United States Patent	12385641
Kind Code	B1
Date of Patent	August 12, 2025
Inventor(s)	Li; Hejie et al.

Combustor for a gas turbine engine

Abstract

A combustor for a gas turbine engine includes a dome-deflector structure and a fuel nozzle-swirler assembly having a mounting wall with a plurality of purge orifices extending therethrough. A circumferential purge cavity is defined between a fuel nozzle-swirler assembly housing, a fuel nozzle-swirler assembly opening of the dome-deflector structure, and the mounting wall. The purge orifices provide a purge airflow to the circumferential purge cavity. In a first state, when a radial height of the circumferential purge cavity is constant, the dome-deflector structure overlaps a portion of the purge orifices to block a portion of each purge orifice, and, in a second state when the fuel nozzle-swirler assembly is radially shifted, the dome-deflector structure increases blockage of at least one purge orifice on a second side of the circumferential purge cavity, and reduces blockage of at least one purge orifice on a first side of the circumferential purge cavity.

Inventors: **Li; Hejie (Mason, OH), Salazar Lois; Gerardo Antonio (West Chester, OH), Cooper; Clayton S. (Loveland, OH)**

Applicant: **General Electric Company** (Schenectady, NY)

Family ID: **1000007931628**

Assignee: **GENERAL ELECTRIC COMPANY (Evendale, OH)**

Appl. No.: **18/736927**

Filed: **June 07, 2024**

Publication Classification

Int. Cl.: **F23R3/12** (20060101)

U.S. Cl.:

CPC **F23R3/12** (20130101);

Field of Classification Search

CPC: F23R (3/286); F23R (3/10); F23R (3/02); F23R (3/04); F23R (3/002); F23R (3/14); F23R (3/343); F23R (3/16); F23R (3/12)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2893647	12/1958	Wortman	239/464	B05B 1/323
3853273	12/1973	Bahr	239/404	F23R 3/14
4693074	12/1986	Pidcock	60/746	F23C 7/02
4712370	12/1986	MacGee	60/785	F02C 7/28
4890453	12/1989	Iwai et al.	N/A	N/A
6250062	12/2000	Lawen, Jr.	29/455.1	F23R 3/283
6772594	12/2003	Nishida	60/737	F23R 3/343
6915637	12/2004	Nishida et al.	N/A	N/A
9371990	12/2015	Moran	N/A	F23D 11/383
10422535	12/2018	Knapp	N/A	F23R 3/34
10495312	12/2018	Rodrigues	N/A	F23R 3/14
10920986	12/2020	Tsunoda	N/A	F23R 3/10
11391461	12/2021	Ichihashi	N/A	F23R 3/10
2017/0276356	12/2016	Mulcaire	N/A	F23R 3/002
2018/0003385	12/2017	Rodrigues	N/A	F23R 3/283
2021/0055000	12/2020	Ichihashi	N/A	F01D 25/12
2022/0282870	12/2021	Kim	N/A	F23R 3/286
2023/0053389	12/2022	Vukanti	N/A	F23R 3/16
2023/0112117	12/2022	Salazar Lois	60/722	F23R 3/007
2024/0377066	12/2023	Sharma	N/A	F23R 3/286

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
113606608	12/2022	CN	N/A
1555407	12/2012	EP	N/A
2491310	12/2014	EP	N/A
3421761	12/2019	EP	N/A
3563090	12/2019	EP	N/A
2015/043735	12/2014	WO	N/A

Primary Examiner: Kim; Craig

Attorney, Agent or Firm: Venable LLP

Background/Summary

TECHNICAL FIELD

(1) The present disclosure relates to a combustor for a gas turbine engine.

BACKGROUND

(2) Gas turbine engines include a combustor. The combustor generally includes a dome structure that is connected to a liner to define a combustion chamber. A plurality of fuel nozzle/swirler assemblies are mounted to the dome structure and provide a fuel/air mixture into the combustion chamber. The fuel/air mixture is ignited and burned within the combustion chamber to generate combustion gases. The dome structure may include a heat shield to protect the dome structure from the hot gases generated in the combustion chamber. The heat shield may also include cooling holes to allow compressed air to flow therethrough to provide cooling to the hot side of the heat shield.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Features and advantages of the present disclosure will be apparent from the following description of various exemplary embodiments, as illustrated in the accompanying drawings, wherein like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

(2) FIG. **1** is a schematic cross-sectional side view of an exemplary high by-pass turbofan jet engine, according to an aspect of the present disclosure.

(3) FIG. **2** is a partial cross-sectional side view of an exemplary combustor, according to an aspect of the present disclosure.

(4) FIG. **3** is an enlarged partial cross-sectional view of a fuel nozzle-swirler assembly and dome-deflector structure, taken at detail view **100** of FIG. **2**, according to an aspect of the present disclosure.

(5) FIG. **4** is a forward-looking cross-sectional view of a fuel nozzle-swirler assembly mounting wall and purge orifices, taken at plane **4-4** of FIG. **3**, according to an aspect of the present disclosure.

(6) FIG. **5** is a forward-looking cross-sectional view depicting an alignment of the mounting wall of FIG. **4** with respect to the dome-deflector structure in a first state, taken at plane **5-5** of FIG. **3**, according to an aspect of the present disclosure.

(7) FIG. **6** is an alternate cross-sectional view to that of FIG. **5**, and depicts an alignment of the mounting wall of FIG. **4** with respect to the dome-deflector structure in a second state, according to an aspect of the present disclosure.

(8) FIG. **7** depicts an alternate cross-sectional view of a fuel nozzle-swirler assembly mounting wall and purge orifices to that shown in FIG. **4**, according to an aspect of the present disclosure.

(9) FIG. **8** depicts an alternate forward-looking cross-sectional view to that of FIG. **5** of the alternate mounting wall and the dome-deflector structure in the first state, according to an aspect of the present disclosure.

(10) FIG. **9** depicts an alternate forward-looking cross-sectional view to that of FIG. **6** of the alternate mounting wall and the dome-deflector structure in the second state, according to an aspect of the present disclosure.

(11) FIG. **10** depicts an alternate cross-sectional view of a fuel nozzle-swirler assembly mounting wall and purge orifices to that shown in FIG. **7**, according to an aspect of the present disclosure.

(12) FIG. **11** depicts an alternate forward-looking cross-sectional view to that of FIG. **8** of the alternate mounting wall and the dome-deflector structure in the first state, according to an aspect of the present disclosure.

(13) FIG. **12** depicts an alternate forward-looking cross-sectional view to that of FIG. **9** of the alternate mounting wall and the dome-deflector structure in the second state, according to an aspect of the present disclosure.

(14) FIG. **13** is a cross-sectional view through the mounting wall of FIG. **10**, taken at plane **13-13**

in FIG. **10**, according to an aspect of the present disclosure.
(15) FIG. **14** is a cross-sectional view through the mounting wall of FIG. **10**, taken at plane **14-14** in FIG. **10**, according to an aspect of the present disclosure.
(16) FIG. **15**A depicts an example of a hexagonal-shaped purge orifice, according to an aspect of the present disclosure.
(17) FIG. **15**B depicts an example of a rectangular-shaped purge orifice, according to an aspect of the present disclosure.
(18) FIG. **15**C depicts an example of a diamond-shaped purge orifice, according to an aspect of the present disclosure.
(19) FIG. **15**D depicts an example of a triangular-shaped purge orifice, according to an aspect of the present disclosure.
(20) FIG. **15**E depicts an example of a keyhole-shaped purge orifice, according to an aspect of the present disclosure.
(21) FIG. **15**F depicts an example of a star-shaped purge orifice, according to an aspect of the present disclosure.

