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(72) Inventors:

- **BHAGAT, Reena**
560066 Bangalore (IN)
- **CAI, Jun**
Greenville, SC South Carolina 29615-4614 (US)

(74) Representative: **Lee, Brenda**
GE International Inc.
Global Patent Operation - Europe
The Ark
201 Talgarth Road
Hammersmith
London W6 8BJ (GB)

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(71) Applicant: **General Electric Company**
Schenectady, NY 12345 (US)

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

(57) An air shield (100) for an injector (32) of a combustor (20) includes a first section (102) that extends axially from a first end (101) to a second end (103). The first section includes at least one side wall and a top wall. The at least one side wall and the top wall at least partially define a channel (112) configured to distribute a channel

airflow to the injector. The air shield also includes at least one first inlet defined through the at least one side wall and at least one second inlet defined through the top wall. The at least one first inlet and the at least one second inlet are configured to receive a portion of a surrounding airflow to at least partially form the channel airflow.

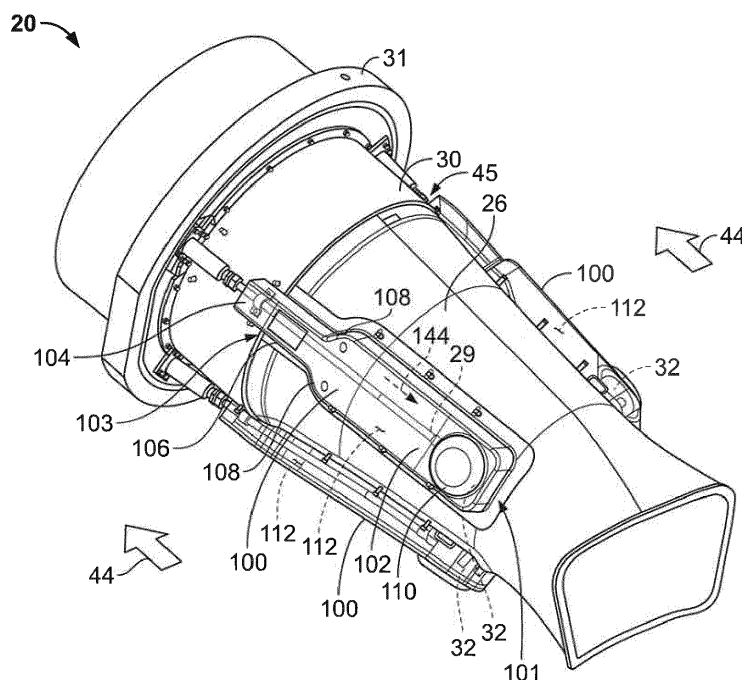


FIG. 3

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, if the supply of air includes low velocity or recirculation zones, unintended flameholding at the late lean injector may result.

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. The first section includes at least one side wall and a top wall. The at least one side wall and the top wall at least partially define a channel configured to distribute a channel airflow to the injector. The air shield also includes at least one first inlet defined through the at least one side wall and at least one second inlet defined through the top wall. The at least one first inlet and the at least one second inlet are configured to receive a portion of a surrounding airflow to at least partially form the channel airflow.

[0004] In another aspect, a combustor for a gas turbine is provided. The combustor includes a liner that defines a primary combustion zone, a sleeve that substantially circumscribes the liner, 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 also includes an air shield coupled to the sleeve. The air shield includes a first section that extends axially from a first end to a second end. The first section includes at least one side wall and a top wall. The at least one side wall and the top wall at least partially define a channel configured to distribute a channel airflow to the injector. The air shield also includes at least one first inlet defined through the at least one side wall and at least one second inlet defined through the top wall. The at least one first inlet and the at least one second inlet are configured to receive a portion of a surrounding airflow of the combustor to at least partially form the channel airflow.

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 an exemplary 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 the exemplary injector shown in FIG. 4;

FIG. 7 is a perspective view of a third exemplary embodiment of an air shield coupled to the combustor shown in FIG. 2 and covering the exemplary injector shown in FIG. 4; 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 systems and methods 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 provides an airflow to the late lean injector. The airflow enters the channel through at least one first inlet defined in a side wall of the air shield, and through at least one second inlet defined in a top wall of the air shield. The first and second inlets cooperate to reduce low velocity and/or recirculation zones and improve flow uniformity through 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] Unless otherwise indicated, the terms "first," "second," etc. are used herein merely as labels, and are not intended to impose ordinal, positional, or hierarchical requirements on the items to which these terms refer. Moreover, reference to, e.g., a "second" item does not

require or preclude the existence of, e.g., a "first" or lower-numbered item, and/or, e.g., a "third" or higher-numbered item.

[0008] 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.

[0009] 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.

[0010] 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.

[0011] 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.

[0012] 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).

[0013] 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.

[0014] 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.

[0015] 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.

[0016] 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 four circumferentially spaced late lean injectors 32, and a corresponding plurality of four circumferentially spaced air shields 100 is coupled to combustor 20 such that each air shield 100 covers a corresponding late lean injector 32. In alternative embodiments, the at least one late lean injector 32 is any suitable number of circumferentially spaced late lean injectors 32, and a correspond-

ing 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.

[0017] 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.

[0018] Air shield 100 at least partially 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.

[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. In the illustrated embodiment, first section 102 also includes a dome region 110 proximate first end 101, such that dome region 110 is configured to be disposed radially outwardly from late lean injector 32. Neck 106, pair of shoulder regions 108, dome region 110, and other portions of first section 102 are shaped in any suitable fashion that enables channel 112 to distribute a predetermined channel airflow 144 to late lean injector 32.

[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. 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 a perimeter of a rim 118 of inlet 114 is generally circular in the illustrated embodiment, it should be understood that the perimeter of rim 118 may have other suitable shapes. For another exam-

ple, 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.

[0021] FIG. 5 is another perspective view of air shield 100. With reference to FIGS. 3 and 5, air shield 100 includes at least one side wall 105 that extends generally radially outwardly, with respect to longitudinal axis 40, from sleeve 26 of combustor 20. In the illustrated embodiment, the at least one side wall 105 includes a pair of opposing side walls 105 that each extend from second end 103 to first end 101, and that are connected at first end 101 by an end wall 111 of channel 112. In alternative embodiments, the at least one side wall 105 includes any suitable number of side walls 105 having any suitable configuration that enables air shield 100 to function as described herein.

