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(54) **Fuel Nozzle**

(57) The present invention provides a fuel nozzle (100) for mixing a flow of fuel and a flow of air. The fuel nozzle (100) may include a downstream face (120), a number of fuel passages (140) positioned about the

downstream face (120) for the flow of fuel, and a nozzle collar (160) positioned about the downstream face (120). The nozzle collar (160) may include a number of air vanes (170) for the flow of air and one or more purge holes (200) therethrough.

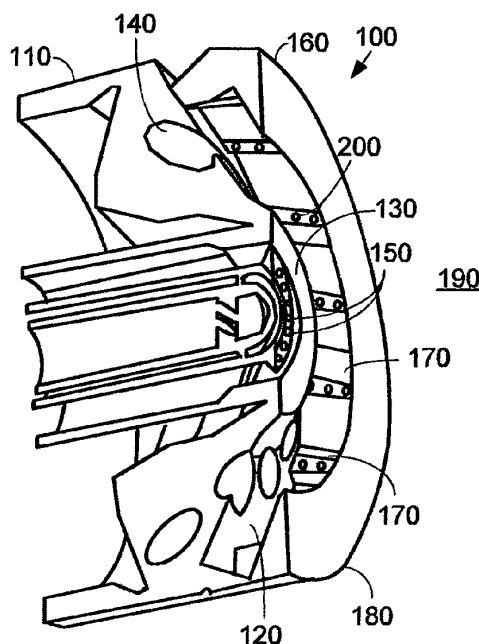


Fig. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates generally to a gas turbine engine and more particularly relate to a fuel nozzle with a nozzle collar having a number of purge holes therein for improved fuel-air mixing, flame holding resistance, and overall performance.

BACKGROUND OF THE INVENTION

[0002] Generally described, a gas turbine engine may employ one or more fuel nozzles to facilitate fuel-air mixing in a combustor. Each fuel nozzle may direct a flow of fuel, a flow of air, and optional flows of other fluids into the combustor for combustion therein. In certain conditions, a combustion flame may flash back and/or hold to a surface of the fuel nozzle. Flame holding may cause significant damage to the fuel nozzles and/or reduce the performance of the fuel nozzles and the overall gas turbine engine.

[0003] Specifically, flame holding may occur if a flammable fuel-air mixture resides in a low velocity region in close proximity to a combustion source. In fuel nozzles used in diffusion based combustion systems, low velocity regions generally may be found near the interior walls of the fuel nozzles due to the aerodynamics therein. Such a flammable mixture potentially may result in flame holding inside the fuel nozzles. Flame holding inside fuel nozzles may result in the fuel nozzles burning out, *i.e.*, experiencing flame damage therein.

[0004] There is thus a desire for an improved fuel nozzle design. Preferably such an improved fuel nozzle design may limit or reduce flammable fuel/air mixtures in low velocity regions about the fuel nozzles so as to limit flame holding and the like. Limiting flame holding should improve the overall performance and durability of the fuel nozzles and the gas turbine engine.

SUMMARY OF THE INVENTION

[0005] The present invention provides an example of a fuel nozzle for mixing a flow of fuel and a flow of air. The fuel nozzle may include a downstream face, a number of fuel passages positioned about the downstream face for the flow of fuel, and a nozzle collar position about the downstream face. The nozzle collar may include a number of air vanes for the flow of air and one or more purge holes therethrough.

[0006] The present invention further provides an example of a method of limiting flame holding about a fuel nozzle. The method may include the steps of providing a flow of fuel through a downstream face of the fuel nozzle, providing a flow of air through a number of air vanes of a nozzle collar of the fuel nozzle, mixing the flow of fuel and the flow of air downstream of the fuel nozzle, providing a flow of purge air through a number of purge

holes in the air vanes, and limiting the creation of one or more recirculation zones downstream of the fuel nozzle with the flow of purge air.

[0007] The present invention further provides an example of a combustor for use with a gas turbine engine. The combustor may include a combustion chamber and a number of fuel nozzles positioned about the combustion chamber. Each of the fuel nozzles may include a nozzle collar thereon. The nozzle collar may include one or more air vanes with one or more purge holes for a flow of purge air therethrough.

[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, and a turbine.

Fig. 2 is a side view of an example of the compressor such as that shown in Fig. 1.

Fig. 3 is a perspective view of an example of a fuel nozzle with a nozzle collar as may be described herein.

Fig. 4 is a partial side cross-sectional view of the fuel nozzle with the nozzle collar of Fig. 3.

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. Other configurations and other components may be used herein.

[0011] 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.

