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(54) AXIAL RETENTION DEVICE FOR TURBINE SYSTEM

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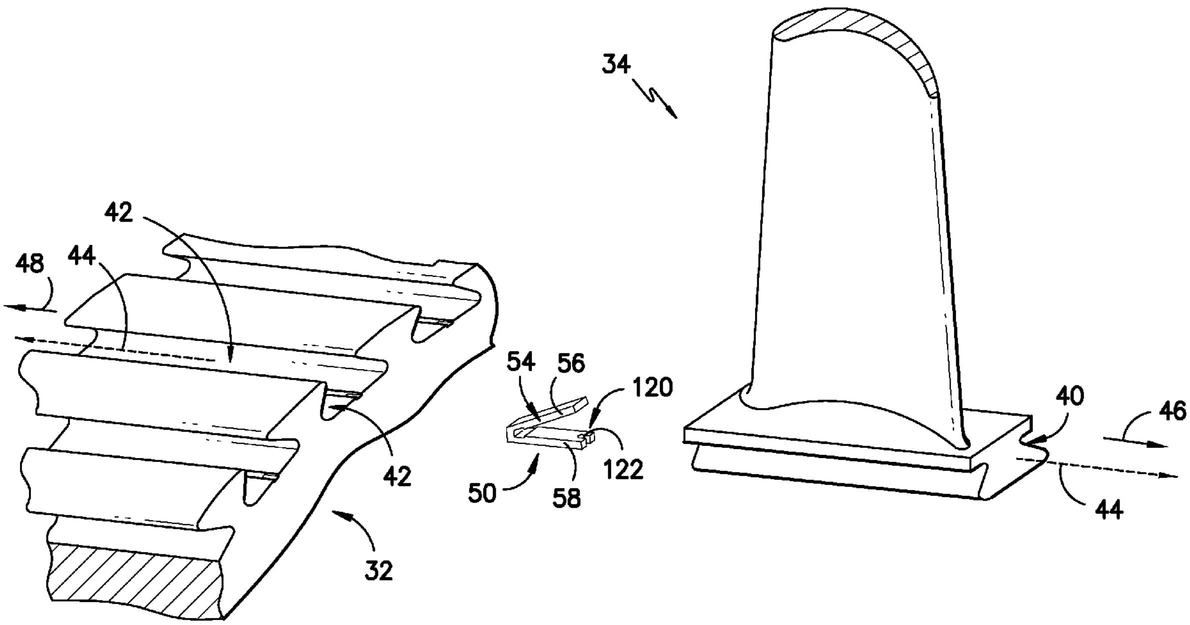
(57) **ABSTRACT**

An axial retention device for a turbine system is disclosed. The axial retention device includes a pocket defined in a mating surface of one of a turbine component and a support structure. The pocket includes a first axial load surface. The axial retention device further includes a latch comprising a base member and a pivotal member. The base member is associated with a mating surface of the other of the turbine component and the support structure. The pivotal member is configured to engage the pocket and includes a first mating axial load surface. Engagement of the pivotal member and the pocket allows the first axial load surface and the first mating axial load surface to interact, preventing axial movement of the turbine component with respect to the support structure in the at least one direction.



