b in a limited manner. When clutch 44 is locked by piston 50 pressing clutch plate 48 axially against inner radially extending surface 46 of radially extending section 12b, cover plates 38, 40 transfer torque from front cover 12 to drive flange 30 via springs 36. Drive flange 30 in turn drives the transmission input shaft via hub section 24.

[0017] Torque converter 10 also includes a drive plate 54 configured for connecting front cover 12 to an engine crankshaft. Drive plate 54 includes a pilot 56 a radial center thereof centered on center axis 11. Pilot includes a radially extending center disc portion 58 perpendicularly intersecting center axis 11 and an axially extending section 60 forming an outer circumference of pilot 56 that extends axially away from an outer circumference of disc portion 58. Pilot 56 is axially offset from pilot 12a and allows torque converter 10 to extend axially further than pilot 12a for mating with a corresponding centering bore in the engine crankshaft to center torque converter on the engine crankshaft. Adding drive plate 54 to front cover 12 allows torque converter 10 to be used with a drive train having a greater axial gap between the engine crankshaft and the transmission input shaft than torque converter 10 could be used by the use of pilot 12a, essentially allowing torque converter 10 to be used for drive trains having different axial gaps between the engine crankshaft and the transmission input shaft. Additionally, pilot 54 is radially larger than pilot 12a, allowing torque converter 10 to be used with an

engine crankshaft having a centering bore that is radially larger than a centering with which pilot 12a could be used, essentially allowing torque converter 10 to be used for engine crankshafts having centering bores of different radial widths.

[0018] Drive plate 54 further includes a flat connecting section 62 configured for connecting to radially extending portion 12b of front cover 12 and lugs 64 configured for connecting torque converter 10 to an engine flexplate. A first radially and axially extending section 66 extends radially outward from axially extending section 60 of pilot 56 and axially toward radially extending section 12b of front cover 12. Radially and axially extending section 66 connects pilot 56 to flat connecting section 62, which extends perpendicular to center axis 11. In this embodiment, flat connecting section 62 is riveted by rivets 68 to a flat radially extending section 70 of front cover portion 12b that extends perpendicular to center axis 11 and is axially aligned with springs 36. Rivets 68 are extruded rivets formed by extruding front cover portion 12b through holes in flat section 62.

[0019] Radially outside of connecting section 62, drive plate 54 further includes a second radially and axially extending section 72 extending radially outward from connecting section 62 and axially away from front cover section 12b to lugs 64. Lugs 64 are formed to be thicker than a remainder of drive plate 54 by folding protrusions 74 at an outer circumference 75 of drive plate 54 multiple times. In this embodiment, lugs 64 are formed by folding the protrusions 74 twice to form three layers 76a, 76b, 76c. Lugs 64 each include a base layer 76a contiguous with and radially protruding from outer circumference 75 away from center axis 11. At a first bend 76d, base layer 76a merges with an intermediate layer 76b that is bent radially inward from base layer 76a and extends radially inward from base layer 76a toward center axis 11. At a second bend 76e, intermediate layer 76b merges with an end layer 76c that is bent radially outward from intermediate layer 76b and extends away from center axis 11 to form a free end 78 of protrusion 74. Accordingly, each of lugs 64 is formed by three layers 76a, 76b, 76c that are axially and circumferentially aligned with each other and extending in different planes parallel to each other, with each of layers 76a, 76b, 76c extending perpendicular to

center axis 11. Lugs 64 each include an axially extending threaded hole 80 extending therethrough, with hole 80 passing through each layer 76a, 76b, 76c.

[0020] Figs. 2a to 2c illustrate a method of forming one of lugs 64 in accordance with a first embodiment of the present invention. Fig. 2a shows a plan view of protrusion 74, before any folding thereof, protruding radially away from outer circumference 75 of drive plate 54. Protrusion 74 is provided with notches 82a, 82b on radial edges 84a, 84b of protrusion 74 for ease in the folding of protrusion 74 to form layers 76a, 76b, 76c.

