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(54) Locking spacer assembly for circumferential attachment of rotor blades

(57) A locking spacer assembly (218) for use with a rotor blade assembly (200) is provided. The locking spacer assembly including a first end portion (40), a second end portion (404), at least one securing device (422,424), and a center portion (406) positioned between the first end portion (402) and the second end portion (404) such that an opening (418,420) is defined between the center portion and at least one of the first end portion and the second end portion, the opening is sized to receive the securing device therein.

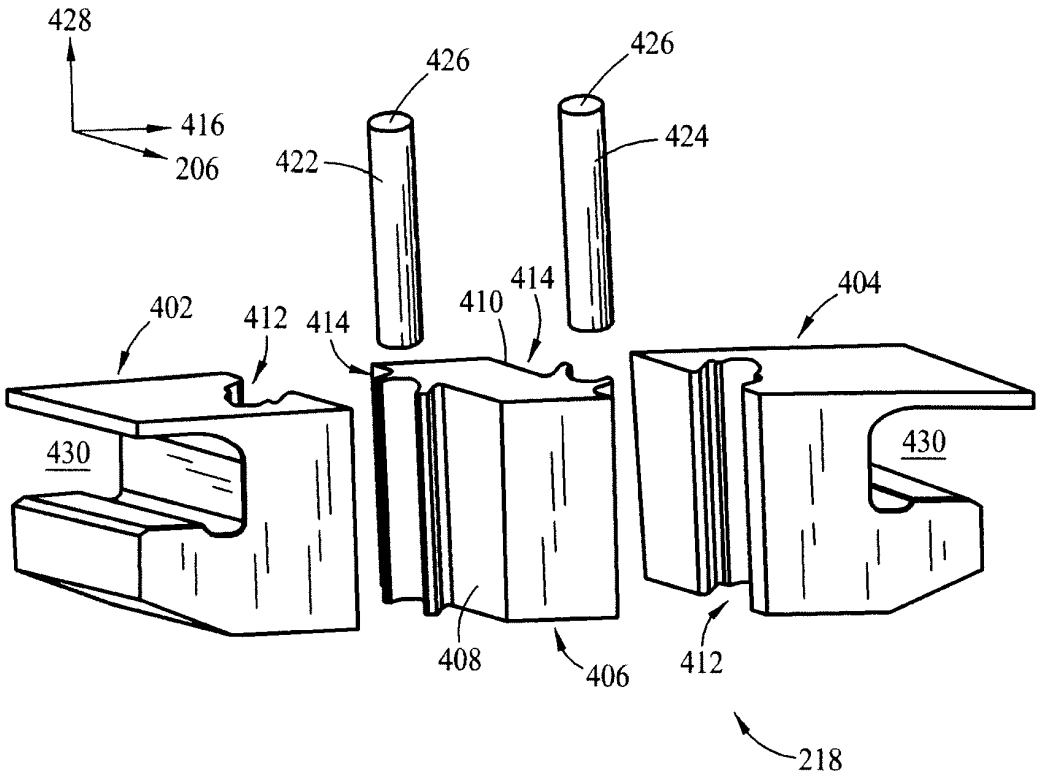


FIG. 4

EP 2 378 080 A2

Description

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates generally to turbine engines and, more particularly, to a blade assembly that may be used with a turbine engine.

[0002] At least some known turbine engines include a rotor, such as an axial compressor rotor, that includes a rotor blade assembly coupled thereto. Known rotor blade assemblies include a plurality of circumferentially-spaced rotor blades arranged in rows spaced axially along the rotor. Moreover, in some known rotor blade assemblies, the plurality of rotor blades are removably coupled to a wheel. More specifically, at least some known wheels include a groove defined therein that is sized and shaped to receive the plurality of rotor blades therein such that a blade root of each rotor blade is inserted in the groove.

[0003] After all of the rotor blades in a row are coupled to the wheel by their blade roots, a spacer is inserted into the groove to fill any remaining space in the groove between the first and last circumferentially spaced blades coupled in the groove. At least some known spacers include multiple components that are assembles together to be locked into position. However, centrifugal forces generated during operation of the turbine engine may cause known spacers to undesirably separate, which may enable the blades to shift circumferentially within the groove. Over time, continual movement of the rotor blades may cause damage to the rotor blade assembly and/or decrease the efficiency of the turbine engine.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In one aspect, a locking spacer assembly is provided for use with a rotor blade assembly. The locking spacer assembly includes a first end portion, a second end portion, at least one securing device, and a center portion positioned between the first end portion and the second end portion. An opening is defined between the center portion and at least one of the first end portion and the second end portion. The opening is configured to receive the securing device.