DETAILED DESCRIPTION

(22) Features, advantages, and embodiments of the present disclosure are set forth or apparent from a consideration of the following detailed description, drawings, and claims. Moreover, the following detailed description is exemplary and intended to provide further explanation without limiting the disclosure as claimed.
(23) Various embodiments are discussed in detail below. While specific embodiments are discussed, this is done for illustration purposes only. A person skilled in the relevant art will recognize that other components and configurations may be used without departing from the present disclosure.
(24) The terms “upstream” and “downstream” refer to the relative direction with respect to fluid flow in a fluid pathway. For example, “upstream” refers to the direction from which the fluid flows, and “downstream” refers to the direction to which the fluid flows.
(25) The terms “forward” and “aft” refer to a relative side of an element and may be used interchangeably with the terms “upstream” and “downstream,” respectively.
(26) As used herein, the terms “axial” and “axially” refer to directions and orientations that extend substantially parallel to a centerline of the turbine engine. Moreover, the terms “radial” and “radially” refer to directions and orientations that extend substantially perpendicular to the centerline of the turbine engine. In addition, as used herein, the terms “circumferential” and “circumferentially” refer to directions and orientations that extend arcuately about the centerline of the turbine engine.
(27) The singular forms “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise.
(28) Approximating language, as used herein throughout the specification and claims, is applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “approximately,” and “substantially” is not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or the machines for constructing or manufacturing the components and/or systems. For example, the approximating language may refer to being within a one, two, four, ten, fifteen, or twenty percent margin in either individual values, range(s) of values, and/or endpoints defining range(s) of values.
(29) Gas turbine engines include a combustor. The combustor generally includes a dome structure that is connected to a liner to define a combustion chamber. A plurality of fuel nozzle/swirler assemblies are mounted to the dome structure and provide a fuel/air mixture into the combustion chamber. The fuel/air mixture is ignited and burned within the combustion chamber to generate

combustion gases. The dome structure may include a heat shield to protect the dome structure from the hot gases generated in the combustion chamber. The heat shield may also include cooling holes to allow compressed air to flow therethrough to provide cooling to the hot side of the heat shield. The fuel nozzle/swirler assembly is mounted to the dome structure with a circumferential gap between the swirler and the dome-deflector structure, and a flow of purge cooling air is provided to the circumferential gap via cooling holes. The circumferential gap allows for radial shifting of the fuel nozzle/swirler assembly with respect to the dome structure. With the foregoing structure, however, when the fuel nozzle/swirler assembly shifts radially, a larger gap occurs in at least part of the circumferential gap, which increases the risk for hot combustion gases from the combustion chamber to be ingested into the larger gap. The ingestion of the hot combustion gases into the gap can cause thermal distress of the swirler, as well as to the dome-deflector structure.

(30) The present disclosure provides a technique to increase the purge air flow locally within the circumferential gap when shifting of the fuel nozzle/swirler assembly occurs. According to the present disclosure, purge orifices provide a purge airflow to the circumferential gap between the swirler and the dome structure. In a first state, when the radial height of the circumferential gap is constant, the dome-deflector structure blocks a portion of each of the plurality of purge orifices. In a second state, when the fuel nozzle-swirler assembly shifts radially to result in a larger gap on one side and a smaller gap on the other side, some of the purge orifices on the smaller gap side are further blocked, while some of the purge orifices on the larger gap side are unblocked to provide additional purge airflow to the larger gap side. As a result, localized ingestion of hot combustion gases into the larger gap side can be prevented by providing the additional purge airflow. The total purge airflow for the circumferential gap remains the same for the first state and second state.

(31) Referring now to the drawings, FIG. **1** is a schematic cross-sectional side view of an exemplary high by-pass turbofan jet engine **10**, herein referred to as "engine **10**," as may incorporate various embodiments of the present disclosure. Although further described below with reference to a ducted turbofan engine, the present disclosure is also applicable to turbomachinery in general, including turbojet, turboprop, and turboshaft gas turbine engines, including marine and industrial turbine engines and auxiliary power units. In addition, the present disclosure is not limited to ducted fan type turbine engines such as that shown in FIG. **1**, but can be implemented in unducted fan (UDF) type turbine engines as well. As shown in FIG. **1**, engine **10** has a longitudinal centerline axis **12** that extends therethrough from an upstream end **96** of the engine **10** to a downstream end **98** of the engine **10** for reference purposes. In general, engine **10** may include a fan assembly **14** and a turbo-engine **16** disposed downstream from the fan assembly **14**.

(32) The turbo-engine **16** may generally include an outer casing **18** that defines an annular inlet **20** to the turbo-engine **16**. The outer casing **18** encases, or at least partially forms, in serial flow relationship, a compressor section that includes a booster or a low-pressure compressor (LPC) **22** and a high-pressure compressor (HPC) **24**, a combustor **26**, a turbine section that includes a high-pressure turbine (HPT) **28** and a low-pressure turbine (LPT) **30**, and a jet exhaust nozzle **32**. A high-pressure rotor shaft **34** drivingly connects the HPT **28** to the HPC **24**. A low-pressure rotor shaft **36** drivingly connects the LPT **30** to the LPC **22**. The low-pressure rotor shaft **36** may also be connected to a fan shaft **38** of the fan assembly **14**. In particular embodiments, as shown in FIG. **1**, the low-pressure rotor shaft **36** may be connected to the fan shaft **38** by way of a reduction gearbox assembly **40**, such as in an indirect-drive or a geared-drive configuration. In other embodiments, although not illustrated, the engine **10** may further include an intermediate-pressure compressor and an intermediate-pressure turbine rotatable with an intermediate-pressure shaft that connects the intermediate-pressure turbine and the intermediate-pressure compressor.

(33) As shown in FIG. **1**, the fan assembly **14** includes a plurality of fan blades **42** that are coupled to, and extend radially outwardly from, the fan shaft **38**. An annular fan casing or a nacelle **44** circumferentially surrounds the fan assembly **14** and/or at least a portion of the turbo-engine **16**. The nacelle **44** may be supported relative to the turbo-engine **16** by a plurality of circumferentially

spaced outlet guide vanes or struts **46**. Moreover, at least a portion of the nacelle **44** may extend over an outer portion of the turbo-engine **16** so as to define a bypass airflow passage **48** between the nacelle **44** and the outer casing **18**.

(34) FIG. **2** is a partial cross-sectional side view of the exemplary combustor **26** of the turbo-engine **16** as shown in FIG. **1**. FIG. **2** depicts an example of a twin annular pre-mixing swirler (TAPS) type combustor, but the present disclosure can be implemented with other types of combustors as well. The combustor **26** is generally an annular combustor that extends circumferentially about the longitudinal centerline axis **12**. The combustor **26** includes a cowl **60**, and a combustor liner **50**, having an inner liner **52** and an outer liner **54**. Each of the inner liner **52** and the outer liner **54** is an annular liner that extends circumferentially about the longitudinal centerline axis **12**. A dome-deflector structure **56** extends between the inner liner **52** and the outer liner **54**. The inner liner **52**, the outer liner **54**, and the dome-deflector structure **56** together define a combustion chamber **62**.

(35) The combustor **26** further includes an outer casing **64** that extends circumferentially about the longitudinal centerline axis **12**, and an inner casing **65** that also extends circumferentially about the longitudinal centerline axis **12**. An outer flow passage **88** is defined between the outer casing **64** and the outer liner **54**, and an inner flow passage **90** is defined between the inner casing **65** and the inner liner **52**. The outer casing **64** and the inner casing **65** converge at an upstream end **70** of the combustor **26**, and, together, define a pressure plenum **66**. The outer casing **64** and the inner casing **65** are also connected with a diffuser **68**. The diffuser **68** is in flow communication with the HPC **24** to receive a flow of compressed air **82** from the HPC **24** and to provide the flow of the compressed air **82** into the pressure plenum **66**.

(36) A fuel nozzle assembly **55** is connected to the outer casing **64** and includes a fuel nozzle-swirler assembly **58**, which is described in more detail below. An ignitor **69** is connected to the outer casing **64**, and extends through the outer flow passage **88** and through the outer liner **54**. The ignitor **69** provides an ignition source (e.g., a spark) to ignite a pilot fuel-air mixture **57**. A main fuel-air mixture **61** may be ignited via the ignited pilot fuel-air mixture **57**, or the ignitor **69** may also be used to ignite the main fuel-air mixture **61**. In the combustion chamber **62**, an initial chemical reaction of the ignited pilot fuel-air mixture **57** injected into the combustion chamber **62** by a pilot swirler portion (to be described below) of the fuel nozzle-swirler assembly **58** may occur to generate combustion gases **86**. In higher power operations of the combustor **26**, the main fuel-air mixture **61** is injected into the combustion chamber **62** by a main swirler portion (to be described below) of the fuel nozzle-swirler assembly **58** to generate combustion gases **86**. The combustion gases **86** then flow further downstream into the HPT **28** and the LPT **30** (FIG. **1**) via a turbine nozzle **59** at a downstream end **63** of the combustion chamber **62**.

(37) Referring back to FIG. **1**, in operation of the engine **10**, a volume of inlet air **72** enters the nacelle **44** at a nacelle inlet **76**, and the inlet air **72** is propelled through the fan assembly **14**. A portion of the inlet air **72** propelled by the fan assembly **14** enters the LPC **22** at the annular inlet **20** as a compressor inlet airflow **80**, where the compressor inlet airflow **80** is compressed by the LPC **22** to generate compressed air **81**. The compressed air **81** then flows to the HPC **24**, where the compressed air **81** is further compressed to generate the compressed air **82**. The compressed air **82** from the HPC **24** enters the combustor **26** via the diffuser **68** (FIG. **2**). Another portion of the inlet air **72** propelled by the fan assembly **14** flows through the bypass airflow passage **48**, thereby providing a bypass airflow **78**. The bypass airflow **78** provides a majority of the thrust for the engine **10**.

