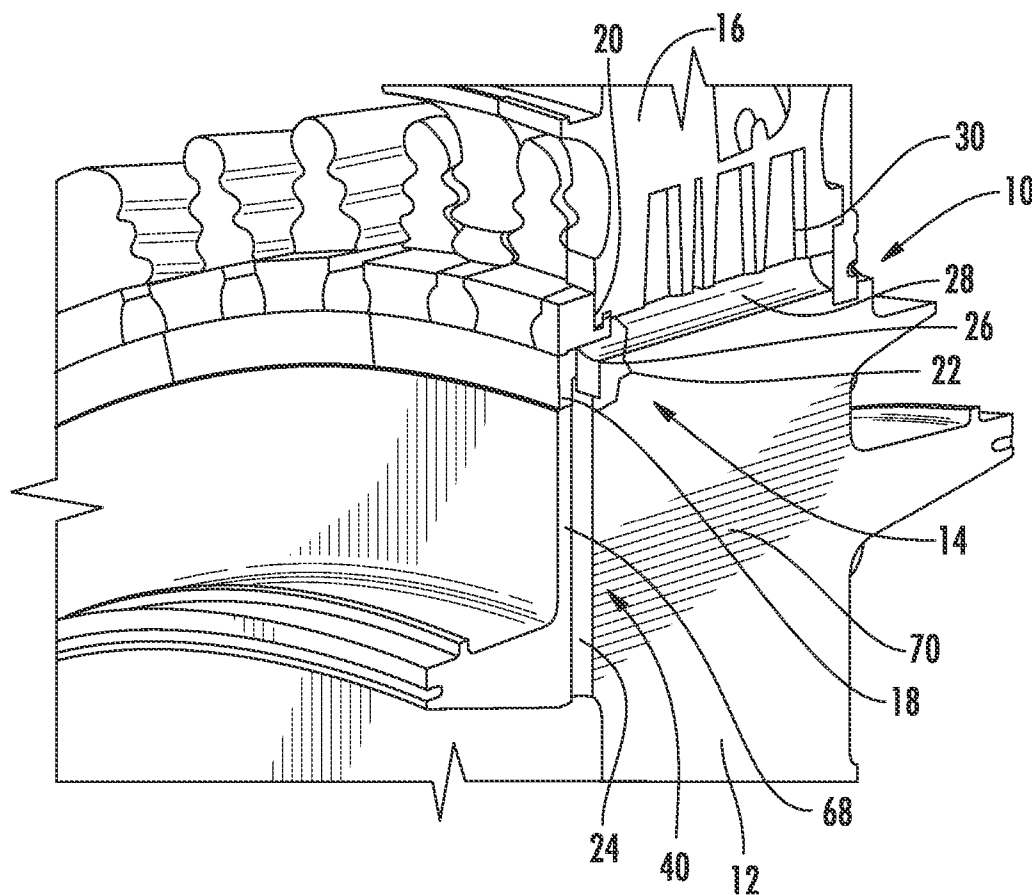




US 20120183389A1

(19) **United States**(12) **Patent Application Publication**
Mhetras et al.(10) **Pub. No.: US 2012/0183389 A1**(43) **Pub. Date: Jul. 19, 2012**(54) **SEAL SYSTEM FOR COOLING FLUID FLOW
THROUGH A ROTOR ASSEMBLY IN A GAS
TURBINE ENGINE**(52) **U.S. Cl. 415/115**(57) **ABSTRACT**(76) **Inventors:** **Shantanu P. Mhetras**, Orlando, FL
(US); **Manjit Shivanand**, Orlando,
FL (US); **Abdullatif M. Chehab**,
Oviedo, FL (US); **Ching-Pang Lee**,
Cincinnati, OH (US)(21) **Appl. No.: 13/005,752**(22) **Filed: Jan. 13, 2011****Publication Classification**(51) **Int. Cl.**
F01D 5/18 (2006.01)

A sealing system for a rotor assembly in a gas turbine engine is disclosed. The sealing system may include a seal formed from a side block and an upper seal that seals a gap between a radially outward extending first rotor supply channel in a rotor assembly terminating at an inlet of an axially extending second rotor supply channel that is in fluid communication with an internal blade cooling system of a turbine blade. The seal may include components that enhance the flow of cooling fluids over conventional configurations. In another embodiment, the sealing system may include an integrated sealing block configured to seal a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels. The integrated sealing block may be formed from a radially inward extending leg and central body.



