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(54) **Solid seal with cooling pathways**

(57) The present application provides a seal (100) for use between components (92,94) facing a high pressure cooling air flow and a hot gas path in a gas turbine engine. The seal (100) includes a first surface with a first surface air plenum (190) facing the high pressure cooling

air flow, a second surface with a second surface air plenum (210) facing the hot gas path, and a number of cooling pathways (250) extending from the first surface air plenum (190) to the second surface air plenum (210) for the high pressure cooling air flow to pass therethrough.

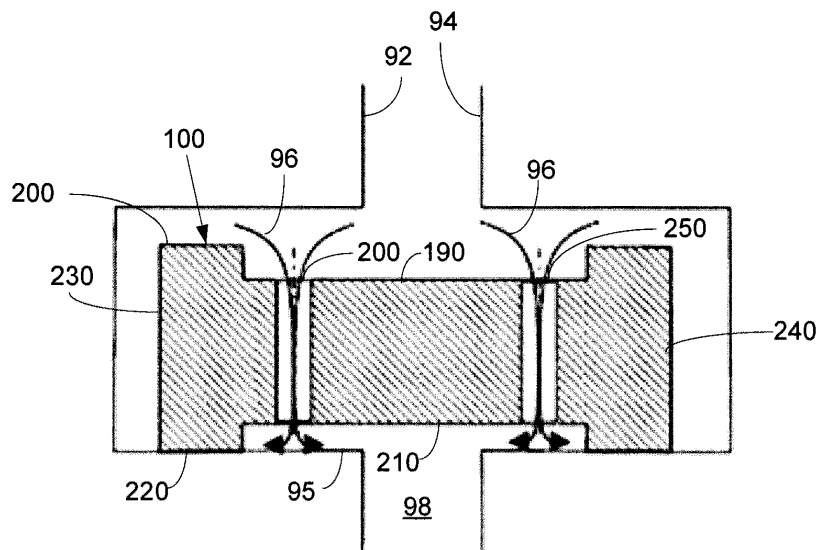


Fig. 5

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Description

TECHNICAL FIELD

[0001] The present application and resultant patent relate generally to gas turbine engines and more particularly relate to solid seals and the like having cooling pathways extending therethrough.

BACKGROUND OF THE INVENTION

[0002] Generally described, turbo-machinery such as gas turbine engines and the like include a main gas flow path extending therethrough. Gas leakage, either out of the gas flow path or into the gas flow path, may lower overall gas turbine efficiency, increase fuel costs, and possibly increase emission levels. Secondary flows also may be used within the gas turbine engine to cool the various heated components. Specifically, cooling air may be extracted from the later stages of the compressor for use in cooling the heated components and for purging gaps and cavities between adjacent components. For example, seals may be placed between turbine components such as stators and the like. These locations, however, may face very high temperatures and velocities that may lead to heavy oxidation and even seal failure. This potential damage may be mitigated somewhat by providing purge air to the gap with the seal therein. This purge air, however, may be a largely inefficient use of the cooling air.

[0003] There is thus a desire for improved solid seal for use between stator components and other components in a heavy duty gas turbine engine. Such a solid seal may be cooled with less flow than is generally necessary to purge the gap therein for higher overall efficiency and with increased component lifetime.

SUMMARY OF THE INVENTION

[0004] The present application and the resultant patent thus provide a seal for use between components facing a high pressure cooling air flow and a hot gas path in a gas turbine engine and the like. The seal may include a first surface facing the high pressure cooling air flow, a second surface having a second surface air plenum facing the hot gas path, and a number of cooling pathways extending from the first surface to the second surface air plenum of the second surface for the high pressure cooling air flow to pass therethrough.

[0005] The present application and the resultant patent further provide a method of cooling a seal positioned between components in a gas turbine engine. The method may include the steps of flowing high pressure cooling air about a first surface of the seal, drawing the high pressure cooling air through a number of cooling pathways in the seal, and drawing the high pressure cooling air through an air plenum about a second surface of the seal towards a hot gas path. The method may include the

further step of cooling the components with the high pressure cooling air passing through the air plenum.