(38) Referring back to FIG. **2**, as discussed above, the compressed air **82** flows through the diffuser **68**, which provides for a reduction in velocity of the compressed air **82** entering the pressure plenum **66**, and increases the pressure of the compressed air **82** within the pressure plenum **66**. A portion of the compressed air **82** in the pressure plenum **66** enters the cowl **60** (shown schematically as compressed air **82***a*), while another portion of the compressed air **82** passes to the outer flow passage **88** and to the inner flow passage **90** (shown schematically as compressed air

82*b*). The compressed air **82***a* passes through the fuel nozzle-swirler assembly **58** to mix with a pilot fuel flow to generate the pilot fuel-air mixture **57**, and to mix with a main fuel flow to generate the main fuel-air mixture **61**, both of which are then ignited to generate the combustion gases **86**. The compressed air **82***b* in the outer flow passage **88** and in the inner flow passage **90** may be used for various purposes, such as dilution air flowing through dilution openings **74** though the outer liner **54**, and flowing through dilution openings **75** through the inner liner **52**.
(39) Referring back to FIG. **1**, the combustion gases **86** flow from the combustor **26** to the HPT **28**, where work is extracted from the combustion gases **86** to rotate the HPT **28**. The rotation of the HPT **28** supports rotation of the HPC **24** via the high-pressure rotor shaft **34**. The combustion gases **86** then continue to flow downstream of the HPT **28** to the LPT **30**, where additional work is extracted from the combustion gases **86** to rotate the LPT **30**. The rotation of the LPT **30** supports rotation of the LPC **22** via the low-pressure rotor shaft **36**, and also supports rotation of the fan assembly **14** via the fan shaft **38** connected to the reduction gearbox assembly **40**. The remaining combustion gases **86** pass through the jet exhaust nozzle **32** and provide turbo-engine thrust.
(40) FIG. **3** is an enlarged partial cross-sectional view of the fuel nozzle-swirler assembly **58** and a portion of dome-deflector structure **56**, taken at detail view **100** of FIG. **2**, according to an aspect of the present disclosure. The fuel nozzle-swirler assembly **58** may generally be a twin annular premixing swirler (TAPS) fuel nozzle assembly that includes a pilot mixer **102** and a main mixer **104**. The pilot mixer **102** includes a venturi **106** that extends circumferentially about a fuel nozzle centerline axis **108**, and a pilot fuel injector **110** mounted within the venturi **106**. Further, the pilot mixer **102** includes a pilot swirler **112** that constitutes a plurality of pilot swirl vanes **114** arranged radially outward of the pilot fuel injector **110**. The pilot swirler **112** is generally oriented parallel to the fuel nozzle centerline axis **108**, and includes the plurality of pilot swirl vanes **114** for swirling the compressed air **82***a* traveling therethrough. A pilot fuel flow **116** is provided via a pilot fuel line **118** to the pilot fuel injector **110**. The pilot fuel flow **116** and the compressed air **82***a* are generally provided to the pilot mixer **102** during the engine operating cycle.
(41) The pilot fuel injector **110** may be any type of fuel injector, including an air blast type of fuel injector where pre-filming and atomization of the pilot fuel flow **116** provided by the pilot fuel injector **110** is performed almost exclusively by blasting the compressed air **82***a* at the pilot fuel flow **116**. The pilot fuel flow **116** is injected from the pilot fuel injector **110** into the venturi **106**. The pilot fuel-air mixture **57** (FIG. **2**) is then generated within the venturi **106** by mixing the swirling compressed air **82***a* passing through the pilot swirl vanes **114** and the pilot fuel flow **116** injected by the pilot fuel injector **110**. The pilot fuel-air mixture **57** is then injected into the combustion chamber **62**, where the pilot fuel-air mixture **57** is ignited and burned to generate the combustion gases **86**.
(42) The main mixer **104** is attached to a fuel nozzle housing **120** that surrounds the pilot mixer **102**. The main mixer **104** includes an annular main swirler housing **122** radially surrounding the fuel nozzle housing **120**, where the main swirler housing **122** defines an annular cavity **124**. The main mixer **104** includes a radial swirler **126** that is oriented substantially radially to the fuel nozzle centerline axis **108**, and includes a plurality of radial swirl vanes **128** (shown generally) for swirling the compressed air **82***a* flowing therebetween. The radial swirl vanes **128** are substantially uniformly spaced circumferentially, and a plurality of substantially uniform passages are defined between adjacent radial swirl vanes **128**.
(43) A main fuel circuit **134** is located within the fuel nozzle housing **120** between the pilot mixer **102** and the main mixer **104**. The main fuel circuit **134** is provided with a main fuel flow **136** via a main fuel line **138**. A plurality of main fuel injectors **140** are provided at the main fuel circuit **134**, and are arranged to inject the main fuel flow **136** into the annular cavity **124** of the main mixer **104**. The main fuel-air mixture **61** (FIG. **2**) is generated within the annular cavity **124** by mixing of the compressed air **82***a* passing through the radial swirl vanes **128** with the main fuel flow **136** injected by the main fuel injectors **140** into the annular cavity **124**. The main fuel-air mixture **61** then flows

into the combustion chamber **62**, where the main fuel-air mixture **61** is ignited and burned to generate the combustion gases **86**.

(44) The main swirler housing **122** includes a mounting wall **130** for mounting the fuel nozzle-swirler assembly **58** to the dome-deflector structure **56**. The mounting wall **130** extends in a radial direction (R) with respect to the fuel nozzle centerline axis **108** from the main swirler housing **122**, and also extends circumferentially about the fuel nozzle centerline axis **108**. The mounting wall **130** includes a plurality of purge orifices **132** extending through the mounting wall **130**. As will be described in more detail below, the plurality of purge orifices **132** are arranged to provide a purge airflow **82***c* therethrough. As will be described in more detail below, the plurality of purge orifices **132** are circumferentially spaced apart from each other about the fuel nozzle centerline axis **108**.

(45) The dome-deflector structure **56** includes a dome **142** and a deflector **144** that are connected together. The deflector **144** functions as a heat shield and protects the dome **142** from the hot combustion gases **86** generated in the combustion chamber **62**. The dome-deflector structure **56** includes a fuel nozzle-swirler assembly opening **146** therethrough. The fuel nozzle-swirler assembly opening **146** is generally a circular shaped opening that defines an opening centerline axis **152**. In FIG. **3**, the fuel nozzle centerline axis **108** and the opening centerline axis **152** are shown to be congruent with each other. Here, congruent is intended to mean that the fuel nozzle centerline axis **108** and the opening centerline axis **152** coincide with one another when superimposed on one another such that they form a same single centerline axis. The fuel nozzle-swirler assembly **58**, when mounted to the dome-deflector structure **56**, extends through the fuel nozzle-swirler assembly opening **146**. A mounting member **148** is connected to the dome-deflector structure **56** (e.g., connected via brazing), and is provided for mounting the fuel nozzle-swirler assembly **58** to the dome-deflector structure **56**. The mounting wall **130** slidingly engages within a cavity **154** of the mounting member **148** to allow radial motion of the fuel nozzle-swirler assembly **58** with respect to the fuel nozzle-swirler assembly opening **146**. The fuel nozzle-swirler assembly **58** can move in any radial and circumferential direction with respect to the opening centerline axis **152** such that the fuel nozzle centerline axis **108** and the opening centerline axis **152** are radially offset from one another in the direction of the radial movement. When the fuel nozzle-swirler assembly **58** is mounted to the dome-deflector structure **56**, a circumferential purge cavity **150** is defined between the main swirler housing **122**, the fuel nozzle-swirler assembly opening **146** of the dome-deflector structure **56**, and the mounting wall **130**. The plurality of purge orifices **132** are arranged to provide the purge airflow **82***c* to the circumferential purge cavity **150**. As will be described in more detail below, when the fuel nozzle-swirler assembly **58** moves radially, a radial height **156** of the circumferential purge cavity **150** changes from being a constant height circumferentially to having different radial heights on opposing sides of the circumferential purge cavity **150**.

