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(54) **AIR SHIELD FOR A FUEL INJECTOR OF A COMBUSTOR**

(57) An air shield (100, 200) for an injector (32) of a combustor includes a first section (102) that extends axially from a first end (101) to a second end (103), and a channel (112) defined by the air shield. The channel includes at least one inlet proximate to the second end. The at least one inlet is configured to receive a channel airflow (144) that is a portion of a surrounding airflow (44). The channel (112) is configured to control a distribution of the channel airflow (144) to the injector (32).

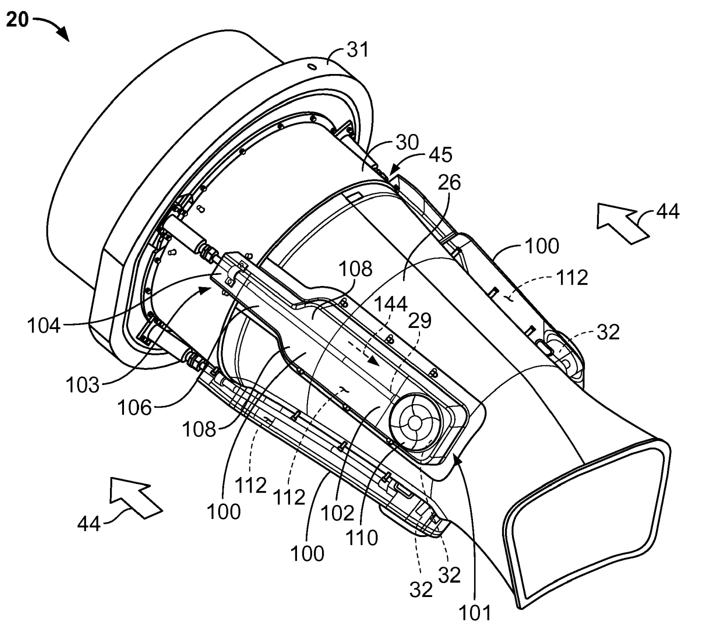

FIG. 3

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Description

BACKGROUND

[0001] The field of the disclosure relates generally to a fuel injector for a combustor of a rotary machine, and more particularly to an air shield to control air flow to a fuel injector.

[0002] At least some known combustors used with rotary machines, such as gas turbines, include at least one secondary fuel injector, often referred to as a "late lean injector," located downstream from a primary fuel nozzle. At least some known late lean injectors mix a fuel supply with a supply of air, such as from a compressor discharge casing. However, such a supply of air may not be as steady or uniform as is desired under some operating conditions, and a potential exists for small quantities of fuel to escape through the late lean injector to the outside of the combustor.

BRIEF DESCRIPTION

[0003] In one aspect, an air shield for an injector of a combustor is provided. The air shield includes a first section that extends axially from a first end to a second end, and a channel defined by the air shield. The channel includes at least one inlet proximate to the second end. The at least one inlet is configured to receive a channel airflow that is a portion of a surrounding airflow. The channel is configured to control a distribution of the channel airflow to the injector.

[0004] In another aspect, a combustor for a gas turbine is provided. The combustor includes a liner that defines a primary combustion zone, and a sleeve that substantially circumscribes the liner. The combustor also includes a secondary combustion zone downstream from, and in flow communication with, the first combustion zone, and an injector coupled to the sleeve upstream from the secondary combustion zone. The injector includes at least one transfer tube in flow communication with the primary combustion zone. The combustor further includes an air shield. The air shield includes a first section that extends axially from a first end to a second end, and a channel defined by the air shield. The channel includes at least one inlet proximate to the second end. The at least one inlet is configured to receive a channel airflow that is a portion of a surrounding airflow of the combustor. The channel is configured to control a distribution of the channel airflow to the injector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

FIG. 1 is a schematic view of an exemplary gas turbine;

FIG. 2 is a schematic section view of an exemplary combustor that may be used with the exemplary gas turbine of FIG. 1;

FIG. 3 is a perspective view of a first exemplary embodiment of an air shield coupled to the exemplary combustor of FIG. 2;

FIG. 4 is a schematic section view of a first embodiment of an injector covered by the first exemplary air shield of FIG. 3;

FIG. 5 is another perspective view of the first exemplary air shield shown in FIGS. 3 and 4;

FIG. 6 is a perspective view of a second exemplary embodiment of an air shield coupled to the combustor shown in FIG. 2 and covering a second embodiment of an injector;

FIG. 7 is a schematic section view of the second exemplary air shield covering the second exemplary injector shown in FIG. 6; and

FIG. 8 is a flow diagram of an exemplary method of assembling a combustor for a gas turbine, such as the exemplary gas turbine shown in FIG. 1.

DETAILED DESCRIPTION

[0006] The exemplary methods and systems described herein overcome at least some of the disadvantages associated with known late lean injectors for combustors of rotary machines. The embodiments described herein include an air shield configured to cover a late lean injector. The air shield defines a channel that controls a distribution of an airflow to the late lean injector. For example, the air shield may be shaped to distribute the air flow in the channel to facilitate symmetric flow into an inlet of the late lean injector, facilitating improved fuel/air mixing and flow uniformity in the late lean injector. Moreover, the air shield may enclose at least a portion of a fuel supply line to the late lean injector.

[0007] FIG. 1 is a schematic view of an exemplary gas turbine 10 in which embodiments of the air shield of the current disclosure may be used. In the exemplary embodiment, gas turbine 10 includes an intake section 12, a compressor section 14 coupled downstream from intake section 12, a combustor section 16 coupled downstream from compressor section 14, and a turbine section 18 coupled downstream from combustor section 16.

[0008] Turbine section 18 is coupled to compressor section 14 via a rotor shaft 17. It should be noted that, as used herein, the term "couple" is not limited to a direct mechanical, electrical, and/or communication connection between components, but may also include an indirect mechanical, electrical, and/or communication connection between multiple components. During operation of gas turbine 10, intake section 12 channels air towards compressor section 14. Compressor section 14 compresses the air to a higher pressure and temperature and discharges the compressed air towards combustor section 16. In combustor section 16, the compressed air is mixed with fuel and ignited to generate combustion gases that are channeled towards turbine section 18. More specifically, combustor section 16 includes at least one combustor 20, in which a fuel, for example, natural gas and/or fuel oil, is injected into the air flow, and the fuel-air mixture is ignited to generate high temperature combustion gases that are channeled towards turbine section 18.

[0009] Turbine section 18 converts the thermal energy from the combustion gas stream to mechanical rotational energy, as the combustion gases impart rotational energy to at least one rotor blade 19 coupled to rotor shaft 17 within turbine section 18. Rotor shaft 17 may be coupled to a load (not shown) such as, but not limited to, an electrical generator and/or a mechanical drive application. The exhausted combustion gases exit turbine section 18.

[0010] FIG. 2 is a schematic section view of an exemplary embodiment of combustor 20 that may be used with gas turbine 10. Although embodiments of the present disclosure will be described with reference to combustor 20, in alternative embodiments, combustor 20 may be any suitable combustor that enables embodiments of the present disclosure to function as described herein. In the illustrated embodiment, combustor 20 includes a head end 22. A liner 24 extends axially, with respect to a longitudinal axis 40 of combustor 20, from head end 22 to an opposite aft end 46. Liner 24 is substantially circumscribed by a sleeve 26. In addition, a forward portion 45 of sleeve 26 proximate to head end 22 is circumscribed by a sleeve housing 30. Liner 24 also extends circumferentially about longitudinal axis 40 to generally define a primary combustion zone 23. A secondary combustion zone 33 extends downstream from, and is in flow communication with, primary combustion zone 23.

