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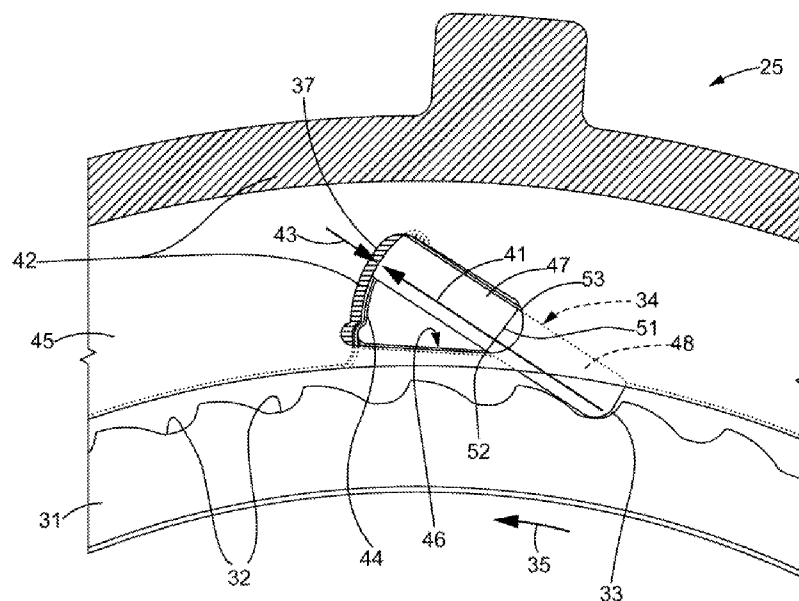


FIG. 3

(57) Abstract: A transmission clutch module (25, 125) includes an inner race (31, 131), an outer race (42, 142), a side plate (45, 145) and a plurality of pawls (34, 134) adapted to lock and unlock the races (31, 131, 42, 142). The inner race (31, 131) includes a plurality of spaced apart detents (32, 132) for engaging one end of the pawls (34, 134). The outer race (42, 142) includes radially aligned and spaced apart abutments (44, 144) for engaging the other end of the pawls (34, 134). Each abutment (44, 144) extends through one of the apertures (46, 146) in the side plate (45, 145). Each pawl (34, 134) includes a head (47, 147) accommodated in one of the apertures (46, 146) of the side plate (45, 145) and each pawl (34, 134) includes a neck (48, 148) that extends between the side plate (45, 145) and outer race (42, 142). The pawls (34, 134) engage edges of the apertures (46, 146) so the pawls (34, 134) can pivot between locked and unlocked positions without being connected to the side plate (45, 145) or the races (31, 131, 42, 142).



SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

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SIDE PLATE AND PAWLS FOR MULTI-MODE CLUTCH MODULES WITH IMPROVED TORQUE PATH

Field of Disclosure

[0001] This disclosure relates generally to overrunning clutches for automotive
5 transmissions, and more particularly to multiple mode clutches employed in such transmissions.

Background of Disclosure

[0002] An automotive vehicle typically includes an internal combustion engine containing a rotary crankshaft configured to transfer motive power from the engine
10 through a driveshaft to turn the wheels. A transmission interposed between engine and driveshaft components selectively controls torque and speed ratios between the crankshaft and the driveshaft. In a manually operated transmission, a corresponding manually operated clutch interposed between the engine and transmission selectively engages and disengages the crankshaft from the driveshaft to facilitate manual
15 shifting among available transmission gear ratios.

[0003] On the other hand, if the transmission is automatic, the transmission will normally include a plurality of automatically actuated clutches adapted for dynamically shifting between available gear ratios without requiring driver intervention. Such transmissions include a plurality of clutches, also called clutch
20 modules, to facilitate the automatic gear ratio changes.

[0004] In an automatic transmission for an automobile, anywhere from three to ten forward gear ratios may be available, not including a reverse gear. The various gears may be structurally comprised of inner gears, intermediate gears such as planet or

pinion gears supported by carriers, and outer ring gears. Specific transmission clutches may be associated with specific sets of the selectable gears within the transmission to facilitate the desired ratio changes.

[0005] For example, in FIG. 1, one of the clutch modules 10 of an automatic transmission associated with first (low) and reverse gear ratios may be normally situated at the front of the transmission and closely adjacent the engine crankshaft (not shown). The clutch module 10 may have an inner race 11 and an outer race 12 disposed circumferentially about the inner race 11. One of the races 11, 12 may be drivingly rotatable in one or both directions. The inner race 11 may selectively lock to the outer race 12 via an engagement mechanism that includes one or more pawls 13 or other similar components. When locked, in the direction of rotation, the inner race 11 transfers torque to the outer race 12 via the pawls 13 and a side plate 14. The pawls 13 transmit torque to the side plate 14, which then transmits torque to the outer race 12. The outer race 12 couples to a transmission component shown schematically at 18.