[0005] In another aspect, a rotor blade assembly is provided for use with a turbine engine. The rotor blade assembly includes a wheel, a plurality of rotor blades coupled to the wheel, and a locking spacer assembly coupled to the wheel. The locking spacer assembly includes a first end portion, a second end portion, at least one securing device, and a center portion positioned between the first end portion and the second end portion. An opening is defmed between the center portion and at least one of the first end portion and the second end portion. The opening is configured to receive the securing device.

[0006] In yet another aspect, a turbine engine is provided. The turbine engine includes a rotor and a rotor blade assembly. The rotor blade assembly includes a wheel, a plurality of rotor blades coupled to the wheel, and a locking spacer assembly coupled to the wheel. The locking spacer assembly includes a first end portion, a second end portion, at least one securing device, and a center portion positioned between the first end portion and the second end portion. An opening is defmed between the center portion and at least one of the first end portion and the second end portion. The opening is configured to receive the securing device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a schematic illustration of an exemplary gas turbine engine system;

FIG. 2 is a perspective illustration of an exemplary blade assembly that may be used with the turbine engine shown in FIG. 1;

FIG. 3 is a detailed perspective illustration of the blade assembly shown in FIG. 2

FIG. 4 is an exploded illustration of an exemplary locking spacer assembly that may be used with the blade assembly shown in FIG. 2; and

FIG. 5 is a top illustration of the locking spacer assembly shown in FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

[0008] The subject matter described herein relates generally to turbine engines. More particularly, the subject matter described herein relates to a mechanism for use in retaining a plurality of rotor blades within in a groove defined in a rotor wheel. In one embodiment, a locking spacer assembly is provided for use with a rotor blade assembly. In such an embodiment, the locking spacer assembly includes a first end portion, a second end portion, at least one securing device, and a center portion that is positioned between the first and second end portions. An opening is defined between the center portion and either the first end portion and/or the second end portion. The opening is sized and shaped to receive the securing device therein. The locking spacer assembly may be used with circumferential attachments assembles with or without a loading groove. Notably, the locking spacer assembly described herein does not require a loading slot or a modified blade for the rotor blade assembly to be assembled.

[0009] As used herein, an element or step recited in the singular and proceeded with the word "a" or "an" should be understood as not excluding plural elements or steps unless such exclusion is explicitly recited. Furthermore, references to "one embodiment" of the present invention are not intended to be interpreted as excluding

the existence of additional embodiments that also incorporate the recited features.

[0010] FIG. 1 is a schematic illustration of an exemplary gas turbine engine system 100. In the exemplary embodiment, gas turbine engine system 100 includes, coupled in serial flow arrangement, a filter house 102, a compressor 104, a combustor assembly 106, and a turbine 108 that is rotatably coupled to compressor 104 via a rotor shaft 110.

[0011] During operation, in the exemplary embodiment, ambient air enters filter house 102, wherein the ambient air is filtered. More specifically, in the exemplary embodiment, the filtered air is channeled through an air inlet (not shown) an is directed downstream towards compressor 104, wherein the filtered air is compressed prior to being discharged towards combustor assembly 106. The compressed air is mixed with fuel, and the resulting fuel-air mixture is ignited within combustor assembly 106 to generate combustion gases that flow towards turbine 108. In the exemplary embodiment, turbine 108 extracts rotational energy from the combustion gases and rotates a rotor shaft 110 that drives compressor 104. Moreover, in the exemplary embodiment, gas turbine engine system 100 drives a load 112, such as a generator, coupled to rotor shaft 110.

[0012] FIGS. 2 and 3 are perspective illustrations of an exemplary rotor blade assembly 200 that is coupled to rotor shaft 110 (shown in FIG. 1). In the exemplary embodiment, rotor blade assembly 200 includes a wheel 202 and a plurality of rotor blades 204 that extend outward from a circumference 206 of wheel 202. More specifically, in the exemplary embodiment, each rotor blade 204 includes a blade root 208 that is inserted within a groove 210 that extends about circumference 206. Groove 210 is substantially similar about an entire circumference 206 of wheel 202. In the exemplary embodiment, each blade 204 has a shape and/or size that is substantially similar to the other blades 204.

[0013] In the exemplary embodiment, wheel 202 includes a pair of flanges 212 that are positioned within groove 210. Flanges 212 cooperate with rotor blade root 208 to securely retain rotor blades 204 within groove 210. More specifically, each blade root 208 includes a recess 214 defined therein that is shaped and/or sized to engage flange 212 such that at least a portion of flange 212 is retained therein. Alternatively, each rotor blade 204 may include a flange, and wheel 202 may include a recess defined therein.

