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(54) PREMIX BURNER FOR A GAS TURBINE ASSEMBLY FOR POWER PLANT PROVIDED WITH A PILOT LANCE SUITABLE TO BE FED WITH COMMON AND HIGHLY REACTIVE FUELS, METHOD FOR OPERATING THIS BURNER AND GAS TURBINE ASSEMBLY FOR POWER PLANT COMPRISING THIS BURNER

(57) Premix burner (34) of a gas turbine assembly, the premix burner comprising: a swirler (35)configured for swirling an air flow and provided with premix nozzles (36) connected to a first gas fuel source; a pilot lance (38) comprising: a cylindrical casing (39) having a base connected to the first gas fuel source and a tip (40) provided with a plurality of gas nozzles (41); at least a main duct (42) configured for being a channel for pilot fuel or compressed air and extending inside the casing from the base to the tip, each main duct having a tip end provided with at least a pilot nozzle (45); the premix burner moreover comprises at least an inner duct (44) extending inside the corresponding main duct, each inner duct having a first end connected to a second gas fuel source and a second end provided with an inner nozzle arranged upstream the pilot nozzles of the corresponding main duct so that between the inner nozzle and the corresponding pilot nozzle a mixing volume (46) is present for mixing H2-based gas fuel source fed into the inner duct and compressed air fed into the main duct.

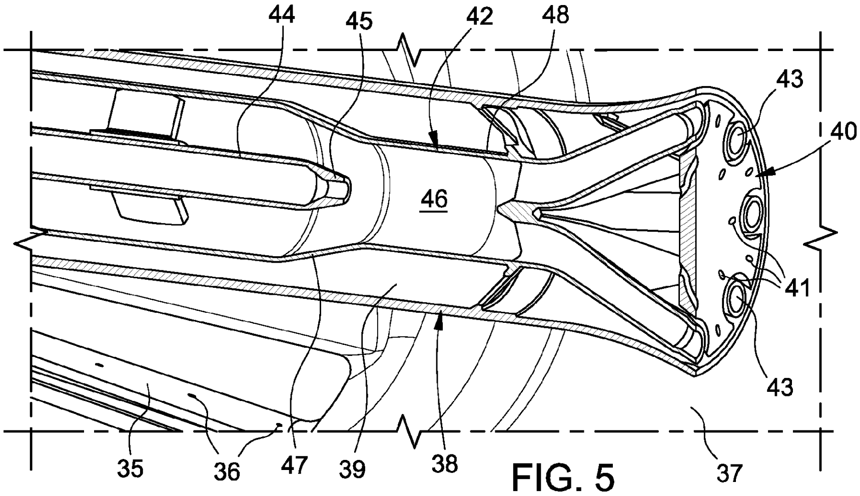

FIG. 5

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Description

Field of the Invention

[0001] The present invention relates to the technical field of the gas turbine assemblies for power plants (in the following only "gas turbine"). As known, in these assemblies an incoming air flow is compressed in a compressor and then mixed with fuel (gas fuel and/or oil fuel) in a combustor before entering in a turbine wherein the hot gas expansion generates a rotating work on a rotor in turn connected to a generator for power production. In particular, the present invention relates to all kinds of the above gas turbines (very general definition) wherein the combustor comprises at least a "premix burner". A premix burner is a burner configured not only for injecting the fuel in the compressed air flow but also for mixing (with a swirl) the compressed air and the fuel before injecting the mixture into the combustion chamber. In this context, the present invention refers to the problem of how to improve the premix burner in order to allow a feeding not only with common fuels and also with highly reactive fuel, for instance fuel comprising H2.