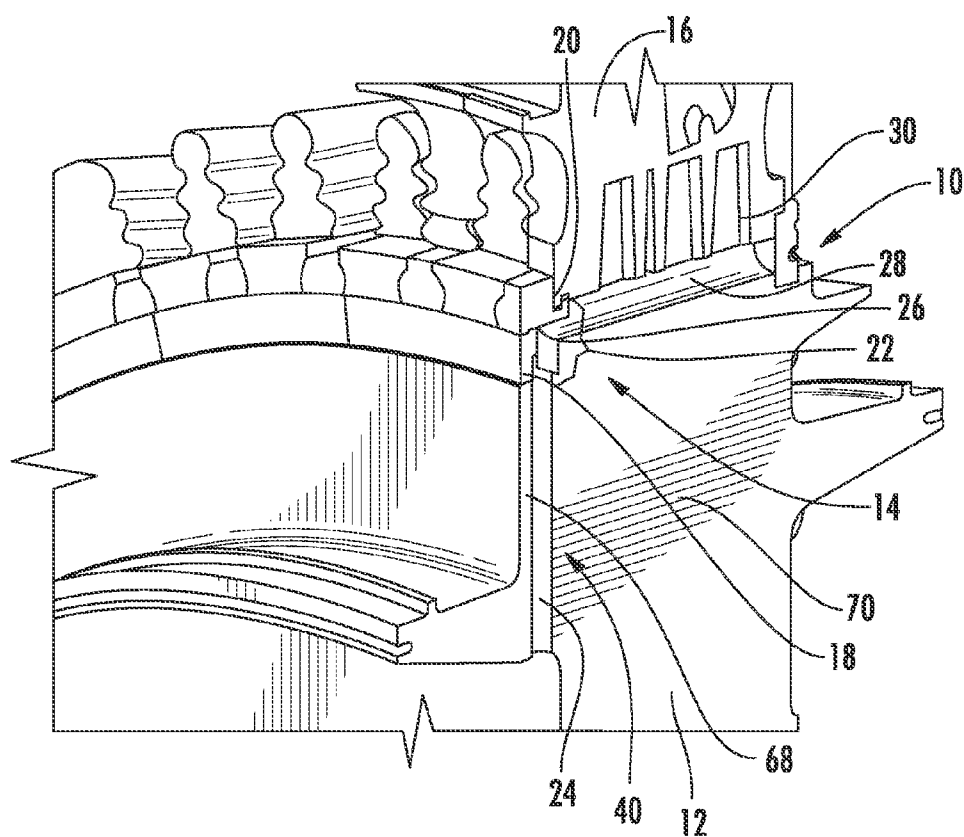
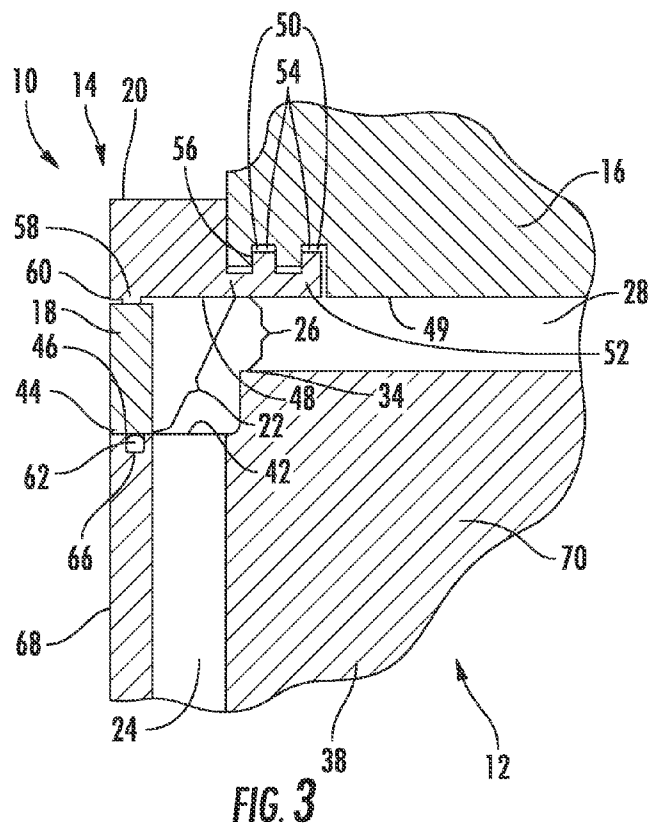


