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(54) **Vortex reducing device for a gas turbine engine**

(57) A gas turbine engine (12) has a vortex reducing device (20) therein that includes a retainer (30) and paddles (32). The retainer is arcuate in shape and has a plurality of circumferentially spaced slots (46) that extend through it. The paddles are circumferentially spaced about the retainer and extend outward therefrom. Each paddle is disposed between adjacent slots.

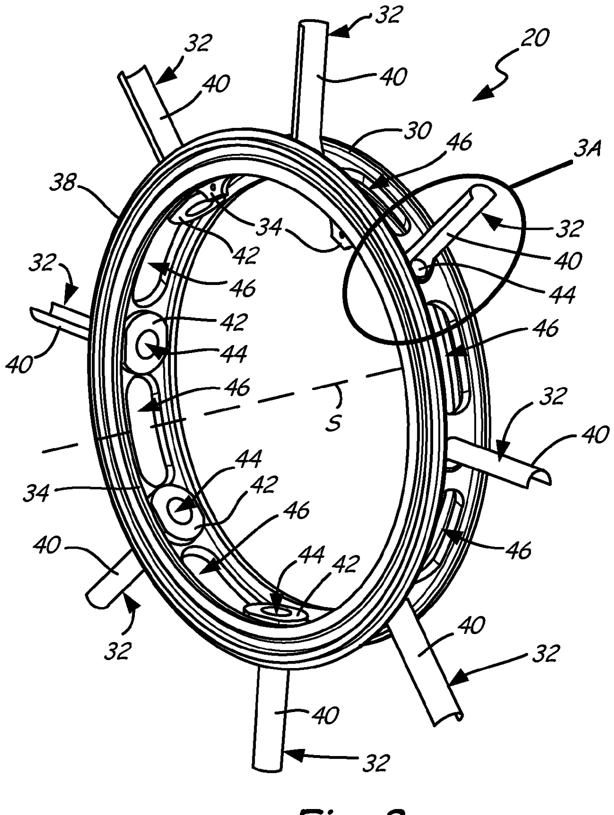


Fig. 3

EP 2 410 136 A2

Description

BACKGROUND

[0001] The present invention relates to gas turbine engines, and more particularly, to gas turbine engines with anti-vortex devices.

[0002] Anti-vortex tubes (also known as secondary air tubes or vortex reducing tubes) are known in the art, and are commonly disposed within the high pressure compressor section of gas turbine engines. The tubes direct air bled from a core flowpath radially into a bore of the high pressure compressor adjacent the turbine engine's shaft(s). As is known, anti-vortex tubes are used to achieve a desired temperature and pressure profile within the engine for performance purposes. The anti-vortex tubes are also used for cooling and other purposes including scrubbing compressor disks, providing buffer air to bearing compartments, and directing cooling airflow to portions of the gas turbine engine's turbine section.

[0003] Existing anti-vortex tubes are assemblies that commonly include multiple parts such as snap rings and retaining rings in addition to individual tubes. Parts such as snap rings and retaining rings are used to couple the tube assembly to adjoining compressor disks. Such multiple part assemblies add weight to the turbine engine and can add unwanted complexity to the assembly/disassembly processes. For example, a detail balancing of the anti-vortex tubes is done when all the components are assembled together. The balancing requires that each individual tube and tube receiving part be numbered in the event of disassembly to ensure proper balancing of thermal/mechanical stresses upon reassembly.

SUMMARY

[0004] A gas turbine engine has a vortex reducing device therein that includes a retainer and paddles. The retainer is arcuate in shape and has a plurality of circumferentially spaced slots that extend through it. The paddles are circumferentially spaced about the retainer and extend outward thereform. Each paddle is disposed between adjacent slots.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a cross-section of a rotor section of a high pressure compressor for a gas turbine engine.

[0006] FIG. 2 is an enlarged cross-section of a vortex reducing device mounted to a compressor disk.

[0007] FIG. 3 is a perspective view of the vortex reducing device of FIG. 2.

[0008] FIG. 3A is an enlarged perspective view of a paddle and slots of the vortex reducing device of FIG. 3.

[0009] FIG. 4 is a perspective view of another embodiment of the vortex reducing device.

[0010] FIG. 4A is an enlarged perspective view of a paddle and slots of the vortex reducing device of FIG. 4.

[0011] FIG. 5 is a perspective view of yet another embodiment of the vortex reducing device.

