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(54) **Turbine diffuser**

(57) The present invention provides a diffuser (100) for use with a gas turbine (10). The diffuser (100) may include hub (120), a number of struts (110) extending from the hub (120), and a number of airfoils (130) extending from the hub (120).

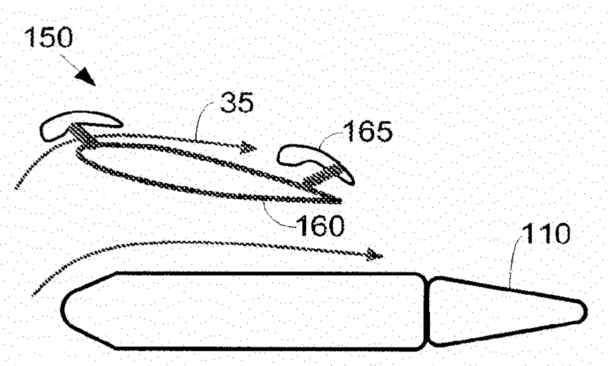

Fig. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to gas turbine engines and more particularly relate to a turbine diffuser with an airfoil arrangement to reduce swirl and flow separation during partial load operations and the like.

BACKGROUND OF THE INVENTION

[0002] Gas turbine engines and the like typically include a diffuser downstream of the last stage of a turbine. Generally described, the diffuser converts the kinetic energy of the hot flow gases exiting the last stage into potential energy in the form of increased static pressure. The diffuser directs the hot flow gases through a casing of increasing area in the direction of the flow. The diffuser generally includes a number of struts mounted onto a hub and enclosed by the casing. Other configurations also may be known.

[0003] During partial load operations, a bucket exit tangential flow angle (swirl) may increase and may lead to flow separation on the struts and the hub of the diffuser. Flow separation and an increase in swirl may reduce the diffuser static pressure recovery. Such a reduction may have an impact on overall gas turbine engine performance and efficiency.

[0004] There is thus a desire for an improved gas turbine engine diffuser design. Such an improved design preferably may limit flow separations and swirl so as to improve overall performance and efficiency.

SUMMARY OF THE INVENTION

[0005] The present invention thus provides a diffuser for use with a gas turbine. The diffuser may include hub, a number of struts extending from the hub, and a number of airfoils extending from the hub.

[0006] The present invention further provides a diffuser for use with a gas turbine. The diffuser may include a hub, a number of struts extending from the hub, a number of airfoils extending from the hub such that one of the airfoils is positioned between a pair of the struts, and a casing.

[0007] The present invention further provides a diffuser for use with a gas turbine. The diffuser may include a hub, a number of struts extending from the hub, and a number of airfoils extending from the hub. The airfoils may have a number of configurations.

[0008] 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

[0009] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

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

Fig. 2 is a partial perspective view of a portion of a diffuser as may be described herein.

Fig. 3 is a plan view of portions of the diffuser of Fig. 2

Fig. 4 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

Fig. 5 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

Fig. 6 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

Fig. 7 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

Fig. 8 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

Fig. 9 is a plan view of portions of an alternative embodiment of a diffuser as may be described herein.

DETAILED DESCRIPTION

[0010] 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.

[0011] The gas turbine engine 10 also may include a diffuser 55. The diffuser 55 may be positioned downstream of the turbine 40. As described above, the diffuser 55 may include a number of struts 60 mounted on a hub 65 and enclosed within an outer casing 70. The diffuser

55 turns the flow of combustion gases 35 in an axial direction. Other configurations and other components may be used.

[0012] 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. 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.

[0013] Fig. 2 and Fig. 3 show portions of an example of a diffuser 100 as may be described herein. Generally described, the diffuser 100 may include a number of struts 110 positioned on a hub 120. Any number of struts 110 may be used. The struts 110 and the hub 120 may have any size or shape. The struts 110 may be enclosed within a casing that expands in diameter along the flow path therethrough. The casing may be similar to that described above. Other components and other configurations also may be used herein.

[0014] The diffuser 100 also may have a number of airfoils 130 positioned on the hub 120. In this example, the airfoils 130 may be positioned adjacent to the struts 110. Specifically, an airfoil 130 may be positioned between each pair of the struts 110. Any number of the airfoils 130 may be used herein. The angle, length, size, shape, and configuration of the airfoils 130 may vary. Airfoils 130 of different configurations may be used herein together. A slot 140 may be positioned through a portion of the airfoil 130. The slot 140 serves to direct the flow of combustion gases 35 therethrough. The slot 140 may have any desired size, shape, or configuration. Other components and other configurations may be used herein.

