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AXIALLY ADJUSTABLE INSERTED RING WITHIN PACKING RING AND METHOD OF USING SAME

Abstract

A turbine assembly including a turbine stationary component, which includes an inner ring and a packing segment positioned relative to the inner ring such that a steam joint is defined therebetween. The packing segment defines a groove open to the steam joint, a first seal face within the groove and opposite from the portion open to the steam joint, and a second seal face within the groove and adjacent to the first seal face. An inserted ring includes a body having a first face, a second face adjacent to the first face, and a third face opposite from the first face. The first face is positioned in close proximity to the first seal face of the packing segment, the second face is positioned in close proximity to the second seal face of the packing segment, and the third face is positioned in close proximity to the inner ring.

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Background/Summary

BACKGROUND OF THE INVENTION

[0001] The present disclosure relates generally to an inserted ring used in rotating machinery and, more particularly, relates to methods of adjusting such inserted rings within a packing ring in the axial direction.

[0002] Rotary machines, such as steam and gas turbines used for power generation and mechanical drive applications, are generally large machines that include multiple turbine stages. High-pressure fluid flowing through these stages must pass through a series of adjoining stationary and rotating components. Seals between the stationary and the rotating components are used to control fluid leakage.

[0003] Over time, the stationary and the rotating components, for example, a packing ring, may require refurbishment and/or replacement to enable the associated rotary machine to continue to operate efficiently. The refurbishment can include, but is not limited to, repairing the packing ring seal face. This is typically referred to as the “steamface” or “seal face”, which is located between the packing ring and the inner ring axial downstream interface. Presently, frequently the component requiring refurbishment must be removed from operation to enable it to be analyzed and/or repaired as necessary. However, removing the component from operation costs time and money, especially in the power generation industry where an outage is often further penalized and may require replacement power to be purchased, for example.

[0004] Accordingly, there exists a need for a method of refurbishing a component used in rotating machinery, wherein the method efficient and facilitates limiting downtime of the rotating machinery.

BRIEF DESCRIPTION OF THE INVENTION

[0005] In one aspect, an inserted ring for a turbine assembly, wherein the turbine assembly includes a turbine stationary component, the turbine stationary component includes an inner ring and a packing segment positioned relative to the inner ring such that the inner ring and the packing segment define a steam joint therebetween. The inserted ring includes a first face positioned adjacent to the inner ring; and a second face positioned in close proximity to the packing segment such that the second face is spaced a distance from and opposite to the first face, wherein the inserted ring has an axial width defined by the first and second faces.

[0006] In another aspect, a turbine assembly including an inner ring and a packing segment positioned relative to the inner ring such that a steam joint is defined therebetween. The packing segment defines a groove open to the steam joint, the packing segment defines a first seal face within the groove and opposite from the portion open to the steam joint, and a second seal face within the groove and adjacent to the first seal face. An inserted ring includes a body having a first face, a second face adjacent to the first face, and a third face opposite from the first face. The first face is positioned in close proximity to the first seal face of the packing segment, the second face is positioned in close proximity to the second seal face of the packing segment, and the third face is positioned in close proximity to the inner ring.

[0007] In yet another aspect, a method for selectively positioning an inserted ring relative to a turbine assembly that includes an inner ring and a packing segment positioned relative to the inner ring such that the inner ring and the packing segment define a steam joint therebetween. The method includes identifying a seal position required at a packing seal location and identifying an axial width defined between a first seal face of the packing segment and a radially inner surface of the inner ring. The method includes selecting an inserted ring having an axial width that is approximately the same as the axial width identified between the first seal face of the packing segment and the radially inner surface of the inner ring. The method includes inserting the inserted ring at least partially within a groove defined circumferentially within the packing segment. The method includes fixedly securing the inserted ring within the groove of the packing segment to facilitate improving the operating efficiency of the turbine assembly.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a prior art cross-sectional illustration of a portion of a steam turbine assembly;

[0009] FIG. **2** is a cross-sectional illustration of a portion of an exemplary steam turbine assembly including two inserted rings and a radial spring;

[0010] FIG. **3** is an enlarged cross-sectional view of the steam turbine assembly shown in FIG. **2** and taken within detail **1**;

[0011] FIG. **4** is an enlarged cross-sectional illustration of a packing ring of the steam turbine assembly shown in FIG. **2** with a first of the inserted rings;

[0012] FIG. **5** is an enlarged cross-sectional illustration of the packing ring of the steam turbine assembly shown in FIG. **2** with a second of the inserted rings;

[0013] FIG. **6** is an enlarged cross-sectional illustration of an exemplary inserted ring that may be used with the steam turbine assembly shown in FIG. **2**;

[0014] FIG. **7** is a cross-sectional illustration of an exemplary steam turbine assembly including an inserted pin;

[0015] FIG. **8** is a top schematic illustration of a first half of the exemplary steam turbine assembly including a plurality of inserted rings as shown in FIG. **2** and taken along line A-A;

[0016] FIG. **9** is a flow chart illustrating an exemplary method that may be implemented to identify and insert an inserted ring and/or pin into a steam turbine assembly, such as the steam turbine assembly shown in FIGS. **3** and **7**;

[0017] FIG. **10** is a cross-sectional illustration of a portion of the exemplary steam turbine assembly shown in FIG. **2** including two inserted rings and a leaf spring; and

[0018] FIG. **11** is a side view illustration of the leaf spring shown in FIG. **10**.

