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- (71) **Applicant:** EATON CORPORATION [US/US]; 1000 Eaton Boulevard, Cleveland, Ohio 44122 (US).
- (72) **Inventors:** FRANKE, Brian W.; 2259 S. 475 E., Hamilton, Indiana 46742 (US). KULKARNI, Prashant;
- 9743 Chambray ST, Portage, Michigan 49002 (US). KUP-PUSWAMY, Deevakar; B-702 Umang Premiere, Ivy Estate, Wagholi, Pune, Maharashtra 412207 (IN).
- (74) **Agents:** COLANTONI, Krystyna et al.; Mei & Mark LLP, P.O. Box 65981, Washington, District of Columbia 20035-5981 (US).
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(54) **Title:** TABBED FRICTION PLATE CLUTCH

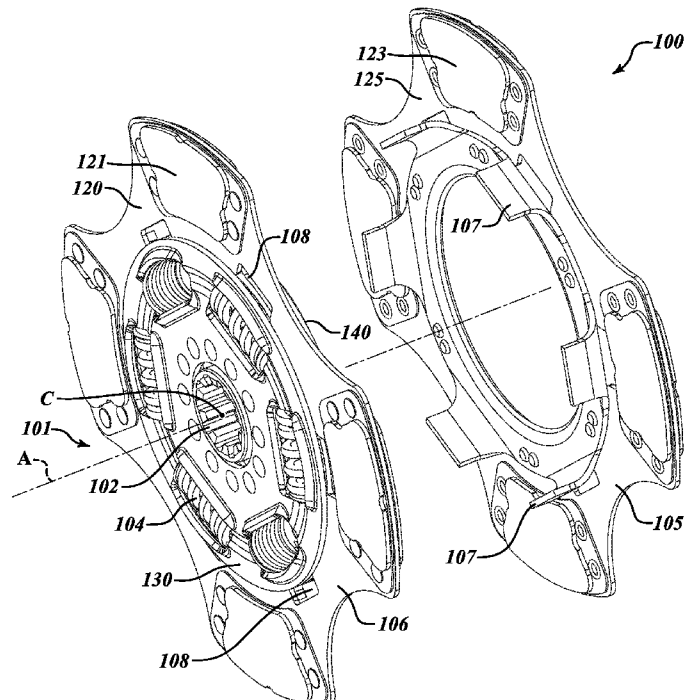


FIG. 1

(57) **Abstract:** A clutch assembly comprises a hub and a damper assembly. The damper assembly comprises a first damper cover plate, a second damper cover plate, a plurality of springs located radially outward from the hub, a stack plate, a center, and an axis passing through the center of the damper assembly. The clutch assembly further comprises a first friction disc comprising a tab. The first friction disc is located between the first damper cover plate and the second damper cover plate. The clutch assembly further comprises a second friction disc comprising a slot. A portion of the tab on the first friction disc is located inside the slot of the second friction disc.



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TABBED FRICTION PLATE CLUTCH

Field

[001] This application relates to a multiple plate clutch assembly with tabbed friction plates.

Background

[002] Traditional dual disc clutch assemblies include two damper assemblies, one for each friction disc. Two friction discs are used to increase the surface area of frictional contact, thereby improving the ability to transfer torque. Dual disc assemblies are often used in heavy duty vehicles, for example, in transport vehicles in the NAFTA market.

[003] Damper assemblies absorb shock and vibrations occurring during deceleration and acceleration. Clutch assemblies must comprise sufficient damping capability to absorb the shock and vibrations experienced during the operation of heavy duty vehicles.

[004] Damper assemblies must be periodically replaced as they wear over time. Friction discs and damper components can wear at different rates if they do not carry the same load.

SUMMARY

[005] The devices disclosed herein overcome the above disadvantages and improve the art by way of a clutch assembly comprising a damper assembly. The damper assembly comprises a plate, a spring connected to the plate, and an axis passing through the center of the damper assembly. The clutch assembly comprises a first friction disc comprising a tab and a second friction disc comprising a slot, wherein a portion of the tab on the first friction disc is located inside the slot of the second friction disc.

[006] A clutch assembly comprises a hub and a damper assembly. The damper assembly comprises a first damper cover plate, a second damper cover plate, a plurality of springs located radially outward from the hub, a stack plate, a center, and an axis passing through the center of the damper assembly. The clutch assembly further comprises a first friction disc comprising a tab. The first friction disc is located between the first damper cover plate and the second damper cover

plate. The clutch assembly further comprises a second friction disc comprising a slot. A portion of the tab on the first friction disc is located inside the slot of the second friction disc.

[007] A clutch assembly comprises a damper assembly. The damper assembly comprises a stack plate comprising a plurality of teeth, a center, an axis passing through the center of the damper assembly, and a hub comprising a plurality of teeth located to engage the plurality of teeth on the stack plate. The distance between the plurality of teeth on the stack plate is greater than the width of the teeth on the hub, thereby allowing the stack plate to rotate relative to the hub. The damper assembly further comprises a plurality of springs located radially outward from the hub, a plurality of apertures in the stack plate wherein at least some of the apertures surround respective ones of the plurality of springs, a damper cover plate connected to the hub, and a plurality of apertures in the damper cover plate. At least some of the apertures surround respective ones of the plurality of springs. The damper assembly further comprises a sleeve surrounding the stack plate. The sleeve comprises a plurality of teeth extending radially outward from the sleeve. The clutch assembly further comprises a first friction disc comprising a plurality of teeth in meshing engagement with the plurality of teeth on the sleeve and a second friction disc fixed to the sleeve. The damper assembly is the only damper assembly in contact with the first friction disc.

[008] A clutch assembly comprises a damper assembly. The damper assembly comprises a stack plate, at least one spring connected to the stack plate, a center, and an axis passing through the center of the damper assembly. The clutch assembly further comprises a first friction disc comprising first projections and a second friction disc comprising second projections in meshing engagement with the first projections to directly connect the second friction disc to the first friction disc. The second friction disc rotates at the same angular velocity as the first friction disc when the first friction disc rotates. The damper assembly is the only damper assembly in contact with the first friction disc.

[009] A method of assembling a clutch assembly comprising the steps of forming a plurality of coupling mechanisms on a first friction disc, forming a plurality of coupling mechanisms on a second friction disc, joining the first friction disc to a

damper assembly, and interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc.

[010] Additional objects and advantages will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the disclosure. The objects and advantages will also be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

[011] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the claimed invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[012] Figure 1 is a view of a clutch assembly with a damper assembly connected to a friction disc.

[013] Figure 2A is a view of a friction disc with a slot.

[014] Figure 2B is a view of a friction disc and a stack plate with slots.

[015] Figure 3 is a view of a friction disc with tabs on a retaining disc.

[016] Figure 4 is a view of a clutch assembly with two friction discs and a damper assembly.

[017] Figure 5A is a view of a U-shaped tab on a friction disc.

[018] Figure 5B is a perspective view of a U-shaped tab on a friction disc.

[019] Figure 6 is a view of a clutch assembly connected to a shaft.

[020] Figure 7 is a view of a friction disc connected to damper assembly.

[021] Figure 8 is a view of two friction discs connected by projections.

[022] Figure 9 is a view of two friction discs connected by projections on a ring.

[023] Figure 10 is a view of two friction discs connected by projections.

[024] Figure 11 is a view of a stack plate connected to torsional springs, cover plates, and a hub.

[025] Figure 12 is a view of a stack plate with teeth extending radially inward.

[026] Figure 13 is a flow diagram of a method of assembling a clutch assembly.

DETAILED DESCRIPTION

[027] Reference will now be made in detail to the examples, which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. Directional references such as “left” and “right” are for ease of reference to the figures. “First” and “second” are for ease of antecedence with respect to the friction discs, but are not limiting of the interchangeable nature of the disclosed coupling mechanisms. As described in more detail below, certain aspects of the coupling mechanisms can be included with either of the first or second friction discs, with complementary features affiliated with the other of the discs.

[028] Figure 1 shows a clutch assembly 100 comprising a damper assembly 101 and a hub 102. Damper assembly 101 comprises a first damper cover plate 130 and a plurality of springs 104 located radially outward from hub 102. Axis A passes through the center C of damper assembly 101. A second friction disc 106 can be located in between first damper cover plate 130 and second damper cover plate 140.

[029] First friction disc 105 can comprise tabs 107, which can be inserted into slots 108, thereby connecting second friction disc 106 directly to first friction disc 105. In this arrangement, first friction disc 105 and second friction disc 106 do not rotate relative to one another except as allowed by any clearance between tabs 107 and slots 108. Second friction disc 106 rotates at the same angular velocity as the first friction disc 105 when the first friction disc rotates 105.

[030] One could also include tabs on second friction disc 106 and slots on first friction disc 105, thereby connecting the two friction discs. The clutch assembly can comprise any number of slots and tabs and is not limited by the number illustrated in the arrangement in Figure 1.

[031] Second friction disc 106 can be fixed to a stack plate such as a stack plate 103 of Figure 2A, stack plate 131 of Figure 2B, stack plate 403 of Figure 4, stack plate 603 of Figure 6, or any other stack plate known to one skilled in the art. Second friction disc 106 can be fixed to a stack plate by any means known to a skilled artisan, for example, by welding, bolting, bonding, gluing, or riveting.

[032] Tabs 107 can slide into slots 108 such that first friction disc 105 can move towards and away from second friction disc 106 along axis A while first friction

disc 105 and second friction disc 106 rotate together about axis A. This arrangement allows both friction discs to use a single damper assembly 101. The slots 108 can be in the friction disc radially inward of paddles 120 comprising mounted friction pads 121.

[033] First damper cover plate 130 can be located next to the second friction disc 106 so that the first damper cover plate 130 forms a perimeter for the slots 108. When the tabs 107 engage in the slots 108, the first damper cover plate 130 can also serve to restrict the radial motion of the first friction disc 105 with respect to the axis A and with respect to second friction disc 106. By their shape, the slots 108 can restrict both the radial and rotational motion of the tab 107 on axis A, so as to restrict the radial and rotational motion of the first friction disc 105, while permitting axial motion of the first friction disc 105 on axis A. Selecting the shape of tabs 107 and slots 108 permits tailoring of these axial freedoms.