Sections 88a, 88b, 88c are formed to be substantially rectangular shaped, with notches 82a, 82b modifying the rectangular shape. Edges 84a, 84b each includes a notch 82a for delimiting a fold line 86a for forming bend 76d and a notch 82b for delimiting a fold line 86b for forming bend 76e. Fold line 86a forms a radially outer edge of a first section 88a that forms base layer 76a and a radially inner edge of a second section 88b that forms intermediate layer 76b. Fold line 86b forms a radially outer edge of second section 88b and a radially inner edge of a third section 88c, whose radially outer edge is formed by free end 78. Before folding, sections 88a, 88b, 88c all extend in the same plane and form a single flat planer piece. Protrusion 74 is folded at fold lines 86a, 86b such that an axial facing surface of section 88b on a first side of protrusion contacts an axial facing surface of section 88a on the first side of protrusion and an axial facing surface of section 88c on a second side of protrusion contacts an axial facing surface of section 88b on the second side of protrusion, with the first and second sides referring to the two opposite axial facing sides of protrusion 74 before folding.

[0021] Fig. 2b shows a cross-sectional side view of protrusion 74 being folded at fold lines 86a, 86b to begin forming bends 76d, 76e. Section 88b is angled with respect to section 88a and section 88c is angled with respect to section 88b.

[0022] Fig. 2c shows a cross-sectional side view of protrusion 74 after bends 76d, 76e at fold lines 86a, 86b are completed. Sections 88a, 88b, 88c are stacked on top of each other as layers 76a, 76b, 76c with an axial facing surface of section 88b contacting an axial facing surface of section 88a and an axial facing surface of section 88c contacting an axial facing surface of section 88b. Sections 88a, 88b, 88c are now circumferentially

and axially aligned with each other and extending parallel to each other. More specifically, base section 88a remains in place and the other sections 88b, 88c are folded to axially align with base section 88a. Next, threaded hole 80 is formed to pass axially through sections 88a, 88b, 88c to form lug 64.

[0023] Figs. 3a to 3d illustrate a method of forming a lug in accordance with another embodiment of the present invention. Fig. 3a shows a plan view of a protrusion 174, before any folding thereof, protruding radially away from an outer circumference 175 of a drive plate 154. Protrusion 174 includes three sections 188a, 188b, 188c and an optional fourth section 188d, which may be provided in addition to sections 188a to 188c or as an alternative to one of sections 188b, 188c. A base section 188a protrudes radially from outer circumference 175. A second section 188b protrudes tangentially from a first circumferential side of base section 188a and a third section 188c protrudes tangentially from a second circumferential side of base section 188a opposite second section 188b such that sections 188a, 188b, 188c are circumferentially aligned with each other. Fourth section 188d protrudes radially outward from base section 188a.

[0024] For ease in the folding, at a fold line 186a delimiting a border between sections 188a, 188b, notches 182a are provided at a radially inner edge and a radially outer edge and at a fold line 186b delimiting a border between sections 188a, 188c, notches 182b are provided at a radially inner edge and a radially outer edge. Similarly, at a fold line 186c delimiting a border between sections 188a, 188d, notches 182c may be provided at circumferential edges. Protrusion 174 is folded at fold lines 186a, 186b and optionally fold line 186c such that an axial facing surface of one of section 188b or section 188c on a first side of protrusion contacts an axial facing surface of section 188a on the first side of protrusion and an axial facing surface of the other of section 188b or section 188c on the first side of protrusion contacts an axial facing surface of the one of section 188b or 188c on the second side of protrusion, with the first and second sides referring to the two opposite axial facing sides of protrusion 174 before folding. Section 188d may be folded such that an axial facing surface of section 188d on the first side of protrusion 174 contacts the axial facing surface of section 188a on the first side of protrusion 174, the

axial facing surface of section 188b on the second side of protrusion 174, or the axial facing surface of section 188c on the second side of protrusion 174.

[0025] Fig. 3b shows a cross-sectional side view of protrusion 174 being folded at fold lines 186a, 186b to begin forming bends 176d, 176e. Section 188b is angled with respect to section 188a and section 188c is angled with respect to section 188a.