DETAILED DESCRIPTION OF THE INVENTION

[0019] The embodiments described herein relate to systems and methods that enable axial adjustment of an inserted ring/pin used in rotating machinery. At least some of the advantages of the systems described herein, over the prior art, include, at least: (i) selective adjustments of the axial position of the inserted ring/pin; (ii) incremental adjustments of the inserted ring/pin for ease of repair; (iii) reduced downtime of the rotating machinery; and (iv) reduced analysis required to select an appropriate inserted ring/pin based on a determined axial width between components of the rotating machinery.

[0020] When introducing elements of various embodiments disclosed herein, 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.

[0021] Unless otherwise indicated, approximating language, such as “generally,” “substantially,” and “about,” as used herein indicates that the term so modified may apply to only an approximate degree, as would be recognized by one of ordinary skill in the art, rather than to an absolute or perfect degree. Accordingly, a value modified by a term or terms such as “about,” “approximately,” and “substantially” is 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. Additionally, unless otherwise indicated, the terms “first,” “second,” etc. are used herein merely as labels, and are not intended to impose ordinal, positional, or hierarchical requirements on the items to which these terms refer. Moreover, reference to, for example, a “second” item does not require or preclude the existence of, for example, a “first” or lower-numbered item or a “third” or higher-numbered item.

[0022] As used herein, spatially relative terms, such as “beneath”, “below”, “lower”, “above”, “upper”, “front”, “back”, “side”, “left”, “right”, “rear”, “top”, “bottom”, and the like, are used for ease of description to describe one element or feature's relationship to another element(s) or feature(s). It is further understood that the terms “front”, “back”, “left”, and “right” are not intended to be limiting and are intended to be interchangeable, where appropriate. Further, it should be noted that the terms “first,” “second,” and the like herein do not denote any order, quantity, or relative importance, but rather are used to distinguish one element from another.

[0023] All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., “such as”), is intended merely to better illustrate the invention and does not pose a limitation on the scope of the invention or any embodiments unless otherwise claimed.

[0024] FIG. **1** is a cross-sectional schematic view of a prior art version of a steam turbine assembly **10′**. The steam turbine assembly **10′** includes a casing **12′** and a diaphragm outer ring **14′** positioned relative to the casing **12′**. The steam turbine assembly **10′** includes a nozzle **15′** and an inner ring **16′** positioned in proximity to the diaphragm outer ring **14′**. The steam turbine assembly **10′** includes a turbine stationary component including a packing ring **19′** that is positioned in proximity to the inner ring **16′**. The packing ring **19′** defines one or more protrusions **21′** that extend outwardly and in the direction of opposing protrusions **25′** of a rotor **23′**.

[0025] FIG. **2** is a cross-sectional schematic view of an exemplary steam turbine assembly **10**. In the exemplary embodiment, assembly **10** includes a casing **12** and a turbine stationary component **14** positioned relative to the casing **12**. The turbine stationary component **14** may include, but is not limited to, a diaphragm outer ring, a packing head, a packing ring, a packing carrier, an oil deflector, and/or variations thereof. The steam turbine assembly **10** includes a nozzle **15** and an inner ring **16** positioned in proximity to the diaphragm outer ring **14**. More specifically, the nozzle **15** is between the diaphragm outer ring **14** and the inner ring **16**. The steam turbine assembly **10** includes the turbine stationary component including **14** that further includes a packing ring **19** that is positioned in proximity to the inner ring **16**. The packing ring **19** may be referred to as a packing segment **19**. In some embodiments, the packing ring **19** may be coupled directly with the casing **12** or with the turbine stationary component **12**. The inner ring defines a channel **30** that extends in a direction away from the packing ring **19**. The channel **30** may extend a distance relative to the inner ring **16**. For example, the distance of the channel **30** may be equal to or less than the circumferential distance of the inner ring **16**. The channel **30** may be sized and shaped to receive, at least partially, a biasing member **32**, such as, a radial spring, a coil spring, a leaf spring. As depicted in FIGS. **2** and **3**, The radial spring **32** may be in direct or indirect contact with the packing ring **19**. For example, the radial spring **32** may be in direct or indirect contact with a first surface **34** of the packing ring **19** such that the radial spring **32** is in contact with the inner ring **16** and the packing ring **19**. The radial spring **32** is partially positioned within a recessed portion **35** relative to the first surface **34** of the packing ring **19**. In some instances, two or more radial springs **32** may be used. Although the biasing member **32** is depicted as a radial spring, it should be understood that any biasing member **32** may be used, unless expressly stated otherwise.

[0026] In a non-limiting example, the biasing member **32** may be a leaf spring, as depicted in FIGS. **10** and **11**. The leaf spring **32** may be in direct or indirect contact with the packing ring **19**. For example, the leaf spring **32** may be in direct or indirect contact with the first surface **34** of the packing ring **19** such that the radial spring **32** is in contact with the inner ring **16** and the packing ring **19**. The leaf spring **32** is partially positioned within the recessed portion **35** relative to the first surface **34** of the packing ring **19**. The leaf spring **32** includes a curved feature **33**. The curved feature **33** is sized and shaped to at least partially fit within the recessed portion **35** of the packing ring **19**. At least the curved feature **33** of the leaf spring **32** reacts against the inner diameter of the recessed portion **35** to impart a radial inward force on the packing ring **19**. In some instances, two or more leaf springs **32** may be used.

