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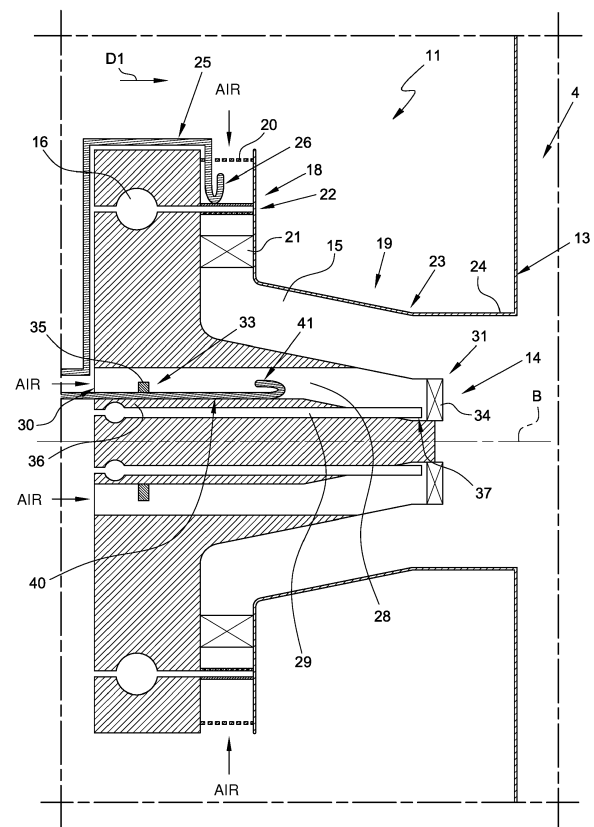
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(54) **BURNER ASSEMBLY FOR A GAS TURBINE PLANT, GAS TURBINE PLANT COMPRISING SAID BURNER ASSEMBLY AND METHOD FOR OPERATING SAID PLANT**

(57) A burner assembly for a combustion chamber (4) of a gas turbine plant (1) extending along an axis (B) is provided with a main burner (13), which is supplied with a main air flow rate ( $Q_{Ap}$ ) and with a main fuel flow rate ( $Q_{Cp}$ ) and is configured to create a main combustion area; a secondary burner (14), which is supplied with a secondary air flow rate ( $Q_{As}$ ) and a secondary fuel flow rate ( $Q_{Cs}$ ) and is configured to create at least one secondary combustion area; the secondary burner (14) extending substantially along the axis (B) and the main burner (13) extending around the secondary burner (14) parallel to the axis (B); the main burner (13) being provided with at least one main detecting device (25; 124; 224) configured to detect the current main air flow rate ( $Q_{Ap}$ ); the secondary burner (14) being provided with at least one secondary detecting device (40; 130) configured to detect the current secondary air flow rate ( $Q_{As}$ ).



**FIG. 2**

## Description

**[0001]** The present invention relates to a burner assembly for a gas turbine plant, to a gas turbine plant comprising said burner assembly and to a method for operating said plant. Gas turbine plants of known type generally comprise a compressor, a gas turbine and a combustion chamber.

**[0002]** The combustion chamber comprises at least one burner assembly supplied with fuel and combustion air.

**[0003]** The combustion air is normally air coming from the compressor.

**[0004]** The ratio between the amount of fuel and of combustion air supplied to the burner assembly is a quite relevant parameter because it affects both the combustion stability and the amounts of pollutants emitted by the plant.

**[0005]** It is therefore essential that this ratio be adequately controlled.

**[0006]** Usually, in the gas turbine plants only the amount of fuel supplied to the burner assembly is controlled. The fuel flow rate supplied to the burners is in fact monitored by known detection techniques during the operation of the burner assembly.

**[0007]** However, currently available techniques do not allow a reliable measurement of the combustion air flow rate supplied to the burner assembly during the operation of the burner assembly.

**[0008]** Consequently, the known techniques cannot adequately control the ratio between the amount of fuel and combustion air supplied to the burner assembly.

**[0009]** It is therefore an object of the present invention to provide a burner assembly, which allows overcoming the aforesaid drawbacks in a simple and inexpensive manner, both from the functional point of view and from the structural point of view. In particular, it is an object of the present invention to provide a burner assembly that is configured to allow a reliable measurement of the combustion air flow rate supplied thereto.

**[0010]** According to these objects, the present invention relates to a burner assembly for a combustion chamber of a gas turbine plant extending along an axis comprising:

a main burner, which is supplied with a main air flow rate and with a main fuel flow rate and is configured to create a main combustion area;

a secondary burner, which is supplied with a secondary air flow rate and with a secondary fuel flow rate and is configured to create at least one secondary combustion area;

the secondary burner extending substantially along the axis and the main burner extending around the secondary burner parallel to the axis;

the main burner being provided with at least one main detecting device configured to detect the current main air flow rate;

the secondary burner being provided with at least one secondary detecting device configured to detect the current secondary air flow rate.

**[0011]** Thanks to the presence of the main detecting device and of the secondary detecting device, it is possible to detect the total air flow rate supplied to the burner assembly and even the distribution of the air flow rate between the main burner and the secondary burner.

**[0012]** Therefore, this not only allows controlling and optimizing the ratio between fuel and combustion air supplied to the burner assembly, but it also allows optimizing this ratio for each individual burner of the burner assembly. This allows a targeted control of the stability of the main combustion area and of the secondary combustion area.

**[0013]** It is a further object of the present invention to provide a gas turbine plant that allows optimizing the combustion stability, at the same time guaranteeing a level of emissions that does not exceed the legal limits.

**[0014]** According to these objects, the present invention relates to a gas turbine plant for the production of electrical energy comprising a compressor, a gas turbine, a combustion chamber provided with at least one burner assembly as claimed in any one of the claims from 1 to 10.

**[0015]** Finally, it is a further object of the present invention to provide a method for operating a gas turbine plant for the production of electrical energy that can optimize the combustion stability and at the same time guarantee a level of emissions that does not exceed the legal limits.