[0011] Head end 22 includes a plurality of primary fuel nozzles 21 that are configured to mix fuel and air in any suitable fashion for combustion within primary combustion zone 23. The combustion of the mixture of fuel and air in primary combustion zone 23 produces combustion gases that flow into secondary combustion zone 33 and are channeled towards turbine section 18 (shown in FIG. 1).

[0012] Combustor 20 also includes at least one secondary, or late lean, injector 32. In the illustrated embodiment, each at least one late lean injector 32 is coupled to sleeve 26 upstream from secondary combustion zone 33. In certain embodiments, the at least one late lean injector 32 is a plurality of late lean injectors 32 that are spaced circumferentially around liner 24. Each at least one late lean injector 32 receives fuel from a corresponding fuel supply line 29. In an embodiment, each fuel supply line 29 extends generally axially along a radially outer surface of sleeve housing 30 and a radially outer surface of sleeve 26 to the corresponding late lean injector 32. In alternative embodiments, fuel supply line 29 may be at least partially defined within at least one of sleeve housing 30 and sleeve 26. Additionally or alternatively, fuel supply line 29 may be at least partially offset radially outwardly from at least one of sleeve housing 30 and sleeve 26.

[0013] Each at least one late lean injector 32 is configured to mix fuel delivered from fuel supply line 29 and air drawn from an airflow 44 that surrounds combustor 20. In certain embodiments, surrounding airflow 44 is a compressed air flow supplied from compressor section 14 (shown in FIG. 1). Moreover, each at least one late lean injector 32 includes at least one transfer tube 34 that is in flow communication with primary combustion zone 23. The at least one late lean injector 32 is configured to inject the mixed fuel and air through the at least one transfer tube 34 into primary combustion zone 23. The fuel injected by the at least one late lean injector 32 is combusted in secondary combustion zone 33.

[0014] Each at least one late lean injector 32 may be of any suitable design to enable combustor 20 to function as described herein. For example, but not by way of limitation, the at least one late lean injector 32 may be at least one of a bell-mouth injector, a tube-in-tube injector, a swirl injector, a rich catalytic injector, and a shower-head type multi-tube injector.

[0015] FIG. 3 is a perspective view of a first exemplary embodiment of an air shield 100 coupled to combustor 20. It should be understood that the particular illustrated embodiment of combustor 20 is used for purposes of example only, and that air shield 100 may be used with any suitable alternative combustor. In the illustrated embodiment, the at least one late lean injector 32 is a plurality of circumferentially spaced late lean injectors 32, and a corresponding plurality of circumferentially spaced air shields 100 is coupled to combustor 20 such that each air shield 100 covers a corresponding late lean injector 32. In the illustrated embodiment, each air shield 100 is formed from a partially transparent plastic material. In alternative embodiments, air shield 100 may be formed from any suitable material.

[0016] Each air shield 100 includes a first section 102 that extends axially from a first end 101, configured to be disposed proximate the corresponding late lean injector 32, to a second end 103, configured to be disposed proximate sleeve housing 30. In certain embodiments, each air shield 100 extends circumferentially along combustor 20 for a maximum distance of about one times to about three times a diameter of the corresponding late lean injector 32. In a particular embodiment, each air shield 100 extends circumferentially along combustor 20 for a maximum distance of about two times the diameter of the corresponding late lean injector 32. In alternative embodiments, each air shield 100 extends circumferentially along combustor 20 for a maximum distance of greater than about three times the diameter of the corresponding late lean injector 32.

[0017] Air shield 100 defines a channel 112 when air shield 100 is coupled to combustor 20. Channel 112 is configured to receive a channel airflow 144 that is a portion of surrounding airflow 44, and to distribute channel airflow 144 to late lean injector 32. Moreover, air shield 100 defines channel 112 to control a distribution of channel airflow 144 to late lean injector 32 in a desired fashion.

[0018] For example, channel 112 is configured to receive a substantial portion of channel airflow 144 from surrounding airflow 44 proximate second end 103, rather than from surrounding airflow 44 proximate to first end 101. In certain embodiments, surrounding airflow 44 proximate to second end 103 is relatively less dynamic as compared to surrounding airflow 44 proximate to first end 101. Thus, each channel 112 is configured to distribute a relatively uniform airflow 144 to each of the corresponding plurality of circumferentially spaced late lean injectors 32.

[0019] In the illustrated embodiment, first section 102 is coupled to sleeve 26, and air shield 100 also includes a second section 104 coupled to sleeve housing 30. Second section 104 is in flow communication with first section 102. In alternative embodiments, second section 104 may be omitted. Also in the illustrated embodiment, first section 102 includes a neck 106 proximate to second end 103 and a pair of shoulder regions 108 that extend from neck 106. First section 102 also includes an annular dome region 110 proximate first end 101, such that annular dome region 110 is configured to be disposed radially outwardly from late lean injector 32. Neck 106, pair of shoulder regions 108, and annular dome region 110 of air shield 100 further define channel 112 to control the distribution of channel airflow 144 to late lean injector 32 in a desired fashion, as will be described with reference to FIGS. 4 and 5.

[0020] FIG. 4 is a schematic section view of a first particular embodiment of late lean injector 32 covered by air shield 100, as shown in FIG. 3. In the illustrated embodiment, late lean injector 32 includes a bell-mouth air inlet 114, in addition to a central spindle inlet 146. Channel airflow 144 approaches bell-mouth air inlet 114 within channel 112 from second end 103. If an effect of annular dome region 110 is disregarded, a disproportionate portion of channel airflow 144 would tend to flow over a side of a rim 118 of bell-mouth air inlet 114 that is closest to second end 103, which would tend to produce an asymmetric air flow through late lean injector 32. Such asymmetric air flow would tend to result in less effective mixing of fuel and air in late lean injector 32.

[0021] As can be seen in FIG. 4, annular dome region 110 of air shield 100 further defines channel 112 to control distribution of channel airflow 144 to late lean injector 32. More specifically, annular dome region 110 is substantially centered over late lean injector 32, and annular dome region 110 is sized such that a peak 116 of annular dome region 110 is positioned over rim 118 of bell-mouth air inlet 114. Thus, a portion of channel 112 defined by annular dome region 110 is configured to distribute channel airflow 144 into late lean injector 32 substantially evenly around a perimeter of bell-mouth air inlet 114 as compared to the late lean injector with no air shield 100, producing a more symmetric airflow through late lean injector 32. It should be understood that air shield 100 may be used with any suitable late lean injector 32, and is not limited to use with the particular embodiment of late lean injector 32 shown in FIG. 4. For example, although peak 116 and the perimeter of rim 118 are generally circular in the illustrated embodiment, it should be understood that peak 116 and the perimeter of rim 118 may have other suitable shapes. For another example, although late lean injector 32 includes spindle inlet 146 in the illustrated embodiment, certain other embodiments of late lean injector 32 do not include spindle inlet 146.

[0022] FIG. 5 is another perspective view of air shield 100 in which at least one inlet 120 to channel 112 is illustrated. The at least one inlet 120 is configured to receive a portion of surrounding airflow 44 as channel airflow 144 (shown in FIG. 3). Each at least one inlet 120 is located generally proximate second end 103. In the illustrated embodiment, each at least one inlet 120 is located on at least one of neck 106 and shoulder regions 108.

[0023] In the illustrated embodiment, the at least one inlet 120 includes side windows 122. Each side window 122 is defined through a side wall of first section 102 of air shield 100 along a corresponding shoulder region 108. The at least one inlet 120 also may include at least one top window 124 defined through a top wall of neck 106. Additionally, the at least one inlet 120 may include a plurality of apertures 126 defined through a top wall of each shoulder region 108, and may include a plurality of apertures 128 defined through the top wall of neck 106. The at least one inlet 120 further may include an aperture or window 130 defined through a wall of second section 104. For example, in the illustrated embodiment, aperture 130 is defined around an opening through which fuel supply line 29 extends into channel 112. Additionally or alternatively, the at least one inlet 120 may include any other suitable window, aperture, channel, or other type of inlet into channel 112.

