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(54) Compressor Casing Assembly Providing Access to Compressor Blade Sealing Assembly

(57) A compressor casing assembly (31) includes a forward compressor casing (17), a removable cover (43) and a seal assembly (39). A midcompressor casing (17) is provided with a cavity adapted to receive the seal as-

sembly (39), and a cover groove adapted to receive the removable cover (43). The removable cover (43) secures the seal assembly (39).

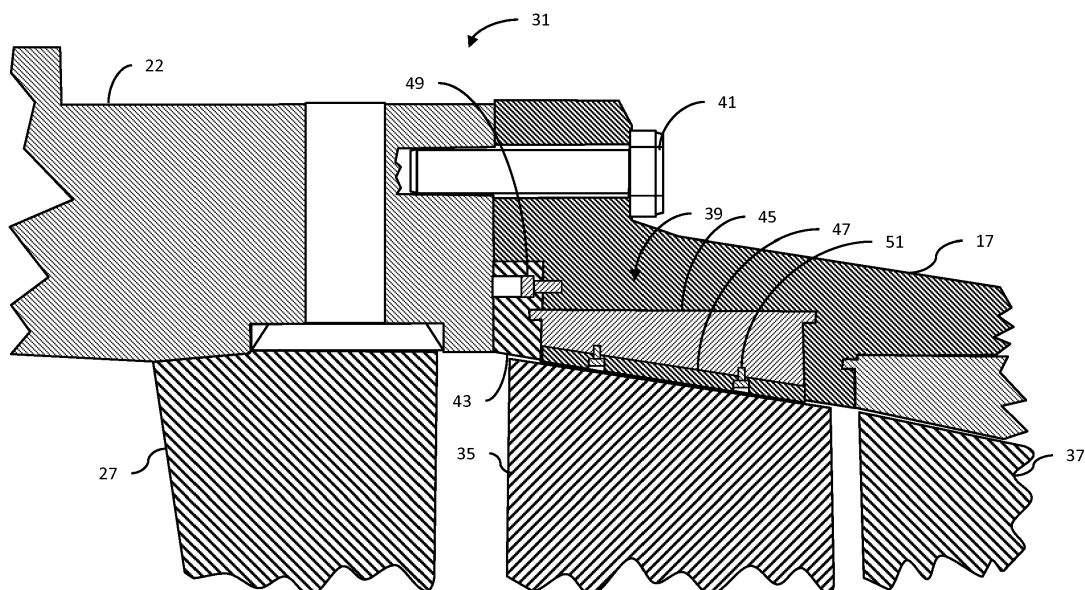


Fig. 2

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Description

TECHNICAL FIELD

[0001] The subject matter disclosed herein relates generally to turbine engine components and, more specifically, to compressor casing assemblies.

BACKGROUND

[0002] Turbine engines operate according to well-known principles wherein an incoming stream of atmospheric air flows through the engine along an axially-extending flow path. In at least some turbine engines, at least a portion of the incoming air is compressed in a compressor section of the engine and is then mixed with fuel and ignited in a combustor section to produce a high-energy, high-temperature exhaust gas stream. The hot gas stream exits the combustor and is channeled through a turbine section that extracts energy from the exhaust stream to power the compressor and to provide useful work, such as powering an aircraft in flight or producing electricity.

[0003] In the compressor and turbine sections of known gas turbine engines, blades rotate about the center axis of the engine. Engine efficiency depends at least partially on minimizing leakage in an effort to maximize interaction between the gas stream and blades. Within known turbines, one source of inefficiency is leakage of gas past the tips of the blades and between the blade tips and the surrounding engine casing. Although a close tolerance fit may be obtained by fabricating the mating parts to a close tolerance range, such a fabrication process is costly and time-consuming, and may result in rubbing an inner surface of the casing.

[0004] As such, to increase engine efficiency, at least some turbines use a sealing element along the inner surface of the casing, to reduce leakage between the blade tips and the casing. Various sealing techniques have been used. Generally, known sealing elements lose effectiveness over time and may require replacement.

[0005] However, in order to replace known sealing elements, the engine casing and the rotor must be removed from the engine to provide workers access to the sealing elements. Such a process significantly increases the maintenance costs and may cause a prolonged duration in engine outages.