[0027] The packing ring **19** includes a base segment **36**, which is coupled to a neck segment **38**, which is coupled to a hook base segment **40**. The hook base segment **40** defines the first surface **34** that is positioned relative to the channel **30** of the inner spring **16**. It should be understood that although the packing ring **19** is described with reference to multiple segments, the packing ring **19** may be one component, for example, as shown in the figures. The packing ring **19** includes protrusions **21** that extend outwardly from the base segment **36** in a direction away from the first surface **34**. The protrusions correlate with the protrusions **21**′ as depicted in prior art FIG. **1**. Although a steam turbine assembly **10** is illustrated, it should be understood that the following may apply to other turbine assemblies, including gas turbine assemblies.

[0028] FIG. **3** is a cross-sectional schematic view of the steam turbine assembly **10** including an enlarged view depicting the relationship between inner ring **16** and the packing ring **19**. In an exemplary embodiment, the inner ring **16** and the packing ring **19** define a steam joint **17** that is within the steam flow path and is thus exposed to steam pressure. The steam joint **17** may be also referred to as a downstream joint, as the steam joint **17** is downstream based on the direction of the steam pressure. The steam joint **17** is defined by a surface **18** of the inner ring **16** and by a steam face **20** of the packing ring **19** that is opposite the inner ring surface **18**. The steam face **20** is the axial interface between the packing ring **19** and the inner ring **16** that counteracts the axial pressure induced to the nozzle **15**.

[0029] The axial width W.sub.1 of the steam joint **17** can vary based upon a variety of factors, including but not limited to, the size of the steam turbine assembly **10**, “dishing” of the packing ring **19**, and combinations thereof. The term “dishing” is used to describe creep deformation that may form within a web portion (not shown) of the packing ring **19**. In some instances, the axial width W.sub.1 may have a range between about 0 inches “in” and about 0.25 in.

[0030] In another exemplary embodiment, the inner ring **16** and the packing ring **19** define a joint **42** that is upstream from the steam joint **17** based on the direction of the steam pressure. The joint **42** is defined by a surface **44** of the inner ring **16** and by a surface **46** of the packing ring **19** that is opposite the inner ring surface **44**. The packing ring surface **46** is the axial interface between the packing ring **19** and the inner ring **16** that counteracts the axial pressure induced to the nozzle **15**.

[0031] The axial width W.sub.4 of the joint **42** can vary based upon a variety of factors, including but not limited to, the size of the steam turbine assembly **10**, “dishing” of the packing ring **19**, and combinations thereof. In some instances, the axial width W.sub.4 may have a range between about 0 inches “in” and about 0.25 in.

[0032] It should be understood that although the axial width W.sub.1 is illustrated as being smaller than the axial width W.sub.4, the disparity between the two axial widths W.sub.1, W.sub.4 is not intended to be limiting. Thus, axial width W.sub.1 may be larger than, equal to, or smaller than axial width W.sub.4. Similarly, axial width W.sub.4 may be larger than, equal to, or smaller than axial width W.sub.1.

[0033] In some embodiments, the packing ring **19** includes a first groove **22** defined therein that is formed relative to the inner ring **16**. The first groove **22** is open to the steam joint **17**, as best seen in FIG. **4**. The packing ring **19** includes a first seal face **24** that is defined opposite the steam joint **17**. The packing ring **19** defines a second seal face **26** that is adjacent to the first seal face **24**. The packing ring **19** also includes a third face **28** that is defined opposite the second seal face **26**. The first seal face **24**, the second seal face **26**, and the third face **28** define, at least in part, the first groove **22**.

[0034] The first groove **22** has an axial width W.sub.2 that is measured between the steam face **20** of the packing ring **19** and the opposite first seal surface **24** of the packing ring, as best seen in FIG. **4**. In some instances, the axial width W.sub.2 may be between about 0.25 inches “in” to about 0.50 in. The first groove **22** has an axial width W.sub.3 that is measured between the inner ring surface

18 and the first seal surface **24** of the packing ring **19**. In some instances, the radial axial width W.sub.3 may be between about 0.25 inches "in" to about 0.50 in.

[0035] In some embodiments, the packing ring **19** includes a second groove **29** defined therein that is formed relative to the inner ring **16**. It should be understood that first and second are merely to differentiate the two grooves **22**, **29** to ensure the description is easy to follow. The labeling of first and second in no way requires one groove to be part of the system without the other. The second groove **29** is open to the joint **42**. The packing ring **19** includes a first seal face **31** that is defined opposite the joint **42**. The packing ring **19** defines a second face **33** that is adjacent to the first seal face **31**, as best seen in FIG. **5**. The packing ring **19** also includes a third seal face **35** that is defined opposite the second face **33**. The first seal face **31**, the second face **33**, and the third seal face **35** define, at least in part, the second groove **29**.

[0036] The second groove **29** has an axial width W.sub.5 that is measured between the surface **46** of the packing ring **19** and the opposite first seal surface **31** of the packing ring **19**, as best seen in FIG. **5**. In some instances, the axial width W.sub.5 may be between about 0.25 inches "in" to about 0.50 in. The second groove **29** has an axial width W.sub.6 that is measured between the inner ring surface **46** and the first seal surface **31** of the packing ring **19**. In some instances, the radial axial width W.sub.6 may be between about 0.25 inches "in" to about 0.50 in.

