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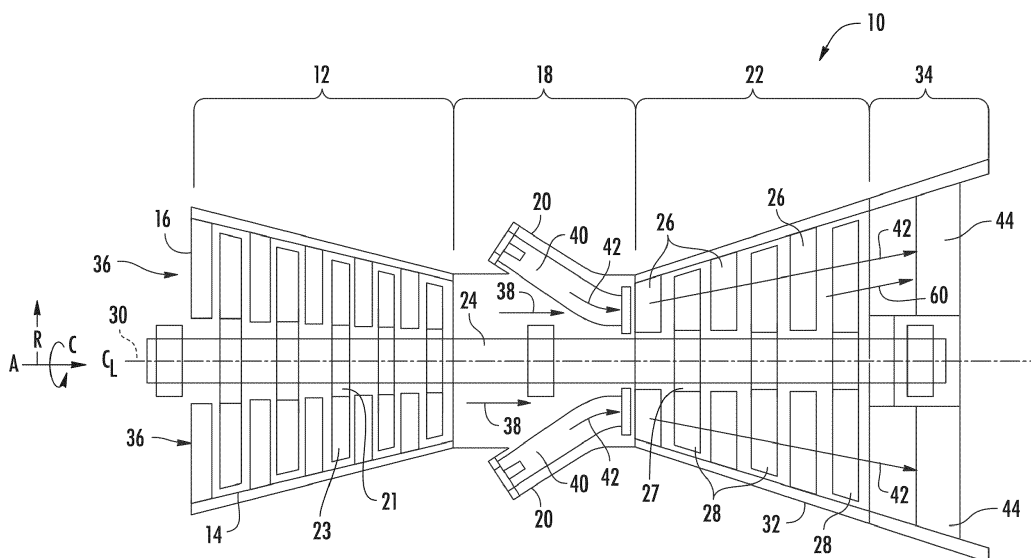
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(54) SUPPORT LINK FOR AN EXHAUST DIFFUSER ASSEMBLY

(57) A support link assembly (300) for coupling an exhaust diffuser (34) to a diffuser casing (56) is provided. The support link assembly (300) includes a support link (301). The support link (301) includes a main body (302) that extends from a forward end (308) to an aft end (312). The support link (301) further includes a forward flange (304) that extends from the main body (302) at the forward end (308). The forward flange (304) is configured to

couple to the diffuser casing (56). The support link (301) further includes a pair of arms (306) that extend from the main body (302) at the aft end (312). The pair of arms (306) are configured to couple to the exhaust diffuser (34). A vibrational damping assembly (200) may be affixed to the support link (301). An exhaust diffuser (34) with the support link assembly (300) is also provided.

**FIG. 1**

Description

FIELD

[0001] The present disclosure relates generally to support links for connecting two or more components in a turbomachine. Specifically, the present disclosure relates to support links for connecting an exhaust diffuser to a casing of a turbomachine.

BACKGROUND

[0002] Turbomachines are utilized in a variety of industries and applications for energy transfer purposes. For example, a gas turbine engine generally includes a compressor section, a combustion section, a turbine section, and an exhaust section. The compressor section progressively increases the pressure of a working fluid entering the gas turbine engine and supplies this compressed working fluid to the combustion section. The compressed working fluid and a fuel (e.g., natural gas) mix within the combustion section and burn in a combustion chamber to generate high pressure and high temperature combustion gases. The combustion gases flow from the combustion section into the turbine section where they expand to produce work. For example, expansion of the combustion gases in the turbine section may rotate a rotor shaft connected, e.g., to a generator to produce electricity. The combustion gases are then exhausted from the turbine section through an exhaust diffuser positioned downstream from the turbine section.

[0003] The exhaust diffuser typically includes an inner liner and an outer liner that is radially separated from the inner liner to form an exhaust flow passage through the diffuser. One or more generally airfoil shaped diffuser struts extend between the inner and outer liners within the exhaust flow passage to provide structural support to the outer liner and/or to an aft bearing that supports the shaft. Additionally, the exhaust diffuser is generally connected to a casing (e.g., an outer casing) via an array of circumferentially spaced support links.

[0004] Operation of the turbomachine for power generation can result in frequency oscillations (i.e., pressure pulsations or vibrations) within the exhaust diffuser that could cause damage over time to various components of the exhaust diffuser or that could result in an unscheduled or premature shutdown of the turbomachine. For example, the support links may be exposed to these vibrations, which may reduce or limit the useful hardware life of the support links and/or the entire exhaust diffuser. Particularly, existing support links may experience high stresses at the junctions between the support link and the turbomachine (e.g., where the support link couples to the exhaust diffuser and/or the casing)

[0005] Accordingly, an improved support link that is robust to the vibrations experienced by the exhaust diffuser is desired. Particularly, an improved support link having features that reduce vibrations and reduce junctional stresses is desired and would be appreciated in the art.

art.

BRIEF DESCRIPTION

[0006] Aspects and advantages of the support link assemblies and exhaust diffuser assemblies in accordance with the present disclosure will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the technology.

[0007] In accordance with one embodiment, a support link assembly for coupling an exhaust diffuser to a diffuser casing is provided. The support link assembly includes a support link. The support link includes a main body that extends from a forward end to an aft end. The support link further includes a forward flange that extends from the main body at the forward end. The forward flange is configured to couple to the diffuser casing. The support link further includes a pair of arms that extend from the main body at the aft end. The pair of arms are configured to couple to the exhaust diffuser.

[0008] In accordance with another embodiment, a support link assembly for coupling an exhaust diffuser to a diffuser casing is provided the support link assembly includes a support link that has a main body extending from a forward end to an aft end. The support link assembly further includes a vibrational damping assembly that is affixed to the support link. The vibrational damping assembly includes at least one pin assembly coupled to the main body of the support link. The at least one pin assembly includes a pin and a disk. The pin includes a pin head and a pin body. The vibrational damping assembly further includes at least one plate disposed between the pin head and the support link. The at least one plate surrounds the pin body, and the at least one plate is movable between the pin head and the support link relative to the pin and relative to the support link to dampen vibrations experienced by the support link.

[0009] In accordance with yet another embodiment, an exhaust diffuser assembly is provided. The exhaust diffuser assembly includes a diffuser casing, an exhaust diffuser, and a support link coupling the exhaust diffuser to the diffuser casing. The support link includes a main body that extends from a forward end to an aft end. The support link further includes a forward flange that extends from the main body at the forward end. The forward flange is configured to couple to the diffuser casing. The support link further includes a pair of arms that extend from the main body at the aft end. The pair of arms are configured to couple to the exhaust diffuser.

[0010] These and other features, aspects and advantages of the present support link assemblies and exhaust diffuser assemblies will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the technology and, together with

the description, serve to explain the principles of the technology.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] A full and enabling disclosure of the present support link assemblies and exhaust diffuser assemblies, including the best mode of making and using the present systems and methods, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

FIG. 1 is a schematic illustration of a turbomachine in accordance with embodiments of the present disclosure;

FIG. 2 schematically illustrates an enlarged cross-sectional view of an exhaust diffuser assembly in accordance with embodiments of the present disclosure;

FIG. 3 illustrates a cross-sectional view of the exhaust diffuser assembly from along the line 3-3 shown in FIG. 2, in accordance with embodiments of the present disclosure in accordance with embodiments of the present disclosure;

FIG. 4 illustrates an isometric view of an exhaust diffuser assembly having an exhaust diffuser with a plurality of support link assemblies coupled thereto in accordance with embodiments of the present disclosure;

FIG. 5 illustrates a cross-sectional view of a support link assembly in accordance with embodiments of the present disclosure;

FIG. 6 illustrates a perspective view of a support link, which may be incorporated in the support link assembly discussed above with reference to FIG. 5 in accordance with embodiments of the present disclosure;

FIG. 7 illustrates a perspective view of a first side of a support link in accordance with embodiments of the present disclosure;

FIG. 8 illustrates a perspective view of a second side of a support link in accordance with embodiments of the present disclosure;

FIG. 9 illustrates an enlarged view of the detail boxed in FIG. 7 in accordance with exemplary aspects of the present disclosure;

FIG. 10 illustrates a cross-sectional view of the support link assembly from along the line 10-10 shown in FIG. 7 in accordance with embodiments of the pre-

sent disclosure; and

FIG. 11 illustrates an enlarged view of a portion of FIG. 10 in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0012] Reference now will be made in detail to embodiments of the present support link assemblies and exhaust diffuser assemblies, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation, rather than limitation of, the technology. In fact, it will be apparent to those skilled in the art that modifications and variations can be made in the present technology without departing from the scope or spirit of the claimed technology. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present disclosure covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0013] The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other implementations. Additionally, unless specifically identified otherwise, all embodiments described herein should be considered exemplary.

[0014] The detailed description uses numerical and letter designations to refer to features in the drawings. Like or similar designations in the drawings and description have been used to refer to like or similar parts of the invention. As used herein, the terms "first", "second", and "third" may be used interchangeably to distinguish one component from another and are not intended to signify location or importance of the individual components.

[0015] The term "fluid" may be a gas or a liquid. The term "fluid communication" means that two or more areas defining a flow passage are joined to one another such that a fluid is capable of making the connection (i.e., flowing) between the areas specified.

