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(54) Turbine shroud cooling assembly for a gas turbine system and corresponding gas turbine system

(57) A turbine shroud cooling assembly (30) for a gas turbine system includes an inner shroud component (34) disposed within a turbine section of the gas turbine system and proximate a hot gas path (32) therein, wherein the inner shroud component (34) includes a base portion (40) in direct contact with the hot gas path (32). Also includes is a rib (70) protruding radially away from the base portion (40) and disposed proximate at least one cavity (54) configured to receive a cooling flow (38) from a cooling source, wherein the cooling flow (38) passes through a main passage (72) of the rib (70) for cooling the inner shroud component (34). A corresponding gas turbine system is also provided.

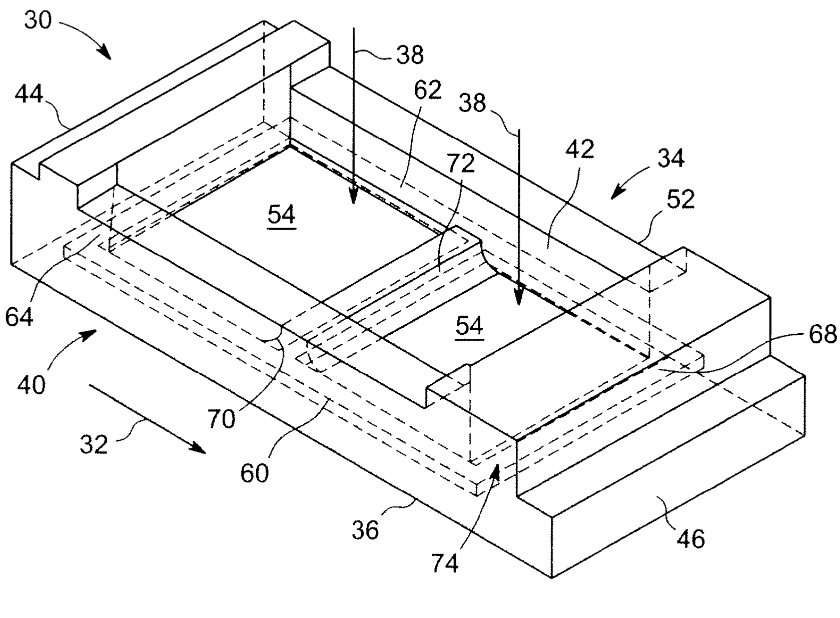

FIG. 2

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Description

BACKGROUND OF THE INVENTION

[0001] The subject matter disclosed herein relates to gas turbine systems, and more particularly to a turbine shroud cooling assembly for cooling turbine shrouds of such gas turbine systems.

[0002] In gas turbine systems, a combustor converts the chemical energy of a fuel or an air-fuel mixture into thermal energy. The thermal energy is conveyed by a fluid, often compressed air from a compressor, to a turbine where the thermal energy is converted to mechanical energy. As part of the conversion process, hot gas is flowed over and through portions of the turbine as a hot gas path. High temperatures along the hot gas path can heat turbine components, causing degradation of components.

[0003] A turbine shroud assembly is an example of a component that is subjected to the hot gas path and often comprises two separate pieces, such as an inner shroud and an outer shroud. Based on the immediate proximity of the inner shroud to the hot gas path, various cooling schemes have been employed to maintain the structural integrity, as well as the intended functionality, of the inner shroud. Such cooling schemes typically result in excessive cooling flow from a cooling source, thereby sacrificing overall efficiency of the gas turbine system.

BRIEF DESCRIPTION OF THE INVENTION

[0004] According to one aspect of the invention, a turbine shroud cooling assembly for a gas turbine system includes an inner shroud component disposed within a turbine section of the gas turbine system and proximate a hot gas path therein, wherein the inner shroud component includes a base portion in direct contact with the hot gas path. Also includes is a rib protruding radially away from the base portion and disposed proximate at least one cavity configured to receive a cooling flow from a cooling source, wherein the cooling flow passes through the main passage of the rib for cooling the inner shroud component.