[0006] The present application and the resultant patent further provide a solid seal for use between components facing a high pressure cooling air flow and a hot gas path in a gas turbine engine. The solid seal may include a first surface with a first surface air plenum facing the high pressure cooling air flow, a second surface with a second surface air plenum facing the hot gas path, and a number of cooling pathways extending from the first surface air plenum of the first surface to the second surface air plenum of the second surface for the high pressure cooling air flow to pass therethrough.

[0007] These and other features and improvements of the present application and the resultant patent will become apparent to one of ordinary skill in the art upon review of the following detailed description when taken in conjunction with the several drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a schematic view of a gas turbine engine showing a compressor, a combustor, and a turbine.

Fig. 2 is a partial side view of a turbine showing a number of components positioned along a hot gas path.

Fig. 3 is a side cross-sectional view of a known seal positioned between adjacent turbine components.

Fig. 4 is a perspective view of a solid seal as may be described herein with a number of cooling pathways extending therethrough.

Fig. 5 is a side cross-sectional view of the solid seal of Fig. 4 with the cooling pathways extending there-through.

DETAILED DESCRIPTION

[0009] Referring now to the drawings, in which like numerals refer to like elements throughout the several views, Fig. 1 shows a schematic view of gas turbine engine 10 as may be used herein. The gas turbine engine 10 may include a compressor 15. The compressor 15 compresses an incoming flow of air 20. The compressor 15 delivers the compressed flow of air 20 to a combustor 25. The combustor 25 mixes the compressed flow of air 20 with a pressurized flow of fuel 30 and ignites the mixture to create a flow of combustion gases 35. Although only a single combustor 25 is shown, the gas turbine engine 10 may include any number of combustors 25. The flow of combustion gases 35 is in turn delivered to a turbine 40. The flow of combustion gases 35 drives the

turbine 40 so as to produce mechanical work. The mechanical work produced in the turbine 40 drives the compressor 15 via a shaft 45 and an external load 50 such as an electrical generator and the like.

[0010] The gas turbine engine 10 may use natural gas, various types of syngas, and/or other types of fuels. The gas turbine engine 10 may be any one of a number of different gas turbine engines offered by General Electric Company of Schenectady, New York, including, but not limited to, those such as a 7 or a 9 series heavy duty gas turbine engine and the like. The gas turbine engine 10 may have different configurations and may use other types of components. Other types of gas turbine engines also may be used herein. Multiple gas turbine engines, other types of turbines, and other types of power generation equipment also may be used herein together.

Fig. 2 shows a portion of the turbine 40. Generally described, the turbine 40 may include a first stage nozzle 55, a first stage bucket 60, and a first stage shroud 62 of a first stage 65. Also shown is a second stage nozzle 70 of a second stage 75. Any number of stages may be used herein. The nozzles 55, 70 may be positioned on a diaphragm 80. Any number of nozzles 70 and diaphragms 80 may be positioned circumferentially about an axis 85. A seal 90 may be positioned between each pair of adjacent shrouds 62, diaphragms 80, or other turbine components. The seal 90 may be used between adjacent turbine components so as to prevent the leakage of the cooling air flows 20 from the compressor 15 or elsewhere therethrough. As described above, the seals 90 may have many different configurations. Other types of sealing mechanisms also may be used. Other components and other configurations may be used herein.

Fig. 3 shows an example of the seal 90 positioned between adjacent turbine components, a first component 92 and a second component 94. The components 92, 94 may be adjacent turbine components such as stator components and the like. The turbine components 92, 94 may define a seal slot 95 therebetween. The seal 90 may be a solid material seal although other types of seals may be used. Any number of the seals 90 may be used herein. The seals 90 may prevent or reduce leakage of a flow of high pressure cooling air 96 between the components 92, 94 into the lower pressure hot gas path 98.

Fig. 4 shows an example of a seal 100 as may be described herein. The seal 100 may have a top surface 110, a bottom surface 120 (a slash face), a first side 130, an opposed second side 140, a first end 150, and an opposed second end 160. (The terms "bottom," "top," "side," "end," "first," "second," and the like are used for the purposes of relative orientation only and not as an absolute position.) The seal

100 may be a solid seal 170. Alternatively, the seal 100 may have a number of layers of material therein. The seal 100 may be made out of a high temperature material such as stainless steel, nickel-based alloys, and the like. Other types of materials also may be used herein. The seal 100 may have any size, shape, or configuration.