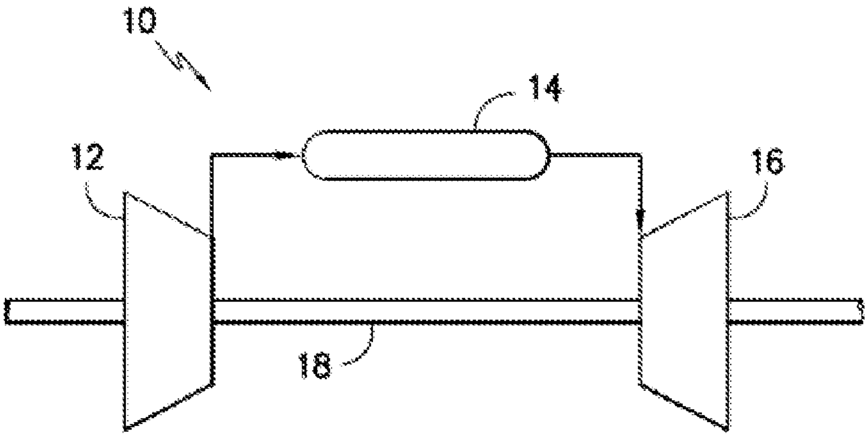


FIG. –1–

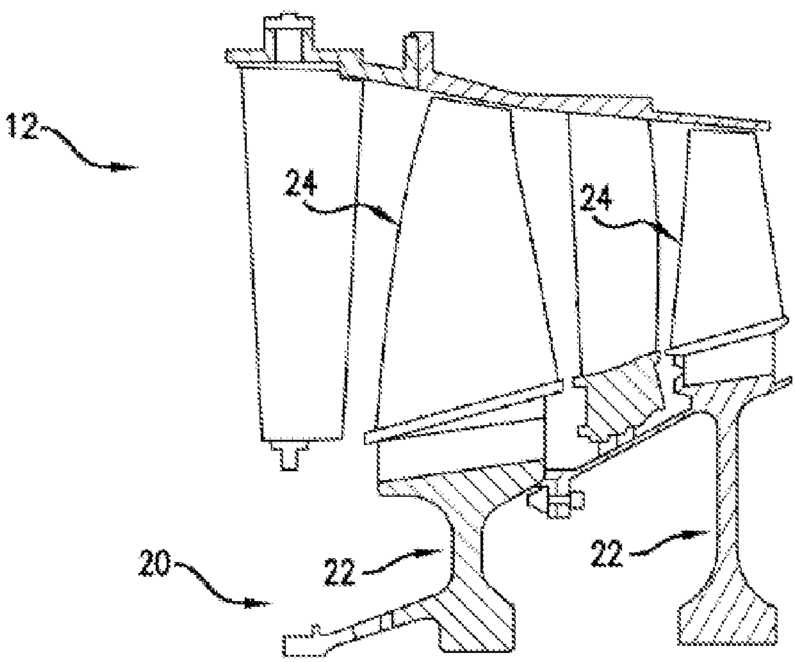


FIG. –2–

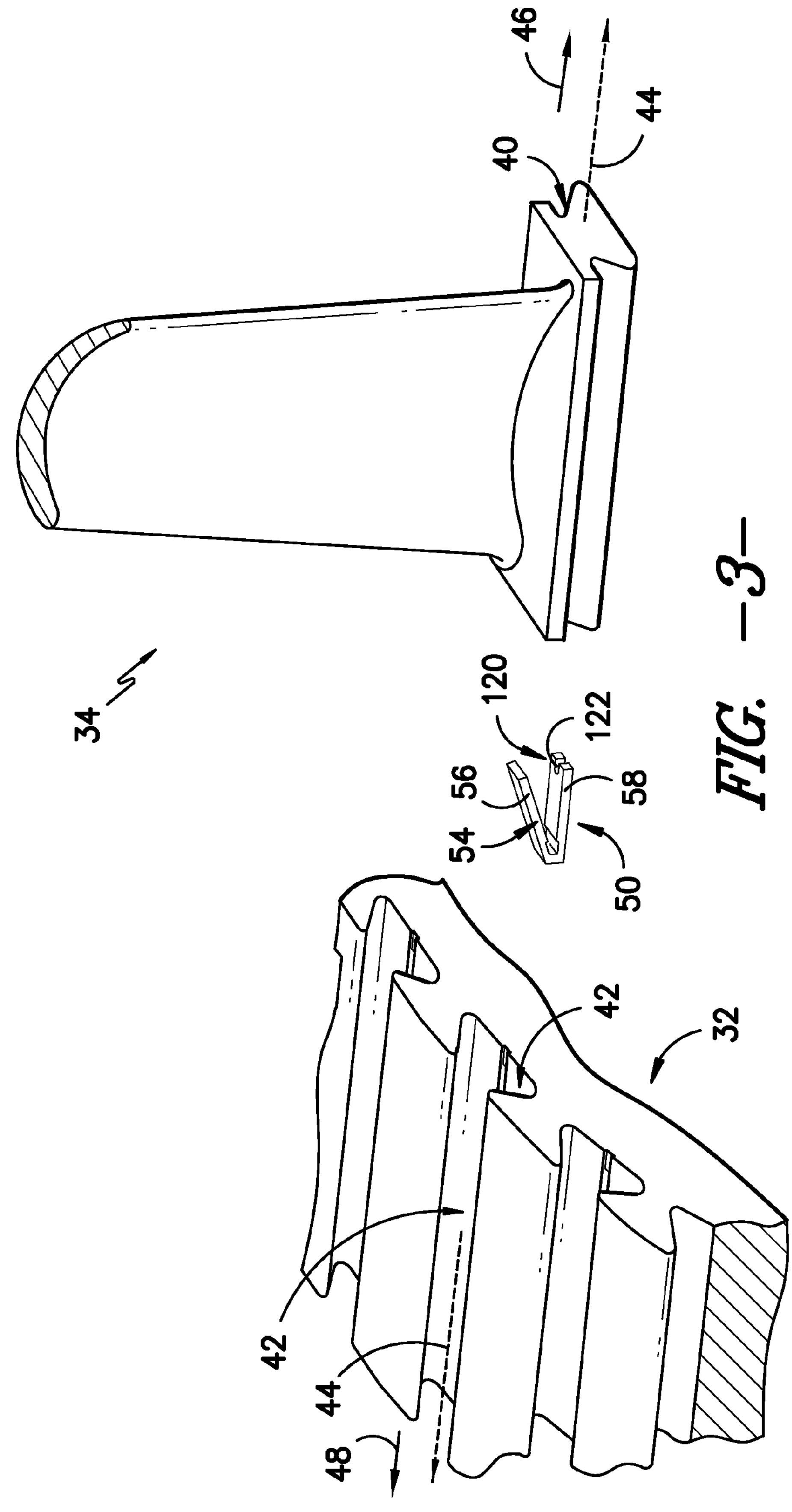


FIG. -3-

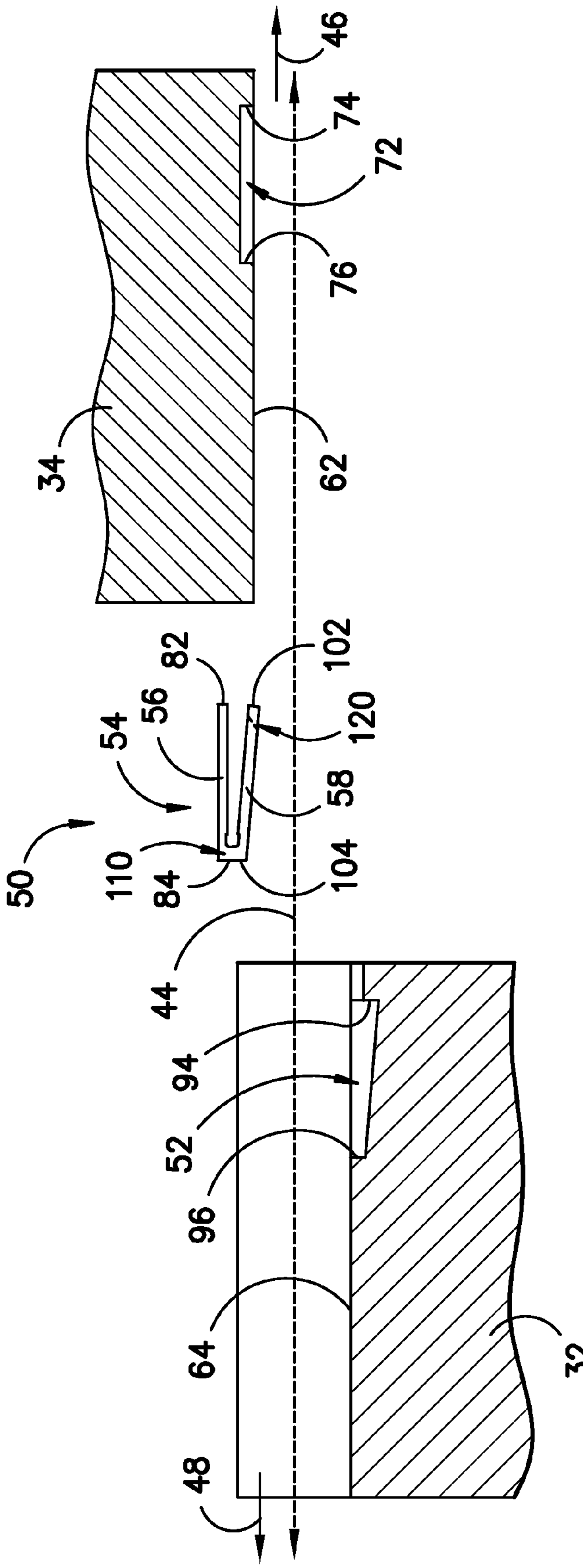

46
74
72
76
34
62
82
102
56
54
120
58
50
110
84
104
44
94
52
96
64
32
