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(54) Turbine and rotor blade with brush seal

(57) A turbine rotor for a turbine engine includes multiple rotor disks (26) having rotor blades (28) mounted about the circumference of each of the rotor disks (26). A fluid seal extends about the circumference of each rotor disk (26) in close proximity to a stationary component (36) of the rotor to separate the space between the rotor blades (28) and a stationary component (36) into separate cavities. The fluid seal includes a seal land (44) on the rotor disk (26) and a brush seal (46) extending from the stationary component (36). A plurality of disk land segments (54) and a plurality of blade land segments (56) form the seal land (44). The disk seal segments (54) are located on the rotor disk (26) between the rotor blades (28). The blade land segments (56) are located on the rotor blades (28). After the rotor blades (28) are assembled, the blade land segments (56) and the disk land segments (54) fit together to form a segmented ring-like seal land (44) around the circumference of the rotor disk (26).

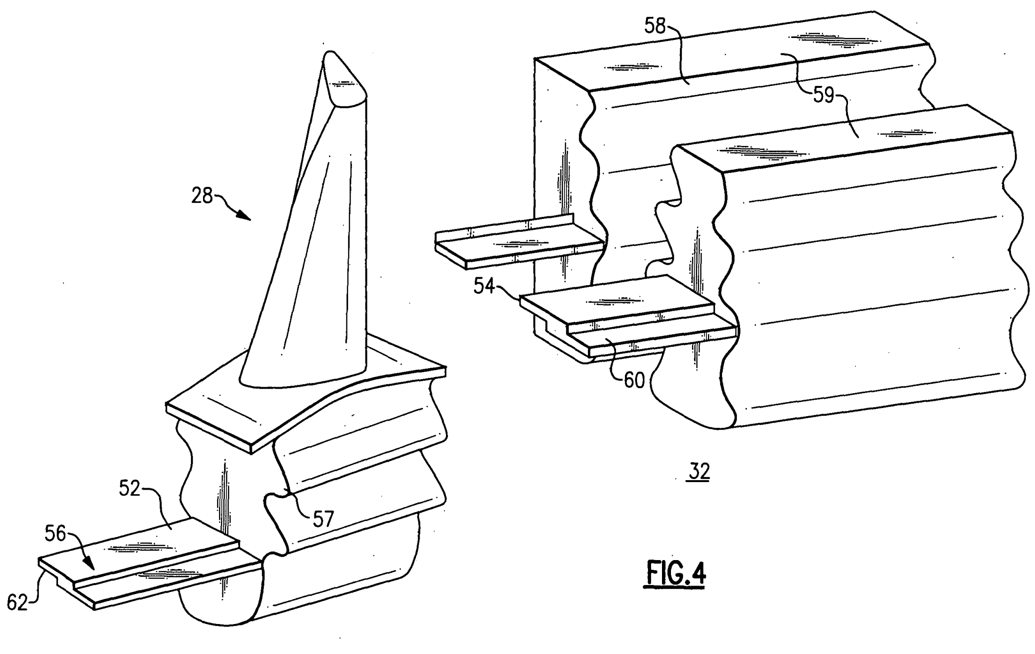

FIG.4

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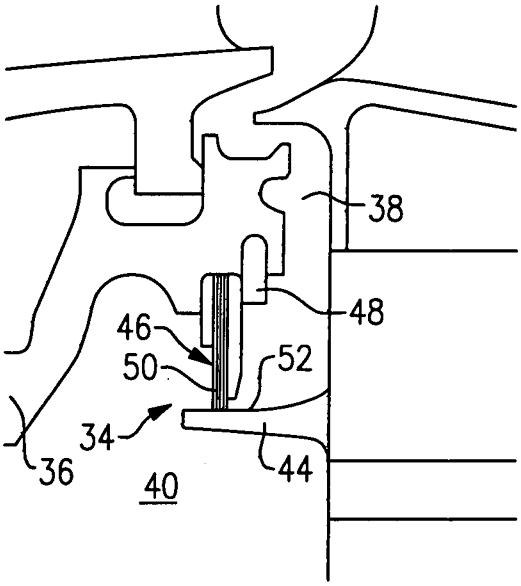

FIG.3

Description

BACKGROUND OF THE INVENTION

[0001] The invention generally relates to an arrangement for fluid seals within a gas turbine engine.

[0002] Turbine engines include high and low pressure rotor spools comprising multiple rotor disks. Fluid seals are formed integrally into each rotor disk to contact stator components, such as a tangential on-board injector. The seals restrict leakage of compressed air from between the stator component and the rotor disks and separate the lower pressure gaspath air from high pressure air used for cooling.