[0012] FIG. 5A is an enlarged perspective view of a paddle and slots of the vortex reducing device of FIG. 5.

DETAILED DESCRIPTION

[0013] FIG. 1 shows a rotor portion of a high pressure compressor 10 for a gas turbine engine 12 with stator portions within the high pressure compressor 10 not illustrated. The gas turbine engine 12 includes blades 14A-14H, disks 16A-16H, a shaft 18, and a vortex reducing device 20. Blades 14A-14H are disposed along a core flowpath 22 (indicated with a direction arrow). Disks 16A-16H extend from blades 14A-14H into a bore 24 of high pressure compressor 10 adjacent engine centerline C_L and shaft 18. Disks 16A-16H are disposed to form compressor disk interspace 26A-26H therebetween.

[0014] High pressure compressor 10 and gas turbine engine 12 are of conventional construction and operate in a manner well known in the art. In particular, air passes from a forward fan section (not shown) of gas turbine engine 12 through a low pressure compressor section (not shown) to high pressure compressor section 10 via core flowpath 22. Blades 14A-14H are disposed within core flowpath 22 generally intermittently with stator vanes (not shown). Each blade 14A-14H is connected to one corresponding disk 16A-16H. The upper portion of disks 16A-16H at the connection with blades 14A-14H comprises a platform that forms a wall of core flowpath 22.

[0015] Disks 16A-16H are connected to, and rotate, with shaft 18. Disks 16A-16H extend radially inward from blades 14A-14H into bore 24 and terminate adjacent engine centerline C_L and shaft 18. Vortex reducing device 20 is connected to disk 16G and is disposed within compressor disk interspace 26G. In other embodiments, multiple vortex reducing devices may be utilized in one or more compressor disk interspaces.

[0016] Blades 14A-14H and vanes (not shown) of high pressure compressor 10 work to incrementally increase the pressure and temperature of air passing along core flowpath 22 in a manner known in the art. Air is bled from core flowpath 22 and a portion of this bleed air passes through vortex reducing device 20 to achieve a desired temperature and pressure profile within the gas turbine engine 12 for performance purposes.

[0017] As will be elaborated upon subsequently, the present application describes various embodiments of vortex reducing device 20. Vortex reducing device 20 can comprise a single assembly, for example a weldment, which significantly reduces the number of parts and weight of vortex reducing device 20 relative to prior art anti-vortex tubes. Additionally, vortex reducing device 20 does not utilize tubes in the manner associated with the prior art but rather utilizes a paddle and retainer with circumferentially spaced slots. This configuration simplifies the assembly/disassembly and installation processes for vortex reducing device 20.

[0018] FIG. 2 shows an enlarged sectional view of one embodiment of vortex reducing device 20 mating with disk 16G. FIG. 3 gives a perspective view of vortex reducing device 20 without illustrating disk 16G. As shown in FIG. 2, disk 16G includes a tab projection 28. Vortex reducing device 20 includes a retainer 30, paddles 32, and a snap ring 34. The retainer 30 includes a flange 36 with a groove 38. Paddles 32 include a main body 40 and a base 42 with an aperture 44 therethrough. Retainer 30 includes a plurality of circumferentially spaced slots 46.

[0019] Tab projection 28 extends from disk 16G in a middle portion thereof to abut and connect to retainer 30 via groove 38 on flange 36. In particular, tab projection 28 is adapted to connect to groove 38 via conventional techniques such as snap fitting. Friction between tab projection 28 and retainer 30 keeps vortex reducing device 20 from moving relative to disk 16G leaving retainer 30 coupled to disk 16G.

[0020] In one embodiment, retainer 30 comprises an arcuate ring that extends entirely around the engine centerline C_L and shaft 18 (FIG. 1). Paddles 32 (only a single paddle is illustrated in FIG. 2) are circumferentially spaced about retainer 30 and are received in retainer 30. Paddles 32 are circumferentially spaced about the retainer 30 and extend outward therefrom. In particular, paddles 32 are disposed to extend radially outward from retainer 30 (as defined with respect to the axis of symmetry S). Each paddle 32 is disposed between adjacent slots 46. Paddles 32 can be attached to retainer 30 by conventional means. In one embodiment, each paddle 32 is welded (by e.g., electron beam, inertia bond, or friction) to retainer 30 and extends outward therefrom into compressor disk interspace 26G. Snap ring 34 is attached to the inner radial surface of the retainer 30 (with respect to the engine centerline C_L) and is used to prevent paddles 32 from rotating once installed. Flange 36 extends from an outer axial portion of retainer 30 to contact tab projection 28 along groove 38.