[0026] Fig. 3c shows a plan view of protrusion 174 after bends 176d, 176e at fold lines 186a, 186b are completed and a threaded hole 180 is added and Fig. 3d shows a cross-sectional side view of protrusion 174 along A-A in Fig. 3c. Sections 188a, 188b, 188c are stacked on top of each other as layers with an axial facing surface of section 188b contacting an axial facing surface of section 188a and an axial facing surface of section 188c contacting an axial facing surface of section 188b. Sections 188a, 188b, 188c are now circumferentially and axially aligned with each other and extending parallel to each other. Threaded hole 180 is formed to pass axially through sections 188a, 188b, 188c to form the lug.

[0027] Fig. 4 illustrates a method of forming a lug in accordance with another embodiment of the present invention. Fig. 4 shows a plan view of a protrusion 274, before any folding thereof, protruding radially from an outer circumference 275 of a drive plate 254 and extending tangentially with respect to outer circumference 275. Protrusion 274 is provided with notches 282a, 282b on radially inner and outer tangentially extending edges 284a, 284b of protrusion 274 for ease in the folding of protrusion 274 to form three different layers, with edge 284a being radially outside of edge 284b. Edges 284a, 284b each include a notch 282a for delimiting a fold line 286a for forming a first bend and a notch 282b for delimiting a fold line 286b for forming a second bend. Fold line 286a forms an edge of a first section 288a that forms a base layer and a first edge of a second section 288b that forms an intermediate layer. Fold line 286b forms a second edge of second section 288b and a first edge of a third section 288c, whose second edge is formed by a free end 278 of protrusion 274. First section 288a protrudes radially outward from outer circumference 275, then protrusion 274 juts tangentially to outer circumference 275 to form sections 288b, 288c. Protrusion 274 is folded at fold lines

286a, 286b such that an axial facing surface of section 288b on a first side of protrusion contacts an axial facing surface of section 288a on the first side of protrusion and an axial facing surface of section 288c on a second side of protrusion contacts an axial facing surface of section 288b on the second side of protrusion, with the first and second sides referring to the two opposite axial facing sides of protrusion 274 before folding, one of which is shown in Fig. 4. Then, after sections 288a, 288b, 288c are stacked on top of each other to form layers, a threaded hole is formed to pass axially through sections 288a, 288b, 288c to form the lug.

[0028] Fig. 5 illustrates a method of forming a lug in accordance with another embodiment of the present invention. Fig. 5 shows a plan view of a protrusion 374, before any folding thereof, protruding radially from an outer circumference 375 of a drive plate 354 and including sections 388a to 388c extending radially outward from outer circumference 375 of a drive plate 354 and including a section 388d extending tangentially with respect to outer circumference 375 from base section 388a. More specifically, an intermediate section 388b protrudes radially from an outer radial edge of base section 388a, a radially outer section 388c protrudes radially from an outer radial edge of intermediate section 388b and tangentially extending section 388d protrudes tangentially from a radial edge of base section 388a. For ease in the folding, at a fold line 386a delimiting a border between sections 388a, 388b, notches 382a are provided at radial edges of protrusion 374 and at a fold line 386b delimiting a border between sections 388b, 388c, notches 382b are provided at radial edges of protrusion 374. Similarly, at a fold line 386c delimiting a border between sections 388a, 388d, notches 382c may be provided at radially inner and outer edges of section 388d. Protrusion 374 may thus be folded at fold lines 386a, 386b, 386c to fold sections 388a to 388d into four layers such that at least one axial facing surface of each section 388a to 388d contacts an axial facing surface of another of section 388a to 388d. Then, after sections 388a to 388d are stacked on top of each other to form layers, a threaded hole is formed to pass axially through sections 388a to 388d to form the lug.