[0016] As used herein, the terms "upstream" (or "forward") and "downstream" (or "aft") refer to the relative direction with respect to fluid flow in a fluid pathway. For example, "upstream" refers to the direction from which the fluid flows, and "downstream" refers to the direction to which the fluid flows. In the context of an exhaust diffuser assembly, "upstream" refers to the direction closest to the turbine section, and "downstream" refers to the outlet end of the exhaust diffuser assembly.

[0017] The term "radially" refers to the relative direction that is substantially perpendicular to an axial centerline of a particular component; the term "axially" refers to the relative direction that is substantially parallel and/or coaxially aligned to an axial centerline of a particular component; and the term "circumferentially" refers to

the relative direction that extends around the axial centerline of a particular component.

[0018] Terms of approximation, such as "about," "approximately," "generally," and "substantially," are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or machines for constructing or manufacturing the components and/or systems. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or machines for constructing or manufacturing the components and/or systems. For example, the approximating language may refer to being within a 1, 2, 4, 5, 10, 15, or 20 percent margin in either individual values, range(s) of values and/or endpoints defining range(s) of values. When used in the context of an angle or direction, such terms include within ten degrees greater or less than the stated angle or direction. For example, "generally vertical" includes directions within ten degrees of vertical in any direction, e.g., clockwise or counter-clockwise.

[0019] The terms "coupled," "fixed," "attached to," and the like refer to both direct coupling, fixing, or attaching, as well as indirect coupling, fixing, or attaching through one or more intermediate components or features, unless otherwise specified herein. The terms "directly coupled," "directly fixed," "directly attached to," and the like mean that two components are joined in contact with one another and that no intermediate components or features are present.

[0020] As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but may include other features not expressly listed or inherent to such process, method, article, or apparatus. Further, unless expressly stated to the contrary, "and/or" refers to a condition satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0021] Here and throughout the specification and claims, where range limitations are combined and interchanged, such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise. For example, all ranges disclosed herein are inclusive of the endpoints, and the endpoints are independently combinable with each other.

[0022] Referring now to the drawings, FIG. 1 illustrates a schematic diagram of one embodiment of a turbomachine, which in the illustrated embodiment is a gas turbine engine 10. Although an industrial or land-based gas turbine engine is shown and described herein, the present disclosure is not limited to an industrial and/or land-based gas turbine engine, unless otherwise specified in

the claims. For example, the invention as described herein may be used in any type of turbomachine including but not limited to a steam turbine, an aircraft gas turbine, or a marine gas turbine.

[0023] As shown, the gas turbine engine 10 generally includes a compressor section 12. The compressor section 12 includes a compressor 14. The compressor section 12 includes an inlet 16 that is disposed at an upstream end of the gas turbine engine 10. The gas turbine engine 10 further includes a combustion section 18 having one or more combustors 20 disposed downstream from the compressor section 12. The gas turbine engine 10 further includes a turbine section 22 that is downstream from the combustion section 18. A shaft 24 extends generally axially through the gas turbine engine 10.

[0024] The compressor section 12 may generally include a plurality of rotor disks 21 and a plurality of rotor blades 23 extending radially outwardly from and connected to each rotor disk 21. Each rotor disk 21 in turn may be coupled to or form an upstream portion of the shaft 24 that extends through the compressor section 12. The rotor blades 23 of the compressor section 12 may include turbomachine airfoils that define an airfoil shape (e.g., having a leading edge, a trailing edge, and side walls extending between the leading edge and the trailing edge). Additionally, the compressor section 12 includes stator vanes disposed between the rotor blades to define a series of compression stages. The stator vanes may extend from, and couple to, a compressor casing.

[0025] The turbine section 22 may generally include a plurality of rotor disks 27 and a plurality of rotor blades 28 extending radially outwardly from and being interconnected to each rotor disk 27. Each rotor disk 27 in turn may be coupled to or form a portion of the shaft 24 that extends through the turbine section 22. The turbine section 22 further includes an outer casing 32 that circumferentially surrounds the downstream portion of the shaft 24 and the rotor blades 28. The turbine section 22 may include stationary nozzles 26 extending radially inward from the outer casing 32. The rotor blades 28 and stationary nozzles 26 may be arranged in alternating fashion in stages along an axial centerline 30 of gas turbine 10. Both the rotor blades 28 and the stationary nozzles 26 may include turbomachine airfoils that define an airfoil shape (e.g., having a leading edge, a trailing edge, and side walls extending between the leading edge and the trailing edge).

[0026] In operation, ambient air 36 or other working fluid is drawn into the inlet 16 of the compressor 14 and is progressively compressed to provide compressed air 38 to the combustion section 18. The compressed air 38 flows into the combustion section 18 and is mixed with fuel to form a combustible mixture. The combustible mixture is burned within a combustion chamber 40 of the combustor 20, thereby generating combustion gases 42 that flow from the combustion chamber 40 into the turbine section 22. Energy (kinetic and/or thermal) is transferred from the combustion gases 42 to the rotor

blades 28, causing the shaft 24 to rotate and produce mechanical work.

[0027] The gas turbine engine 10 may define a cylindrical coordinate system having an axial direction A extending along the axial centerline 30, a radial direction R perpendicular to the axial centerline 30, and a circumferential direction C extending around the axial centerline 30.

[0028] The combustion gases 42 exit the turbine section 22 and flow through the exhaust diffuser 34 across a plurality of struts 44 that are disposed within the exhaust diffuser 34. During various operating conditions of the gas turbine engine 10, such as during part-load operation, the combustion gases 42 flowing into the exhaust diffuser 34 from the turbine section 22 are conferred with a high level of swirl that is caused by the rotating turbine rotor blades 28. Such swirling flow can cause pressure fluctuations, frequency oscillations, or acoustic vibrations.

[0029] FIG. 2 illustrates a cross-sectional view of an exhaust diffuser assembly 100 (which includes an exhaust diffuser 34), and FIG. 3 illustrates a cross-sectional view of the exhaust diffuser assembly 100 from along the line 3-3 shown in FIG. 2, in accordance with embodiments of the present disclosure. As shown, the exhaust diffuser 34 generally includes an inner liner 46 and an outer liner 48 radially spaced apart from the inner liner 46. The inner liner 46 may extend generally axially along an axial centerline 50 of the exhaust diffuser 34. The axial centerline 50 of the exhaust diffuser 34 may be coaxial with the axial centerline 30 of the gas turbine engine 10. The inner liner 46 is generally annular shaped and may at least partially surround rotating components. For example, the inner liner 46 may surround or encase a portion of the shaft 24.

[0030] In many embodiments, the outer liner 48 may be radially separated from the inner liner 46, such that an exhaust flow passage 52 is defined between the inner liner 46 and the outer liner 48. In particular embodiments, the inner liner 46 is concentrically and coaxially aligned within the outer liner 48 with respect to the axial centerline 50. In certain embodiments, a diffuser casing 56 may be radially spaced apart from the outer liner 48 and annularly surround the outer liner 48 such that a fluid plenum 58 is defined between the diffuser casing 56 and the outer liner 48. A flow of compressed air (or other working fluid) may flow within the fluid plenum 58 to cool the various components of the exhaust diffuser 34 (such as the outer liner 48 and the struts 44). The present disclosure is not limited to any particular size, shape, material, or other physical characteristics of the inner liner 46, the outer liner 48, and/or the diffuser casing 56, except as recited in the claims.

[0031] Each of the diffuser struts 44 may extend between the inner liner 46 and the outer liner 48 and within the exhaust flow passage 52 defined therebetween. The diffuser struts 44 are spaced circumferentially around the inner liner 46, and the diffuser struts 44 may orient, align,

or otherwise center the inner liner 46 within the outer liner 48. In addition, the diffuser struts 44 may provide structural support between the inner and the outer liners 46, 48. As shown in FIG. 1, the diffuser struts 44 are positioned relative to a direction of flow 60 of the spent combustion gases 42 flowing from the turbine section 22 of the gas turbine engine 10. As shown in FIG. 3, each diffuser strut 44 generally includes a root portion 62 that is connected to the inner liner 46, and a tip portion 64 radially separated from the root portion 62 and connected to the outer liner 48.

[0032] In exemplary embodiments, as shown in FIGS. 2 and 3, the exhaust diffuser assembly 100 may further include one or more support link assemblies 300 coupling the exhaust diffuser 34 to the diffuser casing 56. Particularly, the exhaust diffuser assembly 100 may include a plurality of support link assemblies 300 circumferentially spaced apart (e.g., equally or unequally) from one another and coupled to the outer liner 48 and the diffuser casing 56. The diffuser casing 56 may include a forward end 57 having a flange 59 extending outwardly (e.g., radially) from the diffuser casing 56 at the forward end 57. The flange 59 may include one or more bolt holes (not shown) for coupling the forward end 57 of the diffuser casing 56 to a flange 67 at an aft end 65 of a turbine casing 63. The turbine casing 63 and the diffuser casing 56 may each be annular such that both the turbine casing 63 and the diffuser casing 56 surround the axial centerline 50. The support link assemblies 300 may include a support link 301 having a main body 302, a forward flange 304, and a pair of aft arms 306. The forward flange 304 may couple to the forward end 57 of the diffuser casing 56. Particularly, the forward flange 304 may be positioned between the aft end 65 of the turbine casing 63 and the forward end 57 of the diffuser casing 56. The forward flange 304 may extend along (e.g., parallel to) the radial direction R.