(46) FIG. **4** is a forward-looking cross-sectional view of a mounting wall **130** and purge orifices **132**, taken at plane **4-4** of FIG. **3**, according to an aspect of the present disclosure. In FIG. **4**, only the mounting wall **130** is depicted and other aspects of the fuel nozzle-swirler assembly **58** are omitted from the cross-sectional view. In FIG. **4**, the plurality of purge orifices **132** are shown to be circumferentially spaced apart about the fuel nozzle centerline axis **108**. Each of the plurality of purge orifices **132** may be spaced apart an angular spacing **158** from each other. Alternatively, the angular spacing **158** need not be the same between each of the plurality of purge orifices **132**, and a different angular spacing **158** between a respective pair of the plurality of purge orifices **132** may be implemented instead. In the FIG. **4** aspect, each of the plurality of purge orifices **132** are shown to be an oval-shaped purge orifice **160**. Each oval-shaped purge orifice **160** has a major axis **162** and a minor axis **164**, and each oval-shaped purge orifice **160** is arranged with the major axis **162** extending in the radial direction (R) with respect to the fuel nozzle centerline axis **108**. Each oval-shaped purge orifice **160** also has a length **166** along the major axis **162** and a height **168** along the minor axis **164**. The length **166** and the height **168** is selected to provide a desired volume of the purge airflow **82***c* (FIG. **3**) through the plurality of purge orifices **132**. In addition, a centroid **170** of

each oval-shaped purge orifice **160** is arranged at a radial distance **172** from the fuel nozzle centerline axis **108**, and the radial distance **172** is selected based on a potential radial shift amount (described below) of the fuel nozzle-swirler assembly **58** (FIG. **3**) so as to maintain an overall total volume of the purge airflow **82***c* through the plurality of purge orifices **132**.

(47) FIG. **5** is a forward-looking cross-sectional view depicting a first state of alignment of the mounting wall **130** of FIG. **4** with respect to the dome-deflector structure **56**, taken at plane **5-5** of FIG. **3**, according to an aspect of the present disclosure. In FIG. **5**, similar to FIG. **4**, only the mounting wall **130**, the mounting member **148**, and a portion of the deflector **144** are shown, and other aspects of the fuel nozzle-swirler assembly **58** are omitted from the cross-sectional view. In FIG. **5**, a radial relationship in a first state of the fuel nozzle centerline axis **108** and the opening centerline axis **152** of the fuel nozzle-swirler assembly opening **146** is shown. As shown in FIG. **5**, the first state may be, for example, a neutral state in which both the fuel nozzle centerline axis **108** and the opening centerline axis **152** are congruent with each other. In the first state of FIG. **5**, the circumferential purge cavity **150** has a constant radial height **174**. That is, the radial height **174** of the circumferential purge cavity **150** is generally substantially the same about the entire circumference of the circumferential purge cavity **150**, although some very small variations (e.g., 0.005 to 0.010 mm) may exist due to manufacturing tolerances, etc. Thus, the term “constant” is intended to mean substantially the same within a very small variance amount and is not required to be exactly the same about the entire circumference. As shown in FIG. **5**, in the first state, the dome-deflector structure **56** overlaps a portion of each of the plurality of purge orifices **132** so as to block a radially outward portion of each of the purge orifices **132**. That is, the overlapping of the purge orifices **132** by the dome-deflector structure **56** reduces the effective airflow area of each of the purge orifices **132** through which the purge airflow **82***c* can pass through the mounting wall **130** and into the circumferential purge cavity **150**. The amount of unblocked area for all of the plurality of purge orifices **132** combined provides for a total effective flow area to provide a desired total volume of the purge airflow **82***c* to the circumferential purge cavity **150**. Each purge orifice **132** is sized so that, in the first state where the dome-deflector structure **56** blocks a portion of each purge orifice **132**, the total purge airflow volume is obtained. The total purge airflow volume of the purge airflow **82***c* in the first state is sufficient to prevent the ingestion of hot combustion gases from the combustion chamber **62** from flowing into the circumferential purge cavity **150**.

(48) FIG. **6** is an alternate cross-sectional view to that of FIG. **5**, and depicts a second state of alignment the mounting wall **130** of FIG. **4** with respect to the dome-deflector structure **56**, according to an aspect of the present disclosure. In FIG. **6**, the fuel nozzle centerline axis **108** of the fuel nozzle-swirler assembly **58** (FIG. **3**) is shown to be shifted in the radial direction (R) with a radial shift distance **176** such that the fuel nozzle centerline axis **108** and the opening centerline axis **152** of the fuel nozzle-swirler assembly opening **146** are no longer congruent and are radially offset from one another. FIG. **6** depicts a second state where the fuel nozzle-swirler assembly **58** has shifted radially with respect to the dome-deflector structure **56**, and the radial shift distance **176** is shown as a total radial shift limit that the fuel nozzle-swirler assembly **58** can shift with respect to the dome-deflector structure **56**. In the second state in which the fuel nozzle-swirler assembly **58** is radially shifted, the radial height **174** (FIG. **5**) of the circumferential purge cavity **150** also shifts so that the circumferential purge cavity **150** no longer has a constant radial height **174** about the circumference of the circumferential purge cavity **150**. Rather, the radial height **174** of the circumferential purge cavity **150** is increased on a first side **178** of the circumferential purge cavity **150** and the radial height **174** of the circumferential purge cavity **150** on a second side **180** of the circumferential purge cavity **150** opposing the first side **178** is decreased. The first side **178** refers to a portion of the circumferential purge cavity **150** that is on one side of a horizontal reference plane **182** through the fuel nozzle centerline axis **108**, and the second side **180** refers to a portion of the circumferential purge cavity **150** that is on an opposite side of the horizontal reference plane **182**. For example, on the first side **178**, the radial height **174** (FIG. **5**) of the circumferential purge

cavity **150** increases to range from a radial height **184** at the horizontal reference plane **182** to a radial height **186** at a vertical reference plane **188**. On the other hand, on the second side **180**, the radial height **174** of the circumferential purge cavity **150** decreases from the radial height **184** at the horizontal reference plane **182** to a radial height **190** at the vertical reference plane **188**. The increase in the radial height **174** of the circumferential purge cavity **150** to be between the radial height **184** and the radial height **186** may allow the ingestion of the hot combustion gases **86** (FIG. **2**) into the increased radial height portions of the circumferential purge cavity **150**, and, more particularly, adjacent to the radial height **186**. The ingestion of the hot combustion gases **86** into the circumferential purge cavity **150** at the increased radial height portions can cause more rapid localized deterioration of the fuel nozzle-swirler assembly **58** and the dome-deflector structure **56**.
(49) To prevent the ingestion of the hot combustion gases **86** into the circumferential purge cavity **150**, the purge orifices **132** are shaped so that, when the fuel nozzle-swirler assembly **58** shifts as shown in FIG. **6**, the dome-deflector structure **56** increases blockage of at least one purge orifice on the second side **180** (e.g., on the side where the radial height **174** is decreased) such that the effective flow area as shown in FIG. **5** in the first state through the purge orifices **132** on the second side **180** is decreased, and the dome-deflector structure **56** reduces blockage of at least one purge orifice **132** on the first side **178** (e.g., on the side where the radial height **174** is increased) such that the effective flow area as shown in FIG. **5** in the first state through the purge orifices **132** on the first side **178** is increased. The increase in the effective flow area (e.g., the at least partial unblockage of the purge orifices **132** on the first side **178**) provides an increase to the purge airflow volume through the purge orifices on the first side **178**. The decrease in the effective flow area (e.g., the at least partial further blockage of the purge orifices **132** on the second side **180**) provides a decrease in the purge airflow volume through the purge orifices **132** on the second side. However, the increase in purge flow volume through the purge orifices **132** on the first side **178** corresponds to the decrease in the purge flow volume through the purge orifices **132** on the second side **180** such that the total airflow volume through the purge orifices **132** in the second state shown in FIG. **6** is constant with the total purge airflow volume in the first state shown in FIG. **5**. As a result, the increase in the purge airflow through the portion of the circumferential purge cavity **150** with the increased radial height **186** prevent the ingestion of the hot combustion gases **86** into the first side **178** of the circumferential purge cavity **150**.
(50) FIG. **7** depicts an alternate cross-sectional view of a fuel nozzle-swirler assembly mounting wall **130***a* and purge orifices **132***a* to that shown in FIG. **4**, according to an aspect of the present disclosure. Elements in FIG. **7** that are the same as those of FIG. **4** are labeled with the same reference numerals and the description above for those elements is also applicable to FIG. **7**, unless stated otherwise. In FIG. **7**, the plurality of purge orifices **132***a* are seen to be arranged in a plurality of circumferential rows, including a first circumferential row **192** of purge orifices **132***a* and a second circumferential row **194** of purge orifices **132***a*. The first circumferential row **192** of the purge orifices **132***a* is arranged a first radial distance **196** from the fuel nozzle centerline axis **108**, and the second circumferential row **194** of the purge orifices **132***a* is arranged a second radial distance **198** greater than the first radial distance **196** from the fuel nozzle centerline axis **108**. The purge orifices **132***a* in the first circumferential row **192** are circumferentially spaced apart from each other by an angular spacing **200**, and the purge orifices **132***a* in the second circumferential row **194** are circumferentially spaced apart from each other by an angular spacing **202**. In addition, the purge orifices **132***a* in the first circumferential row **192** may be angularly staggered from the purge orifices **132***a* in the second circumferential row **194** by an angular offset spacing **204**. In FIG. **7**, the plurality of purge orifices **132***a* in the first circumferential row **192** are shown to be circular-shaped purge orifices **206**, while the plurality of purge orifices **132***a* in the second circumferential row **194** are shown to be oval-shaped purge orifices **208**, similar to the oval-shaped purge orifices **160** (FIG. **4**). A center **209** of each of the circular-shaped purge orifices **206** is aligned in the first circumferential row **192** the first radial distance **196** from the fuel nozzle centerline axis **108**, and a