[0022] Air shield 100 also includes a top wall 107 that extends generally circumferentially, with respect to longitudinal axis 40, from the at least one sidewall 105. In the illustrated embodiment, top wall 107 extends between the pair of opposing side walls 105 to define a top wall of channel 112, while sleeve 26 defines a bottom wall of channel 112. In alternative embodiments, top wall 107 has any suitable configuration that enables air shield 100 to function as described herein.

[0023] Air shield 100 further includes at least one first inlet 120 defined through side wall 105 of first section 102, and at least one second inlet 122 defined through top wall 107 of first section 102. The at least one first inlet 120 and the at least one second inlet 122 are each configured to receive a portion of surrounding airflow 44 of combustor 20 to at least partially form channel airflow 144. In certain embodiments, each first inlet 120 and second inlet 122 is located generally proximate second end 103. For example, in the illustrated embodiment, each first inlet 120 and second inlet 122 is located on at least one of neck 106 and shoulder regions 108. In alternative embodiments, at least one first inlet 120 and/or second inlet 122 is located other than generally proximate second end 103.

[0024] In the exemplary embodiment, the at least one first inlet 120 includes an opposing pair of first inlets 120 each defined along one of pair of shoulder regions 108. The size and position of the pair of first inlets 120 on opposite shoulder regions 108 is configured to direct channel airflow 144 in a generally axial direction defined from second end 103 towards first end 101 of first section 102. In alternative embodiments, the at least one first inlet 120 includes any suitable number of first inlets 120 each positioned at any suitable location on side wall 105 that enables air shield 100 to function as described herein.

[0025] In certain embodiments, however, a location of air shield 100 on combustor 20 relative to a source of surrounding airflow 44 inhibits first inlets 120 from providing a suitable channel airflow 144. For example, but not by way of limitation, and using the terms "below,"

"downward," and "upward" with respect to the perspective view shown in FIG. 3, the source of surrounding airflow 44 is located below combustor 20. Under certain operating conditions, a downward facing shoulder region 108 of each of the two uppermost air shields 100 is subject to a different pressure as compared to a respective upward facing shoulder region 108 of each of the two uppermost air shields 100. Thus, for the two uppermost air shields, an unequal airflow through each of the opposing first inlets 120 under certain operating conditions, in an absence of any other inlets, could result in recirculation zones and/or low velocity within channel 112.

[0026] In certain embodiments, the at least one second inlet 122 is configured to reduce or eliminate the potential for recirculation zones and/or low velocity within channel 112 of air shield 100. In certain embodiments, the at least one second inlet 122 includes at least one top window 124 defined in top wall 107 along neck 106 of first section 102. At least one of a size and a position of the at least one top window 124 is configured to enhance the component of channel airflow 144 that flows in the axial direction defined from second end 103 towards first end 101 of first section 102. For example, in the exemplary embodiment shown in FIG. 5, the at least one second inlet 122 includes a single top window 124 defined in top wall 107 along neck 106 of first section 102, and the single top window 124 is centered with respect to opposing shoulder regions 108 to facilitate equalizing a potential pressure difference within channel 112 between opposing first inlets 120. For another example, a size of top window 124 relative to a size of the at least one first inlet 120 is selected to reduce non-axial components of channel airflow 144 as it approaches late lean injector 32.

[0027] With further reference to FIGS. 3 and 5, in the illustrated embodiment, each 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] Notably, the configuration of top window 124 in the exemplary embodiment of FIG. 5 exposes a portion of fuel line 29 within channel 112. FIG. 6 is a perspective view of a second exemplary embodiment of air shield 100 that is substantially similar to the embodiment of FIG. 5 in most respects, and similar features are given the same reference numbers. However, in the second exemplary embodiment, the at least one second inlet 122 includes a pair of top windows 124 defined in top wall 107 along neck 106 of first section 102. As with the embodiment of FIG. 5, at least one of a size and a position of the pair of top windows 124 on top wall 107 along neck 106 is configured, for example, to enhance the compo-

nent of channel airflow 144 that flows in the axial direction defined from second end 103 towards first end 101 of first section 102. For example, pair of top windows 124 is centered with respect to opposing shoulder regions 108 to facilitate equalizing a potential pressure difference within channel 112 between opposing first inlets 120. For another example, a size of pair of top windows 124 relative to a size of the at least one first inlet 120 is selected to reduce non-axial components of channel airflow 144 as it approaches late lean injector 32. However, in contrast to the embodiment shown in FIG. 5, a central portion 109 of top wall 107 between the pair of top windows 124 remains intact, facilitating increased protection of fuel line 29.

[0029] FIG. 7 is a perspective view of a third exemplary embodiment of air shield 100 that is substantially similar to the embodiment of FIG. 5 in most respects, and similar features are given the same reference numbers. However, in the third exemplary embodiment, the at least one second inlet 122 includes a plurality of neck apertures 128 defined in top wall 107 along neck 106 of first section 102. As with the embodiment of FIG. 5, at least one of a size and a position of the plurality of neck apertures 128 on top wall 107 along neck 106 is configured, for example, to enhance the component of channel airflow 144 that flows in the axial direction defined from second end 103 towards first end 101 of first section 102. For example, plurality of neck apertures 128 is centered with respect to opposing shoulder regions 108 to facilitate equalizing a potential pressure difference within channel 112 between opposing first inlets 120. For another example, a size of plurality of neck apertures 128 relative to a size of the at least one first inlet 120 is selected to reduce non-axial components of channel airflow 144 as it approaches late lean injector 32. Again, a central portion 109 of top wall 107 between the each of the plurality of neck apertures 128 remains intact, facilitating increased protection of fuel line 29.

[0030] Referring to FIGS. 5-7, in certain embodiments, the at least one second inlet 122 further includes a plurality of shoulder apertures 126 defined in top wall 107 proximate shoulder regions 108 of first section 102. In the illustrated embodiments, the plurality of shoulder apertures 126 includes a pair of shoulder apertures 126 each defined on a corresponding shoulder region. At least one of a size and a position of shoulder apertures 126 is configured to receive a portion of channel airflow 144 into channel 112 near shoulder regions 108 such that a tendency of channel airflow 144 to separate near shoulder regions 108 is reduced or eliminated. In alternative embodiments, the at least one second inlet 122 does not include shoulder apertures 126.