[0024] It should be understood that any type or position of inlet 120 may be used in combination with any other type or position of inlet 120 without departing from the scope of this disclosure. For example, in a particular embodiment, the at least one inlet 120 includes side windows 122 and top window 124, and does not include apertures 126, 128, and 130. For another example, in an alternative embodiment, the at least one inlet 120 includes side windows 122 and apertures 126 and 128, and does not include top window 124 and aperture 130. In general, a type and number of inlets 120 may be chosen to further control a distribution of channel airflow 144 to late lean injector 32 (shown in FIG. 3) in a desired fashion. For example, apertures 126 may be used to input additional channel airflow 144 near shoulder regions 108 to compensate for a tendency of channel airflow 144 to separate near shoulder regions 108. Similarly, at least one of top window 124 and apertures 128 may be used to push channel airflow 144 closer to the side walls of air shield 100. For another example, a size of side windows 122 relative to a size of at least one of top window 124 and apertures 128 can be chosen to reduce non-axial components of channel airflow 144 as it approaches late lean injector 32.

[0025] In certain embodiments, air shield 100 is configured to capture any fuel that escapes from late lean injector 32. More specifically, channel 112 is configured such that channel airflow 144 develops a velocity towards late lean injector 32 sufficient to sweep the escaped fuel back through the late lean injector 32 into the primary combustion zone 23. The velocity of channel airflow 144 prevents the escaped fuel from exiting channel 112 through the at least one inlet 120.

[0026] In the illustrated embodiment, first section 102 includes a telescoping portion 134 at second end 103 that is configured to extend at least partially over second section 104. More specifically, telescoping portion 134 is configured for sliding movement over second section 104 in a direction generally parallel to longitudinal axis 40 (shown in FIG. 2), such that air shield 100 accommodates relative motion parallel to longitudinal axis 40 between sleeve 26 and sleeve housing 30. For example, in certain embodiments, upon initiation of operation of gas turbine 10, sleeve 26 expands axially towards head end 22 relative to sleeve housing 30. Because first section 102 is coupled to sleeve 26, first section 102 moves towards second section 104. Telescoping portion 134 slides over second section 104 towards head end 22 to maintain an integrity of channel 112. Upon cessation of operation of gas turbine 10, sleeve 26 retracts axially from sleeve housing 30, and telescoping portion 134 slides over second section 104 away from head end 22 to maintain an integrity of channel 112. In alternative embodiments, first section 102 does not include telescoping portion 134.

[0027] With reference to FIGS. 3 and 5, in the illustrated embodiment, air shield 100 is configured to enclose at least a portion of the corresponding fuel supply line 29. In certain embodiments, air shield 100 is configured to protect fuel supply line 29 from damage during at least one of shipping, installation, and maintenance of the combustor. For example, air shield 100 may have a suitable strength and stiffness to absorb accidental impacts that otherwise potentially could damage fuel supply line 29. In alternative embodiments, air shield 100 is not configured to enclose at least a portion of the corresponding fuel supply line 29.

[0028] FIG. 6 is a perspective view, and FIG. 7 is a schematic section view, of a second exemplary embodiment of an air shield 200 coupled to combustor 20 and covering a second particular embodiment of late lean injector 32. As described above, the at least one late lean injector 32 may be a plurality of circumferentially spaced late lean injectors 32, and a corresponding plurality of circumferentially spaced air shields 200 may be coupled to combustor 20 such that each air shield 200 covers a corresponding late lean injector 32. Each air shield 200 generally has an axial and circumferential extent similar to that described for air shield 100.

[0029] With reference to FIGS. 6 and 7, air shield 200 is substantially similar to air shield 100 in several respects, and similar features will be given the same reference numbers. For example, air shield 200 extends from first end 101 to second end 103, defines channel 112 configured to receive channel airflow 144 that is a portion of surrounding airflow 44, and is configured to receive a substantial portion of channel airflow 144 from surrounding airflow 44 proximate second end 103, rather than from proximate first end 101. In addition, air shield 200 includes first section 102 coupled to sleeve 26 and, optionally, second section 104 coupled to sleeve housing 30. In the illustrated embodiment, first section 102 includes neck 106 proximate to second end 103, pair of shoulder regions 108 that extend from neck 106, at least one inlet 120, and, optionally, telescoping portion 134. In the illustrated embodiment, the at least one inlet 120 includes side windows 122 and top window 124, although in alternative embodiments, any suitable combination of inlets 120 may be used, as described above with regard to air shield 100. Similarly, in the illustrated embodiment, air shield 200 is configured to enclose at least a portion of the corresponding fuel supply line 29, although in alternative embodiments, air shield 200 is not configured to enclose at least a portion of the corresponding fuel supply line 29.

[0030] As described above, late lean injector 32 is configured to inject mixed fuel and air through the at least one transfer tube 34 into primary combustion zone 23 (shown in FIG. 2). In the illustrated embodiment of FIGS. 6 and 7, late lean injector 32 includes a swirler inlet 214, in addition to a spindle inlet 246. Swirler inlet 214 includes a plurality of vanes 216 circumferentially spaced about a central axis 220 of swirler inlet 214. Central axis 220 is defined to be normal to a surface of sleeve 26 when air shield 200 is coupled to combustor 20. Each vane 216 is oriented at a vane angle 226 with respect to a radial line 222 extending from central axis 220 through the vane, such that swirler inlet 214 is configured to impart a swirl about central axis 220 to air received from channel airflow 144. In certain embodiments, the swirl imparted by swirler inlet 214 improves a mixing of fuel and air by late lean injector 32.

[0031] In the illustrated embodiment, air shield 200 includes a scroll region 232 proximate first end 101, such that scroll region 232 is configured to be disposed radially outwardly from late lean injector 32. Air shield 200 also includes a transition region 230 disposed between scroll region 232 and second end 103. Scroll region 232 is defined by a radius 234 measured from a central point 236 that is configured to lie on central axis 220 when air shield 200 is coupled to combustor 20. Radius 234 generally decreases along an arcuate path about swirler inlet 214, as illustrated in FIG. 6 at several representative locations. In the illustrated embodiment, radius 234 generally decreases from a maximum value proximate a location at which scroll region 232 intersects transition region 230. Scroll region 232, transition region 230, neck 106, and pair of shoulder regions 108 are in flow communication and define channel 112 to control the distribution of channel airflow 144 to late lean injector 32 in a desired fashion, as will be described herein.

[0032] Channel airflow 144 approaches swirler inlet 214 within channel 112 from second end 103. If an effect of scroll region 232 is disregarded, a disproportionate portion of channel airflow 144 would tend to impinge certain ones of the plurality of vanes 216 at a range of angles that vary significantly with respect to vane angle 226, which would tend to produce a significant variation in inlet velocities around a perimeter of swirler inlet 214 and produce an asymmetric air flow through late lean injector 32. Such asymmetric air flow would tend to result in less effective mixing of fuel and air in late lean injector 32.

[0033] As can be seen in FIG. 6, the general decrease of radius 234 along the arcuate path about swirler inlet 214 tends to impart a pre-swirl to channel airflow 144. Thus, scroll region 232 is shaped to decrease a variation in the angle at which airflow 144 impinges each vane 216. Moreover, in the illustrated embodiment, transition region 230 is shaped to transition channel airflow 144 from a generally axial velocity proximate second end 103 to a velocity that approaches late lean injector 32 generally tangential to swirler inlet 214. Thus, transition region 230 cooperates with scroll region 232 to decrease the variation in the angle at which airflow 144 impinges each vane 216.