Description of prior art

[0002] As known, in general a gas turbine assembly for power plants (in the following only gas turbine) comprises a rotor, a compressor, a combustor and a turbine unit. The compressor is configured for compressing air supplied at a compressor inlet. The compressed air leaving the compressor flows into the combustor provided with a plurality of burners configured for injecting fuel in the compressed air. The mixture of fuel and compressed air flows into a combustion chamber where this mixture is combusted for generating a hot gas flow. The expansion of this hot gas flow inside the turbine generates a rotating work on the rotor in turn connected to a generator. As known, the turbine and the compressor comprise a plurality of stages, or rows, of rotor blades that are interposed by a plurality of stages, or rows, of vanes supported by an outer casing surrounding the assembly.

[0003] In order to achieve a high efficiency, a high turbine inlet temperature is required. However, in general this high temperature involves an undesired high NOx emission level. In order to reduce this emission and to increase operational flexibility without decreasing the efficiency, a so called "sequential" gas turbine is particularly suitable. In general, a sequential gas turbine comprises two combustors or combustion stages in series wherein each combustor is provided with a plurality of burners and with at least a combustion chamber. Usually, the upstream or first combustor comprises a plurality of so-called "premix burners".

[0004] In general a premix burner is a burner configured not only for injecting the fuel in the compressed air but also for mixing with a swirl the compressed air and the fuel before injecting the mixture into the combustion chamber. This swirling mixture is obtained by providing a swirling cone configured for generating a swirl in the air flow wherein this cone is provided with a plurality of fuel injecting nozzles (called premix nozzles). This swirling mixture allows to reduce the NOx emission but the generated flame is not enough stable under some conditions. In order to solve this problem of the premix flame stability, in the middle of the cone the burner is also provided with a pilot lance configured for injecting fuel in a more concentrate manner into a less turbulent air flow. The diffusion flame generate by the pilot is actually more stable but it generates a high NOx emission. In general, a premix burner is thus widely used because it allows to use a premix flame with low NOx emission during the normal operation and has the option to introduce a more stable diffusion pilot flame, if required for stability reasons. Usually, both stages are in operation wherein the majority of the fuel is fed to the premix nozzles for the low NOx and a small portion of the fuel is fed to the pilot for adding stability of the overall burner and to prevent "lean blow out" of the premix stage. Please notice that the present invention is not limited only to sequential gas turbines but it could be applied in all gas turbine provided with a premix burner as above described.

[0005] Starting from the above mentioned structure of a premix burner, today is present the need of improving the fuel flexibility while keeping low emission and high performance. In particular, a real challenge today is to use a highly reactive fuel, e.g. with high amounts of H2 or higher hydrocarbons (e.g. ethane, propane). Indeed, the increasing use of renewables for energy production is also accompanied by an increasing need for flexible power production, while aiming at carbon free emissions. The potential solutions of energy storage of excess generation from renewables through hydrogen production and precombustion carbon capture are gaining momentum. Thus, these scenarios require gas turbines capable of operation with hydrogen-based fuels. At the same time, the composition of natural gas considered for use within gas turbines is becoming significantly more variable due to increased use of liquefied natural gas and a wider range of gas sources and extraction methods. Fuel flexibility, both in terms of the amount of hydrogen and higher hydrocarbons is therefore of utmost importance in modern gas turbine development.

[0006] A change in fuel reactivity implies a change in flame location and behavior. In particular, higher fuel reactivity (like H2) forces the flame to move upstream, increasing NOx emissions, and potentially overheating the nozzles. Consequently, when burning highly reactive fuels (e.g. fuels containing large quantities of either higher hydrocarbons or hydrogen) the flame, in particular the premix flame, moves upstream compared to the case of natural gas, thus increasing the risk of flashback. A solution for avoiding this flashback of the premix flame could be to lower the flame temperature (by feeding less fuel) to the first stage combustor. However, the flame temperature cannot be lowered beyond a certain limit, called "lean blow out" temperature, because under this temperature the operation of the combustor is compromised. Thus, today the solution offered by the prior art practice in case of using highly reacting fuels is to switch a relevant part of the fuel from the premix nozzles to the pilot. For instance, it is diverted up to 10-40% of the total fuel to the pilot lance (Vs 0-10% in case of natural gas operation). As known, the pilot flame is not premixed and is operating in a diffusion flame mode. The consequence is high NOx emissions which can be only party compensated by the further oxidation along the system.

