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(54) **SECOND-STAGE COMBUSTOR FOR A SEQUENTIAL COMBUSTOR OF A GAS TURBINE**

SEKUNDÄRE BRENNKAMMERSTUFE FÜR EINE SEQUENTIELLE
GASTURBINENBRENNKAMMER

CHAMBRE DE COMBUSTION DE SECOND ÉTAGE POUR CHAMBRE DE COMBUSTION
SÉQUENTIELLE D'UNE TURBINE À GAZ

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Description

TECHNICAL FIELD

[0001] The present invention relates to a second-stage combustor for a sequential combustor of a gas turbine.

BACKGROUND

[0002] As it is known, increase of power output and efficiency of gas turbines for power plants involves several challenges and fuel injection to obtain efficient and emission-compliant combustion is among the most critical ones. In order to achieve higher power output, in fact, also fuel supply is to be significantly increased and injection must be carried out in such a manner that the fuel flowrate is adequately mixed with a flowrate of a dilutant fluid (e.g. fresh air or exhaust of first combustor stage in sequential combustors). Poor mixing may negatively affect combustion and levels of pollutant emissions.

[0003] The need to supply increased fuel flowrates and to provide adequate mixing led to developing burners with complex structures. Known burners tend to meet heavy requirements in terms of fuel supply and mixing capacity, nevertheless some limitations still stand, in particular because complex structure has important implications. Depending on the type of combustor, multipoint lance injectors or streamlined bodies with critical aerodynamic properties need to be provided. Manufacturing of such complex structures may be difficult and processes required to obtain acceptable results may involve substantial cost.

[0004] Moreover, it is in general desired that burner assemblies (i.e. devices devoted to fuel injection and mixing) can be retracted from their housings for the purpose of maintenance or retrofitting without the need to disassemble large part of the combustors. In particular, it is desired that burner assemblies are axially retractable for simple extraction from can combustors. Exactly on account of their complex structure, however, known burner assemblies cannot be retracted.

[0005] EP 3 015 772 A1 discloses a combustor of a gas turbine, comprising: a first-stage combustor, a second-stage combustor, an axial lance injector and a flame stabilizer device. The second-stage combustor is arranged downstream of the first-stage combustor and includes a second-stage combustion chamber extending along an axial direction. The axial lance injector comprises an elongated streamlined body extending in the axial direction from the first-stage combustor through a transition region of the second-stage combustor. A plurality of first cross-flow injection nozzles and a plurality of second cross-flow injection nozzles are provided on the elongated streamlined body at respective axial locations. The flame stabilizer device is arranged downstream of the first cross-flow injection nozzles and of the second cross-flow injection nozzles.

[0006] Other examples of known combustors are dis-

closed in US 6 895 759 B2, in EP 2 072 899 A1, in US 5 802 854 A and in EP 2 647 911 A2.

SUMMARY OF THE INVENTION

[0007] It is an aim of the present invention to provide a second-stage combustor for a sequential combustor of a gas turbine and a method of controlling a sequential combustor of gas turbine with a first-stage combustor and a second-stage combustor, which allow to overcome or at least to attenuate the limitations described.

[0008] According to the present invention, there is provided a combustor of a gas turbine, comprising:

a first-stage combustor and a second-stage combustor, wherein the second-stage combustor is arranged downstream of the first-stage combustor and includes a second-stage combustion chamber extending along an axial direction;
an axial lance injector; and
a flame stabilizer device;
wherein the axial lance injector comprises:

an elongated streamlined body extending in the axial direction from the first-stage combustor into the second-stage combustion chamber through a transition region of the second-stage combustor, wherein the elongated streamlined body and the transition region are configured to prevent gas flowing from the first-stage combustor to the second-stage combustion chamber from recirculating in the transition region;
a plurality of first cross-flow injection nozzles and a plurality of second cross-flow injection nozzles provided on the elongated streamlined body at respective axial locations;
and wherein the flame stabilizer device is arranged downstream of the first cross-flow injection nozzles and of the second cross-flow injection nozzles;
characterized in that the flame stabilizer device comprises a full-load flame stabilizer at a downstream end of the elongated streamlined body and at least one partial-load flame stabilizer between the second cross-flow injection nozzles and the full-load flame stabilizer.

[0009] The combustor combines an axial lance injector with extremely simple design and a flame stabilizer device that allows to anchor the flame at one or more desired locations. In particular, the front flame may be set at an axially downstream location at full load, to reduce post-flame residence time and production of NOx.

[0010] The axial lance injector is essentially defined by an elongated streamlined body that extends from the first-stage combustor into the second-stage combustion chamber and exploits cross-flow injection for providing effective supply and mixing even when large fuel flow-

rates are required. Cross-flow injection nozzles may be provided on the surface of the elongated streamlined body and there is no need for special components, creating complex fluid-dynamic structures. As a result, the axial lance injector may be manufactured by conventional manufacturing processes and it is not necessary to resort to additive techniques, to the advantage of cost. In addition, the axial lance injector is easily retractable in the axial direction, thus simplifying maintenance and retrofitting operations.

[0011] Axial locations of the first and second cross-flow injection nozzles can be selected to exploit different time delays from injection locations and the flame front. This can be used for the purpose of mitigating thermoacoustic oscillations and for providing short mixing paths for highly reactive fuels.

[0012] According to an aspect of the present invention, the second cross-flow injection nozzles are axially displaced downstream of the first cross-flow injection nozzles.

[0013] According to an aspect of the present invention, the first cross-flow injection nozzles are fluidly coupled to a fuel gas supply line and the second cross-flow injection nozzles are fluidly coupled to a liquid fuel supply line.

[0014] Separate supply paths for different fuels may be provided. Advantages of separate oil injection may thus be exploited. In particular, less strict purging requirements are allowed. Also, separate supply valves can be used and mixing paths can be separately optimized for different fuels.

[0015] According to an aspect of the present invention, at least one of the first cross-flow injection nozzles is axially displaced with respect to the other first cross-flow injection nozzles.

[0016] According to an aspect of the present invention, the first cross-flow injection nozzles are staggered in the axial direction.

[0017] According to an aspect of the present invention, at least one of the second cross-flow injection nozzles is axially displaced with respect to the other second cross-flow injection nozzles.

[0018] According to an aspect of the present invention, the second cross-flow injection nozzles are staggered in the axial direction.

[0019] All the above features, separately and possibly in combination, allow to optimize beneficial effects of fuel injection at different axial locations, in particular with respect to mixing paths, ignition time and damping of thermoacoustic oscillations.

[0020] According to an aspect of the present invention, the second cross-flow injection nozzles are oriented at such an angle that fuel oil is injected in the second-stage combustion chamber with a non-zero axial component of velocity.

