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(54) **Trapped vortex combustor cavity manifold for gas turbine engine**

(57) In accordance with one embodiment, the present technique provides a combustor assembly (34) for use in a gas-turbine device. The combustor assembly (34) includes a first combustion zone (66) and a second combustion zone (46). The combustor assembly (34) further includes a first premix chamber (38) configured to receive a fuel (24) and air (58) to facilitate a first fuel-air mixture (62) having a first fuel-to-air ratio, wherein the first premix chamber (38) is fluidiclly coupled to the combustion chamber (42) at the first combustion zone (66). The combustor assembly also includes a second premix chamber (40) configured to receive a fuel (24) and air (60) to facilitate a second fuel-air mixture (72) having a second fuel-to-air ratio, wherein the second premix chamber (40) is fluidiclly coupled to the combustion chamber (42) at the second combustion zone (46), wherein the second combustion zone (46) is radially outboard of the first combustion zone (66).

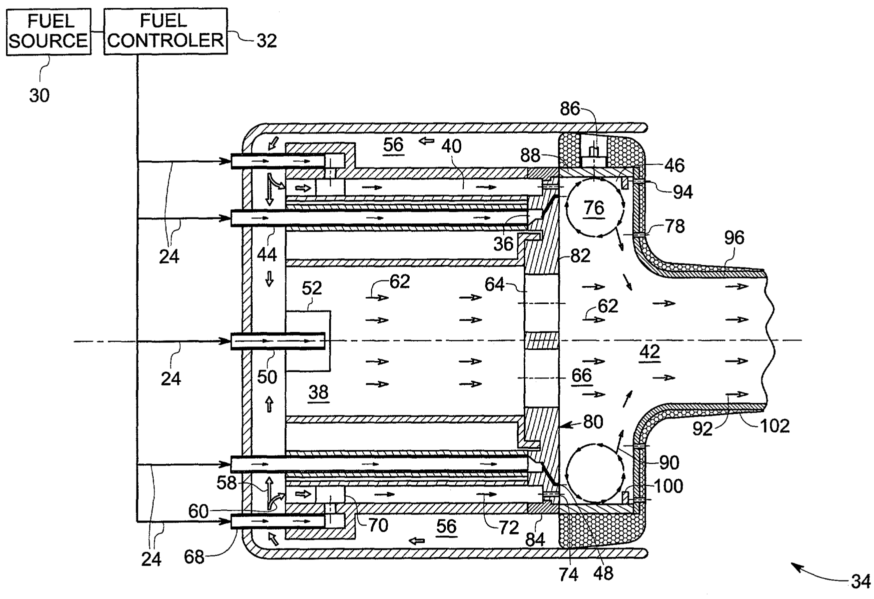

FIG.2

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Description

[0001] The present invention relates generally to fuel aeration and combustion with respect to a combustion device, such as a gas turbine device.

[0002] In traditional gas turbine devices, air is drawn from the environment, mixed with fuel and, subsequently, ignited to produce combustion gases, which may be used to drive a machine element or to generate power, for instance. Traditional gas turbine devices generally include three main systems: a compressor, a combustor and a turbine. The compressor pressurizes air and sends this air towards the combustor. The combustor can be configured as multiple can combustors or as an annulus in direct fluid communication with the turbine. The compressed air and the fuel are mixed and burnt in the combustor, and the resulting combustion gases actuate a turbine, generating power or driving a machine element, for instance. That is, the combustion gases flow across a turbine and actuate the turbine that, in turn, drives a shaft to power the compressor and produces output power for powering an electrical generator or for powering an aircraft, to name but few examples.

[0003] Gas turbine engines are typically operated for extended periods of time, and exhaust emissions from the combustion gases are a concern, often subject to regulatory limits. For example, during combustion, nitrogen combines with oxygen to produce oxides of nitrogen (NOx), and these NOx emissions are often subject to regulatory limits and are generally undesired. Traditionally, gas turbine devices reduce the amount of NOx emissions by decreasing the fuel-to-air ratio, and these devices are often referred to as lean devices. Lean device reduce the combustion temperature within the combustion chamber and, in turn, reduce the amount of NOx emissions produced during combustion. Unfortunately, traditional lean combustion devices are susceptible to combustion instabilities that cause the fuel-to-air mixture to vary and are also susceptible to inefficiencies that increase carbon monoxide (CO) emissions, for instance.

[0004] Another method commonly used to reduce peak temperatures and, thereby, to reduce NOx emissions, is to inject water or steam into the combustor. However, water or steam injection is a relatively expensive technique, and these techniques can cause the undesirable side effect of quenching carbon monoxide (CO) burnout reactions. Additionally, water or steam injection methods are limited in their ability to reach the extremely low levels of pollutants required in many localities.

[0005] Another method used to reduce NOx emissions is to stage the introduction of fuel to the combustor. This reduces the time at the highest temperature and makes the head end of the combustor leaner. Again, the problems associated with very lean premixing can be limiting. The tendency of the staged fuel to burn rich is also limiting.

[0006] Thus, there exists a need to provide a combustion technique that reduces NOx emissions.

[0007] Briefly, in accordance with one embodiment, the present invention provides a combustor assembly for use in a gas-turbine device. The combustor assembly includes a first combustion zone and a second combustion zone. The combustor assembly further includes a first premix chamber configured to receive a fuel and air to facilitate a first fuel-air mixture having a first fuel-to-air ratio, wherein the first premix chamber is fluidiclly coupled to the combustion chamber at the first combustion zone. The combustor assembly also includes a second premix chamber configured to receive a fuel and air to facilitate a second fuel-air mixture having a second fuel-to-air ratio, wherein the second premix chamber is fluidiclly coupled to the combustion chamber at the second combustion zone, wherein the second combustion zone is radially outboard of the first combustion zone.

[0008] In accordance with another aspect, the present invention provides an exemplary method of providing combustion gases for a gas-turbine device. The method includes supplying fuel and compressed air to a first premix chamber of a combustor assembly to produce a first fuel-air mixture having a first fuel-to-air ratio. The method includes routing the first fuel-air mixture to a first combustion zone of a combustion chamber of the combustor assembly. The method also includes supplying fuel and compressed air to a second premix chamber of the combustor assembly to produce a second fuel-air mixture having a second fuel-to-air ratio. The method further includes routing the second fuel-air mixture to a second combustion zone of the combustion chamber of the combustor assembly to generate a vortex flow of the second fuel-air mixture in the second combustion zone, wherein the second combustion zone is disposed radially outboard of the first combustion zone.