[0003] Due to the rotor disk geometry, multiple machining passes are required to produce the thin sectional area required for the fluid seal. This is unduly complex. Also, during operation of the engine, the fluid seal may contact an abradable material on the stationary components, causing wear. Because the fluid seal is integrally formed with the rotor disk of the compressor, the entire rotor disk must be repaired or replaced when the fluid seal has worn.

[0004] An improved arrangement for sealing fluids within a gas turbine engine is needed.

SUMMARY OF THE INVENTION

[0005] An example turbine engine rotor according to this invention includes an arrangement for incorporating a fluid seal assembly while reducing wear on the rotor disk.

[0006] A typical turbine engine rotor includes multiple rotor disks with rotor blades mounted about the circumference of each of the rotor disks. A plurality of stator vanes extend axially between adjacent rotor disks. A fluid seal assembly extends about the circumference of each rotor disk in close proximity to a stationary component of the compressor. The fluid seal assembly separates the space between the rotor blades and stationary components into separate pressurized cavities.

[0007] A preferred embodiment of fluid seal disclosed herein includes a seal land in contact with a brush seal. The seal land extends about the circumference of the disk rim and includes a plurality of disk land segments and a plurality of blade land segments fitting together to form a segmented seal land. The disk land segments are integrally formed with the rotor disk between the rotor blades. The blade land segments are integrally formed with the rotor blades. When the rotor blades are assembled to the rotor disk, the blade land segments and the disk land segments fit together to form a segmented, ring-like seal land around the circumference of the rotor disk.

[0008] Each disk land segment has a first interlocking feature interfitting with a second interlocking feature on the blade land segments to align the land segments and reduce circumferential and radial fluid leaks.

[0009] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Figure 1 is a schematic view of an example turbine engine of the present invention;

Figure 2 illustrates a portion of a cross-section of a typical rotor for the example turbine engine of the present invention;

Figure 3 is an enlarged view of region 3-3 from Figure 2, illustrating a portion of an example fluid seal;

Figure 4 is a perspective view of an example disk land segment and blade land segment of the present invention prior to assembly;

Figure 5 illustrates a portion of a cross-section of another example turbine rotor of the present invention;

Figure 6 is an enlarged view of region 6-6 from Figure 5, illustrating a portion of another example fluid seal; and

Figure 7 is a perspective view of another example disk land segment and blade land segment of the present invention prior to assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Figure 1 is a schematic view of a turbine engine 10. Air is pulled into the turbine engine 10 by a fan 12 and flows through a low pressure compressor 14 and a high pressure compressor 16. Fuel is mixed with the air, and combustion occurs within the combustor 18. Exhaust from combustion flows through a high pressure turbine 20 and a low pressure turbine 22 prior to leaving the engine through an exhaust nozzle 24.

[0012] Figure 2 illustrates a portion of a cross-section of a typical turbine engine turbine, showing a rotor disk 26, which is one of several defining a rotor. Each rotor disk 26 rotates about an axis A located along the longitudinal centerline of the turbine engine 10. A plurality of rotor blades 28 are mounted about the circumference of each rotor disk 26. A plurality of stator vanes 30 extend between the rotor blades 28 of axially adjacent rotor disks 26, as shown.

[0013] Each rotor disk 26 includes a disk rim 32. The disk rim 32 secures the rotor blades 28. A fluid seal 34 is located between the rotor disk 26 and a stationary part of the turbine, such as a stator vane, a support or a tangential on-board injector (TOBI) 36. The fluid seal 34 defines a cavity 38 located axially above the fluid seal 34 and further defined by the stator vane 30 and the rotor blade 28. Air within the cavity 38 is flowing circumferentially about the axis A of rotation for the rotor disk 26. An interior cavity 40 is located axially below the fluid seal 34 and defined by the rotor disk 26 and the stationary component 36. A nozzle 42 leading from the TOBI 36 allows high pressure cooling air to reach the interior cavity 40 to cool the rotor disk 26.

[0014] Figure 3 illustrates an enlarged view of the example fluid seal 34. The fluid seal 34 includes a segmented seal land 44 and a brush seal 46. The seal land 44 extends about the circumference of the disk rim 32. The seal land 44 is preferably formed of the same material as the rotor disk 26, such as any ferrous, nickel, or ceramic materials. The seal land 44 may also be coated with a wear resistant hard facing or coating to reduce wear.

[0015] The seal land 44 is in contact with the brush seal 46 extending from the stationary component 36. The seal land 44 is illustrated as extending axially toward the stationary component 36 along the axis A of the turbine engine 10. However, the seal land 44 can extend toward any stationary component of the turbine engine 10. The brush seal 46 includes an axial locking feature 48 to retain the brush seal 46 to the stationary component 36 and to prevent axial movement of the brush seal 46 along the axis A of the turbine engine 10. The brush seal 46 extends in a radially inward direction from the stationary component 36 and has bristles 50 which contact a radial face 52 of the seal land 44. The bristles 50 are wire bristles or the like to provide radial resilience and reduce wear on the seal land 44.