FIG. 1



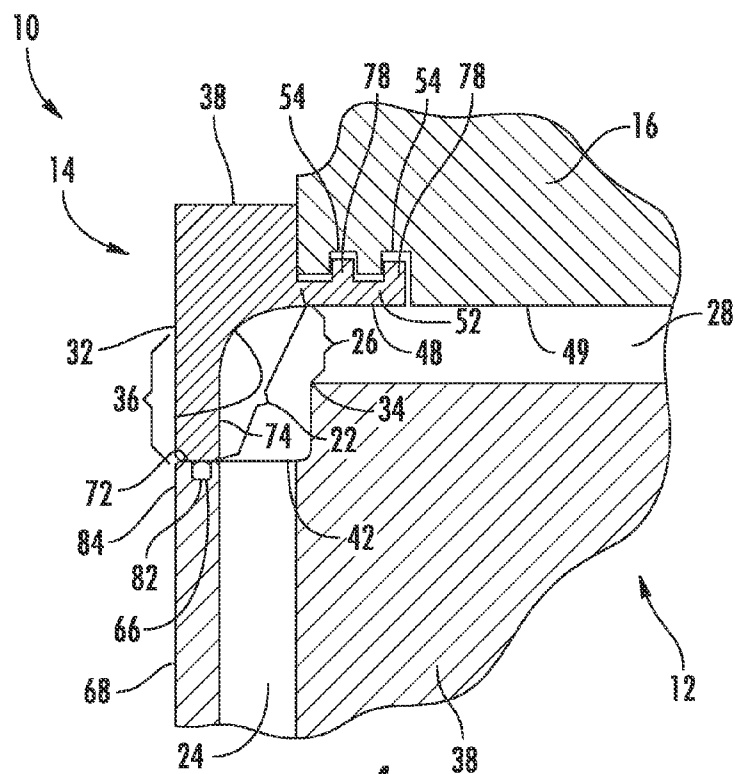


FIG. 4

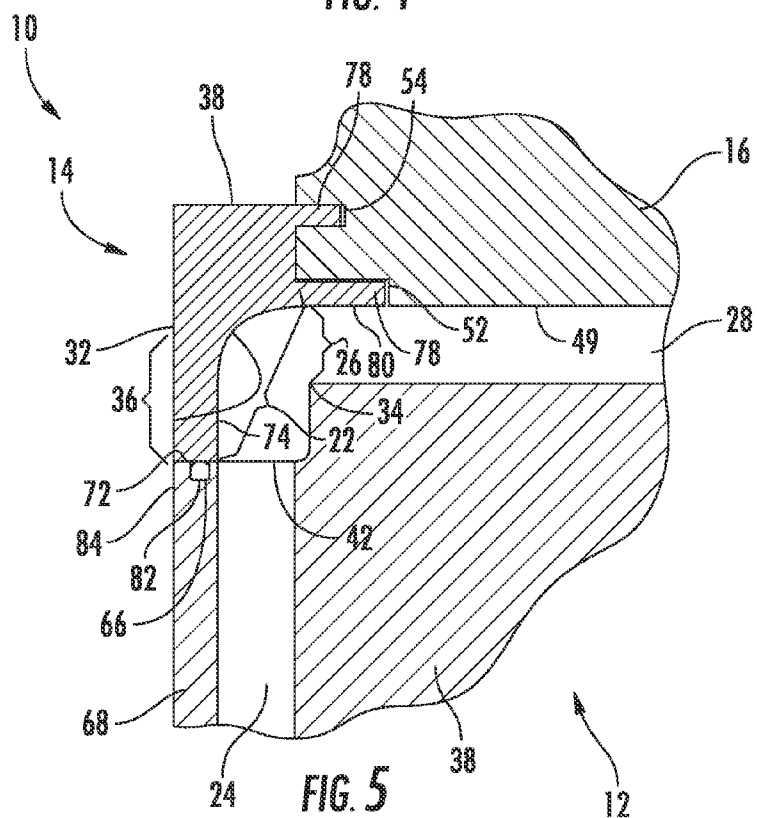


FIG. 5

SEAL SYSTEM FOR COOLING FLUID FLOW THROUGH A ROTOR ASSEMBLY IN A GAS TURBINE ENGINE

FIELD OF THE INVENTION

[0001] This invention is directed generally to turbine engines, and more particularly to cooling fluid feed systems in turbine engines.

BACKGROUND

[0002] Typically, gas turbine engines include a compressor for compressing air, a combustor for mixing the compressed air with fuel and igniting the mixture, and a turbine blade assembly for producing power. Combustors often operate at high temperatures that may exceed 2,500 degrees Fahrenheit. Typical turbine combustor configurations expose turbine blade assemblies to these high temperatures. As a result, turbine blades and turbine vanes must be made of materials capable of withstanding such high temperatures. Turbine blades, vanes and other components often contain cooling systems for prolonging the life of these items and reducing the likelihood of failure as a result of excessive temperatures.

[0003] Turbine blades are typically supported by a rotor assembly that enables turbine blades to extend radially outward circumferentially about the rotor assembly. The turbine blades may be positioned in circumferential rows, forming stages, that are separated by turbine vanes extending radially inward. The turbine airfoils are exposed to combustion gases and extreme heat. Turbine airfoils are cooled with internal cooling systems that receive cooling fluids through channels in the rotor assembly to which the blades are attached. Conventional cooling channels in the rotor assembly often have cooling fluid leaks between radially extending and axially extending cooling channels that direct cooling fluids to turbine vanes. Additionally, conventional cooling fluid supply configurations often have choke points that cause pressure losses and unduly restrict cooling fluid flow.

SUMMARY OF THE INVENTION