[0009] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. 1 is a diagrammatic representation of a gas turbine device, in accordance with an exemplary embodiment of present technique;

FIG. 2 is a partial and diagrammatic, cross-sectional view of a single stage trapped vortex combustor assembly, in accordance with an exemplary embodiment of present technique;

FIG. 3 is a partial and diagrammatic, cross-sectional view of a two-stage trapped vortex combustor assembly, in accordance with an exemplary embodiment of present technique;

FIG. 4 is a front view of an end plate of the second stage trapped vortex combustion chamber of FIG. 3 along line 4-4;

FIG. 5 is a flowchart illustrating an exemplary process for establishing lean and stable fuel for combustion in a single stage combustor assembly of a gas turbine, in accordance with aspects of present technique; and

FIG. 6 is a flowchart illustrating an exemplary process for establishing lean and stable fuel for combustion in a two-stage combustor assembly of a gas turbine, in accordance with aspects of present technique.

[0010] As a preliminary matter, the definition of the term "or" for the purpose of the following discussion and the appended claims is intended to be an inclusive "or." That is, the term "or" is not intended to differentiate between two mutually exclusive alternatives. Rather, the term "or" when employed as a conjunction between two elements is defined as including one element by itself, the other element itself, and combinations and permutations of the elements. For example, a discussion or recitation employing the terminology "A" or "B" includes: "A", by itself "B" by itself and any combination thereof, such as "AB" and/or "BA."

[0011] The present technique is generally directed towards combustion in a gas turbine device. Gas turbine devices, exemplary embodiments of which are discussed further below, are used in many applications, such as commercial aircrafts and power plants, to name but few applications. Typically, a gas turbine device works on the principle that liquid or gaseous fuel, such as propane, natural gas, syngas or kerosene to name but few types of fuel, is ignited in a combustion zone to produce combustion gases, and these combustion gases are used to actuate a turbine.

[0012] Turning now to the drawings, and referring first to FIG. 1, an exemplary embodiment of a gas turbine device 10 in accordance with the present technique is illustrated diagrammatically. It is worth noting that the following discussion relates to exemplary embodiments, and the appended claims should not be limited to the embodiments discussed herein. The gas turbine device 10 includes an outer casing 12 that protects and secures the various internal components of the gas turbine device 10. Additionally, as discussed further below, the outer casing 12 provides a structure that directs airflow with respect to the gas turbine device 10.

[0013] To generate airflow, the exemplary gas turbine device 10 includes a compressor 14. During operation, the compressor 14 draws in air 16 from the atmosphere surrounding the gas turbine device 10 and, then, forces the air 16 downstream in the device. Resultantly, the compressor increases the pressure of the air. In other words, the compressor 14 compresses the air 16 in the environment, and, as such, increases its pressure to produce compressed air 18 and airflow. The compressor 14 acts as a source of compressed air throughout the device and, specifically, the combustors, as discussed further below. By way of example, the compressor 14 is capable of increasing the pressure of the air 16 by a factor of 30, and beyond.

[0014] The compressed air 18 is directed downstream into the device and into a plurality of combustor assemblies 20 (i.e., combustor cans) that are disposed concentrically about the longitudinal axis 22 of the gas turbine device 10. As illustrated, the combustor assemblies 20 have a generally cylindrical shape, however, other shapes are envisaged. As discussed further below, the combustor assemblies 20 receive the compressed air 18 and fuel 24 and facilitate the formation of a fuel-air mixture. In turn, the combustor assemblies 20 ignite the fuel-air mixture to produce exhaust gases or combustion gases 26, which drive the turbine 28. In the exemplary device, the fuel 24 for the plurality of combustors 20 is provided by a fuel source 30. By way of example, the fuel source 30 is a fuel manifold that directs fuel to the various combustor assemblies. The fuel source 30 (i.e., the fuel manifold) is under the direction of a fuel controller 32. In the exemplary embodiment, the delivery of fuel 24 to various components of the combustor assemblies 20 is controlled individually using a system of valves, for example. Thus, a desired quantities of fuel may be provided to various components in the combustor assembly 20 at a desired times and in a manner independent from one another.

[0015] After formation in the plurality of combustor assemblies 20, the combustion gases 26 flow through the turbine 28, and this flow drives the turbine 28. Advantageously, the rotation of the turbine 28 is harnessed to cause rotation of a generator rotor, for example, thereby producing power. Alternatively, the rotation of the turbine 28 may be harnessed to drive a machine element.

[0016] FIG. 2 is a partial and diagrammatic, cross-sectional view of a single stage trapped vortex combustor assembly 34, in accordance with an exemplary embodiment of present technique. More specifically, FIG. 2 illustrates a detail portion of a combustor can or combustor assembly 34 similar to one of the combustor assemblies 20 discussed above in FIG. 1. In continuation of the discussion above, the fuel source 30 and the fuel controller 32 direct fuel 24 into various distribution mechanisms and aeration chambers of the combustor assembly. The fuel 24 can be one of several possible fuel sources such as propane, natural gas, hydrogen, or syngas, and can include dilutes, such as nitrogen, steam or carbon dioxide (CO2). Of course, other types of fuels are also envisaged. In the exemplary assembly, fuel 24 is provided to a diffusion chamber 36, a primary premix chamber (e.g., first premix chamber 38), and a secondary premix chamber (e.g., second remix chamber 40) of the combustor assembly 34. In turn, these regions provide the appropriate fuel or fuel-air mixtures to a combustion chamber 42, as discussed further below.

[0017] Fuel 24 is provided to the combustion chamber 42, among other pathways, through the diffusion chamber 36. Fuel 24 from the plurality of inlet tubes 44 of the diffusion chamber 36, is introduced into a secondary combustion zone or second combustion zone 46 of the combustion chamber 42 via a plurality of apertures 48. Advantageously, the delivery of the diffusion fuel 24 through the plurality of apertures 48 is believed to minimize the thermal gradient with respect to the surfaces defining the combustion chamber 42. As discussed further below, fuel 24 from the diffusion chamber 36 facilitates an increase in the richness of the fuel-air mixture in the combustion chamber 42, if such richness is desired and/or if conditions warrant.

[0018] In the exemplary combustor assembly 34, some of the introduced fuel 24 is aerated prior to insertion into the combustion chamber 42. For example, fuel 24 travels through a plurality of inlet tubes 50 of the primary premix chamber 38. This aeration at least occurs partially in a first premix device 52. As discussed further below, the premix device 52 mixes air and fuel 24 to produce a fuel-air mixture. For aerating the fuel 24, compressed air, which is originated at the compressor 14 (see FIG. 1), travels through an airflow chamber 56 and is then bifurcated into two portions, namely a first airflow portion 58 and a second airflow portion 60. The first airflow portion 58 of the compressed air enters the primary premix chamber 38. The premix device 52 facilitates aeration of the fuel 24; in other words, the premix device 52 facilitates mixing of the fuel 24 and the first airflow portion 58 to produce a primary fuel-air mixture or first fuel-air mixture 62 with a first fuel-to-air ratio. Once mixed, the flow of the first airflow portion 58 drives the primary fuel-air mixture 62 towards a plurality of apertures 64 and, in turn, into the combustion chamber 42. Specifically, the plurality of apertures 64 is located towards the center of the combustion chamber 42 and feeds into a primary combustion zone or first combustion zone 66 of the combustion chamber 42, which is also located towards the center of the combustion chamber 42. In the exemplary embodiment, fuel-air mixture from the primary premix chamber 38 is a relatively lean mixture.