[034] When the clutch assembly 100 is engaged, friction pads 123 mounted to paddles 125 and friction pads 121 grip an intermediate plate, such as intermediate plate 671. As illustrated in Figure 6, both sides of the friction discs 105, 106 can comprise an arrangement of friction pads. The clutch can comprise more or fewer paddles and more or fewer friction pads, and the friction pads can comprise, for example, ceramic or organic materials.

[035] One can assemble clutch assembly 100, or any of the clutch assemblies described herein, by attaching first friction disc 105 to damper assembly 101, placing tabs located on first friction disc 105 into slots located on second friction disc 106. Or instead, second friction disc 106 can comprise tabs and one can assemble clutch assembly 100 by placing the tabs on second friction disc 106 into slots located on first friction disc 105.

[036] Damper assembly 101, and the other damper assemblies described herein, can comprise a single main-stage damper. This damper assembly 101 can replace the dual dampers used on twin disc clutches traditionally used in the NAFTA market for heavy duty vehicles. Instead of two dampers, with all of their complexities, the damper assembly 101 comprises the single main-stage damper. The damping benefits of the single main-stage damper inure to both friction discs via the coupling mechanisms described herein, such as the tabs and slots, tabs and notches, projections and slots, and meshing teeth configurations. Joining the two

friction discs in the manners described herein permits a reduction in damper rate, permitting the use of soft-rate dampers.

[037] Figure 2A shows an arrangement where a portion of slot 108 is located on second friction disc 106 radially outside the outer perimeter 110 of stack plate 103. Figure 2B shows an arrangement where slot 108 is located radially within or equal to the outer perimeter 110 of stack plate 131. A tab inserted into slot 108 of Figure 2B can contact both the edges 111 of slot 108 in the second friction disc 106 and edges 113 of the notch 112 in stack plate 131, thereby connecting both second friction disc 106 and stack plate 131 to the tab.

[038] Figure 3 shows a first friction disc 105 and a retaining disc 133 with tabs 107 extending from retaining disc 133. Retaining disc 133 can be attached to a friction disc by riveting, bolting, bonding, gluing, welding, or other means known in the art.

[039] Retaining disc 133 can comprise a sheet material 151. Tabs 107 can comprise bent portions of the sheet material 151. Retaining disc 133 can comprise a planar portion P for fixing first friction disc 105 to retaining disc 133. Tabs 107 can extend perpendicular to planar portion P.

[040] Figure 4 shows a clutch assembly 100 where first friction disc 105 can be connected to second friction disc 106 and stack plate 131 by inserting tabs 107 into slots 108 on second friction disc 106 and notches 112 on stack plate 131. First friction disc 105 includes a retaining disc 133 with tabs 107 extending from retaining disc 133. Clutch assembly 100 includes a second damper cover plate 140 with a plurality of apertures 126 surrounding respective springs 104 of a damper assembly. The damper assembly can be a main-stage damper assembly. Pre-damper cover plate 122 can have a plurality of apertures 127 surrounding respective springs 124 of an optional pre-damper assembly. Pre-damper cover plate 122 surrounds hub 102, and the affiliated pre-damper assembly can provide additional damping capability to damper assembly 101.

[041] Figure 5A shows a configuration of a friction disc 505 with tab 507, where tab 507 has a U-shaped cross-section. The U-shaped tab can improve the contact between a tab and a slot. For example, the end portions 511, 512 provide more surface area to engage the sides of a slot. Whether U-shaped or rectangular, the tabbed design needs no fasteners and cannot be assembled incorrectly when

the tabs are aligned with the slots. Figure 5B shows a perspective view of the same U-shaped tab 507 on friction disc 505, showing end portions 511, 512 on tab 507 bent downward in a manner parallel to friction disc 505.

[042] Figure 6 is an example of another clutch assembly 600 comprising a single damper assembly 601 and a pressure plate 672. Damper assembly 601 comprises a first friction disc 605 and a second friction disc 606. First friction disc 605 can be connected to second friction disc 606 by interlocking projections 663 with slots 664, as shown in Figure 7, or according to any arrangement discussed herein or equivalents or mirror images thereof. For example, first friction disc 605 can connect directly to second friction disc 606 via tabs and slots. Instead of using tabs and slots, first friction disc 605 and second friction disc 606 can connect to stack plate 603, for example, as shown in Figure 7. Figures 8 - 10 also show arrangements where a friction disc is connected to another friction disc.

[043] Clutch assembly 600 has only one damper assembly 601 connected to first friction disc 605. Clutch assembly 600 comprises only a single, central damper assembly, and no other damper assemblies contact either the first friction disc 605 or the second friction disc 606.

[044] Traditional clutch assemblies in heavy duty vehicles have two friction discs, where each friction disc is attached to a separate damper assembly and each damper assembly is connected to the same shaft, for example, a shaft extending into a transmission assembly. The two friction discs in traditional heavy duty vehicles are connected such that the two friction discs can rotate relative to one another, even if only along a small arc. The two traditional friction discs can rotate relative to one another as the attached damper assemblies rotate about the shaft, for example, during braking or acceleration. The two friction discs can be attached to identical damper assemblies, making the damper assemblies interchangeable and cost effective. Also, having two damper assemblies, each with torsional dampers, increases the clutch assembly's ability to absorb shock, which can occur when there is a sudden change in rotational speed. Shock can occur during braking, where the rotational speed decreases, or during acceleration, where the rotational speed increases.

[045] Through causes such as variation in friction coefficient and varying plate load, the two damper assemblies do not always carry the exact same

proportion of torque, and one of the damper assemblies, often the one against the pressure plate, transfers more torque. The dampers and friction plates in this situation are considered out of phase.

[046] Having two friction discs provides more surface area for friction pads to contact a flywheel and plates connected to the flywheel. Increased surface area improves a clutch assembly's ability to transfer torque. One of the two friction discs in traditional heavy duty assemblies is usually located between a flywheel and an intermediate plate. The other is placed between the intermediate plate and a pressure plate. As discussed above, the improvements disclosed herein eliminate one of the two damper assemblies and eliminate relative rotation of the two friction discs. This improves the service life of the over-all clutch assembly and reduces the overall clutch cost.

[047] Traditional single damper assemblies have only one friction disc. Single friction disc clutch assemblies are often not suitable for use in heavy duty vehicles because the heavy duty vehicles require multiple discs to increase the frictional surface area, thereby increasing the capacity to handle large torque loads. The improvements herein permit the use of multiple friction discs with a single damper.

[048] Clutch assembly 600 allows a flywheel or other disc (not shown) to transmit torque to shaft 670. For example, a flywheel can be placed next to side 651 of first friction disc 605. An intermediate plate 671 is positioned between first friction disc 605 and second friction disc 606. Pressure plate 672 is positioned next to side 661 of second friction disc 606.

[049] When clutch assembly 600 is engaged, pressure plate 672 is in contact with friction element 662 of second friction disc 606. Friction element 665 of second friction disc 606 contacts intermediate plate 671. Intermediate plate 671 also contacts friction element 652 of first friction disc 605. Friction element 653 contacts a flywheel. Any of these friction elements can be a ceramic friction pad, an organic friction pad, a cushioned friction pad, or any other friction pad known to one skilled in the art. The flywheel, intermediate plate 671, and pressure plate 672 can be connected in a manner where they always rotate together. When clutch assembly 600 is engaged, first friction disc 605 and second friction disc 606 rotate with the flywheel, intermediate plate 671, and pressure plate 672.

[050] When clutch assembly 600 is disengaged, first friction disc 605 and second friction disc 606 do not rotate with the flywheel, intermediate plate 671, and pressure plate 672 as there is insufficient pressure applied by pressure plate 672 to create a frictional bond between the friction discs and the plates. The pressure applied to pressure plate 672 can be applied by diaphragm spring 680. Diaphragm spring 680 can also be controlled by a clutch bearing such that the clutch bearing releases pressure applied to the pressure plate, thereby disengaging the clutch assembly.

[051] Clutch assembly 600 can include damper assembly 601, which can comprise a plurality of springs 604 located radially outward from hub 602 in stack plate 603. Damper assembly 601 can include a stack plate 603. Stack plate 603 can engage hub 602. Cover plates 630, 640 can be fixed to hub 602 using rivets, for example. First friction disc 605 is connected to second friction disc 606 such that they do not rotate relative to one another, except as allowed by clearances. The rotation permitted by clearances is insubstantial compared to prior art relative rotation between friction discs. The rotation permitted by clearances, for example, does not permit the friction discs to rotate out of phase. Torque is transferred from the flywheel, intermediate plate 671, and pressure plate 672 to both first friction disc 605 and second friction disc 606. First friction disc 605 and second friction disc 606 can be connected to sleeve 637, which can be connected to or be an integral part of stack plate 603. Accordingly, torque travels from first friction disc 605 and second friction disc 606 to sleeve 637 and stack plate 603. Damper assembly 601 can damp vibrations using torsional springs 604 such that these vibrations do not adversely affect the rotation of hub 602 and shaft 670. Shaft 670 can travel to a transmission or other assembly, providing stable rotation and power to the transmission or other assembly.

[052] Clutch assembly 600 includes a single damper assembly 601 that contacts first friction disc 605 and second friction disc 606. Although Figure 6 shows two friction discs connected to damper assembly by directly connecting the two friction discs to a stack plate such that the two friction discs and the stack plate rotate together, more than two friction discs can be connected to same stack plate.

[053] Having only one damper assembly 601 can result in the friction discs and components of the damper assembly wearing at a uniform rate. Traditional

damper assemblies having dual discs also have dual damper assemblies. Having two damper assemblies can provide more damping capability but it can also result in friction discs being out of phase. Using only one damper assembly 601 eliminates this out-of-phase issue.

[054] First friction disc 605 can be connected to second friction disc 606 using many different arrangements. For example, first friction 605 can be connected to second friction disc 606 via the tab and slot arrangements described in Figures 1 – 5.