[0011] As is shown in cross-section in Fig. 5, the seal 100 may have a substantial "I-beam" like shape 180. Specifically, the seal 100 may include a first plenum 190 defined by a first peripheral lip 200 about the top surface 110 thereof and a second plenum 210 defined by a second peripheral lip 220 about the bottom surface 120 thereof. The plenums 190, 210 thus may be recessed areas within the top surface 110 and the bottom surface 120 of the seal. The plenums 190, 210 and the peripheral lips 200, 220 may have any size, shape, or configuration. Multiple plenums 190, 210 also may be used. The peripheral lips 200, 220 may define a first blocked end 230 on the first end 150 and a second blocked end 240 on the second end 160. The blocked ends 220, 240 may have any size, shape, or configuration. One or more open ends also may be used. Alternatively, the blocked ends 220, 240 may have cooling holes or slots positioned therein. Other components and other configurations may be used herein.

[0012] The seal 100 also may include a number of cooling pathways 250 extending therethrough from the first plenum 190 to the second plenum 210. Any number of the cooling pathways 250 may be used herein. The cooling pathways 250 may have any suitable size, shape, or configuration. Further, the cooling pathways 250 may extend through the seal 100 at a straight and/or an angled configuration. Any angle or combinations of angles may be used. The cooling pathways 250 may be formed by drilling or other types of manufacturing techniques. Cooling pathways 250 of differing configurations may be used herein together. Other components and other configurations may be used herein.

[0013] In use, the seal 100 may be positioned between the first component 92 and the second component 94 within the seal slot 95. The top surface 110 of the seal 100 may face the high pressure cooling air 96 while the bottom surface 120 may face the lower pressure hot gas path 98. The seal 100 may have any number of the cooling pathways 250 extending therethrough in any configuration. The seal cooling pathways 250 extending into the second plenum 210 also act as impingement holes and/or purge holes for the seal slot 95. Specifically, the pressure differential between the high pressure cooling air 96 and the lower pressure hot gas path 98 draws the high pressure cooling air 96 through the cooling pathways 250 and into the second plenum 210 about the bottom surface 120 of the seal 100. The high pressure cooling air 96 thus enhances heat transfer through the seal 100 and impinges upon/purges the seal slot 95 via the impingement holes.

[0014] The cooling pathways 250 may be positioned strategically near localized hot spots or uniformly along the length of the seal 100. The cooling pathways 250 may have any prescribed pitch along the length of the seal 100. The use of the blocked ends 230, 240 also substantially limits any gap leakage about the ends 150, 160 of the seal 100. The seal 100 and the cooling pathways 250 therethrough thus provide purging and cooling of the bottom surface 120 or the slash face as well as about the sealing slot 95 in an efficient manner.

[0015] Moreover, the seal 100 described herein may provide increased seal lifetime, reduced secondary flows, higher overall engine efficiency, and a reduced heat rate. The seal 100 may be original equipment or part of a retro-fit. Different configurations of the seals 100 may be used together herein. The seal 100 also may be applicable for use in other types of sealing locations. Specifically, the seal 100 may be used between any two components with a pressure differential therebetween for a flow of cooling air.

Claims

1. A seal (100) for use between components facing a high pressure cooling air flow (96) and a hot gas path (98) in a gas turbine engine, comprising:

a first surface (190) facing the high pressure cooling air flow;
 a second surface (210) facing the hot gas path;
 the second surface comprising a second surface air plenum; and
 a plurality of cooling pathways (250) extending from the first surface to the second surface air plenum of the second surface for the high pressure cooling air flow to pass therethrough.