[0007] Thus, this solution cannot be accepted as a best practice because the pilot generates high NOx emissions and therefore a large amounts of diluents (nitrogen, steam) need to be added in the gas flow and/or selective catalytic reduction devices have to be used to keep the NOx emissions below the limits.

[0008] Moreover, please be notice that the common pilot system is not designed for such high pilot fuel rates. Diverting gas into the emulsion system also implies higher cost and complexity for auxiliaries and fuel distribution system and this solution does not solve the problem related to the high Nox emission due to a diffusion flame.

<u>Disclosure of the invention</u>

[0009] Accordingly, a primary object of the present invention is to provide a premix burner for a gas turbine assembly for power plants and a method for operating this burner for overcoming the drawbacks of the current prior art practice. In particular, the scope of the present invention is to provide a premix burner having a pilot lance configured to be selectively fed by common (natural) gas fuels and by highly reactive gas fuel, for instance H2-based fuel having an high % of H2 (in vol. up to 100%) . In particular, the scope of the present invention is to provide a pilot lance wherein in case of h2-based gas fuel feeding a relevant part of this fuel can be deviated from the premix nozzles (flashback problem) to the pilot lance without the generation high Nox emission. As will be clear in the following, the main idea at the base of the invention is to create a mixing volume inside the pilot lance wherein the H2-based fuel and air can be mixed prior reaching the pilot nozzles. In other words, the scope is to provide a kind of a premix pilot lance.

[0010] A premix burner structure suitable to be improved by the invention is a premix burner comprising:

- a swirler configured for swirling an air flow and provided with premix nozzles connected to a first gas fuel source, a natural gas fuel for instance or a gas fuel in general that can be fed to the premix nozzles without flashback problems;
- a pilot lance extending to the swirler and having a tip with a plurality of gas nozzles.

[0011] The above pilot lance comprises:

- a cylindrical casing acting as a plenum for the gas fuel and having a base connected to the first gas fuel source and a tip provided with a plurality of gas nozzles;
- at least a main duct acting as a channel extending inside the casing from the base to the tip.

[0012] Each main duct have a base end connected to a compressed air source and a tip end provided with at least an pilot nozzles.

[0013] The feeding of the natural gas to the premix nozzles and/or to pilot gas nozzle are depending of the composition of the gas fuel and on the engine load.

[0014] According to a first aspect of the invention, the premix burner moreover comprises:

- at least an inner duct extending inside the corresponding main duct, wherein each inner duct has a first end connected to a second or pilot gas fuel source and a second end provided with an inner nozzle arranged upstream the pilot nozzles of the corresponding main duct so that between the inner nozzle and the corresponding pilot nozzle a volume is present.

[0015] The second gas fuel source is a H2-based gas fuel source or a source of highly reactive gas fuel that if fed to the premix nozzles may generate flashback problems.

[0016] In case of switching of feeding from natural gas to H2 gas fuel, this kind of gas is proportionally fed to the new inner duct whereas compressed air is fed to the main duct so that during H2-based gas fuel operation the volume between the inner nozzle and the pilot nozzles inside each main duct is a mixing volume for mixing the H2-based gas fuel with air before reaching the corresponding pilot nozzle. Due to this mixing before the injection, the corresponding flame generates an acceptable amount of NOx emission.

[0017] According to a first embodiment, the lance comprises a single main duct provided with a plurality of pilot nozzles and a single inner duct concentric with respect to the main duct.

[0018] According to an alternative embodiment, the pilot lance comprises a plurality of parallel main ducts wherein each main duct comprises a single pilot nozzle and each main duct houses an inner duct concentric with respect to the corresponding main duct.

[0019] Preferably, the mixing volume is limited bay walls defining a cone portion at the inner nozzle and a tubular portion between the inner nozzle and the tip.