[055] Figure 7 shows another example of how one could attach two friction discs. Internal teeth 683 on first friction disc 605 can mesh with external teeth 654 on sleeve 637. Sleeve 637 can surround stack plate 603 and interlock with stack plate 603. Sleeve 637 can be an integral part of stack plate 603, as shown in Figures 11 & 12. Sleeve 637 can be manufactured separately from stack plate 603 and fixed to stack plate 603 by any known means, including for example, welding, riveting, bonding, gluing, or bolting. Second friction disc 606 can be connected to stack plate 603 as shown in Figure 6, for example, by placing projections 663 on sleeve 637 into slots 664 on second friction disc 606. The projections 663 and slots 664 can be, for example, dovetail-style, or they can be tongue and groove-style, or the like. Sleeve 637 is the only sleeve contacting second friction disc 606 and first friction disc 605.

[056] Second friction disc 606 can be fixed to sleeve 637 by any means known to a skilled artisan, for example, by interlocking projections or welding, bolting, bonding, gluing, or riveting second friction disc 606 to sleeve 637. The term “second” friction disc 606 is not restrictive in that it can also be considered the “first” friction disc, where first friction disc is fixed to sleeve 637 by any means known to a skilled artisan, for example, by welding, bolting, bonding, gluing, riveting, or interlocking projections.

[057] First friction disc 605 can move toward and away from second friction disc 606 in the axial direction. First friction disc 605 cannot, however, rotate relative to second friction disc 606 except as allowed by clearances, for example, clearances between teeth 683 and teeth 654. Torque can be transferred from first friction disc 605 and second friction disc 606 to stack plate 603. Stack plate 603 can

transfer torque to springs 604. Springs 604 can transfer torque to hub 602. Springs 604 can also damp torsional vibrations.

[058] Figure 8 shows an arrangement where first friction disc 805 has projections 851 with a slot 852 that interlocks with projections 861 and slot 862 on second friction disc 806. Projections 851 extend away axially from the first friction disc 805 along axis A. In other words, projections 851 extend away from first friction disc 805 in a direction parallel to axis A. Similarly, projections 861 extend away axially from second friction disc 806 along axis A. Like any of the arrangements herein, either first friction disc 805 or second friction disc 806 can be fixed to a stack plate on a damper assembly. This arrangement allows the friction discs to move toward or away from each other when shifting between the engaged and disengaged position.

[059] Figure 9 shows an arrangement where first friction disc 905 comprises a first ring 953 with radially extending projections 954 and slots 955 located between projections 954. Second friction disc 906 comprises a second ring 963 with radially extending projections 964 and slots 965. Second ring 963 can interlock with first ring 953 by placing projections 954 into slots 965. First ring 953 and second ring 963 extend along axis A in that they extend in a manner parallel to axis A. Either first friction disc 905 or second friction disc 906 can be fixed to a stack plate via riveting, welding, bonding, gluing, bolting, interlocking projections, or other way known to one skilled in the art. Either first ring 953 or second ring 963 can be fixed to a friction disc 905, 906 via riveting, welding, bonding, gluing, bolting, interlocking projections, or other way known to one skilled in the art.

[060] Figure 10 shows a first friction disc 1005 and a second friction disc 1006, where the first friction disc 1005 can connect to the second friction disc 1006 using interlocking projections 1051 with projections 1061. Projections 1061 can be attached to an arc-shaped base 1069. Arc-shaped base 1069 can be an integral part of projections 1061 or manufactured separately. Arc-shaped base 1069 can also include projections in line with projections 1061. Projections 1051 could also be attached to a base like arc-shaped base 1069. Arc-shaped base 1069 can have a step 1068, for example, where projections 1061 meet arc-shaped base 1069. The step 1068 can permit a change in radius of the projection 1061.

[061] The assembly can be configured such that first friction disc 1005 can move axially away and toward second friction disc 1006 but also such that first friction disc 1005 cannot rotate relative to second friction disc 1006 except as allowed by clearances, if any, between first projections 1051 and projections 1061. Projections 1051 and 1061 can be part of an arc, as shown, or part of a complete ring. Projections 1051 can extend radially outward away from axis A such that they interlock with projections 1061 extending radially inward toward axis A. The arrangement can be reversed such that projections 1061 extend radially outward and projections 1051 extend radially inward. Projections 1061 can be thicker than projections 1051 in the axial direction, thereby allowing first friction disc 1005 to move a greater distance in the axial direction while remaining rotationally locked to second friction disc 1006.

[062] The arrangements in Figures 7 through 10 allow the friction discs to be locked to each other in the radial direction while free to move toward and away from each other in the axial direction. Any of the arrangements described herein can be attached to the damper assembly shown in Figure 6 or to a damper assembly arranged in a different manner, such as a damper comprising more or few damping springs or other damping elements. One can assemble any of the clutch assemblies with projections by attaching a friction disc to a damper assembly and placing projections on the friction disc in between projections on another friction disc.

[063] Figure 11 shows a damper assembly 601 comprising a stack plate 603 with springs 604 surrounded by apertures 660 in stack plate 603. Damper assembly 601 comprises a hub 602 and cover plates 630, 640. Cover plates 630, 640 can be fixed to hub 602 by rivets 629 or other known or apparent methods of attaching a cover plate to a hub. Rivets 629 can pass through teeth 628 in the hub 602 such that one rivet 629 can connect both cover plates 630, 640 to hub 602. A plurality of rivets 629 can be used to further secure cover plates 630, 640 to hub 602. Teeth 628 on hub 602 can engage teeth 627 on stack plate 603.

[064] Figure 12 shows a stack plate 603 comprising teeth 627 and a plurality of apertures 660, which can surround respective torsional springs. Teeth 627 are shown extending radially inward toward the center of stack plate 603. The spacing between teeth 627 can be selected to allow teeth from a hub to rotate within the spacing. This allows stack plate 603 to rotate relative to a hub, but also limits the

rotational distance to an arc as a hub cannot rotate relative to the stack plate if it's teeth contact the teeth 627 of stack plate 603.

[065] In the arrangement in Figure 11, the spacing or distance between the teeth 627 on stack plate 603 is greater than the width of teeth 628 on the hub, thereby allowing stack plate 603 to rotate relative to hub 602.

[066] Also, a plurality of springs 604 are located in respective apertures 660 in stack plate 603. Springs 604 allow damper assembly 601 to damp torsional vibrations but also can transfer torque from stack plate 603 to cover plates 630, 640. Like stack plate 603, cover plates 630, 640 can have apertures 634 surrounding springs 604.

[067] The damper assembly arrangement is not limited to the descriptions herein and can be rearranged and changed in ways known to those skilled in the art.

[068] As applied to a pair of friction discs, the coupling mechanisms described herein can comprise a protrusion and a mating receiver, such as the tabs and slots, projections and slots, and meshing teeth configurations, to rotationally link one friction disc to another. The linked friction discs can surround an intermediate plate for frictionally gripping an intermediate plate of a clutch device. The linked friction discs can share the torsion-damping benefits of a damper assembly that is mounted radially inward of one of the friction discs. The linked friction disc is rotationally restricted with respect to the damper assembly, but can move axially with respect to the damper assembly. The pair of friction discs can rotate with the damper assembly, and in-phase with the damper assembly.

[069] Figure 13 displays a flow diagram for a process of assembling a clutch assembly. The steps include: S1301—forming a plurality of coupling mechanisms on a first friction disc; S1302—forming a plurality of coupling mechanisms on a second friction disc; S1303—joining the first friction disc to a damper assembly; S1304—interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc.

[070] Steps 1301 and 1302 of forming a plurality of coupling mechanisms on first and second friction disc can include forming teeth, projections, and slots on friction disc. The projections can be of the dovetail type, tongue and groove, or other types, for example, the projections on arc-shaped and ring-shaped bases as

described above and shown in Figures 8-10. An example of teeth formed on friction disc to interlock with teeth on a stack plate is shown in Figure 7. The coupling mechanisms can be cast or machined as an integral part of the first or second friction disc. The coupling mechanisms can be made separately from the friction discs and joined to the friction discs by riveting, bolting, gluing, bonding, welding, or any other way of joining known to one skilled in the art.

[071] Step S1303 of joining a first friction disc to a damper assembly can include any of the ways of attaching a friction disc as described above, including riveting, bolting, bonding, gluing, or welding first friction disc to a stack plate. The stack plate is part of the damper assembly. First friction disc can also be joined to the damper assembly by interlocking projections, for example dovetail, tongue and groove projections, on the first friction disc with projections on a sleeve on the stack plate. The sleeve can be an integral part of the stack plate. Attaching a first friction disc to a stack plate can be achieved by using a plurality of teeth on the first friction disc to meshingly engage with a plurality of teeth on the stack plate.

[072] Step S1304 of interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc can be achieved by placing a tab located on the second friction disc into a slot located on the first friction disc. Also, the step of interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc can be achieved by placing a tab located on the first friction disc into a slot located on the second friction disc or by placing projections on the second friction disc in between projections on the first friction disc. Any one of the arrangements described above and shown in Figures 1-12 can be used to interlock coupling mechanisms to rotationally join the second friction disc to the first friction disc. Second friction disc can move toward and away from first friction disc in an axial direction even though it is rotationally joined to first friction disc. Because a first friction disc is joined to a damper assembly and a second friction disc is rotationally joined to the first friction disc, the second friction disc is joined to the damper assembly.

[073] Other implementations will be apparent to those skilled in the art from consideration of the specification and practice of the examples disclosed herein. It is intended that the specification and examples be considered as exemplary only, with the true scope of the invention being indicated by the following claims.