**[0016]** According to these aims, the present invention relates to a method for operating a gas turbine plant for the production of electrical energy provided with at least one burner assembly comprising a main burner and a secondary burner; the method comprising the steps of:

- supplying a main air flow rate and a main fuel flow rate to the main burner to create at least one main combustion area;
- supplying a secondary air flow rate and a secondary fuel flow rate to the secondary burner to create at least one secondary combustion area;
- detecting the current main air flow rate supplied to the main burner;
- detecting the current secondary air flow rate supplied to the secondary burner;
- adjusting the main fuel flow rate and the secondary fuel flow rate based on the current main air flow rate and on the current secondary air flow rate.

**[0017]** Further characteristics and advantages of the present invention will become apparent from the following description of a non-limiting embodiment thereof, with reference to the figures of the accompanying drawings, in which:

- Figure 1 is a schematic representation of a gas tur-

bine plant for the production of electrical energy according to the present invention;

- Figure 2 is a schematic side view, with parts in section and parts removed for clarity's sake, of a burner assembly according to the present invention;
- Figure 3 is a schematic side view, with parts in section and parts removed for clarity's sake, of a variant of a burner assembly according to the present invention;
- Figure 4 is a schematic side view, with parts in section and parts removed for clarity's sake, of a further variant of a burner assembly according to the present invention.

**[0018]** Figure 1 indicates with the reference number 1 a plant for the production of electrical energy comprising a gas turbine 2 extending along an axis A, a compressor 3, a combustion chamber 4, a fuel supply assembly 6 for supplying fuel to the combustion chamber 4, a generator 8, which transforms the mechanical power supplied by the gas turbine 2 into electrical power, and a control device 9.

**[0019]** The combustion chamber 4 comprises a plurality of seats 10, each of which is adapted to be engaged by a respective burner assembly 11. The seats 10 are arranged along a circular path near a peripheral edge of the combustion chamber 4. In the non-limiting example here described and illustrated, the combustion chamber 4 is of the annular type and the seats 10 and the burner assemblies 11 are twenty-four.

**[0020]** With reference to Figure 2, each burner assembly 11 extends along an axis B and comprises a main burner 13 and a secondary burner 14.

**[0021]** The main burner 13 and the secondary burner 14 are supplied with air coming from the compressor 3 and with fuel coming from the fuel supply assembly 6.

**[0022]** The air and the fuel are supplied along a supply direction D1 directed towards the inside of the combustion chamber 4.

**[0023]** The secondary burner 14 extends substantially along the axis B, while the main burner 13 extends around the secondary burner 14 parallel to the axis B.

**[0024]** The main burner 13 is supplied with an air/fuel mixture and is configured so as to define a main combustion area, also generally referred to as the "main flame" (not shown for the sake of simplicity in the attached figures). The structure of the main burner 13 is such to create a preferably premixed main flame.

**[0025]** In detail, the main burner 13 is supplied with a main air flow rate QAp and with a main fuel flow rate QCp (Figure 1).

**[0026]** In particular, the main burner 13 comprises a main air supply duct 15 and a main fuel supply duct 16.

**[0027]** The main air supply duct 15 is an annular duct extending around the axis B, which comprises a radial portion 18 and an axial portion 19.

**[0028]** The radial portion 18 is in communication with the inside of a casing (not shown), which is supplied with

air coming from the compressor 3.

**[0029]** The radial portion 18 is provided with a grid 20, which is preferably arranged substantially at the inlet of the radial portion 18, and with a main swirler 21, preferably arranged downstream of the grid 20 along the air flow direction.

**[0030]** A plurality of aligned nozzles 22 supplied by the main fuel supply duct 16 are arranged between the grid 20 and the main swirler 21.

**[0031]** The grid 20 evens the air flow passing through it due to the loss of load that it determines and avoids asymmetries in the air distribution.

**[0032]** The main swirler 21, in turn, favours a mixing between the air and the fuel injected into the main air supply duct 15 by the nozzles 22. The main swirler 21 in fact favours the generation of swirls to facilitate the mixing of air and fuel. In particular, the main swirler 21 imparts a rotation to the mixture passing through it in order to stabilize the created flame and to allow a better control of the position of the flame inside the combustion chamber 4.

**[0033]** The axial portion 19 is substantially defined by a truncated conical duct converging towards the combustion chamber 4. In other words, the axial portion 19 has a decreasing radial height in the supply direction D1.

**[0034]** At an end portion 23 of the axial portion 19, the main air supply duct 15 is provided with a cylindrical outlet element 24 (usually called "CBO = cylindrical burner outlet"), which extends axially and has a constant radial height.

**[0035]** The main fuel supply duct 16 extends parallel to the axis B and ends with the plurality of nozzles 22, which directly face the main air supply duct 15, as previously described.

**[0036]** The main burner 13 is provided with a main detecting device 25, which is configured to detect the main air flow rate QAp supplied to the main burner 13 through the main air supply duct 15.

**[0037]** The main detecting device 25 (schematically shown in Figure 2) is a Pitot tube provided with a main detecting end 26.

**[0038]** The main detecting end 25 is arranged upstream of the plurality of nozzles 22. In this way, the main detecting end 25 detects the fluid flow rate passing through the main air supply duct 15 before the fuel is injected therein.

**[0039]** Preferably, the main detecting end 26 is arranged between the grid 20 and the plurality of fuel supply nozzles 22.

**[0040]** In this way, the main detecting end 26, arranged downstream of the grid 20, detects the main air flow rate QAp in an air flow, made substantially even and not asymmetrical by the grid 20.

**[0041]** A variant not shown provides that the main detecting end 26 is arranged downstream of the main swirler 21. In this case, the known fuel flow rate supplied to the main burner 13 must be subtracted from the fuel flow rate detected by the main detecting device 25.

**[0042]** Preferably, the main detecting end 26 is countercurrently oriented, so that the air flow impacts directly against the main detecting end 26.

**[0043]** Preferably, the used Pitot tube is of the multihole type.

**[0044]** More preferably, the used Pitot tube is of the five-hole type. A hole (not shown in the attached figures) is arranged on the main detecting end 26 to detect the pressure substantially along the flow path and in a direction contrary to the flow, while four holes (not shown in the attached figures) are arranged in succession along the side wall of the tube to detect the pressure signal in a direction substantially orthogonal to the flow. The pressure signals detected through the four successive holes are averaged to minimize the oscillations due to turbulence phenomena. The differential pressure between the pressure value detected through the first hole and the averaged value of the values detected through the successive holes is proportional to the flow rate.