[0020] Of course also the premix nozzles may be connected to the H2-based gas fuel source so that a minimal part of this fuel can anyway directed to the swirler.

[0021] The invention is not limited to a particular kind of gas turbine assembly but it can be applied to a general gas turbine comprising:

- a compressor for generating a compressed air flow;
- a combustor for adding fuel the compressed air and generating a hot gas flow;
- a turbine driven by the hot gas flow.

[0022] Therefore, the gas turbine may involve a single combustion stage or a double/sequential combustion. The following detailed description will refer to two not limiting example of sequential combustion gas turbines.

[0023] A first feature of the present invention is to provide a first gas fuel source and a second gas fuel source wherein the first source delivers natural gas fuel and the second source delivers H2-based gas fuel. Of course, the H2 fuel and natural gas may be mixed before the feeding in order to supply a fuel blend with various H2 content. In this sense with the term H2 fuel source we mean a feeding a fuel having a high H2 content. Indeed, the scope of the present invention is, as foregoing cited, to provide a premix burner configured to be selectively fed by common (natural) gas fuels and by highly reactive gas fuel. Please notice that the source may be proximal or distal with respect to the burner and each source may comprise more than one feeding lines for feeding with the same fuel a plurality of components of the gas turbine.

[0024] As an example, the swirler can be realized in form of a cone body and a tubular body may be provided downstream the swirler.

[0025] As evident from the above description, the invention refers also to a method for operating such a premix burner; the method comprising the steps of:

a) providing a premix burner as described ;

b) feeding the premix nozzles and/or the pilot gas nozzles with natural fuel coming from the first fuel source whereas the feeding of the inner duct is not operated;

c) stopping or decreasing the feeding of the premix nozzles and/or the pilot gas nozzles and starting with the feeding of the inner duct with H2-based fuel coming from the second fuel source.

[0026] For returning to a pure natural gas feeding, the method may comprise also the step of:

d) stopping the feeding of the inner duct and re-starting or increasing with the feeding of the premix nozzles and/or the pilot gas nozzles.

[0027] The phases in steps c) and/or d) may be performed simultaneously or a double feeding may be temporary performed.

[0028] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed. Other advantages and features of the invention will be apparent from the following description, drawings and claims.

[0029] The features of the invention believed to be novel are set forth with particularity in the appended claims.

List of drawings

[0030] Further benefits and advantages of the present invention will become apparent after a careful reading of the detailed description with appropriate reference to the accompanying drawings.

[0031] The invention itself, however, may be best understood by reference to the following detailed description of the invention, which describes an exemplary embodiment of the invention, taken in conjunction with the accompanying drawings, in which:

- figure 1 is a first example of a gas turbine that can be provided with a premix burner according to the invention;
- figure 2 is a second example of a gas turbine that can be provided with a premix burner according to the invention;
- figure 3 is an example of a premix burner that can be provided with a pilot lance according to the invention
- figure 4 is an example of a pilot lance according to the prior art;
- figure 5 is an example of a pilot lance according to the invention;
- figures 6 and 7 are two different embodiments of pilot lances according to the invention.

Detailed description

[0032] In cooperation with attached drawings, the technical contents and detailed description of the present invention are described thereinafter according to preferred embodiments, being not used to limit its executing scope. Any equivalent variation and modification made according to appended claims is all covered by the claims claimed by the present invention.

[0033] Reference will now be made to the drawing figures to describe the present invention in detail.