BRIEF DESCRIPTION OF THE INVENTION

[0006] The disclosure provides a solution to the problem of having to remove the midcompressor casing of a turbine engine in order to access the zero stage seal assembly of the compressor.

[0007] In accordance with one aspect, the invention relates to a compressor casing assembly. The compressor casing assembly includes a forward compressor casing; a removable cover and a seal assembly. The com-

pressor casing assembly also includes a midcompressor casing having a cavity adapted to receive the seal assembly, and a cover groove adapted to receive a removable cover that secures the seal assembly.

[0008] In another aspect, a turbine engine is provided having a midcompressor casing having a face surface and an inner surface, the compressor casing having a cavity formed on the inner surface and a groove formed on the face surface. The turbine engine also includes a plurality of arcuate seal segments configured to be inserted into the cavity, and a removable cover disposed in contact with the arcuate seal segments and being removably secured to the midcompressor casing.

[0009] In another aspect, an assembly is provided having a midcompressor casing having a face surface and an inner surface, the inner surface having a cavity and the face surface having a cover groove. The assembly includes a plurality of arcuate seal segments configured to be inserted into the cavity. The assembly also includes a removable cover adapted to be inserted into the cover groove, the removable cover is disposed in contact with at least some of the plurality of arcuate seal segments and secured to the compressor casing.

[0010] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of certain aspects of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 is a cross-sectional view of a turbine engine taken along a longitudinal axis of the turbine engine.

Figure 2 is a detailed cross sectional view of an embodiment of the casing assembly.

Figure 3 is a cross-sectional view of an embodiment of a seal assembly.

Figure 4 is a cross-sectional view of an embodiment of a midcompressor casing.

Figure 5 is a cross-sectional view of an embodiment of a removable cover.

Figure 6 is an axial view of the first compressor stage and illustrates an exemplary seal assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The embodiments disclosed herein provide for easy access to a zero stage seal assembly without removal of a midcompressor casing. This is accomplished with a removable cover that is secured to the midcom-

pressor casing that serves to hold the zero stage seal assembly in place. Removal of the removable cover provides access to the zero stage seal assembly.

[0013] Fig. 1 is a cross-sectional view of a turbine engine 11 taken through a longitudinal axis 12 extending through the turbine engine 11. In the exemplary embodiment, turbine engine 11 also includes a compressor 13 having a plurality of rotor blades 15 that are circumferentially spaced and that extend radially outward towards a midcompressor casing 17 from a rotor wheel 19 which collectively form the rotor shaft. Stator vanes 20 are positioned adjacent to each set of rotor blades 15, and in combination form one of a plurality of stages 21. Stator vanes 20 are securely coupled to midcompressor casing 17 and extend radially inward to interface with rotor wheel 19. Each of the plurality of stages 21 directs a flow of compressed air through compressor 13. Rotor blades 15 are circumscribed by midcompressor casing 17, such that an annular gap (not shown in Fig. 1) is defined between midcompressor casing 17 and a rotor blade tip 23 of each of the rotor blades 15.

[0014] Each gap is sized to facilitate minimizing a quantity of compressed air that bypasses the rotor blades 15. Specifically, in the exemplary embodiment, a seal assembly 25 is used between midcompressor casing 17 and rotor 26 to substantially seal the gap defined therebetween. Specifically, seal assembly 25 facilitates reducing bypass flow of compressed air between midcompressor casing 17 and rotor blade tip 23. In the exemplary embodiment, compressor 13 includes eighteen separate stages 21. Alternatively, seal assembly 25 as described herein may be employed in any suitable type of compressor with any number of stages. An inlet guide vane (IGV 27) is positioned upstream from the rotor blades 15. IGV 27 directs the airflow onto the rotor blades 15.

[0015] During operation, air flows into turbine engine 11 through intake 16 and towards compressor 13. Stator vanes 20 direct the compressed air towards rotor blades 15. The compressed air applies motive forces to rotor blades 15 to compress the air flowing through each of the plurality of stages 21.