**[0045]** The secondary burner 14 is supplied with an air/fuel mixture and is configured to define a secondary combustion area, also generically referred to as a "secondary flame" (not shown for the sake of simplicity in the attached figures).

**[0046]** The structure of the secondary burner 14 is such to create a preferably diffusive or partially premixed secondary flame, which plays a stabilizing role for the main flame. In detail, the secondary burner 14 is supplied with a secondary air flow rate QAs and with a secondary fuel flow rate QCs (Figure 1).

**[0047]** In particular, the secondary burner 14 comprises a secondary air supply duct 28 and a secondary fuel supply duct 29.

**[0048]** The secondary air supply duct 28 is an annular duct extending around the axis B in communication with the inside of the casing (not shown) supplied with air coming from the compressor 3.

**[0049]** The secondary air supply duct 28 is an annular duct provided with an inlet 30 in communication with the inside of the casing and with an outlet 31 leading to the combustion chamber 4.

**[0050]** The secondary air supply duct 28 is further provided with a section narrowing 33, arranged substantially near the inlet 30, and with a secondary swirler 34, arranged downstream of the section narrowing 33 along the direction D1. Preferably, the secondary swirler 34 is arranged at the outlet 31.

**[0051]** Preferably, the section narrowing 33 is defined by a ring 35 coupled to the inner surface of the cylindrical wall 36, which defines the secondary air supply duct 28 and which is proximal to the B axis.

**[0052]** A variant provides that the burner assembly is configured so that the section narrowing is defined by a ring coupled to the inner surface of the cylindrical wall, which defines the secondary air supply duct and which is distal to the axis B.

**[0053]** The section narrowing 33 generates a disturbance in the air flow which can determine a defined ve-

locity profile at the swirler. Moreover, the sizing of the section narrowing 33 substantially regulates the amount of air that can be supplied to the secondary air supply duct 28.

**[0054]** The secondary fuel supply duct 29 is an annular duct, which extends parallel to the axis B and is surrounded by the secondary air supply duct 28.

**[0055]** The secondary fuel supply duct 29 is provided with an outlet 37, which directly leads to the secondary air supply duct 28. In particular, the outlet 37 leads near the outlet 31 of the secondary air supply duct 28, upstream of the secondary swirler 34. In this way, the supplied fuel is suitably mixed with the air thanks to the secondary swirler 34.

**[0056]** The secondary burner 14 is further provided with a secondary detecting device 40, which is configured to detect the secondary air flow rate QAs supplied to the secondary burner 14 through the secondary air supply duct 28.

**[0057]** The secondary detecting device 40 is a Pitot tube (schematically shown in Figure 2) provided with a secondary detecting end 41.

**[0058]** The secondary detecting end 41 is arranged upstream of the swirler 34. In the non-limiting example here described and illustrated, the secondary detecting end 41 is also arranged upstream of the outlet 37.

**[0059]** Preferably, the secondary detecting end 41 is also arranged downstream of the section narrowing 33.

**[0060]** In other words, the secondary detecting end 41 is arranged along the secondary air supply duct 28 between the section narrowing 33 and the secondary swirler 34 of the secondary fuel supply duct 29.

**[0061]** Preferably, the secondary detecting end 41 is arranged along the secondary air supply duct 28 between the section narrowing 33 and the secondary swirler 34, in a position where the flow has substantially lost its own swirling component due to the section narrowing 33 and has a substantially even and symmetrical profile.

**[0062]** Preferably, the secondary detecting end 41 is arranged in a substantially middle position between the section narrowing 33 and the secondary swirler 34.

**[0063]** In this way, the secondary detecting end 41 detects the secondary air flow rate QAs in a substantially even and non-asymmetrical airflow.

**[0064]** Preferably, the secondary detecting end 41 is countercurrently oriented, so that the air flow impacts directly against the secondary detecting end 41.

**[0065]** Preferably, the Pitot tube used is of the multihole type.

**[0066]** More preferably, the Pitot tube is a five-hole type, the same type described with regard to the main detecting device 25.

**[0067]** The burner assembly 11 is further provided with at least one temperature sensor (not shown in the attached figures), which is arranged near the inlet of the main air supply duct 15 and/or the inlet of the secondary air supply duct 28 to detect the temperature of the air supplied to the main burner 13 and to the secondary burn-

er 14.

**[0068]** The values of the primary air flow rate QAp and of the secondary air flow rate QAs respectively detected by the main detecting device 25 and by the secondary detecting device 40 are supplied to the control device 9.

**[0069]** Preferably, also the temperature value of the air supplied to the main burner 13 and to the secondary burner 14 is sent to the control device 9.

**[0070]** The control device 9 is configured to regulate the main fuel flow rate QCp and the secondary fuel flow rate QCs respectively supplied to the main burner 13 and to the secondary burner 14 based on the detected main air flow rate QAp values and on the detected secondary air flow rate QAs values in order to optimize combustion-related parameters.

**[0071]** For example, the control device 9 can regulate the main fuel flow rate QCp and the secondary fuel flow rate QCs so as to obtain a specific trend of the air/fuel ratio for the main burner 13 and for the secondary burner 14 of the burner assembly 11.

**[0072]** A richer combustion (fuel/combustion air ratio higher than an optimal reference value) leads to greater flame stability, but also to higher polluting emissions. On the other hand, a poorer combustion (fuel/combustion ratio lower than the optimal reference value) leads to a lower flame stability, but also to lower polluting emissions.

**[0073]** Moreover, in the burner assembly 11, the premixed main flame is supported by the diffusive or partially premixed secondary flame. Therefore, a correct balance between these types of flame allows maintaining a combustion devoid of thermoacoustic instability and with a limited production of pollutants such as CO and NOx.

**[0074]** Moreover, this balance can also depend on the thermal load of the plant 1. When the plant 1 operates at low loads, in particular CO emissions must be kept under control, whereas at high loads in particular NOx emissions must be kept under control.