[0021] Inclination of the second cross-flow injection nozzles allows to reduce residence time of highly reactive fuel oil, because injected fuel leaves the nozzles with a non-zero axial component of velocity. In turn, lower res-

idence time reduces the need for mixing additional water to fuel oil. In some cases, additional water may not be required at all, especially when inclination of the second cross-flow injection nozzles is supplemented by advanced flame location, as permitted by the flame stabilizer device.

[0022] According to an aspect of the present invention, the combustor comprises vortex generators upstream of the second-stage combustion chamber.

[0023] Large vortex generators determine relatively slow mixing, i.e. longer distance and time are required. At full load, however, the flame stabilizer device may be used to set the flame location downstream. So, despite the large fuel flow rate at full load, efficient mixing is achieved. Early self-ignition of the air and fuel mixture is in any case avoided. The vortex generators may have quite simple shape (e.g. prismatic) and manufacturing thereof does not entail substantial problems in relation to both process complexity and cost.

[0024] According to an aspect of the present invention, the flame stabilizer device comprises a full-load flame stabilizer at a downstream end of the elongated streamlined body.

[0025] Stabilizing the full-load flame at a downstream location helps to enhance beneficial effects in terms of increased mixing distance and reduce post-flame residence time, especially at full-load. This is particularly beneficial for the purpose of maintaining low NOx emission at full-load.

[0026] According to an aspect of the present invention, the flame stabilizer device comprises at least one partial-load flame stabilizer between the second cross-flow injection nozzles and the full-load flame stabilizer.

[0027] Flame location may be adjusted during operation in accordance with load requirement. At partial load, flame temperature is low and long post-flame residence time is desired to achieve complete oxidation of carbon contained in the fuel flow and to reduce CO emissions. Thus, it may be of advantage to set the flame location at an upstream position. On the other hand, at full-load it is preferred to have the flame located as downstream as possible in the second-stage combustion chamber, to obtain good air-fuel mixing and reduce production of NOx.

[0028] According to an aspect of the present invention, the flame stabilizer device comprises at least one of:

a downstream electrode system, operable to provide ignition energy in the second-stage combustion chamber at least at one flame location; and
a change in cross section of the second-stage combustion chamber in the axial direction, the change in cross section being configured to cause gas flowing through the second-stage combustion chamber to recirculate at least at one flame location.

[0029] Flame location can be thus effectively and precisely controlled during operation of the gas turbine.

[0030] According to an aspect of the present invention, the first-stage combustor comprises an upstream end-cap and the elongated streamlined body is supported at the upstream end-cap.

[0031] In this manner, extraction of the axial lance injector is favoured and operations of maintenance and maintenance and retrofitting operations are simplified.

[0032] According to an aspect of the present invention, a flow channel is defined in the first-stage combustor and in the second-stage combustor around the elongated streamlined body and a cross section of the flow channel changes gradually along the flow direction in the transition region.

[0033] The smooth transition between the first-stage combustor and the second-stage combustor prevents flow stagnation at the inlet of the second-stage combustion chamber. In this manner, stable flame anchorage is prevented and the flame location may be moved downstream as desired during operation using the flame stabilizer device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The present invention will now be described with reference to the accompanying drawings, which show some non-limitative embodiment thereof, in which:

- Figure 1 is simplified block diagram of a gas turbine assembly;
- Figure 2 is a longitudinal section through a sequential combustor including a second-stage combustor in accordance to an embodiment of the present invention;
- Figure 3 is an enlarged longitudinal section through the second-stage combustor of figure 2;
- Figure 4 is a perspective view of an enlarged detail of the second-stage combustor of figure 2;
- Figure 5 is a longitudinal section through a second-stage combustor in accordance to another embodiment of the present invention;
- Figure 6 is a side view an enlarged detail of the second-stage combustor of figure 5; and

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0035] Figure 1 shows a simplified view of a gas turbine assembly, designated as whole with numeral 1. The gas turbine assembly 1 comprises a compressor section 2, a combustor assembly 3 and a turbine section 5. The compressor section 2 and the turbine section 3 extend along a main axis A. An airflow compressed in the compressor section 2 is mixed with fuel and is burned in the combustor assembly 3, possibly added with dilution air. The burned mixture is then expanded to the turbine section 5 and converted in mechanical power.

[0036] A controller 7, which is configured to define a setpoint for the gas turbine, receives state signals from

sensors 8 and operates the gas turbine through actuators 9 to provide a controlled power output.

[0037] The combustor assembly 3 is a two-stage sequential combustor and comprises a plurality of can combustors 10 arranged around the main axis A. Each of the can combustors 10, one of which is shown in Figure 2, comprises a first-stage combustor 12 and a second-stage combustor 13 sequentially arranged and defining a flow channel 15. An axial injector lance 16 extends from the first-stage combustor 12 into the second-stage combustor 13.

[0038] More specifically, the first-stage combustor 12 comprises a burner 17 and a first-stage combustion chamber 18.

[0039] The second-stage combustor 13, which is illustrated in greater detail in Figure 3, is arranged downstream of the first-stage combustor 12 and includes a second-stage combustion chamber 20 extending along an axial direction and a transition duct 22 for coupling to the turbine section 5, here not shown. Moreover, a flame stabilizer device 23 is provided in the second-stage combustor 13.

[0040] The second-stage combustion chamber 20 extends along an axial direction downstream of the first-stage combustor 12. In one embodiment, the second-stage combustion chamber 20 comprises an outer liner 24 and inner liner 25. The outer liner 24 surrounds the inner liner 25 at a distance therefrom, so that a cooling channel 27 is defined between the outer liner 24 and the inner liner 25. The inner liner 25 delimits the flow channel 15 outwards in the second-stage combustion chamber 20 and forms a transition region 28 that joins the first-stage combustor 12 in such a way to define a smooth transition without steps and possibly sharp edges.

[0041] The axial lance injector 16 comprises an elongated streamlined body 30 that extends in the axial direction from the first-stage combustor 12 into the second-stage combustion chamber 20 through the transition region 28 of the second-stage combustor 13. A downstream end of the elongated streamlined body 30 is arranged at an interface between the second-stage combustion chamber 20 and the transition duct 22. In one embodiment, the first-stage combustor 12 comprises an upstream end-cap 31 and the elongated streamlined body 30 is supported at the upstream end-cap 31 together with the burner 17 (see figure 2).

[0042] The elongated streamlined body 30 and the transition region 28 are configured to prevent gas flowing from the first-stage combustor 12 to the second-stage combustion chamber 20 from recirculating in the transition region 24. In one embodiment, for example, the elongated streamlined body 30 has a smooth ellipsoidal surface tapering towards a downstream end 30a. The surface of the elongated streamlined body 30 may have different smooth shape, however, such as generally oblong, conical or cylindrical. The downstream end 30a of the elongated streamlined body 30 may be truncated.