[0016] Referring to Figure 4, the segmented seal land 44 includes a plurality of disk land segments 54 and a plurality of blade land segments 56. Spaced around the circumference of the disk rim 32, segments 54 and 56 fit together to form a segmented, ring-like seal land about the disk rim 32. The disk land segments 54 are integrally formed in the disk rim 32 between the rotor blades 28.

[0017] The blade land segments 56 are integrally formed with the rotor blades 28. The rotor blade 28 has a root 57 contoured to fit into a complementary contoured blade slot 58 in the disk rim 32. Walls 59 in the disk rim 32 define the individual blade slots 58. The rotor blade 28 is loaded in the blade slot 58, and each disk land segment 54 and blade land segment 56 mate with a circumferentially adjacent land segment 54 or 56 to provide a rigid structure. When the blade land segments 56 are worn, the individual rotor blades 28 and blade land segments 56 can be repaired or replaced. Also, use of the brush seal 46 reduces wear on the seal land 44, extending the life of the fluid seal 34 compared to the prior art abradable material.

[0018] After the rotor blade 28 is assembled in the blade slot 58, the disk land segments 54 and the blade land segments 56 fit together to form a segmented, ring-like fluid seal 34 around the circumference of the rotor disk 26. Each disk land segment 54 has a first interlocking feature 60, and each blade land segment 56 has a second interlocking feature 62. The first interlocking feature 60 and the second interlocking feature 62 interfit to align the disk land segments 54, with the blade land segments 56. In the example shown, the first interlocking feature 60 is a protrusion extending from the disk land segment 54, and the second interlocking feature 62 is a protrusion extending from the blade land segment 56. The protrusions overlap one another to create a shiplap joint and reduce circumferential and radial fluid leaks between the disk land segments 54 and the blade land segments 56. Alternatively, the first interlocking feature 60 and the second interlocking feature can be tongue and groove or other interfitting elements.

[0019] Figure 5 illustrates a portion of a cross-section of another example embodiment of a turbine including a rotor disk 26 defining a turbine rotor. A fluid seal 102 is located between the rotor disk 26 and a stationary component 36. The fluid seal 102 defines a cavity 38 located axially above the fluid seal 102 and further defined by the stator vane 30 and the rotor blade 28. An interior cavity 40 is located axially below the fluid seal 102 and defined by the rotor disk 26 and the stationary component 36. A nozzle 42 leading from the stationary component 36 allows high pressure cooling air to reach the interior cavity 40 to cool the rotor disk 26.

[0020] Figure 6 illustrates an enlarged view of the example fluid seal 102. The fluid seal 102 includes a seal land 104 and a brush seal 106. The seal land 104 extends about the circumference of the disk rim 32. The seal land 104 is preferably formed of the same material as the rotor disk 26, such as any ferrous or nickel materials. The seal land 104 may also be coated with a wear resistant hard facing or coating to reduce wear.

[0021] The seal land 104 is in contact with the brush seal 106 extending axially from the stationary component 36. The seal land 104 is illustrated as extending axially toward the stationary component 36 along the axis A of the turbine engine 10. The brush seal 106 includes an axial locking feature 108 to retain the brush seal 106 to the stationary component 36 and to prevent axial movement of the brush seal 106 along the axis A of the turbine engine 10. The brush seal 106 extends in an axial direction from the stationary component 36 and has bristles 110 which contact a radial face 112 of the seal land 104. The bristles 110 are wire bristles or the like to provide radial resilience and to reduce wear on the seal land 104.

[0022] Referring to Figure 7, the seal land 104 includes a plurality of disk land segments 114 and a plurality of blade land segments 116 spaced around the circumference of the disk rim 32 and fitting together to form a solid seal land 104 about the disk rim 32. The disk land segments 114 are integrally formed in the disk rim 32 between the rotor blades 28.

[0023] The blade land segments 116 are integrally formed in the rotor blades 28. The rotor blade 28 is loaded into a blade slot 58 in the disk rim 32. Walls 59 in the disk rim 32 define the individual blade slots 58. When the rotor blade 28 is loaded in the blade slot 58, each disk land segment 114 and blade land segment 116 mate with a circumferentially adjacent land segment 114 or 116 to provide a rigid structure. When the blade land segments

116 are worn, the individual rotor blades 28 and blade land segments 116 can be repaired or replaced. The brush seal 106 reduces wear on the seal land 104 extending the life of the fluid seal 102.