[0014] In the exemplary embodiment, rotor blade assembly 200 also includes a plurality of spacers 216 that are positioned within groove 210 between adjacent circumferentially-spaced blades 204 to facilitate maintaining a distance therebetween. As such, in the exemplary embodiment, groove 210 retains a plurality of alternating blade roots 208 and spacers 216. In the exemplary embodiment, spacers 216 include at least one locking spacer assembly 218, described in more detail below. Moreover, in the exemplary embodiment, each spacer 216 includes a recess (not shown) defined therein that is shaped and/or sized to engage flange 212 such that at least a portion of flange 212 is retained therein. Notably, in the exemplary embodiment, the recess defined in spacer 216 is substantially similar in shape and size to recess 214.

[0015] In the exemplary embodiment, blade 204 is coupled to wheel 202 as each blade root 208 is inserted within groove 210 and after each blade 204 is rotated until recess 214 engages flange 212. Similarly, in the exemplary embodiment, spacer 216 is coupled to wheel 202 by inserting spacer 216 into groove 210 and by then rotating spacer 216 until the recess defined in spacer 216 engages flange 212. After every blade 204 is coupled to wheel 202, a void 222 is defined to receive locking spacer assembly 218 therein.

[0016] FIGS. 4 and 5 are illustrations of an exemplary locking spacer assembly 218. In the exemplary embodiment, locking spacer assembly 218 includes a first end portion 402, a second end portion 404, and a center portion 406 that includes a first side 408 shaped and/or sized to engage first end portion 402 and a second side 410 shaped and/or sized to engage second end portion 404.

[0017] In the exemplary embodiment, each end portion 402 and 404 is formed with a first profile 412, and each side 408 and 410 is formed with a second profile 414 that is complementary to first profile 412. More specifically, in the exemplary embodiment, first profile 412 is a female sliding dovetail profile, and second profile 414 is a male sliding dovetail profile that is shaped complementarily to first profile 412. As such, first profile 412 mates against second profile 414 such that end portions 402 and 404 sufficiently interlock with center portion 406 to enable axial stresses to be transmitted along a longitudinal axis 416 of wheel 202 and/or to enables circumferential or hoop stresses to be transmitted along circumference 206.

[0018] In the exemplary embodiment, end portions 402 and 404 are substantially similar in shape and size, and, as such, end portions 402 and 404 are interchangeable. More specifically, in the exemplary embodiment, first side 408 is substantially similar to second side 410. Alternatively, first end portion 402 may have a first configuration, first side 408 may have a first complementary configuration, second end portion 404 may have a second configuration that is different from the first configuration, and second side 410 may have a second complementary configuration that is different from first side 408. It should be understood that any of first end portion 402, second end portion 404, first side 408, and/or second side 410 may have any suitable shape and/or size that enables locking spacer assembly 218 to function as described herein.

[0019] In the exemplary embodiment, a first opening 418 is defined between first end portion 402 and center portion 406, and a second opening 420 is defined between second end portion 404 and center portion 406. Moreover, in the exemplary embodiment, first opening

418 is shaped and/or sized to receive a first securing device 422 therein, and second opening 420 is shaped and/or sized to receive a second securing device 424 therein. More specifically, in the exemplary embodiment, securing devices 422 and 424 are each dowels that securely couple end portions 402 and 404 to center portion 406 such that portions 402, 404, and/or 406 do not move relative to one another. Each securing device 422 and 424 is insertable such that a top 426 of each securing device 422 and 424 does not extend above a top of portion 402, 404, and/or 406. Alternatively, securing devices 422 and 424 are set screws and/or grub screws that include a socket head such that a top of each securing device 422 and 424 does not extend above a top of portion 402, 404, and/or 406.

[0020] In the exemplary embodiment, opening 418 and 420 are substantially similar in shape and size. As such, first securing device 422 and second securing device 424 are interchangeable. Alternatively, first opening 418 may have a first configuration, and second opening 420 may have a second configuration that is different from the first configuration such that first securing device 422 is different than second securing device 424. It should be understood that any of first opening 418, second opening 420, first securing device 422, and/or second securing device 424 may have any suitable shape and/or size that enables locking spacer assembly 218 to function as described herein. In the exemplary embodiment, openings 418 and 420 receive securing devices 422 and 424, respectively, to enable radial stresses to be transmitted along a radial direction 428 of wheel 202.

[0021] In the exemplary embodiment, each end portion 402 and 404 includes a recess 430 defined therein that is positioned opposite first profile 412. More specifically, in the exemplary embodiment, recess 430 is shaped and/or sized to engage flange 212 such that at least a portion of flange 212 is retained therein. Notably, in the exemplary embodiment, recess 430 is shaped and sized substantially similarly to recess 214 and to the recess defined in spacer 216.