[0006] The problem associated with this design is the torque transmitted from the inner race 11, through one end the pawls 13 referred to as the toe 15, through the pivotal connections 16 between the pawls 13 and the side plate 14 and finally from the side plate 14 to the outer race 12. The pivotal connections 16 include coaxial shafts 17 disposed on either side of the main body 21 of the pawl 13, as shown in FIG. 2. FIG. 2 also illustrates the transmission of torque through the toe 22 of the pawl 13 as shown by the arrow 23 to the shafts 17 as shown by the arrows 24. In addition to being indirect, this design imposes torque on the pivotal connections 16 and the bushings 19, which can lead to failure of the pivotal connections 16, resulting in costly repairs and increased maintenance requirements. Additionally, the pivotal

connections 16, bushings 19 and pawls 13 are time consuming to install during the assembly process.

Summary of the Disclosure

5 **[0007]** This application discloses a multi-mode clutch module with an improved torque path. The module comprises an inner race and an outer race, wherein the inner and outer races are aligned along a common axis. The inner race comprises a plurality of circumferentially spaced apart detents. The module also includes a side plate that comprises a plurality of radially aligned and spaced apart apertures. The
10 outer race includes a plurality of radially aligned and spaced apart abutments. Each abutment extends through one of the apertures in the side plate. The module also includes a plurality of pawls, wherein each pawl includes a neck connected to a head. Each neck comprises a toe disposed opposite its respective neck from its respective head while each head comprises a heel disposed opposite its respective head from its
15 respective neck. At least part of the heads of each pawl is accommodated in one of the apertures of the side plate while the neck of each pawl extends between the side plate and outer race. In a locked position, the toe of at least one pawl is received in one of the detents of the inner race and the heel of said at least one pawl engages one of the abutments of the outer race. Also, in an unlocked position, the toe of said at
20 least one pawl pivots outward and disengages from the detent.

[0008] In one or more embodiments, the side plate and the pawls are in engagement with one another but not connected to one another.

[0009] In one or more embodiments, the inner outer race comprises a circular ring having an outer periphery. The detents are disposed along this outer periphery.

[0010] In one or more embodiments, the heads of the pawls are wider than the necks of the pawls.

[0011] In one or more embodiments, the head of each pawl includes two lower edges disposed on opposite sides of the neck. The two lower edges of each head
5 engaging the aperture.

[0012] In one or more embodiments, each aperture includes a wide end, which accommodates one of the abutments of the outer race, and a narrow end, which receives and engages at least one of the lower surfaces of its respective pawl.

[0013] In one or more embodiments, the lower edges of each pawl engage the
10 narrow end of its respective aperture when the pawl pivots between locked and unlocked positions.

[0014] In one or more embodiments, the apertures in the side plate each have a wide end and a narrow end. The apertures are arranged in an alternating configuration wherein the wide end of each aperture faces the wide end of one adjacent aperture and
15 the narrow end of each aperture facing the narrow end of another adjacent aperture.

[0015] A method of manufacturing a clutch module is also disclosed. The method comprises: providing inner race comprising an outer periphery that comprises a plurality of circumferentially spaced apart detents separated by radially outwardly extending lugs; providing a side plate comprising a plurality of radially aligned and
20 spaced apart apertures, the apertures each having a wide end and a narrow end, the apertures having an alternating configuration wherein the wide end of each aperture faces the wide end of one adjacent aperture and the narrow end of each aperture facing the narrow end of another adjacent aperture; providing an outer race with a plurality of radially aligned and spaced apart abutments; providing a plurality of
25 pawls, each pawl including a neck connected to a head, each neck comprising a toe

disposed opposite its respective neck from its respective head, each head comprising a heel disposed opposite its respective head from its respective neck; connecting the side plate to at least one of the inner and outer races; inserting the head of each pawl into one of the apertures in the side plate with the neck extending between the side plate and the outer race and with the toes of the pawls in axial alignment with the detents of the inner race.

Brief Description of Drawings

[0016] FIG. 1 is a partial view of a prior art automatic transmission clutch module illustrating the transmission of torque from the inner race to the pawls, from the pawls to pivotal connections in the side plate and from the side plate to the outer race.

[0017] FIG. 2 is a plan view of the prior art pawls of the clutch module shown in FIG. 1.

[0018] FIG. 3 is a partial view of an automatic transmission clutch module made in accordance with this disclosure, particularly illustrating a pawl in a locked position for counter-clockwise rotation and the transfer of torque from the inner race to the outer race through the pawl without transmission of torque through the side plate.

[0019] FIG. 4 is another partial view of the clutch module of FIG. 3, showing one pawl (on the right) in a locked position for clockwise rotation and one pawl (on the left) in a freewheel position, and further illustrating rotation of the pawls about a pivot axis without being connected to the side plate.

[0020] FIG. 5 is a plan view of a pawl for an automatic transmission clutch module made in accordance with this disclosure.