[0034] Reference is now made to Fig. 1 that is a schematic view of a first example of a gas turbine 1 comprising a sequential combustor that can be operated according to the method of the present invention. In particular, figure 1 discloses a gas turbine with a high pressure and a low pressure turbine. Following the main gas flow 2, the gas turbine 1 of figure 1 comprises a compressor 3, a first combustor 31, a high-pressure turbine 5, a second combustor 32 and a low-pressure turbine 7. The compressor 3 and the two turbines 5, 7 are part of or are connected to a common rotor 8 rotating around an axis 9 and surrounded by a concentric casing 10. The compressor 3 is supplied with air and is provided with rotating blades 18 and stator vanes 19 configured for compressing the air entering the compressor 3. Once left the compressor, the compressed air flows into a plenum 11 and from there into a plurality of first burners 12 of the first combustor 31 arranged as a ring around the axis 9. Each first burner 12 in configured for injecting fuel (supplied by a first fuel supply 13) in the air flow, in particular this first burner 12 may be defined as a "premix" burner because in configured for mixing the air and the injected fuel before the ignition point. Figures 4 and 5 (that will be described in the following) disclose an example of a premix burner according to the present invention. The fuel/compressed air mixture flows into a first combustion chamber 4 annularly shaped where this mixture are combusted via a forced ignition, for instance by a spark igniter. The resulting hot gas leaves the first combustor chamber 4 and is partially expanded in the high-pressure turbine 5 performing work on the rotor 8. Downstream of the high-pressure turbine 5 the hot gas partially expanded flows into a second burner 33 where fuel supplied by a fuel lance 14 is injected. The partially expanded gas has a high temperature and contains sufficient oxygen for a further combustion that occurred based on a self-ignition in the second combustion chamber 6 arranged downstream the second burner 33. This second burner 33 is also called "reheat" burner. The reheated hot gas leaves the second combustion chamber 6 and flows in the low-pressure turbine 7 where it is expanded performing work on the rotor 8. The low-pressure turbine 7 comprises a plurality of stages, or rows, of rotor blades 15 arranged in series in the main flow direction. Such stages of blades 15 are interposed by stages of stator vanes 16. The rotor blades 15 are connected to the rotor 8 whereas the stator vanes 16 are connected to a vane carrier 17 that is a concentric casing surrounding the low-pressure turbine 7.

[0035] Reference is now made to Fig. 2 that is a schematic view of a second example of a gas turbine 20 comprising a sequential combustor that can be operated according to the method of the present invention. In particular, figure 2 discloses a gas turbine 20 provided with a compressor 29, one turbine 21 and a sequential combustor 22. The sequential combustor 22 of figure 2 comprises a plurality of so-called can combustors, i.e. a plurality of cylindrical casings wherein each can combustor houses a plurality of first burners 24, for instance four first burners 24, a first combustion chamber 25, a second burner 26, and a second combustion chamber 27. Upstream the second burner 26 an air mixer (not represented) may be provided configured for adding air in the hot gas leaving the first combustion chamber 25. The sequential combustor arrangement is at least in part housed in an outer casing 28 supporting the plurality of can combustor 22 arranged as a ring around the turbine axis. A first fuel is introduced via a first fuel injector (not shown) into the first burners 24 wherein the fuel is mixed with the compressed gas supplied by the compressor 29. Also each first burner 24 of this embodiment is a "premix" burner configured for generating a premix flame and a diffusion flame. Each first burner 24 of figure 2 and each first burner 12 of figure 1 is independently operable, i.e. each first burner may be switched off independently on the other first burners and each first burner may be operated independently in terms of ratio between the fuel injected in the diffusion mode and the fuel injected in the premix mode. Finally, the hot gas leaving the second combustion chamber 27 expands in the turbine 21 performing work on a rotor 30.

[0036] Reference is now to figure 3 that is an example of a premix burner suitable to be improved by the invention. According to this example the premix burner 34 comprises:

- a cone body 35 having an upstream end fed by compressed air M and an enlarged downstream end; wherein the cone body (as known) is configured for swirling the air flow and it is provided with premix injection nozzles 36 connected to a first gas fuel (natural gas fuel) source;
- a tubular body 37 having a first end connected to the downstream end of the cone body 35 and a second end towards the combustion chamber;
- a pilot lance 38 axially extending in the middle of the burner and having a downstream end housed in the tubular body 37 upstream the second end of the tubular body 37;

[0037] The above structure is well known by the skill person and thus no additional detail is due for a clear understanding of the context of the invention. Figure 4 discloses in detail a known pilot lance 38. This figures allow to disclose that, in general, a pilot lance 38 comprises:

- a cylindrical casing 39 that acts as a plenum for the gas fuel having a base connected to the first gas fuel source and a tip 40 provided with a plurality of gas nozzles;
- a main duct 42 that acts as a channel for fuel and extending inside the casing 39 from the base to the tip 40, wherein each main duct 42 has a base end connected to a fuel source and a tip end provided with a plurality of nozzles.