48

FIG. —4—

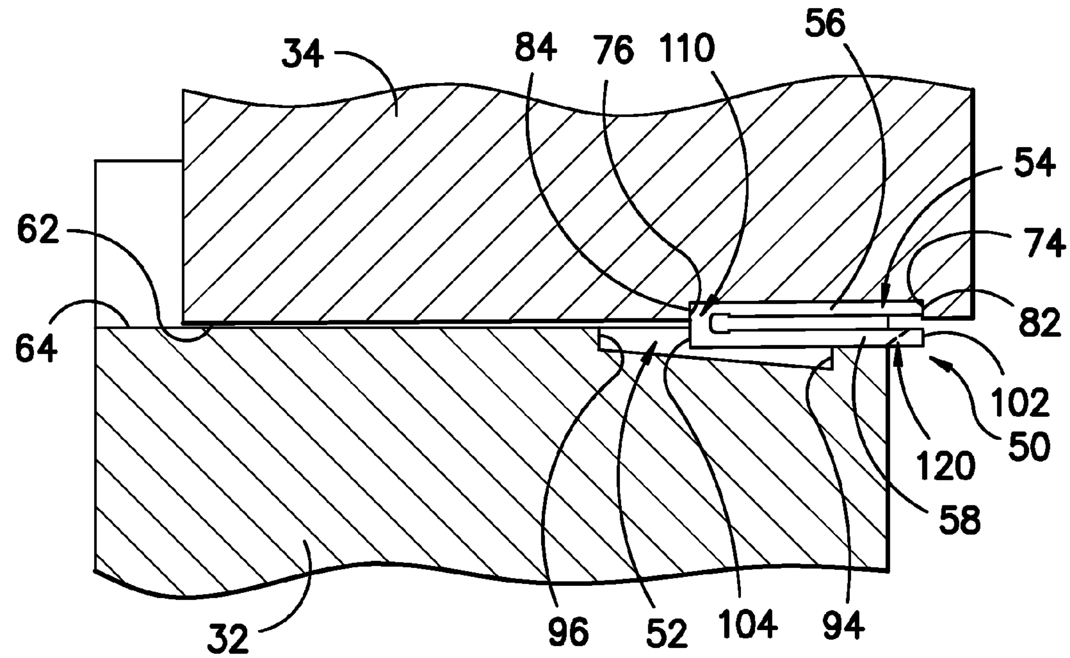

34
84
76
110
56
54
74
82
62
64
102
50
120
58
96
52
104
94
32

FIG. –5–

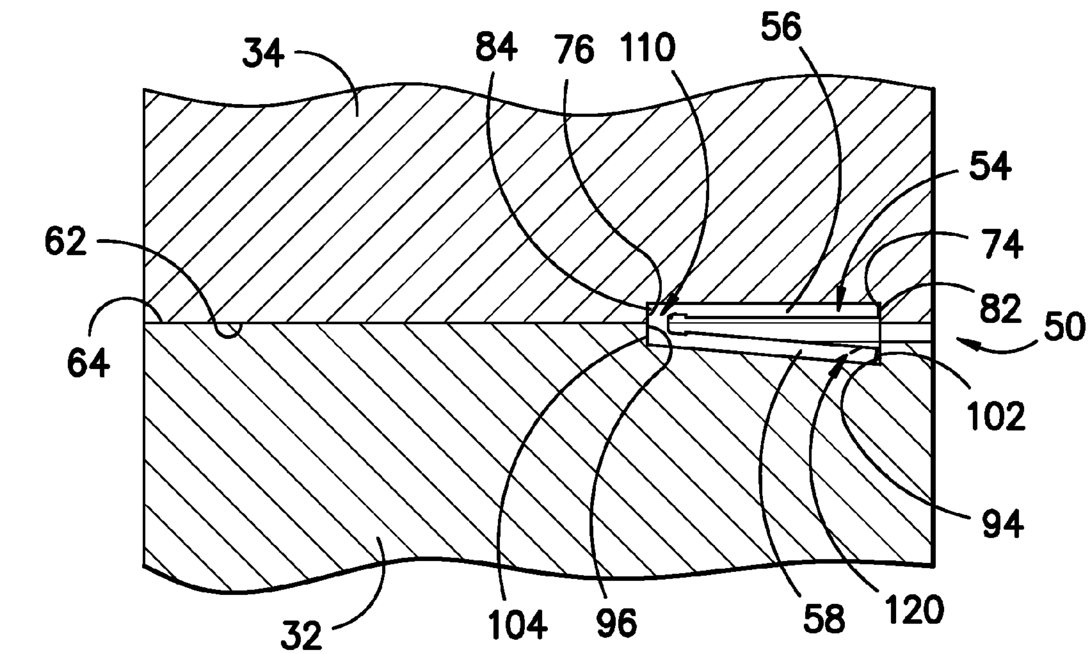

34
84
76
110
56
54
74
82
50
62
64
102
94
104
96
58
120
32

FIG. –6–

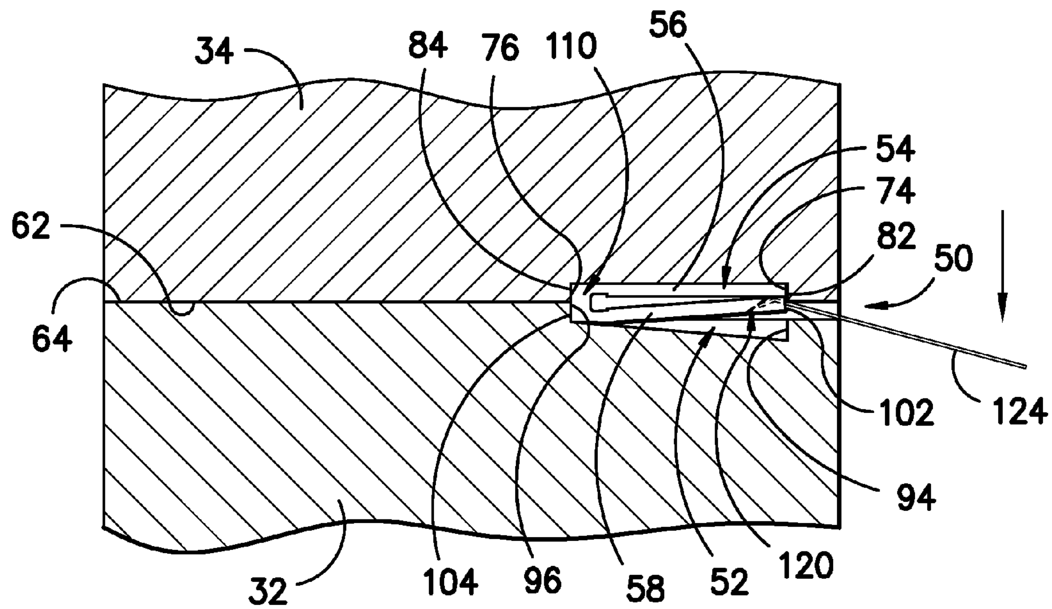


FIG. –7–

AXIAL RETENTION DEVICE FOR TURBINE SYSTEM

FIELD OF THE INVENTION

[0001] The subject matter disclosed herein relates generally to turbine systems, and more particularly to axial retention devices for retaining components within turbine systems.