[0016] Illustrated in Figure 2 is an enlarged view of the detail area 29 shown in Figure 1 illustrating a casing assembly 31. Casing assembly 31 is disposed adjacent to IGV 27, zero stage rotor 35 and zero stage stator 37. Zero stage seal assembly 39 is disposed adjacent to zero stage rotor 35. Casing assembly 31 includes a midcompressor casing 17 and a forward compressor casing 22. Midcompressor casing 17 and forward compressor casing 22 are fastened by means of casing fastener(s) 41. Casing assembly 31 also includes a removable cover 43 disposed between the forward compressor casing 22 and the midcompressor casing 17. Removable cover 43 is an arcuate member (has arcuate shape). Casing assembly 31 also includes a zero stage seal assembly 39 that is secured to midcompressor casing 17 by removable cover 43. Zero stage seal assembly 39 includes a removable seal support 45 and a seal 47. Removable cover 43

may be fastened to midcompressor casing 17 by means of cover fasteners 49. The removable seal support and seal are joined by means of seal fasteners 51.

[0017] Figure 3 is a detailed cross section of zero stage seal assembly 39. Zero stage seal assembly 39 includes a t-shaped member 63 having a base 65, a top surface 66, a first projection 67, a side surface 68 and a second projection 69. Seal 47 may include an abradable seal surface, a honeycomb seal surface, a brush seal surface, and/or any seal surface that enables the zero stage seal assembly 39 to function as described herein. Seal surface 70 may be thermally sprayed, brushed, and/or baked, and may be fabricated from a metallic material, a ceramic material, or any other material that enables seal surface 70 to function as described herein. Seal surface 70 may include a plurality of bristles formed from a metallic or non-metallic material, such as ceramics, carbon fiber, and/or silica.

[0018] Figure 4 is a cross section of a portion of the midcompressor casing 17. The midcompressor casing 17 has a face surface 71, a horizontal inner surface 73 and a vertical inner surface 75. Midcompressor casing 17 has a notch 77 configured to engage the first projection 67 of the zero stage seal assembly 39. The midcompressor casing 17 is additionally provided with a cover groove 79 configured to engage the removable cover 43.

[0019] Figure 5 is a cross-section of the removable cover 43. Removable cover 43 is provided with a cover notch 81 configured to engage second projection 69 of the zero stage seal assembly 39.

[0020] When installed, forward compressor casing 22 is fastened to midcompressor casing 17 and the zero stage seal assembly 39 is disposed in the cavity 82 formed by horizontal inner surface 73, vertical inner surface 75 and notch 77. The zero stage seal assembly 39 is positioned so that first projection 67 of the zero stage seal assembly 39 is disposed in the notch 77 in the midcompressor casing 17. This configuration prevents movement of the zero stage seal assembly 39 in a radial direction. The zero stage seal assembly 39 is secured in place with the removable cover 43. Cover notch 81 is configured to engage second projection 69 of the zero stage seal assembly 39. Forward compressor casing 22 and midcompressor casing 17 maintain the removable cover 43 in place during operation.

[0021] Fig. 6 is an axial view along longitudinal axis 12 of the first of the plurality of stages 21 looking aft with the forward compressor casing 22 removed. The midcompressor casing 17 may include a casing upper half 87 and a casing lower half 89. The removable seal support 45 may include a plurality of arcuate seal segments 90 such as first upper seal segment 91, first lower seal segment 93, second lower seal segment 95, and second upper seal segment 97 that are removably coupled to an inner surface of midcompressor casing 17. Each of the plurality of arcuate seal segments 90 include a sealing surface extending a full circumferential length along each of the plurality of arcuate seal segments 90. The sealing

surface extends a distance above and below a radially inner surface of the midcompressor casing 17 when each of the plurality of arcuate seal segments 90 is coupled to the midcompressor casing 17. In the exemplary embodiment, the seal assembly 25 includes four seal segments, but may include any number of seal segments that enables seal assembly 25 to function as described herein. The removable cover 43 is fastened to the midcompressor casing 17 with cover fasteners 49. The removable cover 43 has a longer peripheral length than any one of the arcuate seal segments 90 (e.g. first upper seal segment 91) so that the individual seal segments can be inserted into the midcompressor casing 17. The fasteners may be countersunk into the removable cover 43 and positively captured by the rear face of the forward compressor casing 22. Upon removal of the removable cover 43 access is provided to the end of a removable seal support 45 within either casing upper half 87 or within casing lower half 89. The removable seal support 45 is removably and slidably coupled to midcompressor casing 17. Access to the removable sealing element is provided without having to remove the midcompressor casing 17. Forward face of midcompressor casing 17 may be turned to permit the installation & removal of removable seal support 45 once access is gained when the forward compressor casing 22 is removed. The removable cover 43 is screwed into the midcompressor casing 17 and is positively captured by the rear face of the forward compressor casing 22 during normal operation, eliminating any risk of loose parts causing foreign object damage to the compressor 13.