[0034] In the illustrated embodiment, vanes 216 have a vane angle 226 oriented such that swirler inlet 214 is configured to impart a counterclockwise swirl about central axis 220, and radius 234 decreases along a correspondingly counterclockwise path about swirler inlet 214 to impart a correspondingly counterclockwise pre-swirl to channel airflow 144. Moreover, transition region 230 is oriented to facilitate transitioning channel airflow 144 to a counterclockwise tangential velocity. In an alternative embodiment (not shown), vanes 216 have an oppositely oriented vane angle 226 such that swirler inlet 214 is configured to impart a clockwise swirl about central axis 220, radius 234 decreases along a correspondingly clockwise path about swirler inlet 214 to impart a correspondingly clockwise pre-swirl to channel airflow 144, and transition region 230 is oriented to facilitate transitioning channel airflow 144 to a clockwise tangential velocity.

[0035] Thus, a portion of channel 112 defined by scroll region 232, and optionally also by transition region 230, is configured to distribute channel airflow 144 into late lean injector 32 substantially evenly around a perimeter of swirler inlet 214 as compared to the late lean injector with no air shield 200, producing a more symmetric airflow through late lean injector 32. It should be understood that air shield 200 may be used with any suitable late lean injector 32, and is not limited to use with the particular embodiment of late lean injector 32 shown in FIGS. 6 and 7.

[0036] An exemplary method 800 of assembling a combustor, such as combustor 20, for a gas turbine, such as gas turbine 10, is illustrated in FIG. 8. With reference also to FIGS. 1-7, method 800 includes disposing 802 a first end, such as first end 101, of an air shield, such as air shield 100 or air shield 200, proximate an injector, such as late lean injector 32. Method 800 also includes disposing 804 a second end, such as second end 103, of the air shield upstream of the first end. Method 800 further includes coupling 806 the air shield to a sleeve, such as sleeve 26, such that a channel, such as channel 112, is defined. The channel is configured to control a distribution of a channel airflow, such as channel airflow 144, to the injector. The channel has at least one inlet, such as at least one inlet 120, proximate to the second end. The at least one inlet is configured to receive a portion of a surrounding airflow, such as surrounding airflow 44, of the combustor as the channel airflow.

[0037] In certain embodiments, coupling 806 the air shield to a sleeve further includes coupling 808 the air shield such that the channel is further configured to distribute the channel airflow substantially evenly around a perimeter of an inlet, such as bell-mouth air inlet 114 or swirler inlet 214, of the injector. The air shield may have an annular dome region, such as annular dome region 110, proximate the first end, and method 800 may further include positioning 810 a peak, such as peak 116, of the annular dome region over a rim, such as rim 118, of the inlet of the injector. Alternatively or additionally, the air shield may include a scroll region, such as scroll region 232, proximate the first end, and coupling 806 the air shield to a sleeve may further include coupling 812 the air shield such that a radius of the scroll region generally decreases along an arcuate path about the inlet of the injector. In certain embodiments, coupling 806 the air shield to a sleeve further includes enclosing 814 at least a portion of a fuel supply line to the injector, such as fuel supply line 29, within the air shield.

[0038] Exemplary embodiments of an air shield configured to cover a late lean injector of a combustor are described above in detail. The embodiments provide an advantage in controlling a distribution of an airflow to the late lean injector. For example, the air shield may be shaped to facilitate symmetric flow into an inlet of the late lean injector, facilitating improved fuel/air mixing and flow uniformity in the late lean injector. The embodiments also provide an advantage in that the air shield may enclose at least a portion of a fuel supply line to facilitate protecting the fuel supply line during, for example, shipping, installation, and maintenance of the combustor.

[0039] The methods and systems described herein are not limited to the specific embodiments described herein. For example, components of each system and/or steps of each method may be used and/or practiced independently and separately from other components and/or steps described herein. In addition, each component and/or step may also be used and/or practiced with other assemblies and methods.

[0040] While the disclosure has been described in terms of various specific embodiments, those skilled in the art will recognize that the disclosure can be practiced with modification within the scope of the claims. Although specific features of various embodiments of the disclosure may be shown in some drawings and not in others, this is for convenience only. Moreover, references to "one embodiment" in the above description are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features. In accordance with the principles of the disclosure, any feature of a drawing may be referenced and/or claimed in combination with any feature of any other drawing.

[0041] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. An air shield for an injector of a combustor, said air shield comprising:

   a first section that extends axially from a first end to a second end; and

   a channel defined by said air shield, said channel comprises at least one inlet proximate to said second end, said at least one inlet is configured to receive a channel airflow that is a portion of a surrounding airflow, said channel is configured to control a distribution of the channel airflow to the injector.

2. The air shield of clause 1, wherein said first section includes a neck proximate to said second end and a pair of shoulder regions that extend from said neck, said at least one inlet is located on at least one of said neck and said shoulder regions.

3. The air shield of any preceding clause, wherein said at least one inlet includes a respective aperture near each of said shoulder regions.

4. The air shield of any preceding clause, wherein said channel is further configured to distribute the channel airflow substantially evenly around a perimeter of an inlet of the injector.

5. The air shield of any preceding clause, wherein said air shield further comprises an annular dome region proximate said first end, said annular dome region comprises a peak configured to be positioned over a rim of the inlet of the injector.

6. The air shield of any preceding clause, wherein said air shield further comprises a scroll region proximate said first end, said scroll region is defined by a radius that generally decreases along an arcuate path configured to lie about the inlet of the injector.

7. The air shield of any preceding clause, wherein said air shield further comprises a transition region shaped to transition the channel airflow to a velocity that approaches the injector generally tangential to the inlet of the injector.

8. The air shield of any preceding clause, wherein said air shield is configured to enclose at least a portion of a fuel supply line to the injector.

9. The air shield of any preceding clause, wherein said air shield further comprises a second section, said first section comprises a telescoping portion at said second end that is configured to extend at least partially over said second section.

10. The air shield of any preceding clause, wherein said air shield is configured to extend circumferentially along the combustor for a maximum distance of about one times to about three times a diameter of the injector.

11. A combustor for a gas turbine, said combustor comprising:

   a liner that defines a primary combustion zone;

   a sleeve that substantially circumscribes said liner;

   a secondary combustion zone downstream from, and in flow communication with, said first combustion zone;

   an injector coupled to said sleeve upstream from said secondary combustion zone, said injector comprises at least one transfer tube in flow communication with said primary combustion zone; and

   an air shield comprising:

   a first section that extends axially from a first end to a second end; and

   a channel defined by said air shield, said channel comprises at least one inlet proximate to said second end, said at least one inlet is configured to receive a channel airflow that is a portion of a surrounding airflow of said combustor, said channel is configured to control a distribution of the channel airflow to said injector.

12. The combustor of any preceding clause, wherein said first section includes a neck proximate to said second end and a pair of shoulder regions that extend from said neck, said at least one inlet is located on at least one of said neck and said shoulder re-

gions.

13. The combustor of any preceding clause, wherein said at least one inlet includes a respective aperture near each of said shoulder regions.

14. The combustor of any preceding clause, wherein said channel is further configured to distribute the channel airflow substantially evenly around a perimeter of an inlet of said injector.

15. The combustor of any preceding clause, wherein said air shield further comprises an annular dome region proximate said first end, said annular dome region comprises a peak positioned over a rim of said inlet of said injector.

16. The combustor of any preceding clause, wherein said air shield further comprises a scroll region proximate said first end, said scroll region is defined by a radius that generally decreases along an arcuate path about said inlet of said injector.

17. The combustor of any preceding clause, wherein said air shield further comprises a transition region shaped to transition the channel airflow to a velocity that approaches said injector generally tangential to said inlet of said injector.

18. The combustor of any preceding clause, wherein said air shield is configured to enclose at least a portion of a fuel supply line to said injector.

19. The combustor of any preceding clause, wherein said air shield further comprises a second section, said first section comprises a telescoping portion at said second end that is configured to extend at least partially over said second section.