[0019] The exemplary combustor assembly 34 also includes a secondary aeration region, that is, the second premix chamber 40. Fuel 24 is provided to the secondary premix chamber 40 by way of a plurality of fuel tubes 68. As described above, compressed air travels through the airflow chamber 56, and the second airflow portion 60 of the compressed air then enters the secondary premix chamber 40. In a manner similar to the primary premix device 52, a second premix device 70 facilitates mixing of fuel 24 and the second airflow portion 60 to produce a secondary fuel-air mixture or a second fuel-air mixture 72 with a second fuel-to-air ratio. In the exemplary embodiment, the second fuel-air mixture 72 has a higher fuel-to-air ratio than the first fuel-air mixture 62 produced in the primary premix chamber 38. That is, the fuel-air mixture 72 produced in the secondary premix chamber 40 is richer than that produced in the primary premix chamber 38. The compressed air 60 drives an airflow that pushes the fuel-air mixture 72 into the secondary combustion zone 46 of the combustion chamber 42 through a plurality of apertures 74. Specifically, the second fuel-air mixture 72 is introduced into the secondary combustion zone 46, which is radially outboard of the primary combustion zone 66. The flow of the secondary fuel-air mixture and the design of the secondary premix zone facilitate avoiding flashbacks. The flashback is a process by which the flame travels in a direction opposite to a desired direction, i.e. the flame may travel from the combustion chamber towards the premix chambers.

[0020] As the second fuel-air mixture 72 is introduced into the combustion chamber, specifically in the secondary combustion zone 46, the second fuel-air mixture 72 begins to travel in a vortex-like manner. In the exemplary combustor assembly, the introduced mixture (i.e., second fuel-air mixture 72) is confined within the U-shaped secondary combustion zone 46, and this U-shape induces the vortex flow 76. For example, fuel-air mixture 72 introduced from the inlet 74 travels axially across the secondary combustion zone 46 and impacts the opposite sidewall, causing the secondary fuel-air mixture 72 to travel back towards the inlet 74. As more fuel-air mixture 72 is introduced from the inlet 74, the process repeats, and the vortex flow 76 is maintained. Advantageously, the exemplary assembly includes apertures 78 that facilitate the generation of vortex flow in the secondary combustion zone 46. Moreover, as discussed further below, the fuel-to-air ratio of the fuel-air mixture, which is subjected to vortex flow can be increased by the introduction of fuel 24 through the diffusion chamber 36 and its corresponding inlet 44.

[0021] In the exemplary combustor assembly 34, the premix chambers 38, 40 and the diffusion chamber 36 are separated from the combustion chamber 42 by an end plate assembly 80. The end plate assembly 80 includes a first disk 82 that is disposed between the combustion chamber 42 and the primary premix chamber 38, the diffusion chamber 36 and the secondary premix chamber 40 and a second disk 84 that circumscribes the first disk 82. The materials of the first and second disks, in the exemplary embodiment, are varied with respect to one another to provide for materials that are best suited to the different operating climates, as discussed further below. For example, in the exemplary combustor, the construction of the first disk 82 is more robust to accommodate the higher combustion temperatures in the combustion chamber.

[0022] During operation, particularly while starting the gas turbine device, the fuel 24 through the diffusion chamber 36 is introduced into the secondary combustion zone 46 of the combustion chamber 42 and ignited by a first igniter 86 which is mounted over a combustion chamber wall 88. Alternatively, in some embodiments, the combustor assemblies may include crossfire tubes instead of igniters in each combustor assembly. Crossfire tubes are tubes that transfer the flame due to ignition of fuel from one combustor assembly to another. In any event, fuel is ignited by an ignition source. Then, the secondary fuel-air mixture 72 is introduced into the secondary combustion zone 46. As described above, the U-shape of the secondary combustion zone 46 creates the vortex flow 76 of the fuel-air mixture inside the secondary combustion zone 46. Advantageously, this vortex flow facilitates the mixing of the fuel 24 from the diffusion chamber 36 and the secondary fuel-air mixture 72 to produce a flame and combustion products, which may include uncombusted fuel and fuel-air mixture. However, it is worth noting that the insertion of the fuel 24 from the diffusion chamber 36 is optional. In any event, the igniter 86 (or ignition source) ignites the fuel subjected to vortex flow in the secondary combustion zone 46, as discussed above. It is believed that, in the combustion chamber 42, the ignited fuel-air mixture produces a flame and combustion product 90, which propagate into the primary combustion zone 66 and ignite the primary fuel-air mixture 62, which is a leaner mixture. The flame 90 acts as a pilot for the fuel-air mixture in the primary combustion zone 66. This flame is thought to provide a more stable combustion of the primary fuel-air mixture, and, as such, the flame facilitates lean and stable operation of the combustor assembly, thereby reducing the NOx emissions generated during combustion, for instance. Moreover, the combination product 90 enters the primary combustion zone and affects the fuel-air mixture therein.

[0023] Advantageously, the flow of fuel 24 to the diffusion chamber 36, the primary premix manifold 38, and the secondary premix manifold 40 is controlled to alter the quality and quantity of fuel-air mixture desired for a particular application. For example, while starting the gas turbine device, fuel 24 through the diffusion chamber 36 is provided to the combustion chamber 42 and ignited. Gradually, the secondary fuel-air mixture 72 from the secondary premix chamber 40 is introduced and mixed with the fuel 24 inside the combustion chamber. The flame due to the ignition of the fuel 24 through the diffusion chamber 36 ignites the rich fuel-air mixture 72 entering through the secondary premix chamber 40. Once stabilized, supply of fuel 24 through the diffusion chamber 36 is gradually reduced, and the flow of the secondary fuel-air mixture 72 through the secondary premix chamber 40 is gradually increased.

[0024] Similarly, lean fuel-air mixture is beneficial for reducing the emission of NOx. Hence the lean fuel-air mixture 62 of primary premix chamber 38 is introduce into the combustion chamber 42 and ignited using the generated flame from the secondary combustion zone 46. By controlling the quality of the fuel, various criteria for the effective functioning of the gas turbine device can be achieved. The combustion in the combustion chamber 42 (in both the secondary and primary combustion zones) results in first combustion gases 92, which flow towards the turbine. A plurality of apertures 94 on the combustion chamber wall 96 and a disk 100 facilitate airflow into the combustion chamber 42, which in-turn facilitates reducing the emissions of NOx. Additionally, the combustion chamber walls 88 and 96 include an impingement layer 102. The impingement layer 102 has a plurality of pores that facilitates a flow of compressed air against the external combustion chamber walls, which, in turn, facilitates cooling of the combustion chamber walls.