[0022] The casing assembly 31 enables the replacement of a zero stage seal assembly 39 without removal of the midcompressor casing 17. The operator can move the zero stage seal assembly 39 by first removing the forward compressor casing 22. This provides access to the removable cover 43 which can then be removed to provide access to the various components of the zero stage seal assembly 39 which can then be easily removed.

[0023] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. Where the definition of terms departs from the commonly used meaning of the term, applicant intends to utilize the definitions provided herein, unless specifically indicated. The singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be understood that, although the terms first, second, etc. may be used to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. The term "and/or" includes any, and all, combinations of one or more of the associated listed items. The phrases "coupled to" and "coupled with" contemplate direct or indirect coupling.

[0024] 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 have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements.

Claims

1. A compressor casing assembly (31), comprising:
 - a forward compressor casing (22);
 - a removable cover (43)
 - a seal assembly (39)
 - a midcompressor casing (17) having a cavity (82) adapted to receive the seal assembly (39), and a cover groove (79) adapted to receive the removable cover (43); and
 - wherein the removable cover (43) secures the seal assembly (39).
2. The compressor casing assembly of claim 1, wherein the removable cover (43) is removably fastened to the midcompressor casing (17).
3. The compressor casing assembly of claim 1 or 2, wherein the cavity (82) is configured to prevent movement of the seal assembly (39) in a radial direction.
4. The compressor casing assembly of any preceding claim, wherein the seal assembly (39) comprises a T-shaped member (63) having a first projection (67) and a second projection (69), and wherein the cavity (82) has a notch (77) adapted to receive the second projection (69).
5. The compressor casing assembly of claim 4, a removable cover (43) has a cover notch (81) adapted to receive first projection (67).
6. The compressor casing assembly of any preceding claim, wherein the removable cover (43) comprises an arcuate member.
7. The compressor casing assembly of any preceding claim, wherein the forward compressor casing (22) is disposed in contact with the removable cover (43).
8. The compressor casing assembly of any of claims 1 to 3, 6 and 7, wherein the midcompressor casing (17) has a face surface (71) and an inner surface, the cavity (82) being formed on the inner surface (73) and the groove (79) being formed on the face surface

(71) and wherein the seal assembly (39) comprises:

a plurality of arcuate seal segments (90); and
the removable cover (43) is disposed in contact
with at least one of the plurality of arcuate seal
segments (90). 5

9. The compressor casing assembly of claim 8, wherein
each of the plurality of arcuate seal segments (90)
comprises a sealing surface extending a full circum-
ferential length along each of the plurality of arcuate
seal segments (90). 10
10. The turbine engine of claim 9, wherein the sealing
surface comprises one of an abradable seal surface,
a honeycomb seal surface, and a brush seal surface. 15
11. The assembly of any of claims 8 to 10, wherein the
removable cover (43) is an arcuate member having
a peripheral length that is longer than a peripheral
length of each of the plurality of arcuate seal seg-
ments (90). 20
12. A gas turbine engine comprising the compress 8 or
casing assembly of any preceding claim. 25