[0043] A plurality of first cross-flow injection nozzles

32 and a plurality of second cross-flow injection nozzles 33 are provided on the elongated streamlined body 30 at respective axial locations. In one embodiment, the first cross-flow injection nozzles 32 are all at a first axial location and the second cross-flow injection nozzles 33 are all at a second axial location. Moreover, the second cross-flow injection nozzles 33 are axially displaced downstream of the first cross-flow injection nozzles 32. Thus the second cross-flow injection nozzles 33 are arranged nearer to the outlet of the second-stage combustion chamber 20 than the first cross-flow injection nozzles 32.

[0044] The first cross-flow injection nozzles 32 and the second cross-flow injection nozzles 33 are fluidly coupled to a fuel gas supply line 35 and to a fuel oil supply line 36, respectively. Terminal portions of the fuel gas supply line 35 and of a fuel oil supply line 36 are accommodated inside the elongated streamlined body 30. Accordingly, fuel gas and fuel oil may be separately fed to the second-stage combustion chamber 20. In addition, fuel oil is supplied at a location displaced axially downstream with respect to the fuel gas.

[0045] Fuel gas is injected through the first cross-flow injection nozzles 32 in a direction substantially perpendicular to an axis B of the axial lance injector 16. The second cross-flow injection nozzles 33 may be inclined to inject fuel oil in an inclined direction, that form an injection angle α with the axis B of the axial lance injector 16. The angle α may be comprised between 30° and 90°. Hence, due to the orientation of the second cross-flow injection nozzles 33, fuel oil is injected in the second-stage combustion chamber with a non-zero axial component of velocity. Radial and/or inclined sleeves (not shown) may be provided as desired to increase penetration of fuel gas and fuel oil, respectively.

[0046] The flame stabilizer device 23 is arranged downstream of the first cross-flow injection nozzles 32 and of the second cross-flow injection nozzles 33 and is configured to anchor the flame selectively at one of a plurality of flame locations. In one embodiment, the flame stabilizer device 23 is controlled by the controller 7 and comprises a full-load flame stabilizer 40 at a downstream end of the elongated streamlined body 30 and a at least one partial-load flame stabilizer 41 between the second cross-flow injection nozzles 33 and the full-load flame stabilizer 40.

[0047] The full-load flame stabilizer 40 comprises a set of full-load electrodes 40a on the elongated streamlined body 30 and a full-load voltage supply line 40b running inside the elongated streamlined body 30. Through the full-load electrodes 40a, the full-load flame stabilizer 40 produces sparks across the second-stage combustion chamber 20 and causes ignition of the mixture flowing through the second-stage combustion chamber 20 irrespective of temperature conditions and of the self-ignition time of the mixture. In this respect, the self-ignition time of the mixture may be even so long that the mixture would not self-ignite within the second-stage combustion cham-

ber 20, but the full-load flame stabilizer 40 is in any case capable of stabilizing the flame at the downstream end of the elongated streamlined body 30.

[0048] The partial-load flame stabilizer 41 comprises a set of partial-load electrodes 41a on the streamlined body 30 and an upstream voltage supply line 41b. The partial-load electrodes 41a are arranged between the second cross-flow injection nozzles 33 and the full-load flame stabilizer 40.

[0049] The full-load flame stabilizer 40 and the partial-load flame stabilizer 41 are selectively activated by the controller 7 on the basis of the load determined for the gas turbine assembly 1. When the load exceeds a high load threshold, the controller 7 activates the full-load flame stabilizer 40 and deactivates the partial-load flame stabilizer 41, thus setting a current flame location at the downstream end of the elongated streamlined body 30. Instead, when the load is below a low load threshold, the controller 7 activates the partial-load flame stabilizer 41 and deactivates the full-load flame stabilizer 40. Accordingly, the current flame location is moved upstream towards the crossflow injection nozzles 32, 33. The low load threshold does not exceed the high load threshold. In addition, the controller 7 controls an inlet gas temperature of hot gas flowing from the first-stage combustor 12 to the second-stage combustor 13. For the purpose of controlling the inlet gas temperature, the controller 7 may act e.g. on a power split or power ratio of power delivered by the first-stage combustor 12 to power delivered by the second-stage combustor 13, and/or on a flow of dilution air admixed to the hot gas from the first-stage combustor 12 before entering the second-stage combustor 13. The controller 7 uses temperature control to help set a current flame location at an upstream region of the second-stage combustion chamber 20 (by increasing the inlet gas temperature at partial-load, with or without the aid of a flame stabilizer) or at a downstream region of the outlet of the second-stage combustion chamber 20 (by decreasing the inlet gas temperature at full-load; the full-load flame stabilizer 40 causes ignition of the mixture flowing through the second-stage combustion chamber 20 irrespective of temperature conditions, so the self-ignition time of the mixture may be even so long that the mixture would not self-ignite within the second-stage combustion chamber 20).

[0050] Vortex generators 42 may be provided upstream of the second-stage combustion chamber 20 on the inner liner 25, for example in the transition region 32. In one embodiment, the vortex generators 42 are configured to cause flow swirl by adding tangential component of velocity. The vortex generators 42 may be e.g. in the form of prismatic projections (see figure 4 by way of example), baffles, deflectors, lobes superficial roughness of the inner liner 25 or have any other suitable shape.

[0051] In another embodiment of the invention, illustrated in figures 5 and 6, at least one of the first cross-flow injection nozzles, here designated by numeral 132, is axially displaced with respect to the other first cross-

flow injection nozzles 132. For example, the first cross-flow injection nozzles 132 may be staggered in the axial direction and arranged along a helical line on the elongated streamlined body 30 with uniform spacing in the circumferential direction.

[0052] Likewise, at least one of the second cross-flow injection nozzles, here designated by numeral 133, is axially displaced with respect to the other second cross-flow injection nozzles 133. For example, the second cross-flow injection nozzles 133 are staggered in the axial direction and arranged along a helical line on the elongated streamlined body 30 with uniform spacing in the circumferential direction.

Claims

1. A combustor of a gas turbine, comprising:

a first-stage combustor (12) and a second-stage combustor (13), wherein the second-stage combustor (13) is arranged downstream of the first-stage combustor (12) and includes a second-stage combustion chamber (20; 220) extending along an axial direction;
an axial lance injector (16);
a flame stabilizer device (23; 223);
wherein the axial lance injector (16) comprises:

an elongated streamlined body (30) extending in the axial direction from the first-stage combustor (12) into the second-stage combustion chamber (20; 220) through a transition region (28) of the second-stage combustor (13), wherein the elongated streamlined body (30) and the transition region (28) are configured to prevent gas flowing from the first-stage combustor (12) to the second-stage combustion chamber (20; 220) from recirculating in the transition region (28);

a plurality of first cross-flow injection nozzles (32; 132) and a plurality of second cross-flow injection nozzles (33; 133) provided on the elongated streamlined body (30) at respective axial locations;
and wherein the flame stabilizer device (23; 223) is arranged downstream of the first cross-flow injection nozzles (32; 132) and of the second cross-flow injection nozzles (33; 133);

characterized in that the flame stabilizer device (23; 223) comprises a full-load flame stabilizer (40) at a downstream end of the elongated streamlined body (30) and at least one partial-load flame stabilizer (41) between the second cross-flow injection nozzles (33; 133) and the full-load flame sta-

bilizer (40).

