(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 636 850 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.09.2013 Bulletin 2013/37

(21) Application number: **13158473.2**

(22) Date of filing: **08.03.2013**

(51) Int Cl.:
F01D 9/04 *(2006.01)* ***F01D 25/24*** *(2006.01)*
F01D 25/26 *(2006.01)* ***F01D 11/18*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **09.03.2012 US 201213416982**

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(54) Stator of a gas turbine

(57) In an embodiment, a system includes a rotary machine. The rotary machine includes a rotor (54) having a plurality of blades (52) and a segmented stator having a plurality of stator segments (74,76) arranged circumferentially about the plurality of blades (52). Each adjacent pair of first and second segments (74,76) of the plurality of stator segments includes a recess (60) extending circumferentially across an intermediate joint (70) between the first and second segments (74,76). Furthermore, each recess (60) includes at least one eccentricity control insert (62) configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

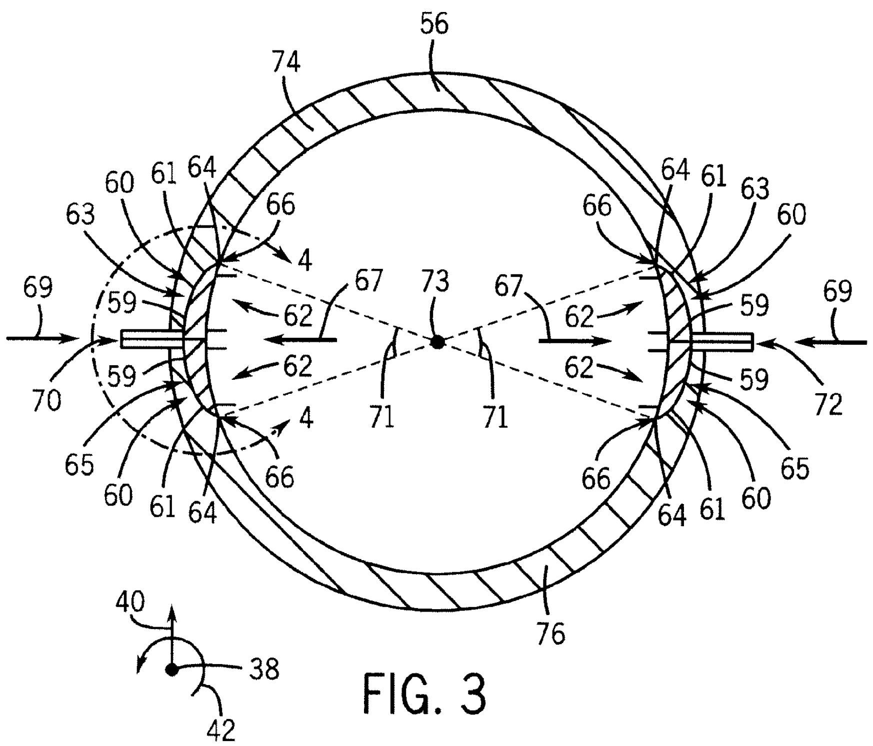

FIG. 3

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Description

[0001] The subject matter disclosed herein relates to casings for use in various types of rotary systems such as compressors and gas turbines.

[0002] Rotary systems, such as compressors and turbines, may generally include a rotor portion that rotates about an axis during the operation of the system as well as a stator portion (e.g., casing, shroud, etc.) that remains substantially immobile during system operation. For example, in a compressor, the rotor portion may include a number of blades disposed about a shaft. During operation of the compressor, this shaft may rotate, causing the attached blades to rotate within a stationary casing (i.e., the stator) surrounding the rotor. However, since the temperature present within the compressor may be high (e.g., in excess of 1000 °C), portions of the rotor and/or casing of the compressor may warm and expand during operation. This expansion may change the clearance between these portions of the rotor and/or casing during operation of the compressor, which may affect the ability of the compressor to properly function and/or operate efficiently.

[0003] Certain embodiments commensurate in scope with the originally claimed invention are summarized below. These embodiments are not intended to limit the scope of the claimed invention, but rather these embodiments are intended only to provide a brief summary of possible forms of the invention. Indeed, the invention may encompass a variety of forms that may be similar to or different from the embodiments set forth below.

[0004] In one aspect of the invention, there is provided a system including a rotary machine. The rotary machine includes a rotor having a plurality of blades and a segmented stator having a plurality of stator segments arranged circumferentially about the plurality of blades. Each adjacent pair of first and second segments of the plurality of stator segments includes a recess extending circumferentially across an intermediate joint between the first and second segments. Furthermore, each recess includes at least one eccentricity control insert configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

[0005] In another aspect of the invention, a system includes an eccentricity control insert configured to mount in a recess at an intermediate joint between an adjacent pair of first and second segments of a segmented stator of a rotary machine. Furthermore, the eccentricity control insert is configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

[0006] In another aspect of the invention, a system includes a segmented stator including a plurality of stator segments arranged circumferentially about a rotational axis of a rotary machine. Each adjacent pair of first and second segments of the plurality of stator segments includes a recess extending circumferentially across an intermediate joint between the first and second segments. Furthermore, each recess includes at least one eccentricity control insert configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