BACKGROUND OF THE INVENTION

[0002] Turbine systems are widely utilized in fields such as power generation. For example, a conventional gas turbine system includes a compressor, a combustor, and a turbine. Further, a conventional gas turbine includes a rotor with various rotor blades mounted to disks in the compressor and turbine sections thereof. Each blade includes an airfoil over which pressurized air or fluid flows, and a platform at the base of the airfoil that defines the radial inner boundary for the air or fluid flow. To attach the blades to the rotor disks, the blades may include a suitable appendage, such as a root or dovetail, configured to engage a complementary attachment cavity in the perimeter of the disk.

[0003] In many cases, the blades disposed in the rotor disks may shift, slide, or become disengaged with respect to the rotor disks during operation of the system, thus potentially allowing air or fluid flow leakage or other damage to the system. Thus, devices for retaining the blades with respect to the rotor disks may be desired.

[0004] One prior art method for axially retaining blades in rotor disks involves staking. Staking creates an interference fit between two components, such as between a blade and rotor disk. The blade and rotor disk are connected, and then the apparatus connecting the blade and rotor disk together is deformed to create the interference fit. However, the use of staking for retaining blades in rotor disks has many disadvantages. For example, blades must be replaced after certain periods of use due to, for example, wear or damage. Each time a blade is replaced, the blade must be staked to the rotor disk at a different location. Utilizing staking to retain the replacement blade in the rotor disk is a time consuming process. Further, the available locations on the rotor disk for staking are generally limited. After a certain number of replacements, locations may be unavailable. The unavailability of staking locations thus necessitates replacement of the rotor disk. Replacement of the rotor disk is both time consuming and, due to the cost of the rotor disk and the loss of production of the turbine system during replacement, expensive.

[0005] Thus, an improved retention device for retaining blades and other suitable components within rotor disks and other suitable support structures would be desired in the art. For example, an axial retention device that prevents axial movement of the blades and other components with respect to the rotor disks and other support structures would be advantageous. Further, a retention device that provides for efficient and cost-effective replacement of the blades and other components, and that reduces or eliminates the need to replace the rotor disks and other support structures, would be desired.

BRIEF DESCRIPTION OF THE INVENTION

[0006] Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

[0007] In one embodiment, an axial retention device for a turbine system is disclosed. The axial retention device includes a pocket defined in a mating surface of one of a turbine component and a support structure. The pocket includes a first axial load surface. The axial retention device further includes a latch comprising a base member and a pivotal member. The base member is associated with a mating surface of the other of the turbine component and the support structure. The pivotal member is configured to engage the pocket and includes a first mating axial load surface. Engagement of the pivotal member and the pocket allows the first axial load surface and the first mating axial load surface to interact, preventing axial movement of the turbine component with respect to the support structure in the at least one direction.

[0008] These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

[0010] FIG. **1** is a schematic illustration of a turbine system;

[0011] FIG. **2** is a sectional side view of the compressor of a turbine system according to one embodiment of the present disclosure;

[0012] FIG. **3** is an exploded perspective view of a support structure and turbine component according to one embodiment of the present disclosure;

[0013] FIG. **4** is an exploded cross-sectional view of an axial retention device according to one embodiment of the present disclosure;

[0014] FIG. **5** is a cross-sectional view of an axial retention device in a first position during assembly according to one embodiment of the present disclosure;

[0015] FIG. **6** is a cross-sectional view of an axial retention device in a second position according to one embodiment of the present disclosure; and

[0016] FIG. **7** is a cross-sectional view of an axial retention device in a first position during disassembly according to one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0018] FIG. **1** is a schematic diagram of a turbine system **10**. While the turbine system **10** described herein may generally be a gas turbine system, it should be understood that the turbine system **10** of the present disclosure is not limited to gas turbine systems, and that any suitable turbine system, including but not limited to a steam turbine system, is within the scope and spirit of the present disclosure.

[0019] Thus, the system may include a compressor **12**, a combustor **14**, and a turbine **16**. The compressor **12** and turbine **16** may be coupled by a shaft **18**. The shaft **18** may be a single shaft or a plurality of shaft segments coupled together to form shaft **18**.

[0020] Various components of the compressor **12** of a turbine system **10** are shown in FIG. **2**. For example, a rotor **20** of the compressor **12** may include a plurality of rotor disks **22**. A plurality of blades **24** may be disposed in an annular array about each rotor disk **22**, and may be attached to the rotor disk **22** as discussed below. As discussed below, each of the blades **24** may be attached to a rotor disk **22** by sliding the blade **24** in a generally axial direction such that an appendage of the blade **24** engages a cavity of the rotor disk **22**. For the blade **24** to be securely attached to the rotor disk **22**, and to prevent axial movement of the blade **24** with respect to the rotor disk **22**, an axial retention device may be provided to prevent such axial movement.

[0021] It should be understood, however, that the present disclosure is not limited to axial retention devices for blades **24** in rotor disks **22** in the compressor **12** of a turbine system **10**. Rather, the axial retention device according to the present disclosure may be utilized in conjunction with any suitable support structure **32** to retain any suitable turbine component **34** in any section of the turbine system **10**. The support structure **32** and turbine component **34** may, in exemplary embodiments, be a rotor disk **22** and blade **24**, respectively, in the compressor **12**. Alternatively, however, the support structure **32** and turbine component **34** may be a rotor disk and blade in the turbine **16**, or a sealing device and spacer rim structure in the compressor **12** or turbine **16**, or any other suitable support structure **32** and turbine component **34** in the turbine system **10**.