2. The combustor of claim 1, wherein the second cross-flow injection nozzles (33; 133) are axially displaced downstream of the first cross-flow injection nozzles (32; 132) .

3. The combustor of claim 2, wherein the first cross-flow injection nozzles (32; 132) are fluidly coupled to a fuel gas supply line (35) and the second cross-flow injection nozzles (33; 133) are fluidly coupled to a fuel oil supply line (36).

4. The combustor of claim 2 or 3, wherein at least one of the first cross-flow injection nozzles (32; 132) is axially displaced with respect to the other first cross-flow injection nozzles (32; 132).

5. The combustor of any one of claims 2 to 4, wherein the first cross-flow injection nozzles (32; 132) are staggered in the axial direction.

6. The combustor of any one of claims 2 to 5, wherein at least one of the second cross-flow injection nozzles (33; 133) is axially displaced with respect to the other second cross-flow injection nozzles (33; 133).

7. The combustor of any one of claims 2 to 6, wherein the second cross-flow injection nozzles (33; 133) are staggered in the axial direction.

8. The combustor of any one of the preceding claims, wherein the second cross-flow injection nozzles (33; 133) are oriented at such an angle (α) that fuel oil is injected in the second-stage combustion chamber (20; 220) with a non-zero axial component of velocity.

9. The combustor of any one of the preceding claims, comprising vortex generators (42) upstream of the second-stage combustion chamber (20; 220).

10. The combustor of any one of the preceding claims, wherein the flame stabilizer device (23; 223) comprises at least one of:

a downstream electrode system (40a, 41a), operable to provide ignition energy in the second-stage combustion chamber (20; 220) at least at one flame location; and

a change in cross section of the second-stage combustion chamber (20; 220) in the axial direction, the change in cross section being configured to cause gas flowing through the second-stage combustion chamber (20; 220) to recirculate at least at one flame location.

11. The combustor of any one of the preceding claims,

wherein the first-stage combustor (12) comprises an upstream end-cap (31) and the elongated streamlined body (30) is supported at the upstream end-cap (31).

12. The combustor of any one of the preceding claims, wherein a flow channel is defined in the first-stage combustor (12) and in the second-stage combustor (13) around the elongated streamlined body (30) and a cross section of the flow channel changes gradually along the flow direction in the transition region (28).
13. A gas turbine assembly comprising a compressor section (2), a combustor assembly (3), a turbine section (5) and a controller (7), configured to operate the gas turbine assembly to provide a controlled power output, wherein the combustor assembly (3) includes a combustor according to any one of the preceding claims and the controller (7) is further configured to control a hot gas temperature of hot gas flowing from the first-stage combustor (12) to the second-stage combustor (13) so that the hot gas temperature is higher at partial-load and lower at full-load.

Patentansprüche

1. Brenneinrichtung einer Gasturbine, umfassend:

eine Erste-Stufe-Brenneinrichtung (12) und eine Zweite-Stufe-Brenneinrichtung (13), wobei die Zweite-Stufe-Brenneinrichtung (13) stromabwärts der Erste-Stufe-Brenneinrichtung (12) angeordnet ist und eine Zweite-Stufe-Brennkammer (20; 220) aufweist, die sich entlang einer axialen Richtung erstreckt; einen axialen Lanzeninjektor (16); eine Flammenstabilisierungsvorrichtung (23; 223); wobei der axiale Lanzeninjektor (16) umfasst:

einen langgestreckten stromlinienförmigen Körper (30), der sich in der axialen Richtung von der Erste-Stufe-Brenneinrichtung (12) in die Zweite-Stufe-Brennkammer (20; 220) durch einen Übergangsbereich (28) der Zweite-Stufe-Brenneinrichtung (13) erstreckt, wobei der langgestreckte stromlinienförmige Körper (30) und der Übergangsbereich (28) dazu konfiguriert sind, zu verhindern, dass Gas, das von der Erste-Stufe-Brenneinrichtung (12) zu der Zweite-Stufe-Brennkammer (20; 220) strömt, in dem Übergangsbereich (28) rezirkuliert; mehrere erste Querstrom-Injektionsdüsen (32; 132) und mehrere zweite Querstrom-

Injektionsdüsen (33; 133), die an dem langgestreckten stromlinienförmigen Körper (30) an entsprechenden axialen Stellen vorgesehen sind;

und wobei die Flammenstabilisierungsvorrichtung (23; 223) stromabwärts der ersten Querstrom-Injektionsdüsen (32; 132) und der zweiten Querstrom-Injektionsdüsen (33; 133) angeordnet ist;

dadurch gekennzeichnet, dass die Flammenstabilisierungsvorrichtung (23; 223) einen Vollastflammenstabilisator (40) an einem stromabwärts gelegenen Ende des langgestreckten stromlinienförmigen Körpers (30) und wenigstens einen Teillastflammenstabilisator (41) zwischen den zweiten Querstrom-Injektionsdüsen (33; 133) und dem Vollastflammenstabilisator (40) umfasst.

2. Brenneinrichtung nach Anspruch 1, wobei die zweiten Querstrom-Injektionsdüsen (33; 133) von den ersten Querstrom-Injektionsdüsen (32; 132) axial stromabwärts verschoben sind.
3. Brenneinrichtung nach Anspruch 2, wobei die ersten Querstrom-Injektionsdüsen (32; 132) strömungstechnisch mit einer Brennstoffgas-Zuführungsleitung (35) verbunden sind und die zweiten Querstrom-Injektionsdüsen (33; 133) strömungstechnisch mit einer Brennstofföl-Zuführungsleitung (36) verbunden sind.
4. Brenneinrichtung nach Anspruch 2 oder 3, wobei wenigstens eine der ersten Querstrom-Injektionsdüsen (32; 132) in Bezug auf die anderen ersten Querstrom-Injektionsdüsen (32; 132) axial verschoben ist.
5. Brenneinrichtung nach einem der Ansprüche 2 bis 4, wobei die ersten Querstrom-Injektionsdüsen (32; 132) in axialer Richtung gestaffelt sind.
6. Brenneinrichtung nach einem der Ansprüche 2 bis 5, wobei wenigstens eine der zweiten Querstrom-Injektionsdüsen (33; 133) in Bezug auf die anderen zweiten Querstrom-Injektionsdüsen (33; 133) axial verschoben ist.
7. Die Brenneinrichtung nach einem der Ansprüche 2 bis 6, wobei die zweiten Querstrom-Injektionsdüsen (33; 133) in axialer Richtung gestaffelt sind.
8. Brenneinrichtung nach einem der vorangehenden Ansprüche, wobei die zweiten Querstrom-Injektionsdüsen (33; 133) in einem solchen Winkel (α) ausgerichtet sind, dass Brennstofföl mit einer axialen Geschwindigkeitskomponente ungleich Null in die

Zweite-Stufe-Brennkammer (20; 220) injiziert wird.