[0007] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. 1 is a block diagram of an embodiment of a rotary machine, e.g., a turbine system, having an eccentricity control system for a segmented stator (e.g., segmented casing);

FIG. 2 is a schematic cross-section of an embodiment of a rotary machine, e.g., a compressor, having an eccentricity control system with an eccentricity control insert disposed in a recess in a segmented stator;

FIG. 3 is a schematic cross-section of the segmented stator of FIG. 2, taken along line 3-3, illustrating an embodiment of the recess and the eccentricity control insert disposed across an intermediate joint between adjacent stator segments;

FIG. 4 is a partial schematic cross-sectional view of the segmented stator of FIG. 3, taken within line 4-4, illustrating an arcuate shaped configuration, a variable radial thickness, an arc length, and other characteristics of the recess and the eccentricity control insert; and

FIG. 5 is a partial perspective view of one segment of the segmented stator of FIGS. 1-4, illustrating a T-shaped joint that couples the eccentricity control insert to the recess.

[0008] One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0009] When introducing elements of various embodiments of the present invention, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0010] As set forth above, the temperature of the gases present within a rotary system (e.g., a compressor, turbine of a gas turbine system, steam turbine, pump, or similar rotary system) may be relatively high and/or fluctuate during certain points during the operation of the system. These elevated and fluctuating temperatures in the rotary system may cause portions the casing (i.e., stator) encircling the rotor to warm and expand or cool and contract during system operation. Additionally, since a casing of a rotary system may include a number of coupled segments, then the expansion/contraction of the casing at or near the joints may not be the same as the expansion in the middle of the casing segments. This may generally result in the casing (e.g., the inner circumference of the casing) becoming less round (e.g., more eccentric) as a result of the thermal expansion. As such, if, for example, the casing of a rotary system (e.g., a compressor or turbine) expands and/or contracts in a certain manner during operation, then portions of rotor and casing may contact one another, resulting in premature wear, vibration, and/or cracking in the rotary system. If, by further example, the casing of the rotary system expands and/or contracts in another manner during operation, then clearance between the rotor and the casing may be too great, resulting in reduced efficiency of the rotary system. Accordingly, it may be generally desirable to improve the casing (i.e., stator) design to control the clearance between the rotor and the casing by mitigating the eccentricity of the casing at it warms and/or cools during operation of the rotary system. The disclosed embodiments employ inserts in recesses along each joint between casing segments, thereby helping to maintain roundness of the casing (e.g., an inner surface of the casing) despite thermal expansion or contraction.

[0011] With the foregoing in mind, FIG. 1 is a block diagram of an embodiment of a turbine system 10 that includes two rotary systems (i.e., a compressor and a gas turbine) having an eccentricity control system in accordance with aspects of the present technique. That is, as discussed in detail below, the casings of the rotary systems of the turbine system 10 have been modified to include an eccentricity control insert to help maintain the roundness of the casings despite thermal expansion or contraction. The illustrated turbine system 10 includes a gas turbine engine 12 coupled to a load 14, such as an electrical generator. The gas turbine engine 12 includes a compressor 16, a plurality of combustors 18 each having at least one fuel nozzle 20, a turbine 22, and an exhaust section 24. As illustrated, one or more shafts 26 connect the load 14, compressor 16, and turbine 22. The compressor 16 and the turbine 22 each include a rotor with blades, which rotate about a rotational axis 28 within a stator (i.e., casing) that has been modified to mitigate eccentricity during thermal expansion, as discussed in detail below. During operation, the compressor 16 receives air 30 and delivers compressed air 32 to the combustors 18 and/or fuel nozzles 20, which then injects fuel 34 (or an air-fuel mixture) into a combustion region in the combustors 18. In turn, the air-fuel mixture combusts in the combustors 18 to produce hot combustion gases 36, which drive blades within the turbine 18. As the turbine is driven to rotate the shaft 26, the compressor 16 is driven to compress the air 16 into the combustors 18 and/or fuel nozzles 20. For purposes of discussion, reference may be made to an axial direction or axis 38, a radial direction or axis 40, and a circumferential direction or axis 42. The axial direction 38 is generally oriented along the rotational axis 28.

[0012] As mentioned, the illustrated compressor 16 and turbine 22 include casings (i.e., stators or shrouds) that have been modified in order to reduce the potential of the casings to expand or contract out of roundness (e.g., become eccentric) during operation of the system 10. In particular, disclosed embodiments generally have portions of each of the segments of the case absent or removed near the joints (e.g., removed portions where the individual segments of the case meet). For example, in certain embodiments, the removed portions of the segments near the joints may take the form of a recess, a groove, or a slot. Furthermore, the disclosed embodiments utilize an insert that may be disposed within the groove or recess to generally control the clearance between the blades of the rotor and the casing of the rotary machine (e.g., compressor 16 or turbine 22). While the various aspects of the modified casing embodiments are described below with respect to the compressor 16, it should be appreciated that the presently disclosed casing embodiments are applicable to the gas turbine 22 or any rotary system where uniform and/or minimized clearance between the rotor and stator are desirable.