centroid **211** of each of the oval-shaped purge orifices **208** is aligned in the second circumferential row **194** the second radial distance **198** from the fuel nozzle centerline axis **108**.
(51) FIG. **8** depicts an alternate forward-looking cross-sectional view to that of FIG. **5** of the alternate mounting wall **130***a* and the dome-deflector structure **56**, according to an aspect of the present disclosure. In FIG. **8**, elements that are the same as those in FIG. **5** include the same reference numerals and the description provided above for FIG. **5** of those elements is also applicable to FIG. **8**, unless stated otherwise. In the same manner as described above for FIG. **5**, FIG. **8** depicts the radial relationship in the first state in which the fuel nozzle centerline axis **108** and the opening centerline axis **152** of the fuel nozzle-swirler assembly opening **146** are congruent with each other such that the circumferential purge cavity **150** has the constant radial height **174**. In the FIG. **8** aspect, the dome-deflector structure **56** overlaps at portion of each of the oval-shaped purge orifices **208** in the second circumferential row **194** (FIG. **7**), while each of the circular-shaped purge orifices **206** remains unblocked to allow the purge airflow **82***c* to pass therethrough into the circumferential purge cavity **150**. The size (e.g., diameter) of each of the circular-shaped purge orifices **206**, as well as the number of the circular-shaped purge orifices **206** included through the mounting wall **130***a*, along with the unblocked effective flow area of the overlapped oval-shaped purge orifices **208**, is designed to provide the sufficient total purge airflow **82***c* to the circumferential purge cavity **150** in the first state so as to prevent the ingestion of the hot combustion gases **86** into the circumferential purge cavity **150**.
(52) FIG. **9** depicts an alternate forward-looking cross-sectional view to that of FIG. **6** of the alternate mounting wall **130***a* and the dome-deflector structure **56** in the second state, according to an aspect of the present disclosure. In FIG. **9**, elements that are the same as those in FIG. **6** include the same reference numerals and the description provided above for FIG. **6** of those elements is also applicable to FIG. **9**, unless stated otherwise. In FIG. **9**, in the same manner described above for FIG. **6**, the fuel nozzle-swirler assembly **58** is shown in the second state as being shifted in the radial direction (R) by the radial shift distance **176**. As a result, in the same manner described above for the FIG. **6** aspect, the radial height **174** of the circumferential purge cavity **150** increases on the first side **178** to be between the radial height **184** and the radial height **186**. The radial height **174** of the circumferential purge cavity **150** decreases on the second side **180** to be between the radial height **184** and the radial height **190**. Thus, as shown in FIG. **9**, in the second state, the dome-deflector structure **56** decreases the blockage of oval-shaped purge orifices **208** in the second circumferential row **194** on the first side **178** of the circumferential purge cavity **150**, and increases the blockage of the oval-shaped purge orifices **208** in the second circumferential row **194** on the second side **180** opposing the first side **178** of the circumferential purge cavity **150**. The circular-shaped purge orifices **206** remain unblocked in both the first state and in the second state, and can provide the purge airflow **82***c* therethrough in both states. In the same manner described above for FIG. **6**, the total purge airflow amount through the purge orifices **132***a* in the first state and in the second state remains constant due to a corresponding effective flow area unblocking of some of the purge orifices **132***a* with an increased blocking of some of the other purge orifices **132***a*. Thus, although a larger radial height **186** may be present on the first side **178** of the circumferential purge cavity **150**, the increased purge airflow on the first side **178** can counter the increased radial height **186** so as to prevent the ingestion of the hot combustion gases **86** into the circumferential purge cavity **150**.
(53) FIG. **10** depicts an alternate cross-sectional view of fuel nozzle-swirler assembly mounting wall **130***b* and purge orifices **132***b* to that shown in FIG. **7**, according to an aspect of the present disclosure. Elements in FIG. **10** that are the same as those of FIG. **7** are labeled with the same reference numerals and the description above for those elements is also applicable to FIG. **10**, unless stated otherwise. In FIG. **10**, the plurality of purge orifices **132***b* are seen to be arranged in a plurality of circumferential rows, including a first circumferential row **210** of purge orifices **132***b*, a second circumferential row **212** of purge orifices **132***b*, and a third circumferential row **214** of

purge orifices **132***b*. The first circumferential row **210** of the purge orifices **132***b* is arranged a first radial distance **216** from the fuel nozzle centerline axis **108**, the second circumferential row **212** of the purge orifices **132***b* is arranged a second radial distance **218** greater than the first radial distance **216** from the fuel nozzle centerline axis **108**, and the third circumferential row **214** of the purge orifices **132***b* is arranged a third radial distance **220** greater than the second radial distance **218** from the fuel nozzle centerline axis **108**. The purge orifices **132***b* in the first circumferential row **210** are circumferentially spaced apart from each other by an angular spacing **222**. The purge orifices **132***b* in the second circumferential row **212** are circumferentially spaced apart from each other by an angular spacing **224**. The purge orifices **132***b* in the third circumferential row **214** are circumferentially spaced apart from each other by an angular amount **226**. In addition, the purge orifices **132***b* in the first circumferential row **210** may be angularly staggered from the purge orifices **132***b* in the second circumferential row **212** and from the purge orifices **132***b* in the third circumferential row **214** by an angular offset spacing **228**. In FIG. **10**, the plurality of purge orifices **132***b* in the first circumferential row **210** are shown be circular-shaped purge orifices **230** that may have a first diameter **232**. The plurality of purge orifices **132***b* in the second circumferential row **212** are shown to be circular-shaped purge orifices **234** that may have a second diameter **236**. The plurality of purge orifices **132***b* in the third circumferential row **214** are shown to be circular-shaped purge orifices **238** that may have a third diameter **240**. The first diameter **232**, the second diameter **236**, and the third diameter **240** may be the same diameter, or may each be different from one another. For example, as shown in FIG. **10**, the first diameter **232** of the circular-shape purge orifices **230** in the first circumferential row **210** and the second diameter **236** of the circular-shaped purge orifices **234** in the second circumferential row **212** may be the same, while the third diameter **240** of the circular-shaped purge orifices **238** in the third circumferential row **214** may be greater than the first diameter **232** and the second diameter **236**.

(54) FIG. **11** depicts an alternate forward-looking cross-sectional view to that of FIG. **8** of the alternate mounting wall **130***b* and the dome-deflector structure **56** in the first state, according to an aspect of the present disclosure. In FIG. **11**, elements that are the same as those in FIG. **8** include the same reference numerals and the description provided above for FIG. **8** of those elements is also applicable to FIG. **11**, unless stated otherwise. In the same manner as described above for FIG. **8**, FIG. **11** depicts the radial relationship in the first state in which the fuel nozzle centerline axis **108** and the opening centerline axis **152** of the fuel nozzle-swirler assembly opening **146** are congruent with each other such that the circumferential purge cavity **150** has the constant radial height **174**. In the FIG. **11** aspect, the dome-deflector structure **56** overlaps each of the circular-shaped purge orifices **238** (FIG. **10**) in the third circumferential row **214** in the first state, while each of the circular-shaped purge orifices **230** in the first circumferential row **210** and each of the circular-shaped purge orifices **234** in the second circumferential row **212** remain unblocked to allow the purge airflow **82***c* (FIG. **3**) to pass therethrough into the circumferential purge cavity **150**. The size (e.g., diameter) of each of the circular-shaped purge orifices **230** and the circular-shaped purge orifices **234**, as well as the number of the circular-shaped purge orifices **230** and the circular-shaped purge orifices **234** included through the mounting wall **130***b* is designed to provide the sufficient total purge airflow **82***c* to the circumferential purge cavity **150** in the first state so as to prevent the ingestion of the hot combustion gases **86** into the circumferential purge cavity **150**.