[0022] In the exemplary embodiment, end portions 402 and 404 are inserted within void 222 and are moved in opposite directions along circumference 206 such that recess 430 engages flange 212. Moreover, in the exemplary embodiment, center portion 406 is inserted between end portions 402 and 404 such that first side 408 engages first end portion 402 and second side 410 engages second end portion 404. As such, when first profile 412 engages second profile 414, end portions 402 and 404 interlock with center portion 406 to enables axial stresses to be transmitted along a longitudinal axis 416 of wheel 202 and/or to enables circumferential or hoop stresses to be transmitted along circumference 206.

[0023] In the exemplary embodiment, during assembly, first securing device 422 is inserted into first opening 418, and second securing device 424 is inserted into second opening 420 to securely couple end portions 402 and 404 to center portion 406 such that portions 402, 404, and/or 406 do not move relative to one another. In the exemplary embodiment, openings 418 and 420 receive securing devices 422 and 424, respectively, to enables radial stresses to be transmitted along a radial direction 428 of wheel 202. After locking spacer assembly 400 is fully installed, rotor blade assembly 200 is securely retained within groove 210.

[0024] Exemplary embodiments of methods and systems are described and/or illustrated herein in detail. The exemplary methods and systems provide a blade assembly that facilitates inserting blade roots and/or spacers within a groove that is substantially similar about a circumference of a wheel. As such, the methods and systems described enable locking a blade assembly such that adjacent turbine blades are not moved, thereby enabling repairing and/or replacing one turbine blade without disturbing the other turbine blades. Moreover, implementing the locking assembly facilitates reducing a time and/or cost associated with assembling the turbine engine. The exemplary systems and methods are not limited to the specific embodiments described herein, but rather, components of each system and/or steps of each method may be utilized independently and separately from other components and/or method steps described herein. Each component and each method step may also be used in combination with other components and/or method steps.

[0025] This written description uses examples to disclose certain embodiments of the present invention, including the best mode, and also to enable any person skilled in the art to practice those certain embodiments, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the present 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.

[0026] For completeness, various aspects of the invention are now set out in the following numbered clauses:

1. A locking spacer assembly for use with a rotor blade assembly, said locking spacer assembly comprising:

a first end portion;

a second end portion;

at least one securing device; and

a center portion positioned between said first end portion and said second end portion such that an opening is defined between said center

portion and at least one of said first end portion and said second end portion, said opening is sized to receive said securing device therein.

2. A locking spacer assembly in accordance with clause 1, wherein said center portion comprises a first side that is configured to engage said first end portion and a second side that is configured to engage said second end portion.

3. A locking spacer assembly in accordance with clause 2, wherein at least one of said first end portion and said second end portion has a first profile, and at least one of said first side and said second side has a second profile that is shaped substantially complementary to the first profile.

4. A locking spacer assembly in accordance with clause 3, wherein one of the first profile and the second profile is a male dovetail profile, and wherein the other of the first profile and the second profile is a female dovetail profile.

5. A locking spacer assembly in accordance with clause 1, wherein said first end portion is substantially similar to said second end portion.

6. A locking spacer assembly in accordance with clause 1, wherein a top of said securing device does not extend beyond a top of at least one of said first end portion, said second end portion and said center portion.

7. A locking spacer assembly in accordance with clause 1, wherein said first end portion, said second end portion, and said center portion are configured to carry at least one of a circumferential load and an axial load, and said securing device is configured to carry a radial load.

8. A rotor blade assembly for use with a turbine engine, said rotor blade assembly comprising:

a wheel;

a plurality of rotor blades coupled to said wheel; and

a locking spacer assembly coupled to said wheel, said locking spacer assembly comprising a first end portion, a second end portion, at least one securing device, and

a center portion positioned between said first end portion and said second end portion such that an opening is defined between said center portion and at least one of said first end portion and said second end portion, said opening is sized to receive said securing device therein.

9. A rotor blade assembly in accordance with clause 8, wherein each of said plurality of blades is substantially similar to another rotor blade.

10. A rotor blade assembly in accordance with clause 8, wherein said locking spacer assembly is positioned between adjacent rotor blades.

11. A rotor blade assembly in accordance with clause 8, wherein said center portion comprises a first side that is configured to engage said first end portion and a second side that is configured to engage said second end portion.

12. A rotor blade assembly in accordance with clause 8, wherein a top of said securing device does not extend beyond a top of at least one of said first end portion, said second end portion ,and said center portion.

13. A rotor blade assembly in accordance with clause 8, wherein said first end portion, said second end portion, and said center portion are configured to carry at least one of a circumferential load and an axial load, and said securing device is configured to carry a radial load.

14. A turbine engine comprising:

a rotor; and

a rotor blade assembly comprising a wheel, a plurality of rotor blades coupled to said wheel, and a locking spacer assembly coupled to said wheel, said locking spacer assembly comprising a first end portion, a second end portion, at least one securing device, and a center portion positioned between said first end portion and said second end portion such that an opening is defined between said center portion and at least one of said first end portion and said second end portion, said opening is sized to receive said securing device therein.