[0037] It should be understood that the first groove **22** and the second groove **29** may define axial widths W.sub.2, W.sub.5, respectively, that are equal to each other or different from each other. Similarly, the axial widths W.sub.3, W.sub.6 may be equal to each other or different from each other. In some embodiments, the packing ring **19** may include both the first groove **22** and the second groove **29**. In other embodiments, the packing ring **19** may include one of the first groove **22** or the second groove **29**.

[0038] In some instances, the first groove **22** and/or the second grooves **29** may be formed at the time of refurbishment to correct, for example, downstream deflection (dishing) at the shaft packing seal location of the packing ring **19**. In other instances, the first groove **22** and/or the second grooves **29** may be formed before or after refurbishment, for example, when the steam turbine assembly **10** is originally manufactured.

[0039] In the exemplary embodiment, the steam turbine assembly **10** includes an inserted ring **52** that is sized and shaped to be inserted at least partially within the first and second grooves **22**, **29**, either directly or indirectly. The inserted ring **52** is of a standard-size wherein inserted rings **52** are manufactured with various incremental sizes that may be combined to increase the overall size. Similarly, portions of the inserted ring **52** may be removed to reduce the overall size. The term "size" is not limited to a diameter, but may also include, but is not limited to only including, the thickness, the width, and/or combinations thereof. The size may be measured relative to the inserted ring **52** and/or may be based on a radial dimension from an axis (e.g., a longitudinal axis). In some embodiments, a first inserted ring **52**A is sized and shaped to be inserted at least partially within the first groove **22**, either directly or indirectly. A second inserted ring **52**B is sized and shaped to be inserted at least partially within the second groove **29**, either directly or indirectly. The first inserted ring **52**A and the second inserted ring **52**B may be collectively referred to as reference number **52** and distinguishing between the two inserted rings **52** enables a more thorough explanation of the steam turbine assembly **10**. It does not, however, inherently indicate differences between the inserted rings **52**, unless otherwise expressly stated.

[0040] Referring to FIG. **6**, the inserted ring **52** has a body **54** that has an axial width W.sub.a. The axial width W.sub.a of the inserted ring **52** may vary based on the application and may be incrementally sized. The desired axial width W.sub.a of the body **54** of the inserted ring **52** may be selected prior to installation within the first groove **22** and/or the second groove **29**. The body **54** of the inserted ring **52** includes a first seal face **60** and a second seal face **62**. The first and second seal faces **60** and **62** are adjacent to each other. In some embodiments, the second seal face **62** may be a second face **62**. The body **54** includes a third face **64** that is opposite the second seal face **62**. The third face **64** in some embodiments may be a third seal face **64**. The body **54** may also include a defined angled feature **66** in one or more corners **67** relative to the first seal face **60**, the second seal face **62** and/or the third face **64**. Additional modifications to the inserted ring **52** beyond what is shown in FIG. **6** are anticipated, such as, including a through hole along the longitudinal axis (FIG. **4**).

[0041] Referring to FIGS. **3** and **4**, the first inserted ring **52**A may be sized and shaped to be at least partially inserted within the groove **22** of the packing ring **19**. The distance D.sub.1 between the second seal face **26** and the third face **28** of the first groove **22** may be equal to or larger than a distance D.sub.2 measured between the second seal face **62** and the third face **64** of the first inserted ring **52**A (see, e.g., FIG. **6**). The distance D.sub.2 between the second seal face **62** and the third face **64** of the inserted ring **52** may be about the same as, or smaller than, the distance D.sub.1 between the second seal face **26** and the third face **28** of the first groove **22**. The first inserted ring **52**A may have an axial width W.sub.a (see, e.g., FIG. **6**) that is about the same as the axial width W.sub.3 measured between the inner ring surface **18** and the first seal surface **24** of the packing ring **19**. In some embodiments, the first inserted ring **52**A has an axial width W.sub.a that is about the same as the axial width W.sub.3.

[0042] The axial width W.sub.a of the first inserted ring **52**A may vary based, in part, on the axial width W.sub.1 of the steam joint **17**. When installed, the first inserted ring **52**A at least partially contacts the first seal face **24** of the first groove **22** such that a seal is formed between the first seal face **24** of the first groove **22** and the first seal face **60** of the first inserted ring **52**A. The first inserted ring **52**A also at least partially contacts the second seal face **26** of the first groove **22** such that a seal is formed between the second seal face **26** of the first groove **22** and the second seal face **62** of the first inserted ring **52**A. In some instances, the first inserted ring **52**A at least partially contacts the first seal face **24** and the second seal face **26** of the first groove **22** such that a seal is formed between the first seal face **24** of the first groove **22** and the first seal face **60** of the first inserted ring **52**A, and between the second seal face **26** of the groove **22** and the second seal face **62** of the first inserted ring **52**A.