[0029] Fig. 6 illustrates a method of forming a lug in accordance with another embodiment of the present invention. Fig. 6 shows a plan view of a protrusion 474,

before any folding thereof, protruding radially from an outer circumference 475 of a drive plate 454 and including sections 488a, 488b extending radially outward from an outer circumference 475 of a drive plate 454 and including sections 488c, 488d extending tangentially with respect to outer circumference 475 from base section 488a. More specifically, an intermediate section 488c protrudes tangentially from a radial edge of base section 488a, a tangentially outer section 488d protrudes tangentially from a radial edge of intermediate section 488c and a radially extending section 488b protrudes radially from an outer edge of base section 488a. For ease in the folding, at a fold line 486a delimiting a border between sections 488a, 488b, notches 482a are provided at radial edges of protrusion 474. Additionally, at a fold line 486b delimiting a border between sections 488a, 488c, notches 482b are provided at inner and outer edges of protrusion 474 and at a fold line 486c delimiting a border between sections 488c, 488d, notches 482c are provided at inner and outer edges of section 488d of protrusion 474. Protrusion 474 may thus be folded at fold lines 486a, 486b, 486c to fold sections 488a to 488d into four layers such that at least one axial facing surface of each section 488a to 488d contacts an axial facing surface of another of section 488a to 488d. Then, after sections 488a to 488d are stacked on top of each other to form layers, a threaded hole is formed to pass axially through sections 488a to 488d to form the lug.

[0030] In the preceding specification, the invention has been described with reference to specific exemplary embodiments and examples thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative manner rather than a restrictive sense.

WHAT IS CLAIMED IS:

1. A method of forming a drive plate for a torque converter comprising:
folding a portion of the drive plate into a plurality of sections stacked to form aligned layers; and
providing a hole through the layers to form a lug for connecting the drive plate to an engine.
2. The method as recited in claim 1 wherein, before the folding, the portion is a protrusion extending radially from an outer circumference of the drive plate.
3. The method as recited in claim 1 wherein the portion includes at least three sections that are folded to form at least three layers.
4. The method as recited in claim 1 wherein, after the folding, the layers are circumferentially and axially aligned with each other and extending in different planes parallel to each other.
5. The method as recited in claim 1 wherein the sections include a base section abutting an outer circumference of the drive plate and other sections connected to the base section, the other sections being folded to axially align with the base section.
6. The method as recited in claim 5 wherein, before the folding, the other sections each extend either tangentially or radially from the base section.
7. The method as recited in claim 1 further comprising forming the drive plate to include a pilot at a radial center thereof.
8. The method as recited in claim 1 further comprising fixing the drive plate to a front cover of the torque converter.

9. A torque converter comprising:

a front cover; and

a drive plate connected to the front cover and configured for connecting to an engine, the drive plate including a plurality of sections stacked to form aligned layers, the layers including a hole passing therethrough.