15. A turbine engine in accordance with clause 14, wherein each of said plurality of blades is substantially similar to another rotor blade.

16. A turbine engine in accordance with clause 14, wherein said locking spacer assembly is positioned between adjacent rotor blades.

17. A turbine engine in accordance with clause 14, wherein said center portion comprises a first side that is configured to engage said first end portion and a second side that is configured to engage said

second end portion.

18. A turbine engine in accordance with clause 14, wherein a top of said securing device does not extend beyond a top of at least one of said first end portion, said second end portion ,and said center portion.

19. A turbine engine in accordance with clause 14, wherein said first end portion, said second end portion, and said center portion are configured to carry at least one of a circumferential load and an axial load, and said securing device is configured to carry a radial load.

20. A turbine engine in accordance with clause 14, wherein said plurality of rotor blades are not directly coupled to said rotor.

Claims

1. A locking spacer assembly (218) for use with a rotor blade assembly (200), said locking spacer assembly comprising:

a first end portion (40);
a second end portion (404);
at least one securing device (422,424); and
a center portion (406) positioned between said first end portion (402) and said second end portion (404) such that an opening (418,420) is defined between said center portion and at least one of said first end portion and said second end portion, said opening is sized to receive said securing device therein.

2. A locking spacer assembly (218) in accordance with claim 1, wherein said center portion (406) comprises a first side (408) that is configured to engage said first end portion (402) and a second side (410) that is configured to engage said second end portion (404).

3. A locking spacer assembly (218) in accordance with claim 2, wherein at least one of said first end portion (402) and said second end portion (404) has a first profile (412), and at least one of said first side and said second side (410) has a second profile that is shaped substantially complementary to the first profile.

4. A locking spacer assembly (218) in accordance with claim 3, wherein one of the first profile (412) and the second profile (414) is a male dovetail profile, and wherein the other of the first profile and the second profile is a female dovetail profile.

5. A locking spacer assembly (218) in accordance with any of the preceding claims, wherein said first end portion (402) is substantially similar to said second end portion (404).

6. A locking spacer assembly (218) in accordance with any of the preceding claims, wherein a top of said securing device (420,422) does not extend beyond a top of at least one of said first end portion (402), said second end portion (404),and said center portion (406).

7. A locking spacer assembly (218) in accordance with any of the preceding claims, wherein said first end portion (402), said second end portion (404), and said center portion (406) are configured to carry at least one of a circumferential load and an axial load, and said securing device (422,424) is configured to carry a radial load.