**[0075]** The control device 9 according to the present invention is configured to regulate the main fuel flow rate QCp and the secondary fuel flow rate QCs during the operation of the plant 1 so that the fuel/air ratio is always optimized to stabilize the combustion and, at the same time, to maintain the level of polluting emissions below the legal limits in any load condition of the plant 1.

**[0076]** This is made possible thanks to the on-line detection of the main air flow rate QAp and of the secondary air flow rate QAs for the burner assembly 11 during the operation of the plant 1.

**[0077]** In fact, errors during the construction phase, machining errors, variations in the section of the main air supply duct 15 and of the secondary air supply duct 28 due to accumulation of dirt, etc. may cause an unexpected variation of the main air flow rate QAp and of the secondary air flow rate QAs with respect to what defined in the design phase.

**[0078]** Such variations can negatively and unexpectedly affect the combustion stability and the polluting

emissions.

**[0079]** A continuous monitoring of the main air flow rate QAp and of the secondary air flow rate QAs allows detecting these variations and correcting the combustion parameters to optimize their yield.

**[0080]** Once having learnt the distribution of combustion air between the main air supply duct 15, which creates the premixed main flame, and the secondary air supply duct 28, which creates the most stable and most polluting flame part, the control device 9 can regulate the main fuel flow rate QCp and the secondary fuel flow rate QCs to have the correct stoichiometric ratio in the main flame and in the secondary flame according to the load. This allows managing the combustion while keeping emissions and thermoacoustic instability under control.

**[0081]** Preferably, all the burner assemblies 11 of the combustion chamber 4 are provided with the main detecting device 25 and with the secondary detecting device 40.

**[0082]** This allows monitoring any difference in the main air flow rate QAp and in the secondary air flow rate QAs among the burner assemblies 11.

**[0083]** The application of the detecting devices on all the burner assemblies 11 of the combustion chamber 4 allows the control device 9 to vary the air/fuel ratio only for some burner assemblies 11 in order to modify the stoichiometric uniformity in the combustion chamber 4 and intervene on specific thermoacoustic instabilities within the same.

**[0084]** Figure 3 shows a burner assembly 111 according to a variant of the present invention.

**[0085]** The burner assembly 111 differs from the burner assembly 11 just because it uses a different type of flow detecting device.

**[0086]** In the following, previously used reference numbers will indicate parts of the burner assembly 111 that are substantially identical to respective parts of the burner assembly 11 shown in Figures 1 and 2.

**[0087]** The burner assembly 111 comprises a main detecting device 124, which is configured to detect the main air flow rate QAp supplied to the main burner 13 through the main air supply duct 15.

**[0088]** The main detecting device 124 is defined by a first main pressure inlet 125 and by a second main pressure inlet 126.

**[0089]** The first main pressure inlet 125 is arranged in the main air supply duct 15 upstream of the plurality of nozzles 22 and comprises one or more holes 125a.

**[0090]** Preferably, the holes 125a are orthogonal to the flow direction.

**[0091]** Preferably, the first main pressure inlet 125 is arranged between the grid 20 and the plurality of fuel supply nozzles 22.

**[0092]** The second main pressure inlet 126 is arranged upstream of the grid 20 along the air flow direction.

**[0093]** Preferably, the second main pressure inlet 126 is arranged upstream of the grid 20 out of the air supply duct 15. Basically, the second main pressure inlet 126 is

housed inside the casing (not shown) and supplied with air coming from the compressor 3.

**[0094]** Preferably, the second main pressure inlet 126 is formed by a ring 127 (schematically shown in Figure 3) provided with a plurality of successive holes 126a to detect the pressure signal. The pressure signals detected through the plurality of holes 126a are averaged so as to minimize the oscillations due to turbulence phenomena. The differential pressure between the pressure value detected through the hole 125a and the average value of the values measured through the holes 126a is proportional to the flow rate.

**[0095]** The burner assembly 111 further comprises a secondary detecting device 130, which is configured to detect the secondary air flow rate QAp supplied to the secondary burner 14 through the secondary air supply duct 28.

**[0096]** The secondary detecting device 130 is defined by a first secondary pressure inlet 131 and by a second secondary pressure inlet 132.

**[0097]** The first secondary pressure inlet 131 is arranged downstream of the section narrowing 34, whereas the second pressure inlet is arranged upstream of the section narrowing 33.

**[0098]** Preferably, the first secondary pressure inlet 131 comprises one or more holes 131a arranged orthogonally to the flow direction.

**[0099]** Preferably, the first secondary pressure inlet 131 is arranged upstream of the outlet 37.

**[0100]** In other words, the first secondary pressure inlet 131 is arranged along the secondary air supply duct 28 between the section narrowing 33 and the outlet 37 of the secondary fuel supply duct 29.

**[0101]** Preferably, the first secondary pressure inlet 131 is arranged along the secondary air supply duct 28 between the section narrowing 33 and the inlet of the secondary swirler 34 in a position where the flow has substantially lost its own swirling component due to the section narrowing 33 and has a substantially even and symmetrical profile.

**[0102]** Preferably, the first secondary pressure inlet 131 is arranged in a substantially middle position between the section narrowing 33 and the inlet of the secondary swirler 34.

**[0103]** In the non-limiting example here described and illustrated, the first secondary pressure inlet 131 is arranged along the secondary air supply duct 28, always upstream of the outlet 37 of the secondary fuel supply pipe 29.

**[0104]** In this way, the first secondary pressure inlet 131 detects the secondary air flow rate QAs in a substantially even and not asymmetrical air flow.

**[0105]** The second secondary pressure inlet 132 is preferably arranged inside the secondary air supply duct 28 upstream of the section narrowing 33.

**[0106]** Preferably, the second secondary pressure inlet 132 comprises a hole 132a, orthogonal to the flow direction.

**[0107]** A variant not shown provides that the second secondary pressure inlet is provided with a plurality of holes orthogonal to the flow and configured to detect respective values, which will be averaged in order to reduce the influence of turbulences and swirls.

**[0108]** A variant not shown provides that the second secondary pressure outlet is arranged out of the secondary air supply duct 28 inside the casing (not shown) supplied with air coming from the compressor 3.