[0021] The drawings used to illustrate the disclosed embodiments are not necessarily to scale, and may provide only partial and/or diagrammatic views. Further, this disclosure is not limited to the particular embodiments illustrated herein.

5 Detailed Description

[0022] FIG. 3 is a partial view of a clutch module 25 that may be adapted as a sub-unit of an automatic transmission (not shown), such as a transmission for an automobile. The clutch module 25 includes an inner race 31 that includes a plurality of circumferentially spaced detents 32 disposed on the outer periphery of the inner
10 race 31. The detents 32 could also be disposed along a face of the inner race 31. The detents 32 permit locked rotation in the direction of the arrow 35 only. The detents 32 engage the toe 33 of the pawl 34 thereby transmitting torque from the inner race 31 when the inner race 31 is rotating in the direction of the arrow 35, through the toe 33, the neck 48 and head 47 to the heel 37 of the pawl 34 as indicated by the arrow 41.
15 The heel 37 of the pawl 34 engages an abutment 44 that extends axially outward from the outer race 42 thereby transmitting torque to the outer race 42 as indicated by the arrow 43.

[0023] Referring to FIGS. 3 and 5, rather than being pivotally connected to the pawl 34, the side plate 45 includes apertures 46 for receiving the head 47 of the pawl 34
20 while the neck 48 of the pawl 34 is positioned between the side plate 45 and outer race 42 and in alignment with the detents 32 of the inner race 31. Assuming a single side plate 45 is employed, engagement between the side plate 45 and the pawl 34 occurs along one of the lower edges 51 of the head 47 of the pawl 34 (see also FIG. 5) at the front edge 52 and back edge 53 as shown in FIG. 3. This engagement, as

opposed to a connection, does not cause a stress concentration along the lower edges 51 or at the corners 54 between the head 47 and neck 48 of the pawl 34.

[0024] FIG. 4 is a partial view of a clutch module 125, which includes an inner race 131 that includes a plurality of circumferentially spaced apart detents 132 disposed on 5 the outer periphery of the inner race 131. The detents 132 and tapered toes 133 of the pawls 134 permit locked rotation in both directions as indicated by the double-ended arrow 135. Referring to the pawl 134 shown on the right in FIG. 4, the detent 132 (and/or lug 155) engages the toe 133 of the pawl 134 thereby transmitting torque from the inner race 131, through the toe 133, neck 148, head 147 and the heel 137 as 10 indicated by the arrow 141. The heel 137 of the pawl 134 engages an abutment 144 of the outer race 142 thereby transmitting torque to the outer race 142 as indicated by the arrow 143.

[0025] Again, the side plate 145 is not connected to the pawl 134, but includes an aperture 146 for receiving the head 147 of the pawl 134 while the neck 148 of the 15 pawl 134 remains behind the side plate 145 (between the side plate 145 and the outer race 142) and in alignment with the circumference or the detents 132 and lugs 155 of the inner race 131. Assuming a single side plate 145 is employed, engagement between the side plate 145 and the pawl 134 occurs along one of the lower surfaces 151 of the head 147 of the pawl 134 at the front edge 152 and back edge 153 as 20 shown at the right in FIG. 4. This engagement, as opposed to a connection, does not cause a stress concentration along the lower surfaces 151 or at the corners between the head 147 and neck 148 of the pawl 134.

[0026] As disclosed, the pawls 34, 134 are hardened steel members circumferentially positioned about the axis (not shown) of the clutch modules 25, 125. 25 Alternatively, the pawls 34, 134 maybe forgings or other manufactured structures,

otherwise generally adapted to handle required loads of engagement as necessary for any particular clutch design.

Industrial Applicability

5 **[0027]** The clutch module of this disclosure is applicable to a variety of vehicular applications, including but not limited to, automobiles, trucks, off-road vehicles, and other machines of the type having engines, automatic transmissions, and drivelines.

[0028] The disclosed clutch module offers a unique approach to avoiding stress concentrations associated with pawls generally employed to engage inner and outer
10 races of clutches in automatic transmissions. Stress concentrations are avoided by employing a side plate, not as a pivotal connection or mounting for the pawls, but merely as a guide for the pawls as they engage and disengage from the inner race. Because there is no pivotal connection between the pawls and the side plate, stress concentrations are eliminated, thereby reducing maintenance costs and facilitating the
15 assembly of the clutch modules, thereby also reducing manufacturing costs.