[0012] Fig. 2 shows an example of the combustor 25 that may be used with the gas turbine engine 10 and the like. The combustor 25 may include a number of fuel nozzles 55 therein. As described above, each of the fuel nozzles 55 may direct a flow of air 20, a flow of fuel 30, and optional flows of other fluids into the combustor 25 for combustion therein. Any number of the fuel nozzles 55 may be used in any configuration. The fuel nozzles 55 may be attached to an end cover 60 near a head end 65 of the combustor 25. The flows of air 20 and fuel 30 may be directed through the end cover 60 and the head end 65 to each of the fuel nozzles 55 so as to distribute a fuel-air mixture therein.

[0013] The combustor 25 also may include a combustion chamber 70 therein. The combustion chamber 70 may be defined by a combustion casing 75, a combustion liner 80, a flow sleeve 85, and the like. The liner 80 and the flow sleeve 85 may be coaxially positioned with respect to one another so as to define an air pathway 90 for the flow of air 20 therethrough. The combustion chamber 70 may lead to a downstream transition piece 95. The flows of air 20 and fuel 30 may mix downstream of the fuel nozzles 55 for combustion within the combustion chamber 70. The flow of combustion gases 35 then may be directed via the transition piece 95 towards the turbine 40 so as to produce useful work therein. Other components and other configuration also may be used herein.

[0014] Fig. 3 and Fig. 4 show an example of a fuel nozzle 100 as may be described herein. The fuel nozzle 100 may include an outer tube 110. The outer tube 110 may lead to a downstream face 120 with a fuel nozzle tip 130. The outer tube 110 may include a number of fuel and air passages therein. Specifically, a number of fuel passages 140 may extend therethrough and may be axially positioned about the downstream face 120. The fuel passages 140 may be in communication with the flow of fuel 30. A number of tip outlets 150 also may extend therethrough and may be positioned about the fuel nozzle tip 130. The tip outlets 150 may be in communication with the flow of fuel 30, the flow of air 20, or other types of flows. The flows of fuel 30 extending through the fuel passages 140 and through the tip outlets 150 may be the same and/or different types of fuel flows depending upon the nature of the combustion and other types of parameters. Other components and other configurations also may be used herein.

[0015] The fuel nozzle 100 also may include a nozzle collar 160 positioned about the downstream end of the outer tube 110. The nozzle collar 160 may surround the downstream face 120 and the fuel nozzle tip 130. The nozzle collar 160 may include a number of air vanes 170. The air vanes 170 may be angled so as to direct the flow of air 20 therethrough and/or to impart swirl therein. The air vanes 170 may have size, shape, or configuration. Any number of the air vanes 170 may be used. The air vanes 170 may direct the flow of air 20 about the fuel passages 140 and the tip outlets 150. The air vanes 170 may support a downstream ring 180 at the end thereof. Other components and other configurations also may be used herein.

[0016] As described above, a number of recirculation zones 190 may be formed as a result of the interaction between the flows of air 20 and fuel 30. These recirculation zones 190 may lead to flame holding about the fuel nozzle 100 via a region of low velocity. As a result, a number of purge holes 200 may be positioned through the air vanes 170. The purge holes 200 may have any size, shape, or configuration. Any number of the purge hole 200 may be used herein. The purge holes 200 may be angled and/or multiple angles may be used herein. Additional purge holes 200 also may extend through the downstream ring 180 and/or elsewhere. Other components and other configurations may be used herein.