[0043] Referring to FIGS. **3** and **5**, the second inserted ring **52**B may be sized and shaped to be at least partially inserted within the second groove **29** of the packing ring **19**. The distance D.sub.3 between the second seal face **33** and the third face **35** of the second groove **29** may be equal to or larger than a distance D.sub.2 measured between the second face **62** and the third seal face **64** of the second inserted ring **52**B (see, e.g., FIG. **6**). The distance D.sub.2 between the second face **62** and the third seal face **64** of the second inserted ring **52**B may be about the same as, or smaller than, the distance D.sub.3 between the second face **33** and the third seal face **35** of the second groove **29**. The second inserted ring **52**B may have an axial width W.sub.a (see, e.g., FIG. **6**) that is about the same as the axial width W.sub.6 measured between the inner ring surface **18** and the first seal surface **31** of the packing ring **19**. In some embodiments, the second inserted ring **52**B has an axial width W.sub.a that is about the same as the axial width W.sub.6.

[0044] The axial width W.sub.a of the second inserted ring **52**B may vary based, in part, on the axial width W.sub.4 of the joint **42**. When installed, the second inserted ring **52**B at least partially contacts the first seal face **31** of the second groove **29** such that a seal is formed between the first seal face **31** of the second groove **29** and the first seal face **60** of the second inserted ring **52**B. The second inserted ring **52**B also at least partially contacts the third seal face **35** of the second groove **29** such that a seal is formed between the third seal face **35** of the second groove **29** and the third seal face **64** of the second inserted ring **52**B. In some instances, the second inserted ring **52**B at least partially contacts the first seal face **31** and the third seal face **35** of the second groove **29** such that a seal is formed between the first seal face **31** of the second groove **29** and the first seal face **60** of the second inserted ring **52**B, and between the third seal face **35** of the second groove **29** and the third seal face **64** of the second inserted ring **52**B.

[0045] The inserted ring(s) **52** may be held in place within the first groove **22** and/or the second groove **29** using a variety of techniques, including but not limited to, peening, welding, adhesives, press fitting, pinning, and combinations thereof. In some instances, different techniques may be utilized within the steam turbine assembly **10**. FIG. **3** illustrate the steam turbine assembly **10** including different techniques for securing each of the inserted rings **52** within the corresponding groove **22**, **29**. Notwithstanding, the various installation techniques, as they relate to the upstream and downstream grooves **22**, **29**, are in no way intended to be limiting and merely illustrate various embodiments. Thus, different installation techniques may be used for retaining the inserted ring(s) **52** within one or both of the first and second grooves **22**, **29**. The installation technique for retaining the inserted ring **52** within the first groove **22** is not limited to the pinning technique, as shown in FIGS. **3** and **4**. The installation technique for retaining inserted ring **52** within the second groove **29** is not limited to the peening technique, as shown in FIGS. **3** and **5**.

[0046] In some embodiments and as shown in FIGS. **3** and **4**, the installation technique for retaining the first inserted ring **52**A within the first groove **22** is the pinning technique. The first inserted ring **52**A further defines a through hole **56** that extends along the axial width W.sub.a of the body **54**. The through hole **56** is sized and shaped to receive a pin **58**, such as a slotted spring pin, dowel pin. The pin **58** may have a diameter that is equal to or larger than the diameter of the through hole **56**. The pin **58** may define a length, in the direction of the axial width W.sub.a, that is equal to, longer than, or shorter than the axial width W.sub.a. The pin **58** may be positioned within the through hole **56** of the first inserted ring **52**A and in proximity to the surface **18** of the inner ring **16**. Insertion of the pin **58** within the through hole **56** of the first inserted ring **52**A may cause the second seal face **62** and the third face **64** of the inserted ring **52** to spread away from each other and in contact with the corresponding second seal face **26** and third face **28** of the first groove **22**. Thus, insertion of the pin **58** within the through hole **56** of the first inserted ring **52**A aids in retaining the first inserted ring **52**A within the first groove **22**. In some instances, two or more pins **58** may be utilized to retain the first inserted ring **52**A within the first groove **22**. The pin **58** may be selected from a variety of pins **58**, such as a pinch pin.

[0047] In some embodiments and as shown in FIGS. **3** and **5**, the installation technique for retaining the second inserted ring **52**B within the second groove **29** is the peening technique. For example, the second inserted ring **52**B is peened such that a portion **68** of the second face **33** of the packing ring **19** is deformed in the direction of the second face **62** of the second inserted ring **52**B (FIG. **5**). The deformed portion **68** at least partially retains the second inserted ring **52**B within the second groove **29** of the packing ring **19**. In one embodiment, to create the peened area **68**, a peening tool (not shown), such as, for example, a punch, an impact hammer, or the like, is directed at an angle relative to the second seal face **33** of the packing ring **19**.

[0048] Although depicted with only one first inserted ring **52**A within the first groove **22** and one second inserted ring **52**B within the second groove **29**, it should be understood that a plurality of inserted rings **52** may be used. For example, as shown in FIG. **8**, in the exemplary embodiment, the steam turbine assembly **10** includes a plurality of inserted rings **52** that are positioned axially relative to a longitudinal axis (L.sub.1). The plurality of inserted rings **52** may be selectively positioned at various circumferential locations relative to the longitudinal axis (L.sub.1). For example, in one embodiment, a first half **10**A of the steam turbine assembly **10** may include a first quantity of inserted rings **52**, and a second half (not shown) of the steam turbine assembly **10** may include a second quantity of inserted rings **52**. FIG. **8** depicts a downstream view of the first half **10**A of the steam turbine assembly **10** taken along line A-A of FIG. **2**. FIG. **8** illustrates the plurality of packing segments **19** positioned axially relative axis (L.sub.1) and in proximity to the inner ring **16**. The plurality of inserted rings **52** are depicted in cross-hatching and are positioned in proximity to the packing segment **19**. The first and second quantities of inserted rings **52** may be the same or may be different. It should be understood that various quantities of inserted rings **52** may be used, without departing from the spirit/scope of this disclosure. For example, the first half **10**A of the steam turbine assembly **10** may include one or more inserted rings **52** and the second half **10**B of the steam turbine assembly **10** may include one or more inserted rings **52**.