**[0109]** The differential pressure between the pressure value detected through the hole 131a and the pressure value detected through the hole 132a is proportional to the secondary air flow rate QAs which passes through the secondary air supply duct 28.

**[0110]** The main detecting device 124 and the secondary detecting device 130 feed the respective primary air flow rate QAp values and secondary air flow rate QAs values detected at the control device 9, which, as already described above, processes them to regulate the main fuel flow rate QCp and the secondary fuel flow rate QCs.

**[0111]** Figure 4 shows a burner assembly 211 according to a further variant of the present invention.

**[0112]** The burner assembly 211 differs from the burner assembly 111 exclusively because it uses a different type of main detecting device 224.

**[0113]** In the following, previously used reference numbers will indicate parts of the burner assembly 211 that are substantially identical to respective parts of the burner assembly 111 shown in Figure 3.

**[0114]** The burner assembly 211 comprises a main detecting device 224, which is configured to detect the main air flow rate QAp supplied to the main burner 13 through the main air supply duct 15.

**[0115]** The main detecting device 224 is defined by a first main pressure inlet 225 and by a second main pressure inlet 226.

**[0116]** The first main pressure inlet 225 is arranged downstream of the main swirler 21.

**[0117]** Preferably, the first main pressure inlet 225 faces the main air supply duct 15 supported by a structure housed in a respective channel 228 formed in the body of the burner assembly 211, and in particular in the body of the secondary burner 14.

**[0118]** In particular, the first main pressure outlet 225 faces the main air supply duct 15 downstream of the main swirler 21 and upstream with respect to the axial position of the secondary swirler 31.

**[0119]** Preferably, the first main pressure inlet 225 faces the inner wall of the main air supply duct 15 downstream of the auxiliary fuel supply nozzles 230 of the fuel supply outlet.

**[0120]** The auxiliary nozzles 230 are fed by a respective annular channel 231 and are arranged along the inner wall of the main air supply duct 15 in a position between the injection point of the plurality of nozzles 22 and the cylindrical outlet element 24.

**[0121]** Preferably, the auxiliary nozzles 230 are arranged downstream of the main swirler 21.

**[0122]** In the non-limiting example here described and illustrated, the auxiliary nozzles 230 are substantially equidistant from the main swirler 21 and from the cylindrical outlet element 24.

**[0123]** In the non-limiting example here described and illustrated, the auxiliary nozzles 230 have a circular cross-section and are evenly distributed along the annular air supply duct 13 of the main burner 10.

**[0124]** The first pressure inlet 225 comprises one or more holes 225a.

**[0125]** Preferably, the holes 225a are orthogonal to the flow direction.

**[0126]** The second main pressure inlet 226 is substantially identical to the second pressure inlet 126 of FIG. 3 and is therefore arranged upstream of the grid 20 along the air flow direction.

**[0127]** Preferably, the second main pressure inlet 226 is arranged upstream of the grid 20 out of the air supply duct 15. Basically, the second main pressure inlet 226 is housed inside the casing (not shown) supplied with air coming from the compressor 3.

**[0128]** Preferably, the second main pressure inlet 226 is formed by a ring 227 (schematically shown in Figure 4) provided with a plurality of holes 226a arranged in succession to detect the pressure signal. The pressure signals detected through the plurality of holes 226a are averaged so as to minimize the oscillations due to turbulence phenomena. The differential pressure between the pressure value detected through the hole 225a and the averaged value of the values detected through the holes 226a is proportional to the flow rate.

**[0129]** Since the first pressure inlet 225 is arranged downstream of the fuel injection points, the known fuel flow rate supplied to the main burner 13 must be subtracted from the flow rate calculated by the main detecting device 224.

**[0130]** Advantageously, the main detecting devices 25, 124, 224 and the secondary detecting devices 40, 130 can detect the current values of the main air flow rate QAp and of the secondary air flow rate QAs passing through each burner assembly 11, without estimates or simulations.

**[0131]** The possible accurate measuring of the flow rate of combustion air supplied to the main burner 13 and to the secondary burner 14 is advantageous with regard to the validation of the development tools (e.g. calculation models) and with regard to an improvement of the performance of the plant 1, thanks to the possibility of adjusting the fuel supply so as to optimize combustion in the combustion chamber 4.

**[0132]** Finally, it is clear that modifications and variations can be made to the burner assembly, to the gas turbine plant for the production of electrical energy and to the method described herein without departing from the scope of the appended claims.

## Claims

1. Burner assembly for a combustion chamber (4) of a gas turbine plant (1) extending along an axis (B) comprising:

a main burner (13), which is supplied with a main air flow rate (QAp) and with a main fuel flow rate (QCp) and is configured to create a main combustion area;

a secondary burner (14), which is supplied with a secondary air flow rate (QAs) and with a secondary fuel flow rate (QCs) and is configured to create at least one secondary combustion area; the secondary burner (14) extending substantially along the axis (B) and the main burner (13) extending about the secondary burner (14) parallel to the axis (B);

the main burner (13) being provided with at least one main detecting device (25; 124; 224) configured to detect the current main air flow rate (QAp);

the secondary burner (14) being provided with at least one secondary detecting device (40; 130) configured to detect the current secondary air flow rate (QAs).

2. An assembly according to claim 1, wherein the main burner (13) is provided with a main air supply duct (15); the main detecting device (25; 124; 224) being arranged along the main air supply duct (15).
3. An assembly according to claim 2, wherein the main air supply duct (15) comprises a grid (20) and a plurality of fuel supply nozzles (22), arranged downstream of the grid (20) along the air flowing direction.
4. An assembly according to claim 3, wherein the main detecting device (25) is a Pitot tube provided with a main detecting end (26).
5. An assembly according to claim 4, wherein the main detecting end (26) is arranged between the grid (20) and the plurality of fuel supply nozzles (22).
6. An assembly according to claim 5, wherein the main detecting end (26) is countercurrently oriented.
7. An assembly according to claim 3, wherein the main detecting device (25; 124; 224) comprises at least one first main pressure inlet (125; 225) and at least one second main pressure inlet (126; 226).
8. An assembly according to claim 7, wherein the first main pressure inlet (125) is arranged between the grid (20) and the plurality of nozzles (22) and the second main pressure inlet (126) is arranged upstream of the grid (20).