[0004] This invention is directed to a sealing system for a rotor assembly in a gas turbine engine that enhances the flow of cooling fluids from a rotor assembly to turbine blades. The sealing system may include a seal configured to seal a conduit directing cooling fluids from a cooling fluid source into turbine blades attached to the rotor assembly. In one embodiment, the seal may be formed from a side block and an upper seal that seal a gap between a radially outward extending first rotor supply channel in the rotor assembly terminating at an inlet of an axially extending second rotor supply channel that is in fluid communication with an internal blade cooling system of a turbine blade. The seal may include components that enhance the flow of cooling fluids over conventional configurations. In another embodiment, the sealing system may include an integrated sealing block configured to seal the gap between adjacent turbine blades at an intersection between the first and second rotor supply channels. The integrated sealing block may be formed from a radially inward extending leg and a central body.

[0005] The sealing system may include a rotor assembly having one or more rows of turbine blades extending radially outward and one or more internal rotor cooling systems in fluid communication with an internal blade cooling system within one or more turbine blades. The internal rotor cooling

system may include a radially outward extending first rotor supply channel terminating at a radially outward end of the outward extending first rotor supply channel and at an inlet of an axially extending second rotor supply channel that is in fluid communication with the internal blade cooling system. The seal of the sealing system may be formed from one or more side blocks sealing a portion of a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels. The side block may extend partially circumferentially around the rotor assembly, may be curved circumferentially, may be attached to a radially outer end of a wall defining the first rotor supply channel, and may be a generally linear inner surface forming a portion of the first rotor supply channel. In one embodiment, the side block may extend circumferentially to seal at least two gaps between multiple sets of turbine blades in the at least one row of turbine blades. The seal may also be formed from one or more upper seals sealing a remaining portion of the gap between adjacent turbine blades at the intersection between the first and second rotor supply channels.