[0033] In exemplary embodiments, as shown in FIG. 3, the plurality of support link assemblies 300 may be circumferentially spaced apart from one another and each coupled to the outer liner 48 and the diffuser casing 56 within the fluid plenum 58. The forward flange 304 may be removably coupled to the forward end 57 of the diffuser casing 56 (e.g., via one or more bolts, dowel pins, etc.), and the pair of aft arms 306 may be fixedly coupled to a radially outer surface of the outer liner 48 (e.g., via welding, brazing, or other methods). In exemplary embodiments, as shown, the pair of aft arms 306 may be non-parallel to one another.

[0034] FIG. 4 illustrates an isometric view of an exhaust diffuser assembly 100 having an exhaust diffuser 34 with a plurality of support link assemblies 300 coupled thereto. As discussed above, the exhaust diffuser 34 may include an inner liner 46, an outer liner 48, and a plurality of struts 44 extending (e.g., radially) between the inner liner 46 and the outer liner 48. The exhaust diffuser 34 may include a top half 70 and a bottom half 72, which are joined together at a split line 74. Additionally, the exhaust

diffuser 34 may extend axially between a forward end 78 and an aft end 76.

[0035] As shown in FIG. 4, the plurality of support link assemblies 300 that are affixed to the outer liner 48, some of which may be arranged in circumferential groups 310 (e.g., groups of three). Each support link assembly 300 in a group 310 of support link assemblies 300 may be approximately (e.g., $\pm 5\%$) circumferentially equally spaced from the other support link(s) 300 in the group 310. As shown in FIG. 4, each strut 44 of the plurality of struts 44 defines an interior 86 that extends between an outer opening 88 defined in the outer liner 48 and an inner opening 90 defined in the inner liner 46. In such embodiments, the support link assemblies 300 that are affixed to the outer liner 48 may be disposed between circumferentially neighboring outer openings 88. Particularly, one or more groups 310 may be disposed circumferentially between two neighboring outer openings 88. Additionally, a single split-line support link assembly 300 may be disposed between the split line 74 and an outer opening 88 in closest proximity to the outer split-line 110. Although the circumferential groups 310 are shown as having three support link assemblies 300, other numbers of support link assemblies 300 may be used (e.g., two or more).

[0036] Referring now to FIG. 5, a cross-sectional view of a support link assembly 300 installed within an exhaust diffuser assembly 100 is illustrated in accordance with embodiments of the present disclosure. As shown, the exhaust diffuser assembly 100 includes an outer liner 48 of an exhaust diffuser 34, a diffuser casing 56 radially spaced apart from the outer liner 48, and a support link assembly 300 coupling the outer liner 48 of the exhaust diffuser 34 to the diffuser casing 56. The diffuser casing 56 may include a casing body 104, a forward flange 106 extending radially outwardly from the casing body 104, and a tab 108 extending radially inwardly from the casing body 104. The forward flange 106 may couple to the aft flange 67 of the turbine casing 63 (FIG. 2) when the exhaust diffuser assembly 100 is implemented in a gas turbine engine (such as the gas turbine engine 10 discussed above with reference to FIG. 1).

[0037] The support link assembly 300 may include a support link 301 and a vibrational damping assembly 200 (FIGS. 7-8) affixed to the support link 301. The support link 301 may include a main body 302, a forward flange 304, and a pair of aft arms 306 (one of which is shown in FIG. 5). The main body 302 may extend from a forward end 308 to an aft end 312. The forward flange 304 may extend (e.g., generally radially outwardly) from the main body 302 at the forward end 308 and couple (e.g., removably couple) to the diffuser casing 56. Particularly, the forward flange 304 may couple to a forward face of the tab 108 of the diffuser casing 56 via one or more bolts 110. The aft arms 306 may extend (e.g., generally radially inwardly) from the main body 302 at the aft end 312. The aft arms 306 may be fixedly coupled to a radially outer surface of the outer liner 48 of the exhaust diffuser 34 (such as via welding, brazing, or other means). Particu-

larly, the aft arms 306 may form a weld joint 305 with an outer surface of the outer liner 48.

[0038] FIG. 6 illustrates a perspective view a support link 301, which may be incorporated in the support link assemblies 300 discussed above with reference to FIGS. 2 through 5. Specifically, the vibrational damping assembly 200 as well as other mounting hardware has been removed from the support link assembly 300 to isolate the support link 301 in order to show details of the support link 301. As shown, the support link 301 includes the main body 302, the forward flange 304 at the forward end 308 of the main body 302, and the pair of aft arms 306 at the aft end 312 of the main body 302.

[0039] As shown in FIG. 6, the support link defines a longitudinal centerline 350 and a cartesian coordinate system relative to the longitudinal centerline 350 (e.g., a coordinate system having three directions mutually perpendicular to one another). For example, the support link 301 defines a longitudinal direction L extending along the longitudinal centerline 350, a transverse direction T extending perpendicular to the longitudinal centerline 350, and a vertical direction V extending perpendicular to the longitudinal centerline 350. The longitudinal direction L, the transverse direction T, and the vertical direction V are mutually perpendicular.

[0040] The main body 302 may include a forward portion 316 and an aft portion 318, which may intersect with one another at a junction 317). The forward portion may extend (e.g., longitudinally) from the forward end 308 to the aft portion 318. The aft portion 318 may extend (e.g., longitudinally) from the forward portion 316 to the aft end 312. The pair of arms 306 may each extend from the aft portion 318 of the main body 302, and the forward flange 304 may extend from the forward end 308 of the forward portion 316 of the main body 302. Particularly, the aft portion 318 may extend to an aft edge 328 at the aft end 312, and the pair of arms 306 may extend from the aft portion 318 between the forward portion 316 and the aft edge 328.

[0041] The forward portion 316 may be longer in the longitudinal direction L than the aft end 312, such as between about 1.5 times longer and about 5 times longer, or such as between about 2 times longer and about 4 times longer. Alternatively stated, the forward portion 316 may define a longitudinal length that is between about 150% and about 500% of a longitudinal length of the aft portion 318, or such as between about 200% and about 400%.

[0042] The main body 302 may define a width 320 in the transverse direction T that varies in the longitudinal direction L between the forward end 308 and the aft end 312. Particularly, the forward portion 316 converges in width 320 in the transverse direction T as the forward portion 316 extends longitudinally from the forward end 308 to the junction 317, such that the width 320 (e.g., the transverse width) of the forward portion 316 gradually decreases from the forward end 308 to the aft portion 318. The aft portion 318 may diverge in width 320 in the

transverse direction T as the aft portion 318 extends longitudinally from the junction 317 with the forward portion 316 to the aft end 312, such that the width 320 (e.g., the transverse width) of the aft portion 316 increases from the junction 317 to the aft end 312. In summary, the junction 317 between the forward portion 316 and the aft portion 318 may be an inflection point at which the width 320 transitions from decreasing to increasing as the main body extends from the forward end 308 to the aft end 312.

[0043] As shown in FIG. 6, the forward flange 304 extends generally vertically from the main body in a first direction, and the pair of arms 306 each extend generally vertically from the main body 302 in a second direction that is opposite the first direction. Alternatively stated, the forward flange 304 may extend generally vertically outwardly from the main body 302, and the pair of arms 306 may each extend generally vertically inwardly from the main body 302.

[0044] The forward flange 304 may include an arcuate segment 322 and a straight segment 324, and the forward flange 304 may extend to a terminal edge 326. The arcuate segment may extend between the forward end 308 of the main body 302 to the straight segment 324, and the straight segment 324 may extend from the arcuate segment 322 to the terminal edge 326. The arcuate segment 322 may increase in transverse width from the forward end 308 to the straight segment 324. The straight segment 324 may have a generally constant or uniform transverse width.

[0045] As shown in FIG. 6, the main body 302 may extend longitudinally between the forward end 308 and the aft end 312, and the main body 302 may extend transversely from a first side 330 to a second side 332. The main body 302 may be longer in the longitudinal direction L than the transverse direction T, e.g., a length between the forward end 308 and the aft end 312 may be longer than the width 320.

[0046] In exemplary embodiments, the pair of arms 306 may include a first arm 307A and a second arm 307B spaced apart from the first arm 307A in the transverse direction T. The first arm 307A may extend from the first side 330 of the main body 302. More particularly, the first arm 307A may extend from the first side 330 of the main body 302 at the aft portion 318. Similarly, the second arm 307B may extend from the second side 332 of the main body 302. That is, the second arm 307B may extend from the second side 332 of the main body 302 at the aft portion 318.