[0024] After the rotor blade 28 is assembled in the blade slot 58, the disk land segments 114 and the blade land segments 116 fit together to form a segmented, ring-like fluid seal 34 around the circumference of the rotor disk 26. Each disk land segment 114 can have a first interlocking feature 60, and each blade land segment 116 can have a second interlocking feature 62 as illustrated in Figure 4 of the previous example. The first interlocking feature and the second interlocking feature interfit to align the disk land segments 114 with the blade land segments 116. The first interlocking feature and the second interlocking feature can be a ship lap, a tongue and a groove or other interfitting elements.

[0025] Although the example embodiment discloses an arrangement of assembling fluid seal segments onto a rotor disk for a turbine, the arrangement may be used for any rotor and seal assembly.

[0026] Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

Claims

1. A turbine engine (10) comprising:

a rotor disk (26) to rotate about an axis defining a disk rim (32) and having a plurality of rotor blades (28) mounted to the disk rim (32);
a plurality of disk land segments (54; 114) extending from the disk rim (32) between each of the plurality of rotor blades (28);
a plurality of blade land segments (56; 116) extending from each of the plurality of rotor blades (28), wherein the plurality of disk land segments (54; 114) and the plurality of blade land segments (56; 116) form a seal land (44; 104) located about a circumference of the disk rim (32); and
a brush seal (46; 106) extending from a stationary component (36) of the turbine engine (10) and contacting the seal land (44; 104).

2. A fluid seal assembly for a jet engine (10) comprising:

a plurality of rotor disks (26) rotating about an axis and each defining a disk rim (32) and having a plurality of rotor blades (28) mounted to the disk rim (32);
a plurality of disk land segments (54; 114) extending from the disk rim (32) between each of the plurality of rotor blades (28);
a plurality of blade land segments (56; 116) extending from each of the plurality of rotor blades (28), wherein the plurality of disk land segments (54; 114) and the plurality of blade land segments (56; 116) form a seal land (44; 104) located about the circumference of the disk rim (32); and
a brush seal (46; 106) extending from a stationary component (36) of the turbine engine (10) to contact the seal land (44; 104).

3. The turbine engine or assembly of claim 1 or 2, wherein the plurality of disk land segments (54; 114) are integrally formed in or with the rotor disk (26).

4. The turbine engine or assembly of any preceding claim, wherein the plurality of blade land segments (56; 116) are integrally formed in or with each of the plurality of rotor blades (28).

5. The turbine engine or assembly of any preceding claim, wherein the seal land (104) comprises a radial face (112) and the brush seal (106) extends axially to contact the radial face (112).

6. The turbine engine or assembly of any of claims 1 to 4, wherein the seal land (44) comprises an axial face (52) and the brush seal (46) extends radially inward to contact the axial face (52).

7. The turbine engine or assembly of any preceding claim, wherein the stationary component (36) is a tangential on-board injector.

8. The turbine engine or assembly of any preceding claim, wherein the brush seal (46; 106) further comprises an axial locking feature (48; 108) to prevent axial movement of the brush seal (46; 106).

9. The turbine engine or assembly of any preceding claim, wherein an interfitting structure (60, 62) on each of the plurality of disk land segments (54; 114) and the plurality of blade land segments (56; 116) align the plurality of disk land segments (54; 114) and the plurality of blade land segments (56; 116).

10. A rotor blade (28) comprising:

a blade platform having a blade root (57) extending from the blade platform for receiving in a blade slot (58) of a rotor disk (26); and
a blade seal segment (56; 116) extending from the blade root (57), wherein the blade seal segment (56; 116) defines a seal land for contacting a brush seal (46; 106) extending from a stationary turbine engine component (36).

11. The rotor blade of claim 10, comprising a first interlocking feature (62) on the blade seal segment (56; 116) for interfitting with a second interlocking feature (60) on a disk seal segment (54; 114) of the rotor disk (26).