WHAT IS CLAIMED IS:

1. A friction disc assembly comprising:
a first friction disc comprising a slot;
a friction pad radially outward from the slot;
a second friction disc comprising a tab seated in the slot; and
a second friction pad radially outward from the tab.
2. The friction disc assembly of claim 1, further comprising a damper assembly installed on one of the first friction disc or the second friction disc.
3. The friction disc assembly of claim 1, wherein the tab seated in the slot rotationally fixes the first friction disc and the second friction disc while permitting axial movement between the first friction disc and the second friction disc.
4. A friction disc assembly comprising:
first friction disc comprising a first plurality of projections around a central axis;
a first friction pad radially outward from the first plurality of projections;
a second friction disc comprising a second plurality of projections complementary to the first plurality of projections, the second plurality of projections around the central axis; and
a second friction pad radially outward from the second plurality of projections, wherein the first plurality of projections engage with the second plurality of projections to engage the first friction disc with the second friction disc for rotation about the central axis.
5. The friction disc assembly of claim 4, wherein the first plurality of projections of the first friction disc comprise an arc-shaped base.
6. The friction disc assembly of claim 4, wherein the first friction disc comprises a fixed ring, and wherein the first plurality of projections are part of the fixed ring.
7. The friction disc assembly of claim 4, wherein the first plurality of projections and the second plurality of projections are configured to permit the second friction disc to move along the central axis.
8. A clutch assembly comprising:
a hub;
a damper assembly comprising:
a first damper cover plate;

a second damper cover plate;
a plurality of springs located radially outward from the hub;
a stack plate, the stack plate located between the first damper cover plate
and the second damper cover plate;
a center; and
an axis passing through the center of the damper assembly;
a first friction disc comprising a tab; and
a second friction disc comprising a slot,
wherein a portion of the tab on the first friction disc is located inside the slot
of the second friction disc.

9. The clutch assembly of claim 1, wherein one of the first friction disc and the second friction disc is fixed to the stack plate.

10. The clutch assembly of claim 1, wherein the damper assembly is the only damper assembly contacting either the first friction disc or the second friction disc.

11. The clutch assembly of claim 1, wherein the stack plate comprises a plurality of radially-inward teeth.

12. The clutch assembly of claim 11, wherein the damper assembly further comprises:

a hub comprising a plurality of teeth located externally to engage the plurality of teeth on the stack plate, wherein the distance between the plurality of teeth on the stack plate is greater than the width of the teeth on the hub, thereby allowing the stack plate to rotate relative to the hub;
a plurality of apertures in the stack plate, wherein at least some of the apertures surround respective ones of the plurality of springs;
a cover plate connected to the hub; and
a plurality of apertures in the hub, wherein at least some of the apertures surround respective ones of the plurality of springs.

13. The clutch assembly of claim 8, wherein the first friction disc further comprises a fixed retaining disc, and wherein the tab is located on the retaining disc.

14. The clutch assembly of claim 13, wherein the retaining disc comprises a sheet material, and wherein the tab comprises bent portions of the sheet material.

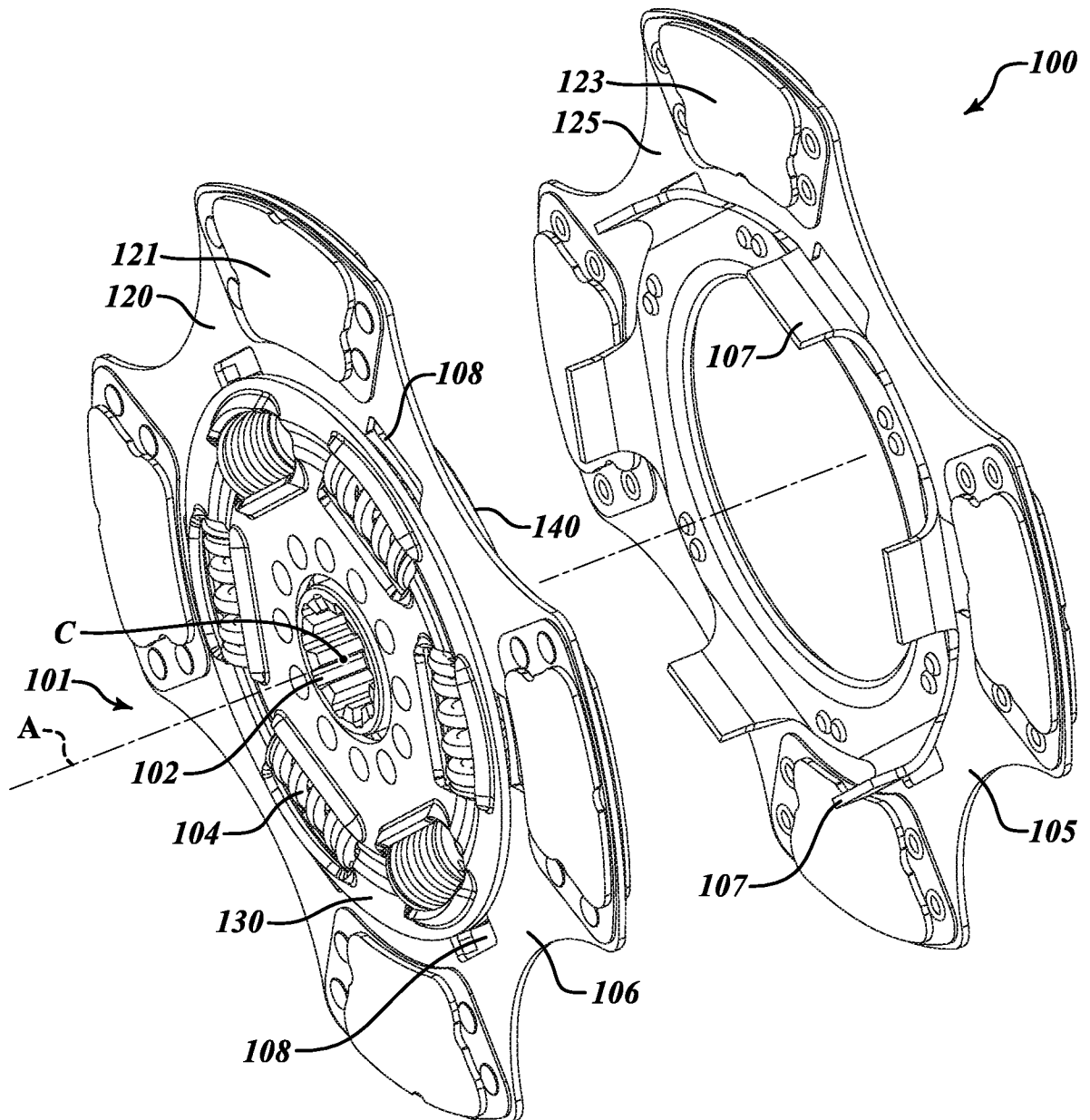
15. The clutch assembly of claim 14, wherein the retaining disc comprises a planar portion for fixing to the friction disc, and wherein the tab is perpendicular to the planar portion.
16. The clutch assembly of claim 8, wherein the friction disc comprises a sheet material, and wherein the tab comprises bent portions of the sheet material.
17. The clutch assembly of claim 16, wherein the friction disc comprises a planar portion, and wherein the tab is perpendicular to the planar portion.
18. A clutch assembly comprising:
 - a damper assembly comprising:
 - a stack plate comprising a plurality of teeth;
 - a center;
 - an axis passing through the center of the damper assembly;
 - a hub comprising a plurality of teeth located to engage the plurality of teeth on the stack plate, wherein the distance between the plurality of teeth on the stack plate is greater than the width of the teeth on the hub, thereby allowing the stack plate to rotate relative to the hub;
 - a plurality of springs located radially outward from the hub;
 - a plurality of apertures in the stack plate wherein at least some of the apertures surround respective ones of the plurality of springs;
 - a damper cover plate connected to the hub;
 - a plurality of apertures in the damper cover plate, wherein at least some of the apertures surround respective ones of the plurality of springs;
 - and
 - a sleeve surrounding the stack plate wherein the sleeve comprises a plurality of teeth extending radially outward from the sleeve;
 - a first friction disc comprising a plurality of teeth in meshing engagement with the plurality of teeth on the sleeve; and
 - a second friction disc fixed to the sleeve,wherein the damper assembly is the only damper assembly in contact with the first friction disc.
19. The clutch assembly of claim 18, wherein the second friction disc can move in a direction along the axis towards and away from first friction disc.
20. A clutch assembly comprising:

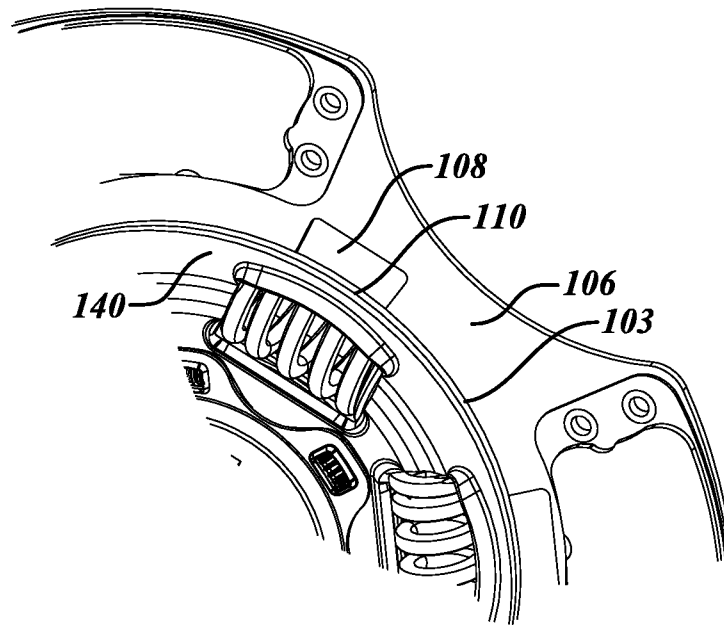
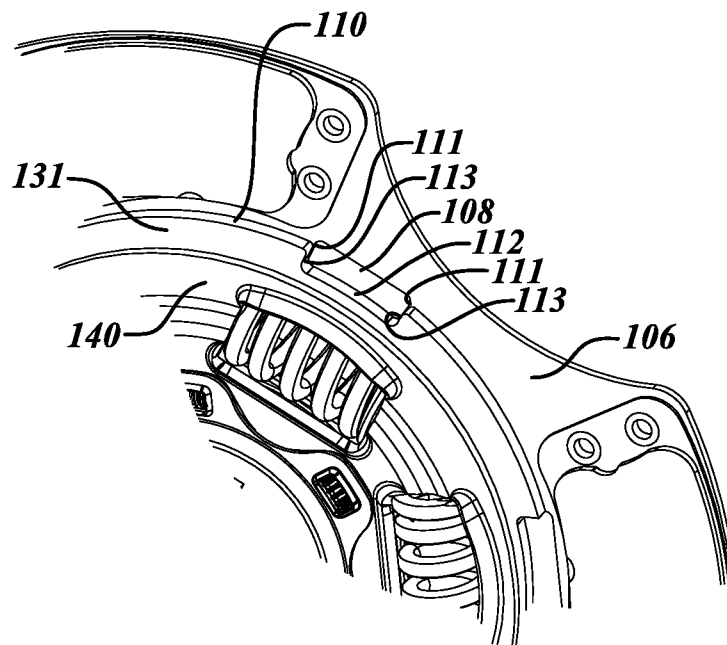
a damper assembly comprising:
a stack plate
at least one spring connected to the stack plate;
a center; and
an axis passing through the center of the damper assembly;
a first friction disc comprising first projections; and
a second friction disc comprising second projections in meshing engagement with the first projections to couple the second friction disc to the first friction disc,
wherein the second friction disc rotates at the same angular velocity as the first friction disc when the first friction disc rotates,
wherein the damper assembly is the only damper assembly in contact with the first friction disc.