[0005] According to another aspect of the invention, a turbine shroud cooling assembly for a gas turbine system includes an inner shroud component disposed within a turbine section of the gas turbine system and proximate a hot gas path therein, wherein the inner shroud component includes a leading edge and a trailing edge disposed at an aft location of the inner shroud component relative to the leading edge. Also included is a base portion extending from the leading edge to the trailing edge, wherein the base portion is in direct contact with the hot gas path. Further included is a rib extending from a first side portion to a second side portion and radially outward from the base portion, wherein the rib includes a main passage extending between the first side portion and the second side portion and configured to receive a cooling flow from a cooling source.

[0006] According to yet another aspect of the invention, a gas turbine system includes a compressor for distributing a cooling flow at a high pressure. Also included is a turbine casing operably supporting a turbine shroud assembly for receiving the cooling flow for cooling therein. Further included is an inner shroud component comprising a leading edge, a trailing edge spaced axially rearward of the leading edge, and a base portion connecting the leading edge to the trailing edge. Yet further included is a rib disposed between the leading edge and the trailing edge, and extending between a first side portion and a second side portion, wherein the rib includes a main passage configured to receive the cooling flow for cooling the inner shroud component.

[0007] These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWING

[0008] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

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

FIG. 2 is a top perspective view of an inner shroud component of a turbine shroud assembly;

FIG. 3 is a side, cross-sectional view of the inner shroud component having a passage extending through a rib; and

FIG. 4 is a top plan view of the inner shroud component.

[0009] The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Referring to FIG. 1, a gas turbine system is schematically illustrated with reference numeral 10. The gas turbine system 10 includes a compressor 12, a combustor 14, a turbine 16, a shaft 18 and a fuel nozzle 20. It is to be appreciated that one embodiment of the gas turbine system 10 may include a plurality of compressors 12, combustors 14, turbines 16, shafts 18 and fuel nozzles 20. The compressor 12 and the turbine 16 are coupled by the shaft 18. The shaft 18 may be a single shaft or a plurality of shaft segments coupled together to form the shaft 18.

[0011] The combustor 14 uses a combustible liquid and/or gas fuel, such as natural gas or a hydrogen rich synthetic gas, to run the gas turbine system 10. For example, fuel nozzles 20 are in fluid communication with an air supply and a fuel supply 22. The fuel nozzles 20 create an air-fuel mixture, and discharge the air-fuel mixture into the combustor 14, thereby causing a combustion that creates a hot pressurized exhaust gas. The combustor 14 directs the hot pressurized gas through a transition piece into a turbine nozzle (or "stage one nozzle"), and other stages of buckets and nozzles causing rotation of the turbine 16 within a turbine casing 24. Rotation of the turbine 16 causes the shaft 18 to rotate, thereby compressing the air as it flows into the compressor 12. In an embodiment, hot gas path components are located in the turbine 16, where hot gas flow across the components causes creep, oxidation, wear and thermal fatigue of turbine components. Controlling the temperature of the hot gas path components can reduce distress modes in the components and the efficiency of the gas turbine system 10 increases with an increase in firing temperature. As the firing temperature increases, the hot gas path components need to be properly cooled to meet service life and to effectively perform intended functionality.

[0012] Referring to FIGS. 2-4, a turbine shroud cooling assembly 30 is shown. A shroud assembly is an example of a component disposed in the turbine 16 proximate the turbine casing 24 and subjected to the hot gas path described in detail above, the hot gas path referred to with numeral 32. The turbine shroud cooling assembly 30 includes an inner shroud component 34 with an inner surface 36 proximate the hot gas path 32 within the turbine 16. The turbine shroud cooling assembly 30 also includes an outer shroud component (not illustrated) that is generally proximate to a relatively cool fluid and/or air in the turbine 16, with the inner shroud component 34 being operably coupled to the outer shroud component. To improve cooling of the overall turbine shroud cooling assembly 30, a cooling flow 38 supplied by a cooling source is introduced into the outer shroud component and directed toward the inner shroud component 34. Specifically, a plenum within the outer shroud component may be present to ingest and direct the cooling flow 38 toward the inner shroud component 34.