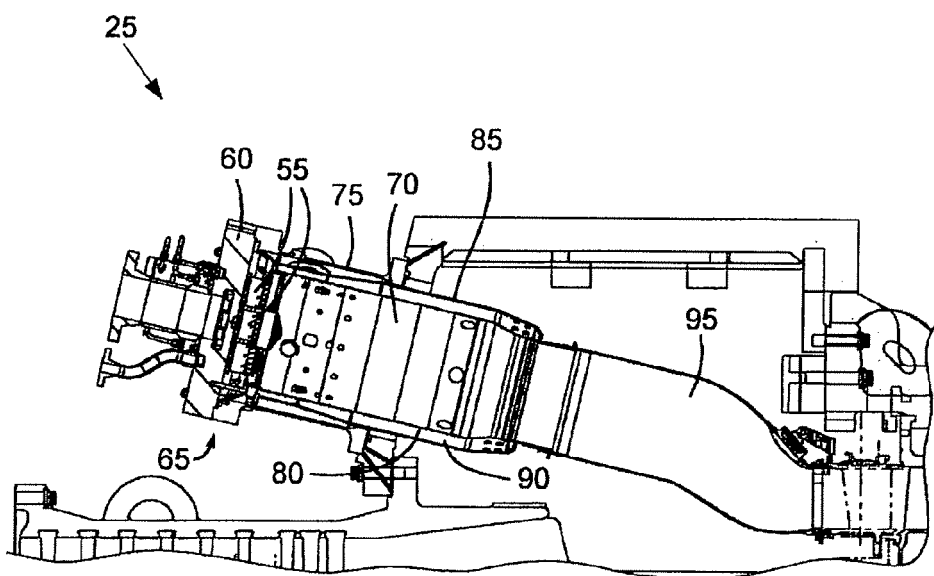
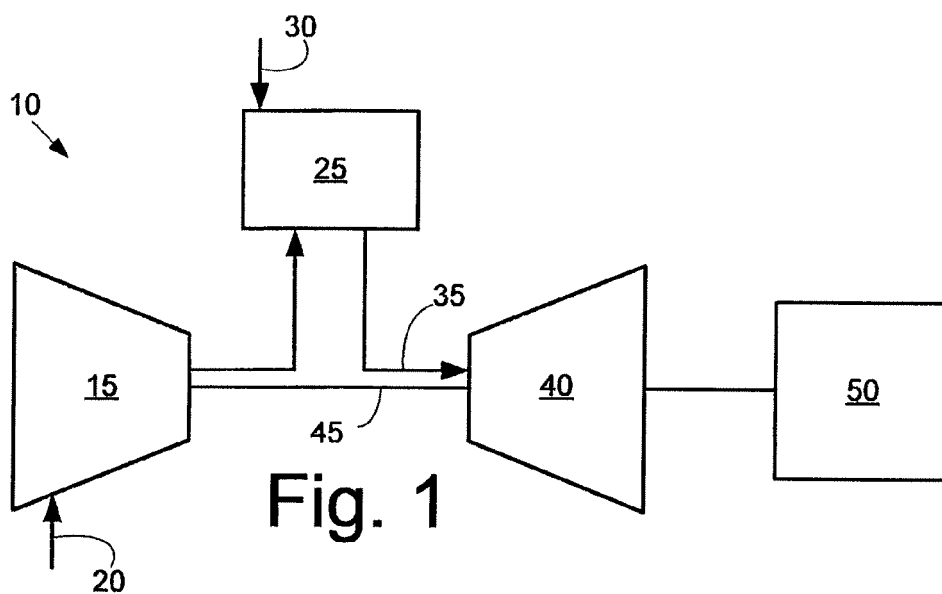
[0017] The purge holes 200 thus provide for a flow of purge air 210 therethrough as part of the overall flow of air 20. The flow of purge air 210 through the purge holes 200 may disrupt the recirculation zones 190 downstream of the fuel nozzles 100 caused by the regions of low velocity or otherwise. The purge holes 200 may be angled such that the purge air 210 disrupts the creation of the recirculation zones 190 in a substantially circumferential direction. Elimination or reduction of these recirculation zones 190 along the circumferential direction should reduce flame holding thereon. As such, the reduction in flame holding should provide the fuel nozzle 100 with improved durability and lifetime. Moreover, the overall gas turbine engine 100 may have improved emissions and overall improved performance. The use of the purge holes 200 with the flow of purge air 210 therethrough may be original equipment or added as part of a retrofit.

[0018] 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 fuel nozzle (100) for mixing a flow of fuel (30) and a flow of air (20), comprising:

- a downstream face (120);
a plurality of fuel passages (140) positioned about the downstream face (120) for the flow of fuel (30) therethrough;
a nozzle collar (16) positioned about the downstream face (120), the nozzle collar (160) comprising a plurality of air vanes (170) for the flow of air therethrough and one or more of the plurality of air vanes (170) comprising one or more purge holes (200) therethrough.
2. The fuel nozzle of claim 1, further comprising an outer tube (110) with the plurality of fuel passages (140) extending therethrough to the downstream face (120).
3. The fuel nozzle of claim 1 or 2, wherein the downstream face (120) comprises a fuel nozzle tip (130) positioned thereon.
4. The fuel nozzle of claim 3, wherein the fuel nozzle tip (130) comprises one or more tip outlets (150) positioned thereon for the flow of fuel (30) and/or the flow of air (20) therethrough.
5. The fuel nozzle of claim 4, wherein the flow of fuel (30) through the plurality of fuel passages (140) comprises a first flow of fuel and wherein the flow of fuel through the one or more tip outlets (150) comprises a second flow of fuel.
6. The fuel nozzle of any preceding claim, wherein the nozzle collar (160) comprises a downstream ring (180) adjacent to the plurality of air vanes (170).
7. The fuel nozzle of any preceding claim, further comprising a plurality of fuel nozzles (100) positioned about a combustion chamber (70).
8. The fuel nozzle of any preceding claim, further comprising a flow of purge air (210) through the one or more purge holes (200).
9. The fuel nozzle of claim 8, wherein the flow of purge air (210) through the one or more purge holes (200) limits a zone of recirculation (190) of the flow of fuel (30) and the flow of air (20) downstream of the fuel nozzle (100) which limits flame holding about the fuel nozzle (100).
10. A combustor (25) for use with a gas turbine engine (10), comprising:
a combustion chamber (70); and
a plurality of fuel nozzles (100) positioned about the combustion chamber (70);
each of the plurality of fuel nozzles (100) as recited in any of claims 1 to 9.
11. A method of limiting flame holding about a fuel nozzle, (100) comprising:
providing a flow of fuel (30) through a downstream face (120) of the fuel nozzle (100);
providing a flow of air (20) through a plurality of air vanes (170) of a nozzle collar (160) of the fuel nozzle (100);
mixing the flow of fuel (30) and the flow of air (20) downstream of the fuel nozzle (100);
providing a flow of purge air (210) through a plurality of purge holes (200) in the plurality of air vanes (170); and
limiting the creation of one or more recirculation zones (190) downstream of the fuel nozzle (55) with the flow of purge air (210).
12. The method of claim 11, wherein the step of providing a flow of fuel (30) comprises providing a flow of fuel (30) through a plurality of fuel passages (140).
13. The method of claim 11 or 12, wherein the step of providing a flow of fuel comprises providing a flow of fuel (30) through a plurality of tip outlets (150) in a fuel nozzle tip (55).
14. The method of any of claims 11 to 13, wherein the step of providing a flow of air (20) through a plurality of air vanes (170) comprises providing the flow of air (20) through a plurality of angled air vanes.
15. The method of any of claims 11 to 14, wherein the step of limiting the creation of one or more recirculation zones (190) comprises limiting the creation of one or more recirculation zones (190) extending in a circumferential direction.



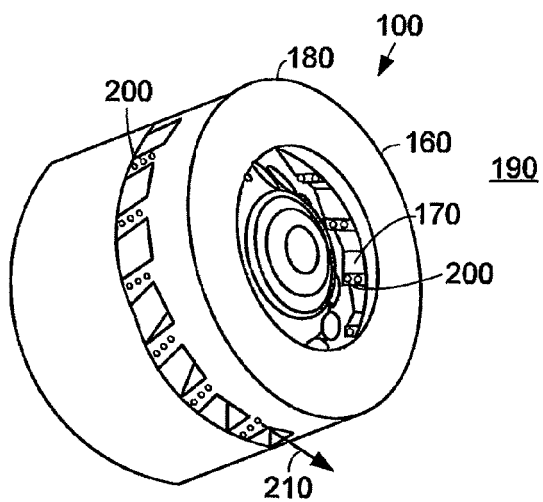


Fig. 3

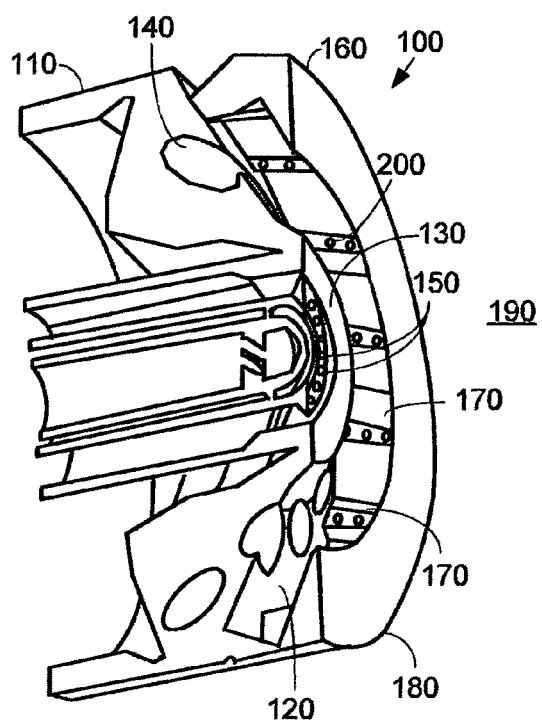


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
EP 13 15 2025

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	EP 1 243 854 A1 (ALSTOM SWITZERLAND LTD [CH] ALSTOM TECHNOLOGY LTD [CH]) 25 September 2002 (2002-09-25) * figure 2 * * paragraphs [0015], [0022], [0023] * -----	1-15	INV. F23D11/38 F23R3/28 F23R3/14
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			TECHNICAL FIELDS SEARCHED (IPC)
			F23D F23R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 17 May 2013	Examiner Christen, Jérôme
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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