[0006] The upper seal may contact the side block and may include a radially inner surface that is generally flat and flush with an inner surface forming the second rotor supply channel. With the upper seal being flush with the second rotor supply channel, the upper seal is capable of increasing the cooling fluid flow past the seal and into the second rotor channel towards the turbine blades. The upper seal may include one or more teeth on the upper seal extending radially outward from the upper seal and contacting two turbine blades. The teeth may be used to assist in attaching the seal to the turbine blades and to prevent cooling fluid leakage between the turbine blades and the seal. The seal may include an arm extending axially from the upper seal away from the intersection between the upper seal and the side block. One or more of the teeth may extend radially outward from the arm, and in one embodiment, two teeth may extend radially outward from the arm. One or more of the teeth may form an interference fit in a cavity in each of the two turbine blades to reduce leakage.

[0007] The upper seal further may include one or more teeth extending radially inward from a radially inner surface of the upper seal into contact with the side block. The tooth may have a width that is less than a width of the side block. The side block may also include one or more wire seals extending radially inward from a radially inner surface of the side block. The wire seal may have a width that is less than a width of the side block.

[0008] The first rotor supply channel extending radially outward may be sized to increase the cooling fluid flow to the turbine blades. The size of the first rotor supply channel may be increased. Increasing the size of the first rotor supply channel increases the flow of cooling fluids to the turbine blades. In one embodiment, the first rotor supply channel may have a diameter of about 15 millimeters.

[0009] In another embodiment, the seal may be formed from one or more integrated sealing blocks sealing a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels. The integrated sealing block may include a radially inward extending leg and central body. The integrated sealing block may extend partially circumferentially around the rotor assembly may be curved circumferentially. The radially inward extending leg may be attached to a radially outer end of a wall defining the first rotor supply channel and may have a generally linear,

radially extending, inner surface on the leg forming a portion of the first rotor supply channel. The central body may include an axially extending inner surface that is generally flat and flush with an inner surface forming the second rotor supply channel. The integrated sealing block further increases the ability of the seal to seal the gap between the first and second rotor supply channels and increase the amount of cooling fluid flow past the seal to the turbine blades. The filleted inner surface of the sealing block and positioning the inner surface of the central body to be flush with the inner surface of the second rotor supply channel increases the flow of cooling fluids.

[0010] An advantage of this invention is that the seal is configured to increase the flow of cooling fluids from a cooling fluid supply source to the turbine blades.

[0011] Another advantage of this invention is a size of the first radially extending rotor supply channel is larger than conventional configurations, thereby increasing cooling fluid flow.

[0012] Yet another advantage of this invention is that the inner radial surface of the seal is positioned flush relative to an inner surface of the axially extending second rotor supply channel, thereby eliminating a conventional flow pinch point.

[0013] Another advantage of this invention is that the seal may be formed from an integrated sealing block that further reduces leakage.

[0014] Still another advantage of this invention is that the seal may include one or more radially or axially extending teeth to attach the seal to the adjacent turbine blades and the rotor assembly, whereby cooling fluid leakage is reduced.

[0015] Another advantage of this invention is that the seal may include a curved corner between the axially extending leg and the radially extending central body, thereby further reducing cooling air pressure losses.

[0016] These and other embodiments are described in more detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The accompanying drawings, which are incorporated in and form a part of the specification, illustrate embodiments of the presently disclosed invention and, together with the description, disclose the principles of the invention.

[0018] FIG. 1 is a perspective view of partial view of a seal system attached to a rotor assembly to seal a gap within a cooling fluid system directing cooling fluids to turbine blades attached to the rotor assembly.

[0019] FIG. 2 is a detailed view of a seal of the seal system sealing the gap in the cooling fluid system shown in FIG. 1 at detail 2.

[0020] FIG. 3 is a detailed view of another embodiment of the seal of the seal system sealing the gap in the cooling fluid system shown in FIG. 1 at detail 3.

[0021] FIG. 4 is a detailed view of yet another embodiment of the seal of the seal system sealing the gap in the cooling fluid system shown in FIG. 1 at detail 4.

[0022] FIG. 5 is a detailed view of still another embodiment of the seal of the seal system sealing the gap in the cooling fluid system shown in FIG. 1 at detail 5.