[0022] As shown in FIG. **3**, the turbine components **34** and support structures **32** may include mating appendages **40** and cavities **42** for mating the turbine components **34** and support structures **32** together. For example, in some embodiments, the appendages **40** may be dovetails, and the cavities **42** may be shaped and sized to receive the dovetails therein. In general, the turbine components **34** are mated to the support structures **32** by sliding the appendages **40** into the cavities **42** along a generally axial axis **44**, as shown in FIG. **3**. Mating of the appendages **40** in the cavities **42** prevents movement of the turbine components **34** with respect to the support structures **32** in the generally radial and tangential directions, but may not prevent movement of the turbine components **34** with respect to the support structures **32** in a generally axial direction. For example, when the appendages **40** are mated with the cavities **42**, the appendages are free to move along the axial axis **44** in direction **46** or direction **48**.

[0023] Thus as shown in FIGS. **3** through **7**, an axial retention device **50** is provided for axially retaining a turbine component **34** in a support structure **32**. The axial retention device **50** includes a pocket **52** and a latch **54**. The latch **54** according to the present disclosure includes a base member **56** and a pivotal member **58**. In general, the pocket **52** may be defined in one of the turbine component **34** and the support structure **32**, and the base member **56** may be associated with the other of the turbine component **34** and the support structure **32**. For example, in exemplary embodiments as illustrated in FIGS. **3** through **7**, the pocket **52** may be associated with the support structure **32** and the base member **56** may be defined in the turbine component **34**. In alternative embodiments, the pocket **52** may be associated with the turbine component **34** and the base member **56** may be defined in the support structure **32**.

[0024] The turbine component **34** may define a mating surface **62**, and the support structure **32** may define a mating surface **64**. The mating surfaces **62**, **64** may be defined on the appendage **40** and in the cavity **42**, respectively, as shown in FIGS. **3** through **7**. For example, in exemplary embodiments, the mating surface **62** of the turbine component **34** may be the bottom surface of the appendage **40**, and the mating surface **64** of the support structure **32** may be the surface within the cavity **42** configured to mate with the bottom surface of the appendage **40**. In alternative embodiments, the mating surface **62** may be any side or other surface of the appendage **40**, and the mating surface **64** may be the surface within the cavity **42** configured to mate with that surface of the appendage **40**. In further alternative embodiments, the mating surfaces **62**, **64** may be defined adjacent the appendage **40** and cavity **42**. For example, the mating surface **64** may be the rim of the support structure **32**, and the mating surface **62** of the turbine component **34** may be the surface configured to mate with that surface of the support structure **32**. The mating surfaces **62**, **64**, generally mate together when the turbine component **34** and support structure **32** are mated together. The pocket **52** may be defined in the mating surface **62** or **64** of the turbine component **34** or support structure **32**, and the base member **56** may be associated with the other of the mating surface **62** or **64** of the turbine component **34** or support structure **32**. For example, in exemplary embodiments as shown in FIGS. **3** through **7**, the pocket **52** may be defined in the mating surface **64** of the support structure **32** and the base member **56** may be associated with the mating surface **62** of the turbine component **34**.

[0025] As discussed, the base member **56** may be associated with the mating surface **62** or **64**. In some embodiments, the base member **56** may be, for example, mounted to the mating surface **62** or **64**. In these embodiments, the base member **56** may be mounted utilizing, for example, a suitable adhesive, mechanical fastener, or other suitable mounting device or method. In other embodiments, the base member **56**, or a portion thereof, may be integral with the mating surface **62** or **64**. In other exemplary embodiments, as shown in FIGS. **3** though **7**, the mating surface **62** or **64** that is associated with the base member **56** may define a second pocket **72** therein. The base member **56** may be configured to engage the second pocket **72**. In general, engagement of the base member **56** and the second pocket **72** prevents axial movement along the axial axis **44** of the base member **56** with respect to the second pocket **72** in at least one direction. For example, as shown, the base member **56** may be disposed in the second pocket **72**. In some embodiments, the base member **56** may be mounted in the second pocket **72** utilizing, for example, a suitable adhesive, mechanical fastener, or other suitable mounting device or method, and thus may engage the second pocket **72**. In other exemplary embodiments, the base member **56** may not be mounted or otherwise attached to the second pocket **72**, and may simply be positioned in the second pocket **72**. In these embodiments, the second pocket **72** may include a first axial load surface **74** and, optionally, a second axial load surface **76**. Further, the base member **56** may include a first mating axial load surface **82** and, optionally, a second mating axial load surface **84**. When the base member **56** is positioned in the second pocket **72**, the first axial load surface **74** and the first mating axial load surface **82** may interact, preventing axial movement of the base member **56** in one direction, such as in direction **46**. Further, in exemplary embodiments, the second axial load surface **76** and the second mating axial load surface **84** may interact, preventing axial movement of the base member **56** in a second opposite direction, such as in direction **48**. Thus, the base member **56** in these embodiments may engage the second pocket **72**.