[0025] FIG. 3 is a partial and diagrammatic, cross-sectional view of a two-stage trapped vortex combustor assembly 104, in accordance with an exemplary embodiment of present technique. The two-stage trapped vortex combustor assembly 104 includes the first stage trapped vortex combustor assembly 34 of FIG. 2, coupled to a second stage trapped vortex combustor assembly 106. The second stage trapped vortex combustor assembly 106 includes a combustion gas chamber 108, a third premix chamber 110 and a downstream combustion chamber 112. Advantageously, the second stage trapped vortex combustor assembly is located relatively close to a turbine inlet, to facilitate improved reduction of NOx emissions.

[0026] The first combustion gases 92 from the first stage trapped vortex combustor assembly 34 travel towards the second stage trapped vortex combustor assembly 106. These combustion gases 92 flow through an opening 114 in an end plate 116 into the downstream combustion chamber 112.

[0027] As discussed above, the second stage combustor assembly 106 also includes the third premix chamber 110. The fuel source 30 and the fuel controller 32 provide a fuel 24 to the inlet tubes 120 of the third premix chamber 110. Compressed air 122 travels through an air chamber 124 and enters the third premix chamber 110. As described above, a third premix device 128 facilitates mixing of fuel 24 and the compressed air 122 to produce a third fuel-air mixture 130 with a third fuel-to-air ratio. This fuel-air mixture 130 is then forced in to a third combustion zone 132 of the combustion chamber 112 through a plurality of apertures 134.

[0028] During operation, similar to the first stage combustor assembly, the fuel-air mixture 130 travels into the third combustion zone 132. A second igniter 136 (i.e., ignition source) coupled to the combustion chamber wall 137, ignites the fuel-air mixture 130 in the combustion zone 132 of the second stage combustion chamber 112. As described above, the ignition source may include the igniter or a crossfire tube. The ignition of the fuel-air mixture 130 results in combustion gases 138. As discussed above in FIG.2, the U-shape of this combustion zone 132 facilitates the vortex flow 140 of the combustion gases 138. This vortex flow, in turn, facilitates mixing of the combustion gases 138 with the first combustion gases 92 inside the combustion chamber 112 of the second stage combustor assembly to produce second combustion gases 142. As described above, a plurality of apertures 144, provided in the combustion chamber walls 146 and a disk 150 facilitate an air flow that in-turn reduces the emission of NOx. The combustion chamber walls 137 and 146 are also provided with an impingement layer 152. As described above, the impingement layer 152 facilitates a flow of air along the external surfaces of the combustion chamber walls, which in-turn facilitates cooling of the combustion chamber walls. The number of stages in a combustor assembly may not be limited to two. In some embodiments, the combustor assembly may include as many stages as desired.

[0029] FIG. 4 is a front view of the end plate 116 of the second stage trapped vortex combustion chamber of FIG. 3. The end plate 116 includes an opening 114 to facilitate free flow of the first combustion gas mixture 92 towards the combustion chamber 112 of the second stage combustor assembly 106. As will be appreciated by those skilled in the art, the temperature of the combustion gases 92 from the first stage combustion chamber 42 are relatively high, and the end plate 116 needs to accommodate these combustion gases 92 to mitigate the likelihood of damage. Hence, the opening 114 is designed in such a way that it facilitates the free flow of the combustion gases 92 towards the combustion chamber 112 of the second stage combustor assembly 106 while concurrently benefiting the mixing of flame and combustion gases 138 due to the ignition of fuel-air mixture 130 and the first combustion gases 92. Indeed, the exemplary end plate includes fingers 117 that partially facilitate the mixing of flame and combustion product 138 and the combustion gases 92 in the combustion chamber 112. As illustrated, these fingers 117 are at least partially defined by the convoluted inner surface of the end plate 116.

[0030] With FIG. 2 in mind, FIG. 5 is a flowchart illustrating an exemplary process for establishing lean and stable fuel-air mixture for combustion in a single stage combustor assembly of a gas turbine, in accordance with aspects of present technique. The process includes routing fuel 24 through the diffusion chamber 36 to the combustion chamber 42, as represented by step 154 to start a gas turbine device. The igniter 86 ignites the fuel 24 to produce combustion product 92, as represented by step 156. Then, the fuel-air mixture 72 is routed to the combustion chamber 42 in such a way that it creates a vortex flow 76 inside the combustion chamber 42. This vortex flow 76 facilitates mixing of the fuel-air mixture 72 with fuel 24 through diffusion chamber 36 to produce a flame and combustion product 90, as represented by step 158. The flow of the fuel-air mixture 72 from of the secondary premix chamber is gradually increased, and the flow of the fuel 24 from the diffusion chamber 36 is gradually reduced, as represented by step 160. The process further includes introducing a primary fuel-air mixture 62 to the combustion chamber 42 through the primary premix chamber 38, as represented by step 162. As described above, the vortex flow 76 of the flame and the combustion product 90 in the secondary combustion zone also facilitates ignition of the primary fuel-air mixture 62 in the primary combustion zone 66, as represented by step 164 to produce combustion gases 92.

[0031] With FIG. 3 in mind, FIG. 6 is a flowchart illustrating an exemplary process for establishing lean and stable fuel-air mixture for combustion in a two-stage combustor assembly of a gas turbine, in accordance with aspects of present technique. The process includes igniting the lean fuel-air mixture 62 in the combustion chamber 42 of the first stage combustor assembly 34 to generate first combustion gases 92. The process further includes routing the combustion gases 92 from the combustion chamber of the first stage combustor assembly 34 to the combustion chamber 112 of the second stage combustor assembly 106, as represented by step 166. Further, the fuel-air mixture 130 produced in the premix chamber 110 of the second stage combustor assembly 106 is routed to the combustion chamber 112 in such a way that it creates a vortex flow 140 inside the combustion chamber 112, as represented by step 168. The second igniter 136 ignites the fuel-air mixture 130 inside the combustion chamber 112 to produce a flame and combustion gases 138, as represented by step 170. The vortex flow 140 facilitates the mixing of the combustion gases 138 with the first combustion gases 92 to produce the second combustion gases 142, as represented by step 172. The combustion gases 142 from the combustion chamber 112 of the second stage combustor assembly 106 are then routed to the turbine to activate the turbine, as represented by step 174.