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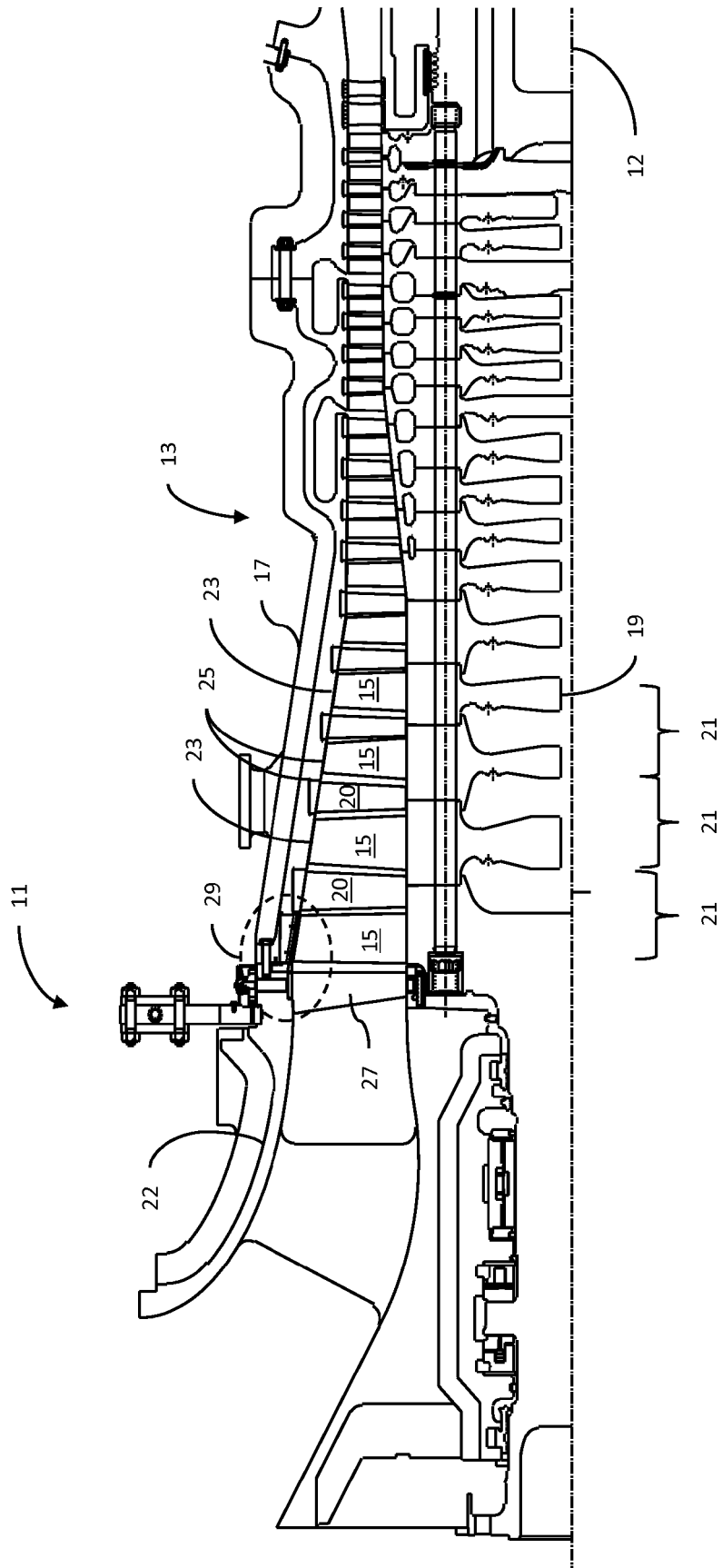