[0049] In operation (FIG. **9**), in the exemplary method **100** of using the inserted ring **52**, identify **102** the seal position required at the packing seal location relative to the packing ring **19** and identify the axial width W.sub.3, W.sub.6, which is measured between the surface **18** of the inner ring **16** and the first seal surface **24**, **31** of the packing ring **19**. The preferred seal position is based on the axial distance **27**′ between the protrusion **21** of the packing ring **19** and the protrusions **25**′ of the rotor **23**′. The axial distance **27**′ may vary based, in part, on the selected turbine. A corresponding inserted ring **52** is selected **104** that has an axial width W.sub.a that is approximately the same as, or slightly smaller than the measured axial width W.sub.3, W.sub.6. The inserted ring **52** is then inserted **106** at least partially into the first groove **22** and/or the second groove **29** defined within the packing ring **19**. The inserted ring **52** is fixedly secured **108** within the first groove **22** and/or the second groove **29** of the packing ring **19** to facilitate improving the operating efficiency of the steam turbine assembly **10**. To ensure the inserted ring **52** remains in place during assembly of the steam turbine assembly **10**, the inserted ring **52** is held in place, as described herein.

[0050] Referring to FIG. **6**, the body **54** of the inserted ring **52** has an axial width W.sub.a. The inserted ring **52** may be available in a variety of standard sizes, as defined at least partially by the axial width W.sub.a. The variety of standard sizes may be incrementally sized such that the axial width W.sub.a of the inserted ring is in a range of between about 0.15 inches to about 0.50 inches. The axial width W.sub.a of the body **54** may vary and may depend, in part, on the overall size of the steam turbine assembly **10**.

[0051] In some instances, the body **54** of the inserted ring **52** may include a plurality of inserts (not shown). Each insert (not shown) may include a tear line (not shown) that enables one or more of the inserts (not shown) to be selectively removed from the plurality of inserts (not shown). The tear line (not shown) may indicate an area of reduced material wherein at least one or more of the inserts (not shown) may be selectively separated from the plurality of inserts (not shown). In some instances, the tear line (not shown) is not visible, but rather is created by removing one or more of the inserts (not shown) from the plurality of inserts (not shown). For example, in some embodiments the tear line (not shown) is created by removing at least one insert (not shown) via bending, cutting, or the like. It should be understood, however, that alternatives to the tear line (not shown) may be used, without departing from the spirit/scope of this disclosure.

[0052] FIG. **7** is a cross-sectional view of an exemplary steam turbine assembly **200** including an inner ring **16** and a packing ring **19** that is positioned relative to the inner ring **16**. It should be understood that identical components are identified in FIG. **7** using the same reference numbers as used in FIGS. **2**, **3**, and **5**. The packing ring **19** includes a groove **29** that is open to the joint **42**, as best seen in FIG. **5**. The packing ring **19** includes a first seal face **31** that is defined opposite the joint **42**. The packing ring **19** defines a second seal face **33** that is adjacent to the first seal face **31**. The packing ring **19** also includes a third face **35** that is defined opposite the second seal face **33**. The first seal face **31**, the second seal face **33**, and the third face **35** define, at least in part, the groove **29**.

[0053] The steam turbine assembly **200** includes an inserted pin **202** that is sized and shaped to at least partially be inserted within the groove **29**, either directly or indirectly. More specifically, the inserted pin **202** may be press-fit within the groove **29** so as to directly or indirectly contact the first seal face **31**, the second seal face **33**, and the third face **35** of the groove **29**. The pin **202** has an axial width W.sub.a. The inserted pin **202** has an axial width W.sub.a that is less than the axial width W.sub.6. The axial gap between the pin **202** and the groove **29** may be between about 0.2 inches to about 1 inch. It should be understood that the method described and illustrated with reference to FIG. **9** may be modified to include the inserted pin **202**. For example, the second inserted ring **52**B may be replaced by at least one inserted pin **202**. In some instances, two inserted pins **202** may be inserted within the second groove **29**.