9. Brenneinrichtung nach einem der vorangehenden Ansprüche, die Wirbelgeneratoren (42) stromaufwärts der Zweite-Stufe-Brennkammer (20; 220) umfasst. 5
10. Brenneinrichtung nach einem der vorangehenden Ansprüche, wobei die Flammenstabilisierungsvorrichtung (23; 223) wenigstens eines umfasst von: 10
 - einem stromabwärts gelegenen Elektrodensystem (40a, 41a), das so betreibbar ist, dass es Zündenergie in der Zweite-Stufe-Brennkammer (20; 220) an wenigstens einer Flammenstelle bereitstellt; und 15
 - einer Änderung des Querschnitts der Zweite-Stufe-Brennkammer (20; 220) in axialer Richtung, wobei die Änderung des Querschnitts dazu konfiguriert ist, das durch die Zweite-Stufe-Brennkammer (20; 220) strömende Gas zu veranlassen, an wenigstens einer Flammenstelle zu rezirkulieren. 20
11. Brenneinrichtung nach einem der vorangehenden Ansprüche, wobei die Erste-Stufe-Brenneinrichtung (12) eine stromaufwärts gelegene Endkappe (31) umfasst und der langgestreckte stromlinienförmige Körper (30) an der stromaufwärts gelegenen Endkappe (31) abgestützt ist. 25 30
12. Brenneinrichtung nach einem der vorangehenden Ansprüche, wobei in der Erste-Stufe-Brenneinrichtung (12) und in der Zweite-Stufe-Brenneinrichtung (13) um den langgestreckten stromlinienförmigen Körper (30) herum ein Strömungskanal definiert ist und sich ein Querschnitt des Strömungskanals im Übergangsbereich (28) entlang der Strömungsrichtung allmählich ändert. 35 40
13. Gasturbinenanordnung, umfassend eine Verdichtersektion (2), eine Brenneinrichtungs-Anordnung (3), eine Turbinensektion (5) und eine Steuereinrichtung (7), die dazu konfiguriert ist, die Gasturbinenanordnung zu betreiben, um eine gesteuerte/geregelte Leistungsabgabe bereitzustellen, wobei die Brenneinrichtungs-Anordnung (3) eine Brenneinrichtung nach einem der vorangehenden Ansprüche aufweist und die Steuereinrichtung (7) ferner dazu konfiguriert ist, eine Heißgastemperatur des von der Erste-Stufe-Brenneinrichtung (12) zu der Zweite-Stufe-Brenneinrichtung (13) strömenden Heißgases so zu steuern/regeln, dass die Heißgastemperatur bei Teillast höher und bei Volllast niedriger ist. 45 50

Revendications

1. Chambre de combustion d'une turbine à gaz, comprenant :
 - une chambre de combustion de premier étage (12) et une chambre de combustion de second étage (13), dans laquelle la chambre de combustion de second étage (13) est agencée en aval de la chambre de combustion de premier étage (12) et comprend une chambre de combustion de second étage (20 ; 220) s'étendant le long d'une direction axiale ;
 - un injecteur à lance axiale (16) ;
 - un dispositif de stabilisation de la flamme (23 ; 223) ;
 - dans laquelle l'injecteur à lance axiale (16) comprend :
 - un corps profilé allongé (30) s'étendant dans la direction axiale depuis la chambre de combustion de premier étage (12) dans la chambre de combustion de second étage (20 ; 220) à travers une région de transition (28) de la chambre de combustion de second étage (13), dans laquelle le corps profilé allongé (30) et la région de transition (28) sont configurés pour empêcher le gaz s'écoulant de la chambre de combustion de premier étage (12) vers la chambre de combustion de second étage (20 ; 220) de recirculer dans la région de transition (28) ;
 - une pluralité de premières buses d'injection à écoulements croisés (32 ; 132) et une pluralité de secondes buses d'injection à écoulements croisés (33 ; 133) prévues sur le corps profilé allongé (30) à des emplacements axiaux respectifs ;
 - et dans laquelle le dispositif de stabilisation de la flamme (23 ; 223) est agencé en aval des premières buses d'injection à écoulements croisés (32 ; 132) et des secondes buses d'injection à écoulements croisés (33 ; 133) ;
 - caractérisée en ce que** le dispositif de stabilisation de la flamme (23 ; 223) comprend un stabilisateur de flamme à pleine charge (40) à une extrémité d'aval du corps profilé allongé (30) et au moins un stabilisateur de flamme à charge partielle (41) entre les secondes buses d'injection à écoulements croisés (33 ; 133) et le stabilisateur de flamme à pleine charge (40).
2. Chambre de combustion selon la revendication 1, dans laquelle les secondes buses d'injection à écoulements croisés (33 ; 133) sont déplacées axialement en aval des premières buses d'injection à écou-

lements croisés (32 ; 132).