[0021] Main body 40 of paddle 32 extends from retainer 30 into compressor disk interspace 26G. In the embodiment shown in FIGS. 2 and 3, the outward extending portion of main body 40 has a semi-circular shape. The concave portion of main body 40 is illustrated in FIG. 2 between first edge 41A and second edge 41B. Main body 40 extends through a receiving hole in retainer 30 and transitions to base 42. Base 42 is larger than receiving hole in retainer 30 and is slightly non-circular in shape having a flat portion that allows snap ring 34 to be attached between retainer 30 and base 42. Main body 40 and/or base 42 can be attached to retainer 30 via various means known in the art such as welding, snapping, or pressing. In the embodiment shown in FIGS. 2 and 3, paddle 32 defines aperture 44, which extends through base 42. Aperture 44 allows bleed air through the retainer 30 to bore 24 of the gas turbine engine 10 (FIG. 1). In other embodiments, vortex reducing device 20 does not utilize apertures 44. In yet other embodiments, apertures 44 extend through the retainer 30 and paddles 32.

[0022] FIG. 3A shows an enlarged perspective view of a portion of vortex reducing device 20 of FIGS. 2 and 3. In addition to elements described in FIGS. 2 and 3, vortex reducing device 20 includes radii R.

[0023] Each slot 46 terminates with radii R adjacent paddle 32. The size of radii R varies with various embodiments of vortex reducing device 20. In one embodiment, radii R is between 100 mil (2.54 mm) to 1 inch (25.4 mm). Slots 46 allow bleed air through the retainer 30 to bore 24 of the gas turbine engine 10 (FIG. 1). Slots 46, and indeed paddles 32, can vary in size, shape, and number depending on the temperature and pressure profile that is desired to be achieved within the gas turbine engine 12 for performance purposes. The size, shape, and number of paddles 32 and slots 46 can also be influenced by thermal/mechanical stresses on the paddles 32 and retainer 30.

[0024] FIG. 4 shows a perspective view of another embodiment of vortex reducing device 20. FIG. 4A shows an enlarged perspective view of a portion of vortex reducing device 20 of FIG. 4. The embodiment shown in FIGS. 4 and 4A includes paddles 32 with fillets F.

[0025] Paddles 32 are attached to the outer circumference of retainer 30 using conventional methods such as welding, forging, snapping, riveting, or fastening. In one embodiment, paddles 32 are welded (by e.g., electron beam, inertia bond, or friction) to retainer 30. Paddles 32 are disposed between slots 46 and each paddle 32 has fillet F near the connection with retainer 30. The size of fillet F can vary based on design criteria. In one embodiment, fillet F is between 50 mils (1.27 mm) and 0.5 inch (12.7 mm). Similarly, radii R illustrated in FIGS. 4 and 4A can vary based upon design criteria.

[0026] As illustrated in FIGS. 4 and 4A, the portion 40 of the paddle 32 that extends outward from retainer 30 has a flat cross-sectional shape (i.e., paddle 32 does not have a concave/convex shape as do the paddles 32 shown in FIGS. 2 and 3) between first edge 41A and second edge 41B. Retainer 30 does not include holes for receiving paddles 32, instead paddles 32 are spaced circumferentially apart and connect directly to the outer radial surface of the retainer 30 (as defined with respect to the axis of symmetry S of retainer 30). As described herein, slots 46 allow bleed air through the retainer 30 to bore 24 of the gas turbine engine 10 (FIG. 1).

[0027] FIG. 5 shows a perspective view of yet another embodiment of vortex reducing device 20. FIG. 5A shows an enlarged perspective view of a portion of vortex reducing device 20 of FIG. 5. The embodiment shown in FIGS. 5 and 5A includes paddles 32 with fillets F. In particular, the fillets F are disposed near the connection between an inner radial portion (with respect to the axis of symmetry S) of main body 40 of each paddle 32.

[0028] Paddles 32 are attached to the outer circumference of retainer 30 using conventional methods such as welding, forging, snapping, riveting, or fastening. Paddles 32 are disposed between slots 46 and each paddle 32 has fillet F near the connection between an inner radial portion of main body 40 and retainer 30. The size of fillet F can vary based on design criteria. In one embodiment, fillet F is between 50 mils (1.27 mm) and 0.5 inch (12.7 mm). Similarly, radii R illustrated in FIGS. 5 and 5A can vary based upon design criteria.