[0031] In alternative embodiments, the at least one second inlet 122 includes any suitable number of second inlets 122, such as but not limited to any suitable number of top windows 124, shoulder apertures 126, and/or neck apertures 128, each positioned at any suitable location on top wall 107 that enables air shield 100 to function as

described herein.

[0032] 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 of combustor 20, 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.

[0033] In the illustrated embodiment, second section 104 includes an aperture 130 configured to receive fuel line 29. In certain embodiments, aperture 130 also is configured to receive a portion of surrounding airflow 44 into channel 112 to at least partially form channel airflow 144. In alternative embodiments, aperture 130 is configured to receive fuel line 29 such that little or none of channel airflow 144 is received through aperture 130. In other alternative embodiments, second section 104 does not include aperture 130.

[0034] 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 a first section of an air shield, such as first section 102 of air shield 100, 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 distribute a channel airflow, such as channel airflow 144, to the injector. The channel includes at least one first inlet, such as the at least one first inlet 120, defined through at least one side wall of the first section, such as the at least one side wall 105, and at least one second inlet, such as the at least one second inlet 122, defined through a top wall of the first section, such as top wall 107. The at least one first inlet and the at least one second inlet are configured to receive a portion of a surrounding airflow of the combustor to at least partially form the channel airflow.

[0035] 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 reducing low velocity and/or recirculation zones and improving flow uniformity through the late lean injector. For example, embodiments of the air shield include at least one first inlet defined in a side wall of the air shield and at least one second inlet defined in a top wall of the air shield that cooperate to enhance an axial component of a channel airflow through the air shield, reducing a potential for unintended flameholding at 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.

[0036] 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.

[0037] 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.

[0038] 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, said first section comprising at least one side wall and a top wall, said at least one side wall and said top wall at least partially define a channel configured to distribute a channel airflow to the injector; and

at least one first inlet defined through said at least one side wall and at least one second inlet defined through said top wall, said at least one first inlet and said at least one second inlet are configured to receive a portion of a surrounding airflow to at least partially form the channel airflow.

2. The air shield of clause 1, wherein said first end

is configured to be disposed proximate the injector, said at least one first inlet and said at least one second inlet are located generally proximate said second end.

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3. The air shield 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 first inlet and said at least one second inlet are located on at least one of said neck and said shoulder regions.

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4. The air shield 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 first inlet comprises an opposing pair of first inlets each defined along one of said pair of shoulder regions.

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5. The air shield of any preceding clause, wherein said first section includes a neck proximate to said second end, said at least one second inlet comprises at least one top window defined in said top wall along said neck.

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6. The air shield of any preceding clause, wherein said at least one top window comprises a pair of top windows.

7. The air shield of any preceding clause, wherein said first section includes a neck proximate to said second end, said at least one second inlet comprises a plurality of neck apertures defined in said top wall along said neck.

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8. The air shield 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 second inlet comprises a plurality of shoulder apertures defined in said top wall proximate said pair of shoulder regions.

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9. The air shield of any preceding clause, wherein at least one of a size and a position of said plurality of shoulder apertures is configured to receive a portion of the channel airflow into said channel near said shoulder regions such that a tendency of the channel airflow to separate near said shoulder regions is reduced or eliminated.

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10. The air shield of any preceding clause, wherein at least one of a size and a position of said at least one second inlet is configured to enhance an axial component of the channel airflow.

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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 coupled to said sleeve, said air shield comprising:

a first section that extends axially from a first end to a second end, said first section comprising at least one side wall and a top wall, said at least one side wall and said top wall at least partially define a channel configured to distribute a channel airflow to said injector; and

at least one first inlet defined through said at least one side wall and at least one second inlet defined through said top wall, said at least one first inlet and said at least one second inlet are configured to receive a portion of a surrounding airflow of said combustor to at least partially form the channel airflow.

12. The combustor of any preceding clause, wherein said first end is configured to be disposed proximate said injector, said at least one first inlet and said at least one second inlet are located generally proximate said second end.

13. 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 first inlet and said at least one second inlet are located on at least one of said neck and said shoulder regions.

14. 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 first inlet comprises an opposing pair of first inlets each defined along one of said pair of shoulder regions.

15. The combustor of any preceding clause, wherein said first section includes a neck proximate to said second end, said at least one second inlet comprises

at least one top window defined in said top wall along said neck.

16. The combustor of any preceding clause, wherein said at least one top window comprises a pair of top windows.

17. The combustor of any preceding clause, wherein said first section includes a neck proximate to said second end, said at least one second inlet comprises a plurality of neck apertures defined in said top wall along said neck.

18. 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 second inlet comprises a plurality of shoulder apertures defined in said top wall proximate said pair of shoulder regions.

19. The combustor of any preceding clause, wherein at least one of a size and a position of said plurality of shoulder apertures is configured to receive a portion of the channel airflow into said channel near said shoulder regions such that a tendency of the channel airflow to separate near said shoulder regions is reduced or eliminated.

20. The combustor of any preceding clause, wherein at least one of a size and a position of said at least one second inlet is configured to enhance an axial component of the channel airflow.

Claims

1. An air shield (100) 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), said first section comprising at least one side wall (105) and a top wall (107), said at least one side wall and said top wall at least partially define a channel (112) configured to distribute a channel airflow to the injector; and
at least one first inlet (120) defined through said at least one side wall and at least one second inlet (122) defined through said top wall, said at least one first inlet and said at least one second inlet are configured to receive a portion of a surrounding airflow to at least partially form the channel airflow.

2. The air shield of claim 1, wherein said first end (101) is configured to be disposed proximate the injector (32), said at least one first inlet and said at least one

second inlet are located generally proximate said second end (103).

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

4. The air shield of claim 1, 2 or 3, wherein said first section includes a neck (106) proximate to said second end and a pair of shoulder regions (108) that extend from said neck, said at least one first inlet comprises an opposing pair of first inlets (120) each defined along one of said pair of shoulder regions.