2. The seal of claim 1, wherein the seal comprises a solid seal.

3. The seal of claim 1 or claim 2, wherein the seal comprises a substantial "I" beam-like shape.

4. The seal of any preceding claim, wherein the second surface (210) comprises a second surface peripheral lip.

5. The seal of any preceding claim, wherein the first surface (190) comprises a first surface air plenum.

6. The seal of any preceding claim, wherein the first surface (190) comprises a first surface peripheral lip (200).

7. The seal of any preceding claim, wherein the first surface (190) comprises a top surface and wherein the second surface (210) comprises a bottom sur-

face.

8. The seal of any preceding claim, further comprising a first blocked end and a second blocked end.

9. The seal of any preceding claim, wherein the plurality of cooling holes comprises a straight configuration.

10. The seal of any preceding claim, wherein the plurality of cooling holes comprises an angled configuration.

11. The seal of any preceding claim, wherein the plurality of cooling holes comprises a plurality of impingement holes.

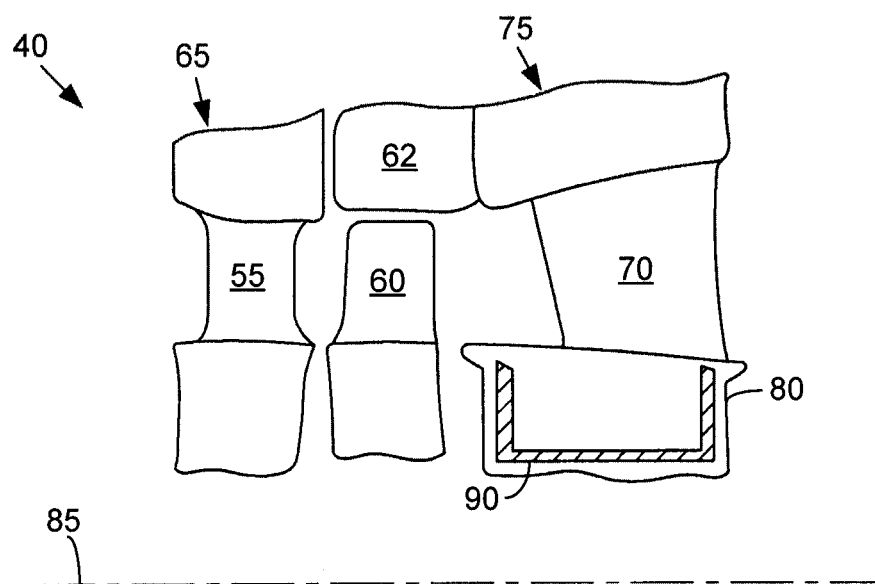
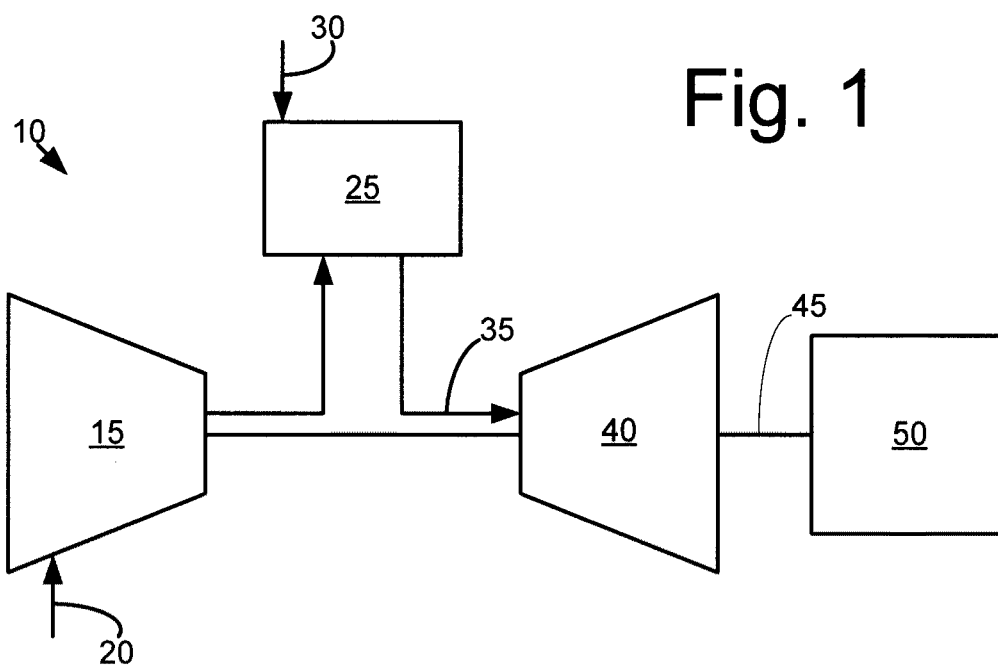
12. The seal of any preceding claim, wherein the components comprise a first stator and a second stator