Claims

1. A combustor assembly (34) for use with a gas-turbine device, the assembly comprising:

    a combustion chamber (42) having a first combustion zone (66) and a second combustion zone (46);
    a first premix chamber (38) configured to receive a fuel (24) and air (58) to facilitate a first fuel-air mixture (62) having a first fuel-to-air ratio, wherein the first premix chamber (38) is fluidiclly coupled to the combustion chamber (42) at the first combustion zone (66); and
    a second premix chamber (40) configured to receive a fuel (24) and air (60) to facilitate a second fuel-air mixture (72) having a second fuel-to-air ratio, wherein the second premix chamber (40) is fluidiclly coupled to the combustion chamber (42) at the second combustion zone (46), wherein the second combustion zone (46) is radially outboard of the first combustion zone (66).

2. The combustor assembly as recited in claim 1, wherein the second combustion zone (46) is configured to produce a vortex flow (76) of the second fuel-air mixture (72).

3. The combustor assembly as recited in claim 1, further comprising a diffusion chamber (36) configure to receive fuel (24) and to provide the fuel (24) to the secondary combustion zone (46).

4. The combustor assembly as recited in claim 1, comprising an ignition source (86) disposed adjacent to the second combustion zone (46) and configured to ignite the second fuel-air mixture (72).

5. The combustor assembly as recited in claim 1, wherein walls (96) of the combustion chamber comprises a plurality of aperture (94) to facilitate airflow towards the combustion chamber (42).

6. The combustor assembly as recited in claim 1, further comprises an impingement layer (102) configured to direct compressed air along an outer surface of the combustion chamber (42).

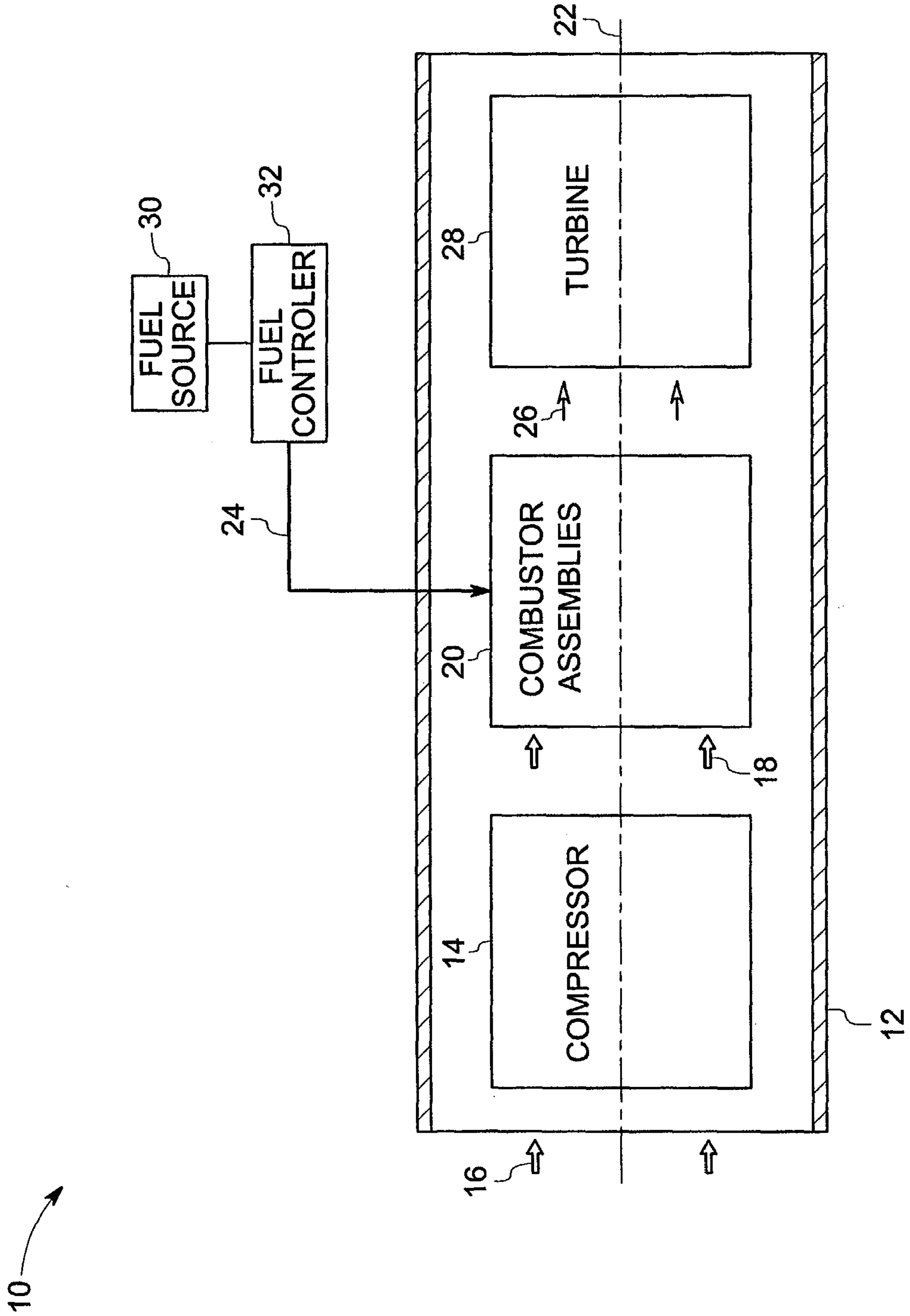
7. A method of providing combustion gases (92) for a gas-turbine device, the method comprising:

supplying fuel (24) and compressed air (58) to a first premix chamber (38) of a combustor assembly (34);
producing a first fuel-air mixture (62) having a first fuel-to-air ratio in the first premix chamber (38) via the supplied fuel (24) and compressed air (58);
routing the first fuel-air mixture (62) to a first combustion zone (66) of a combustion chamber (42) of the combustor assembly (34);
supplying fuel (24) and compressed air (60) to a second premix chamber (40) of the combustor assembly (34);
producing a second fuel-air mixture (72) having a second fuel-to-air ratio in the second premix chamber (40) via the supplied fuel (24) and compressed air (60);
routing the second fuel-air mixture (72) to a second combustion zone (46) of the combustion chamber (42) of the combustor assembly (34), wherein the second combustion zone (46) is disposed radially outboard of the first combustion zone (66); and
generating a vortex flow (76) of the second fuel-air mixture (72) in the second combustion zone (46).

8. The method as recited in claim 7, further comprising supplying a fuel (24) to a diffusion chamber (36) of the combustor assembly (34) and routing the fuel (24) to the second combustion zone (46) of the combustion chamber (42) of the combustor assembly (34).

9. The method as recited in claim 8, further comprising igniting the fuel (24) and the second fuel-air mixture (72) to produce a flame and combustion gases (90).