Claims:

1. A multi-mode clutch module (25, 125), comprising:

an inner race (31, 131) and an outer race (42, 142), the inner and outer
5 races aligned along a common axis,

the inner race (31, 131) comprising a plurality of spaced apart detents
(32, 132);

a side plate (45, 145) comprising a plurality of radially aligned and
spaced apart apertures (46, 146),

10 the outer race (42, 142) including a plurality of radially aligned and
spaced apart abutments (44, 144), each abutment (44, 144) extending through
one of the apertures (46, 146) in the side plate (45, 145),

a plurality of pawls (34, 134), each pawl (34, 134) including a neck
(48, 148) connected to a head (47, 147), each neck (48, 148) comprising a toe
15 (33, 133) disposed opposite its respective neck (48, 148) from its respective
head (47, 147), each head (47, 147) comprising a heel (37, 137) disposed
opposite its respective head (47, 147) from its respective neck (48, 148),

at least part of the heads (47, 147) of each pawl (34, 134)
accommodated in one of the apertures (46, 146) in the side plate (45, 145)
20 while the neck (48, 148) of each pawl (34, 134) extends between the side plate
(45, 145) and outer race (42, 142),

wherein, in a locked position, the toe (33, 133) of at least one pawl (34, 134) is received in one of the detents (32, 132) of the inner race (31, 131) and the heel (37, 137) of said at least one pawl (34, 134) engages one of the abutments of the outer race (42, 142), and

5 wherein, in an unlocked position the toe (33, 133) of said at least one pawl (34, 134) pivots outward and disengages from the detent (32, 132).

2. The multi-mode clutch module (25, 125) of claim 1, wherein the side plate (45, 145) and pawls (34, 134) are in engagement with one another but not
10 connected to one another.

3. The multi-mode clutch module (25, 125) of claim 1, wherein the inner race (31, 131) comprises a circular ring having an outer periphery and the detents (32, 132) are disposed along the outer periphery.

15 4. The multi-mode clutch module (25, 125) of claim 1, wherein the heads of the pawls (34, 134) are wider than the necks of the pawls (34, 134).

5. The multi-mode clutch module (25, 125) of claim 1, wherein the head (47, 147) of each pawl (34, 134) includes two lower edges (51, 151) disposed on
20

opposite sides of the neck (48, 148), the two lower edges (51, 151) of each head (47, 147) engaging the aperture (46, 146).

5 6. The multi-mode clutch of claim 1, wherein each aperture (46, 146) includes a wide end which accommodates one of the abutments (44, 144) of the outer race (42, 142) and a narrow end which receives and engages at least one of the lower edges (51, 151) of its respective pawl (34, 134).

10 7. The multi-mode clutch of claim 6, wherein the lower edges (51, 151) of each pawl (34, 134) engage the narrow end of its respective aperture (46, 146) when the pawl (34, 134) pivots between locked and unlocked positions.

15 8. The multi-mode clutch of claim 1 wherein each aperture (46, 146) in the side plate (45, 145) has a wide end and a narrow end, the apertures (46, 146) positioned in an alternating configuration wherein the wide end of each aperture (46, 146) faces the wide end of one adjacent aperture (46, 146) and the narrow end of each aperture (46, 146) faces the narrow end of another adjacent aperture (46, 146).

20 9. A multi-mode clutch module (25, 125), comprising:

an inner race (31, 131) and an outer race (42, 142) with a side plate (45, 145) at least partially disposed between the inner and outer races, the inner and outer races and side plate (45, 145) being coaxial,

5 the inner race (31, 131) comprising an outer periphery that comprises a plurality of circumferentially spaced apart detents (32, 132) separated by radially outwardly extending lugs (155),

the side plate (45, 145) comprising a plurality of radially aligned and spaced apart apertures (46, 146), the apertures (46, 146) each having a wide end and a narrow end, the apertures (46, 146) having an alternating
10 configuration wherein the wide end of each aperture (46, 146) faces the wide end of one adjacent aperture (46, 146) and the narrow end of each aperture (46, 146) facing the narrow end of another adjacent aperture (46, 146),

the outer race (42, 142) including a plurality of radially aligned and spaced apart abutments (44, 144), each abutment (44, 144) extending through
15 the wide end of one of the apertures (46, 146) in the side plate (45, 145),

a plurality of pawls (34, 134), each pawl (34, 134) including a neck (48, 148) connected to a head (47, 147), each neck (48, 148) comprising a toe (33, 133) disposed opposite its respective neck (48, 148) from its respective head (47, 147), each head (47, 147) comprising a heel (37, 137) disposed
20 opposite its respective head (47, 147) from its respective neck (48, 148),

at least part of the heads (47, 147) of each pawl (34, 134) accommodated in one of the apertures (46, 146) of the side plate (45, 145)

while the neck (48, 148) of each pawl (34, 134) extends between the side plate (45, 145) and outer race (42, 142),

wherein, in a locked position, the toe (33, 133) of at least one pawl (34, 134) is received in one of the detents (32, 132) of the inner race (31, 131) and
5 the heel (37, 137) of said at least one pawl (34, 134) engages one of the abutments (44, 144) of the outer race (42, 142), and

wherein, in an unlocked position the toe (33, 133) of said at least one pawl (34, 134) pivots outward and disengages from the detent (32, 132).

10 10. The multi-mode clutch module (25, 125) of claim 9, wherein the side plate (45, 145) and pawls (34, 134) are in engagement with one another but not connected to one another.