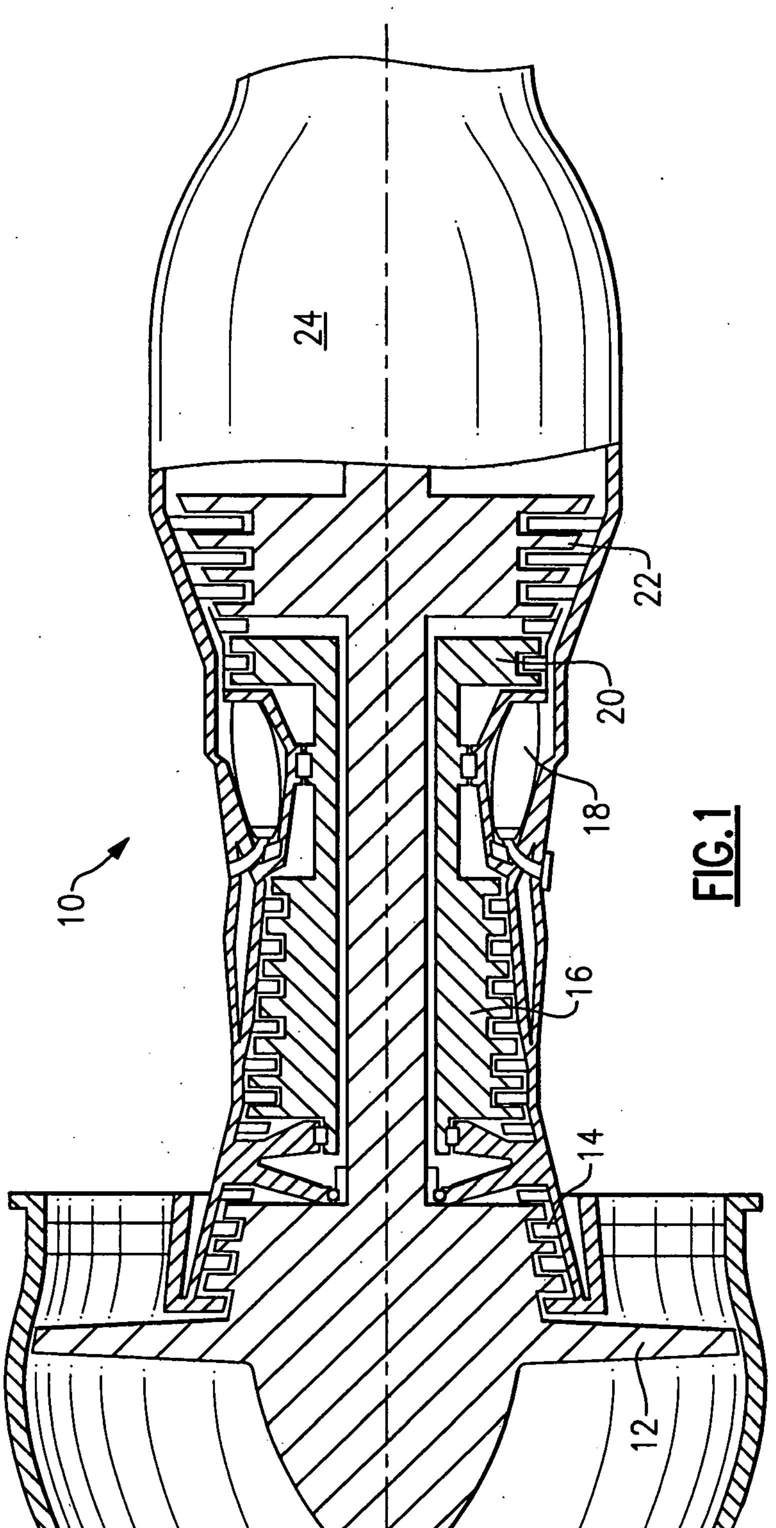

FIG.1

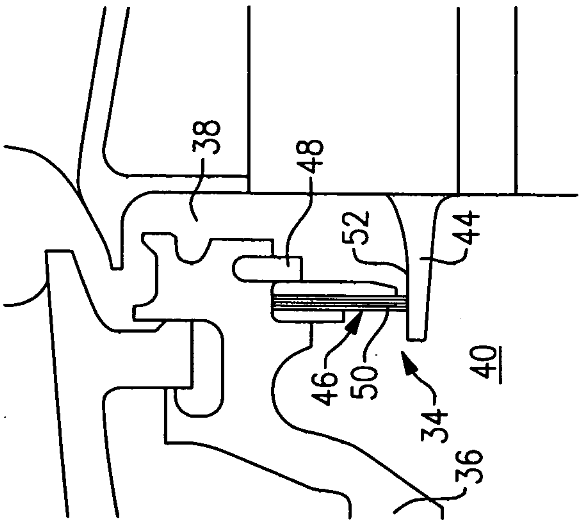