5. The air shield of any of claims 1 to 4, wherein said first section includes a neck (106) proximate to said second end, said at least one second inlet (122) comprises at least one top window (124) defined in said top wall along said neck.

6. The air shield of claim 5, wherein said at least one top window (124) comprises a pair of top windows (124).

7. The air shield of any preceding claim, wherein said first section includes a neck (106) proximate to said second end, said at least one second inlet (122) comprises a plurality of neck apertures (128) defined in said top wall along said neck.

8. The air shield of any preceding claim, wherein said first section includes a neck (106) proximate to said second end and a pair of shoulder regions (108) that extend from said neck, said at least one second inlet (122) comprises a plurality of shoulder apertures (126) defined in said top wall proximate said pair of shoulder regions.

9. The air shield of any preceding claim, wherein at least one of a size and a position of said plurality of shoulder apertures (126) is configured to receive a portion of the channel airflow into said channel near said shoulder regions (108) such that a tendency of the channel airflow to separate near said shoulder regions is reduced or eliminated.

10. The air shield of any preceding claim, wherein at least one of a size and a position of said at least one second inlet (122) is configured to enhance an axial component of the channel airflow.

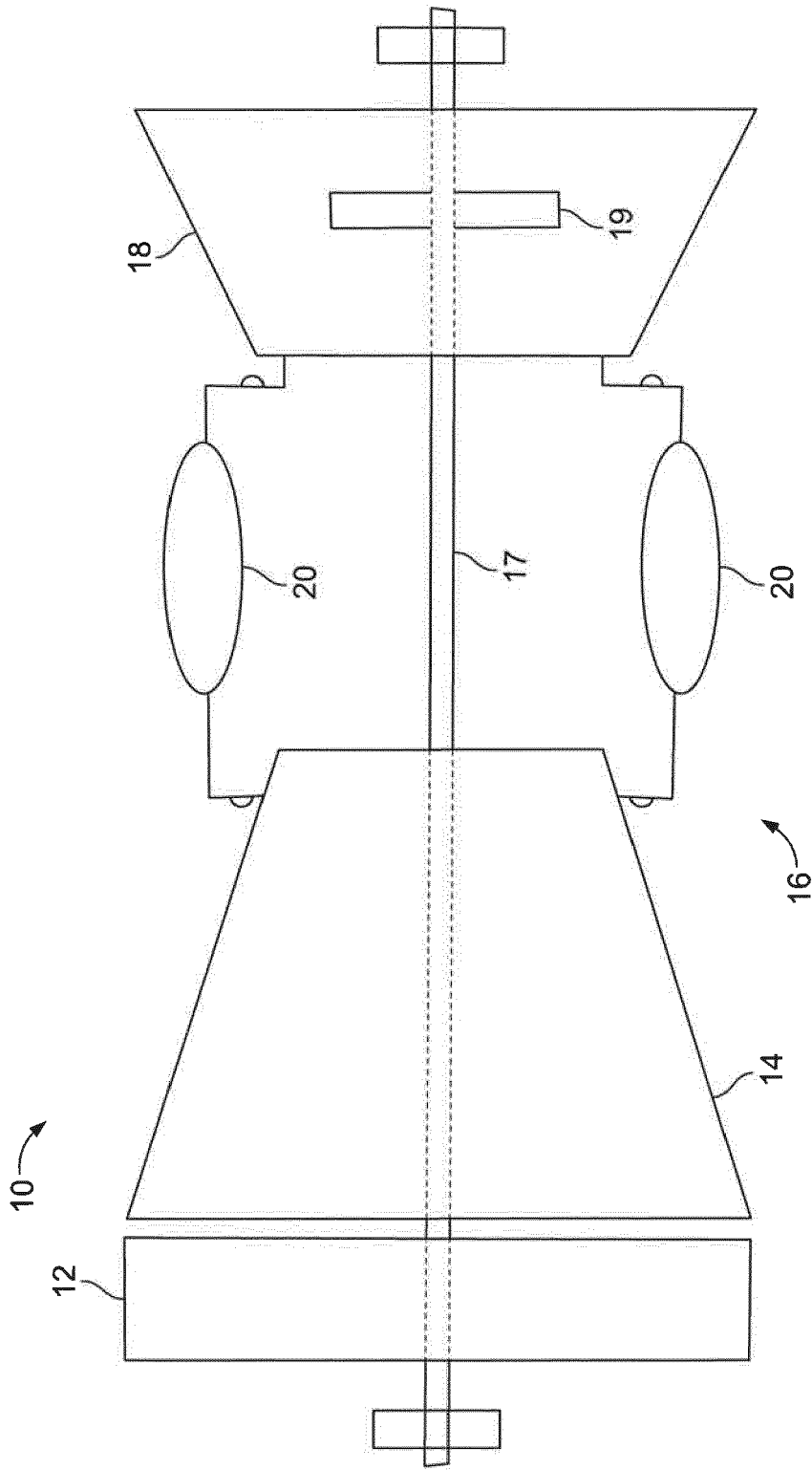