[0054] At least some of the advantages of the systems described herein, over the prior art, include, at least: (i) selective adjustments of the axial position of the inserted ring/plate; (ii) incremental adjustments of the inserted ring/plate for ease of repair; (iii) reduced downtime of the rotating machinery; and (iv) reduced analysis required to select an appropriate inserted ring/plate based on a determined axial width between components of the rotating machinery.
[0055] The systems described herein enable the steam turbine assembly **10** and **200** to be refurbished, thereby reducing the extent the system is not fully operational and, in some cases, entirely removed from use. In some instances, for example in the power generation industry, refurbishment of the steam turbine assembly **10** and **200** may reduce the extent of an outage and save the user and/or the energy provider money based, in some part, on the extent of the outage.
[0056] The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. Modifications, which fall within the scope of the present invention, will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims. The systems described herein are not limited to the specific embodiments described herein, but rather portions of the various systems may be utilized independently and separately from other systems described herein.
[0057] Although specific features of various embodiments of the invention may be shown in some drawings and not in others, this is for convenience only. Moreover, references to “one embodiment” in the above description are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. In accordance with the principles of the invention, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.
[0058] Further aspects of the invention are provided by the subject matter of the following clauses:
[0059] Clause 1. An inserted ring for a turbine assembly, wherein the turbine assembly includes a turbine stationary component, the turbine stationary component includes an inner ring and a packing segment positioned relative to the inner ring such that the inner ring and the packing segment define a steam joint therebetween, the inserted ring including: a first face positioned adjacent to the inner ring; and a second face positioned in close proximity to the packing segment such that the second face is spaced a distance from and opposite to the first face, wherein the inserted ring has an axial width defined by the first and second faces.
[0060] Clause 2. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the inserted ring includes a pin that is positioned within an opening of the inserted ring, the pin configured to at least partially retain the inserted ring relative to the inner ring and the packing segment.
[0061] Clause 3. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the packing segment includes a groove defined therein that opens towards the steam joint, wherein the inserted ring is sized to be inserted at least partially within the groove of the packing segment.
[0062] Clause 4. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the packing segment includes a first seal face opposite from the portion of the groove that opens towards the steam joint, wherein the second face of the inserted ring at least partially contacts the first seal face of the turbine stationary component.
[0063] Clause 5. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the inserted ring defines a body that has an axial width W.sub.a that is in a range between about 0.15 inches and about 0.50 inches.
[0064] Clause 6. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the groove is a first groove, the packing segment further includes a second groove oppositely positioned from the first groove, wherein the second groove opens towards a second steam joint defined between the inner ring and the packing segment, the second groove is

configured to at least partially receive a second inserted ring.
[0065] Clause 7. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the packing segment defines a second seal face that is adjacent to the first seal face, wherein the second face of the inserted ring at least partially contacts the first seal face of the packing segment and a third face of the inserted ring at least partially contacts the second seal face of the packing segment.
[0066] Clause 8. The inserted ring for a turbine assembly according to any of the proceeding clauses, wherein the turbine assembly further comprises a biasing member that is positioned between the inner ring and the packing segment.
[0067] Clause 9. A turbine assembly including an inner ring and a packing segment positioned relative to the inner ring such that the inner ring and the packing segment define a steam joint therebetween, the packing segment defines a groove open to the steam joint, the packing segment defines a first seal face within the groove and opposite from the portion open to the steam joint, and a second seal face within the groove and adjacent to the first seal face, the turbine assembly including an inserted ring, the inserted ring including: a body including a first face, a second face adjacent to the first face, and a third face opposite from the first face, wherein the first face is positioned in close proximity to the first seal face of the packing segment, the second face is positioned in close proximity to the second seal face of the packing segment, and the third face is positioned in close proximity to the inner ring.
[0068] Clause 10. The turbine assembly according to any of the proceeding clauses, wherein the body of the inserted ring has an axial width W.sub.a in a range between about 0.25 inches to about 0.50 inches.
[0069] Clause 11. The turbine assembly according to any of the proceeding clauses, wherein the body of the inserted ring has an axial width W.sub.a that is in a range between about 0.15 inches and about 0.50 inches.
[0070] Clause 12. The turbine assembly according to any of the proceeding clauses, wherein the inserted ring is fixedly secured within the groove of the packing segment by peening, welding, adhesives, press fitting, pinning, and combinations thereof.
[0071] Clause 13. The turbine assembly according to any of the proceeding clauses, wherein a biasing member is positioned between the inner ring and the packing segment.
[0072] Clause 14. The turbine assembly according to any of the proceeding clauses, wherein the groove is a first groove, the packing segment further includes a second groove oppositely positioned from the first groove, wherein the second groove opens towards a second steam joint defined between the inner ring and the packing segment, the second groove is configured to at least partially receive a second inserted ring.
[0073] Clause 15. The turbine assembly according to any of the proceeding clauses, wherein the inserted ring includes a pin that is positioned within an opening of the inserted ring, the pin is configured to fixedly retain the inserted ring within the groove of the packing segment.
[0074] Clause 16. The turbine assembly according to any of the proceeding clauses, wherein the biasing member is selected from the group consisting of a radial spring, a coil spring, or a leaf spring.
[0075] Clause 17. A method for selectively positioning an inserted ring relative to a turbine assembly that includes an inner ring and a packing segment positioned relative to the inner ring such that the inner ring and the packing segment define a steam joint therebetween, the method including: identifying a seal position required at a packing seal location and identifying an axial width defined between a first seal face of the packing segment and a radially inner surface of the inner ring; selecting an inserted ring having an axial width that is approximately the same as the axial width identified between the first seal face of the packing segment and the radially inner surface of the inner ring; inserting the inserted ring at least partially within a groove defined circumferentially within the packing segment; and fixedly securing the inserted ring within the

groove of the packing segment to facilitate improving the operating efficiency of the turbine assembly.
[0076] Clause 18. The method according to any of the proceeding clauses, wherein selecting an inserted ring further includes selecting an inserted ring that includes a body that is positioned relative to the radially inner surface of the inner ring.
[0077] Clause 19. The method according to any of the proceeding clauses, wherein selecting an inserted ring further includes selecting an inserted ring that includes a body that has an axial width Wa that is in a range between about 0.15 inches and about 0.50 inches.
[0078] Clause 20. The method according to any of the proceeding clauses, wherein selecting an inserted ring further includes selecting an inserted ring that includes a first face and a second face adjacent to the first face, wherein the first face of the inserted ring is positioned in close proximity to the first seal face of the packing segment and the second face of the inserted ring is positioned in close proximity to a third seal face adjacent to the first seal face of the packing segment, the first and second faces of the inserted ring combine to produce a seal relative to the packing segment.
[0079] While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