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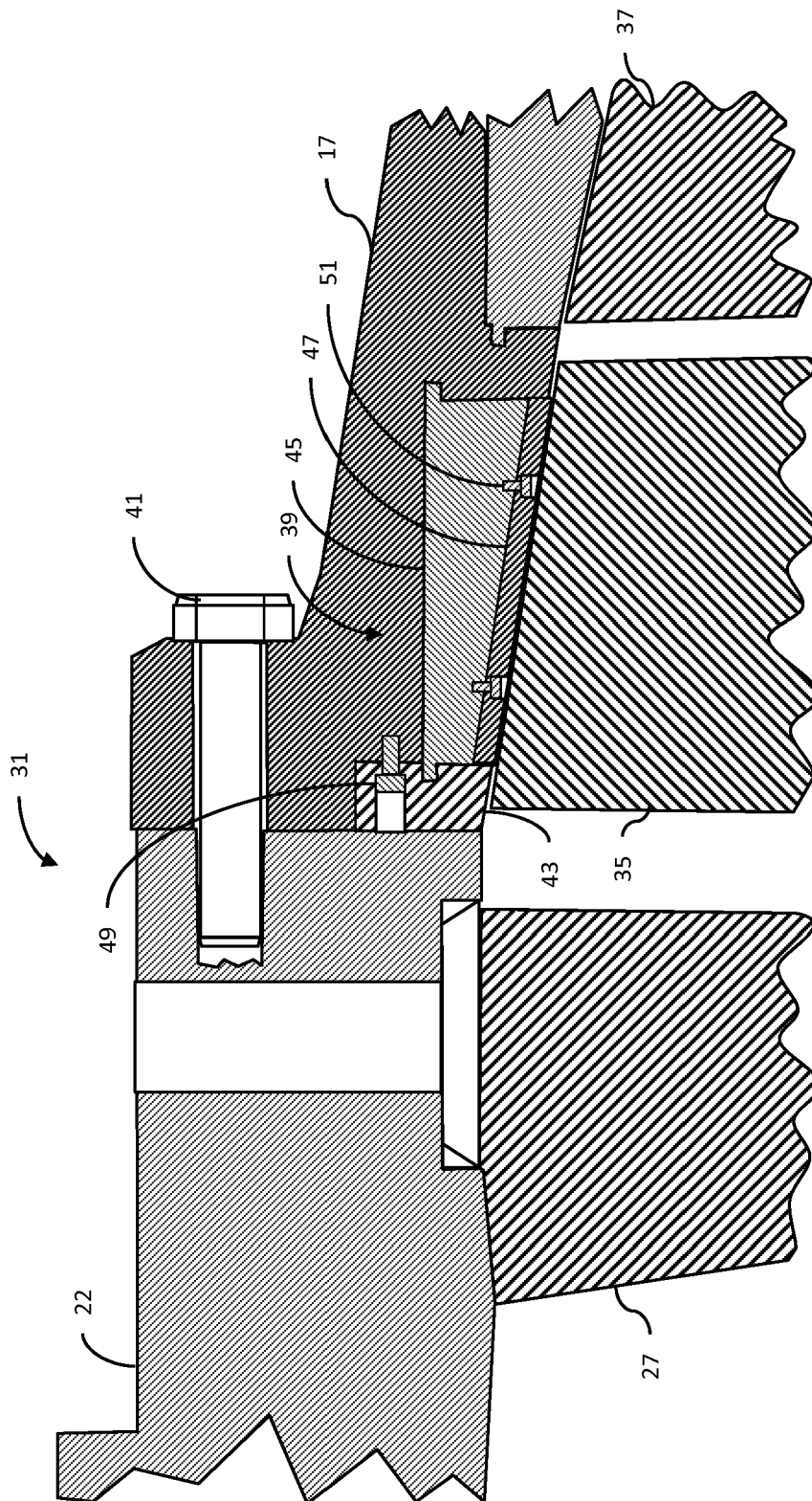