21. The clutch assembly of claim 20, wherein one of the first friction disc and the second friction disc is fixed to the stack plate.
22. The clutch assembly of claim 20, wherein the second friction disc can move in a direction along the axis.
23. The clutch assembly of claim 20, further comprising a first ring fixed to the first friction disc, wherein the first projections of the first friction disc are part of the first ring.
24. The clutch assembly of claim 23, further comprising a second ring fixed to the second friction disc, wherein the second projections of the second friction disc are part of the second ring.
25. The clutch assembly of claim 20, wherein the first projections of the first friction disc comprise an arc-shaped base.
26. The clutch assembly of claim 20, wherein the first projections on the first friction disc extend toward the center of the damper assembly.
27. The clutch assembly of claim 20, further comprising an intermediate plate between the first friction disc and the second friction disc.
28. A method of assembling a clutch assembly comprising the steps of:
forming a plurality of coupling mechanisms on a first friction disc;
forming a plurality of coupling mechanisms on a second friction disc;
joining the first friction disc to a damper assembly; and

interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc.

29. The method of claim 28, wherein the step of interlocking the coupling mechanisms to rotationally join the second friction disc to the first friction disc comprises permitting axial motion of the second friction disc with respect to the first friction disc.

**FIG.1**

**FIG. 2A****FIG. 2B**

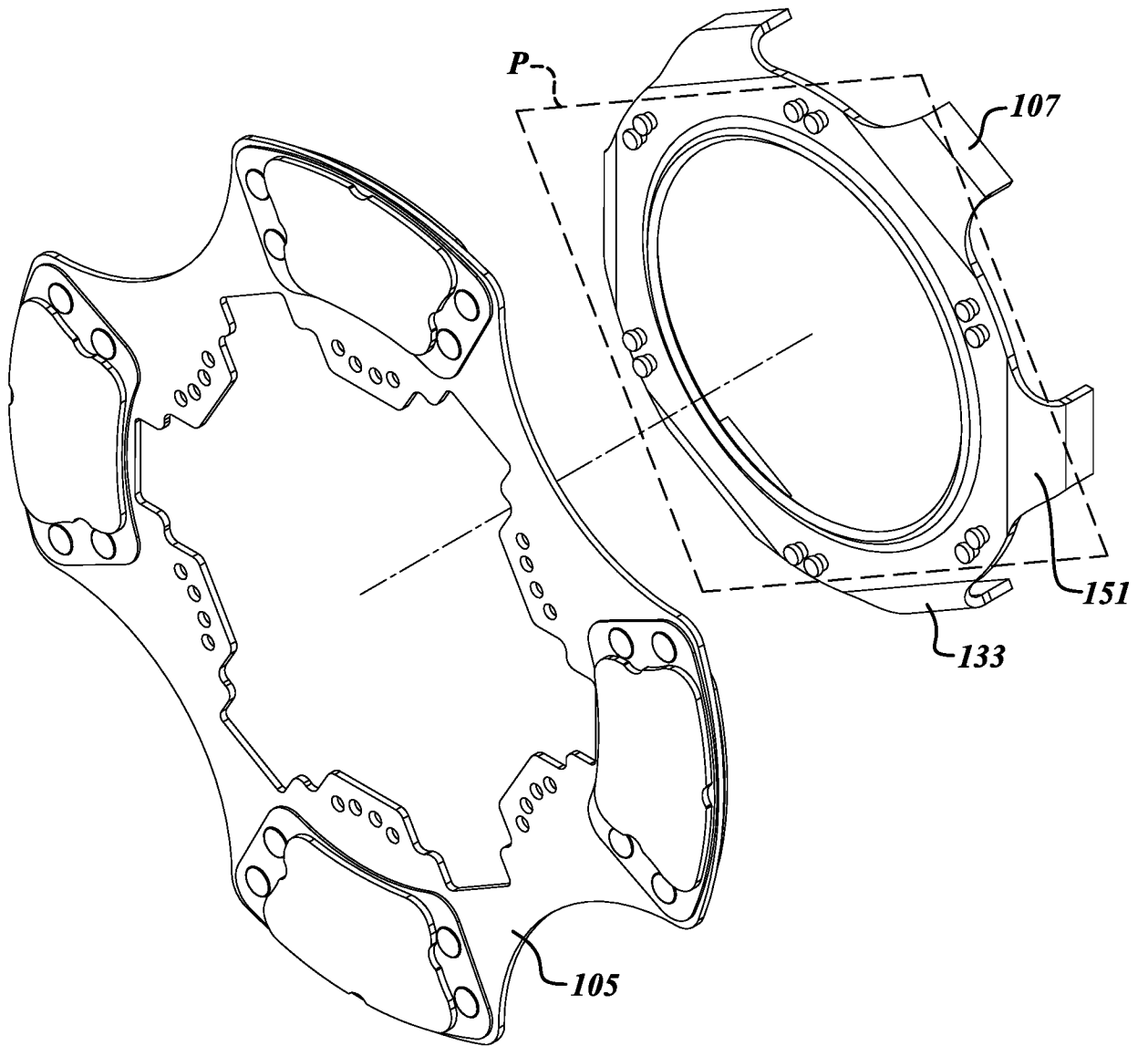
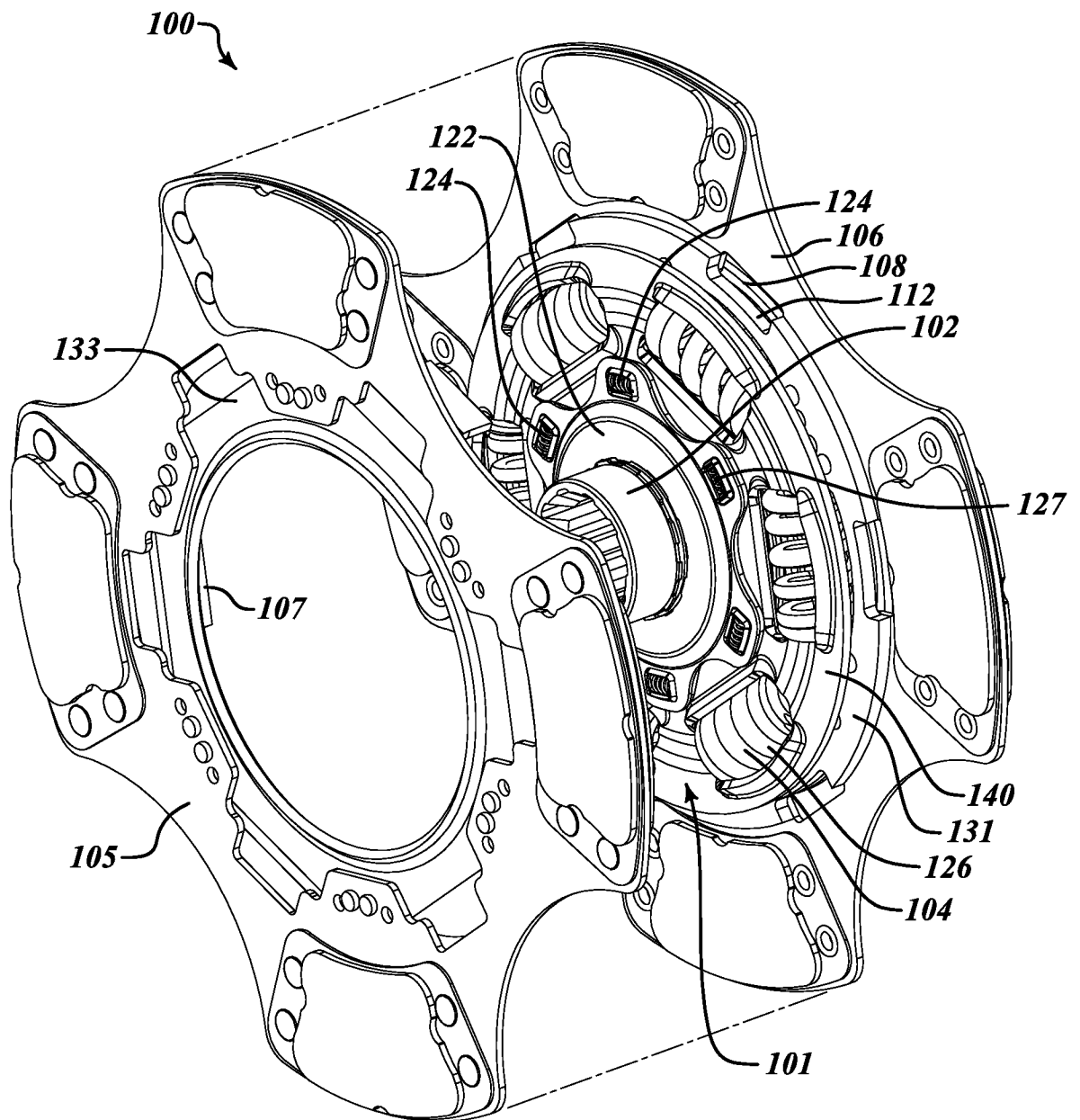
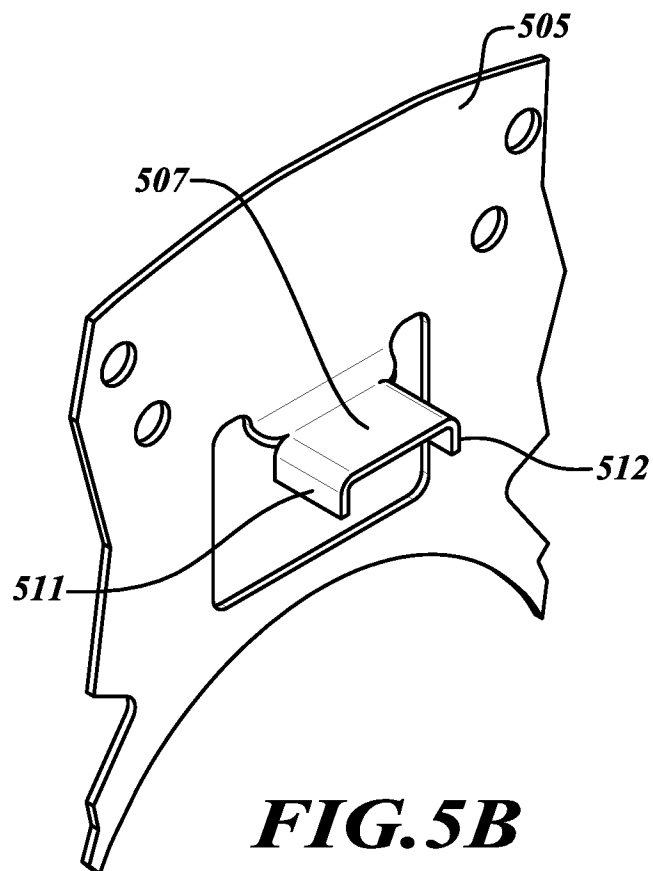
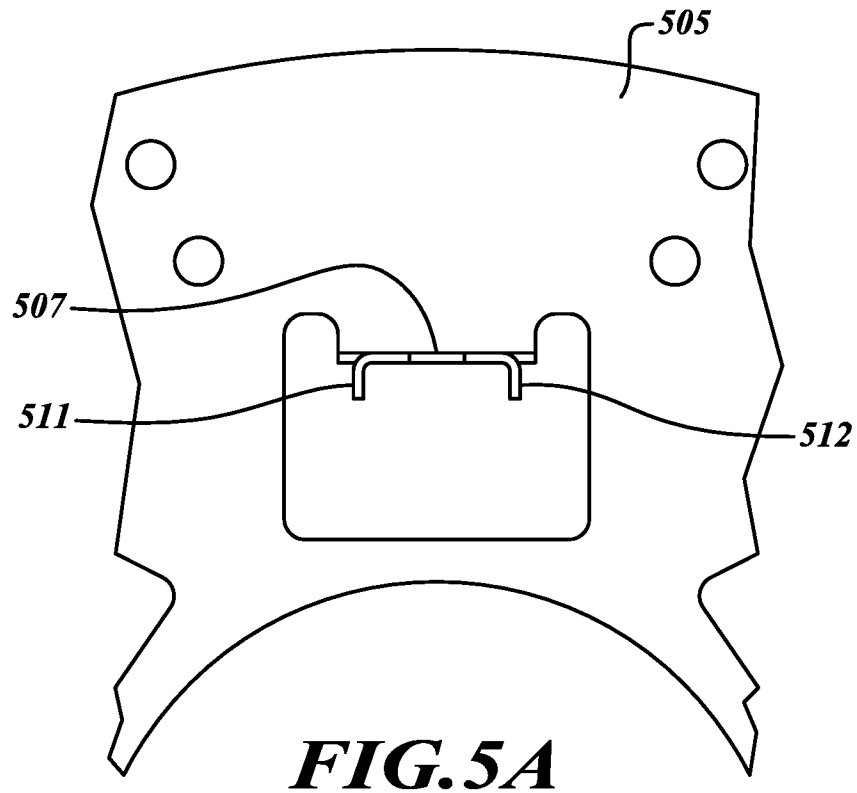
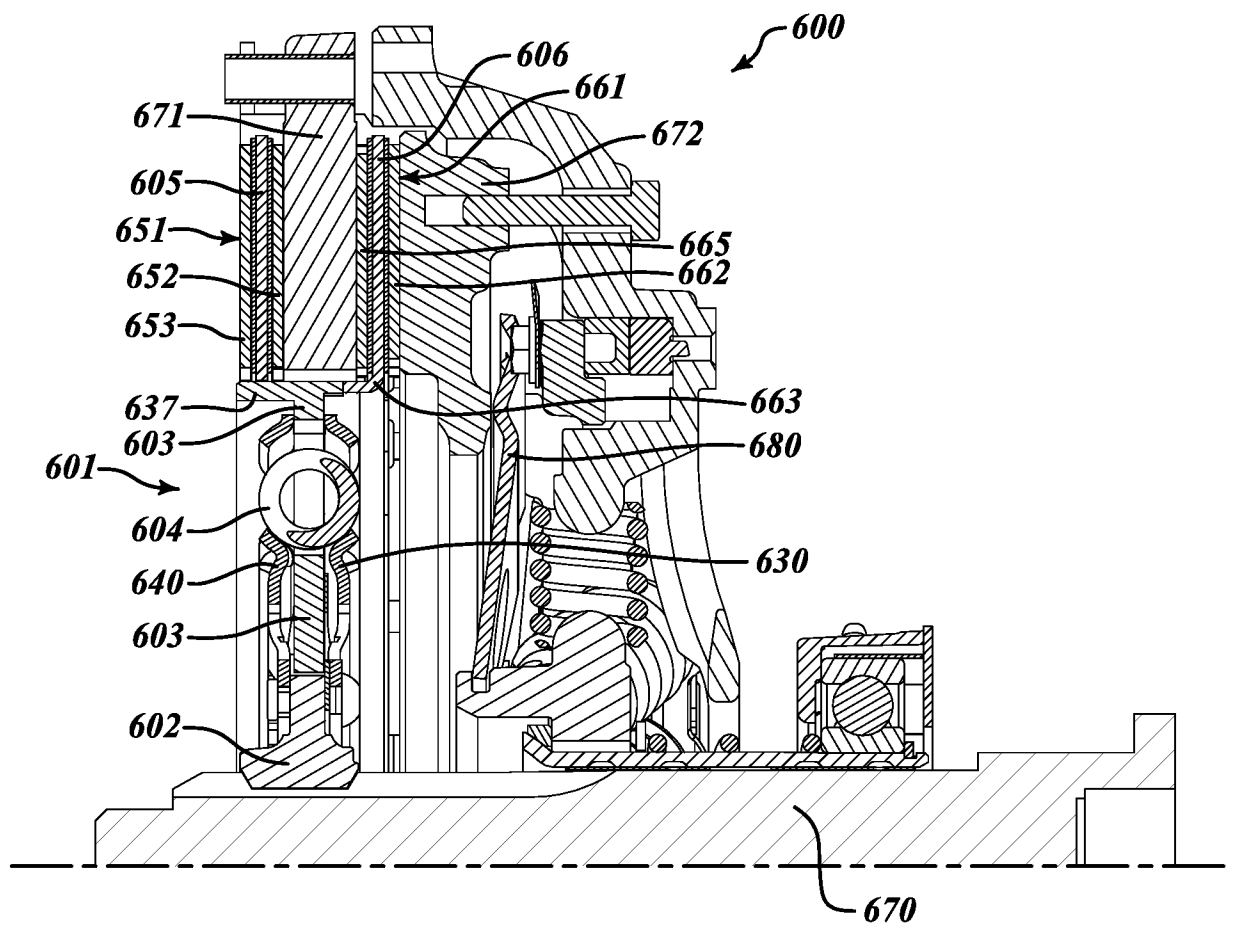
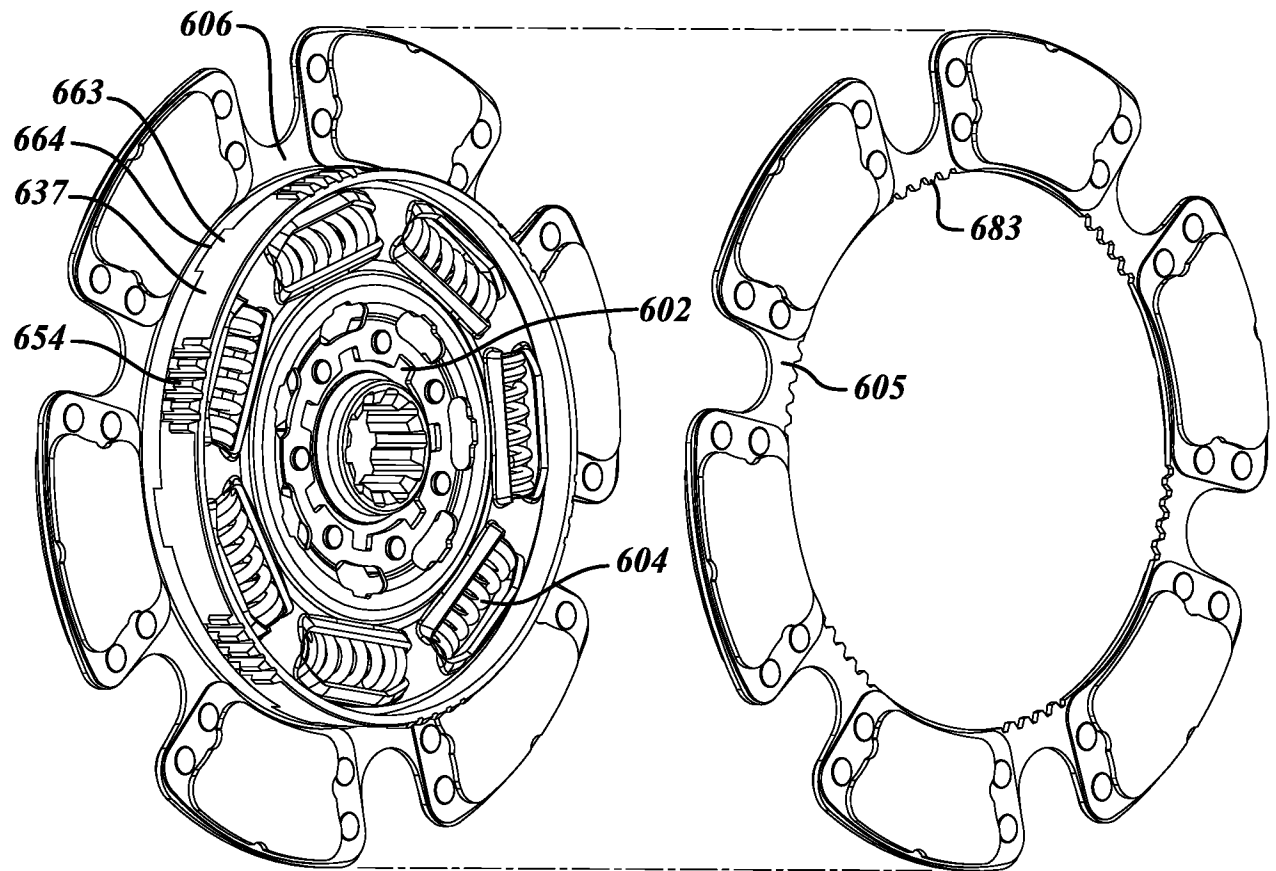