11. The multi-mode clutch module (25, 125) of claim 9, wherein the inner race
15 (31, 131) and outer race (42, 142) comprise circular rings.

12. The multi-mode clutch module (25, 125) of claim 9, wherein the heads of the pawls (34, 134) are wider than the necks (48, 148) of the pawls (34, 134).

20 13. The multi-mode clutch module (25, 125) of claim 12, wherein the head (47, 147) of each pawl (34, 134) includes two lower edges (51, 151) disposed on

opposite sides of the neck (48, 148), the two lower edges (51, 151) of each head (47, 147) engaging its respective aperture (46, 146).

14. The multi-mode clutch of claim 13, wherein each aperture (46, 146) includes a
5 wide end which accommodates one of the abutments (44, 144) of the outer race (42, 142) and a narrow end which receives and engages at least one of the lower edges (51, 151) of its respective pawl (34, 134).

15. A method of making a multi-mode clutch module (25, 125), comprising:

10 providing inner race (31, 131) comprising an outer periphery that comprises a plurality of circumferentially spaced apart detents (32, 132);

providing a side plate (45, 145) comprising a plurality of radially aligned and spaced apart apertures (46, 146), the apertures (46, 146) each having a wide end and a narrow end, the apertures (46, 146) having an alternating

15 configuration wherein the wide end of each aperture (46, 146) faces the wide end of one adjacent aperture (46, 146) and the narrow end of each aperture (46, 146) facing the narrow end of another adjacent aperture (46, 146);

providing an outer race (42, 142) with a plurality of radially aligned and spaced apart abutments (44, 144);

20 providing a plurality of pawls (34, 134), each pawl (34, 134) including a neck (48, 148) connected to a head (47, 147), each neck (48, 148) comprising a toe (33, 133) disposed opposite its respective neck (48, 148) from its respective

head (47, 147), each head (47, 147) comprising a heel (37, 137) disposed opposite its respective head (47, 147) from its respective neck (48, 148), connecting the side plate (45, 145) to at least one of the inner and outer races (31, 131, 42, 142),

- 5 inserting the head (47, 147) of each pawl (34, 134) into one of the apertures (46, 146) in the side plate (45, 145) with the neck (48, 148) extending between the side plate (45, 145) and the outer race (42, 142) and with the toes (33, 133) of the pawls (34, 134) in axial alignment with the inner race (31, 131).