20. The combustor of any preceding clause, wherein said air shield extends circumferentially along said combustor for a maximum distance of about one times to about three times a diameter of said injector.

Claims

1. An air shield (100, 200) for an injector (32) of a combustor (20), said air shield comprising:

   a first section (102) that extends axially from a first end (101) to a second end (103); and
   a channel (112) defined by said air shield, said channel comprises at least one inlet (120) proximate to said second end (103), said at least one inlet is configured to receive a channel airflow (144) that is a portion of a surrounding airflow (44), said channel is configured to control a distribution of the channel airflow to the injector.

2. The air shield (100, 200) of claim 1, wherein said first section (102) includes a neck (106) proximate to said second end (103) and a pair of shoulder regions (108) that extend from said neck, said at least one inlet (120) is located on at least one of said neck and said shoulder regions.

3. The air shield (100, 200) of claim 2, wherein said at least one inlet includes a respective aperture near each of said shoulder regions.

4. The air shield (100, 200) of claim 1, 2 or 3, wherein said channel (112) is further configured to distribute the channel airflow (144) substantially evenly around a perimeter of an inlet (114, 214) of the injector (32).

5. The air shield (100, 200) of claim 4, wherein said air shield further comprises an annular dome region (110) proximate said first end (101), said annular dome region comprises a peak (116) configured to be positioned over a rim (118) of the inlet (114) of the injector (32).

6. The air shield (100, 200) of claim 4, wherein said air shield further comprises a scroll region (232) proximate said first end (101), said scroll region is defined by a radius (234) that generally decreases along an arcuate path configured to lie about the inlet (214) of the injector.

7. The air shield (100, 200) of claim 6, wherein said air shield further comprises a transition region (230) shaped to transition the channel airflow (144) to a velocity that approaches the injector (32) generally tangential to the inlet (214) of the injector.

8. The air shield (100, 200) of any preceding claim, wherein said air shield is configured to enclose at least a portion of a fuel supply line (29) to the injector (32).

9. The air shield (100, 200) of any preceding claim, wherein said air shield further comprises a second section (104), said first section (102) comprises a telescoping portion (134) at said second end (103) that is configured to extend at least partially over said second section.

10. The air shield (100, 200) of any preceding claim, wherein said air shield is configured to extend circumferentially along the combustor (20) for a maximum distance of about one times to about three times a diameter of the injector (32).