(55) FIG. **12** depicts an alternate forward-looking cross-sectional view to that of FIG. **9** of the alternate mounting wall **130***b* and the dome-deflector structure **56** in the second state, according to an aspect of the present disclosure. In FIG. **12**, elements that are the same as those in FIG. **9** include the same reference numerals and the description provided above for FIG. **9** of those elements is also applicable to FIG. **12**, unless stated otherwise. In FIG. **12**, in the same manner described above for FIG. **9**, the fuel nozzle-swirler assembly **58** (FIG. **3**) is shown in the second state as being shifted in the radial direction (R) by the radial shift distance **176**. As a result, in the same manner described above for the FIG. **9** aspect, the radial height **174** of the circumferential

purge cavity **150** increases on the first side **178** to be between the radial height **184** and the radial height **186**. The radial height **174** of the circumferential purge cavity **150** decreases on the second side **180** to be between the radial height **184** and the radial height **190**. Thus, as shown in FIG. **12**, in the second state, the dome-deflector structure **56** decreases the blockage of circular-shaped purge orifices **238** in the third circumferential row **214** on the first side **178** of the circumferential purge cavity **150**, and continues to block the circular-shaped purge orifices **230** in the third circumferential row **214** on the second side **180**, while also blocking at least a portion of the circular-shaped purge orifices **234** in the second circumferential row **212** on the second side **180**. The circular-shaped purge orifices **230** in the first circumferential row **210** remain unblocked in both the first state and in the second state and can provide the purge airflow **82***c* therethrough in both states. In the same manner described above for FIG. **9**, the total purge airflow volume through the purge orifices **132***b* in the first state and in the second state remains constant due to a corresponding effective flow area unblocking of some of the purge orifices **132***b* with an increased blocking of some of the other purge orifices **132***b*. Thus, although a larger radial height **186** may be present on the first side **178** of the circumferential purge cavity **150**, the increased purge airflow on the first side **178** can counter the increased radial height **186** so as to prevent the ingestion of the hot combustion gases **86** into the circumferential purge cavity **150**.
(56) FIG. **13** is a cross-sectional view through the mounting wall **130***b* of FIG. **10**, taken at plane **13-13** in FIG. **10**, according to an aspect of the present disclosure. As shown in FIG. **13**, as least one of the circular-shaped purge orifices **230** may be arranged at a first angle **242** with respect to the fuel nozzle centerline axis **108**, and at least one of the circular-shaped purge orifices **238** may be arranged at a second angle **244** with respect to the fuel nozzle centerline axis **108**. The first angle **242** and the second angle **244** may be the same, or may be different from one another. As some examples, the first angle **242** and the second angle **244** may range from thirty degrees to sixty degrees. The first angle **242** and the second angle **244** direct the flow toward the radially inward side of the circumferential purge cavity **150** to prevent hot gas ingestion from occurring along the main swirler housing **122**, thereby providing better protection of the main swirler housing **122**. In addition, while both the first angle **242** and the second angle **244** are shown in FIG. **13** as being directed toward the fuel nozzle centerline axis **108**, either one of the first angle **242** or the second angle **244** may be directed away from the fuel nozzle centerline axis **108** instead. Either one or both of the first angle **242** or the second angle **244** has an axial component extending longitudinally with respect to the fuel nozzle centerline axis **108**, and a radial component extending orthogonal to the longitudinal direction (L). However, either one of or both of the first angle **242** or the second angle **244** may also have a tangential component that extends in the circumferential direction (C) with respect to the fuel nozzle centerline axis **108**. The inclusion of a tangential component can provide the purge airflow **82***c* in the same direction, or in an opposing direction, of a swirl direction of the main fuel-air mixture **61** exiting the annular cavity **124** of the main swirler housing **122** into the combustion chamber **62**.
(57) FIG. **14** is a cross-sectional view through the mounting wall **130***b* of FIG. **10**, taken at plane **14-14** in FIG. **10**, according to an aspect of the present disclosure. As shown in FIG. **14**, as least one of the circular-shaped purge orifices **234** may be arranged at a third angle **246** with respect to the fuel nozzle centerline axis **108**. The third angle **246** may be the same as, or may be different from either of the first angle **242** (FIG. **13**) or the second angle **244** (FIG. **13**). In addition, while the third angle **246** is shown as being directed toward the fuel nozzle centerline axis **108**, the third angle **246** may be directed away from the fuel nozzle centerline axis **108** instead. The third angle **246** has an axial component extending longitudinally with respect to the fuel nozzle centerline axis **108**, and a radial component extending orthogonal to the longitudinal direction (L). However, the third angle **246** may also have a tangential component that extends in the circumferential direction (C) with respect to the fuel nozzle centerline axis **108**.
(58) In the foregoing aspects, the purge orifices **132**, the purge orifices **132***a*, and the purge orifices

132*b* were described as being either circular orifices or oval-shaped orifices. However, the purge orifices **132**, the purge orifices **132***a*, and the purge orifices **132***b* are not limited to either of the foregoing shapes and other shapes may be implemented instead for the purge orifices. For example, FIG. **15**A depicts an example of a hexagonal-shaped purge orifice **248** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). FIG. **15**B depicts an example of a rectangular-shaped purge orifice **250** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). FIG. **15**C depicts an example of a diamond-shaped purge orifice **252** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). FIG. **15**D depicts an example of a triangular-shaped purge orifice **254** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). FIG. **15**E depicts an example of a keyhole-shaped purge orifice **256** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). FIG. **15**F depicts an example of a star-shaped purge orifice **258** that may be implemented in the mounting wall **130** (FIG. **4**), in the mounting wall **130***a* (FIG. **7**), or in the mounting wall **130***b* (FIG. **10**). The different shapes of the purge orifices **132** can provide a varying directional flow of the purge airflow **82***c* into the circumferential purge cavity **150** so as to provide different airflows for preventing the ingestion of the hot combustion gases into the circumferential purge cavity **150**.

(59) Each of the forgoing aspects provide the ability to circumferentially control the purge airflow **82***c* into the circumferential purge cavity **150** when the fuel nozzle-swirler assembly **58** shifts with respect to the dome-deflector structure **56** in operation of the gas turbine engine **10**. As a result, hot combustion gases that may otherwise be ingested into the circumferential purge cavity **150** can be prevented from flowing to the circumferential purge cavity **150**, thereby increasing the durability of the fuel nozzle-swirler assembly **58**.

(60) While the foregoing description relates generally to a gas turbine engine, the gas turbine engine may be implemented in various environments. For example, the engine may be implemented in an aircraft, but may also be implemented in non-aircraft applications, such as power generating stations, marine applications, or oil and gas production applications. Thus, the present disclosure is not limited to use in aircraft.

(61) Further aspects of the present disclosure are provided by the subject matter of the following clauses.

(62) A combustor for a gas turbine engine, the combustor including a dome-deflector structure having a fuel nozzle-swirler assembly opening therethrough, and a fuel nozzle-swirler assembly having (a) a housing and (b) a mounting wall extending from the housing, the mounting wall having a plurality of purge orifices extending therethrough and being circumferentially spaced apart from each other, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure to extend at least partially through the fuel nozzle-swirler assembly opening and a circumferential purge cavity is defined between the housing, the fuel nozzle-swirler assembly opening of the dome-deflector structure, and the mounting wall, and the plurality of purge orifices are arranged to provide a purge airflow to the circumferential purge cavity, in a first state, in which a radial height of the circumferential purge cavity is constant circumferentially, the dome-deflector structure overlaps a portion of each of the plurality of purge orifices so as to block a portion of each purge orifice, and in a second state, in which the fuel nozzle-swirler assembly is radially shifted such that a radial height of the circumferential purge cavity on a first side of the circumferential purge cavity is increased and a radial height of the circumferential purge cavity on a second side of the circumferential purge cavity opposing the first side is decreased, the dome-deflector structure increases blockage of at least one purge orifice on the second side, and the dome-deflector structure reduces blockage of at least one purge orifice on the first side.