[0047] In exemplary embodiments, as shown in FIG. 6, the support link 301 may define one or more stress relief openings 334A, 334B. The one or more stress relief openings 334A, 334B may each include a hole 336A, 336B and a slit 338A, 338B extending from the hole to an edge of the support link 301. For example, a first stress relief opening 334A may include a first hole 336A defined in the forward portion 316 of the main body 302 proximate the forward end 308. The first stress relief opening 334A

may further include a first slit 338A extending from the first hole 336A to the terminal edge 326 of the forward flange 304. A majority portion of the first slit 338A may be defined in the forward flange 304, and a minority portion of the first slit 338A may be defined in the forward portion 316 of the main body 302. Additionally, a second stress relief opening 334B may include a second hole 336B defined in the aft portion 318 of the main body 302. The second stress relief opening 334B may further include a second slit 338B extending from the second hole 336B to the aft edge 328.

[0048] Additionally, as shown in FIG. 6, the forward flange 304 (such as the straight segment 324 of the forward flange 304) may define bolt holes 362 and dowel holes 364. The bolt holes 362 may be disposed on either side of the slit 338A. Each bolt hole 332 may be disposed between two dowel holes 364. The bolt holes 362 may be configured to receive a bolt, and the dowel holes 364 may be configured to receive a dowel rod to couple the forward flange to a diffuser casing. The bolt holes 362 may have a diameter that is larger than a diameter of the dowel holes 364.

[0049] Referring now to FIGS. 7 and 8, FIG. 7 illustrates a perspective view of a first side of a support link 300, and FIG. 8 illustrates a perspective view of second side of the support link 300, in accordance with embodiments of the present disclosure. As shown in FIGS. 7 and 8, the support link 300 further includes a vibrational damping assembly 200 affixed to the support link 300. The vibrational damping assembly 200 may dampen vibrations experienced by the support link 301 during operation of the exhaust diffuser assembly 100 (and/or the gas turbine engine 10), in order to prevent damage to the support link 301 and increase the hardware life of the support link 301.

[0050] The vibrational damping assembly 200 may include at least one plate 202 and at least one pin assembly 204 (shown more clearly in FIGS. 10-11) coupling the at least one plate 202 to the support link 301. The at least one pin assembly 204 may be coupled to the main body 302 of the support link 301. In many embodiments, as shown in FIGS. 7 and 8, the at least one pin assembly 204 may include a pin 206 and a disk 208 coupled to the pin 206. The pin 206 may include a pin head 210 and a pin body 212. As shown, at least one plate 202 may be disposed between the pin head 210 and the support link 301. For example, the at least one plate 202 surrounds the pin body 206 and is restricted to movement along the pin body 206 to dampen vibrations of the support link 301. That is, the at least one plate 202 is movable between the pin head 210 and the support link 301 relative to the pin 206 and relative to the support link 301 to dampen vibrations experienced by the support link 301.

[0051] The vibrational damping assembly 200 further includes a brace 344 and one or more bands 346 coupled to the brace 344. As shown, brace 344 and the one or more bands 346 may collectively surround the main body 302 and the at least one plate 202. That is, the support link

301 may include a first side surface 340 (such as an outer side surface) and a second side surface 342 (such as an inner side surface) opposite the first side surface 340. The brace 344 may extend along, and be disposed in contact with, the first side surface 340. At least one of the one or more plates 202 may be disposed along, and in contact with, the second side surface 342. The bands 346 may be coupled to the brace 344 and may extend along an exterior plate of the one or more plates 202.

[0052] As shown in FIG. 7, the brace 344 includes a mounting portion 214, a first web portion 216, a first band portion 218, a second web portion 220, and a second band portion 222. The mounting portion 214 may be connected to the pin 206 (e.g., the mounting portion 214 may surround the pin body 212 and be disposed between the disk 208 and the main body 302. That is, the mounting portion 214 may define a hole through which the pin body 212 extends. The first web portion 216 may include a first pair of web branches 217 each extending from the mounting portion 214 to the first band portion 218. The second web portion 220 may include a second pair of web branches 221 each extending from the first band portion 218 to the second band portion 222.

[0053] As shown in FIGS. 7 and 8 collectively, the first band portion 218 may couple to a first band 349 of the one or more bands 346, and the second band portion 220 may couple to the second band 347 of the one or more bands 346. Referring now to FIG. 9, an enlarged view of the detail boxed in FIG. 7 is illustrated in accordance with exemplary aspects of the present disclosure. As should be appreciated, while FIG. 9 illustrates features of the first band portion 218 and the first band 349, the features illustrated in FIG. 9 may also be incorporated in the second band portion 222 and the second band 347.

[0054] As shown in FIG. 9, the first band portion 218 may include a plate segment 224 and two flange segments 226 extending perpendicularly from the plate segment 224 on either side 330, 332 of the main body 302. The plate segment 224 may be generally parallel to the main body 302 and in contact with the first surface 340 of the main body 302. Similarly, the first band 349 may include a plate segment 228 and two tab segments 230 extending perpendicularly from the plate segment 228 on either side 330, 332 of the main body 302. Each flange segment 226 may include an inner surface 232 that is in contact with a side of the main body 302 (such as the first side 330 or the second side 332) and at least one plate of the one or more plates 202. Additionally, each flange segment 226 may include an outer surface 234 that is in contact with an interior surface 236 of a tab segment 230. The tab segment 230 of the first band 349 may form a friction fit with the flange segment 226 of the first band portion 218 of the brace 344.

[0055] FIG. 10 illustrates a cross sectional view of the support link assembly 300 from along the line 10-10 shown in FIG. 7 in accordance with embodiments of the present disclosure, and FIG. 11 illustrates an enlarged view of a portion of FIG. 10. While FIG. 10 only

illustrates the first arm 307A of the pair of arms 306, it should be understood and appreciated that the features shown and described with reference to FIG. 10 may also be incorporated into the second arm 307B.

[0056] In exemplary embodiments, each arm 307A, 307B of the pair of arms 306 may extend from a root 352 connected the main body 302 to a free edge 354. The root 352 may be the junction between the main body 302 and the respective arm 307A, 307B. Each arm 307A, 307B may include a shank portion 356 and a protruding portion 358. The shank portion 356 may extend generally vertically from the root 352 to the protruding portion 358, and the protruding portion 358 may extend from the shank portion 356 to the free edge 354. The protruding portion 358 may extend outwardly (e.g., longitudinally and/or vertically) from the shank portion 356. That is, the protruding portion 358 may include protrusions 360 that extend outwardly from the shank portion 356. In exemplary implementations, as will be discussed below, the free edge 354 of each arm 307A, 307B may be welded to the outer liner 48, and the protrusions 360 may significantly reduce the stresses experienced at the weld joint as well as provide easier access to the junction to be welded, which is advantageous.

[0057] As shown in FIG. 11, the support link assembly 300 includes a support link 301 and a vibrational damping assembly 200 affixed to the support link 301. The vibrational damping assembly 200 may dampen vibrations experienced by the support link 301 during operation of the exhaust diffuser assembly 100 (and/or the gas turbine engine 10), in order to prevent damage to the support link 201 and increase the hardware life of the support link 301.

[0058] The vibrational damping assembly 200 may include at least one plate 202, a brace 344, and at least one pin assembly 204 coupling the at least one plate 202 and the brace 344 to the support link 301. The at least one pin assembly 204 may be coupled to the main body 302 of the support link 301. In many embodiments, as shown in FIGS. 7 and 8, the at least one pin assembly 204 may include a pin 206 and a disk 208 coupled to the pin 206. The pin may include a pin head 210 and a pin body 212. The pin head 210 may be disk shaped, may extend outwardly from the pin body 212 and may be generally parallel to the disk 208. The pin body 212 may extend through the at least one plate 202 (e.g., a first plate 240 and a second plate 242), the main body 302 of the support link 301, the brace 344, and the disk 208. Once installed, the pin 206 may be secured in position by welding or brazing the disk 208 to the pin body 212.

[0059] As shown, at least one plate 202 (such as the first plate 240 and the second plate 242) may be disposed between the pin head 210 and the main body 302 of the support link 301. For example, the at least one plate 202 surrounds the pin body 206 and is restricted to movement along the pin body 206 to dampen vibrations of the support link 301. That is, the at least one plate 202 is movable between the pin head 210 and the support link 301 relative to the pin 206 and relative to the support link

301 to dampen vibrations experienced by the support link 301. Particularly, the at least one plate 202 (such as the first plate 240 and the second plate 242) may be disposed between the pin head 210 and the second side surface 342 of the main body 302. The brace 344 may be disposed between the disk 208 and the first side surface 340 of the main body 302.

[0060] In exemplary embodiments, the plates 202 may include the first plate 242 having a first thickness 128 and the second plate 240 having a second thickness 129. The second thickness 129 may be greater than the first thickness 128. For example, the second thickness 129 may be between about 20% and about 80% greater than the first thickness 128, or such as between about 30% and about 70% greater than the first thickness 128, or such as between about 40% and about 60% greater than the first thickness 128.

[0061] During operation, the plates 202 may move relative to the support link 301 and one another, which causes micro-collisions (or "bumping") between the plates 202. These micro-collisions may counteract vibrations experienced by the support link 301 to which the vibrational damping assembly 200 is attached, thereby advantageously increasing the hardware life of the support link 301. Additionally, the aft arms 306 of the support link 301 advantageously facilitate fixable coupling (e.g., welding) of the support link to the outer liner 48 without introducing unreasonable stresses at the weld location.