DETAILED DESCRIPTION OF THE INVENTION

[0023] As shown in FIGS. 1-5, this invention is directed to a sealing system 10 for a rotor assembly 12 in a gas turbine engine that enhances the flow of cooling fluids from a rotor

assembly 12 to turbine blades 16. The sealing system 10 may include a seal 14 configured to seal a conduit directing cooling fluids from a cooling fluid source into turbine blades 16 attached to the rotor assembly 12. In one embodiment, the seal 14 may be formed from a side block 18 and an upper seal 20 that seal a gap 22 between a radially outward extending first rotor supply channel 24 in the rotor assembly 12 terminating at an inlet 26 of an axially extending second rotor supply channel 28 that is in fluid communication with an internal blade cooling system 30 of a turbine blade 16. The seal 14 may include components that enhance the flow of cooling fluids over conventional configurations. In another embodiment, the sealing system 10 may include an integrated sealing block 32 configured to seal the gap 22 between adjacent turbine blades 16 at an intersection 34 between the first and second rotor supply channels 24, 28. The integrated sealing block 32 may be formed from a radially inward extending leg 36 and a central body 38.

[0024] As shown in FIGS. 1-3, the sealing system 10 for a turbine blade 16 and rotor assembly 12 for a gas turbine engine may be configured to seal a gap 22 within the sealing system 10. The rotor assembly 12 may have at least one row of turbine blades 16 extending radially outward. In at least one embodiment, the rotor assembly 12 may have a plurality of rows of turbine blades 16 forming multiple stages. The rotor assembly 12 may have any appropriate configuration and is not limited to any particular configuration or number of stages of turbine blades 16. The rotor assembly 12 may include one or more internal rotor cooling systems 40 in fluid communication with the internal blade cooling system 30 within one or more turbine blades 16. The internal rotor cooling system 40 may include a radially outward extending first rotor supply channel 24 terminating at a radially outward end 42 of the outward extending first rotor supply channel 24, which is at the inlet 26 of an axially extending second rotor supply channel 28 that is in fluid communication with the internal blade cooling system 30.

[0025] The seal 14 may be formed from one or more side blocks 18 sealing a portion of the gap 22 between adjacent turbine blades 16 at the intersection 34 between the first and second rotor supply channels 24, 28. The side block 18 may extend partially circumferentially around the rotor assembly 12, may be curved circumferentially, and may have a generally rectangular shape.

[0026] In one embodiment, as shown in FIG. 2, the side block 18 may extend circumferentially to seal at least two gaps 22 between multiple sets of turbine blades 16 in the at least one row of turbine blades 16. The side block 18 may be attached to a radially outer end 44 of a wall defining the first rotor supply channel 24 and may have a generally linear inner surface 46 forming a portion of the first rotor supply channel 24. The side block 18 may extend to seal an area covering multiple gaps between adjacent turbine blades 16, as shown in FIG. 1.

[0027] The seal 14 may also include one or more upper seals 20 sealing a remaining portion of the gap 22 between adjacent turbine blades 16 at the intersection 34 between the first and second rotor supply channels 24, 28. The upper seal 20 may contact the side block 18 and may include a radially inner surface 48 that is generally flat and flush with an inner surface 49 forming the second rotor supply channel 28.

[0028] The seal 14 may include one or more teeth 50 on the upper seal 20 extending radially outward from the upper seal 20 and contacting two turbine blades 16. The teeth 50 may

extend from an arm 52 extending axially from the upper seal 20 away from the intersection 34 between the upper seal 20 and the side block 18. The tooth 50 may extend radially outward from the arm 52. The tooth 50 may extend generally orthogonal to the arm 52. As shown in FIG. 33, the seal 14 may include two teeth 50 extending radially outward from the arm 52. The tooth 50 may be sized such that the tooth 50 contacts at least one surface 56 of the cavity 54 in which the tooth 50 is inserted so that leakage of cooling fluids can be limited, if not prevented. In at least one embodiment, the tooth 50 may be sized to form an interference fit in the cavity 54 in each of the two turbine blades 16 to reduce leakage.