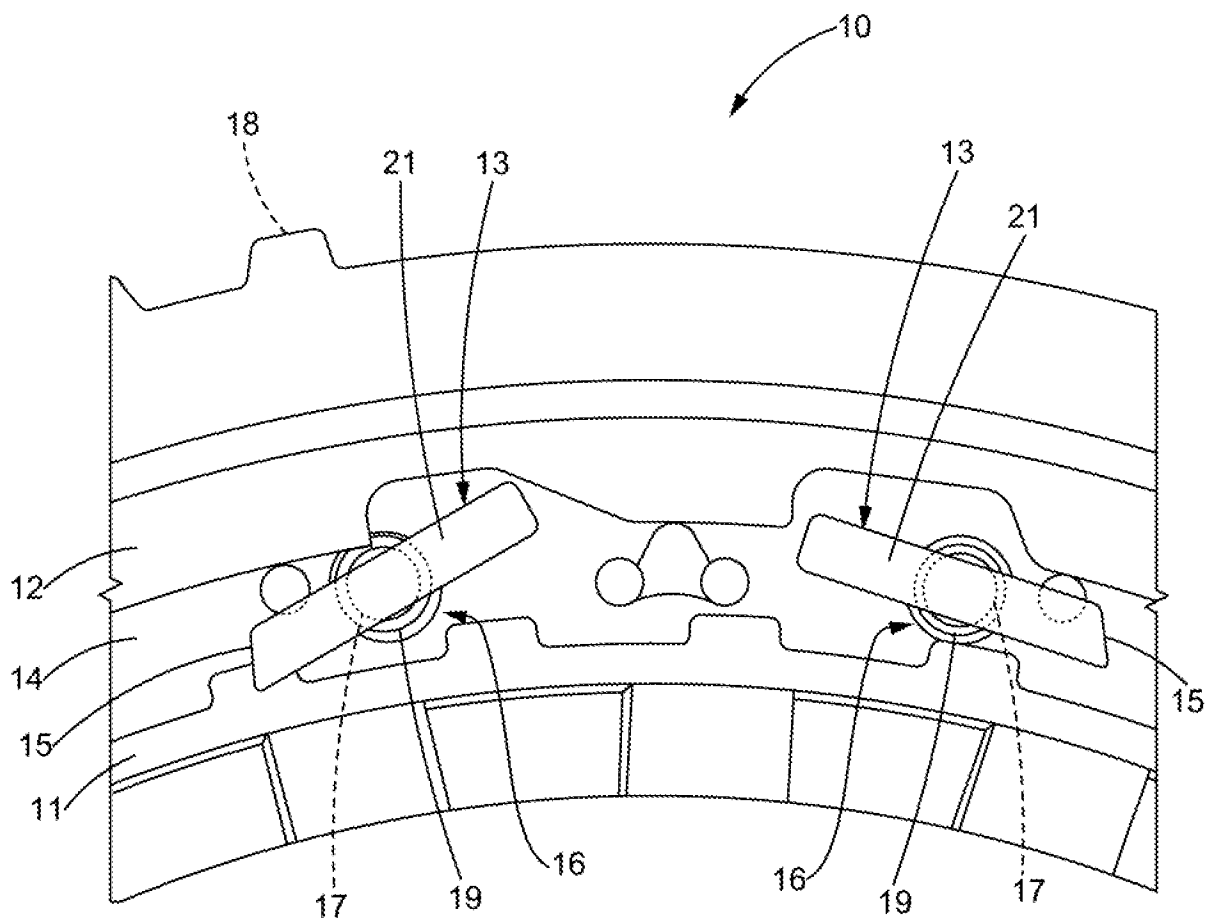


FIG. 1
(PRIOR ART)

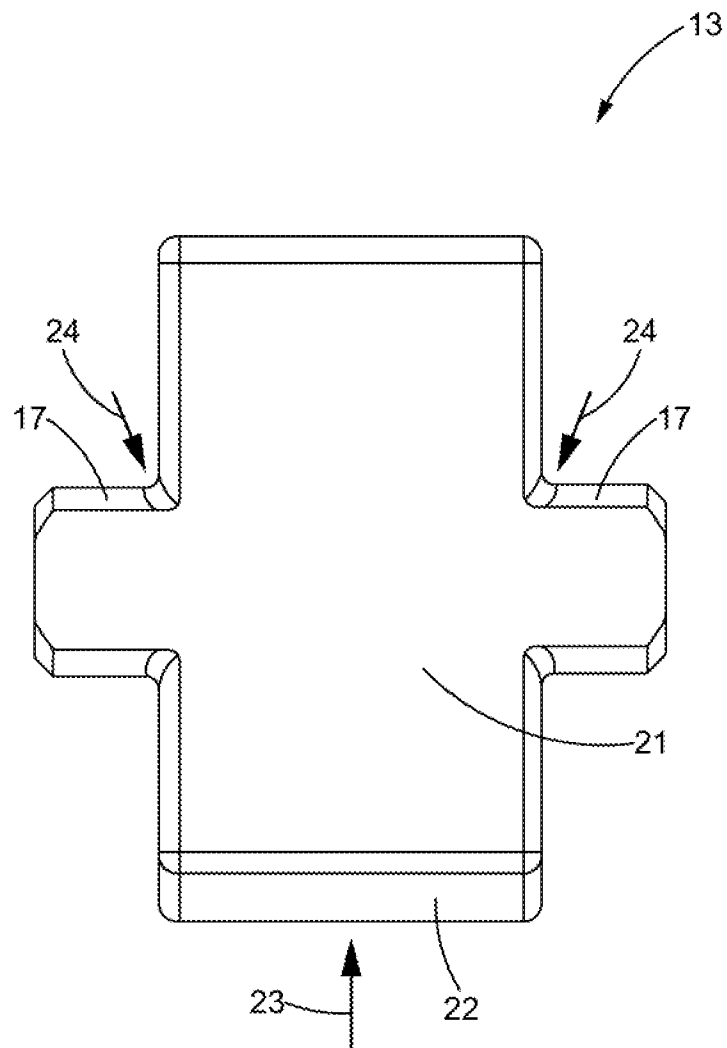


FIG. 2
(PRIOR ART)