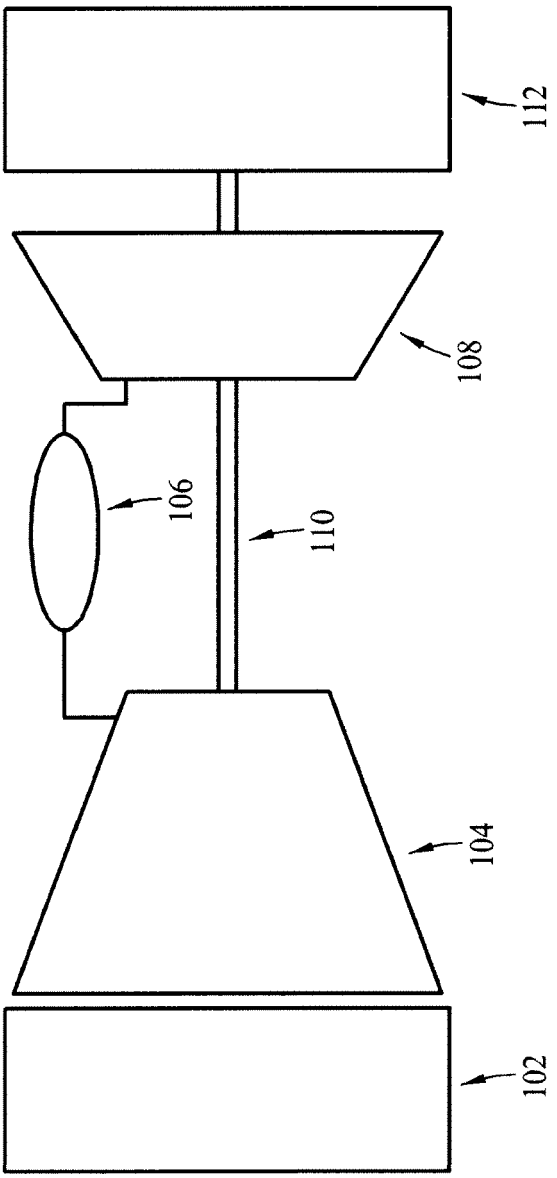


FIG. 1

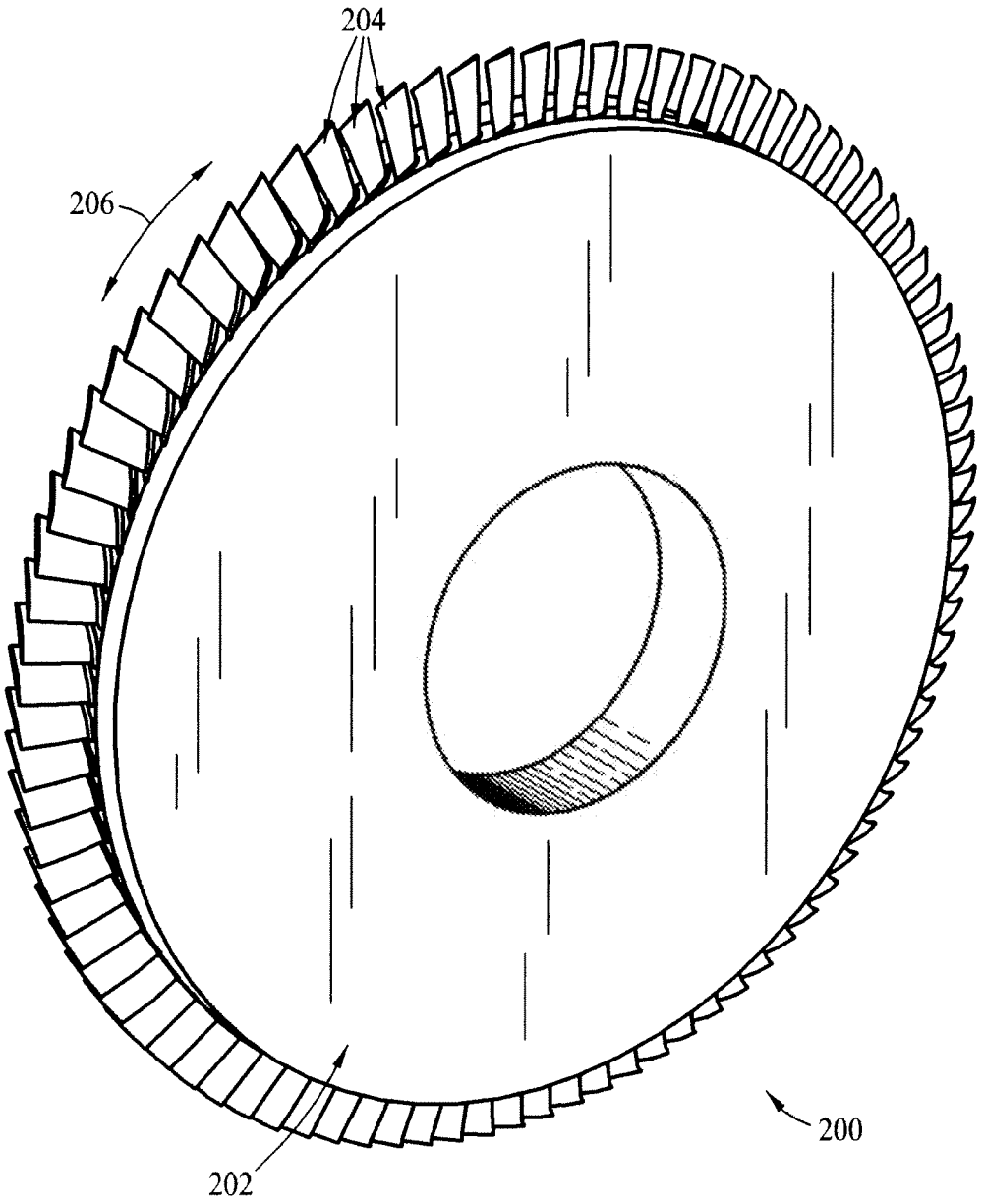