[0013] The inner shroud component 34 includes a base portion 40 having an outer surface 42, as well as the inner surface 36 that is directly exposed to the hot gas path 32, as described above. The base portion 40 typically arcuately extends between a leading edge 44 and a trailing edge 46 of the inner shroud component 34. Both the leading edge 44 and the trailing edge 46 include at least one fastening device 48, such as a rail or clip for example, that operably couples the inner shroud component 34 with the outer shroud component. The inner shroud component 34 also includes a first side portion 50 and a second side portion 52 extending along the base portion 40 between, and connected to, the leading edge 44 and the trailing edge 46. The outer surface 42 of the base portion 40 combines with the outer shroud component to form at least one cavity 54, such as an impingement cavity, into which the cooling flow 38 is directed toward and into.

[0014] Numerous internal passages are formed within the inner shroud component 34 for allowing the cooling flow 38 to pass therethrough. A first side portion passage 60 is disposed proximate the first side portion 50 and a second side portion passage 62 is disposed proximate the second side portion 52. Additionally, a fore passage 64 and an aft passage 68 may be included at locations proximate the leading edge 44 and the trailing edge 46, respectively. Numerous other internal passages may be provided in addition to, or alternatively to, the internal passages described above. In the illustrated embodiment, the first side portion passage 60, the second side portion passage 62, the fore passage 64 and the aft passage 68 are disposed proximate the perimeter of the inner shroud component 34.

[0015] A rib 70 integrally formed with the base portion 40 protrudes radially away from the remainder of the outer surface 42 of the base portion 40 and extends between the first side portion 50 and the second side portion 52. It is to be appreciated that in other embodiments, the rib 70 may extend at various angles across the base portion 40, including relatively perpendicular to that illustrated, where the rib 70 extends from proximate the leading edge 44 to the trailing edge 46. Irrespective of the precise location and orientation of the rib 70, in order to effectively and efficiently cool portions of the inner shroud component 34 other than those proximate the perimeter, a main passage 72 is formed within the rib 70. In the illustrated embodiment, the main passage 72 extends between, and connects with, the first side portion passage 60 and the second side portion passage 62, thereby allowing the cooling flow 38 to be transferred through the main passage 72, the first side portion passage 60 and the second side portion passage 62, in any direction. Additionally, the fore passage 64 and the aft passage 68 extend between, and connect to, the first side portion passage 60 and the second side portion passage 62, thereby forming a continuous, interconnected cooling flow circuit 74. It is to be appreciated that a discontinuous circuit may be formed by including one or more breaks in any of the passages, including the main passage 72, the first side portion passage 60, the second side portion passage 62, the fore passage 64 and/or the aft passage 68.

[0016] Cooling of the inner shroud component 34 is achieved by ingesting an airstream of the cooling flow 38 from a cooling source (not illustrated) that provides the cooling flow 38, which may include air, a water solution and/or a gas. The cooling flow 38 is any suitable fluid that cools the inner shroud component 34. For example, the cooling source is a supply of compressed air from the compressor 12, where the compressed air is diverted from the air supply that is routed to the combustor 14. Thus, the supply of compressed air bypasses the combustor 14 and is used to cool the turbine shroud cooling assembly 30. The inner shroud component 34 receives the cooling flow 38 at the at least one cavity 54 and introduces the cooling flow 38 into at least one of the first side portion passage 60, the second side portion passage 62, the fore passage 64 and the aft passage 68. Such an arrangement allows the cooling flow 38 to be transferred to the main passage 72 for cooling therein. Furthermore, the main passage 72 may be the sole, or an additional, ingestion point for the cooling flow 38 into the internal passages. For example, the main passage 72 may include at least one, but typically a plurality of channels 76 formed in the rib 70 to fluidly connect the at least one cavity 54 and the main passage 72. The plurality of channels 76 may be drilled or formed in any suitable manner. One or more exit paths for the cooling flow 38 may be formed throughout one or more portions of the inner shroud component 34 to allow dumping of the cooling flow 38 to external regions, such as the hot gas path 32. One contemplated location of the exit paths is through the inner surface 36 of the inner shroud component 34.