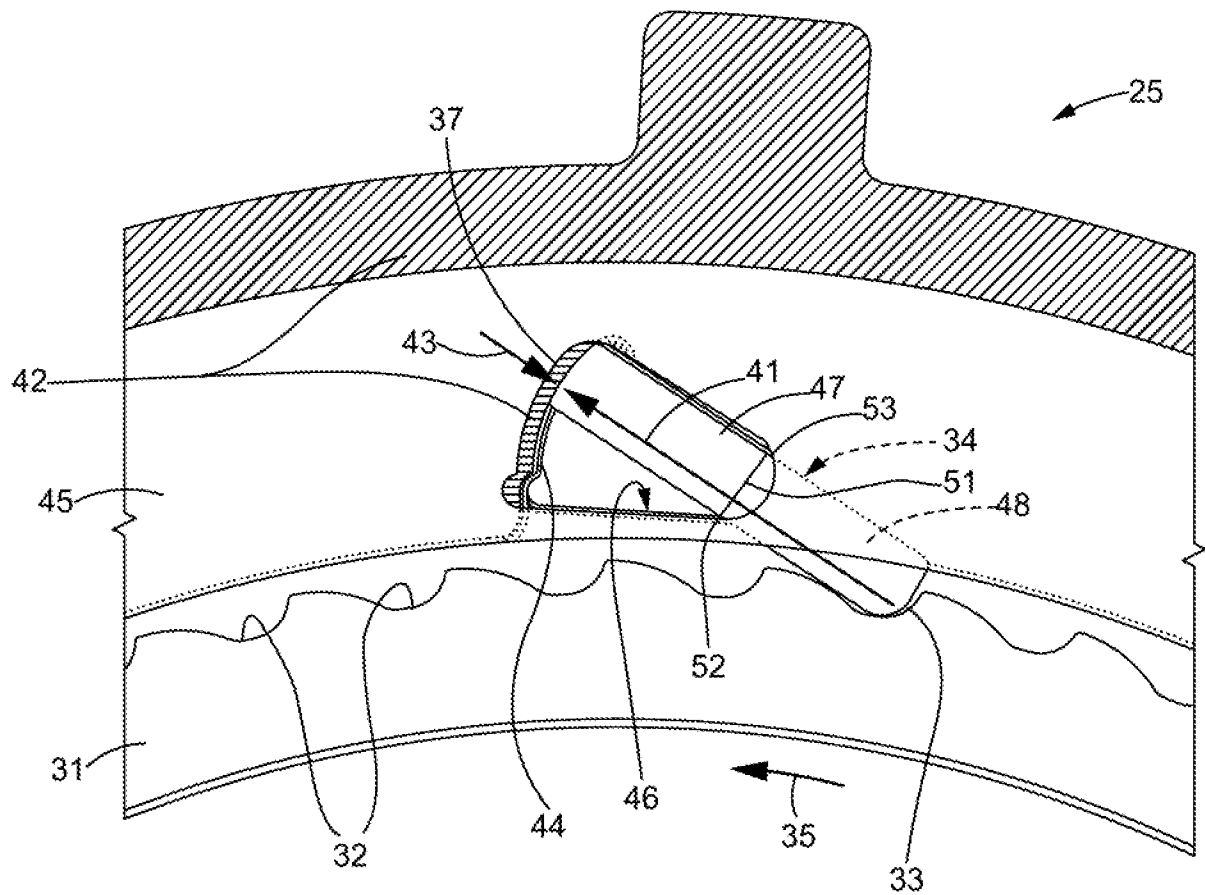


FIG. 3

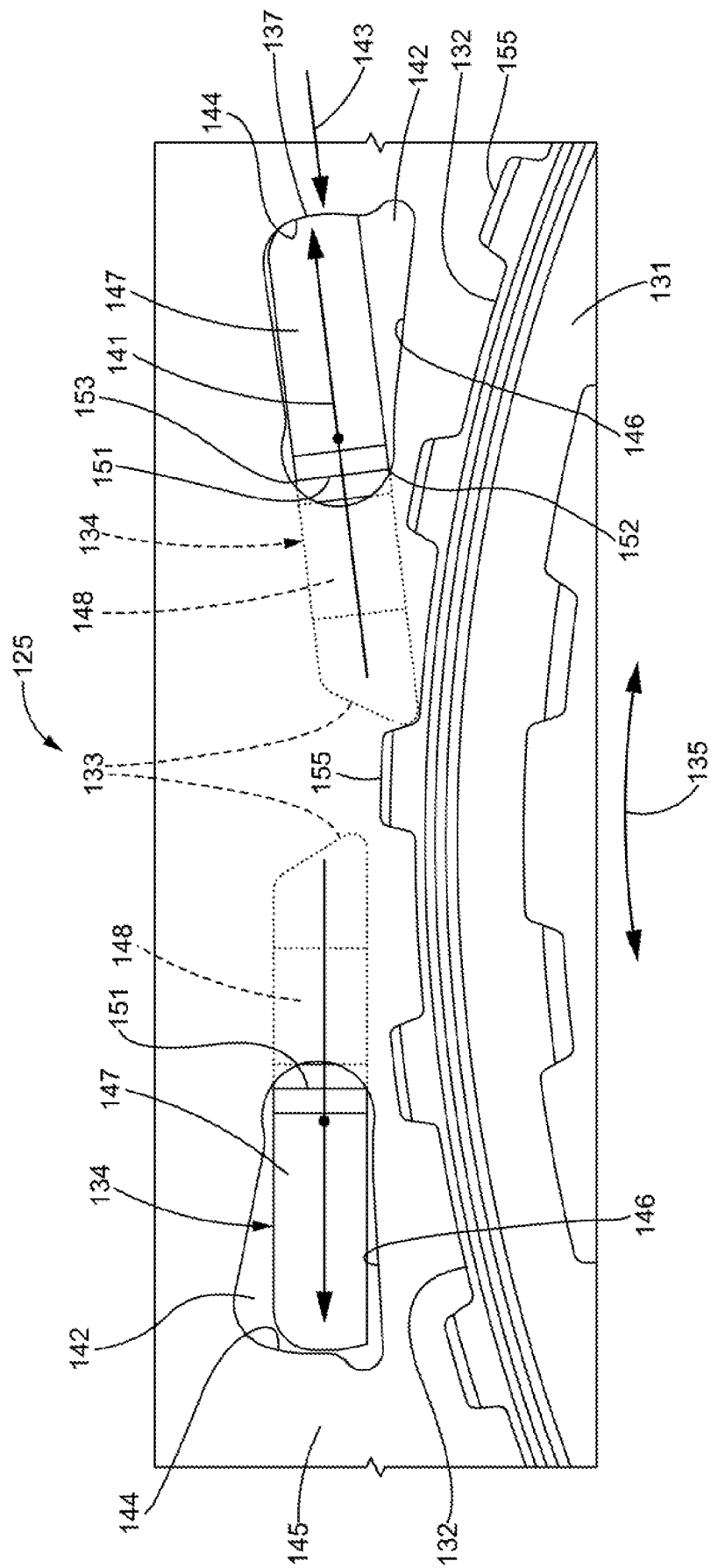


FIG. 4

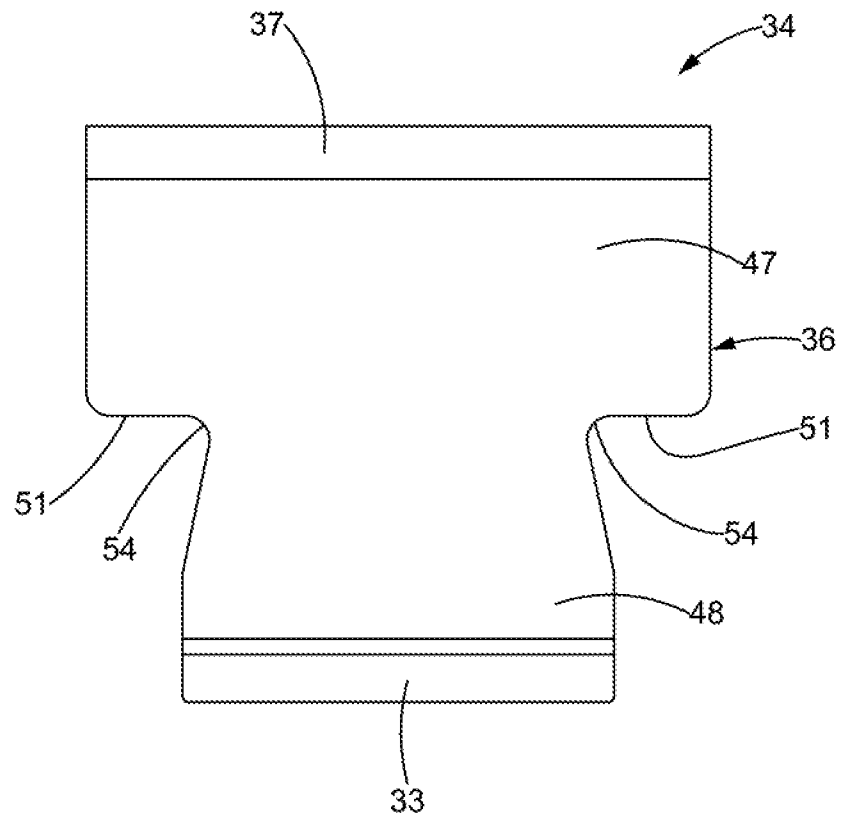


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/061280**A. CLASSIFICATION OF SUBJECT MATTER****F16D 41/063(2006.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
F16D 41/063; F16H 7/00; F16D 48/06; F16D 11/06; F16D 41/12; F16D 41/06; F16D 13/00Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: automatic transmission, clutch, plate, pawl, race, engage, lock, aperture, pocket**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0266667 A1 (SAMIE et al.) 29 October 2009 See paragraphs [0023]-[0033]; and figures 1-6.	1-3, 8-11, 15
Y		4-7, 12-14
Y	US 2009-0159391 A1 (EISENGRUBER, GREGORY M.) 25 June 2009 See paragraphs [0042]-[0043]; and figures 2-5.	4-7, 12-14
A	WO 2014-120595 A1 (BORGWARNER INC.) 07 August 2014 See paragraphs [0021]-[0035]; and figures 1-3, 4A-4B.	1-15
A	US 2014-0102844 A1 (MAGNA POWERTRAIN OF AMERICA, INC.) 17 April 2014 See paragraphs [0026]-[0031]; and figures 1-10.	1-15
A	US 2011-0269587 A1 (PAPANIA, JAMES R.) 03 November 2011 See paragraphs [0033]-[0035]; and figures 3-6, 7a-7e.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

21 February 2018 (21.02.2018)

Date of mailing of the international search report

21 February 2018 (21.02.2018)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

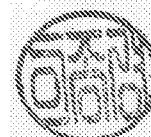
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/061280

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