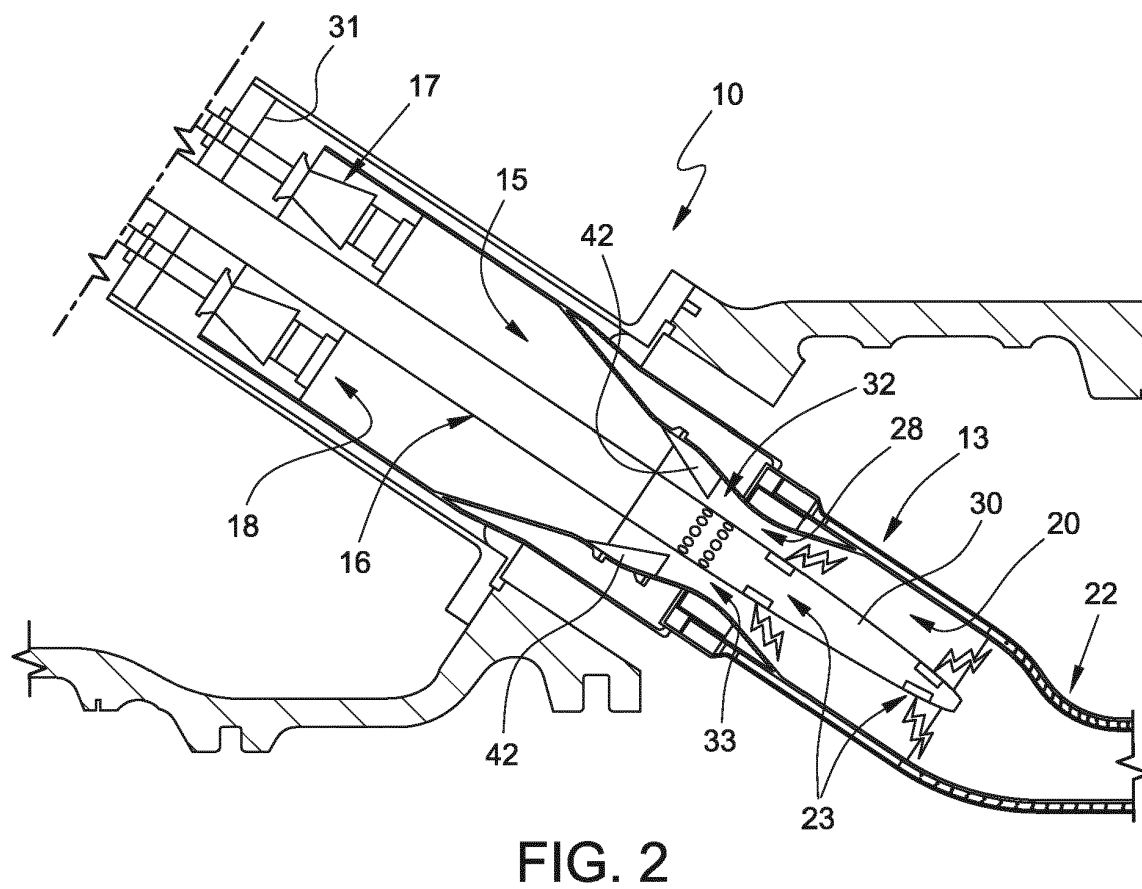
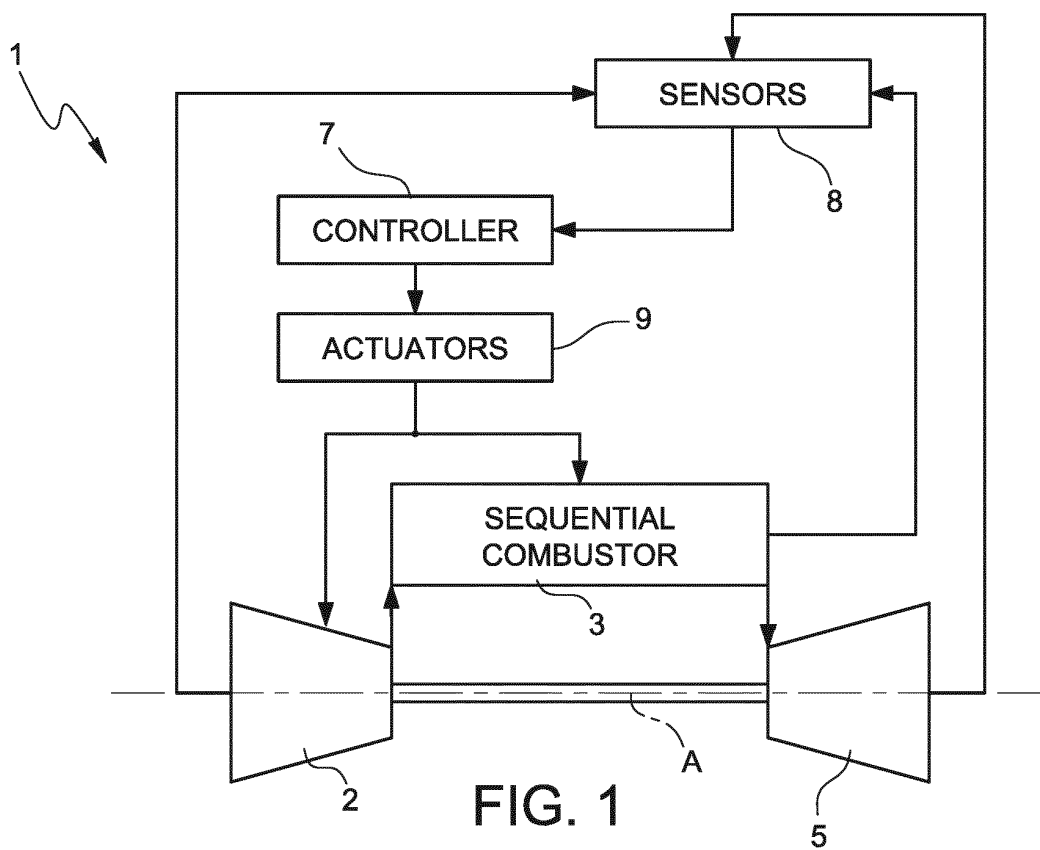
3. Chambre de combustion selon la revendication 2, dans laquelle les premières buses d'injection à écoulements croisés (32 ; 132) sont couplées de manière fluide à une conduite d'alimentation en gaz combustible (35) et les secondes buses d'injection à écoulements croisés (33 ; 133) sont couplées de manière fluide à une conduite d'alimentation en fioul (36). 5
4. Chambre de combustion selon la revendication 2 ou 3, dans laquelle au moins une des premières buses d'injection à écoulements croisés (32 ; 132) est déplacée axialement par rapport aux autres premières buses d'injection à écoulements croisés (32 ; 132). 10
5. Chambre de combustion selon l'une quelconque des revendications 2 à 4, dans laquelle les premières buses d'injection à écoulements croisés (32 ; 132) sont décalées dans la direction axiale. 15
6. Chambre de combustion selon l'une quelconque des revendications 2 à 5, dans laquelle au moins l'une des secondes buses d'injection à écoulements croisés (33 ; 133) est déplacée axialement par rapport aux autres secondes buses d'injection à écoulements croisés (33 ; 133). 20
7. Chambre de combustion selon l'une quelconque des revendications 2 à 6, dans laquelle les secondes buses d'injection à écoulements croisés (33 ; 133) sont décalées dans la direction axiale. 25
8. Chambre de combustion selon l'une quelconque des revendications précédentes, dans laquelle les secondes buses d'injection à écoulements croisés (33 ; 133) sont orientées selon un angle (a) tel que le fioul est injecté dans la chambre de combustion de second étage (20 ; 220) avec une composante de vitesse axiale non nulle. 30
9. Chambre de combustion selon l'une quelconque des revendications précédentes, comprenant des générateurs de tourbillons (42) en amont de la chambre de combustion de second étage (20 ; 220). 35
10. Chambre de combustion selon l'une quelconque des revendications précédentes, dans laquelle le dispositif de stabilisation de la flamme (23 ; 223) comprend au moins l'un des éléments suivants : 40

un système d'électrodes en aval (40a, 41a), pouvant fonctionner pour fournir une énergie d'allumage dans la chambre de combustion de second étage (20 ; 220) au moins à un emplacement de flamme ; et 45

une modification de la section transversale de la chambre de combustion de second étage

(20 ; 220) dans la direction axiale, la modification de la section transversale étant configurée pour amener le gaz s'écoulant à travers la chambre de combustion de second étage (20 ; 220) à recirculer au moins à un emplacement de flamme.