10. The method as recited in claim 8, further comprising igniting the first fuel-air mixture (62) using the flame (90) to produce first combustion gases (92).


FUEL SOURCE
30
FUEL CONTROLER
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TURBINE
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COMBUSTOR ASSEMBLIES
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COMPRESSOR
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FIG.1

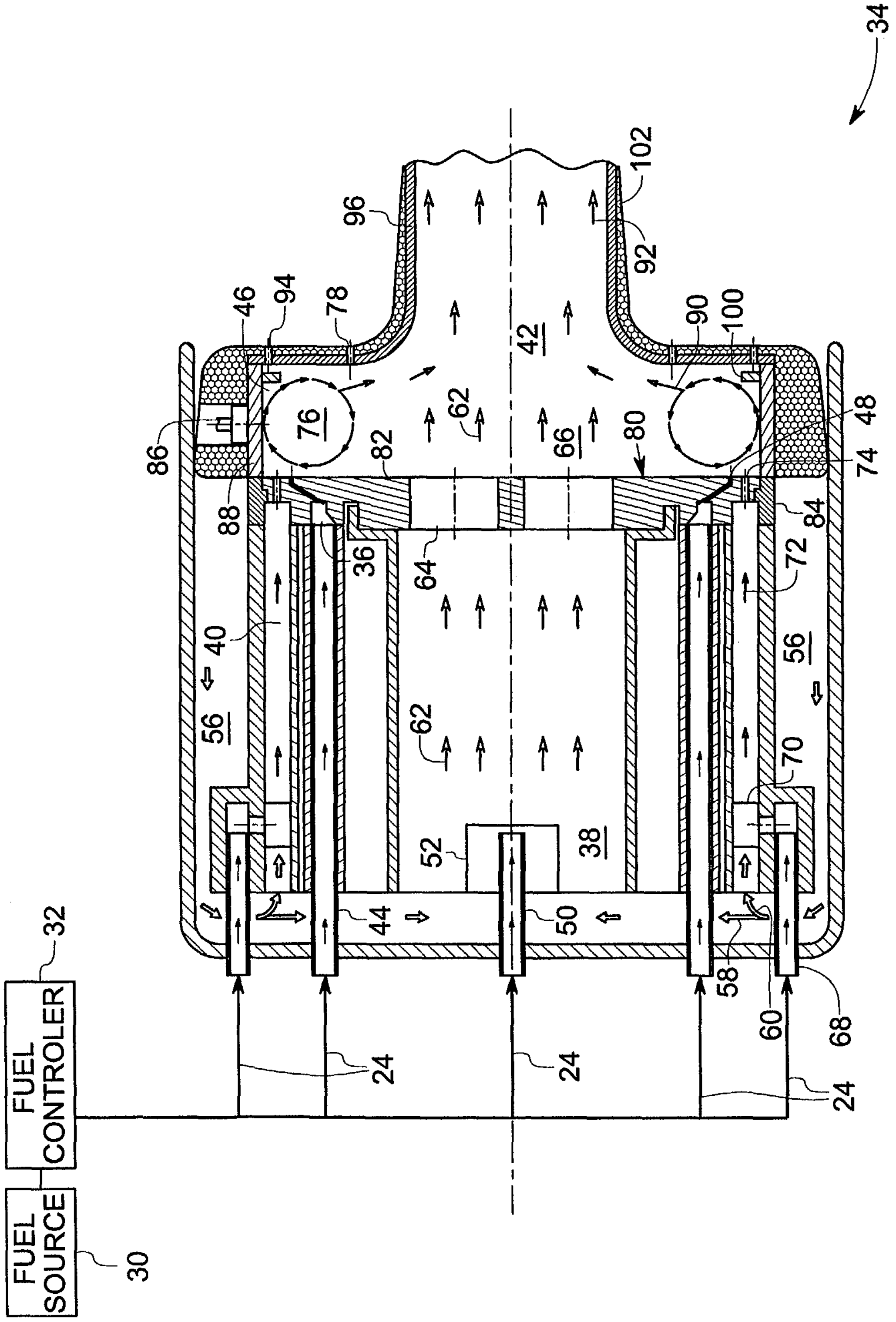
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FIG.2

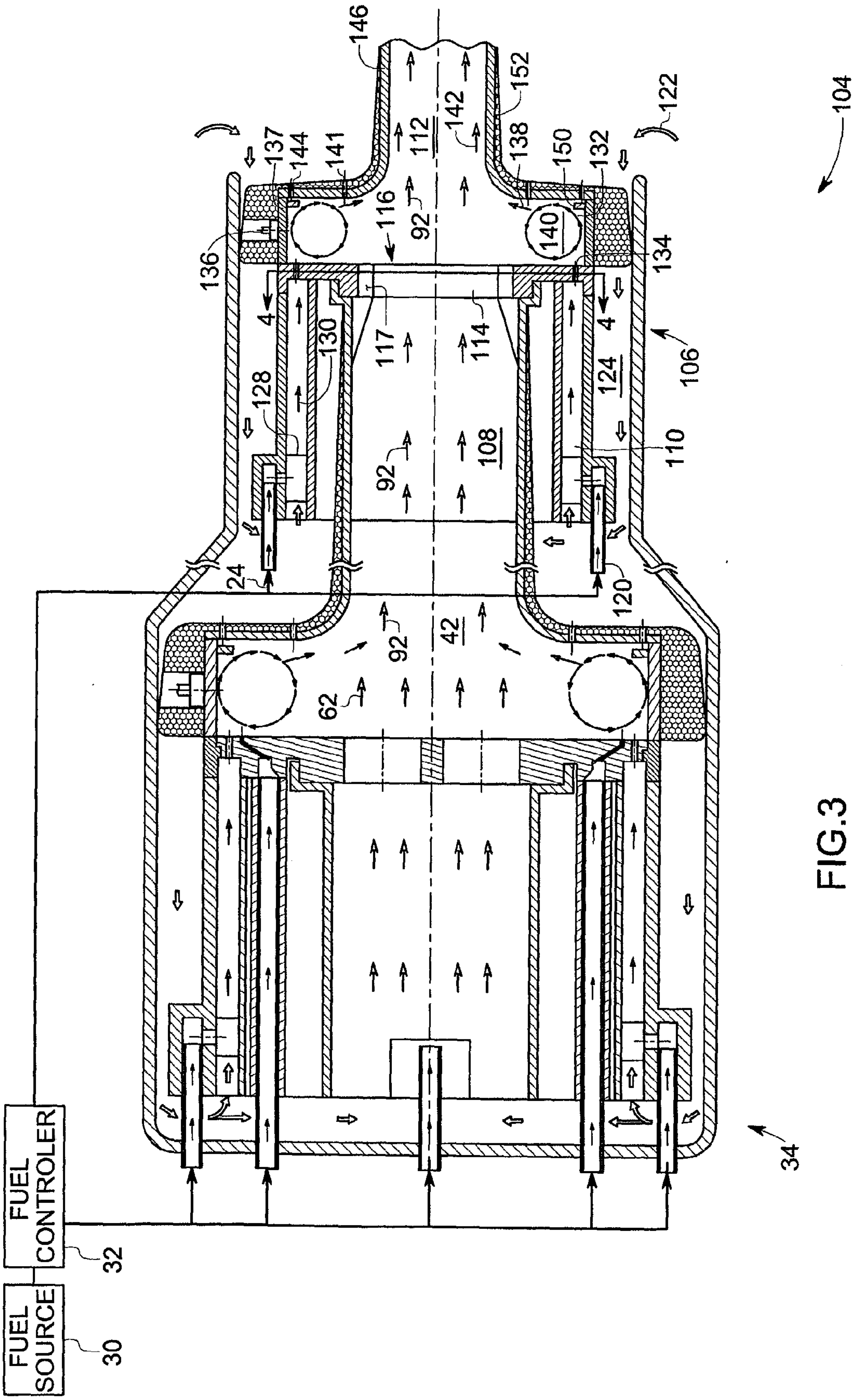
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FIG.3