[0029] The inner radial portion (with respect to the axis of symmetry S) of main body 40 extends outward from retainer 30. The inner radial portion of main body 40 has a circular cross sectional shape, and thus, has no first edge 41A and second edge 41B. However, the outer radial portion of main body 40 has a semi-circular shape with a concave portion extending between first edge 41A and second edge 41B. Main body 40 connects to retainer 30 and partially defines each individual aperture 44, which extends through both main body 40 and retainer 30. Thus, apertures 44 are disposed immediately adjacent the base of the paddles 32 and allow bleed air through the retainer 30 to bore 24 of the gas turbine engine 10 (FIG. 1) along with slots 46.

[0030] In yet other embodiments, paddles 32 may have various geometries as design criteria dictate. For example, paddles 32 may have geometries that are known in the art of impeller technology to facilitate adequate bleed air passage through slots 46 in retainer 30. In such examples, first edge 41A and second edge 41B could be rotated to various angles with respect to the axis of symmetry S of the retainer 30 and with one another. Paddles 32 could also be aligned, offset, tilted, sloped, or otherwise shaped and disposed at various angles with respect to one another and/or the axis of symmetry S of the retainer 30 to facilitate adequate bleed air passage through slots 46.

[0031] While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention, which is defined by the claims. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A vortex reducing device (20) for a gas turbine engine (12), comprising:

an arcuate retainer (30) with a plurality of circumferentially spaced slots (46) extending therethrough; and
a plurality of paddles (32) circumferentially spaced about the retainer to extend outward therefrom, each paddle being disposed between adjacent slots.

2. The device of claim 1, wherein the retainer (30) comprises a ring extending 360° about an axis of symmetry and the paddles (32) extend from the retainer radially outward away from the axis of symmetry (S) of the retainer, and wherein the plurality of slots (46) allow for passage of air to a bore of the gas turbine engine.

3. The device of claim 1 or 2, wherein the paddles (32) are electron beam, inertia bond, or friction welded to the retainer (30).

4. The device of claim 1, 2 or 3, wherein an outward extending main body portion (40) of the paddle has a semi-circular cross-sectional shape.

5. The device of claim 4 wherein a radially inner portion of the main body (40) has a circular cross-sectional shape.

6. The device of claim 4 or 5, wherein each paddle (32) defines or is disposed adjacent to an aperture (44) that extends through the retainer or paddle.

7. The device of claim 4 or 5, wherein each paddle (32) extends through an aperture in the retainer and has a base that is larger than the aperture.

8. The device of claim 7, further comprising a snap ring (34) that connects to the retainer to prevent the paddle from rotating.

9. The device of claim 1, 2 or 3, wherein an outward extending main body portion (40) of the paddle has a flat cross-sectional shape.

10. A vortex reducing device (20) assembled within a compressor (10) of a gas turbine engine (12), the assembly comprising:

a first disk (16G) and a second disk (16H), each disk extending from adjacent a core flowpath (22) into a bore (24) of the gas turbine engine and forming a compressor disk interspace (26G) therebetween; and
a vortex reducing device (20) as claimed in any preceding claim connected to the first disk and disposed in the disk interspace.

11. The assembly of claim 10, wherein the first disk has a tab projection (28) on a middle portion thereof and the retainer (30) has a groove (38) that is adapted to be snap fit into the tab projection.

12. The assembly of claim 10 or 11, wherein the paddles (32) are arranged to rotate with the first disk (16G) such that bleed air from the core flowpath (22) may pass through the slots (46) to the bore (24) of the gas turbine engine.

13. The assembly of claim 10, 11 or 12, wherein the retainer (30) comprises a ring that is disposed about a centerline (S) of the gas turbine engine and the paddles (32) extend from the retainer outward away from the centerline within the compressor disk interspace (26G).

14. The assembly of claim 10, 11, 12 or 13 wherein each disk comprises:

a plurality of blades (14) disposed within the core flowpath of the gas turbine engine.