FIG.3

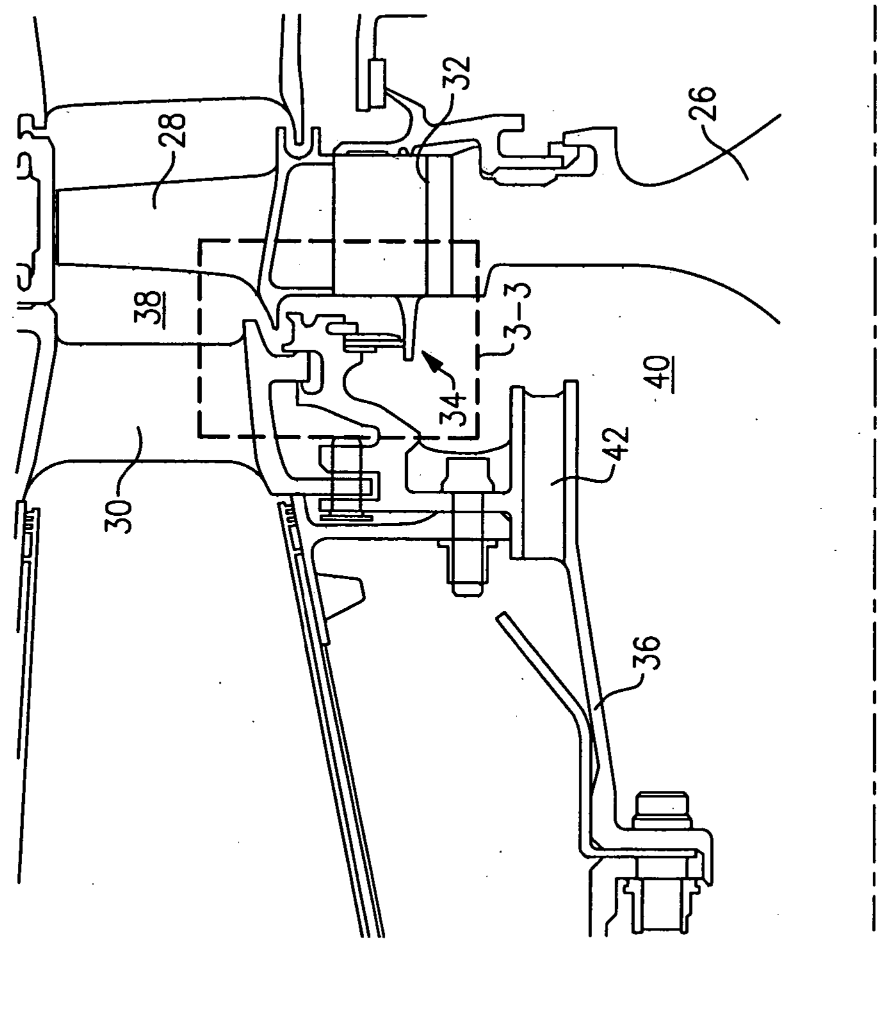

FIG.2

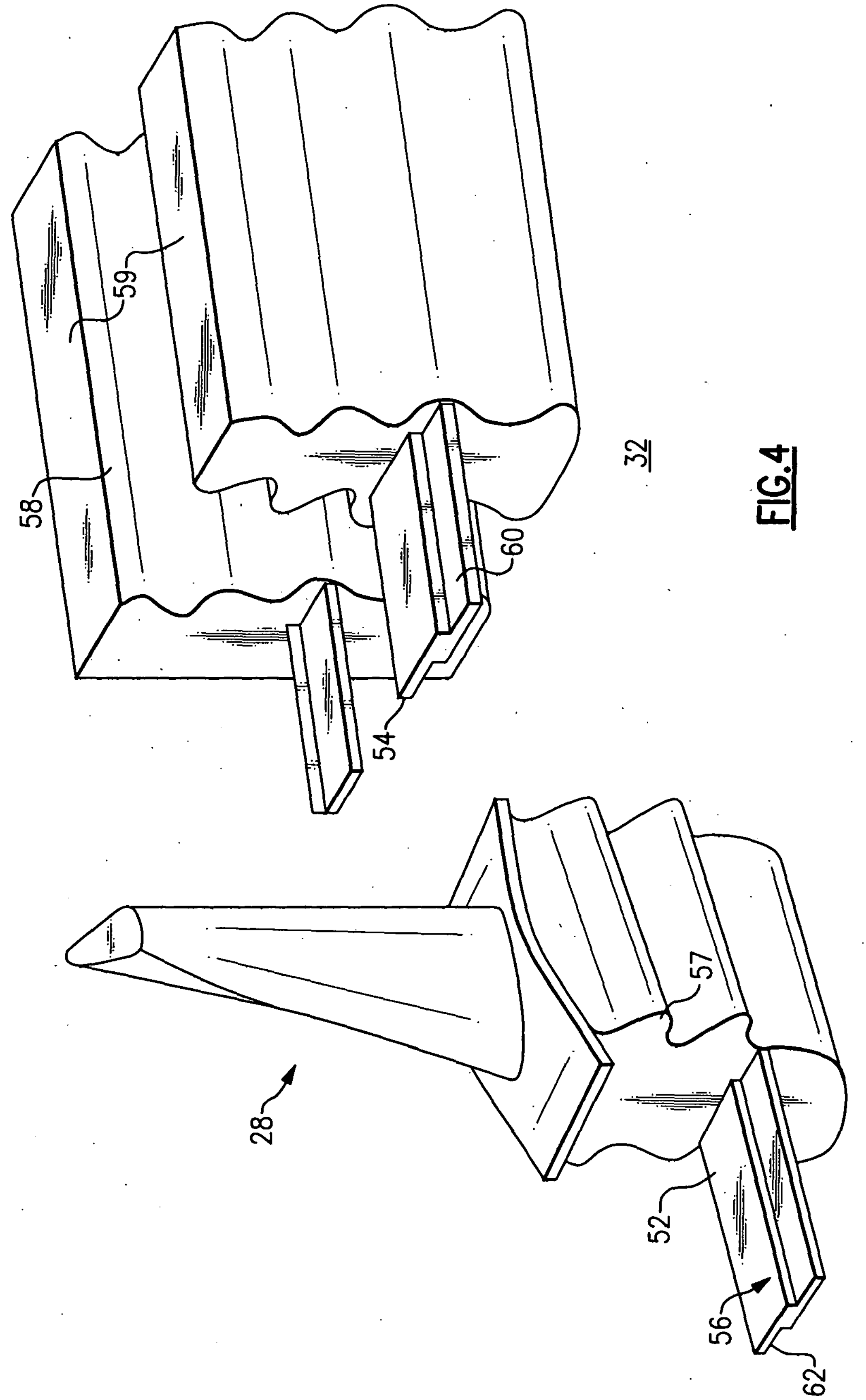