(63) The combustor according to the preceding clause, wherein a total purge airflow volume

through the plurality of purge orifices in the first state and a total purge airflow volume through the plurality of purge orifices in the second state is constant.
(64) The combustor according to any preceding clause, wherein at least one of the plurality of purge orifices is one of a circular orifice, an oval-shaped orifice, a hexagon-shaped orifice, a rectangular-shaped orifice, a triangular-shaped orifice, a diamond-shaped orifice, a keyhole-shaped orifice, or a star-shaped orifice.
(65) The combustor according to any preceding clause, wherein the plurality of purge orifices are arranged at an angle with respect to a fuel nozzle centerline axis.
(66) The combustor according to any preceding clause, wherein the fuel nozzle-swirler assembly opening defines an opening centerline axis therethrough, the fuel nozzle-swirler assembly defines a fuel nozzle centerline axis, in the first state, the opening centerline axis and the fuel nozzle centerline axis are congruent with each other, and, in the second state, the opening centerline axis and the fuel nozzle centerline axis are radially offset with respect to one another.
(67) The combustor according to any preceding clause, wherein the mounting wall extends in a radial direction, with respect to the fuel nozzle centerline axis, from the housing and extends circumferentially about the fuel nozzle centerline axis.
(68) The combustor according to any preceding clause, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure via a mounting member connected to the dome-deflector structure, and the mounting wall slidingly engages with the mounting member to allow radial motion of the fuel nozzle-swirler assembly with respect to the fuel nozzle-swirler assembly opening.
(69) The combustor according to any preceding clause, wherein each of the plurality of purge orifices is an oval-shaped orifice with a major axis extending radially with respect to the fuel nozzle centerline axis.
(70) The combustor according to any preceding clause, wherein, in the first state, the dome-deflector structure blocks a radially outward portion of each oval-shaped orifice.
(71) The combustor according to any preceding clause, wherein the plurality of purge orifices are arranged in a plurality of circumferential rows, including a first circumferential row arranged at a first radial distance from the fuel nozzle centerline axis, and a second circumferential row arranged at a second radial distance greater than the first radial distance from the fuel nozzle centerline axis.
(72) The combustor according to any preceding clause, wherein purge orifices in the first circumferential row are arranged at a first angle with respect to the fuel nozzle centerline axis, and purge orifices in the second circumferential row are arranged at a second angle different from the first angle with respect to the fuel nozzle centerline axis.
(73) The combustor according to any preceding clause, wherein purge orifices in the first circumferential row are circumferentially staggered with respect to purge orifices in the second circumferential row.
(74) The combustor according to any preceding clause, wherein the plurality of purge orifices are further arranged in a third circumferential row arranged at a third radial distance greater than the second radial distance from the fuel nozzle centerline axis.
(75) The combustor according to any preceding clause, wherein, in the first state, the dome-deflector structure overlaps the entirety of each purge orifice in the third circumferential row, and, in the second state, at least one of the purge orifices in the third circumferential row on the first side is at least partially unblocked.
(76) The combustor according to any preceding clause, wherein, in the first state, the dome-deflector structure blocks at least a portion of each of purge orifice in the second circumferential row.
(77) The combustor according to any preceding clause, wherein purge orifices in the first circumferential row are circular-shaped purge orifices, and purge orifices in the second circumferential row are oval-shaped purge orifices.

(78) The combustor according to any preceding clause, wherein, in the second state, the dome-deflector structure decreases the blockage of purge orifices in the second circumferential row on a first side of the circumferential purge cavity, and increases the blockage of purge orifices in the second circumferential row on a second side opposing the first side of the circumferential purge cavity.
(79) A gas turbine engine including a compressor section, and a combustor arranged in fluid communication with the compressor section and arranged to receive a flow of compressed air from the compressor section, the combustor including a dome-deflector structure having a fuel nozzle-swirler assembly opening therethrough, and a fuel nozzle-swirler assembly having (a) a housing and (b) a mounting wall extending from the housing, the mounting wall having a plurality of purge orifices extending therethrough and being circumferentially spaced apart from each other, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure to extend at least partially through the fuel nozzle-swirler assembly opening and a circumferential purge cavity is defined between the housing, the fuel nozzle-swirler assembly opening of the dome-deflector structure, and the mounting wall, and the plurality of purge orifices are arranged to provide a purge airflow to the circumferential purge cavity, in a first state, in which a radial height of the circumferential purge cavity is constant circumferentially, the dome-deflector structure overlaps a portion of each of the plurality of purge orifices so as to block a portion of each purge orifice, and in a second state, in which the fuel nozzle-swirler assembly is radially shifted such that a radial height of the circumferential purge cavity on a first side of the circumferential purge cavity is increased and a radial height of the circumferential purge cavity on a second side of the circumferential purge cavity opposing the first side is decreased, the dome-deflector structure increases blockage of at least one purge orifice on the second side, and the dome-deflector structure reduces blockage of at least one purge orifice on the first side.
(80) The gas turbine engine according to the preceding clause, wherein the fuel nozzle-swirler assembly opening defines an opening centerline axis therethrough, the fuel nozzle-swirler assembly defines a fuel nozzle centerline axis, in the first state, the opening centerline axis and the fuel nozzle centerline axis are congruent with each other, and, in the second state, the opening centerline axis and the fuel nozzle centerline axis are radially offset with respect to one another, the mounting wall extends in a radial direction, with respect to the fuel nozzle centerline axis, from the housing and extends circumferentially about the fuel nozzle centerline axis, and the fuel nozzle-swirler assembly is mounted to the dome-deflector structure via a mounting member connected to the dome-deflector structure, and the mounting wall slidingly engages with the mounting member to allow radial motion of the fuel nozzle-swirler assembly with respect to the fuel nozzle-swirler assembly opening.
(81) The gas turbine engine according to any preceding clause, wherein each of the plurality of purge orifices is an oval-shaped orifice with a major axis extending radially with respect to the fuel nozzle centerline axis, and, in the first state, the dome-deflector structure blocks a radially outward portion of each oval-shaped orifice.
(82) The gas turbine engine according to any preceding clause, wherein a total purge airflow volume through the plurality of purge orifices in the first state and a total purge airflow volume through the plurality of purge orifices in the second state is constant.
(83) The gas turbine engine according to any preceding clause, wherein at least one of the plurality of purge orifices is one of a circular orifice, an oval-shaped orifice, a hexagon-shaped orifice, a rectangular-shaped orifice, a triangular-shaped orifice, a diamond-shaped orifice, a keyhole-shaped orifice, or a star-shaped orifice.
(84) The gas turbine engine according to any preceding clause, wherein the plurality of purge orifices are arranged at an angle with respect to a fuel nozzle centerline axis.
(85) The gas turbine engine according to any preceding clause, wherein the fuel nozzle-swirler assembly opening defines an opening centerline axis therethrough, the fuel nozzle-swirler assembly

defines a fuel nozzle centerline axis, in the first state, the opening centerline axis and the fuel nozzle centerline axis are congruent with each other, and, in the second state, the opening centerline axis and the fuel nozzle centerline axis are radially offset with respect to one another.
(86) The gas turbine engine according to any preceding clause, wherein the mounting wall extends in a radial direction, with respect to the fuel nozzle centerline axis, from the housing and extends circumferentially about the fuel nozzle centerline axis.
(87) The gas turbine engine according to any preceding clause, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure via a mounting member connected to the dome-deflector structure, and the mounting wall slidingly engages with the mounting member to allow radial motion of the fuel nozzle-swirler assembly with respect to the fuel nozzle-swirler assembly opening.
(88) The gas turbine engine according to any preceding clause, wherein each of the plurality of purge orifices is an oval-shaped orifice with a major axis extending radially with respect to the fuel nozzle centerline axis.
(89) The gas turbine engine according to any preceding clause, wherein, in the first state, the dome-deflector structure blocks a radially outward portion of each oval-shaped orifice.
(90) The gas turbine engine according to any preceding clause, wherein the plurality of purge orifices are arranged in a plurality of circumferential rows, including a first circumferential row arranged at a first radial distance from the fuel nozzle centerline axis, and a second circumferential row arranged at a second radial distance greater than the first radial distance from the fuel nozzle centerline axis.
(91) The gas turbine engine according to any preceding clause, wherein purge orifices in the first circumferential row are arranged at a first angle with respect to the fuel nozzle centerline axis, and purge orifices in the second circumferential row are arranged at a second angle different from the first angle with respect to the fuel nozzle centerline axis.
(92) The gas turbine engine according to any preceding clause, wherein purge orifices in the first circumferential row are circumferentially staggered with respect to purge orifices in the second circumferential row.
(93) The gas turbine engine according to any preceding clause, wherein the plurality of purge orifices are further arranged in a third circumferential row arranged at a third radial distance greater than the second radial distance from the fuel nozzle centerline axis.
(94) The gas turbine engine according to any preceding clause, wherein, in the first state, the dome-deflector structure overlaps the entirety of each purge orifice in the third circumferential row, and, in the second state, at least one of the purge orifices in the third circumferential row on the first side is at least partially unblocked.
(95) The gas turbine engine according to any preceding clause, wherein, in the first state, the dome-deflector structure blocks at least a portion of each of purge orifice in the second circumferential row.
(96) The gas turbine engine according to any preceding clause, wherein purge orifices in the first circumferential row are circular-shaped purge orifices, and purge orifices in the second circumferential row are oval-shaped purge orifices.
(97) The gas turbine engine according to any preceding clause, wherein, in the second state, the dome-deflector structure decreases the blockage of purge orifices in the second circumferential row on a first side of the circumferential purge cavity, and increases the blockage of purge orifices in the second circumferential row on a second side opposing the first side of the circumferential purge cavity.
(98) Although the foregoing description is directed to some exemplary embodiments of the present disclosure, other variations and modifications will be apparent to those skilled in the art, and may be made without departing from the present disclosure. Moreover, features described in connection