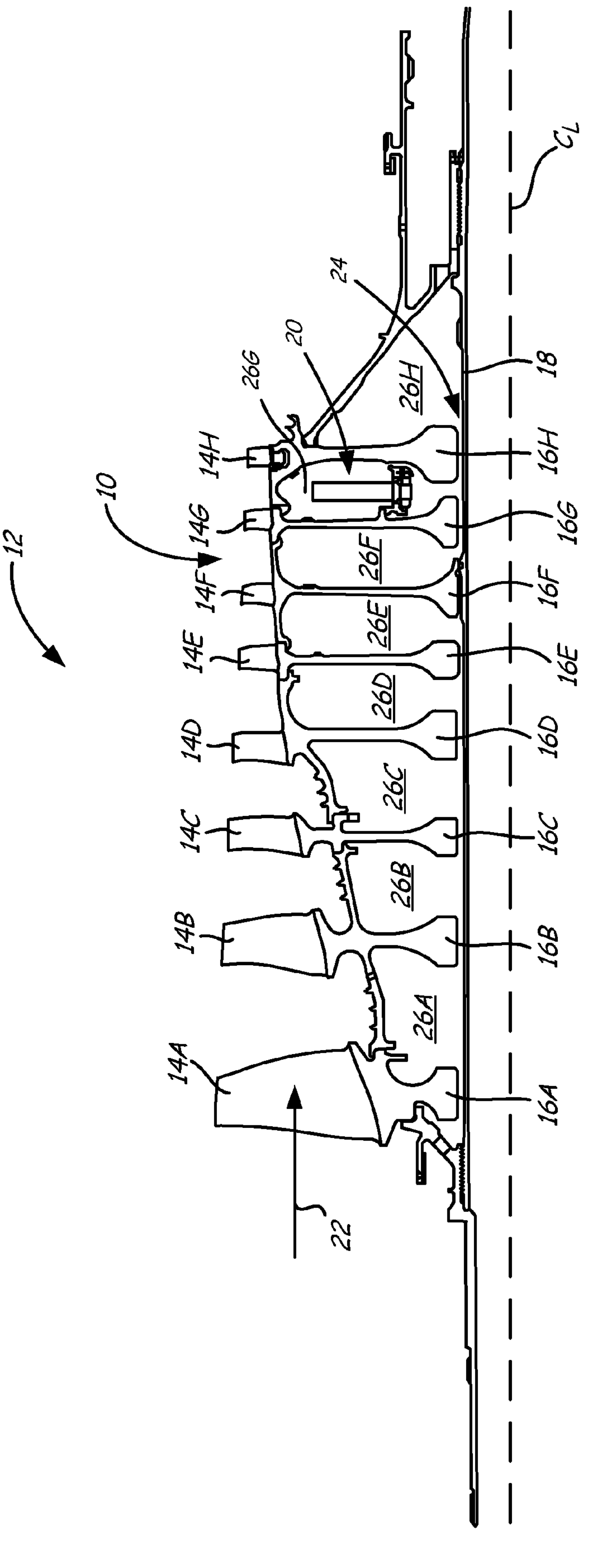

12
10
14A
14B
14C
14D
14E
14F
14G
14H
16A
16B
16C
16D
16E
16F
16G
16H
26A
26B
26C
26D
26E
26F
26G
26H
20
22
24
18
C_L

Fig. 1

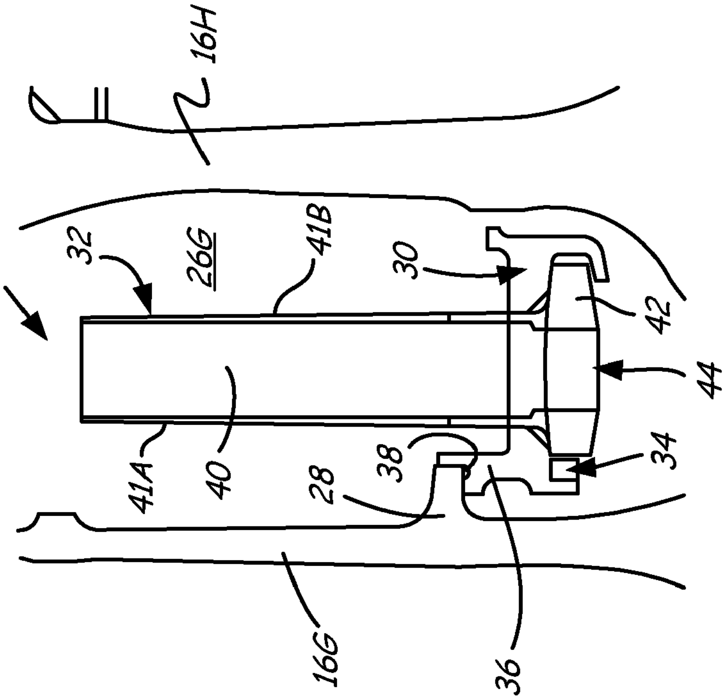