10. The torque converter as recited in claim 9 wherein the drive plate includes a pilot at a radial center thereof.

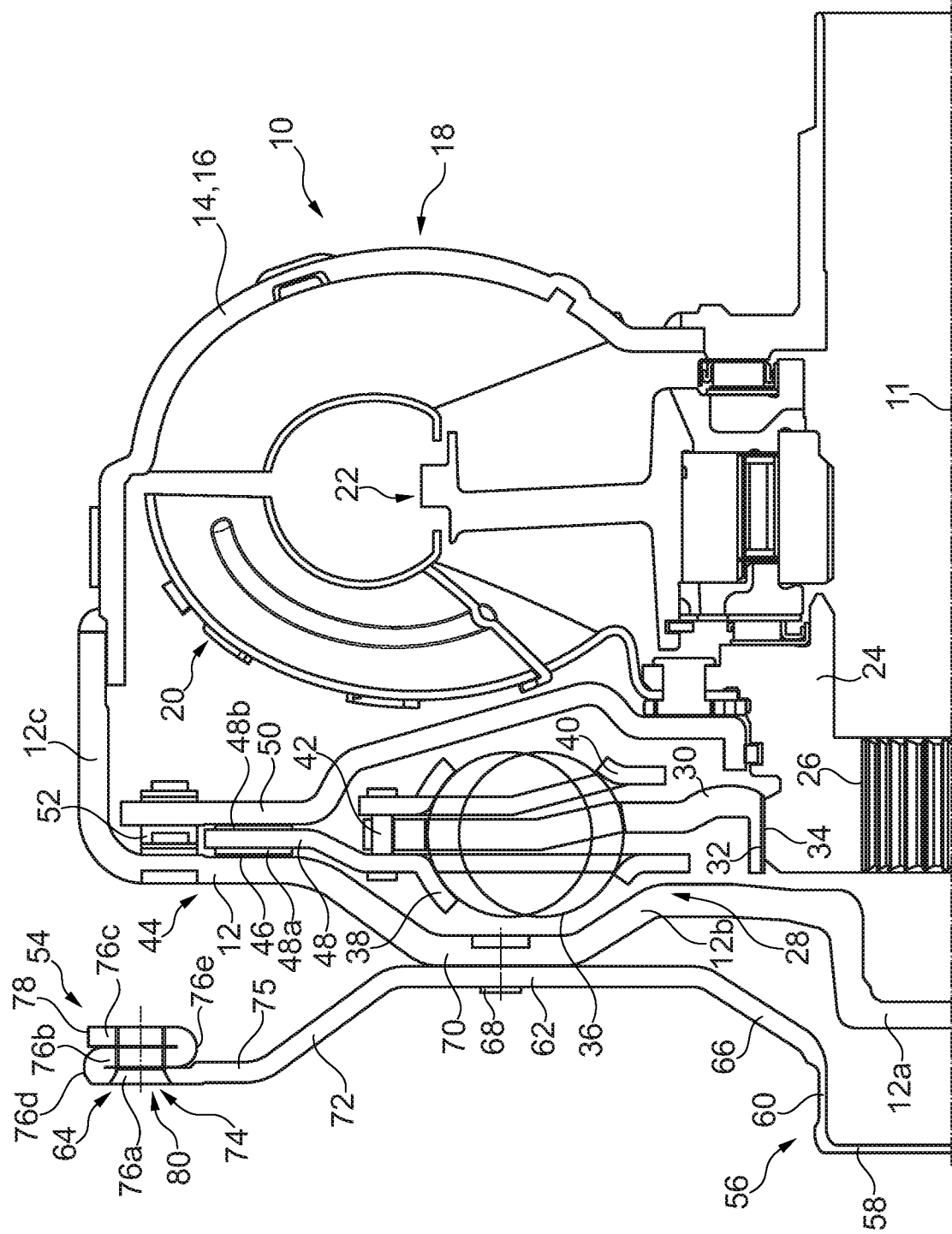


Fig. 1

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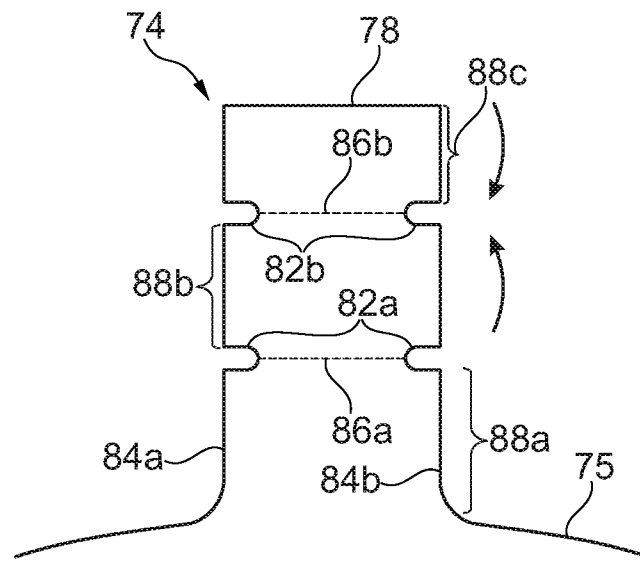