[0062] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

[0063] Further aspects of the invention are provided by the subject matter of the following clauses:

[0064] A support link assembly for coupling an exhaust diffuser to a diffuser casing, the support link assembly comprising: a support link comprising: a main body extending from a forward end to an aft end; a forward flange extending from the main body at the forward end, the forward flange configured to couple to the diffuser casing; and a pair of arms extending from the main body at the aft end, the pair of arms configured to couple to the exhaust diffuser.

[0065] The support link assembly as in any preceding clause, further comprising a vibrational damping assembly affixed to the support link.

[0066] The support link assembly as in any preceding clause, wherein the vibrational damping assembly comprises: at least one pin assembly coupled to the main body of the support link, the at least one pin assembly

having a pin and a disk, the pin including a pin head and a pin body; and at least one plate disposed between the pin head and the support link, wherein the at least one plate surrounds the pin body, and wherein the at least one plate is movable between the pin head and the support link relative to the pin and relative to the support link to dampen vibrations experienced by the support link.

[0067] The support link assembly as in any preceding clause, wherein the vibrational damping assembly further comprises a brace and one or more bands coupled to the brace, wherein the brace and the one or more bands collectively surround the main body and the at least one plate.

[0068] The support link assembly as in any preceding clause, wherein the brace includes a mounting portion, a first web portion, a first band portion, a second web portion, and a second band portion.

[0069] The support link assembly as in any preceding clause, wherein the first band portion couples to a first band of the one or more bands, and wherein the second band portion couples to a second band of the one or more bands.

[0070] The support link assembly as in any preceding clause, wherein the main body includes a forward portion and an aft portion, wherein the forward portion converges in width as the forward portion extends from the forward end to a junction of the forward end with the aft portion, and wherein the aft portion diverges in width as the aft portion extends from the junction with the forward portion to the aft end.

[0071] The support link assembly as in any preceding clause, wherein the pair of arms extends from the aft portion of the main body, and wherein the forward flange extends from the forward portion of the main body.

[0072] The support link assembly as in any preceding clause, wherein the support link defines a longitudinal centerline, a longitudinal direction, a transverse direction, and a vertical direction, wherein the main body extends generally longitudinally from the forward end to the aft end, wherein the forward flange extends generally vertically from the main body in a first direction, and wherein each arm of the pair of arms extends generally vertically from the main body in a second direction that is opposite the first direction.

[0073] The support link assembly as in any preceding clause, wherein the main body extends transversely from a first side to a second side, wherein a first arm of the pair of arms extends from the first side, and wherein a second arm of the pair of arms extends from the second side.

[0074] The support link assembly as in any preceding clause, wherein each arm of the pair of arms extends from a root connected the main body to a free edge, wherein each arm includes a shank portion and a protruding portion, the shank portion extending from the root to the protruding portion, and the protruding portion extending from the shank portion to the free edge.

[0075] The support link assembly as in any preceding clause, wherein one or more stress relief openings are

defined in the support link, each of the one or more stress relief openings including a hole and a slit extending from the hole to an edge of the support link.

[0076] A support link assembly for coupling an exhaust diffuser to a diffuser casing, the support link assembly comprising: a support link comprising a main body extending from a forward end to an aft end; and a vibrational damping assembly affixed to the support link, the vibrational damping assembly comprising: at least one pin assembly coupled to the main body of the support link, the at least one pin assembly having a pin and a disk, the pin including a pin head and a pin body; and at least one plate disposed between the pin head and the support link, wherein the at least one plate surrounds the pin body, and wherein the at least one plate is movable between the pin head and the support link relative to the pin and relative to the support link to dampen vibrations experienced by the support link.

[0077] The support link assembly as in any preceding clause, wherein the vibrational damping assembly further comprises a brace and one or more bands coupled to the brace, wherein the brace and the one or more bands collectively surround the main body and the at least one plate.

[0078] The support link assembly as in any preceding clause wherein the brace includes a mounting portion, a first web portion, a first band portion, a second web portion, and a second band portion.

[0079] The support link assembly as in any preceding clause, wherein the first band portion couples to a first band of the one or more bands, and wherein the second band portion couples to a second band of the one or more bands.

[0080] The support link assembly as in any preceding clause, wherein one or more stress relief openings are defined in the support link, each of the one or more stress relief openings including a hole and a slit extending from the hole to an edge of the support link.

[0081] The support link assembly as in any preceding clause, wherein the support link further comprises: a forward flange extending from the main body at the forward end, the forward flange configured to couple to the diffuser casing; and a pair of arms extending from the main body at the aft end, the pair of arms configured to couple to the exhaust diffuser.

[0082] An exhaust diffuser assembly comprising: a diffuser casing; an exhaust diffuser; and a support link coupling the exhaust diffuser to the diffuser casing, the support link comprising: a main body extending from a forward end to an aft end; a forward flange extending from the main body at the forward end, the forward flange configured to couple to the diffuser casing; and a pair of arms extending from the main body at the aft end, the pair of arms configured to couple to the exhaust diffuser.

[0083] The exhaust diffuser assembly as in any preceding clause, wherein a vibrational damping assembly is affixed to the support link.

Claims

1. A support link assembly (300) for coupling an exhaust diffuser (34) to a diffuser casing (56), the support link assembly (300) comprising:
a support link (301) comprising:

a main body (302) extending from a forward end (308) to an aft end (312);
a forward flange (304) extending from the main body (302) at the forward end (308), the forward flange (304) configured to couple to the diffuser casing (56); and
a pair of arms (306) extending from the main body (302) at the aft end (312), the pair of arms (306) configured to couple to the exhaust diffuser (34).

2. The support link assembly (300) as in claim 1, further comprising a vibrational damping assembly (200) affixed to the support link (301).

3. The support link assembly (300) as in claim 2, wherein the vibrational damping assembly (200) comprises:

at least one pin assembly (204) coupled to the main body (302) of the support link (301), the at least one pin assembly (204) having a pin (206) and a disk (208), the pin (206) including a pin head (210) and a pin body (212); and
at least one plate (202) disposed between the pin head (210) and the support link (301), wherein the at least one plate (202) surrounds the pin body (212), and wherein the at least one plate (202) is movable between the pin head (210) and the support link (301) relative to the pin (206) and relative to the support link (301) to dampen vibrations experienced by the support link (301).

4. The support link assembly (300) as in claim 3, wherein the vibrational damping assembly (200) further comprises a brace (344) and one or more bands (346) coupled to the brace (344), wherein the brace (344) and the one or more bands (346) collectively surround the main body (302) and the at least one plate (202).

5. The support link assembly (300) as in claim 4, wherein a first band portion (218) of the brace (344) couples to a first band (349) of the one or more bands (346), and wherein a second band portion (220) of the brace (344) couples to a second band (347) of the one or more bands (346).

6. The support link assembly (300) as in any preceding claim, wherein the main body (302) includes a forward portion (316) and an aft portion (318), wherein

the forward portion (316) converges in width as the forward portion (316) extends from the forward end (308) to a junction (317) of the forward portion (316) with the aft portion (318), and wherein the aft portion (318) diverges in width as the aft portion (318) extends from the junction (317) with the forward portion (316) to the aft end (312).

7. The support link assembly (300) as in claim 6, wherein the pair of arms (306) extends from the aft portion (318) of the main body (302), and wherein the forward flange (304) extends from the forward portion (316) of the main body (302). 10
8. The support link assembly (300) as in any preceding claim, wherein the support link (301) defines a longitudinal centerline (350), a longitudinal direction (L), a transverse direction (T), and a vertical direction (V), wherein the main body (302) extends generally longitudinally from the forward end (308) to the aft end (312), wherein the forward flange (304) extends generally vertically from the main body (302) in a first direction, and wherein each arm of the pair of arms (306) extends generally vertically from the main body (302) in a second direction that is opposite the first direction. 15 20 25
9. The support link assembly (300) as in claim 8, wherein the main body (302) extends transversely from a first side (330) to a second side (332), wherein a first arm (307A) of the pair of arms (306) extends from the first side (330), and wherein a second arm (307B) of the pair of arms (306) extends from the second side (332). 30 35
10. The support link assembly (300) as in any preceding claim, wherein each arm of the pair of arms (306) extends from a root (352) connected the main body (302) to a free edge (354), wherein each arm (306) includes a shank portion (356) and a protruding portion (358), the shank portion (356) extending from the root (352) to the protruding portion (358), and the protruding portion (358) extending from the shank portion (356) to the free edge (354). 40 45
11. The support link assembly (300) as in any preceding claim, wherein one or more stress relief openings (334A, 334B) are defined in the support link, each of the one or more stress relief openings (334A, 334B) including a hole (336A, 336B) and a slit (338A, 338B) extending from the hole (336A, 336B) to an edge (326, 328) of the support link (301). 50
12. An exhaust diffuser assembly (100) comprising: 55
 - a diffuser casing (56) defining a fluid plenum (58);
 - an exhaust diffuser (34) disposed within the fluid

plenum (58); and
a support link assembly (300) coupling the exhaust diffuser (34) to the diffuser casing (56), the support link assembly (300) being defined according to any of the previous claims.