[0017] Accordingly, the main passage 72 within the rib 70 allows the cooling flow 38 to flow through the rib 70 that is disposed away from the perimeter of the inner shroud component 34, thereby leading to improved cooling of the overall inner shroud component 34. Such a feature ultimately decreases the high temperatures of various regions of the inner shroud component 34, including an aft edge of the rib 70. Overall gas turbine system 10 efficiency is improved based on the reduction of the cooling flow 38 that is required to effectively cool the inner shroud component 34. Additionally, service life of the inner shroud component 34 is increased due to the lower temperature experienced during exposure to the hot gas path 32.

[0018] While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

Claims

1. A turbine shroud cooling assembly (30) for a gas turbine system (10) comprising:

an inner shroud component (34) disposed within a turbine section (16) of the gas turbine system (10) and proximate a hot gas path (32) therein, wherein the inner shroud component (34) includes a base portion (40) in direct contact with the hot gas path (32); and

at least one rib (70) protruding radially away from the base portion (40) and disposed proximate at least one cavity (54) configured to receive a cooling flow (38) from a cooling source, wherein the cooling flow (38) passes through the main passage (72) of the at least one rib (70) for cooling the inner shroud component (34).

2. The turbine shroud cooling assembly of claim 1, further comprising a first side portion passage (60) disposed within a first side portion (50) and a second side portion passage (62) disposed within a second side portion (52).

3. The turbine shroud cooling assembly of claim 2, wherein the main passage (72) extends from the first side portion passage (60) to the second side portion passage (62), wherein the cooling flow (38) is transferred between the first side portion passage (60) and the second side portion passage (62) by passing through the main passage (72).

4. The turbine shroud cooling assembly of claim 2 or 3, further comprising a leading edge (44) of the inner shroud component (34) and a trailing edge (46) of the inner shroud component (34).

5. The turbine shroud cooling assembly of claim 4, wherein the trailing edge (46) is disposed at an aft location of the inner shroud component (34) relative to the leading edge (44) and wherein the base portion (40) extends from the leading edge (44) to the trailing edge (46).

6. The turbine shroud cooling assembly of any of claims 2 to 5, further comprising at least one fore passage (64) disposed proximate a leading edge (44) and at least one aft passage (68) disposed proximate a trailing edge (46), wherein the main passage (72) extends from the at least one fore passage (64) to the at least one aft passage (68).

7. The turbine shroud cooling assembly of claim 6, wherein the at least one fore passage (64) extends from the first side portion passage (60) to the second side portion passage (62), wherein the at least one aft passage (68) extends from the first side portion passage (60) to the second side portion passage (62).

8. The turbine shroud cooling assembly of claim 6 or 7, wherein the cooling flow (38) is free to transfer between the first side portion passage (60), the second side portion passage (62), the at least one fore passage (64), the at least one aft passage (68), and the main passage (72) in a continuous interconnected cooling flow circuit (74).

9. The turbine shroud cooling assembly of any preceding claim, further comprising a plurality of channels (76) extending from the at least one cavity (54) to the main passage (72) to direct the cooling flow (38) into the main passage (72).

10. The turbine shroud cooling assembly of any preceding claim, wherein the main passage (72) includes at least one break forming a plurality of main passages (72).

11. The turbine shroud cooling assembly of any preceding claim, wherein the at least one rib (70) is at least partially surrounded by the at least one cavity (54) configured to receive the cooling flow (38) from the cooling source.

12. The turbine shroud cooling assembly of claim 9, wherein the plurality of channels are drilled through holes.

13. A gas turbine system (10) comprising:

a compressor (12) for distributing a cooling flow (38) at a high pressure;
a turbine casing (24) operably supporting a turbine shroud assembly (34) for receiving the cooling flow (38) for cooling therein; and
a turbine cooling assembly (30) as recited in any of claims 1 to 12.