[0038] Figure 5 discloses an example of a pilot lance according to the invention, i.e. a pilot lance modified with respect to figure 4 in order to be suitable to be fed by h2-based fuel. According to the example of figure 5, the main duct 42 has a base end connected to a compressed air source and a tip with a plurality of pilot nozzles 43. The lance 38 moreover comprises an inner duct 44 extending inside the main duct 42 and having a first end connected to a second or pilot gas fuel source and a second end provided with an inner nozzle 45. This inner nozzle is arranged upstream to the pilot nozzles 43 of the main duct 42 so that between the inner nozzle 45 and the pilot nozzles 43 a volume 46 is present.

[0039] During H2-based fuel operation, the feeding of the premix nozzles is stopped or reduced and the feeding of H2-based gas fuel is open to the inner duct. In the same time the main duct 42 is also fed by compressed air so that the volume 46 becomes a mixing volume for the H2-based gas fuel and the compresses air before. Thus, the gas fuel reaches pilot nozzles 43 already mixed with the air and corresponding less NOx emissions are generated. According to the example of figure 5, the pilot nozzles are not parallel with the axis A of the burner but are arranged so that the premixed H2 fuel is injected directly into the shear layer between swirl flow from the premix stage and bluff body recirculation generated by the lance tip (these terms are well known by the skilled person).

Figure 6 discloses in a more schematic view the above configuration wherein the lance comprises a single main duct 42 provided with a plurality of pilot nozzles 43 and a single inner duct 44 concentric with respect to the main duct 42.
Figure 7 discloses a different embodiment wherein the lance comprises a plurality of parallel main ducts 42 and each main duct 42 houses an inner duct 44 concentric with respect to the corresponding main duct 42.

[0040] In the example disclosed in these figures, the mixing volume 46 comprises a cone portion 47 and a tubular portion 48.
[0041] Finally, of course also the premix nozzles 36 may be connected to the H2-based gas fuel source for allowing minimal feeding of this fuel also to the swirler.
[0042] Although the invention has been explained in relation to its preferred embodiment(s) as mentioned above, it is to be understood that many other possible modifications and variations can be made without departing from the scope of the present invention. It is, therefore, contemplated that the appended claim or claims will cover such modifications and variations that fall within the true scope of the invention.

Claims

1. Premix burner (34) of a gas turbine assembly for a power plant, the premix burner (34) comprising:

   - a swirler (35) configured for swirling an air flow (M) and provided with premix nozzles (36) connected to a first gas fuel source;
   - a pilot lance (38);

   wherein the pilot lance (38) comprises:

   - a cylindrical casing (39) having a base connected to the first gas fuel source and a tip (40) provided with a plurality of gas nozzles (41);
   - at least a main duct (42) configured for being a channel for pilot fuel or compressed air and extending inside the casing (39) from the base to the tip (40), each main duct (42) having a tip end provided with at least a pilot nozzle (43) ;

   characterized in that the premix burner moreover comprises:

   - at least an inner duct (44) extending inside the corresponding main duct (42), each inner duct (44) having a first end connected to a second gas fuel source and a second end provided with an inner nozzle (45) arranged upstream the pilot nozzles (43) of the corresponding main duct (42) so that between the inner nozzle (45) and the corresponding pilot nozzle (42) a volume is present (46);

   wherein the second gas fuel source is a H2-based gas fuel source and the first end of each main duct (42) being also connected to a compressed air source so that during H2-based gas fuel operation the volume(46) between the inner nozzle (45) and the pilot nozzles (43) inside each main duct (42) is a mixing volume (46) for mixing the H2-based gas fuel with air before reaching the corresponding pilot nozzle (43) .