[0013] Accordingly, FIG. 2 illustrates a cross-section of an embodiment of the compressor 16 having the modified casing in accordance with aspects of the present technique. The illustrated compressor 16 includes a rotor 50 having a number of blades 52 disposed about a shaft 54. Furthermore, the blade 52 of the rotor 50 are configured to rotate (i.e., about the rotational axis 28) within the stator or compressor casing 56. Generally speaking, it is desirable for the casing 56 of the compressor 16 to provide a uniform, minimal clearance 58 between the blades 52 of the rotor 50 and the casing 56. That is, it is generally desirable for the blades 52 of the rotor 50 to come as close as possible to the casing 56 without actually contacting the casing 56 during the operation of the compressor 16. It should be also appreciated if the clearance 58 between the blades 52 of the rotor 50 and the casing 56 is too large, then the efficiency of the compressor 16 may be significantly reduced. For example, for certain compressors, a clearance 58 that is 10 mils larger than a desired clearance may result in roughly 1 MW loss in efficiency of the compressor 16. Furthermore, by providing a uniform clearance between the rotor and casing over the inner circumference of the casing may generally enable the rotary system to have more uniform performance (e.g., fewer fluctuations in power output).

[0014] Accordingly, the casing 56 of the compressor 16 has at least one recess 60 that supports at least one insert 62 in accordance with aspects of the present technique. Generally speaking, the recess 60 extends into the interior surface of the casing 56 in the radial direction 40 (i.e., having a radial depth 51 into the wall of the casing 56). In certain embodiments, the recess 60 may be formed by grinding or turning down a portion of the casing 56 after manufacturing. In other embodiments, the recess 60 may be formed during the manufacturing of the casing 56 (e.g., as an element defined by the mold used to cast the casing 56). Regardless, the recess 60 is an area of the casing in which a portion of the casing material (e.g., steel or other suitable metal or alloy) is absent or has been removed (e.g., via grinding or turning). For example, in certain embodiments, the recess 60 may be in the form of a groove, a slot, a channel, or other similar recess 60. Additionally, as discussed below with respect to FIGS. 3 and 4, the recess 60 may be present in the casing 56 of the compressor 16 at portions where the various segments of the casing 56 meet (i.e., at or near casing segment joints). Furthermore, as discussed below with respect to FIG. 5, the recess 60 may have a particular shape (e.g., a V-shape, a rectangular shape, a rounded shape, or other suitable shape).

[0015] Additionally, in the illustrated compressor 16, an insert 62 is disposed within the recess 60. As illustrated, the insert 62 may slightly protrude radially 40 from the recess 60 into the clearance space 58. For example, the insert 62 may extend between approximately 20 mm and 60 mm beyond the inner surface 53 of the casing 56. The illustrated insert 62 also includes at least two layers: a substrate layer 64 and an abradable surface coating 66. In certain embodiments, the substrate layer 64 of the insert 62 may be manufactured from the same material (e.g., metal or alloy) as the casing 56. For example, in certain embodiments, the insert 62 and the casing 56 may both be manufactured from steel. In other embodiments, the substrate layer 64 of the insert 62 may be manufactured from a different material (e.g., metal or alloy) than the casing 56. For example, in certain embodiments, the substrate layer 64 of the insert 62 may be a different type of steel (e.g., higher carbon steel) than the casing 56. Furthermore, the material used for the substrate layer 64 of the insert 62 may be selected based on the thermal expansion properties of the material. That is, the substrate layer 64 of the insert 62 may have slightly different thermal expansion properties from the casing 56 such that the insert 62 and the casing 56 may not expand or contract at the same rate as they are heated and cooled (e.g., during operation of the compressor 16).

[0016] Moreover, the insert 62 is disposed within the recess 60 such that the abradable surface coating 66 is facing the blades 52 of the rotor 54. The abradable surface coating 66 may be any surface coating that may be preferentially removed upon contact with the blades 52 of the rotor 54, rather than remove material from the rotor blades 52 or the casing 56. That is, while the blades 52 of the rotor 54 are generally configured not to contact the casing 56, the aforementioned thermal expansion of the casing 56 during operation of the compressor may cause the blades 52 of the rotor 54 to temporarily contact the abradable surface coating 66 of the insert 62 (e.g., rather than the substrate 64 of the insert 62 or the casing 56). Therefore, the abradable surface coating 66 may generally allow for tighter clearance 58 while protecting the tips of the blades 52. Additionally, the abradable surface coating 66 may generally be considered a self-adjusting coating as it may be slightly by the tips of the blades 52 until the desired clearance 58 is achieved. In certain embodiments, the abradable surface coatings 66 may be an alumina, silica, titania, chrome carbines, or other suitable abradable surface coating 66. In general, materials for the abradable surface coating 66 may be selected according to a relative hardness of the abradable surface coating 66 compared to the casing 56 and the blades 52 of the rotor 54. For example, in certain embodiments, the abradable surface coating 66 may be manufactured from a material that is 10%, 20%, 50%, 75%, or 95% softer than the material used to manufacture the casing 56 and/or the blades 52. Additionally, as set forth below with respect to FIGS. 4 and 5, the abradable surface coating 66 may either have either a uniform thickness or a variable thickness across the insert 62.