FIG. 1

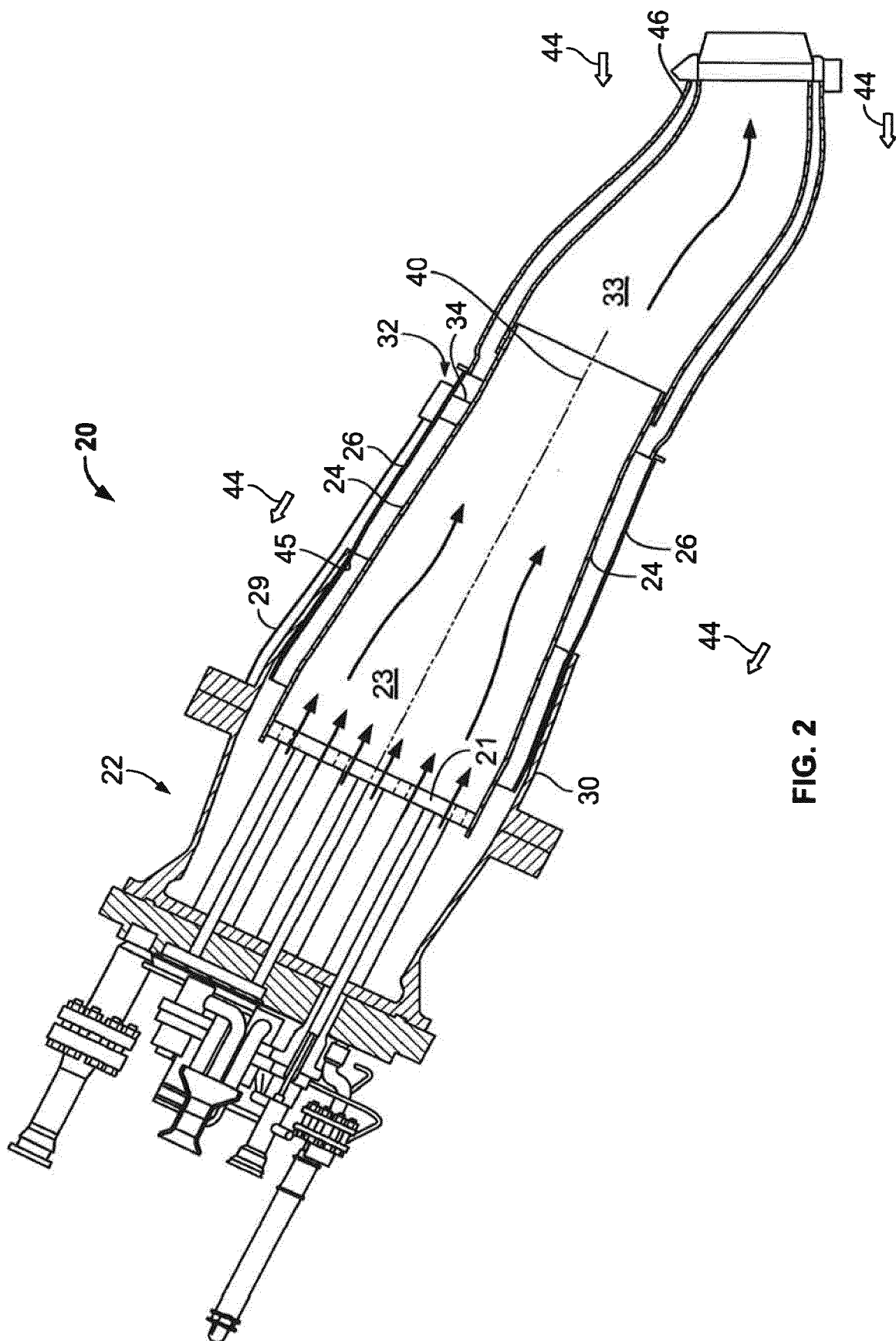


FIG. 2

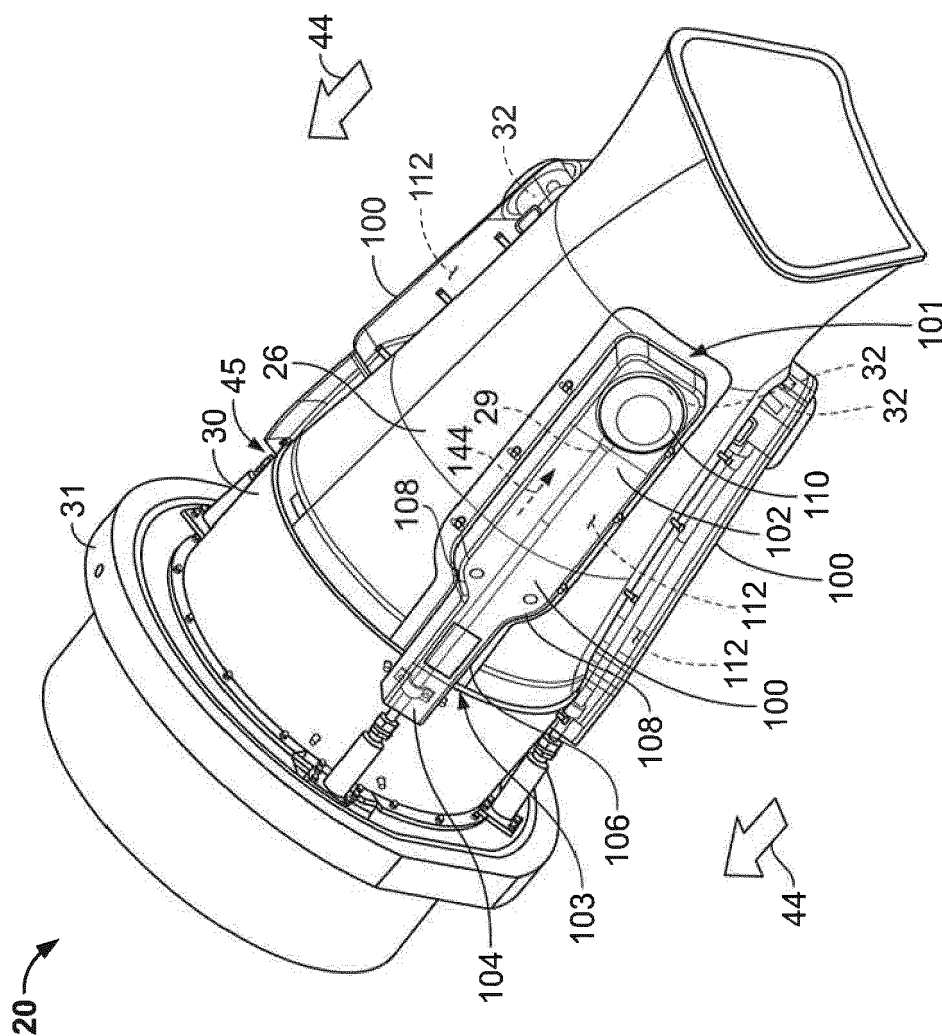


Fig. 3

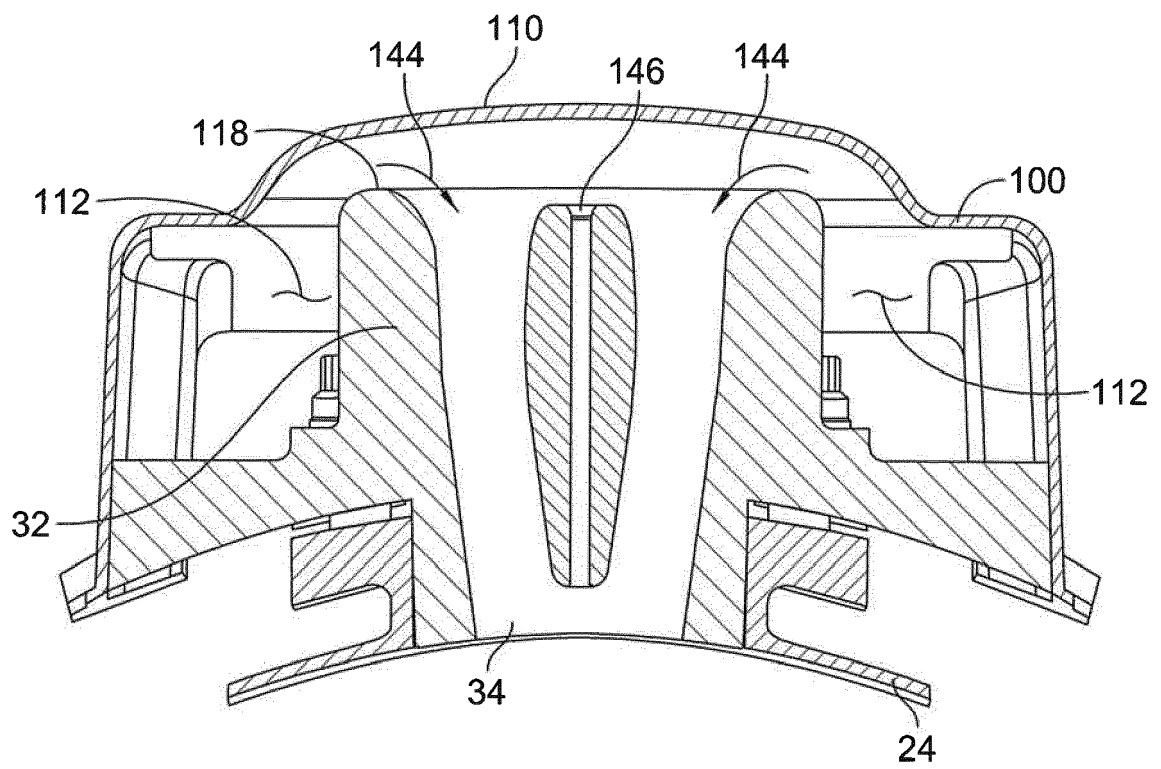


FIG. 4

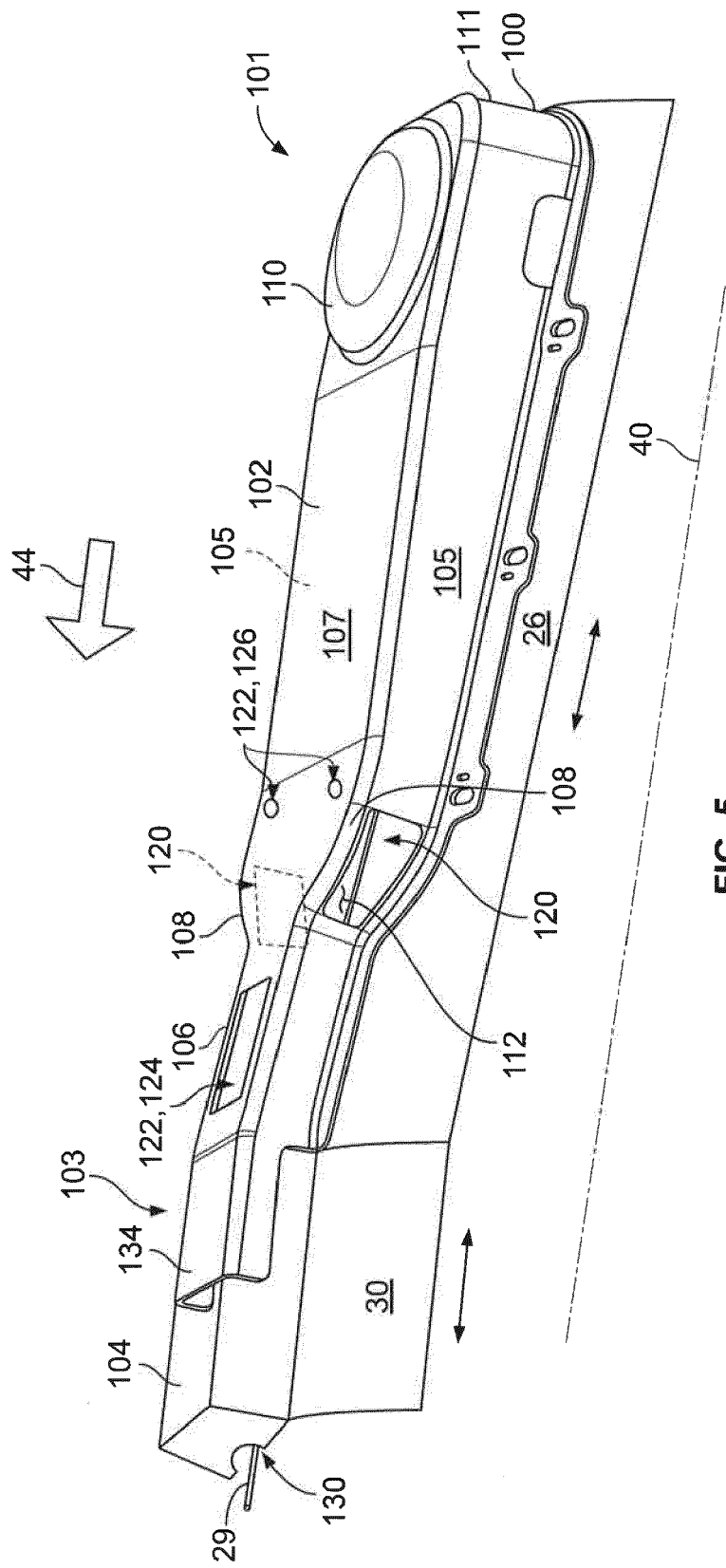


FIG. 5

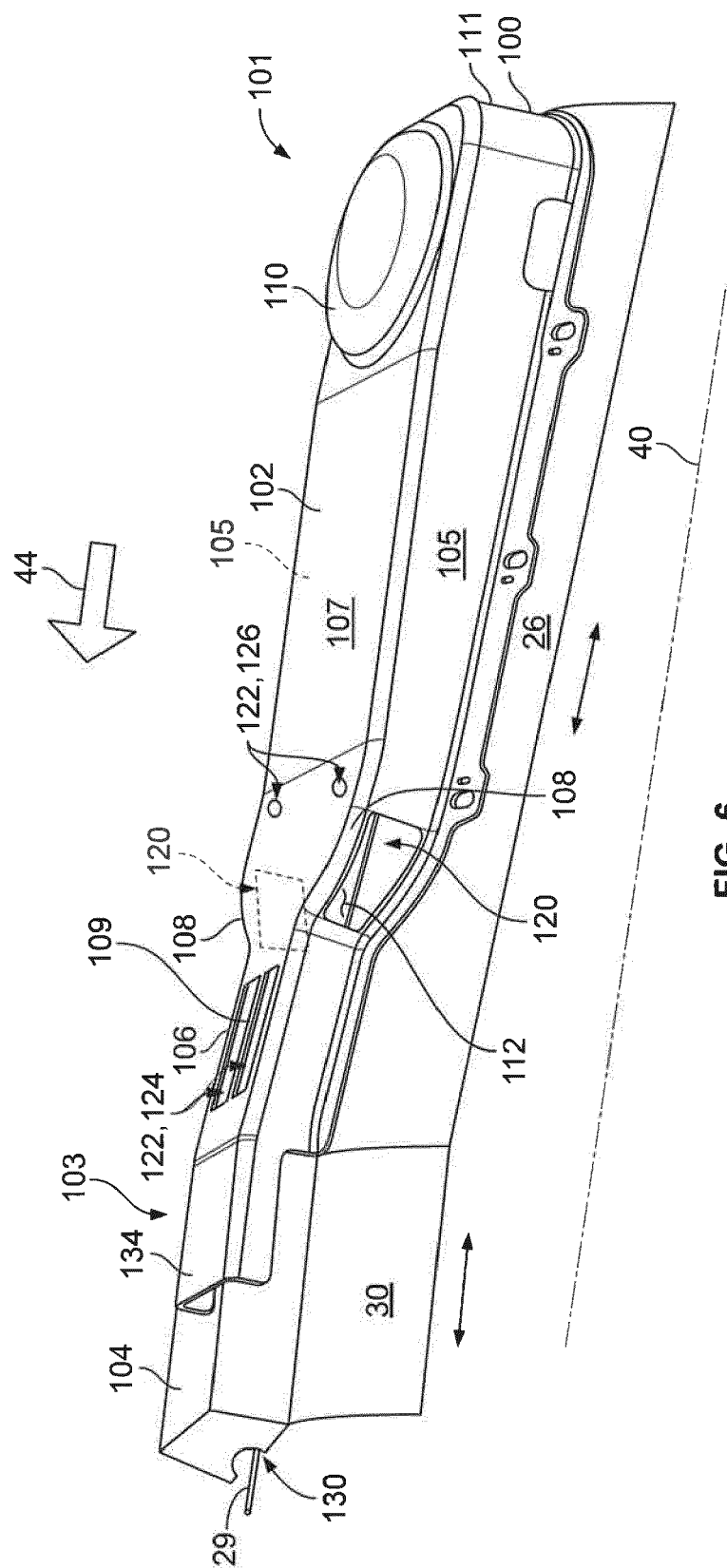


FIG. 6

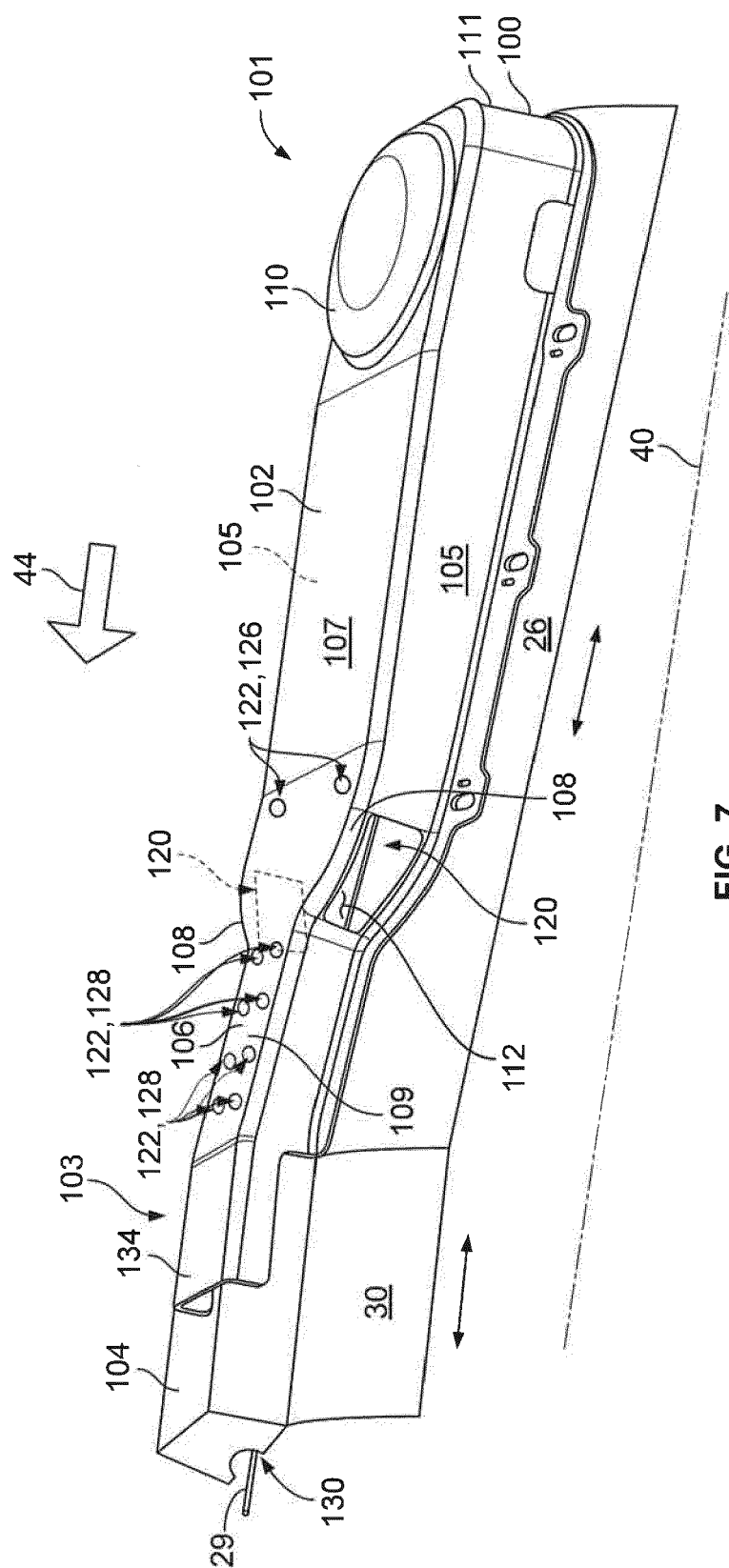


FIG. 7

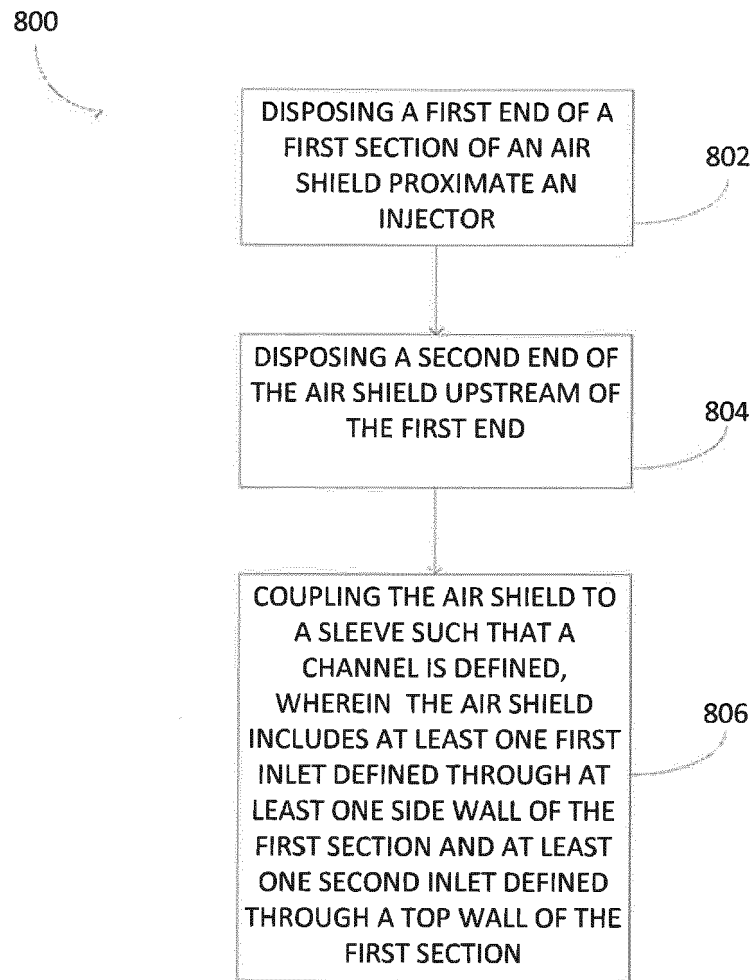


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 16 15 8421

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2014/260272 A1 (DICINTIO RICHARD MARTIN [US] ET AL) 18 September 2014 (2014-09-18) * paragraph [0083]; figures 4, 19 *	1-10	INV. F23R3/34 F23R3/00
X	EP 2 375 167 A2 (GEN ELECTRIC [US]) 12 October 2011 (2011-10-12) * paragraph [0015] - paragraph [0018]; figure 2 *	1,2	