[0026] In exemplary embodiments, the base member **56** may be removable from the second pocket **72**. Alternatively, however, the base member **56** may be permanently mounted in the second pocket **72**.

[0027] As shown in FIGS. **3** though **7**, the pivotal member **58** may be configured to engage the pocket **52**. In general, engagement of the pivotal member **58** and the pocket **52** prevents axial movement along the axial axis **44** of the pivotal member **58** with respect to the pocket **52** in at least one direction. For example, to engage the pocket **52** as shown in FIG. **6**, the pivotal member **58** may be disposed in the pocket **52**. The pocket **52** may include a first axial load surface **94** and, optionally, a second axial load surface **96**. Further, the pivotal member **58** may include a first mating axial load surface **102** and, optionally, a second mating axial load surface **104**. When the pivotal member **58** is disposed in the pocket **52**, the first axial load surface **94** and the first mating axial load surface **102** may interact, preventing axial movement of the pivotal member **58** in one direction, such as in direction **46**, and thus preventing axial movement of the turbine component **34** with respect to the support structure **32** in that direction. Further, in exemplary embodiments, the second axial load surface **96** and the second mating axial load surface **104** may interact, preventing axial movement of the pivotal member **58** in a second opposite direction, such as in direction **48**, and thus preventing axial movement of the turbine component **34** with respect to the support structure **32** in that direction. Thus, the pivotal member **58** in these embodiments may engage the pocket **52**.

[0028] As mentioned, the pivotal member **58** may be configured to engage the pocket **52**. For example, the pivotal member **58** may be pivotal with respect to the base member **56**. The pivotal member **58** may pivot about a pivot point **110**. The pivot point **110** may be located adjacent an end of the base member **56**, as shown in FIGS. **3** through **7**, or may be located adjacent the base member **56** at any point along the base member **56**. The pivot point **110** may generally connect the pivotal member **58** to the base member **56**.

[0029] In exemplary embodiments, the pivotal member **58** may pivot between a first position, as shown in FIGS. **5** and **7**, and a second position, as shown in FIGS. **4** and **6**. In the first position, the pivotal member **58** may be disengaged from the pocket **52**. When disengaged, the first axial load surface **94** and the first mating axial load surface **102** may not interact. Thus, the pivotal member **58** may be allowed to move axially with respect to the pocket **52** in at least one direction, such as in direction **46**. Further, the turbine component **34** may be allowed to move axially with respect to the support structure **32** in at least one direction, such as in direction **46**. In the second position, the pivotal member **58** may be engaged with the pocket **52**. When engaged, the first axial load surface **94** and the first mating axial load surface **102** may interact. Thus, the pivotal member **58** may be prevented from moving axially with respect to the pocket **52** in at least one direction, such as in direction **46**. Further, the turbine component **34** may be prevented from moving axially with respect to the support structure **32** in at least one direction, such as in direction **46**.

[0030] In some embodiments, the pivotal member **58** may be biased towards the second position. For example, the latch **54** may include a spring member (not shown) or other suitable biasing device therein. The spring member or other biasing device may exert a force on the pivotal member **58**, such as a tensile or compressive force, to bias the pivotal member **58** towards the second position. In alternative embodiments, however, the pivotal member **58** may be biased towards the first position, may have no bias, or may have any other suitable bias.

[0031] In some embodiments, the pivotal member **58** may include a disassembly feature **120**. The disassembly feature **120** may be configured to pivot the pivotal member **58** from the second position to the first position. For example, in some embodiments, the disassembly feature **120** may be a tab, handle or other protrusion. The disassembly feature **120** in these embodiments may be engaged by a pivoting device, such as a lever, or by a person, to pivot the pivotal member **58** from the second position to the first position. In other embodiments, the disassembly feature **120** may be a groove **122** (see FIG. **3**) defined in the pivotal member **58**. The groove **122** may be engaged by a pivoting device to pivot the pivotal member **58** from the second position to the first position.

[0032] In some embodiments, as shown in FIG. **7**, the axial retention device **50** may further include a pivoting device, such as a lever **124**. The lever **124** may be configured to engage the disassembly feature **120**, such as the groove **122** in exemplary embodiments, and pivot the pivotal member **58** from the second position to the first position.

[0033] The disassembly feature **120** and the pivoting device, such as the lever **124**, may pivot the pivotal member **58** from the second position to the first position. As discussed above, the turbine component **34** in the first position may be allowed to move axially with respect to the support structure **32** in at least one direction. Thus, pivoting of the pivotal member **58** from the second position to the first position may allow for the turbine component **34** to be disassembled from the support structure **32**.

[0034] Thus, the axial retention device **50** of the present disclosure may allow for efficient, cost-effective, and repeatable assembly, retention, and disassembly of turbine components **34** in support structures **32**. For example, as shown in FIG. **5** and discussed above, the pivotal member **58** of the axial retention device **50** may, in the first position, allow a turbine component **34** to be assembled in a support structure **32**. After the turbine component **34** is moved axially with respect to the support structure **32** to a desired position in the support structure **32**, the pivotal member **58** may pivot to a second position, as shown in FIG. **6**. In the second position, the axial retention device **50** may retain the turbine component **34** within the support structure **32**, thus preventing axial movement of the turbine component **34** with respect to the support structure **32** in at least one direction. To disassemble the turbine component **34** from the support structure **32**, as shown in FIG. **7**, the pivotal member **58** may be pivoted from the second position to the first position. In the first position, the axial retention device **50** may again allow axial movement of the turbine component **34** within the support structure **32** in at least one direction.