[0017] FIG. 3 illustrates a cross-section of the embodiment of the compressor 16 illustrated in FIG. 2 taken within line 3-3 (i.e., without the rotor 54 and blades 52). Accordingly, FIG. 3 illustrates the location of the recesses 60 in the casing 56 of the compressor 16 relative to the locations of intermediate joints 70 and 72 (i.e., where the first segment 74 and the adjacent second segment 76 meet). While the illustrated embodiment of the casing 56 includes two 180° segments (e.g., segments 74 and 76), in other embodiments the casing 56 may include any number of segments (e.g., 3, 4, 5, 6 or more). Furthermore, the illustrated casing 56 includes recesses 60 that are generally deeper 59 near the joints 70 and 72 and become generally shallower 61 moving away from the joints in a circumferential direction 42. Additionally, the recesses 60 may occupy a portion of the casing 56 measured as an angle 71 from the point 73 at the center of the casing (e.g., the axis of rotation 38). For example, the illustrated angle 71 is approximately 60°. In certain embodiments, the angle 71 may be between approximately 10° and 60°, between approximately 20° and 50°, or between approximately 30° and 45°.

[0018] Accordingly, the inserts 62 disposed within each of the recesses 60 similarly are thicker in the portions that are disposed near the joints 70 and 72 and thinner in portions that are disposed away from the joints. Furthermore, in certain embodiments, a one-piece or integral insert 62 may be disposed in the each of the recesses 60, and each of these inserts 62 may occupy the entire recess 60 that extends circumferentially 38 into both segments 74 and 76 of the compressor casing 56. In the illustrated embodiment, recesses 60 include a recess portion 63 and a recess portion 65 that are each loaded with an insert 62. That is, each recess 60 of the illustrated casing 56 includes a first insert 62 (e.g., disposed within the recess portion 63 of the recess 60 in segment 74) and a second insert 62 (e.g., disposed within the recess portion 65 of the recess 60 in segment 76).

[0019] Additionally, the illustrated casing 56 of the compressor 16 is substantially round (i.e., circular). Furthermore, it should be appreciated that, as the casing 56 warms or cools during operation of the compressor 16, the portions of the segments 74 and 76 near the joints 70 and 72 may not expands or contract as much as the portions of the segments 74 and 76 away from the joints 70 and 72. That is, since the casing 56 may generally have more freedom to move near the joints 70 and 72, the casing 56 generally push outwardly 67 or pull inwardly 69 (e.g., center 73 of the casing 56), deforming at the joints 70 and 72 (e.g., shift out of roundness and/or become eccentric). Moreover, the illustrated casing 56 has the recesses 60 with the inserts 62 disposed within. Accordingly, as the casing 56 begins to thermally expand, the recesses 60 and the inserts 62 enable the casing 56 of the compressor to thermally expand without becoming substantially eccentric. That is, the recesses 60 and the inserts 62 generally enable the clearance 58 between the blades 52 of the rotor 54 to remain substantially uniform throughout the operation of the compressor 16. For example, in certain embodiments, the recesses 60 and inserts 62 may cooperate to provide a uniform clearance 58 (e.g., circumferentially 38 between the rotor blades 52 and the casing 56 and insert 62) of between 1 mm and 50 mm, between 5 mm and 30 mm, between 8 mm and 20 mm, or approximately 10 mm at the joints 70 and 72.

[0020] FIG. 4 illustrates an enlarged view of the joint 70 of the casing embodiment illustrated in FIG. 3. Accordingly, FIG. 4 illustrates the recess 60 in the segments 74 and 76 of the casing 56. Moreover, the illustrated recess 60 is substantially deeper 59 near the joint 70 and substantially shallower 61 away from the joint 70. Furthermore, the insert 62, including the substrate 64 and the abradable coating 66, is disposed within the illustrated recess 60. Like the illustrated recess 60, the insert 62 is substantially thicker 75 at the portion disposed near the joint 70 and substantially thinner 77 at the portion disposed away from the joint 70. In other embodiments, the recess 60 and the insert 62 may both have a substantially uniform radial 40 depth and thickness, respectively. Furthermore, the abradable coating 66 of the illustrated insert 62 is substantially thicker 79 near the joint 70 and substantially thinner 81 moving away from the joint 70 circumferentially 42. Accordingly, in certain embodiments, the recess 60, the insert 62, and/or the abradable coating 66 may generally be described as having a generally arcuate shape. In other embodiments, the abradable coating 66 may have a substantially uniform thickness over the length of the insert 62.