13. The exhaust diffuser assembly (100) as in claim 12, wherein the exhaust diffuser (34) includes an outer liner (48) radially inward of the diffuser casing (56); and wherein the support link assembly (300) is one of a plurality of support link assemblies circumferentially spaced around an outer liner (48) of the exhaust diffuser (34) to couple the outer liner (48) to the diffuser casing (56).
14. The exhaust diffuser assembly (100) as in claims 12 or 13, wherein the forward flange (304) of the support link assembly (300) is removably coupled to the diffuser casing (56), and the pair of arms is fixedly coupled to a radially outer surface of the outer liner (48) of the exhaust diffuser (34).
15. The exhaust diffuser assembly (100) as in claim 13 or 14, wherein the plurality of support link assemblies (300) is arranged in circumferential groups (310), the circumferential groups (310) being disposed between circumferentially neighboring outer openings (88) defined in the outer liner (48) of the exhaust diffuser (34); and wherein a single split-line support assembly (300) may be disposed between a split line (74) of the outer liner (48) and an outer opening (88) is closest proximity to the split line (74).

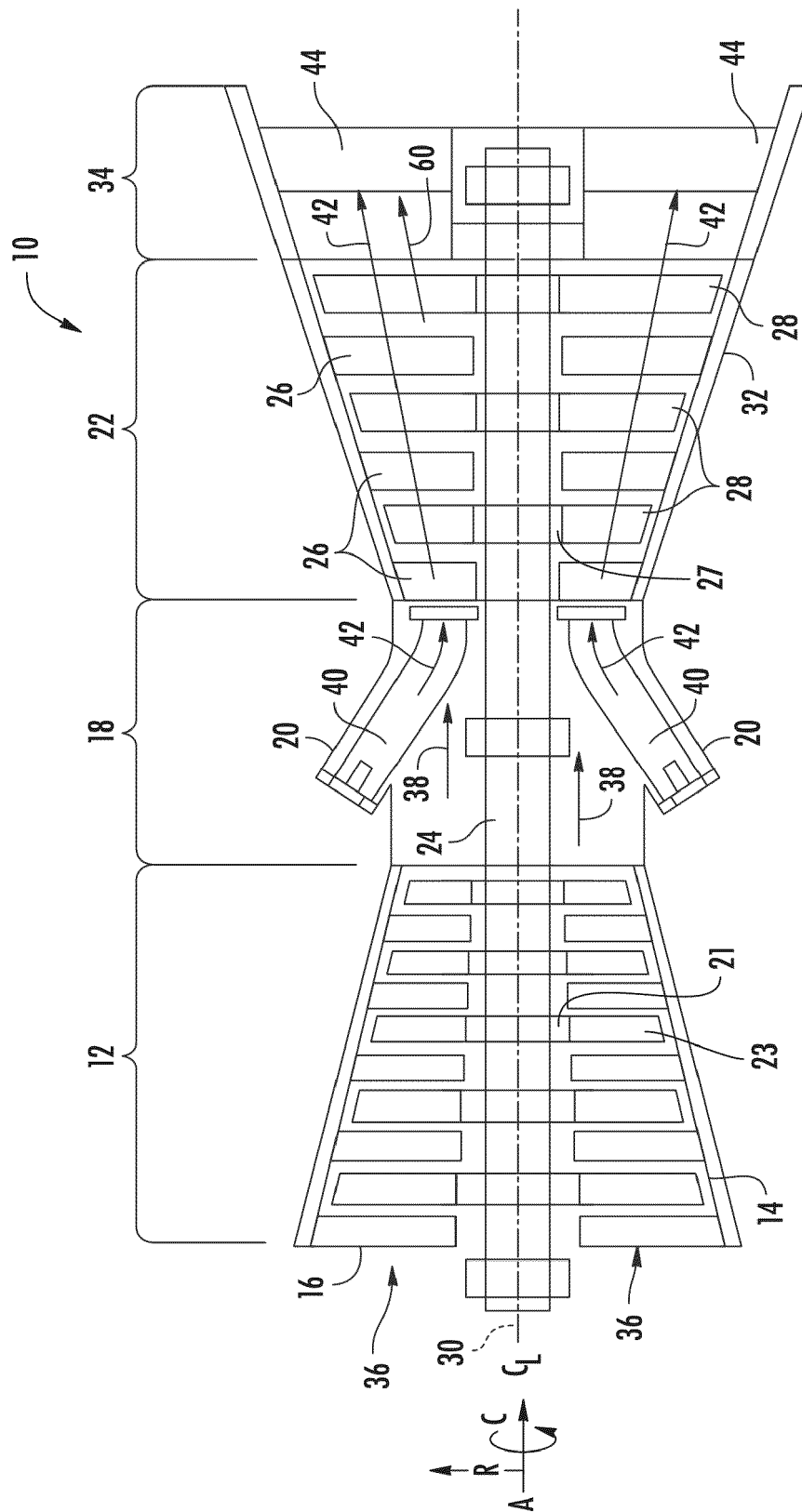
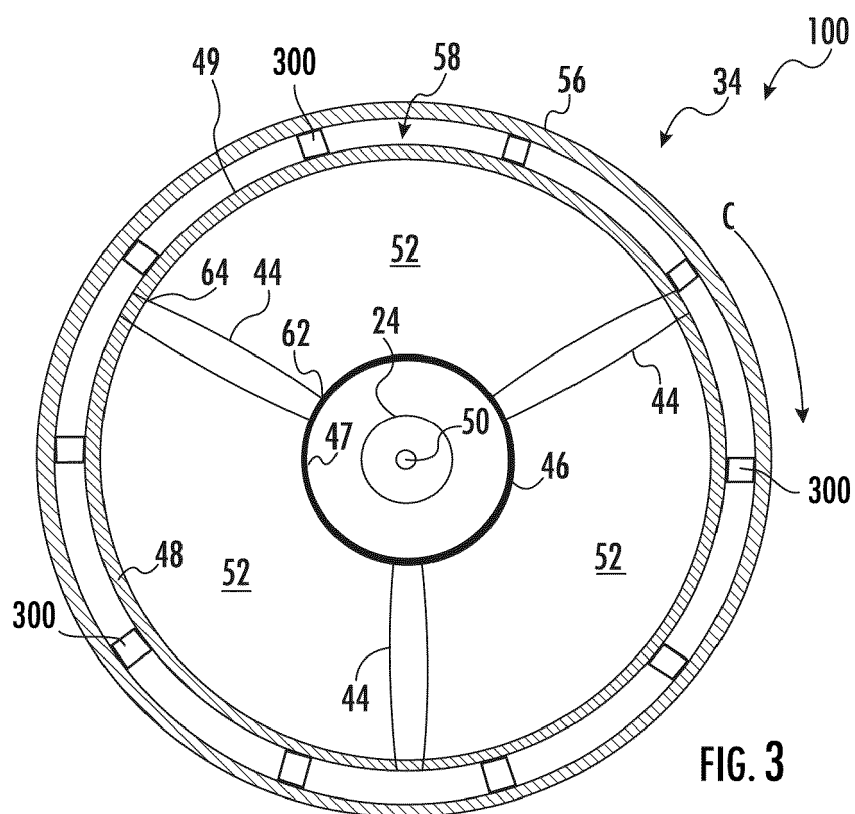
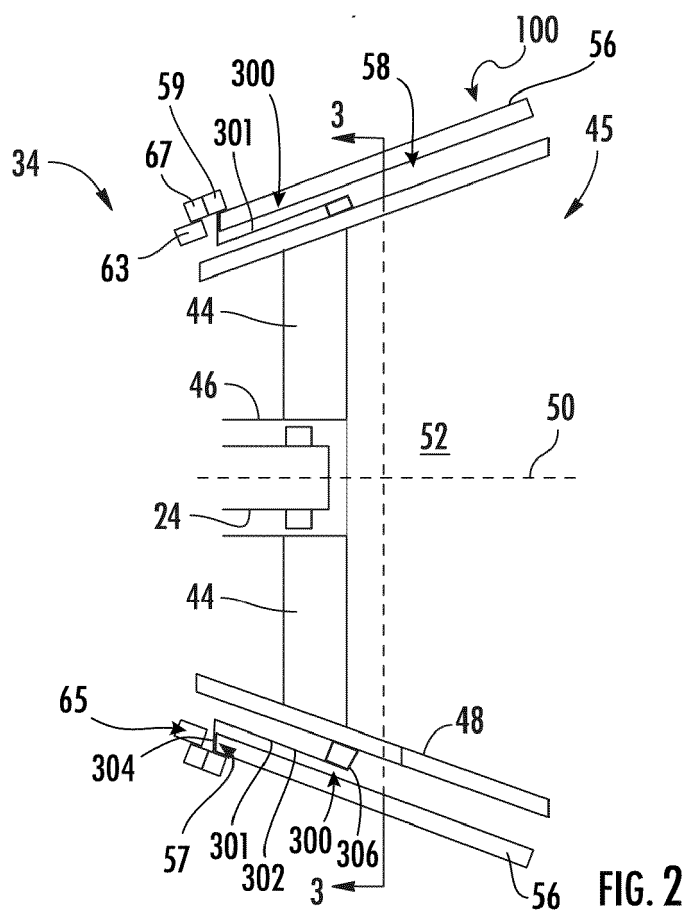
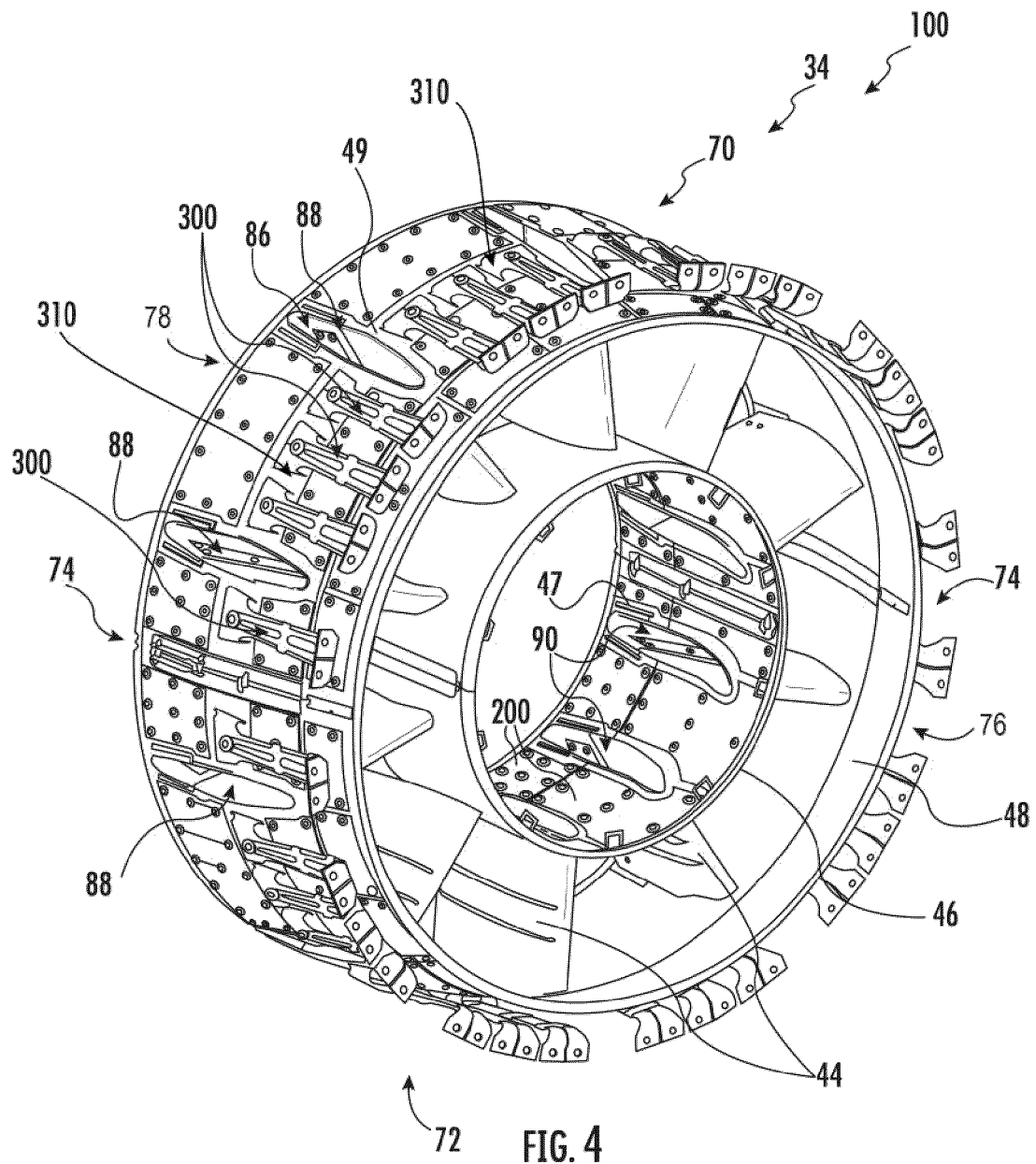