9. An assembly according to claim 7, wherein the first main pressure inlet (225) is arranged downstream of a main swirler (21) and the second main pressure inlet (226) is arranged upstream of the grid (20). 5
10. An assembly according to any one of the preceding claims, wherein the secondary burner (14) is provided with a secondary air supply duct (28), which has a section narrowing (33); the secondary detecting device (40; 130) being arranged along the secondary air supply duct (28). 10
11. An assembly according to claim 10, wherein the secondary detecting device (40) is a Pitot tube comprising a secondary detecting end (41); the secondary detecting end (41) being arranged downstream of the section narrowing (33) along the air flowing direction. 15
12. An assembly according to claim 11, wherein the secondary detecting end (41) is countercurrently oriented. 20
13. An assembly according to claim 10, wherein the secondary detecting device (40; 130) comprises at least one first secondary pressure inlet (131) and at least one second secondary pressure inlet (132); the first secondary pressure inlet (131) being arranged downstream of the section narrowing (33), the second secondary pressure inlet (132) being arranged upstream of the section narrowing (33). 25 30
14. Gas turbine plant for electrical energy production comprising a compressor (3), a gas turbine (2) and a combustion chamber (4) provided with at least one burner assembly (11; 111; 211) as claimed in anyone of the preceding claims. 35
15. A plant according to claim 14, comprising a fuel supply assembly (6) configured to supply fuel to the combustion chamber (4) and a control device (9) configured to regulate the fuel supply assembly (6) based on values of the main air flow rate (QAp) detected by the main detecting device (25; 124; 224) and based on the values of the secondary air flow rate (QAs) detected by the secondary detecting device (40; 130). 40 45
16. Method for operating a gas turbine plant for electrical energy production (1) provided with at least one burner assembly (11; 111; 211) comprising a main burner (13) and a secondary burner (14); the method comprising the steps of: 50
- supplying to the main burner (13) a main air flow rate (QAp) and a main fuel flow rate (QCp) in order to create at least one main combustion area; 55

- supplying to the secondary burner (14) a secondary air flow rate (QAs) and a secondary fuel flow rate (QCs) in order to create at least one secondary combustion area;
- detecting the current main air flow rate (QAp) supplied to the main burner (13);
- detecting the current secondary air flow rate (QAs) supplied to the secondary burner (14); regulating the main fuel flow rate (QCp) and the secondary fuel flow rate (QCs) based on the values of current main air flow rate (QAp) and of the current secondary air flow rate (QAs).