[0021] FIG. 5 is a partial perspective view of one segment of the segmented stator of FIGS. 1-4, illustrating a T-shaped joint 83 that couples the eccentricity control insert 62 to the recess 60. That is, FIG. 5 illustrates the insert 62 disposed within the recess 60 of segment 76 of the casing 56. In particular, the illustrated recess 60 includes the T-shaped joint 83 and, accordingly, the insert 62 is a T-shaped insert 62. Additionally, in certain embodiments, the recess 60 and the insert 62 may have a dove-tail shape, a rounded shape, a "V" shape, a triangular shape, a semicircular shape, or other suitable shape. Furthermore, the T-shaped joint 83 includes ridge portions 85 that may generally serve to hold the insert 62 in place within the T-shaped joint 83. The illustrated T-shaped insert 62 includes a neck portion 89 and a mounting base portion 91 that extend in a lengthwise direction along the eccentricity control insert 62, and the mounting base portion 91 is wider than the neck portion 89 in a crosswise direction relative to the lengthwise direction. In certain embodiments, the abradable coating 66 of the insert 62 extends beyond the neck portions 85 such that, during operation, the tips blades 52 of the rotor 54 most proximate to the abradable coating 66 of the insert 62. Additionally, the insert 62 may be introduced into the T-shaped joint 83 from the top portion 85 of the joint 83, and seated in a downward motion 87 such that the insert 62 is circumferentially loaded or mounted into the segment 76 of the casing 56.

[0022] Furthermore, the illustrated insert 62 is substantially thicker 75 near the joint 70. That is, both the substrate 64 and the abradable coating 66 of the illustrated insert 62 are substantially thicker 75 near the joint 70 and gradually taper along the segment 76 (i.e., moving away from the joint 70 circumferentially 42), where the substrate 64 and the abradable coating 66 of the illustrated insert 62 are thinner 77. Accordingly, when the blades 52 of the rotor 54 are rotating during operation of the compressor 16, the groove 60 and the insert 62 may provide a uniform circumferential clearance 58 such that the compressor 16 may efficiently function.

[0023] Technical effects of the present embodiments include mitigating the eccentricity of stators in rotor/stator system (e.g., casings for compressors, gas turbines, steam turbines, pumps, or other rotary machines) in order to control the clearance between the rotor and the stator as the system expands and/or contracts during heating and/or cooling. By controlling the clearance between the rotor and the casing of the compressor or gas turbine, present embodiments enable the compressor or gas turbine to continue to properly and efficiently function, even as the casing expands and contracts during operation. Accordingly, present embodiments may reduce maintenance costs by reducing the likelihood of contact between the rotor blades in the casing and by providing an abradable coating that may be preferentially removed to preserve the integrity of the rotor blades and/or casing in case of contact. Furthermore, present embodiments enable the compressor or gas turbine to maintain efficiency during operation, limiting energy costs and waste.

[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 with insubstantial differences from the literal language of the claims.

[0025] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A system, comprising:

    an eccentricity control insert configured to mount in a recess at an intermediate joint between an adjacent pair of first and second segments of a segmented stator of a rotary machine, wherein the eccentricity control insert is configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

2. The system of any preceding clause, wherein an arc length of the eccentricity control insert extends less than approximately 60 degrees in a circumferential direction about a rotational axis of the rotary machine, the eccentricity control insert comprises an arcuate shaped body having an abradable portion disposed over a base portion, and at least one of the abradable portion or the base portion has a non-uniform thickness in the circumferential direction.

3. The system of any preceding clause, wherein the eccentricity control insert comprises an abradable material configured to abrade away to protect a plurality of rotary blades of the rotary machine.

4. The system of any preceding clause, wherein an arc length of the eccentricity control insert extends less than approximately 60 degrees in a circumferential direction about a rotational axis of the rotary machine.

5. The system of any preceding clause, wherein a radial thickness of the eccentricity control insert progressively increases from a first end portion to a second end portion in a circumferential direction about a rotational axis of the rotary machine.

6. The system of any preceding clause, wherein the eccentricity control insert comprises a neck portion and a mounting base portion that extend in a lengthwise direction along the eccentricity control insert, and the mounting base portion is wider than the neck portion in a crosswise direction relative to the lengthwise direction.

7. The system of any preceding clause, comprising the rotary machine having a compressor or a turbine.

8. A system, comprising:

    a segmented stator comprising a plurality of stator segments arranged circumferentially about a rotational axis of a rotary machine, wherein each adjacent pair of first and second segments of the plurality of stator segments includes a recess extending circumferentially across an intermediate joint between the first and second segments, and each recess includes at least one eccentricity control insert configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

9. The system of any preceding clause, wherein an arc length of the eccentricity control insert extends less than approximately 60 degrees in a circumferential direction about the rotational axis, and the eccentricity control insert comprises an abradable material configured to abrade away to protect a rotating component of the rotary machine.

10. The system of any preceding clause, comprising the rotary machine having a compressor or a turbine.

Claims

1. A system, comprising:

a rotary machine, comprising:

a rotor (54) comprising a plurality of blades (52); and
a segmented stator comprising a plurality of stator segments (74,76) arranged circumferentially about the plurality of blades (52), wherein each adjacent pair of first and second segments (74,76) of the plurality of stator segments includes a recess (60) extending circumferentially across an inter-

mediate joint (70,72) between the first and second segments, and each recess (60) includes at least one eccentricity control insert (62) configured to mitigate eccentricity of an inner circumference of the segmented stator due to thermal expansion or thermal contraction of the segmented stator.