FIG. 2

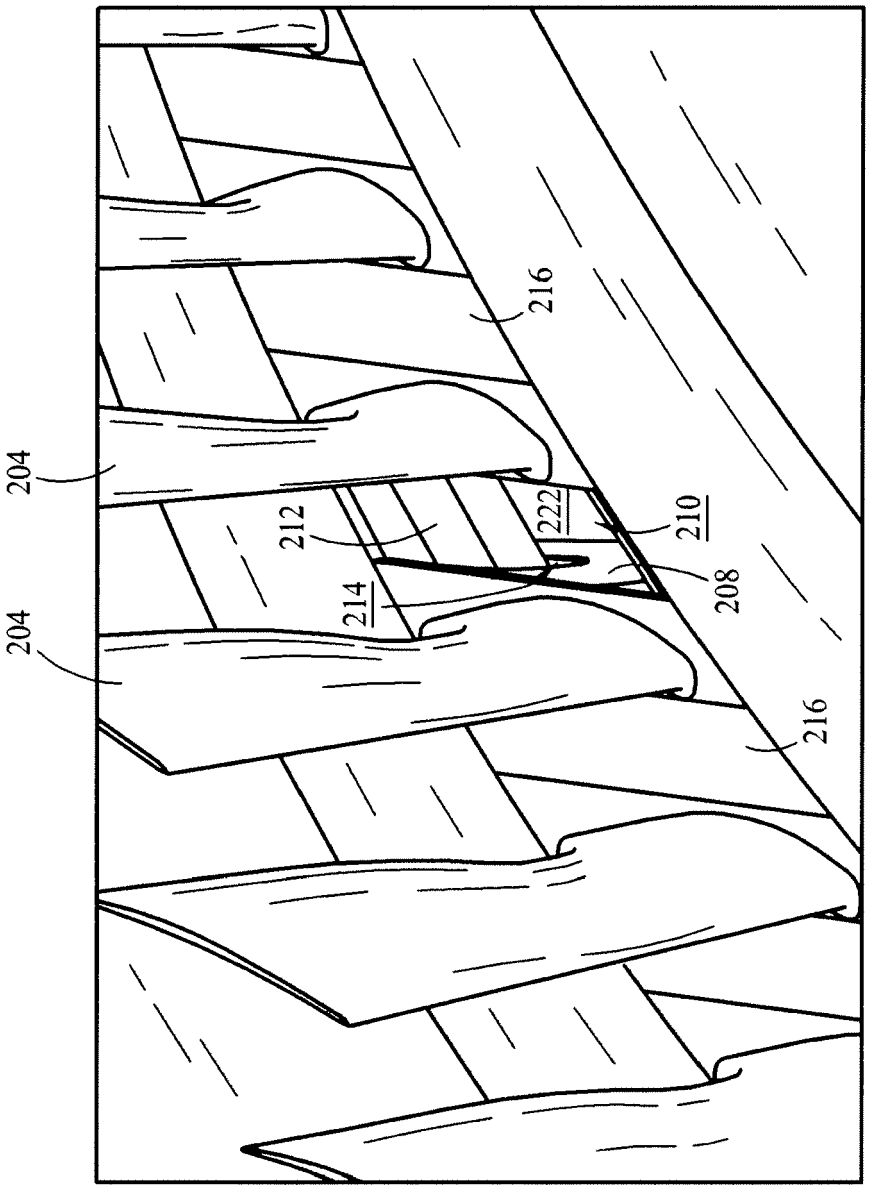
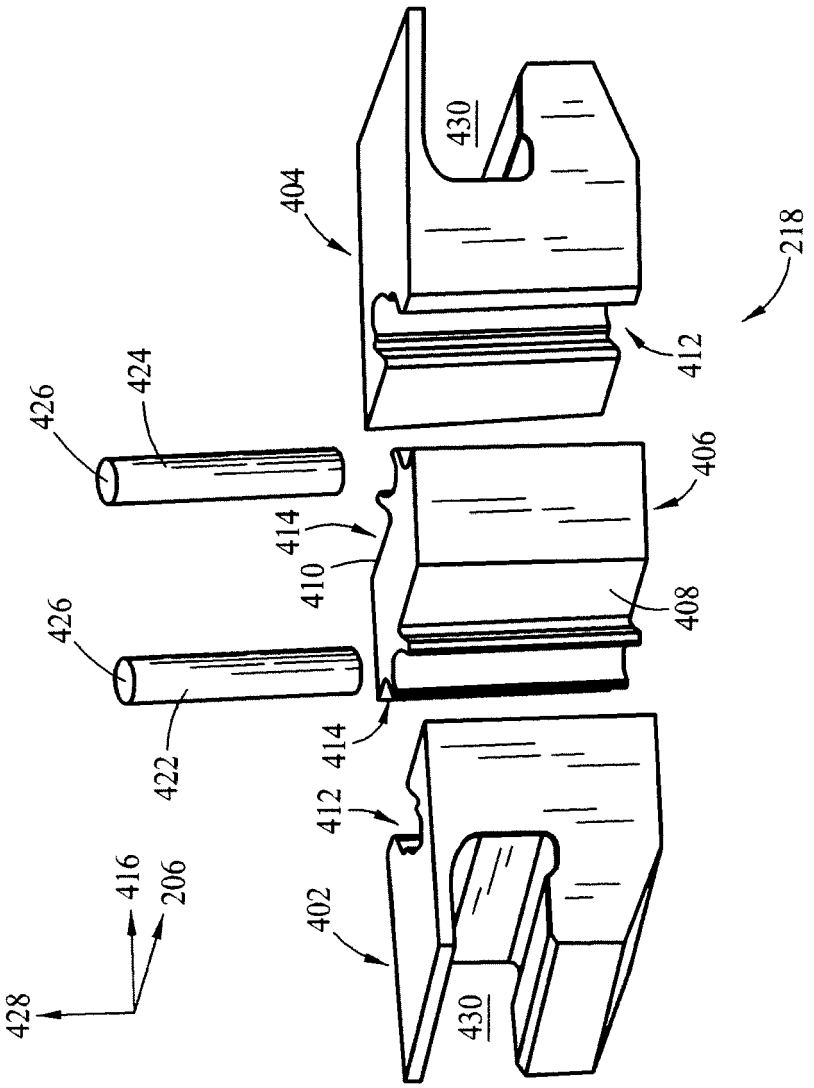