[0035] Beneficially, the axial retention device **50** of the present disclosure may prevent axial movement of turbine components **34** with respect to support structures **32** in one or more directions. This prevention of axial movement may advantageously prevent or reduce the potential leakage of high temperature flow and/or escape of cooling medium between the turbine component **34** and support structure **32**. Further, the use of an axial retention device **50** as discussed herein may provide for efficient and cost-effective assembly and disassembly of turbine components **34** in support structures **32**. Further, the axial retention device **50** may provide for repeated assembly and disassembly of turbine components **34** in support structures **32** without requiring frequent replacement of the support structures **32**. Additionally, existing turbine components **34** and support structures **32** may be retrofitted to accommodate axial retention devices **50**, thus reducing the time and cost previously associated with assembly and disassembly of these turbine components **34** and support structures **32**.

[0036] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

1. An axial retention device for a turbine system, the axial retention device comprising:

a pocket defined in a mating surface of one of a turbine component and a support structure, the pocket including a first axial load surface; and

a latch comprising a base member and a pivotal member, the base member associated with a mating surface of the other of the turbine component and the support structure, the pivotal member configured to engage the pocket and including a first mating axial load surface,

wherein engagement of the pivotal member and the pocket allows the first axial load surface and the first mating axial load surface to interact, preventing axial movement of the turbine component with respect to the support structure in at least one direction.

2. The axial retention device of claim **1**, wherein in a first position, the pivotal member is disengaged from the pocket and allows axial movement of the turbine component with respect to the support structure in the at least one direction, and in a second position, the pivotal member is engaged with the pocket and prevents axial movement of the turbine component with respect to the support structure in the at least one direction.

3. The axial retention device of claim **2**, wherein the pivotal member is biased towards the second position.

4. The axial retention device of claim **2**, the pivotal member further comprising a disassembly feature, the disassembly feature configured to pivot the pivotal member from the second position to the first position.

5. The axial retention device of claim **4**, wherein the disassembly feature is a groove defined in the pivotal member.

6. The axial retention device of claim **4**, further comprising a lever configured to engage the disassembly feature and pivot the pivotal member from the second position to the first position.

7. The axial retention device of claim **1**, the pocket further including a second axial load surface, the pivotal member further including a second mating axial load surface, and wherein interaction of the second axial load surface and the second mating axial load surface prevents axial movement of the turbine component with respect to the support structure in a second opposite direction.

8. The axial retention device of claim **1**, wherein the pocket is defined in a mating surface of the support structure.

9. The axial retention device of claim **1**, the mating surface of the other of the turbine component and the support structure defining a second pocket, and wherein the base member is configured to engage the second pocket.

10. The axial retention device of claim **1**, wherein the turbine component is a blade and the support structure is a rotor disk.

11. A turbine system, comprising:

a support structure, the support structure having a mating surface;

a turbine component, the turbine component having a mating surface;

a pocket defined in a mating surface of one of the turbine component and the support structure, the pocket including a first axial load surface; and

a latch comprising a base member and a pivotal member, the base member associated with a mating surface of the other of the turbine component and the support structure, the pivotal member configured to engage the pocket and including a first mating axial load surface,

wherein engagement of the pivotal member and the pocket allows the first axial load surface and the first mating axial load surface to interact, preventing axial movement of the turbine component with respect to the support structure in at least one direction.

12. The turbine system of claim **11**, wherein in a first position, the pivotal member is disengaged from the pocket and allows axial movement of the turbine component with respect to the support structure in the at least one direction, and in a second position, the pivotal member is engaged with the pocket and prevents axial movement of the turbine component with respect to the support structure in the at least one direction.

13. The turbine system of claim **12**, wherein the pivotal member is biased towards the second position.

14. The turbine system of claim **12**, the pivotal member further comprising a disassembly feature, the disassembly feature configured to pivot the pivotal member from the second position to the first position.

15. The turbine system of claim **14**, wherein the disassembly feature is a groove defined in the pivotal member.

16. The turbine system of claim **14**, further comprising a lever configured to engage the disassembly feature and pivot the pivotal member from the second position to the first position.

17. The turbine system of claim **11**, the pocket further including a second axial load surface, the pivotal member further including a second mating axial load surface, and wherein interaction of the second axial load surface and the second mating axial load surface prevents axial movement of the turbine component with respect to the support structure in a second opposite direction.

18. The turbine system of claim **11**, wherein the pocket is defined in a mating surface of the support structure.

19. The turbine system of claim **11**, the mating surface of the other of the turbine component and the support structure defining a second pocket, and wherein the base member is configured to engage the second pocket.

20. The turbine system of claim **11**, wherein the turbine component is a blade and the support structure is a rotor disk.

* * * * *