2. Premix burner as claimed in claim 1, wherein the lance comprises a single main duct (42) provided with a plurality of pilot nozzles (43) and a single inner duct (44) concentric with respect to the main duct (42).

3. Premix burner as claimed in claim 1, wherein the pilot nozzles (43) are not parallel with the axis (A) of the burner.

4. Premix burner as claimed in claim 1, wherein lance comprises a plurality of parallel main ducts (42), each main duct (42) comprises a single pilot nozzle (43) and each main duct (42) houses an inner duct (44) concentric with respect to the corresponding main duct (42).

5. Premix burner as claimed in any one of the foregoing claim 1, wherein the mixing volume (46) comprises a cone portion (47) and a tubular portion (48).

6. Premix burner as claimed in any one of the foregoing claim 1, wherein also the premix nozzles (36) are connected to the H2-based gas fuel source.

7. A method for operating a premix burner of a gas turbine assembly for a power plant; the method comprising the steps of:

   a) providing a premix burner as claimed in any one of the foregoing claims;
   b) feeding the premix nozzles and/or the pilot gas nozzles with gas fuel coming from the first fuel source whereas the feeding of the inner duct of the lance is not operated;

c) stopping or reducing the feeding from the first fuel source of the premix nozzles and/or the pilot gas nozzles and starting whit the feeding of the inner duct of the lance with the H2-based fuel and the main duct with compressed air.

8. Method as claimed in claim 7, wherein the method comprises the step of:
d) stopping the feeding the inner duct of the lance and re-starting or increasing whit the feeding of the premix nozzles and/or the pilot gas nozzles with gas fuel coming from the first fuel source.

9. Method as claimed in claim 7 or 8, wherein the stopping and starting phases in steps c) and/or d) are performed simultaneously or a double feeding may be temporary performed.

10. Gas turbine for power plant, the gas turbine comprising:

- a compressor for generating a compressed air flow;
- a combustor for adding fuel the compressed air and generating a hot gas flow;
- a turbine driven by the hot gas flow;
- a first gas fuel source;
- a second gas fuel source;

wherein the combustor comprises at least a premix burner according to any one of the foregoing claims from 1 to 6.

11. Gas turbine according to claim 9, wherein the gas combustor is a sequential combustor (22), the sequential combustor (22) comprising:

- a first combustor provided with a plurality of premix burners (12, 24);
- a second combustor provided with a plurality of second burners (26, 33), fed by hot gas leaving the first combustor.

12. Gas turbine as claimed in claim 11, wherein the first and the second combustor are annular shaped and divided by a stage of turbine.

13. Gas turbine as claimed in claim 11, wherein the sequential combustor comprises a plurality of can combustors, each can combustor comprising the first and the second combustor divided by a dilution air mixer.