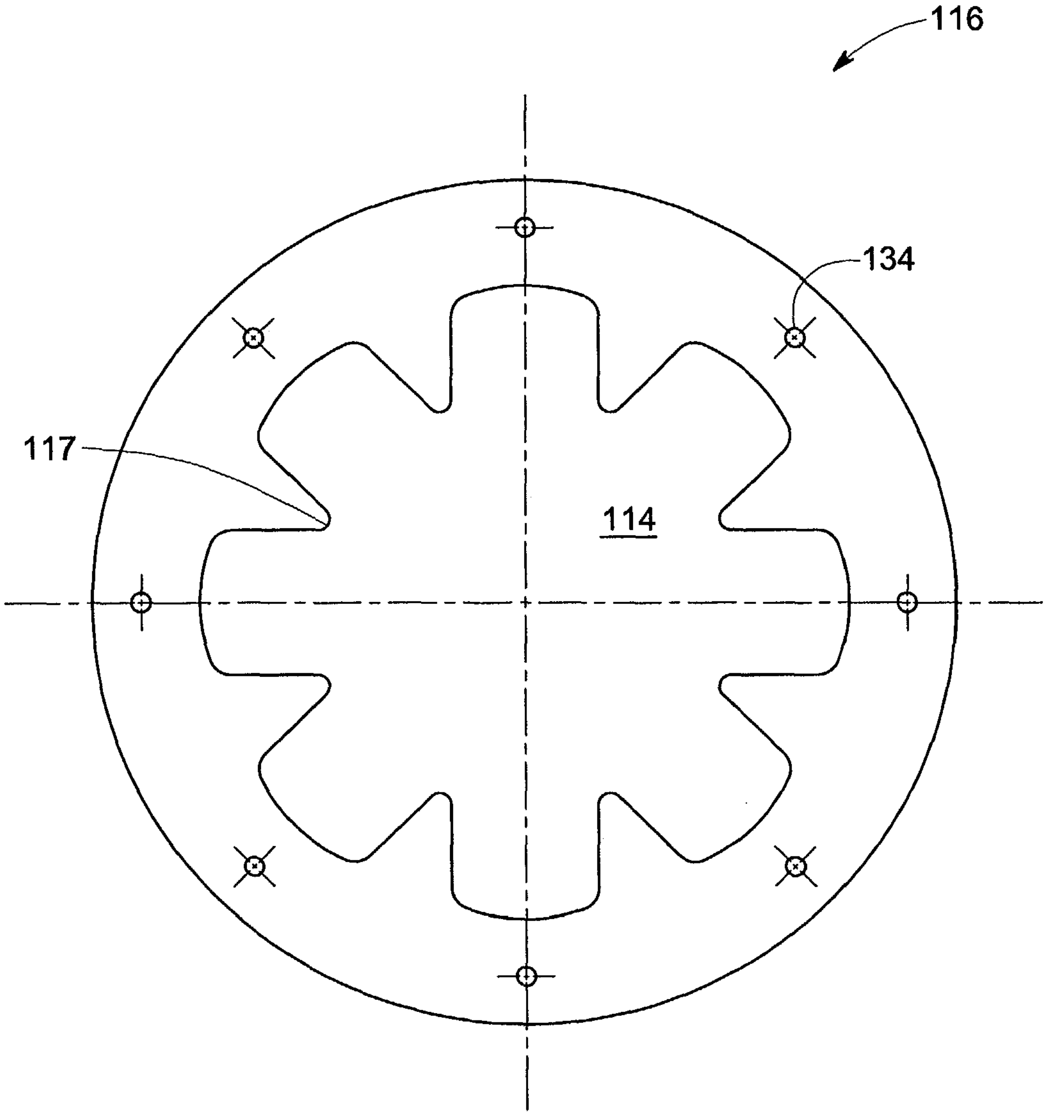

FIG.4

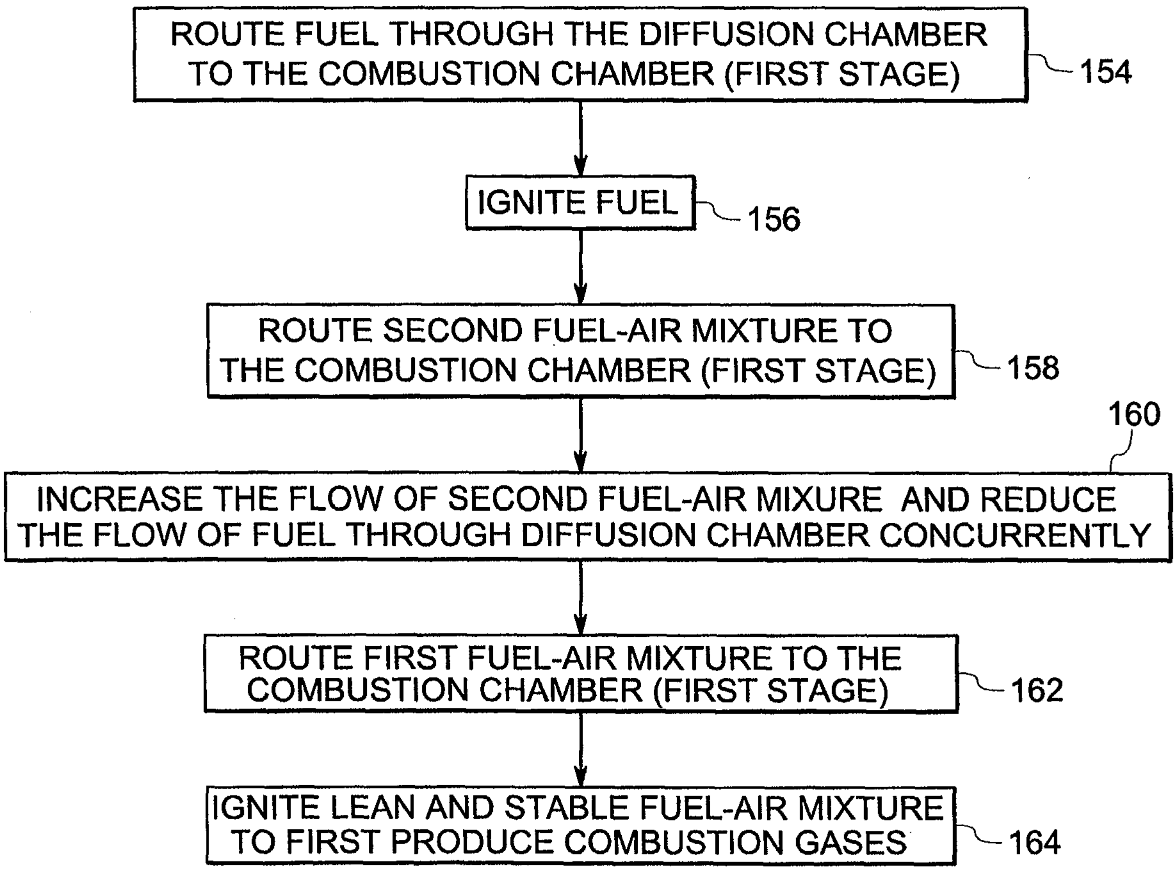
ROUTE FUEL THROUGH THE DIFFUSION CHAMBER TO THE COMBUSTION CHAMBER (FIRST STAGE)
154
IGNITE FUEL
156
ROUTE SECOND FUEL-AIR MIXTURE TO THE COMBUSTION CHAMBER (FIRST STAGE)
158
160
INCREASE THE FLOW OF SECOND FUEL-AIR MIXURE AND REDUCE THE FLOW OF FUEL THROUGH DIFFUSION CHAMBER CONCURRENTLY
ROUTE FIRST FUEL-AIR MIXTURE TO THE COMBUSTION CHAMBER (FIRST STAGE)
162
IGNITE LEAN AND STABLE FUEL-AIR MIXTURE TO FIRST PRODUCE COMBUSTION GASES
164

FIG.5

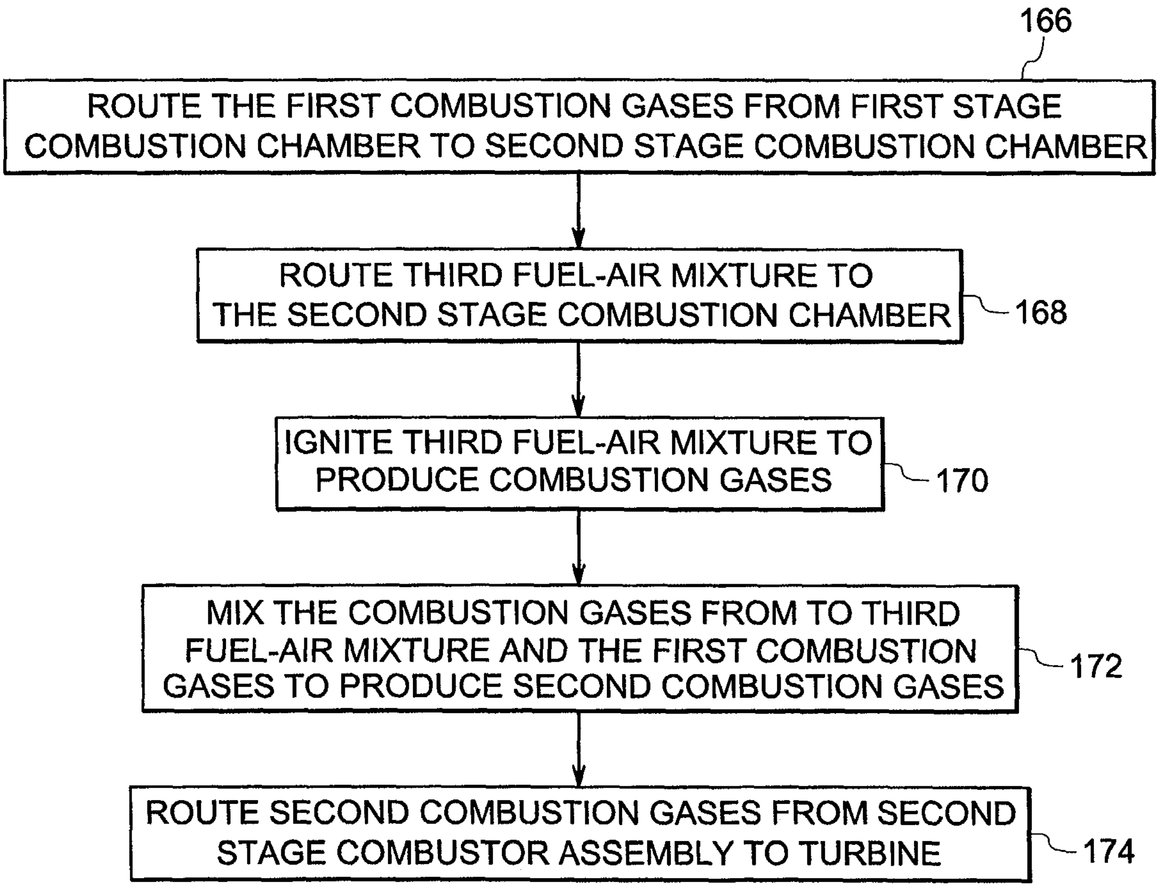
166
ROUTE THE FIRST COMBUSTION GASES FROM FIRST STAGE COMBUSTION CHAMBER TO SECOND STAGE COMBUSTION CHAMBER
ROUTE THIRD FUEL-AIR MIXTURE TO THE SECOND STAGE COMBUSTION CHAMBER
168
IGNITE THIRD FUEL-AIR MIXTURE TO PRODUCE COMBUSTION GASES
170
MIX THE COMBUSTION GASES FROM TO THIRD FUEL-AIR MIXTURE AND THE FIRST COMBUSTION GASES TO PRODUCE SECOND COMBUSTION GASES
172
ROUTE SECOND COMBUSTION GASES FROM SECOND STAGE COMBUSTOR ASSEMBLY TO TURBINE
174

FIG.6

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 25 4296

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 March 2006	Gavriliu, C

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