with one embodiment of the present disclosure may be used in conjunction with other embodiments, even if not explicitly stated above.

Claims

1. A combustor for a gas turbine engine, the combustor comprising: a dome-deflector structure defining a fuel nozzle-swirler assembly opening therethrough; and a fuel nozzle-swirler assembly having (a) a housing and (b) a mounting wall extending from the housing, the mounting wall having a plurality of purge orifices extending therethrough and being circumferentially spaced apart from each other, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure to extend at least partially through the fuel nozzle-swirler assembly opening and a circumferential purge cavity is defined between the housing, the fuel nozzle-swirler assembly opening of the dome-deflector structure, and the mounting wall, and the plurality of purge orifices are arranged to provide a purge airflow to the circumferential purge cavity, in a first state, in which a radial height of the circumferential purge cavity is constant circumferentially, the dome-deflector structure overlaps a portion of each of the plurality of purge orifices so as to block a portion of each purge orifice, and in a second state, in which the fuel nozzle-swirler assembly is radially shifted such that a radial height of the circumferential purge cavity on a first side of the circumferential purge cavity is increased and a radial height of the circumferential purge cavity on a second side of the circumferential purge cavity opposing the first side is decreased, the dome-deflector structure increases blockage of at least one purge orifice on the second side, and the dome-deflector structure reduces blockage of at least one purge orifice on the first side.
2. The combustor according to claim 1, wherein a total purge airflow volume through the plurality of purge orifices in the first state and a total purge airflow volume through the plurality of purge orifices in the second state is constant.
3. The combustor according to claim 1, wherein at least one of the plurality of purge orifices is one of a circular orifice, an oval-shaped orifice, a hexagon-shaped orifice, a rectangular-shaped orifice, a triangular-shaped orifice, a diamond-shaped orifice, a keyhole-shaped orifice, or a star-shaped orifice.
4. The combustor according to claim 1, wherein the plurality of purge orifices are arranged at an angle with respect to a fuel nozzle centerline axis.
5. The combustor according to claim 1, wherein the fuel nozzle-swirler assembly opening defines an opening centerline axis therethrough, the fuel nozzle-swirler assembly defines a fuel nozzle centerline axis, in the first state, the opening centerline axis and the fuel nozzle centerline axis are congruent with each other, and, in the second state, the opening centerline axis and the fuel nozzle centerline axis are radially offset with respect to one another.
6. The combustor according to claim 5, wherein the mounting wall extends in a radial direction, with respect to the fuel nozzle centerline axis, from the housing and extends circumferentially about the fuel nozzle centerline axis.
7. The combustor according to claim 6, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure via a mounting member connected to the dome-deflector structure, and the mounting wall slidingly engages with the mounting member to allow radial motion of the fuel nozzle-swirler assembly with respect to the fuel nozzle-swirler assembly opening.
8. The combustor according to claim 5, wherein each of the plurality of purge orifices is an oval-shaped orifice with a major axis extending radially with respect to the fuel nozzle centerline axis.
9. The combustor according to claim 8, wherein, in the first state, the dome-deflector structure blocks a radially outward portion of each oval-shaped orifice.
10. The combustor according to claim 5, wherein the plurality of purge orifices are arranged in a plurality of circumferential rows, including a first circumferential row arranged at a first radial distance from the fuel nozzle centerline axis, and a second circumferential row arranged at a second

radial distance greater than the first radial distance from the fuel nozzle centerline axis.
11. The combustor according to claim 10, wherein purge orifices in the first circumferential row are arranged at a first angle with respect to the fuel nozzle centerline axis, and purge orifices in the second circumferential row are arranged at a second angle different from the first angle with respect to the fuel nozzle centerline axis.
12. The combustor according to claim 10, wherein purge orifices in the first circumferential row are circumferentially staggered with respect to purge orifices in the second circumferential row.
13. The combustor according to claim 10, wherein the plurality of purge orifices are further arranged in a third circumferential row arranged at a third radial distance greater than the second radial distance from the fuel nozzle centerline axis.
14. The combustor according to claim 13, wherein, in the first state, the dome-deflector structure overlaps an entirety of each purge orifice in the third circumferential row, and, in the second state, at least one of the purge orifices in the third circumferential row on the first side is at least partially unblocked.
15. The combustor according to claim 10, wherein, in the first state, the dome-deflector structure blocks at least a portion of each of purge orifice in the second circumferential row.
16. The combustor according to claim 15, wherein purge orifices in the first circumferential row are circular-shaped purge orifices, and purge orifices in the second circumferential row are oval-shaped purge orifices.
17. The combustor according to claim 15, wherein, in the second state, the dome-deflector structure decreases a blockage of purge orifices in the second circumferential row on a first side of the circumferential purge cavity, and increases the blockage of purge orifices in the second circumferential row on a second side opposing the first side of the circumferential purge cavity.
18. A gas turbine engine, comprising: a compressor section; and a combustor arranged in fluid communication with the compressor section and arranged to receive a flow of compressed air from the compressor section, the combustor including: a dome-deflector structure defining a fuel nozzle-swirler assembly opening therethrough; and a fuel nozzle-swirler assembly having (a) a housing and (b) a mounting wall extending from the housing, the mounting wall having a plurality of purge orifices extending therethrough and being circumferentially spaced apart from each other, wherein the fuel nozzle-swirler assembly is mounted to the dome-deflector structure to extend at least partially through the fuel nozzle-swirler assembly opening and a circumferential purge cavity is defined between the housing, the fuel nozzle-swirler assembly opening of the dome-deflector structure, and the mounting wall, and the plurality of purge orifices are arranged to provide a purge airflow to the circumferential purge cavity, in a first state, in which a radial height of the circumferential purge cavity is constant circumferentially, the dome-deflector structure overlaps a portion of each of the plurality of purge orifices so as to block a portion of each purge orifice, and in a second state, in which the fuel nozzle-swirler assembly is radially shifted such that a radial height of the circumferential purge cavity on a first side of the circumferential purge cavity is increased and a radial height of the circumferential purge cavity on a second side of the circumferential purge cavity opposing the first side is decreased, the dome-deflector structure increases blockage of at least one purge orifice on the second side, and the dome-deflector structure reduces blockage of at least one purge orifice on the first side.
19. The gas turbine engine according to claim 18, wherein the fuel nozzle-swirler assembly opening defines an opening centerline axis therethrough, the fuel nozzle-swirler assembly defines a fuel nozzle centerline axis, in the first state, the opening centerline axis and the fuel nozzle centerline axis are congruent with each other, and, in the second state, the opening centerline axis and the fuel nozzle centerline axis are radially offset with respect to one another, the mounting wall extends in a radial direction, with respect to the fuel nozzle centerline axis, from the housing and extends circumferentially about the fuel nozzle centerline axis, and the fuel nozzle-swirler assembly is mounted to the dome-deflector structure via a mounting member connected to the

dome-deflector structure, and the mounting wall slidingly engages with the mounting member to allow radial motion of the fuel nozzle-swirler assembly with respect to the fuel nozzle-swirler assembly opening.

20. The gas turbine engine according to claim 19, wherein each of the plurality of purge orifices is an oval-shaped orifice with a major axis extending radially with respect to the fuel nozzle centerline axis, and, in the first state, the dome-deflector structure blocks a radially outward portion of each oval-shaped orifice.