13. The seal of any preceding claim, wherein the components define a seal slot and wherein the seal slot is cooled via the high pressure cooling air flow from the plurality of cooling pathways.

14. A method of cooling a seal positioned between components in a gas turbine engine, comprising:

flowing high pressure cooling air about a first surface of the seal;
 drawing the high pressure cooling air through a plurality of cooling pathways in the seal; and
 drawing the high pressure cooling air through an air plenum about a second surface of the seal towards a hot gas path.

15. The method of claim 14, further comprising the step of cooling the components with the high pressure cooling air leaving the air plenum.



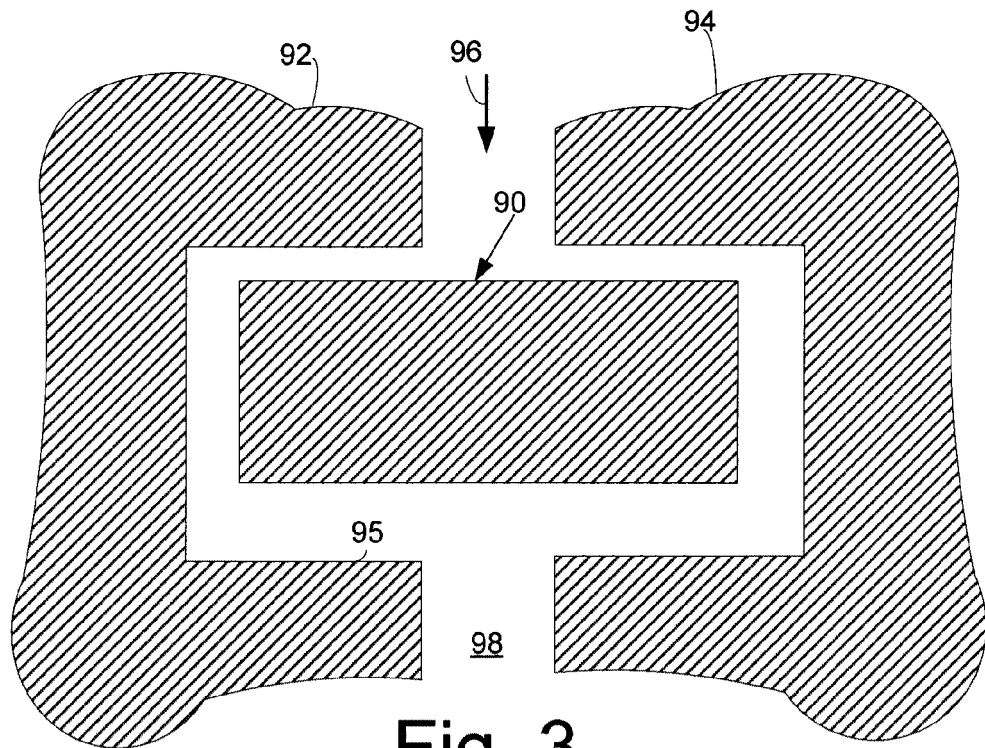


Fig. 3

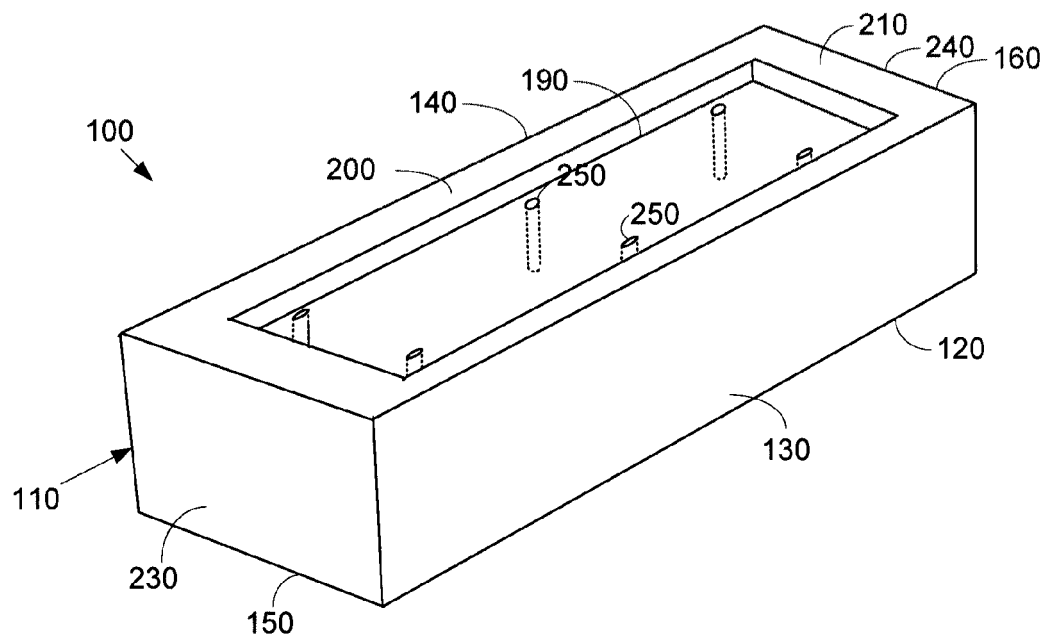


Fig. 4

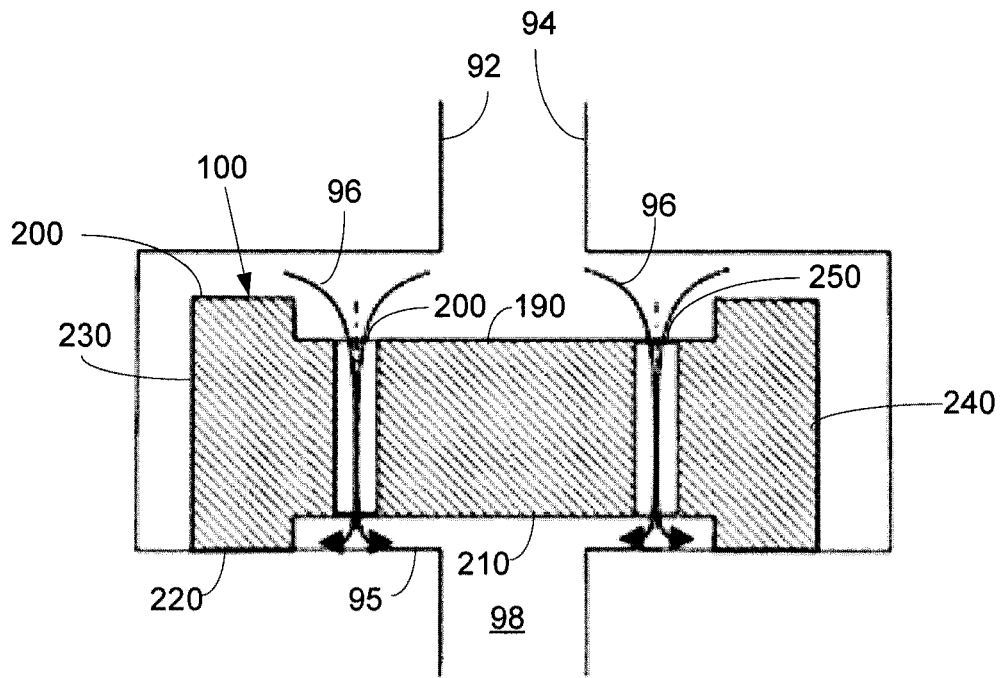


Fig. 5



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Application Number
EP 13 18 6957

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Place of search Munich		Date of completion of the search 20 November 2013	Examiner Balice, Marco
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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The members are as contained in the European Patent Office EDP file on
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