FIG. 1





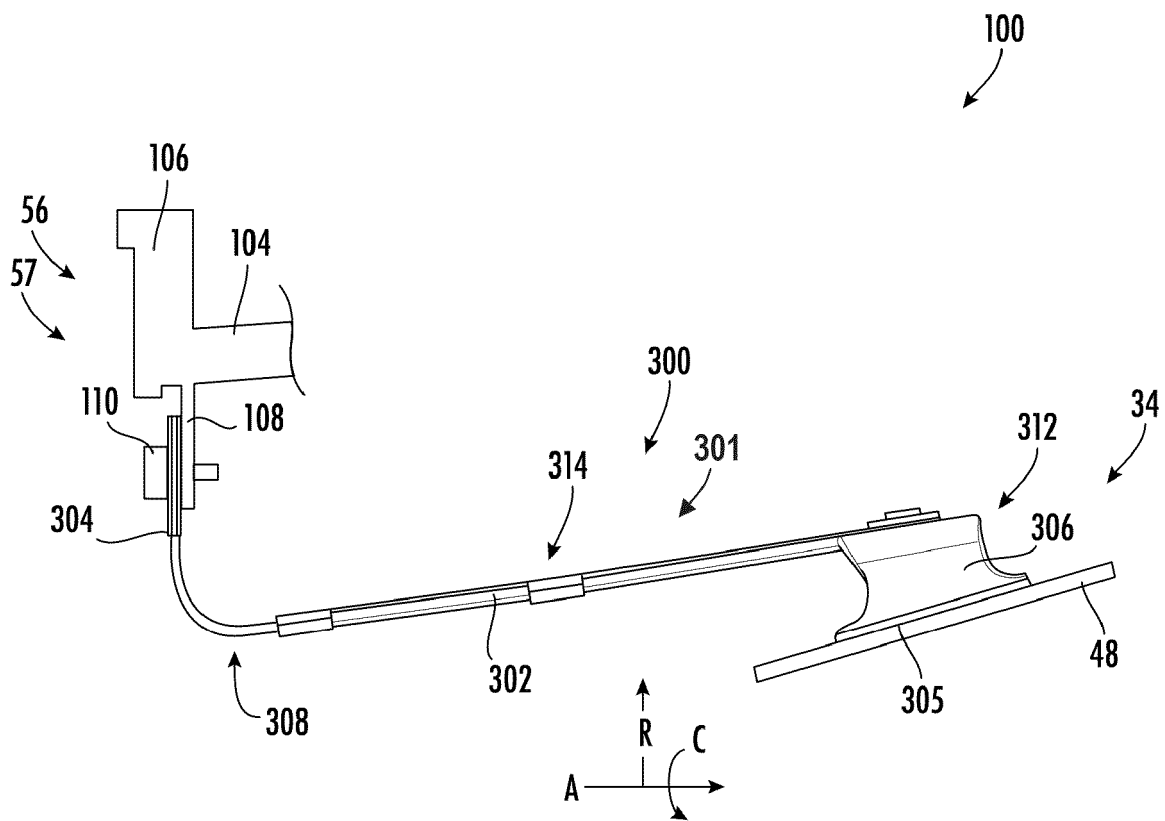
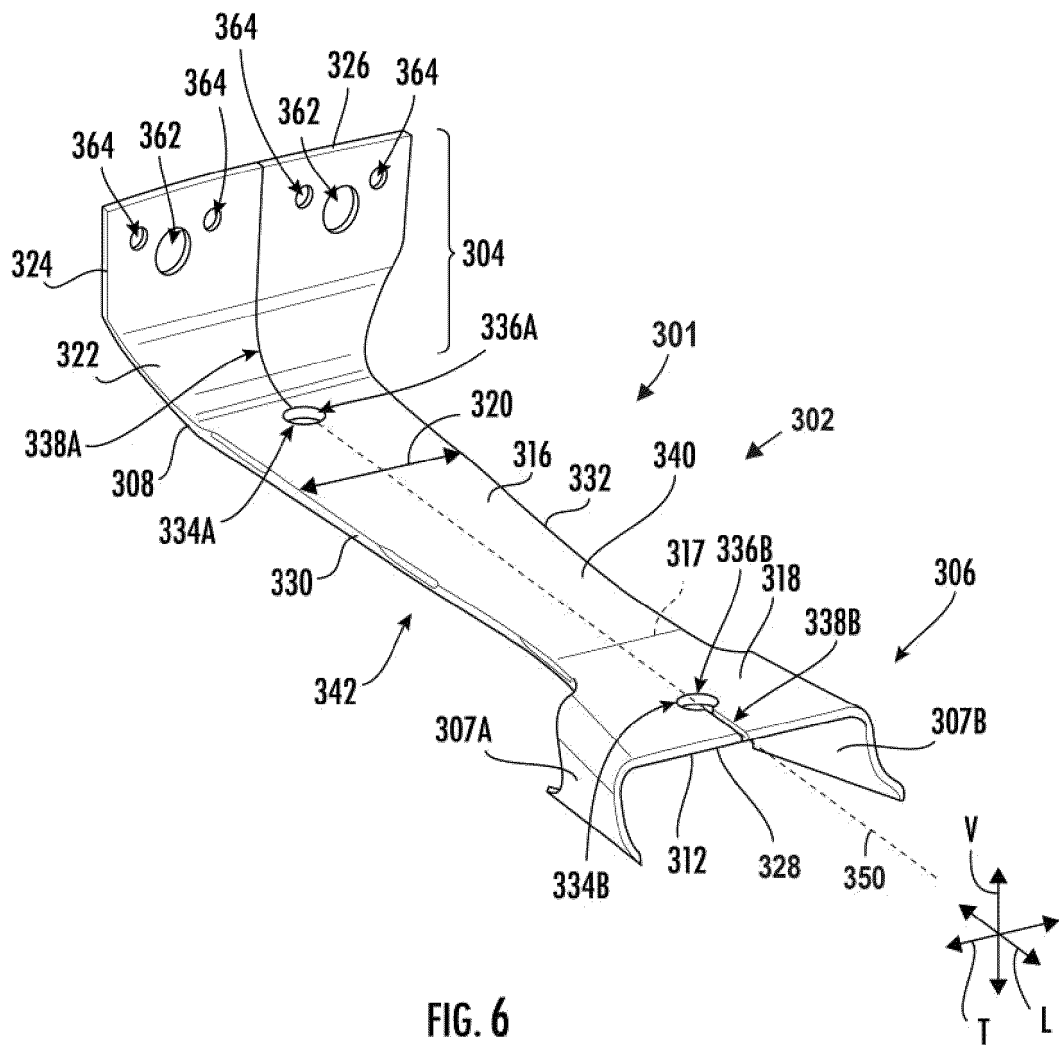