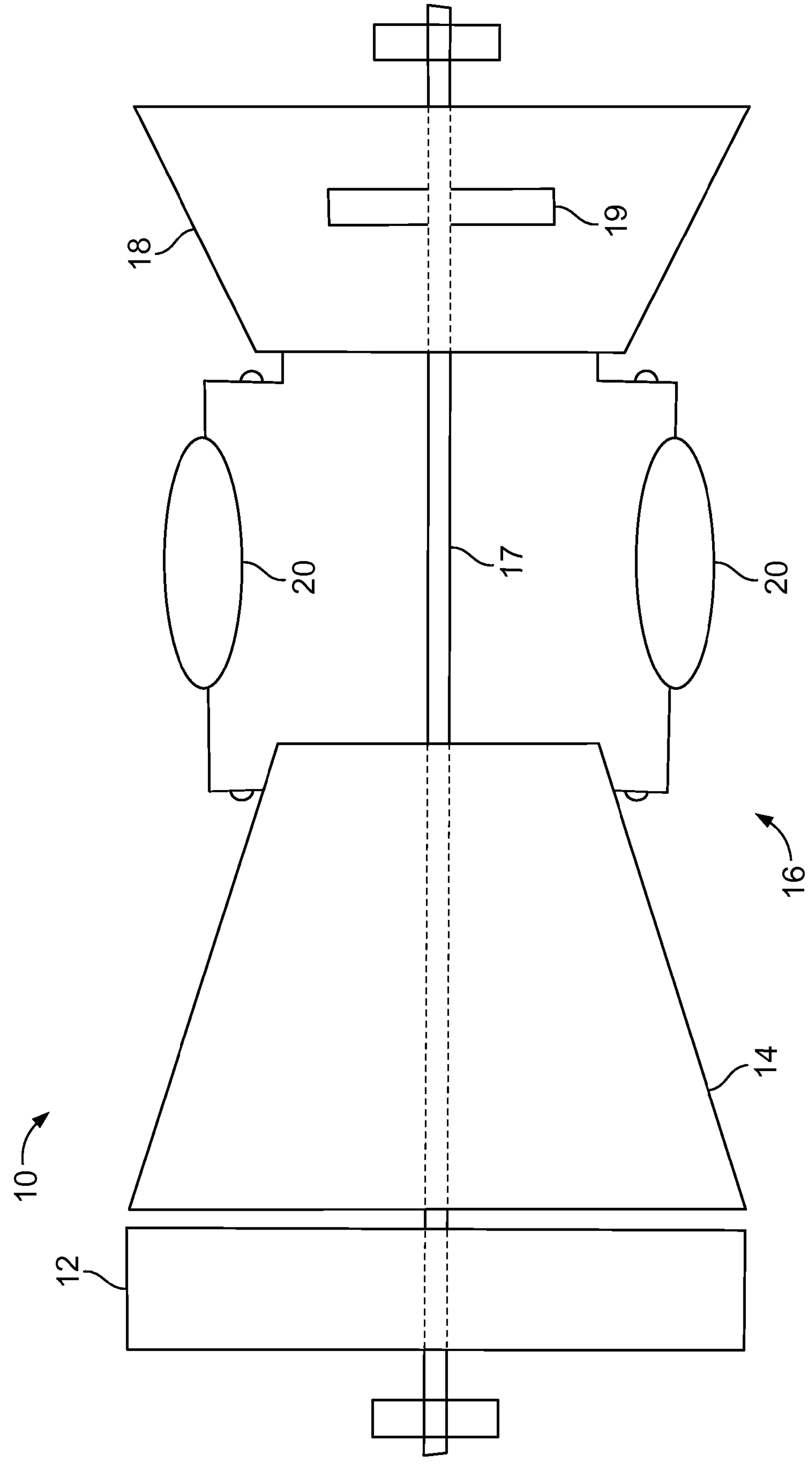


FIG. 1

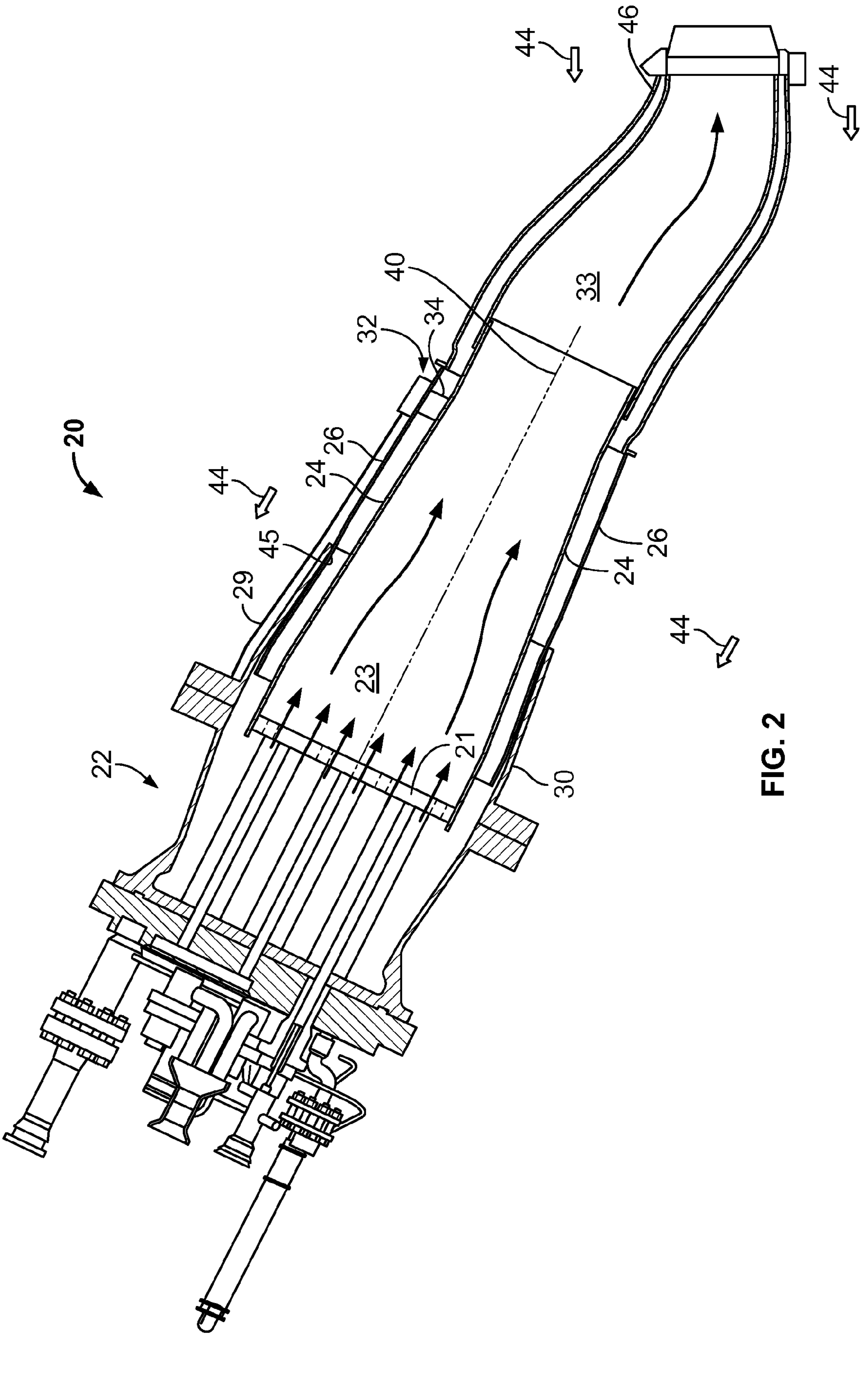
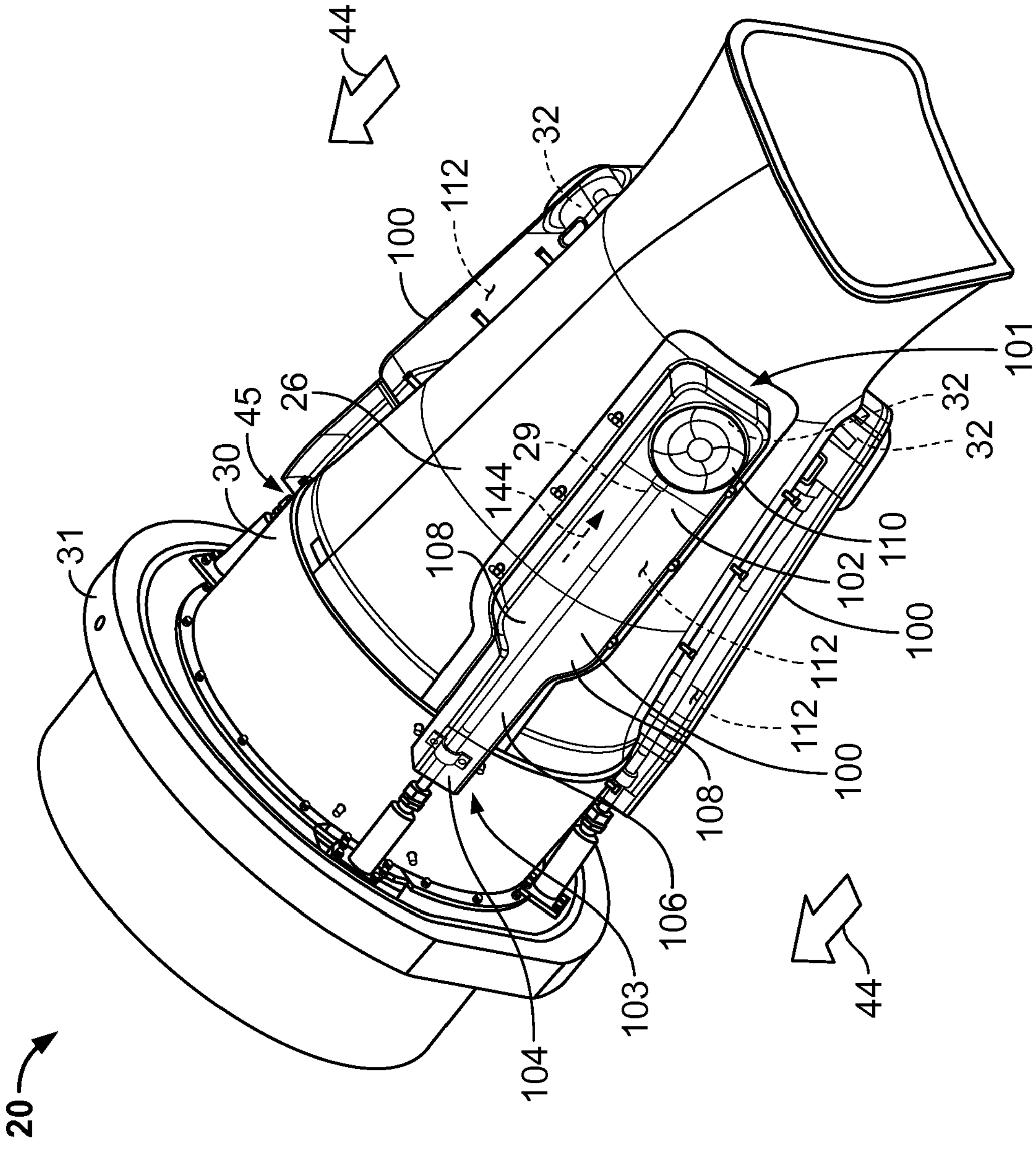


FIG. 2



20
44
44
32
112
100
26
45
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31
101
32
32
29
144
108
110
102
100
112
112
100
108
106
103
104