FIG.4

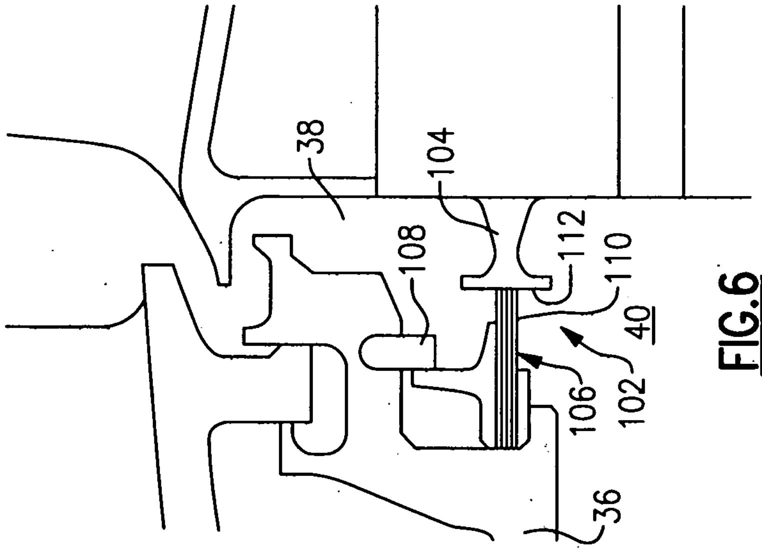

FIG.6