Y	----- EP 2 660 519 A1 (GEN ELECTRIC [US]) 6 November 2013 (2013-11-06) * paragraphs [0018], [0027]; figures 4-9 *	1-10	
X	----- EP 2 660 519 A1 (GEN ELECTRIC [US]) 6 November 2013 (2013-11-06) * paragraphs [0018], [0027]; figures 4-9 *	1,2	
A	----- US 2014/260264 A1 (STOIA LUCAS JOHN [US] ET AL) 18 September 2014 (2014-09-18) * paragraph [0024]; figures 3, 5 *	7	
A	----- US 2014/260264 A1 (STOIA LUCAS JOHN [US] ET AL) 18 September 2014 (2014-09-18) * paragraph [0024]; figures 3, 5 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F23R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 July 2016	Examiner Harder, Sebastian
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 15 8421

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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12-07-2016

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014260272 A1	18-09-2014	CH 707852 A2	30-09-2014
		CN 104061599 A	24-09-2014
		DE 102014103087 A1	18-09-2014
		JP 2014181902 A	29-09-2014
		US 2014260272 A1	18-09-2014

EP 2375167 A2	12-10-2011	CN 102235670 A	09-11-2011
		EP 2375167 A2	12-10-2011
		JP 5236769 B2	17-07-2013
		JP 2011220673 A	04-11-2011
		US 2011247314 A1	13-10-2011

EP 2660519 A1	06-11-2013	CN 103375262 A	30-10-2013
		EP 2660519 A1	06-11-2013
		JP 2013231576 A	14-11-2013
		RU 2013108686 A	10-09-2014
		US 2013283804 A1	31-10-2013

US 2014260264 A1	18-09-2014	CH 707849 A2	30-09-2014
		CN 204063127 U	31-12-2014
		DE 102014103088 A1	18-09-2014
		JP 2014181899 A	29-09-2014
		US 2014260264 A1	18-09-2014