[0015] The use of the airfoils 130 thus corrects the creation of swirl and reduces flow separation about the struts 110 and the hub 120 of the diffuser 100 through the entire partial load operations. Moreover, the airfoils 130 may be designed to not incur additional losses during full load ISO and cold day operations. An increase in airfoil count/solidity reduces airfoil-strut pitch so as to correct the swirl and the flow separation. The diffuser 100 thus may provide improved performance so as to improve overall gas turbine performance and efficiency.

[0016] The airfoil also may include additional features or mechanisms as shown in, for example, Figs. 4-9. These additional features also avoid flow separation on the airfoil and improve performance. Fig. 4 shows a diffuser 150. The diffuser 150 may include the strut 110 and a "hunch back"-like airfoil 160 positioned adjacent thereto. The hunch back airfoil 160 may have a spoiler like configuration 165 to direct the flow of combustion gases 35.

[0017] Fig. 5 shows a further example of a diffuser 170. The diffuser 170 may include the strut 110 and a vortex generator airfoil 180 positioned adjacent thereto. The vortex generator airfoil 180 may have a largely sinusoidal configuration 185 to direct the flow of combustion gases 35.

[0018] Fig. 6 shows a further example of a diffuser 190. The diffuser 190 may include the strut 110 and a fluidic airfoil 200 positioned adjacent thereto. The fluidic airfoil 200 may have a number of fluidic ports 210 to provide suction and/or blowing so as to direct the flow of combustion gases 35.

[0019] Fig. 7 shows a further example of a diffuser 220. The diffuser 220 may include the strut 110 and a high lift airfoil 230 positioned adjacent thereto. The high lift airfoil 230 may include a number of airfoil elements 240 so as to direct the flow of combustion gases 35.

[0020] Fig. 8 shows a further example of a diffuser 250. The diffuser 250 may include the strut 110 and a cambered airfoil 260 positioned adjacent thereto. The cambered airfoil 260 may take a thickened configuration 270 so as to direct the flow of combustion gases 35.

[0021] Fig. 9 shows a further example of a diffuser 250. The diffuser 250 may include the strut 110 and an extended airfoil 280 positioned adjacent thereto. The extended airfoil 280 may take a forward bend 290 so as to direct the flow of combustion gases 35.

[0022] The diffusers described herein thus may include airfoils 130 of various sizes, shapes, and configurations. The use of the airfoils 130 with the struts 110 thus controls the flow separation and swirl during partial load operations so as to improve overall efficiency. Many other sizes, shapes, and configurations of diffusers and airfoils may be used herein.

[0023] It should be apparent that the foregoing relates only to certain embodiments of the present application and the resultant patent. Numerous changes and modifications may be made herein by one of ordinary skill in the art without departing from the general spirit and scope of the invention as defined by the following claims and the equivalents thereof.

Claims

1. A diffuser (100,150,170,190,220,250) for use with a gas turbine (10), comprising:

   a hub (120);
   a plurality of struts (110) extending from the hub (120); and
   a plurality of airfoils (130) extending from the hub (120).

2. The diffuser of claim 1, wherein one of the plurality of airfoils (130) is positioned between a pair of the plurality of struts (110).

3. The diffuser of claim 1 or 2, wherein one or more of the plurality of airfoils (130) comprises a slot (140)

therein.

4. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises a hunch back airfoil (160).

5. The diffuser of claim 4, wherein the hunch back airfoil (160) comprises a spoiler (165) thereon.

6. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises a vortex generator airfoil (180).

7. The diffuser of claim 6, wherein the vortex generator airfoil (180) comprises a sinusoidal configuration (185).

8. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises a fluidic airfoil (200).

9. The diffuser of claim 8, wherein the fluidic airfoil (200) comprises one or more ports (210) thereon.

10. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises a high lift airfoil (230).

11. The diffuser of claim 10, wherein the high lift airfoil (230) comprises one or more airfoil elements (240).

12. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises a cambered airfoil (260).

13. The diffuser of claim 12, wherein the cambered airfoil (260) comprises a thickened configuration (270).

14. The diffuser of any of claims 1 to 3, wherein one or more of the plurality of airfoils (130) comprises an extended airfoil (280).