[0029] As shown in FIGS. 2 and 3, the upper seal 20 may include one or more teeth 58 extending radially inward from a radially inner surface 60 of the upper seal 20. The tooth 58 may have a width that is less than a width of the side block 18. The tooth 58 may contact that side block 18 to seal the upper seal 20 to the side block 18. Similarly, the side block 18 may include one or more seals 62 extending radially inward from a radially inner surface 64 of the side block 18 into a cavity 66. The seal 62 may have a width that is less than a width of the side block 18. The seal may be, but is not limited to being, a wire seal.

[0030] As shown in FIGS. 1-3, the first rotor supply channel 24 is configured to direct cooling fluids towards the turbine blades 16 through the second rotor supply channel 28. The first rotor supply channel 24 may be configured to provide an increased flow of cooling fluids to the turbine blades 16. The forward radially extending wall 68 may be moved forward, which is further away from the body 70 of the rotor assembly 12, to increase the cross-sectional size of the first rotor supply channel 24. In at least one embodiment, the first rotor supply channel 24 may have a diameter of about 15 millimeters, but is not limited to this size, such as larger or smaller than this size.

[0031] In another embodiment, as shown in FIGS. 4 and 5, the seal 14 may be a one or more integrated sealing blocks 32 sealing a gap 22 between adjacent turbine blades 16 at the intersection 34 between the first and second rotor supply channels 24, 28. The integrated sealing block 32 may include a radially inward extending leg 36 and central body 38. The integrated sealing block 32 may extend partially circumferentially around the rotor assembly 12 may be curved circumferentially. The radially inward extending leg 36 may be attached to a radially outer end 72 of the wall 68 defining the first rotor supply channel 24 and has a generally linear, radially extending, inner surface 74 on the leg 36 forming a portion of the first rotor supply channel 24. The central body 38 may include an axially extending inner surface 48 that is generally flat and flush with an inner surface 49 forming the second rotor supply channel 28.

[0032] One or more teeth 78 may extend axially from the central body 38 into a cavity 54 within a turbine blade 16 forming a portion of the row of turbine blades 16. A radially inner surface 80 of the tooth 78 may be generally flat and flush with an inner surface 48 forming the second rotor supply channel 28. As shown in FIG. 5, the tooth 78 may include two teeth 78 extending axially from the central body into cavities 54 within the turbine blade 16 forming a portion of the row of turbine blades 16. Each tooth 78 may contact at least one surface within each cavity 54 to reduce leakage. As shown in FIGS. 4 and 5, the intersection 34 between the radially inward extending leg 36 and the central body 38 may be filleted forming a filleted intersection.

[0033] In another embodiment, as shown in FIG. 4, the seal 14 may include an arm 52 extending axially from the central body 38 away from the intersection 34 between the central body 38 and the radially inward extending leg 36. One or more teeth 78 may extend radially outward from the arm 52 and may contact two turbine blades 16. The tooth 78 may form an interference fit in the cavity 54 in each of the two turbine blades to reduce leakage. As shown in FIG. 4, the seal 14 may include two teeth 78 extending radially outward from the arm 52.

[0034] As shown in FIGS. 4 and 5, the seal 14 may include one or more seals 82 extending radially inward from a radially inner surface 84 of the radially inward extending leg 36. The seal 82 may have a width that is less than a width of the radially inward extending leg 36 such that the seal 82 may fit into a cavity 66 in the forward radially extending wall 68. The seal 82 may be, but is not limited to being, a wire seal.

[0035] The foregoing is provided for purposes of illustrating, explaining, and describing embodiments of this invention. Modifications and adaptations to these embodiments will be apparent to those skilled in the art and may be made without departing from the scope or spirit of this invention.

I claim:

1. A sealing system for a turbine blade and rotor assembly for a gas turbine engine, comprising:

a rotor assembly having at least one row of turbine blades extending radially outward;

at least one internal rotor cooling system in fluid communication with an internal blade cooling system within at least one turbine blade;

wherein the at least one internal rotor cooling system comprises a radially outward extending first rotor supply channel terminating at a radially outward end of the outward extending first rotor supply channel and at an inlet of an axially extending second rotor supply channel that is in fluid communication with the internal blade cooling system;

at least one side block sealing a portion of a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels, wherein the at least one side block extends partially circumferentially around the rotor assembly, is curved circumferentially, is attached to a radially outer end of a wall defining the first rotor supply channel, and has a generally linear inner surface forming a portion of the first rotor supply channel; and

at least one upper seal sealing a remaining portion of the gap between adjacent turbine blades at the intersection between the first and second rotor supply channels, wherein the at least one upper seal contacts the at least one side block and includes a radially inner surface that is generally flat and flush with an inner surface forming the second rotor supply channel.

2. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 1, further comprising at least one tooth on the at least one upper seal extending radially outward from the at least one upper seal and contacting two turbine blades of the at least one row of turbine blades.

3. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 2, further comprising an arm extending axially from the at least one upper seal away from the intersection between the at least one upper seal and the at least one side block, wherein the at least one tooth extends radially outward from the at least one arm.

4. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 3, wherein the at least one tooth extending radially outward from the at least one arm comprises two teeth extending radially outward from the at least one arm.

5. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 3, wherein at least one tooth forms an interference fit in a cavity in each of the two turbine blades to reduce leakage.

6. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 1, wherein the at least one upper seal further includes at least one tooth extending radially inward from a radially inner surface of the at least one upper seal, wherein the at least one tooth has a width that is less than a width of the at least one side block and the tooth contacts that at least one side block.

7. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 1, wherein the at least one side block further includes at least one wire seal extending radially inward from a radially inner surface of the at least one side block, wherein the at least one wire seal has a width that is less than a width of the at least one side block.

8. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 1, wherein the first rotor supply channel has a diameter of about 15 millimeters.

9. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 1, wherein the at least one side block sealing a portion of a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels extends circumferentially to seal at least two gaps between multiple sets of turbine blades in the at least one row of turbine blades.

10. A sealing system for a turbine blade and rotor assembly for a gas turbine engine, comprising:

a rotor assembly having at least one row of turbine blades extending radially outward;

at least one internal rotor cooling system in fluid communication with an internal blade cooling system within at least one turbine blade;

wherein the at least one internal rotor cooling system comprises a radially outward extending first rotor supply channel terminating at a radially outward end of the outward extending first rotor supply channel and at an inlet of an axially extending second rotor supply channel that is in fluid communication with the internal blade cooling system;

at least one integrated sealing block sealing a gap between adjacent turbine blades at an intersection between the first and second rotor supply channels, wherein the at least one integrated sealing block includes a radially inward extending leg and central body;

wherein the at least one integrated sealing block extends partially circumferentially around the rotor assembly, is curved circumferentially,

wherein the radially inward extending leg is attached to a radially outer end of a wall defining the first rotor supply

channel and has a generally linear, radially extending, inner surface on the leg forming a portion of the first rotor supply channel; and

wherein the central body includes an axially extending inner surface that is generally flat and flush with an inner surface forming the second rotor supply channel.

11. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 10, further comprising at least one tooth extending axially from the central body into a cavity within a turbine blade forming a portion of the at least one row of turbine blades.

12. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 11, wherein a radially inner surface of the at least one tooth is generally flat and flush with an inner surface forming the second rotor supply channel.

13. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 12, wherein the at least one tooth comprises two teeth extending axially from the central body into cavities within the turbine blade forming a portion of the at least one row of turbine blades, wherein each of the teeth contact at least one surface within each cavity to reduce leakage.

14. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 13, further comprising a filleted intersection between the radially inward extending leg and the central body.

15. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 10, further comprising at least one tooth extending radially outward from the central body and contacting two turbine blades of the at least one row of turbine blades.

16. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 15, further comprising an arm extending axially from the central body away from the intersection between the central body and the radially inward extending leg, wherein the at least one tooth extends radially outward from the at least one arm.

17. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 16, wherein the at least one tooth extending radially outward from the at least one arm comprises two teeth extending radially outward from the at least one arm.

18. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 17, wherein at least one tooth forms an interference fit in a cavity in each of the two turbine blades to reduce leakage.

19. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 10, further comprising at least one wire seal extending radially inward from a radially inner surface of the radially inward extending leg, wherein the at least one wire seal has a width that is less than a width of the radially inward extending leg.

20. The sealing system for a turbine blade and rotor assembly for a gas turbine engine of claim 10, wherein the first rotor supply channel has a diameter of about 15 millimeters.

* * * * *