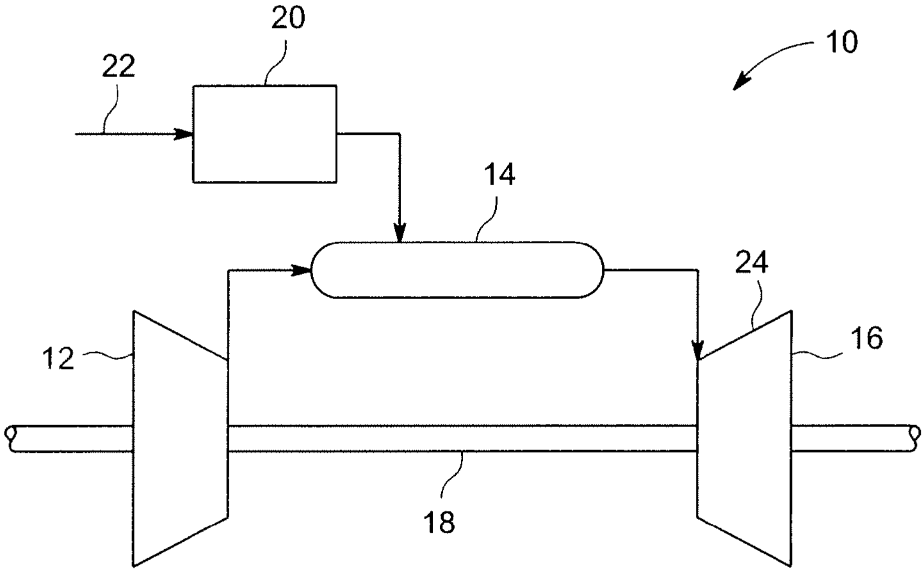
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FIG. 1

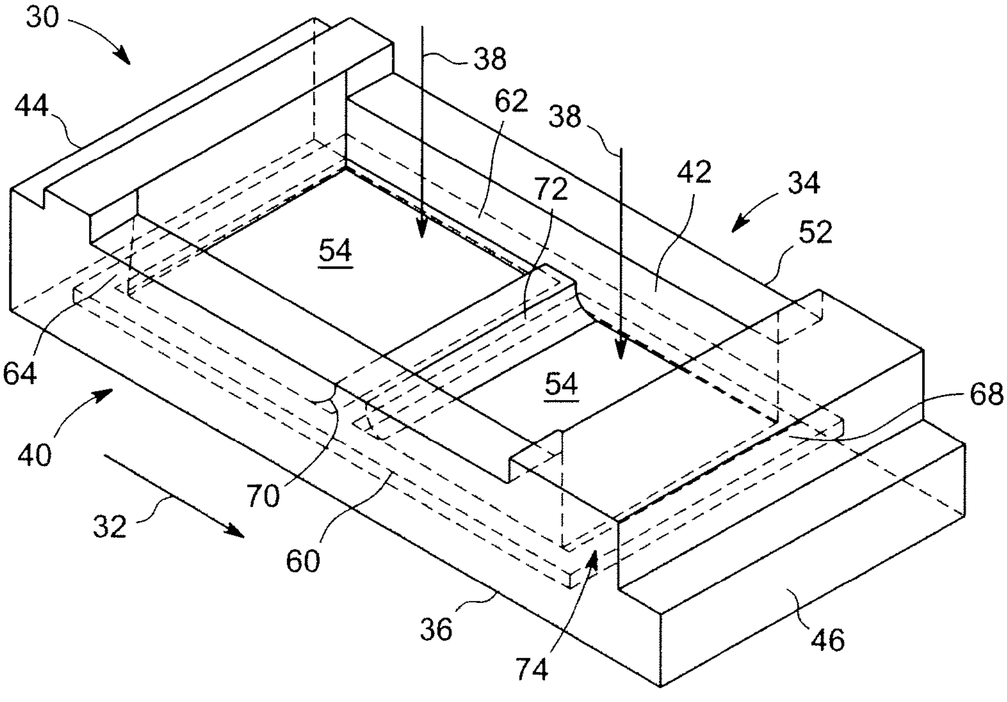
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FIG. 2