2. The system of claim 1, wherein the at least one eccentricity control insert (62) comprises an abradable portion (66) disposed over a base portion.

3. The system of claim 2, wherein the abradable portion (66) comprises alumina or a chrome carbine.

4. The system of claim 2 or 3, wherein the abradable portion (66) has a first non-uniform thickness (79) in a circumferential direction about a rotational axis (38) of the rotor (56), the base portion has a second non-uniform thickness in the circumferential direction, or a combination thereof.

5. The system of any of claims 2 to 4, wherein the at least one eccentricity control insert (62) comprises an arcuate shaped body having the abradable portion (66) disposed over the base portion, wherein an arc length of the at least one eccentricity control insert (62) extends less than approximately 60 degrees in a circumferential direction about a rotational axis (38) of the rotor.

6. The system of any of claims 1 to 5, wherein the recess (60) of each adjacent pair of first and second segments (74,76) comprises a first recess portion (63) disposed in the first segment (74) and a second recess portion (65) disposed in the second segment (76), and the at least one eccentricity control insert (62) comprises a first insert portion (62) disposed in the first recess portion (63) and a second insert portion (62) disposed in the second recess portion (65).

7. The system of any of claims 1 to 6, wherein a radial depth (59) of the first and second recess portions (63,65) gradually decreases circumferentially away from the intermediate joint (70).

8. The system of any preceding claim, wherein a radial thickness (79) of the first and second insert portions (62) gradually decreases circumferentially away from the intermediate joint (70).

9. The system of any preceding claim, wherein the recess (60) comprises a T-shaped slot (83) and the at least one eccentricity control insert (62) comprises at least one T-shaped insert configured to mount into the T-shaped slot (83) in a circumferential direction about a rotational axis (38) of the rotor (54).

10. The system of any preceding claim, wherein the rotary machine comprises a compressor (16) or a turbine (22).

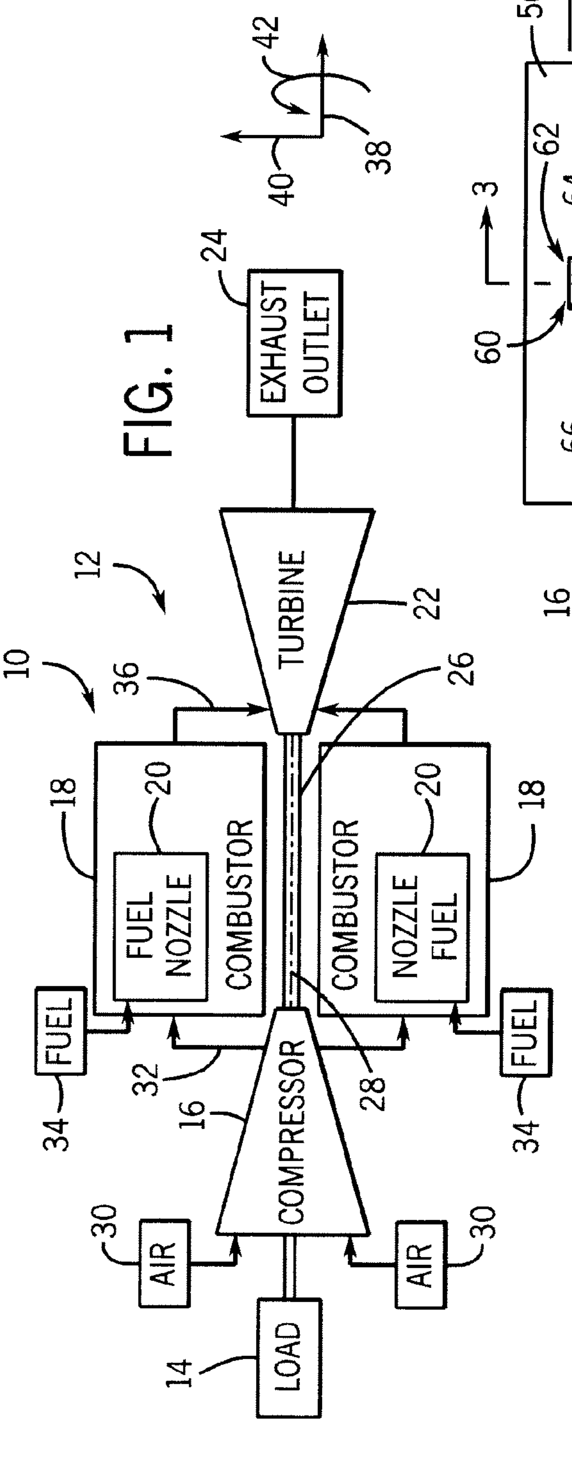
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FIG. 1