Fig. 2

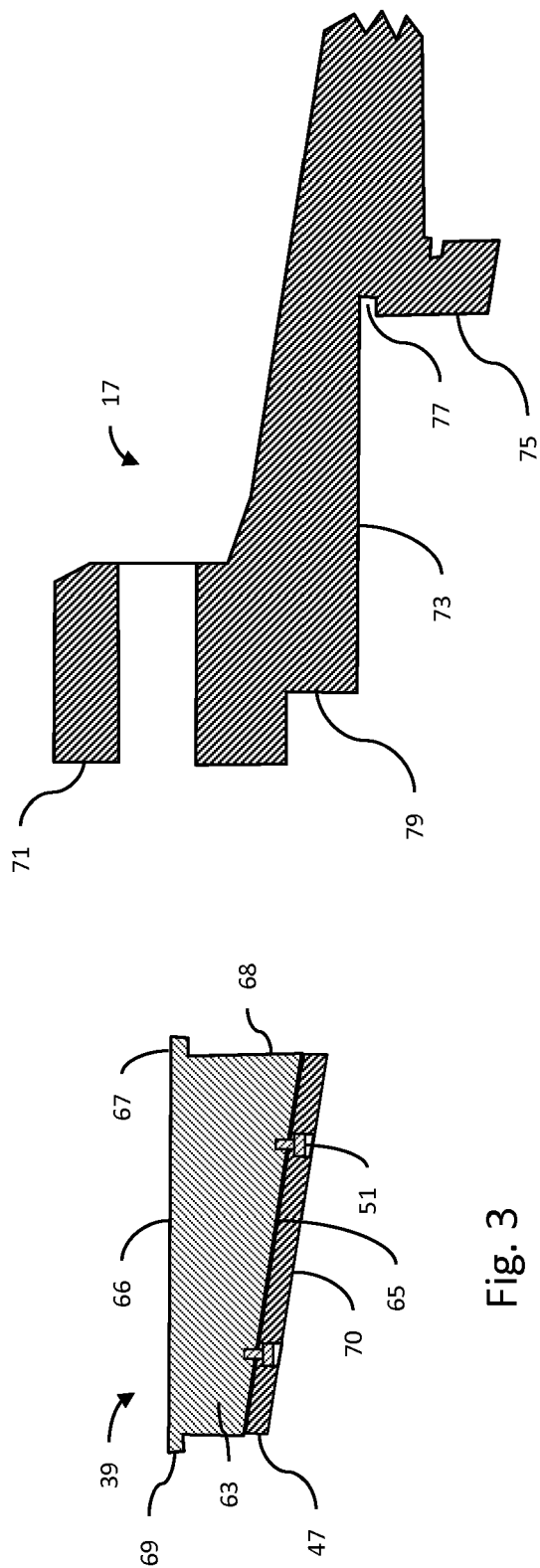


Fig. 3

Fig. 4

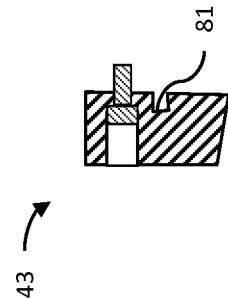


Fig. 5

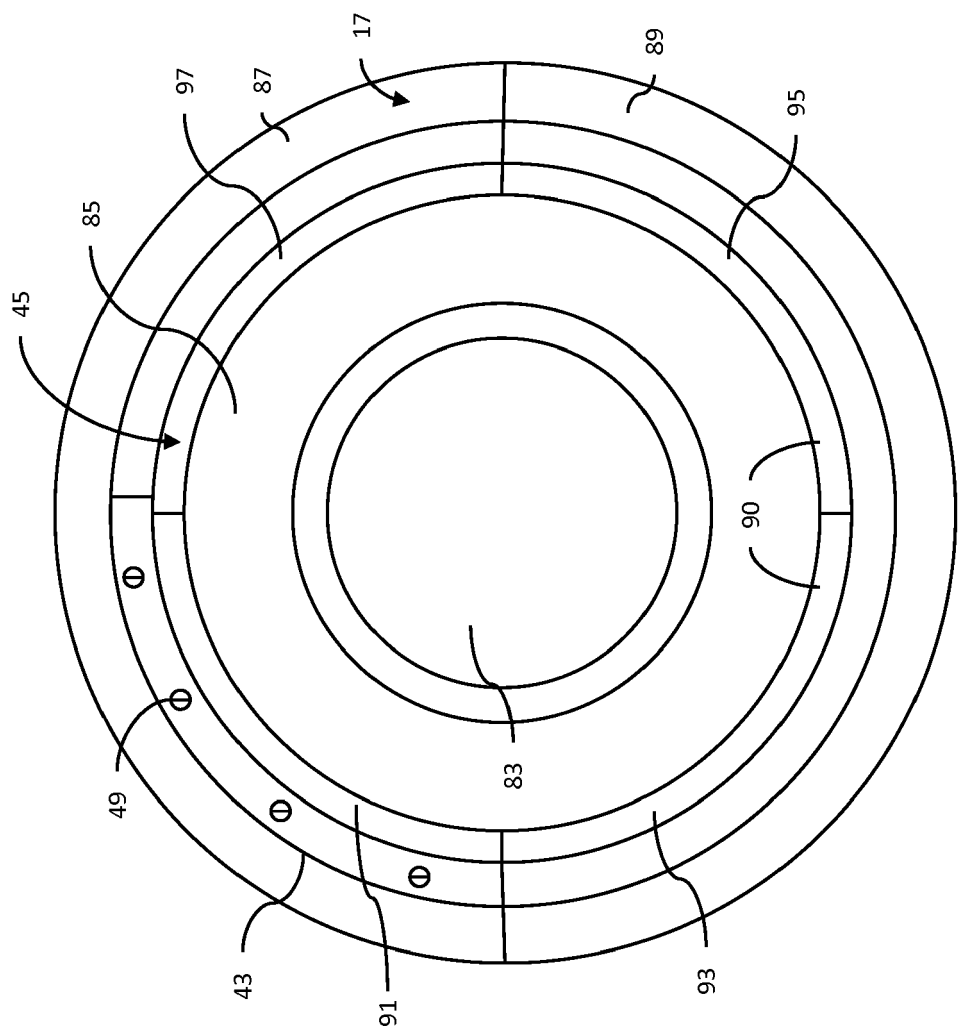


Fig. 6