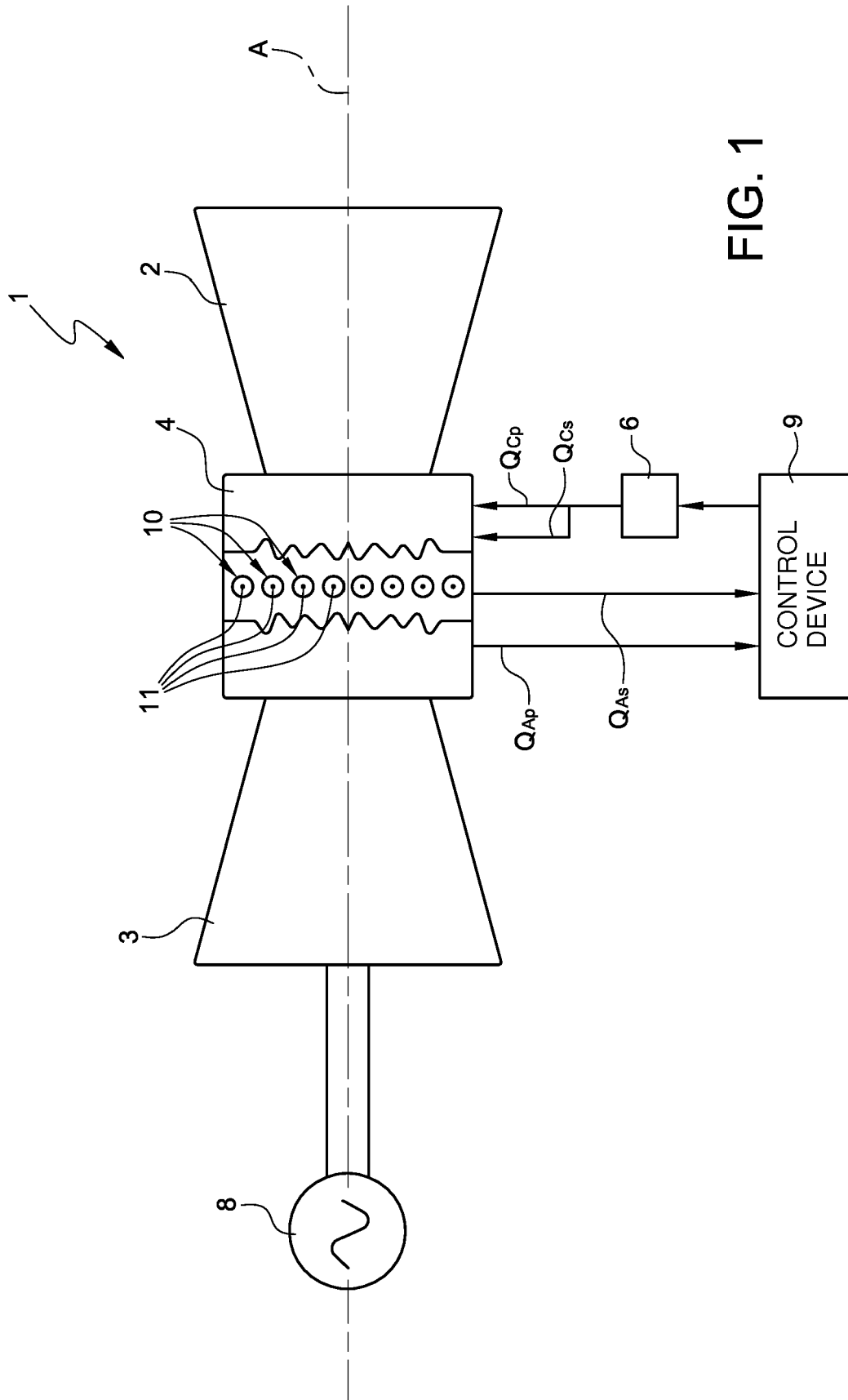


FIG. 1

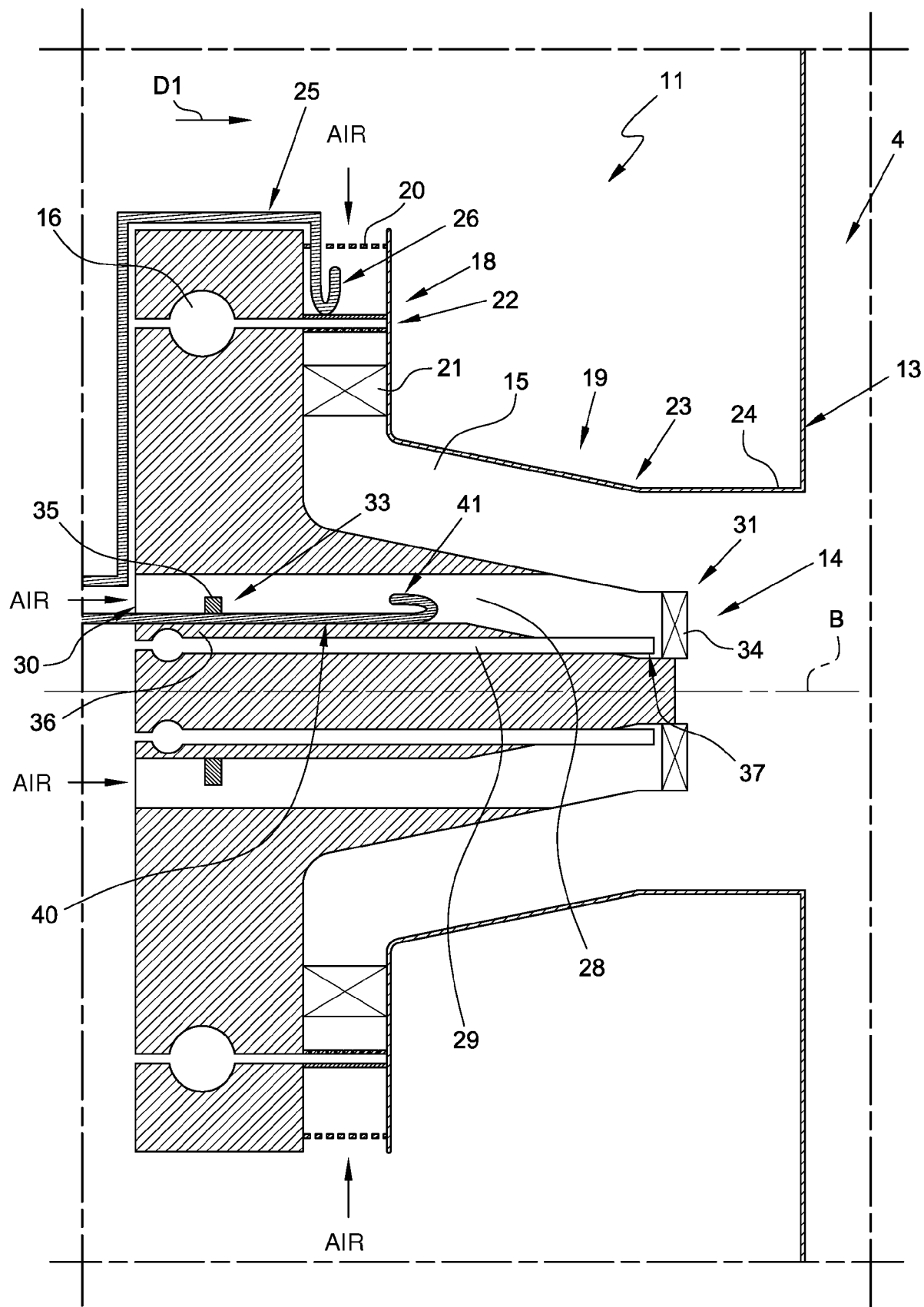


FIG. 2

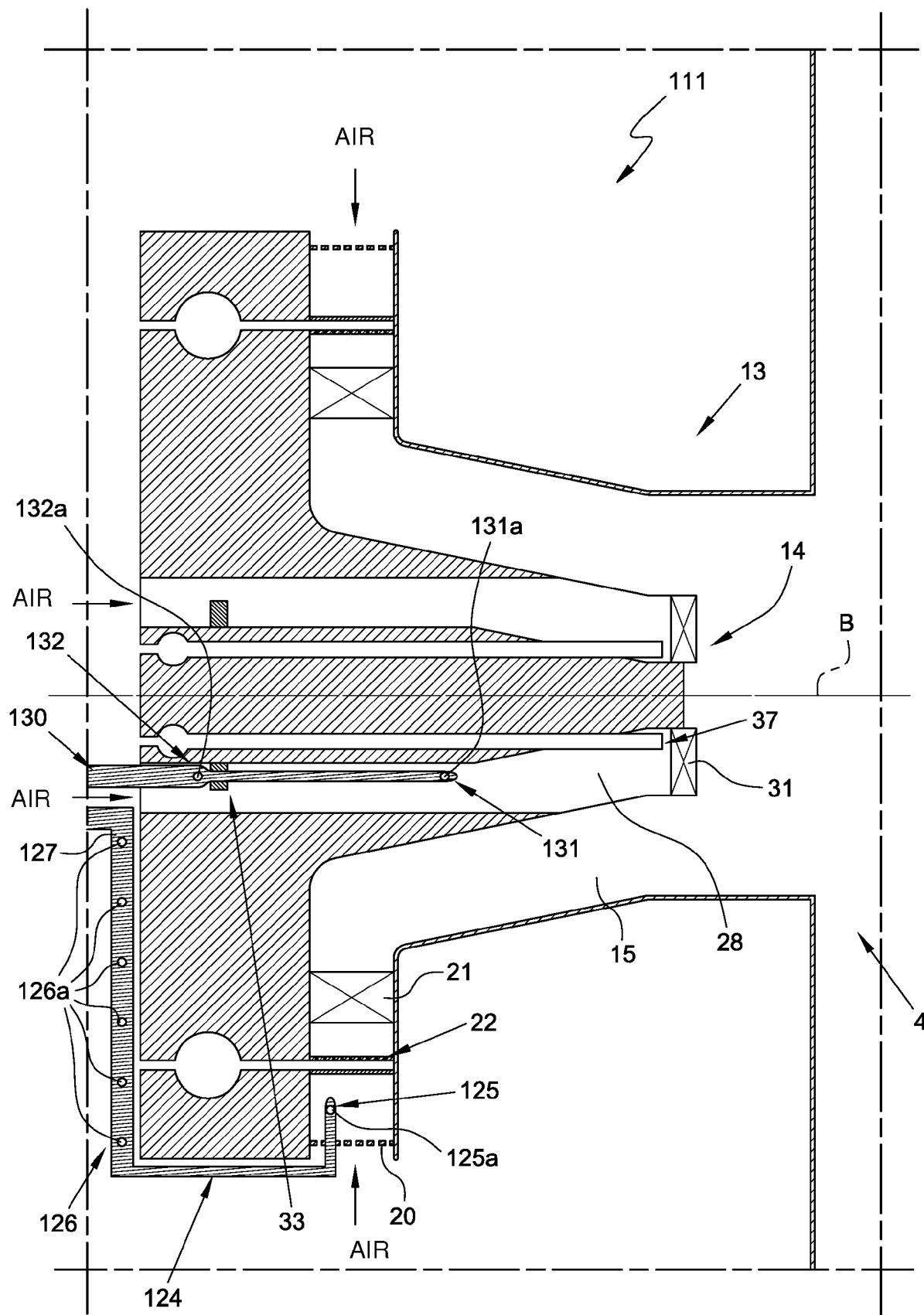


FIG. 3

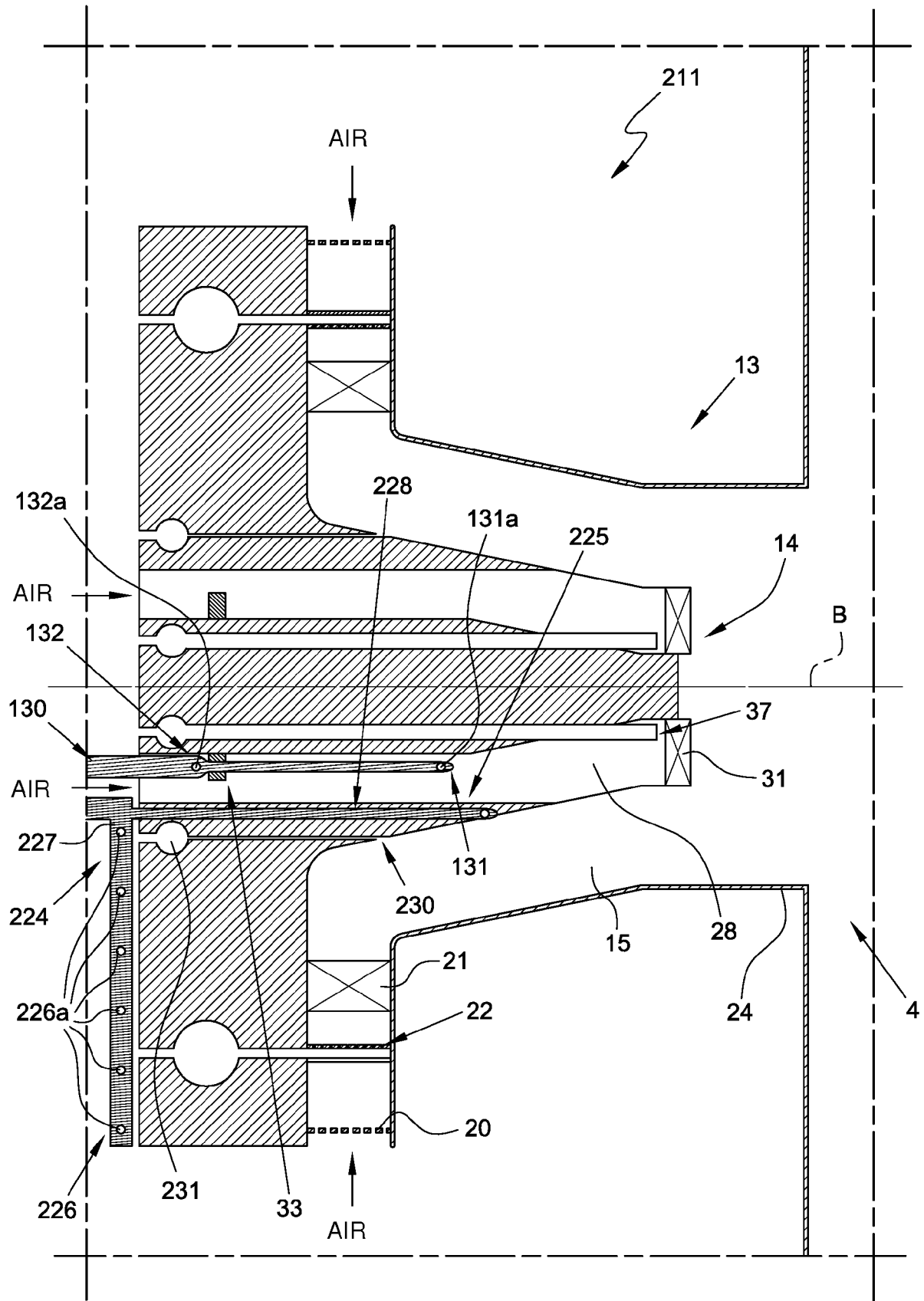


FIG. 4



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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                       |                                                         |                                           |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                       |                                                         |                                           |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                       | Date of completion of the search<br><b>5 April 2018</b> | Examiner<br><b>Hauck, Gunther</b>         |
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05-04-2018

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