Claims

1. An inserted ring for a turbine assembly, wherein the turbine assembly comprises a turbine stationary component, the turbine stationary component comprises an inner ring and a packing segment including a base segment, a hook base segment contacting the inner ring, and a neck segment extending between the base segment and the hook base segment, wherein the inner ring and the packing segment define a steam joint therebetween, and the inserted ring comprising: a first face positioned adjacent to the inner ring; and a second face positioned within a groove formed in the neck segment of the packing segment and radially spaced apart from the base segment and the hook base segment, the second face is spaced a distance from and opposite to the first face, wherein the inserted ring has an axial width defined by the first and second faces, and wherein the inserted ring is radially spaced apart from the base segment and the hook base segment of the packing segment.
2. The inserted ring for the turbine assembly according to claim 1, wherein the inserted ring comprises a pin that is positioned within an opening of the inserted ring, the pin configured to at least partially retain the inserted ring relative to the inner ring and the packing segment.
3. The inserted ring for the turbine assembly according to claim 1, wherein the groove of the packing segment opens towards the steam joint, wherein the inserted ring is sized to be inserted at least partially within the groove of the packing segment.
4. The inserted ring for the turbine assembly according to claim 1, wherein the packing segment comprises a first seal face within the groove and opposite from a portion of the groove that opens towards the steam joint, wherein the second face of the inserted ring at least partially contacts the first seal face of the packing segment.
5. The inserted ring for the turbine assembly according to claim 1, wherein the axial width W.sub.a is in a range between 0.15 inches and 0.50 inches.
6. The inserted ring for the turbine assembly according to claim 1, wherein the groove is a first groove, the packing segment further comprises a second groove oppositely positioned from the first groove, wherein the second groove opens towards a second steam joint defined between the inner ring and the packing segment, the second groove is configured to at least partially receive a second inserted ring.
7. The inserted ring for the turbine assembly according to claim 4, wherein the packing segment defines a second seal face that is adjacent to the first seal face, wherein the second face of the

inserted ring at least partially contacts the first seal face of the packing segment and a third face of the inserted ring at least partially contacts the second seal face of the packing segment.

8. The inserted ring for the turbine assembly according to claim 1, wherein the turbine assembly further comprises a biasing member that is positioned between the inner ring and the packing segment.

9. A turbine assembly comprising an inner ring and a packing segment including a base segment, a hook base segment contacting the inner ring, and a neck segment extending between the base segment and the hook base segment, wherein the inner ring and the packing segment define a steam joint therebetween, the packing segment includes a groove formed in the neck segment and radially spaced apart from the base segment and the hook base segment, the packing segment defines a first seal face within the groove and opposite from a portion open to the steam joint, and a second seal face within the groove and adjacent to the first seal face, the turbine assembly comprising an inserted ring, the inserted ring comprising: a body including a first face, a second face adjacent to the first face, and a third face opposite from the first face, the body within the groove and radially spaced apart from the base segment and the hook base segment of the packing segment, wherein the first face is positioned in close proximity to the first seal face of the packing segment, the second face is positioned in close proximity to the second seal face of the packing segment, and the third face is positioned in close proximity to the inner ring.

10. The turbine assembly according to claim 9, wherein the body of the inserted ring has an axial width W.sub.a in a range between 0.25 inches to 0.50 inches.

11. The turbine assembly according to claim 9, wherein the body of the inserted ring has an axial width Wa that is in a range between 0.15 inches and 0.50 inches.

12. The turbine assembly according to claim 9, wherein the body of the inserted ring is fixedly secured within the groove of the packing segment by peening, welding, adhesives, press fitting, pinning, or combinations thereof.

13. The turbine assembly according to claim 9, wherein a biasing member is positioned between the inner ring and the packing segment.

14. The turbine assembly according to claim 9, wherein the groove is a first groove, the packing segment further comprises a second groove oppositely positioned from the first groove, wherein the second groove opens towards a second steam joint defined between the inner ring and the packing segment, the second groove is configured to at least partially receive a second inserted ring.

15. The turbine assembly according to claim 9, wherein the inserted ring comprises a pin that is positioned within an opening of the inserted ring, the pin is configured to fixedly retain the inserted ring within the groove of the packing segment.

16. The turbine assembly according to claim 13, wherein the biasing member is selected from a group consisting of a radial spring, a coil spring, or a leaf spring.

17. (canceled)

18. (canceled)

19. (canceled)

20. (canceled)

21. The turbine assembly according to claim 13, wherein the packing segment further includes a recessed portion formed in the hook base segment, the recessed portion sized and oriented to receive the biasing member.

22. The turbine assembly according to claim 15, wherein the opening of the inserted ring extends axially between the packing segment and the inner ring.

23. The turbine assembly according to claim 22, wherein the pin extends axially between the neck segment of the packing segment and the inner ring.

24. The turbine assembly according to claim 9, wherein the body of the inserted ring further comprises an angled feature formed between the second face and the third face.