15. The diffuser of claim 14, wherein the extended airfoil (280) comprises a forward bend (290).

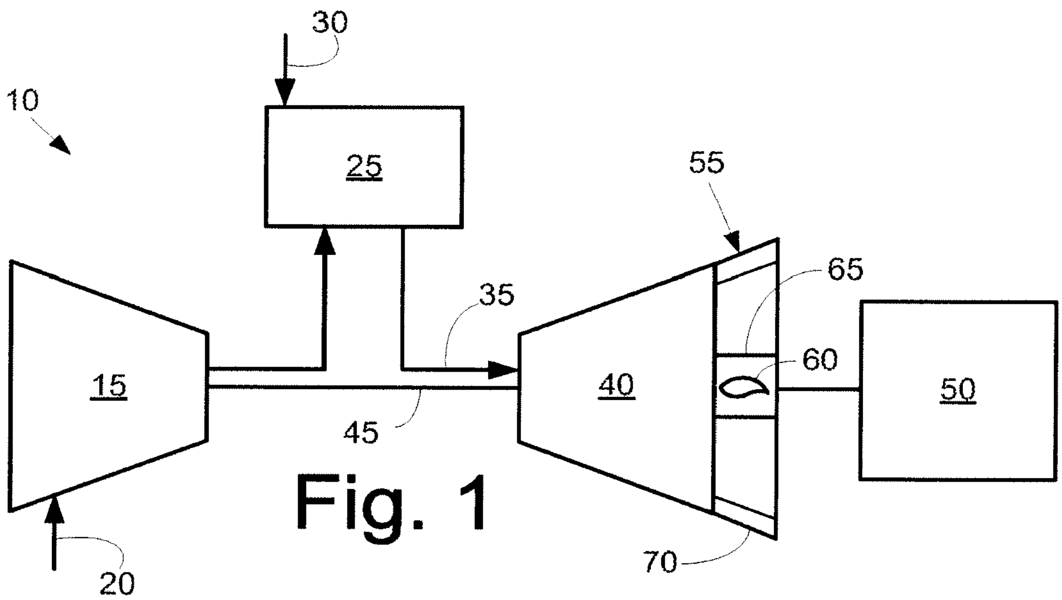

Fig. 1

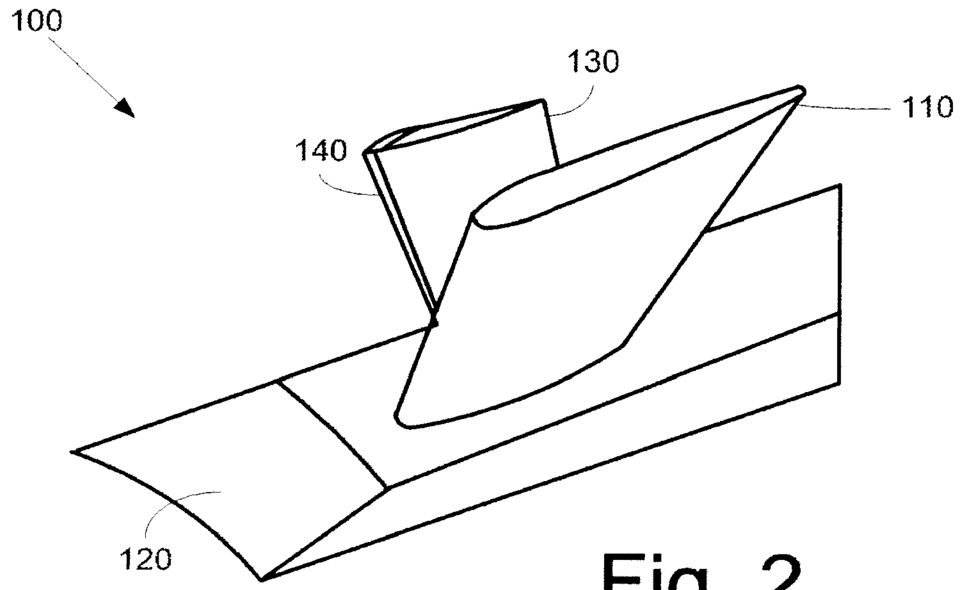

Fig. 2

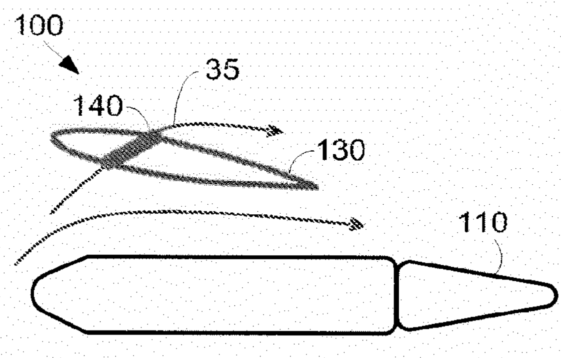

Fig. 3

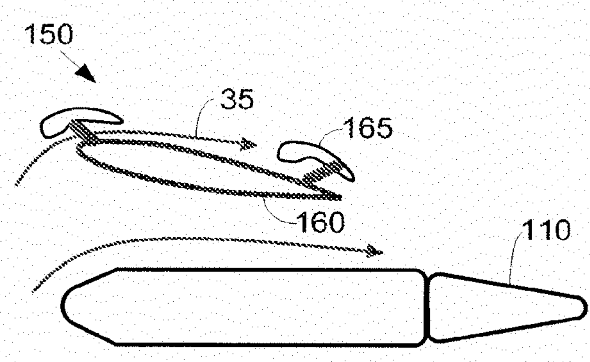

Fig. 4

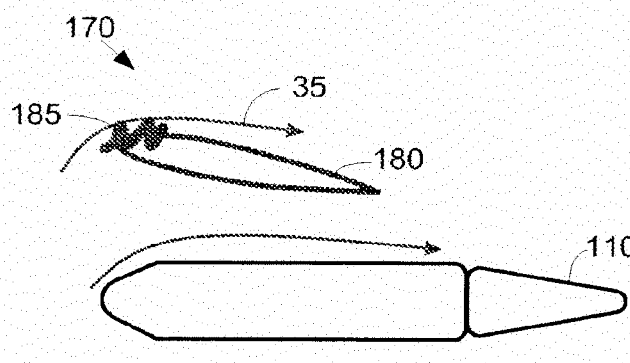

Fig. 5

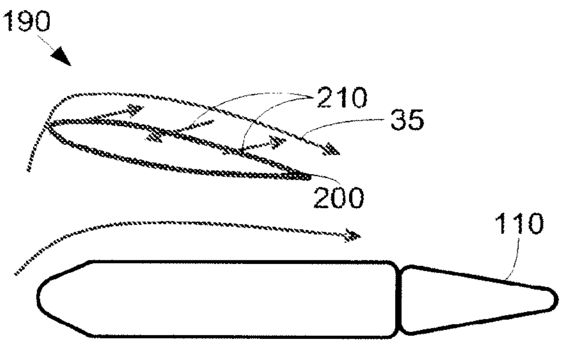

Fig. 6

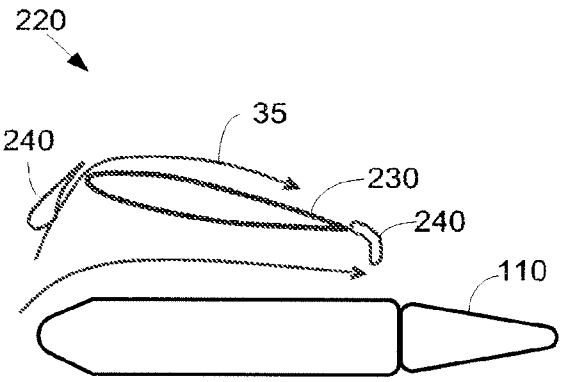

Fig. 7

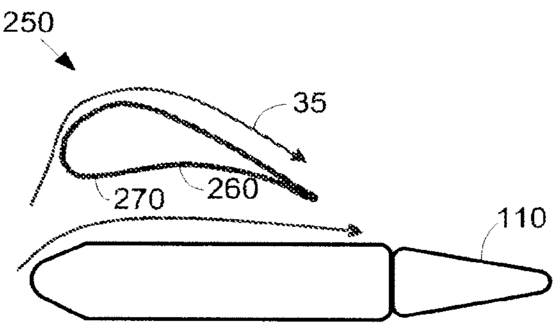

Fig. 8

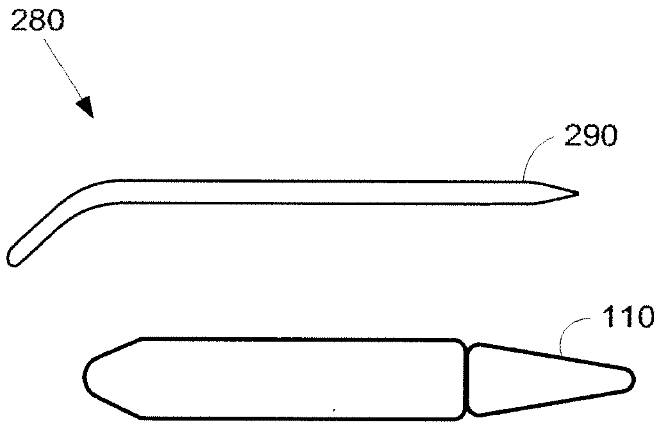

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 8699

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2005/100752 A1 (NORRIS THOMAS R [US]) 27 October 2005 (2005-10-27) * paragraph [0005] - paragraph [0010] * * paragraph [0022] * * paragraph [0071] * * paragraph [0087] - paragraph [0089] * * paragraph [0097] * * paragraph [0100] * * paragraph [0109] * * figures *	1,2,6,7,11 3-5,8-10,15	INV. F01D5/14
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 April 2014	Mielimonka, Ingo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 19 8699

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82