FIG. 5



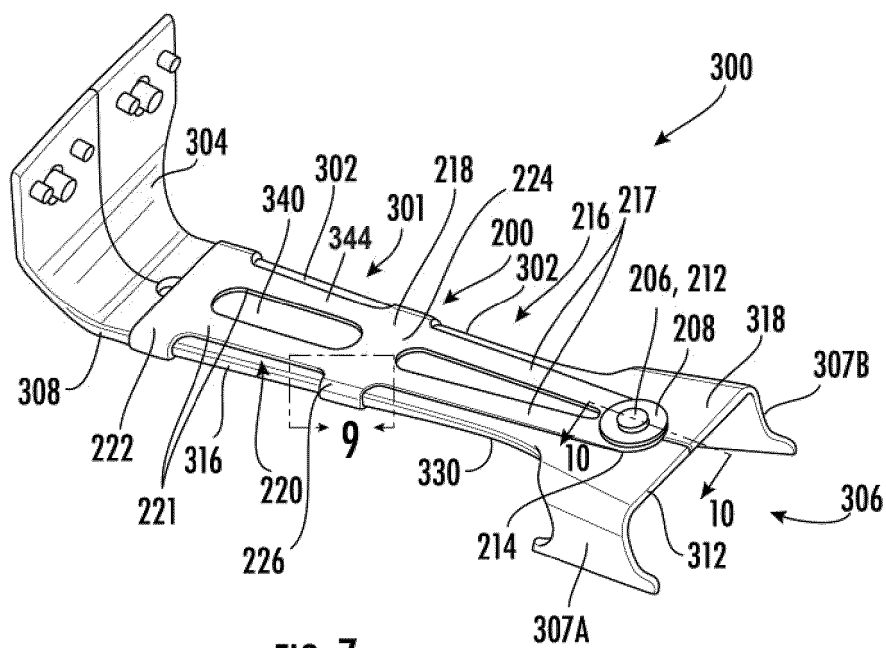


FIG. 7

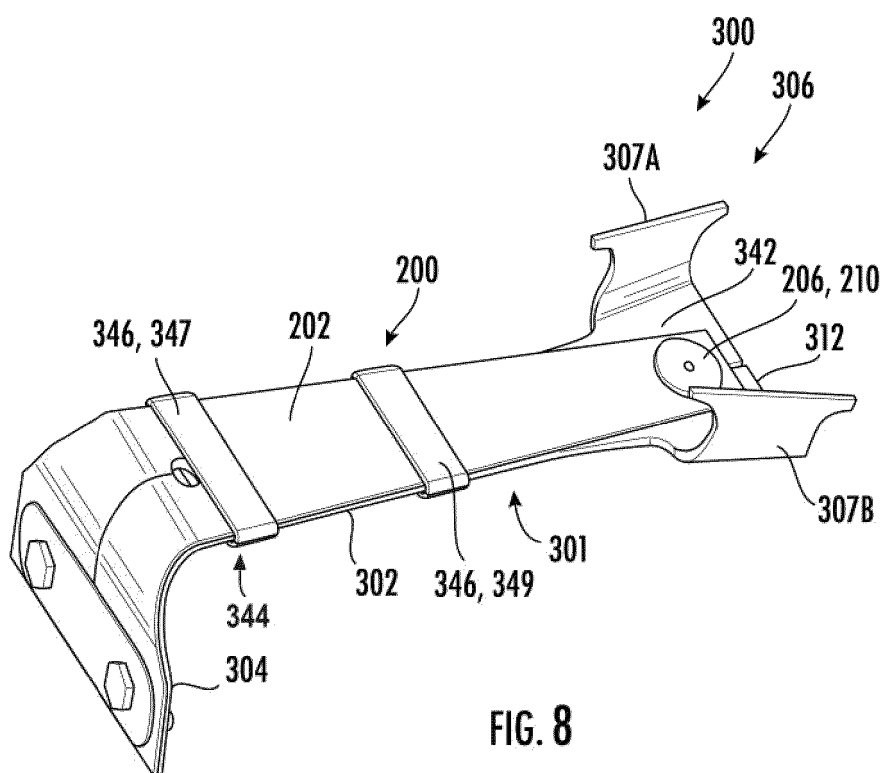


FIG. 8

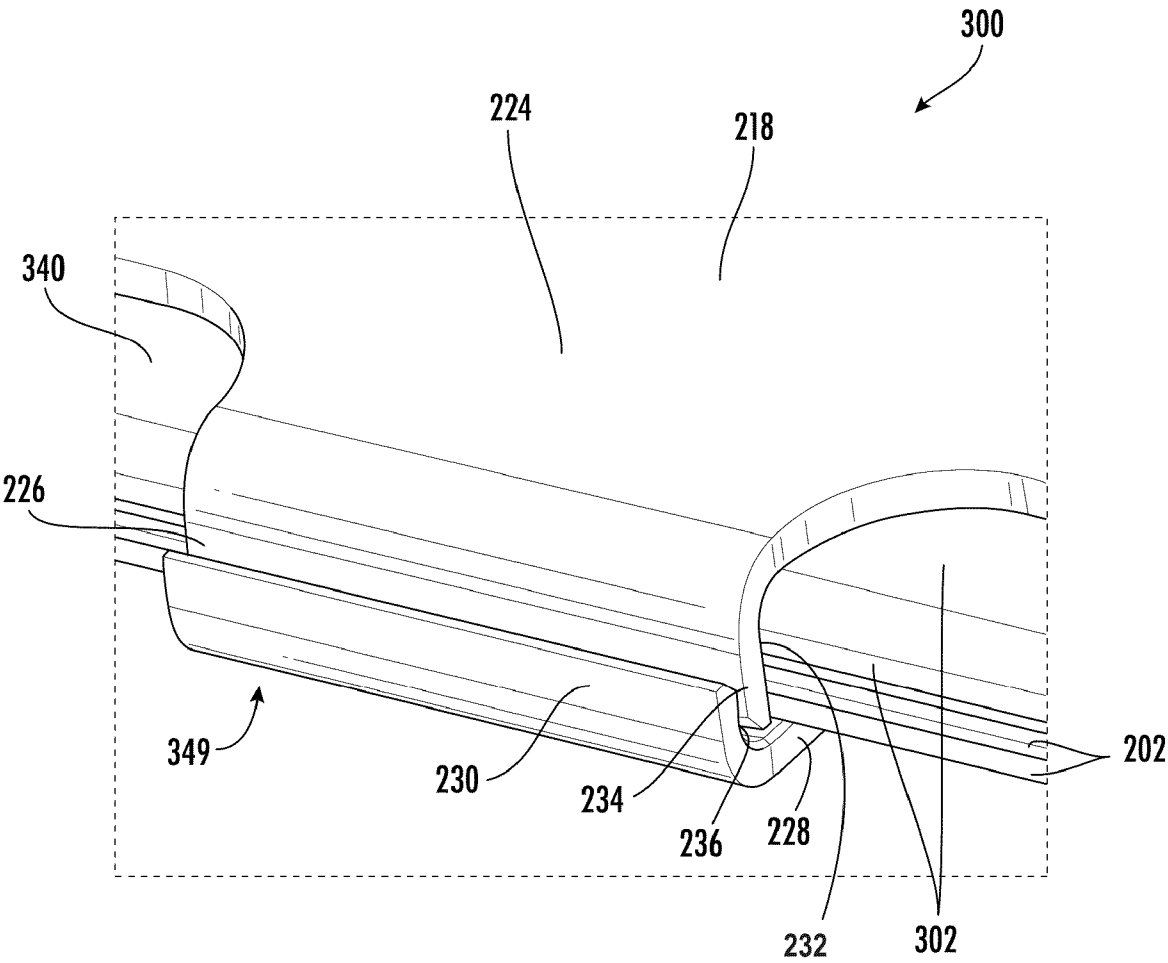


FIG. 9