Fig. 2a

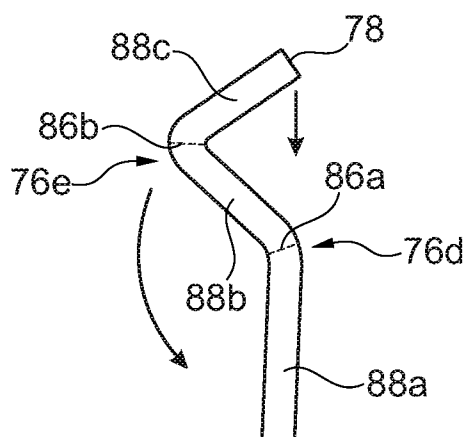


Fig. 2b

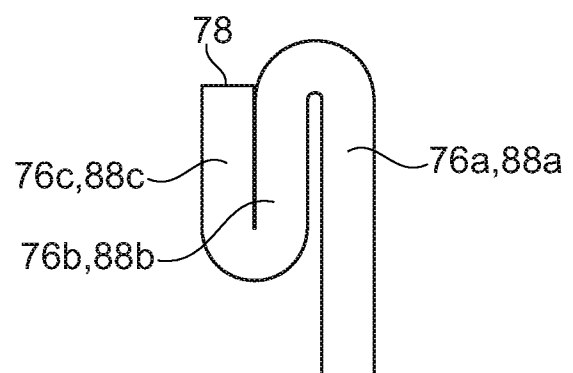


Fig. 2c

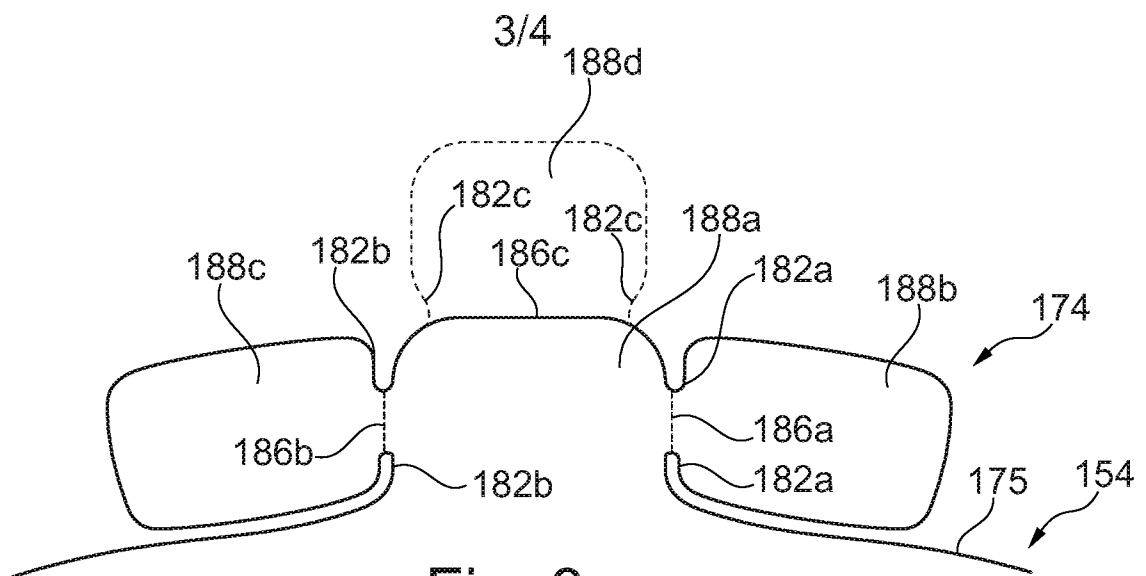


Fig. 3a

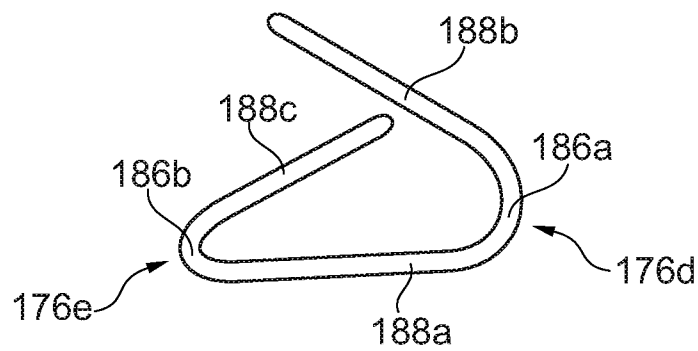


Fig. 3b

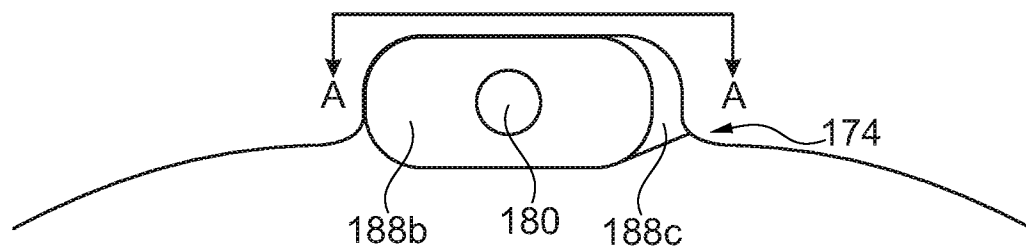


Fig. 3c

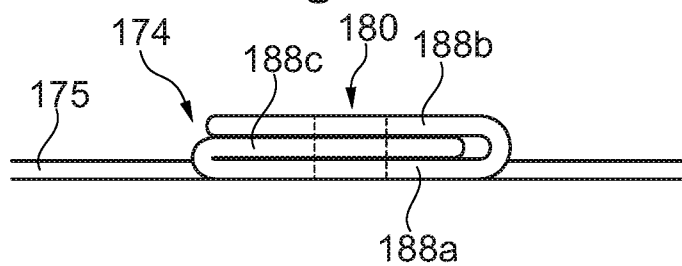


Fig. 3d

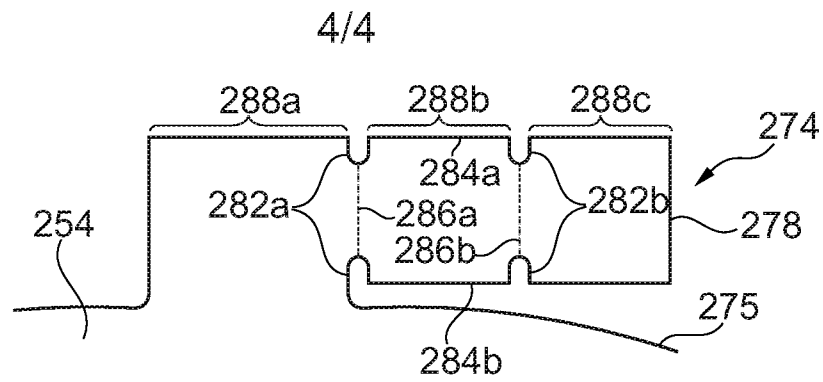


Fig. 4

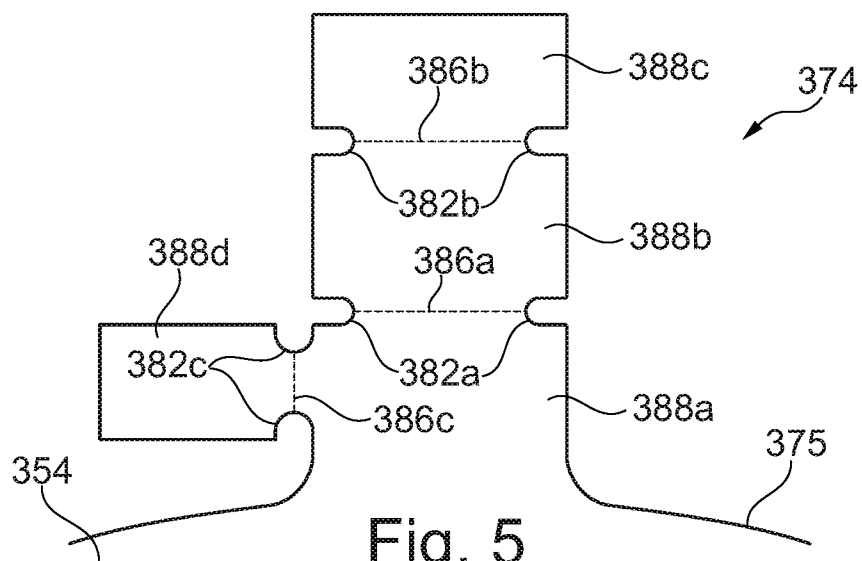


Fig. 5

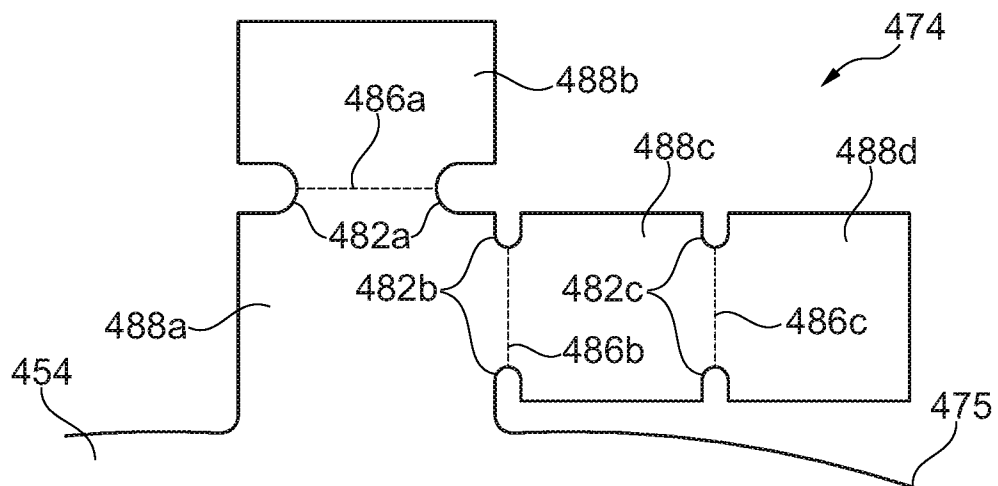


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/028568**A. CLASSIFICATION OF SUBJECT MATTER****F16H 41/28(2006.01)i, F16H 41/24(2006.01)i, B21D 5/00(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 41/28; F16D 33/00; F16H 45/02; F16F 15/121; F16H 41/24; B21D 5/00

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, drive plate, lug, folding, layer, pilot, and hole