FIG. 3

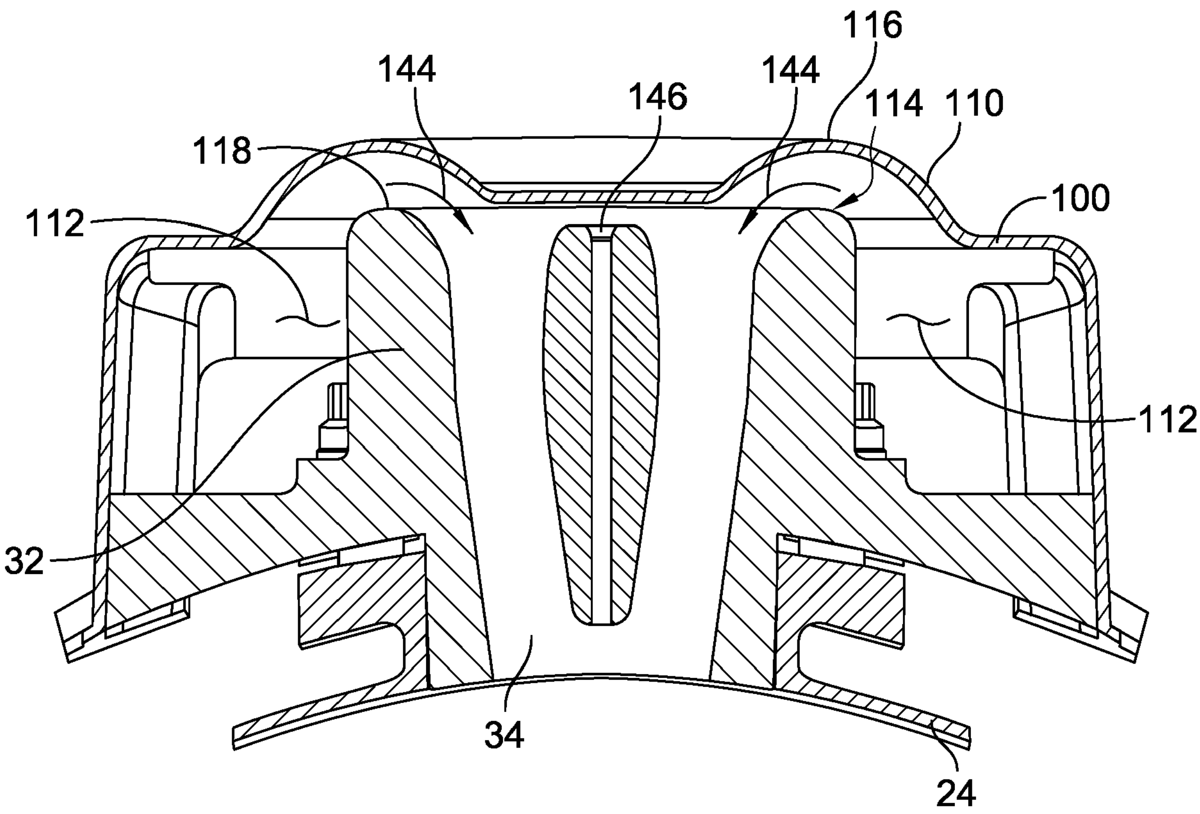
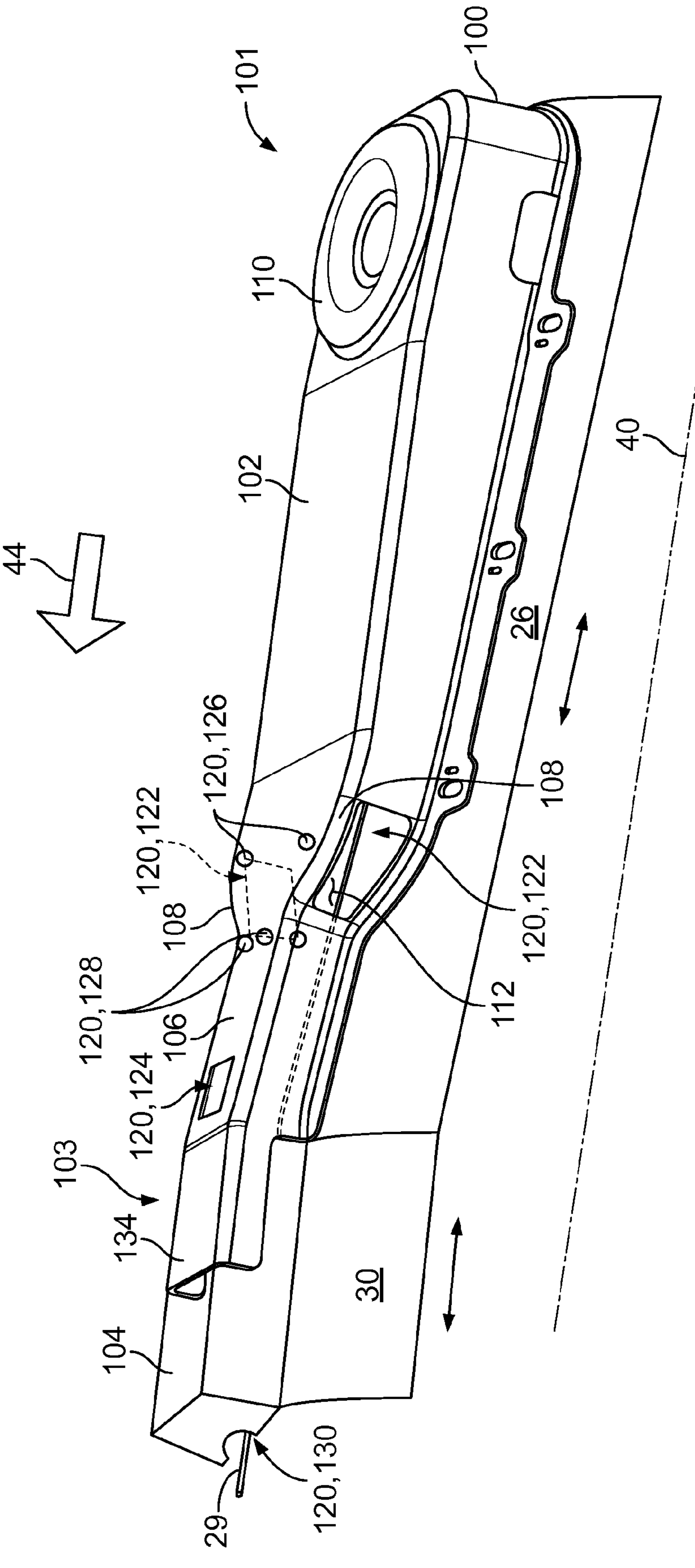


FIG. 4


101
100
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44
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120,126
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120,122
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120,122
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120,124
103
134
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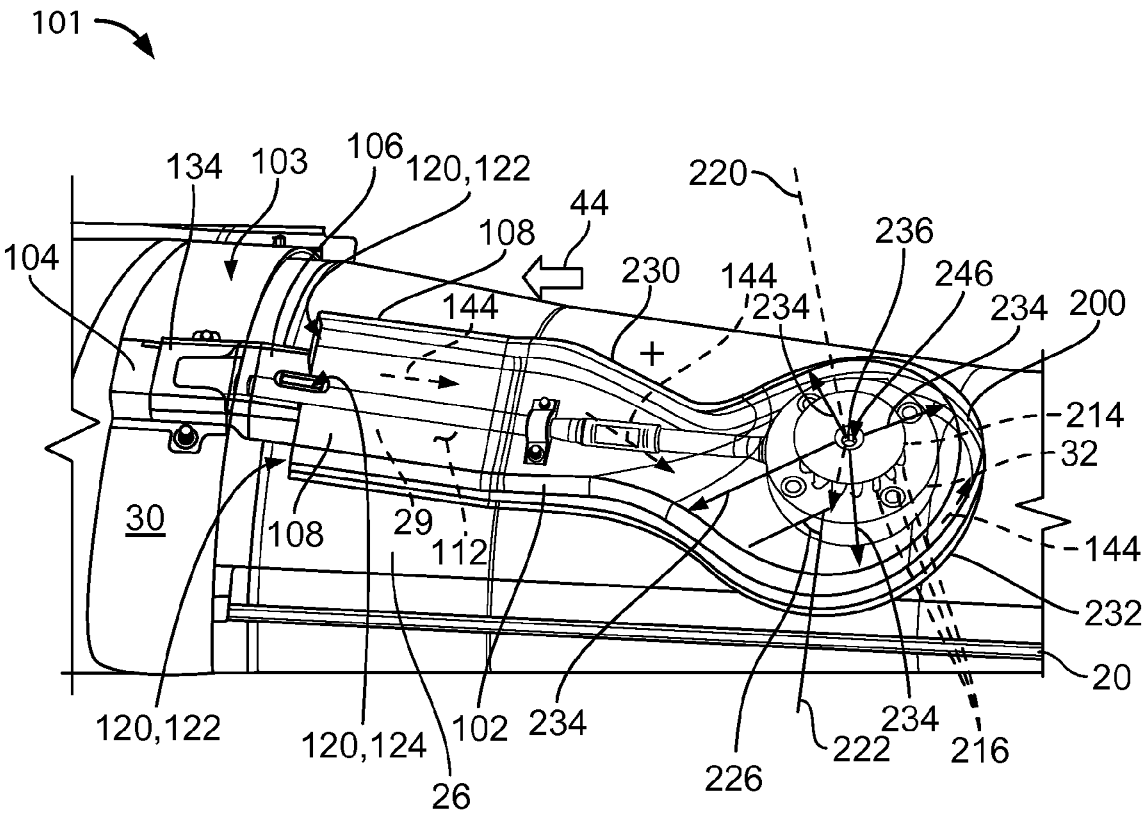
104
29
120,130