11. Chambre de combustion selon l'une quelconque des revendications précédentes, dans laquelle la chambre de combustion de premier étage (12) comprend un bouchon d'extrémité amont (31) et le corps profilé allongé (30) est supporté au niveau du bouchon d'extrémité amont (31). 50
12. Chambre de combustion selon l'une quelconque des revendications précédentes, dans laquelle un canal d'écoulement est défini dans la chambre de combustion de premier étage (12) et dans la chambre de combustion de second étage (13) autour du corps profilé allongé (30) et une section transversale du canal d'écoulement change progressivement le long de la direction d'écoulement dans la région de transition (28). 55
13. Ensemble de turbine à gaz comprenant une section de compresseur (2), un ensemble de chambre de combustion (3), une section de turbine (5) et un dispositif de commande (7), configuré pour faire fonctionner l'ensemble de turbine à gaz pour fournir une puissance de sortie contrôlée, dans lequel l'ensemble de chambre de combustion (3) comprend une chambre de combustion selon l'une quelconque des revendications précédentes et le dispositif de commande (7) est en outre configuré pour contrôler une température de gaz chaud du gaz chaud s'écoulant de la chambre de combustion de premier étage (12) à la chambre de combustion de second étage (13) de sorte que la température du gaz chaud soit plus élevée à charge partielle et plus faible à pleine charge. 60