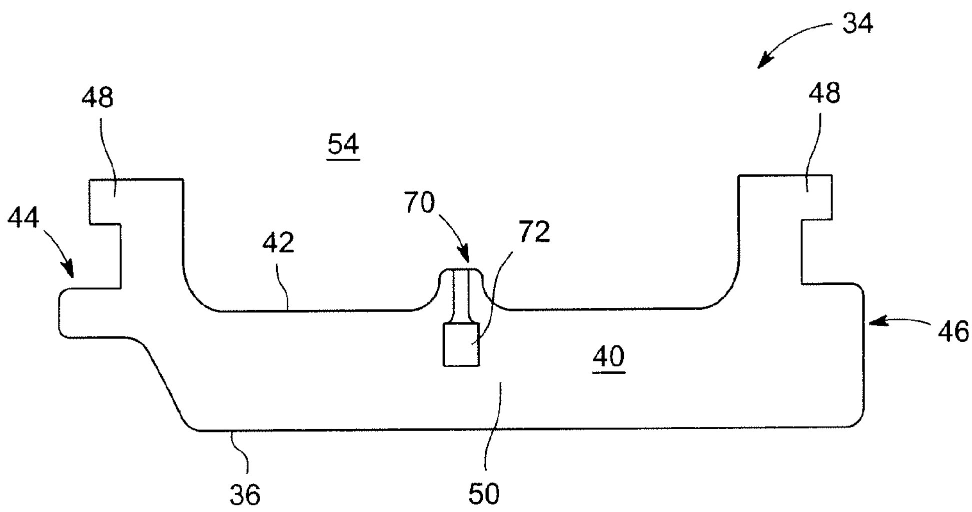

FIG. 3

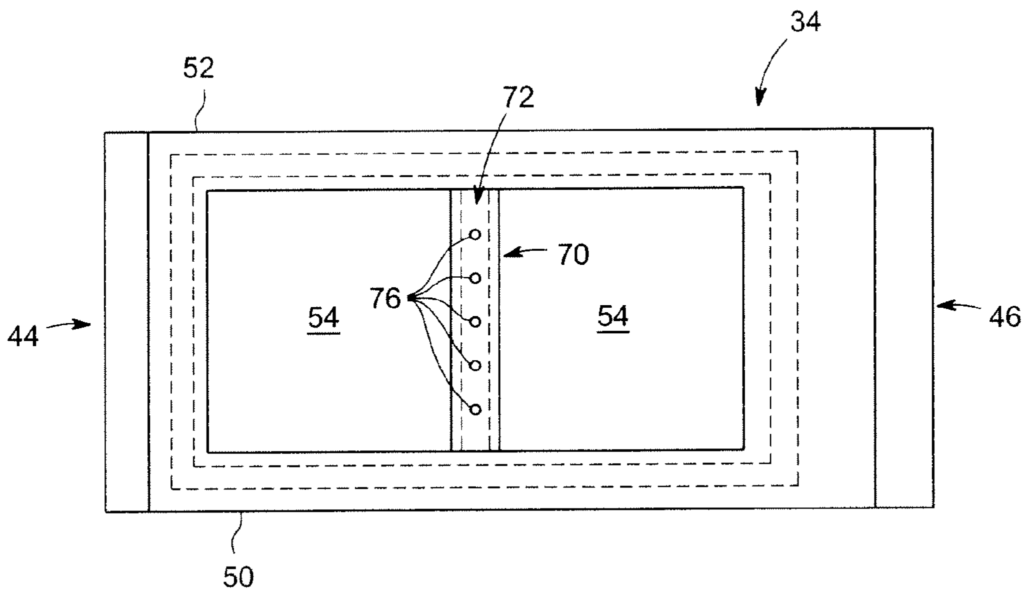

FIG. 4