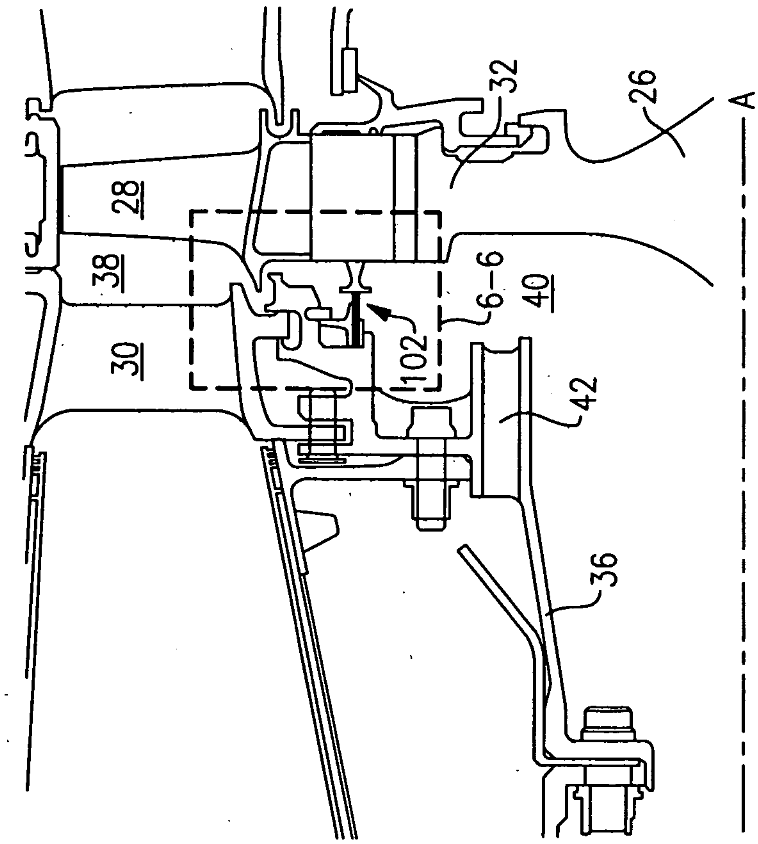

FIG.5

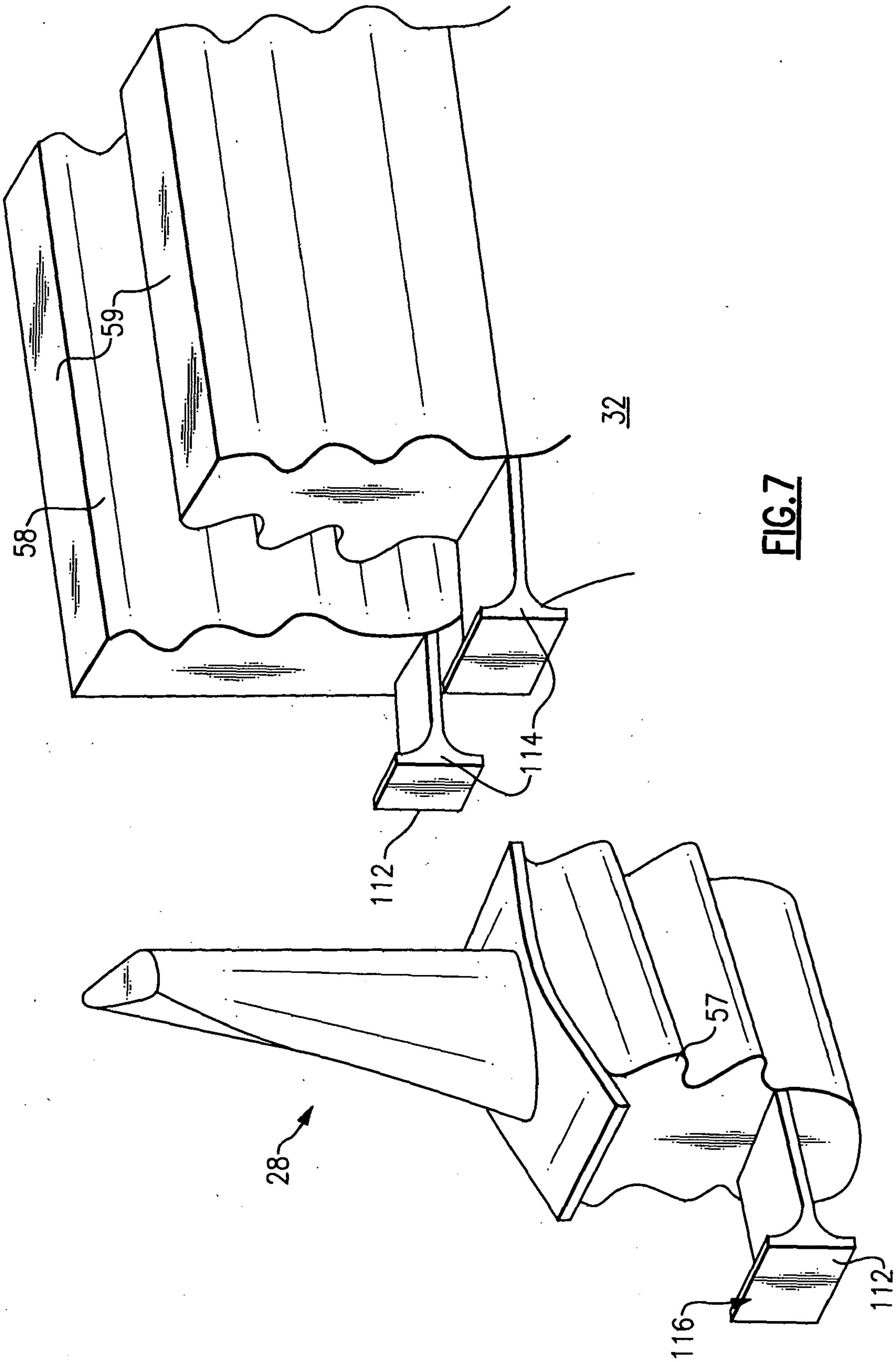

FIG.7