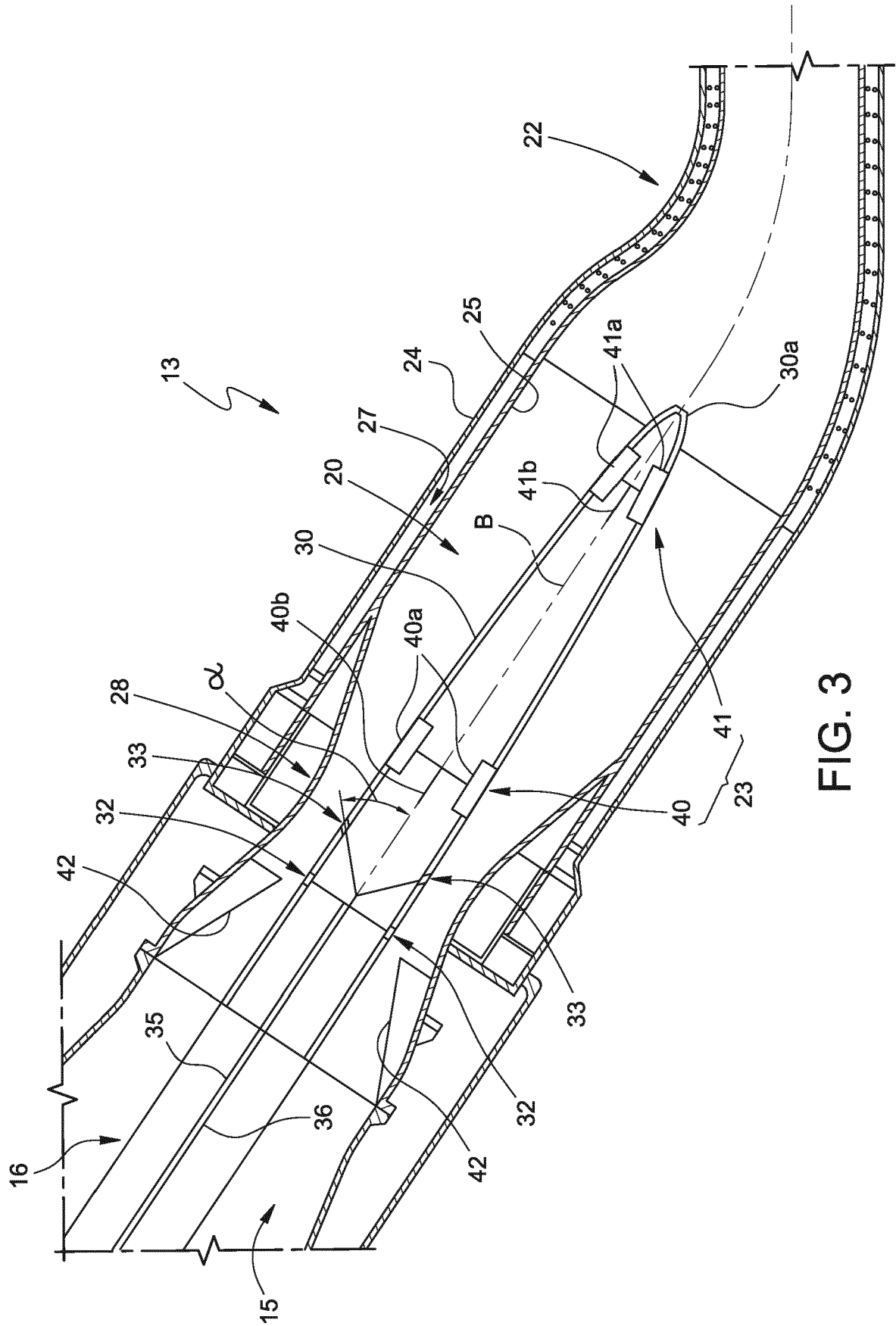


FIG. 3

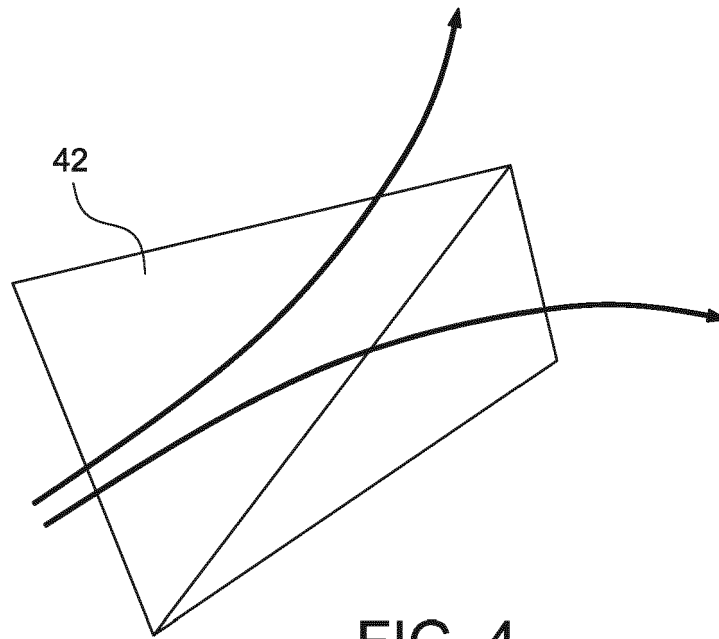


FIG. 4

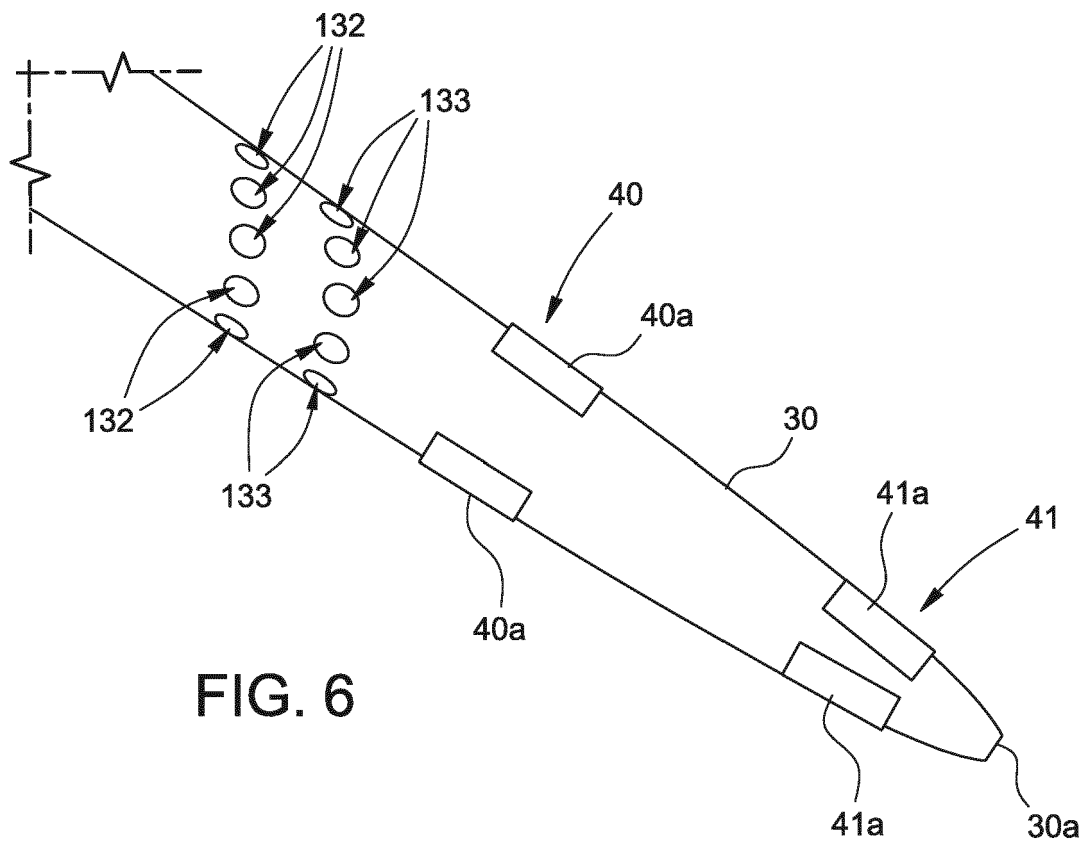


FIG. 6

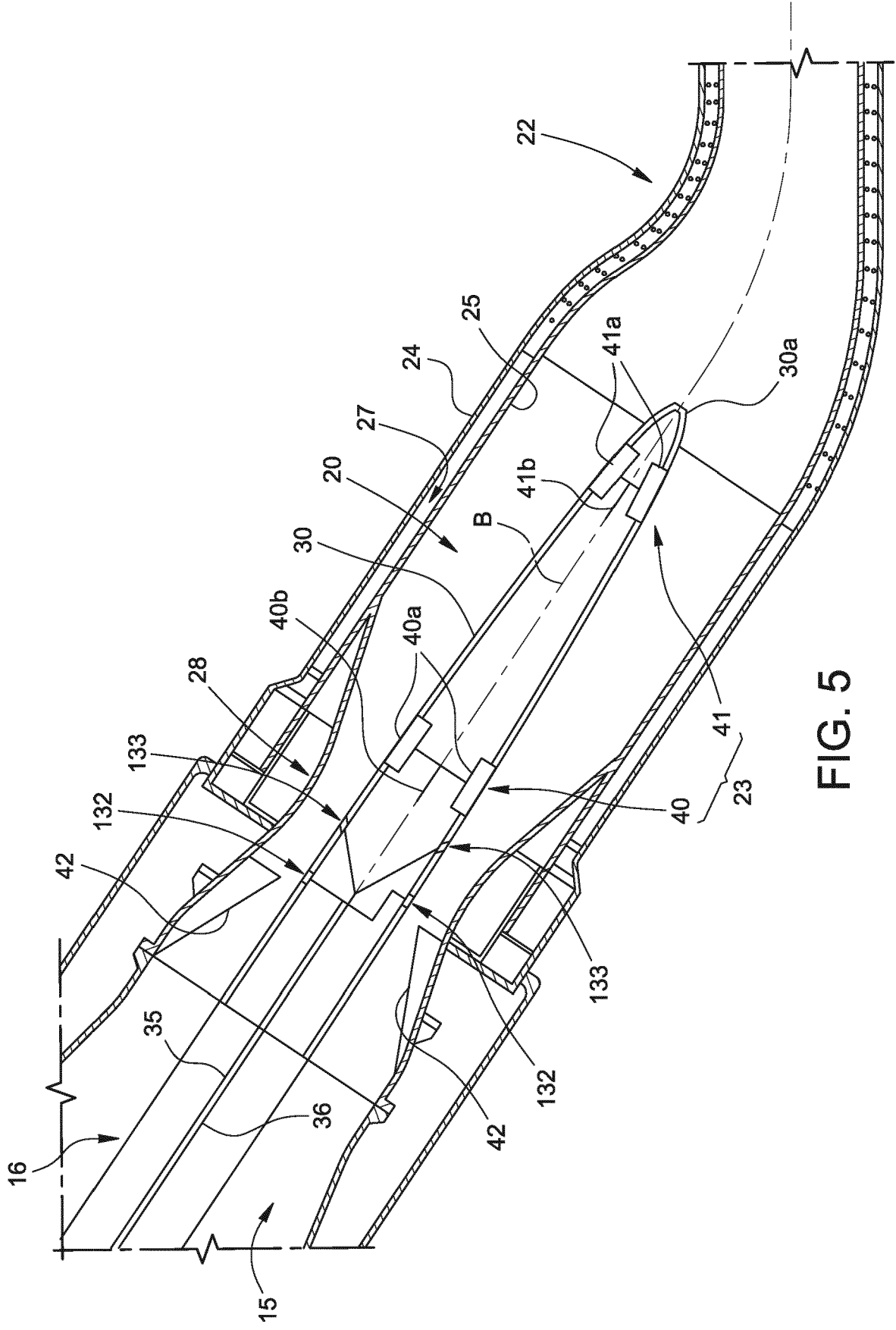


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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