FIG. 3


218
404
430
412
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426
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414
410
408
426
422
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416
206
402
428
430

FIG. 4

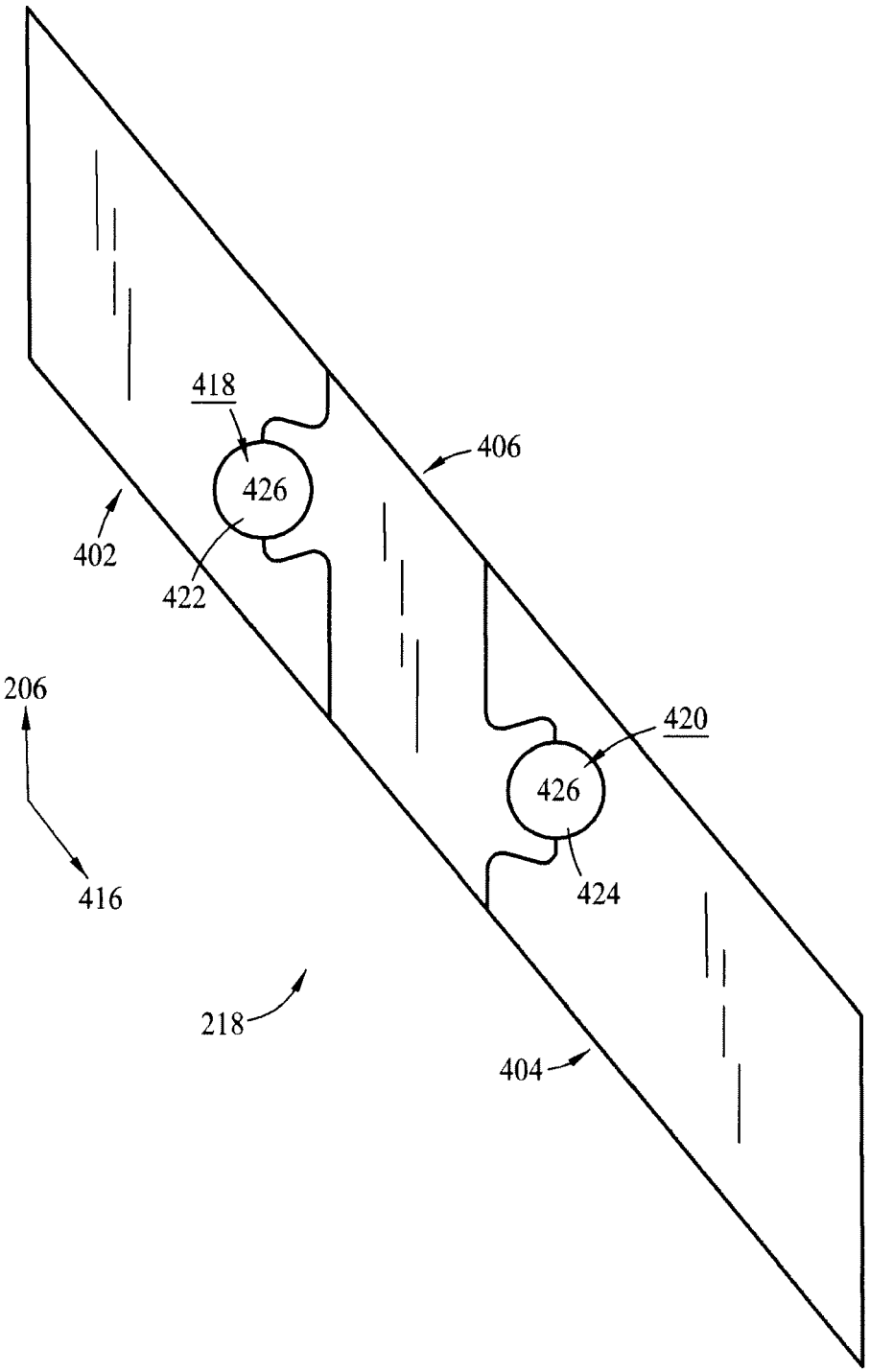

FIG. 5