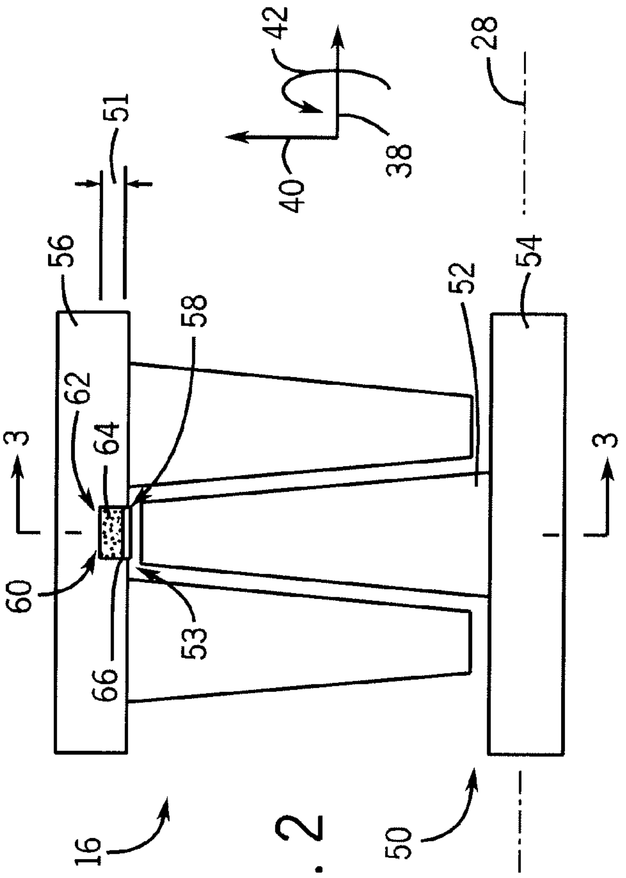
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FIG. 2

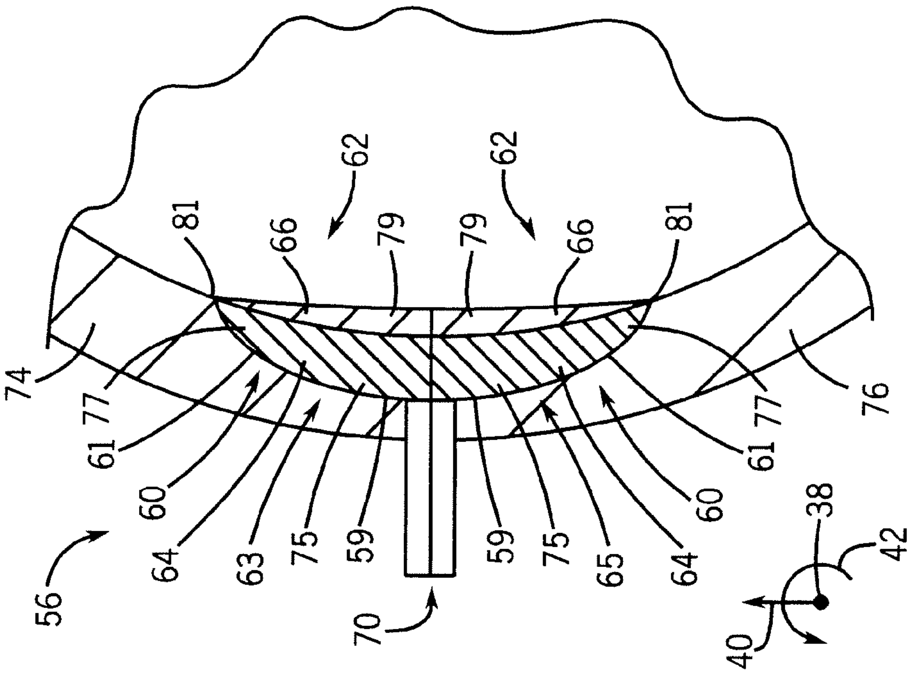
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FIG. 4