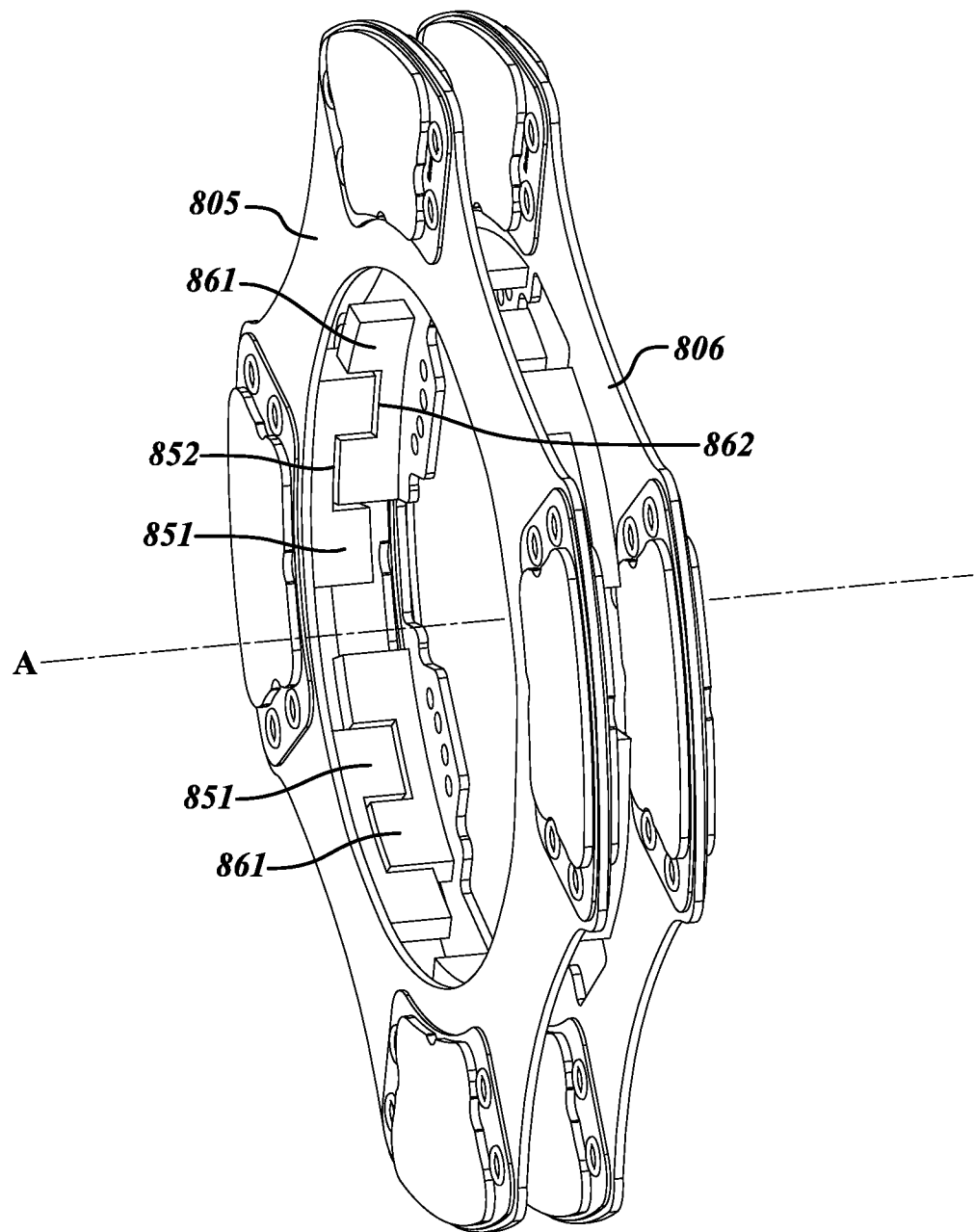
FIG. 3

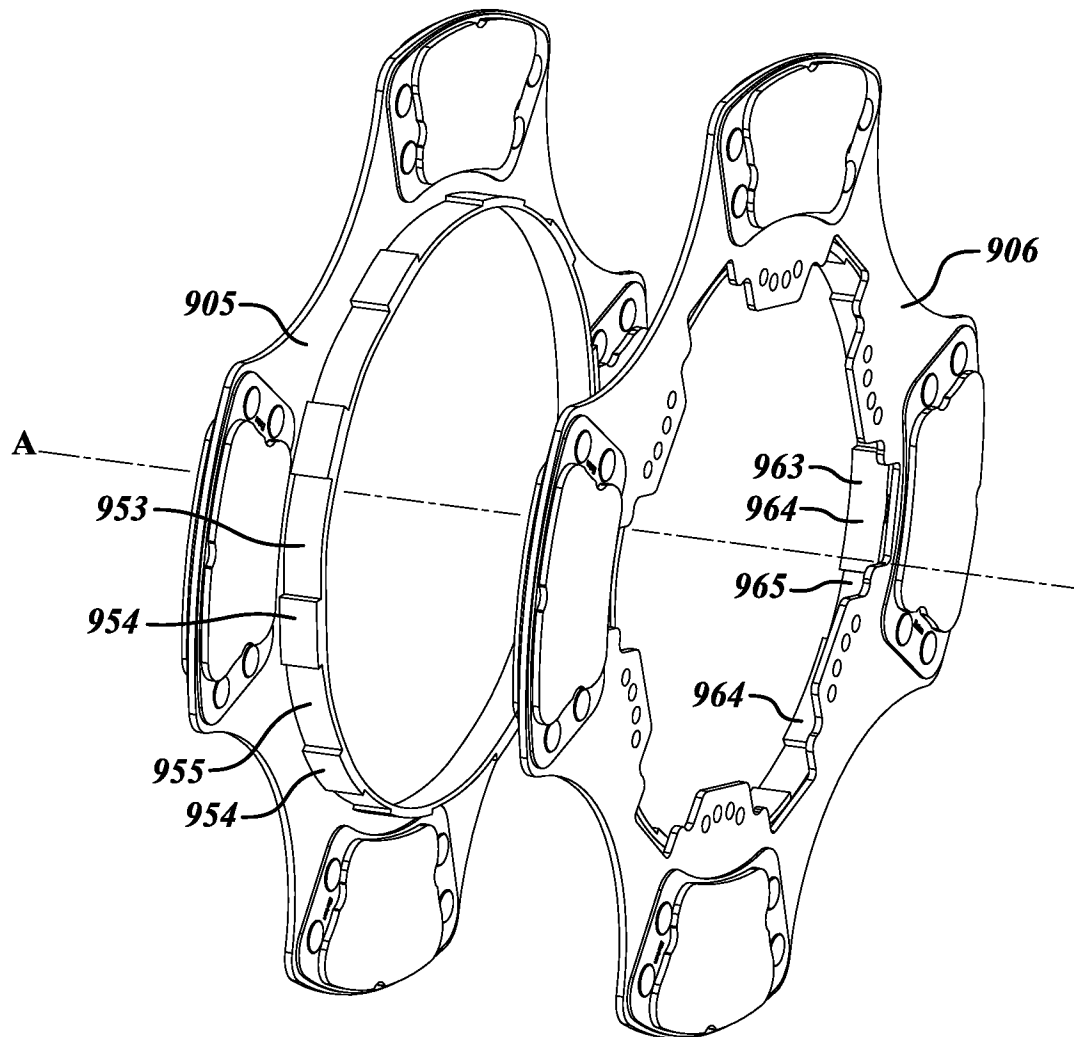
**FIG. 4**

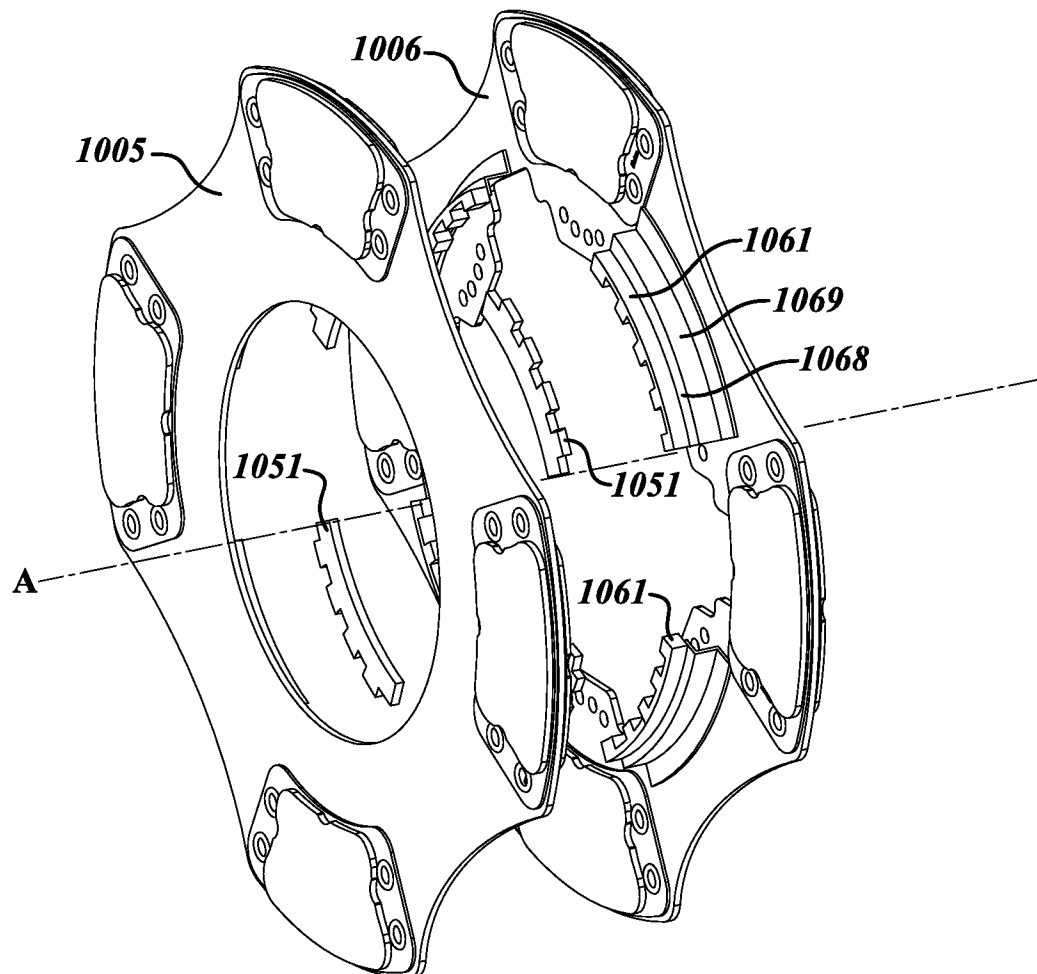


**FIG. 6**

**FIG. 7**

**FIG. 8**

**FIG. 9**

**FIG.10**

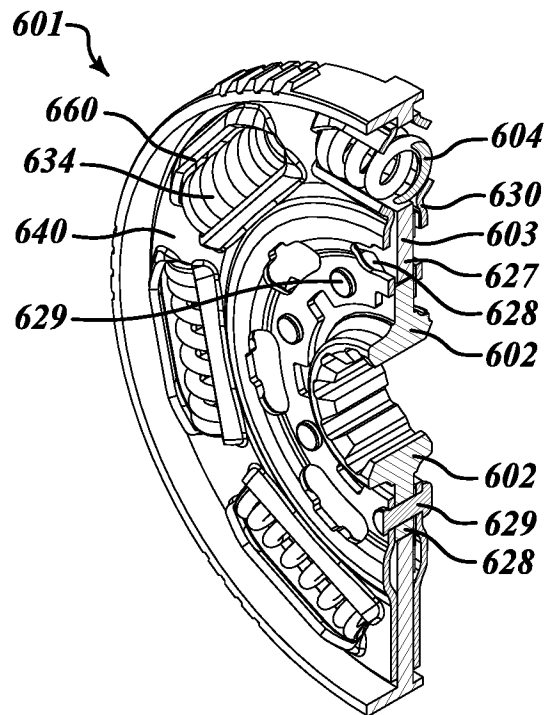


FIG. 11

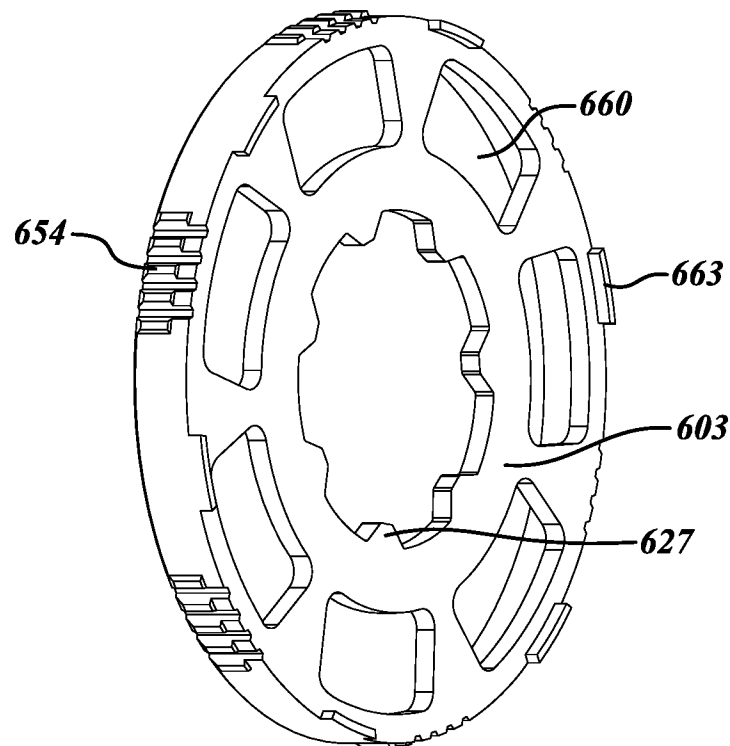
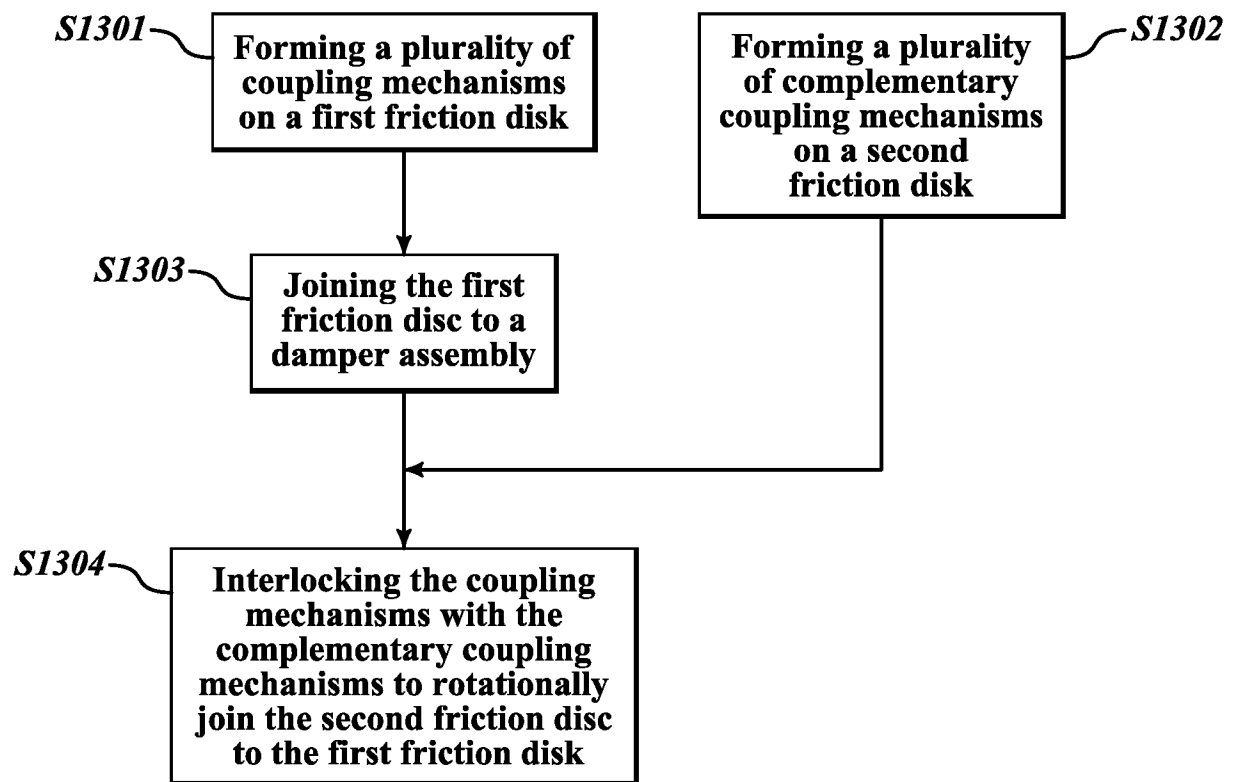


FIG. 12

**FIG.13**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/017965**A. CLASSIFICATION OF SUBJECT MATTER****F16D 13/38(2006.01)i, F16D 13/68(2006.01)i, F16F 15/12(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)

F16D 13/38; F16D 13/62; F16D 21/02; F16D 13/68; F16D 13/52; F16D 3/66; F16D 13/64; F16D 3/12; F16F 15/12

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: clutch, disc, dual, projection, teeth, damper, and hub

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007-0119679 A1 (FUKUDA et al.) 31 May 2007 See paragraphs [0111]-[0115], [0121], [0122], [0138]-[0142] and figures 1, 2, 6-8.	8-10, 13, 20-29
Y		1-7, 11, 12, 18, 19
A		14-17
Y	US 4890712 A (MAUCHER et al.) 02 January 1990 See column 9, lines 45-61 and figures 1, 2.	1-7, 11, 12, 18, 19
A	US 2005-0121281 A1 (ORLAMUNDER et al.) 09 June 2005 See paragraph [0026] and figure 1.	1-29
A	US 2013-0270054 A1 (GM GLOBAL TECHNOLOGY OPERATIONS L.L.C.) 17 October 2013 See paragraphs [0022]-[0025] and figures 1-3.	1-29
A	EP 1936222 A2 (TOYOTA JIDOSHA KABUSHIKI KAISHA) 25 June 2008 See paragraphs [0016]-[0020] and figures 1, 2.	1-29



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

23 May 2017 (23.05.2017)

Date of mailing of the international search report

24 May 2017 (24.05.2017)

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

LEE, Chang Ho

Telephone No. +82-42-481-8288



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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