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11-247966 A (TOCHIGI FUJI IND. CO., LTD.) 14 September 1999 See paragraphs [0029], [0031], [0032], [0037], [0038] and figures 1, 2.	1,3,4,7,8
Y		2,5,6,9,10
Y	KR 10-2007-0096471 A (HYUNDAI MOTOR COMPANY) 02 October 2007 See paragraphs [0032], [0033] and figures 4a, 4b.	2,5,6
Y	JP 2012-207759 A (DAIHATSU MOTOR CO., LTD.) 25 October 2012 See paragraphs [0016], [0018], [0019], [0025] and figures 1-4.	9,10
A	US 2002-0038546 A1 (YAMANAKA et al.) 04 April 2002 See paragraphs [0057]-[0059], [0065] and figures 4D-4H, 5, 8.	1-10
A	US 2013-0324267 A1 (SCHAEFFLER TECHNOLOGIES AG. & CO., KG.) 05 December 2013 See paragraph [0031] and figures 5A, 5B.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

18 January 2017 (18.01.2017)

Date of mailing of the international search report

19 January 2017 (19.01.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

KIM, Jin Ho

Telephone No. +82-42-481-8699



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 11-247966 A	14/09/1999	None	
KR 10-2007-0096471 A	02/10/2007	None	
JP 2012-207759 A	25/10/2012	None	
US 2002-0038546 A1	04/04/2002	DE 69915970 T2	10/02/2005
		EP 0997666 A2	03/05/2000
		EP 0997666 A3	05/09/2001
		EP 0997666 B1	31/03/2004
		JP 2000-130550 A	12/05/2000
		JP 4196366 B2	17/12/2008
		US 2003-0070294 A1	17/04/2003
		US 2003-0074791 A1	24/04/2003
		US 6474062 B1	05/11/2002
		US 6594895 B2	22/07/2003
		US 6651330 B2	25/11/2003
		US 6662446 B2	16/12/2003
US 2013-0324267 A1	05/12/2013	DE 102013208922 A1	05/12/2013
		US 8992333 B2	31/03/2015