FIG. 5


101
134
103
106
120,122
220
44
104
108
230
144
236
246
144
234
234
200
214
32
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112
144
232
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120,122
120,124
102
234
234
222
216
226
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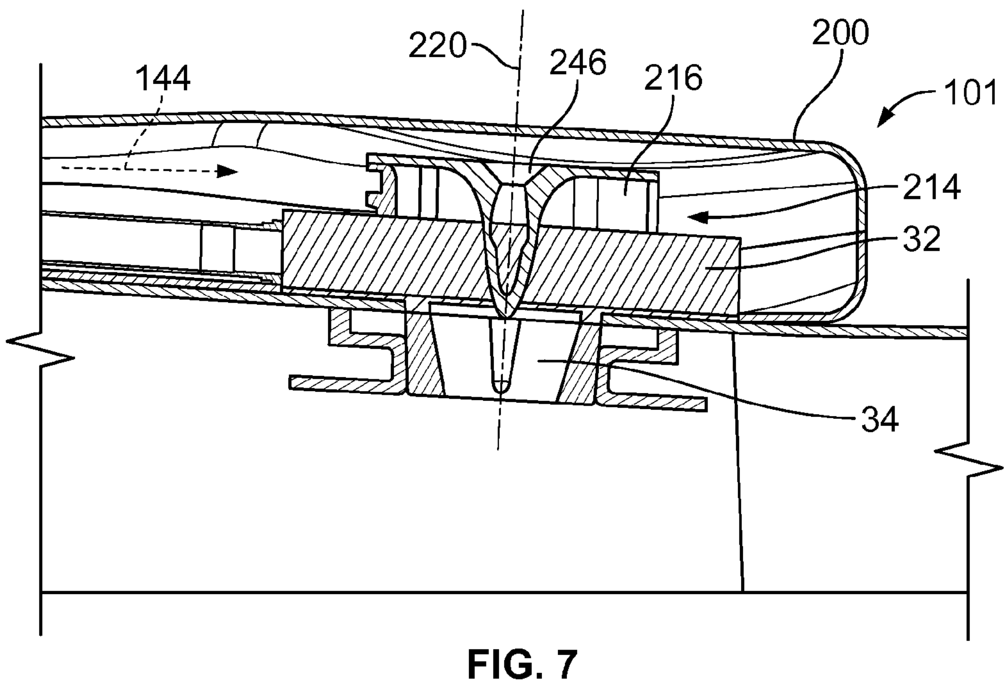
FIG. 6


220
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200
144
216
101
214
32
34

FIG. 7

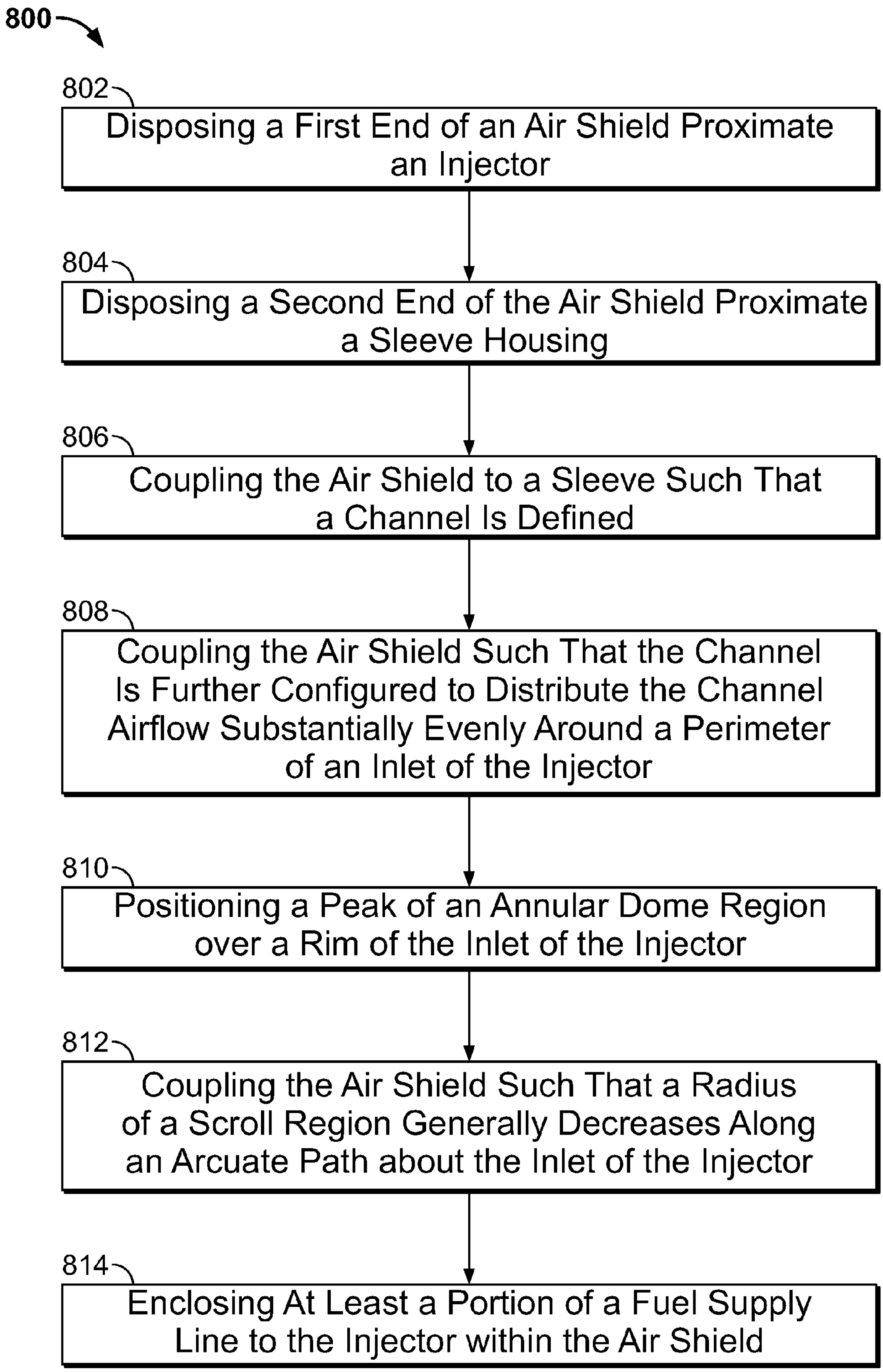
800
802
Disposing a First End of an Air Shield Proximate an Injector
804
Disposing a Second End of the Air Shield Proximate a Sleeve Housing
806
Coupling the Air Shield to a Sleeve Such That a Channel Is Defined
808
Coupling the Air Shield Such That the Channel Is Further Configured to Distribute the Channel Airflow Substantially Evenly Around a Perimeter of an Inlet of the Injector
810
Positioning a Peak of an Annular Dome Region over a Rim of the Inlet of the Injector
812
Coupling the Air Shield Such That a Radius of a Scroll Region Generally Decreases Along an Arcuate Path about the Inlet of the Injector
814
Enclosing At Least a Portion of a Fuel Supply Line to the Injector within the Air Shield

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 16 15 8422

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	13 July 2016	Harder, Sebastian

CATEGORY OF CITED DOCUMENTS

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