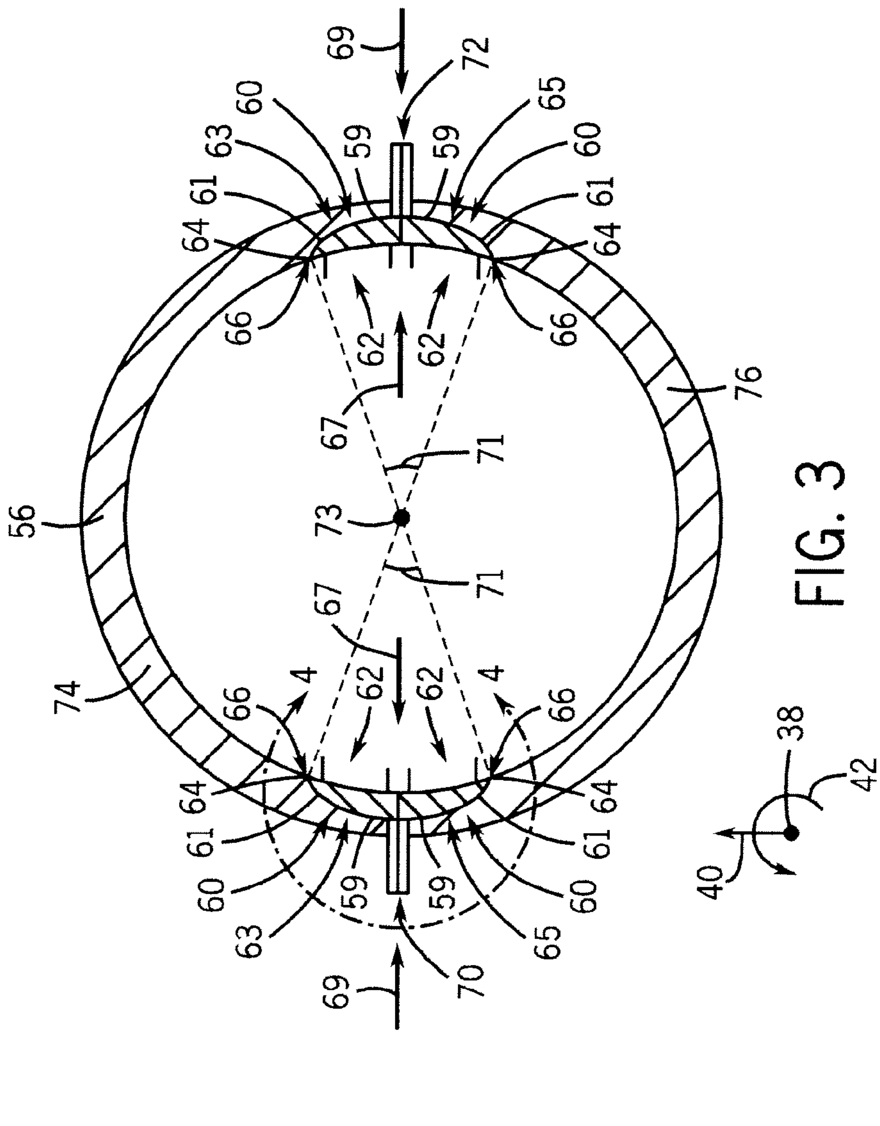
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FIG. 3

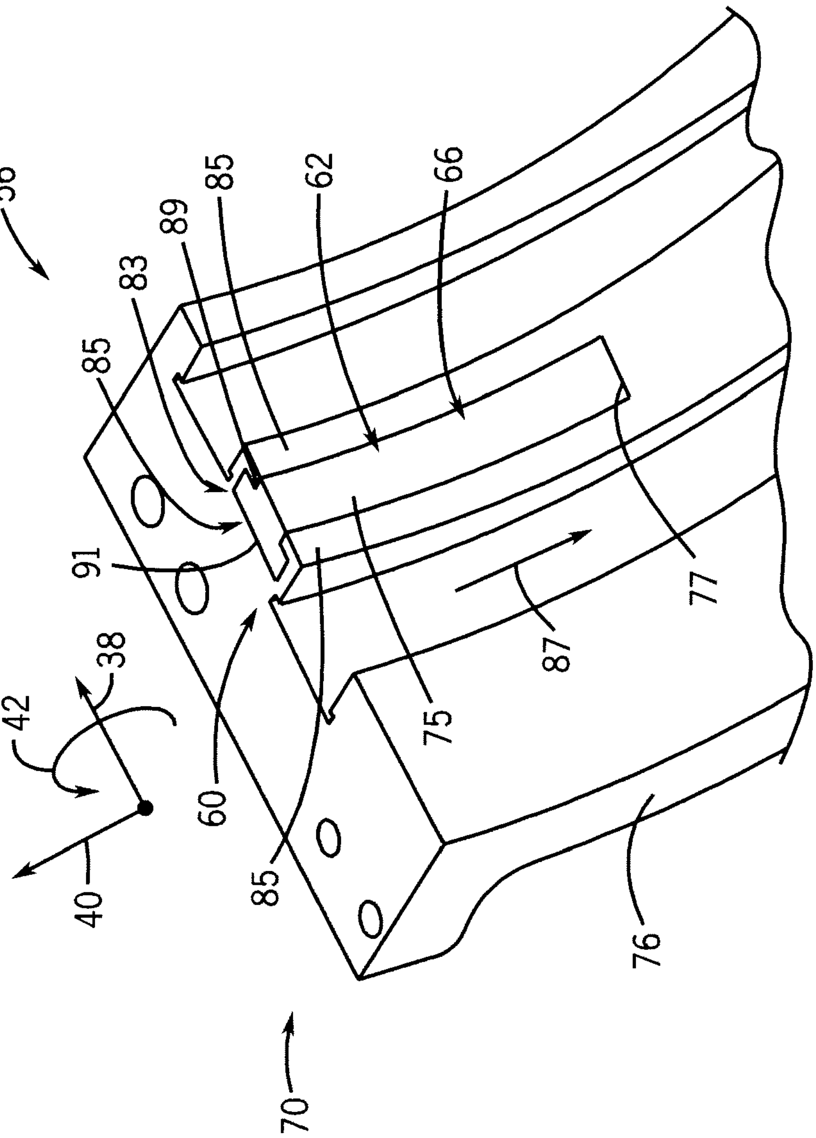

FIG. 5

Europäisches Patentamt
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EUROPEAN SEARCH REPORT

Application Number
EP 13 15 8473

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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X : particularly relevant if taken alone
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