Fig. 2

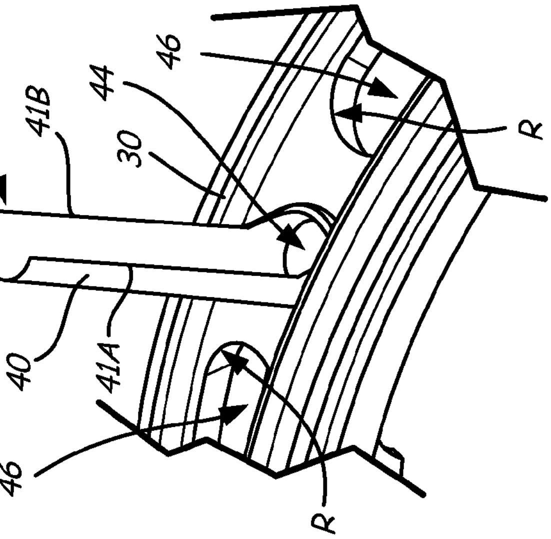


Fig. 3A

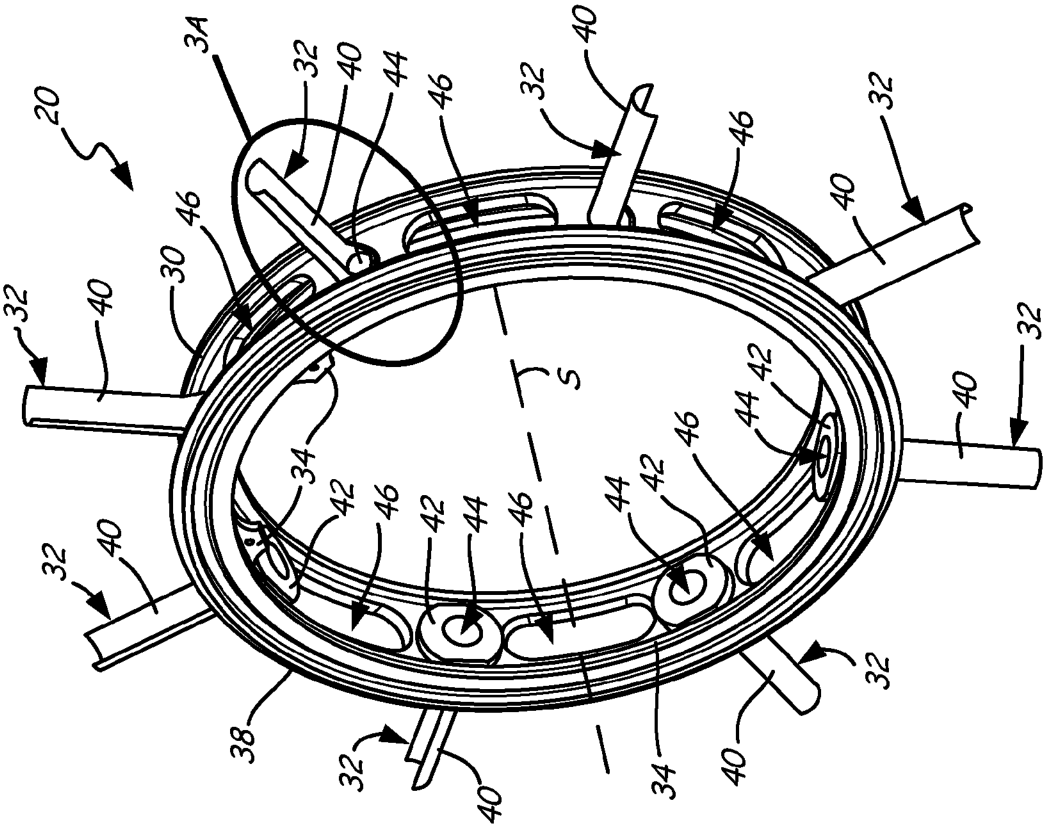


Fig. 3

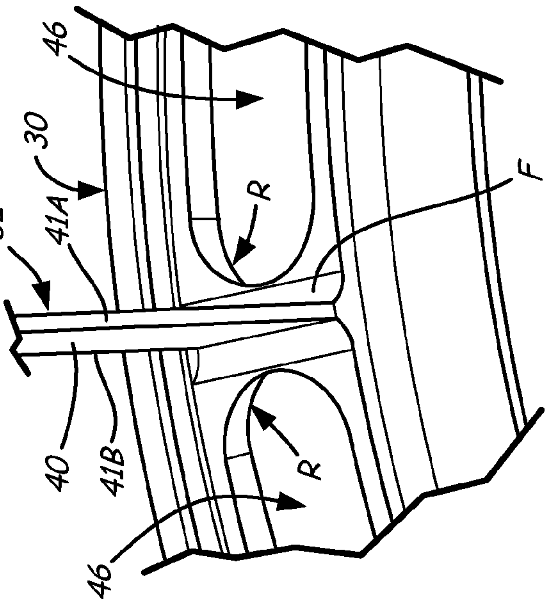
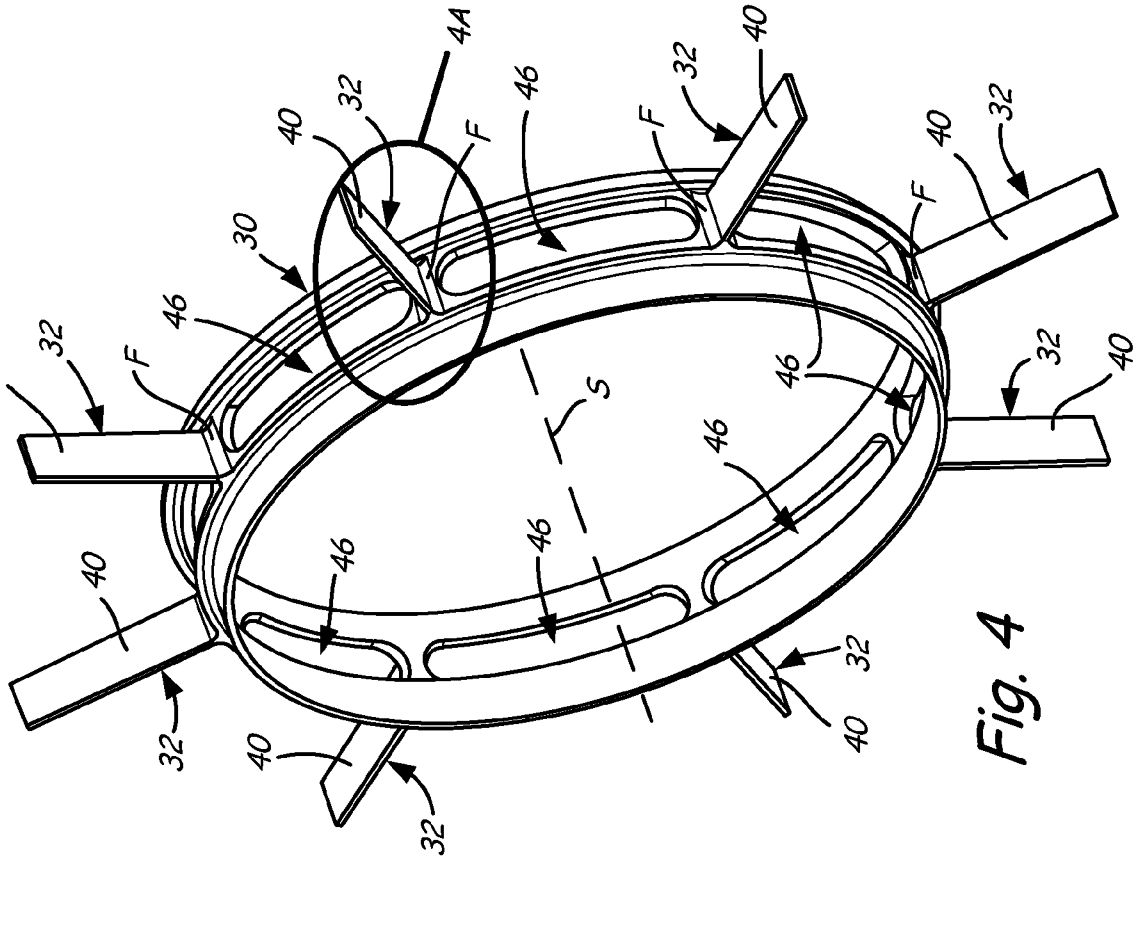

46
30
32
41A
R
F
40
41B
R
46

Fig. 4A


4A
32
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32
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F
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32

Fig. 4

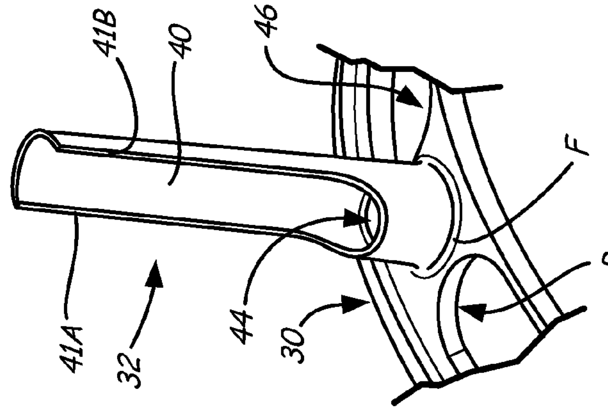

Fig. 5A

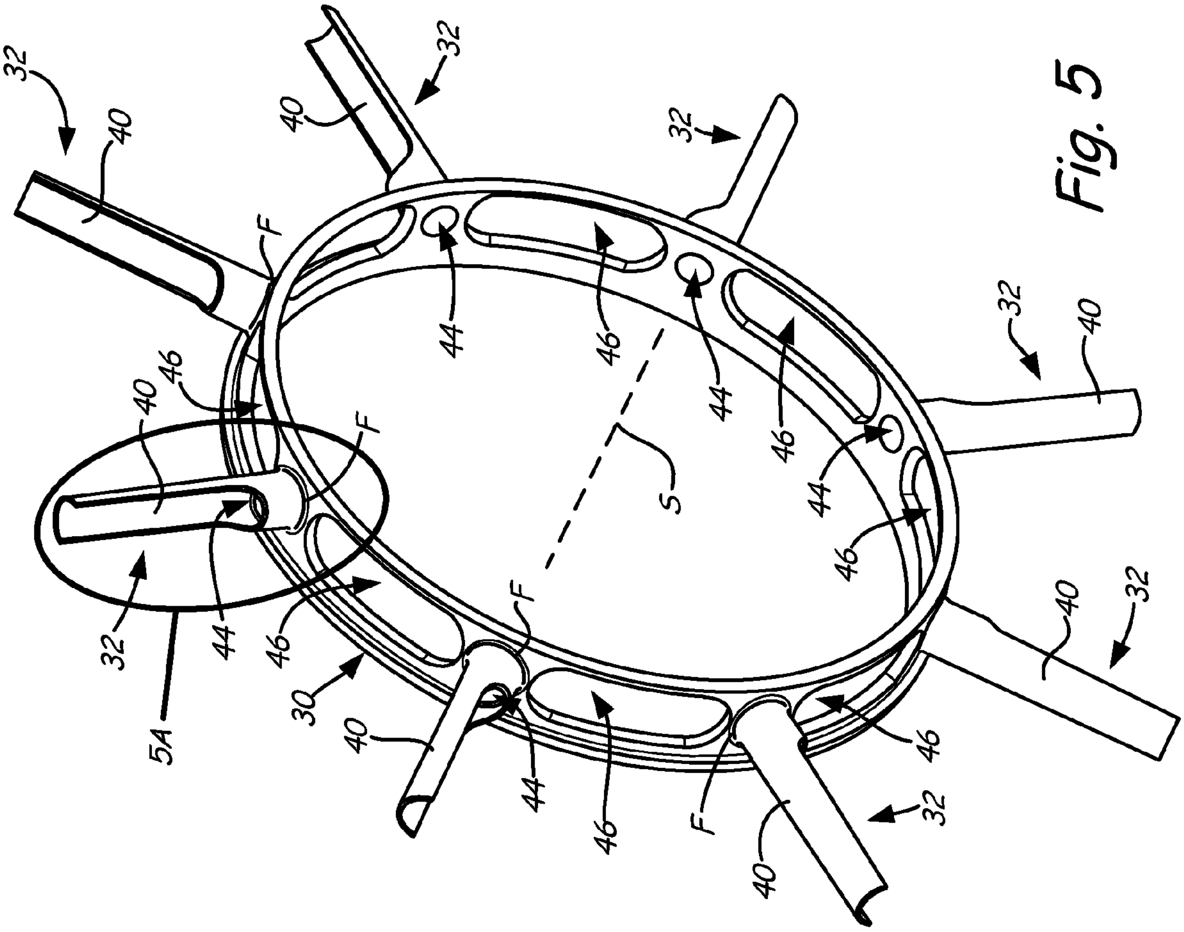

Fig. 5