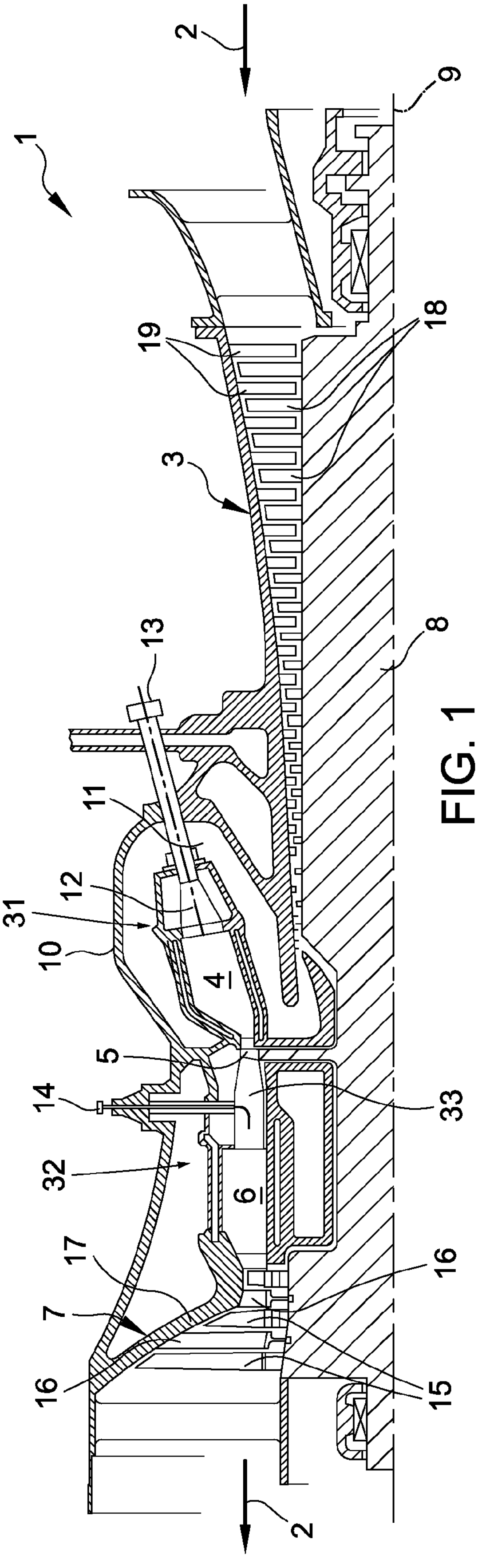
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FIG. 1

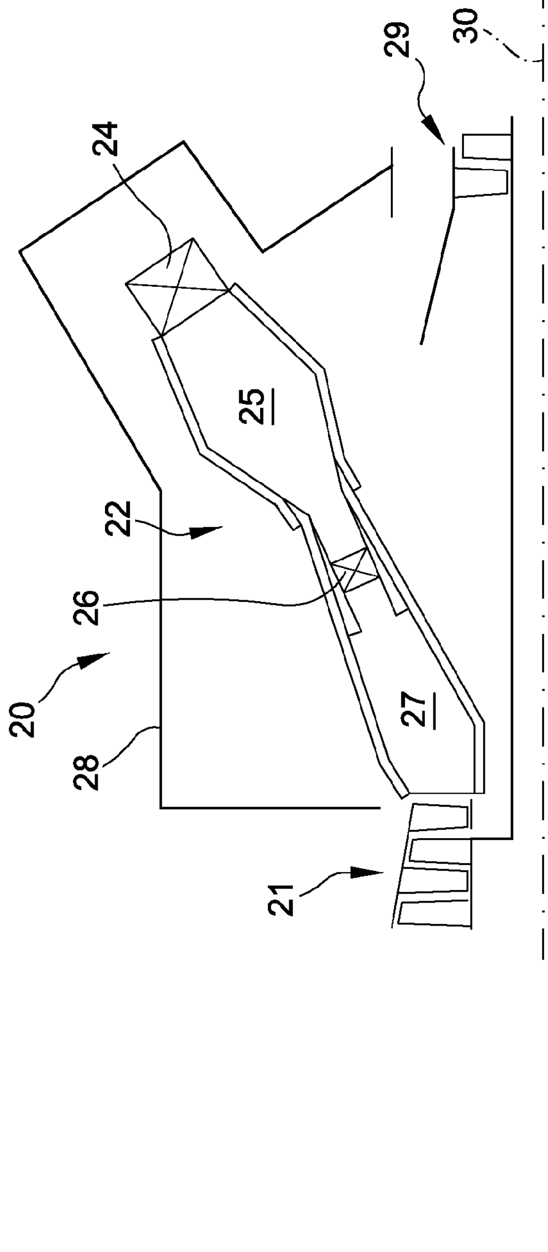
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FIG. 2

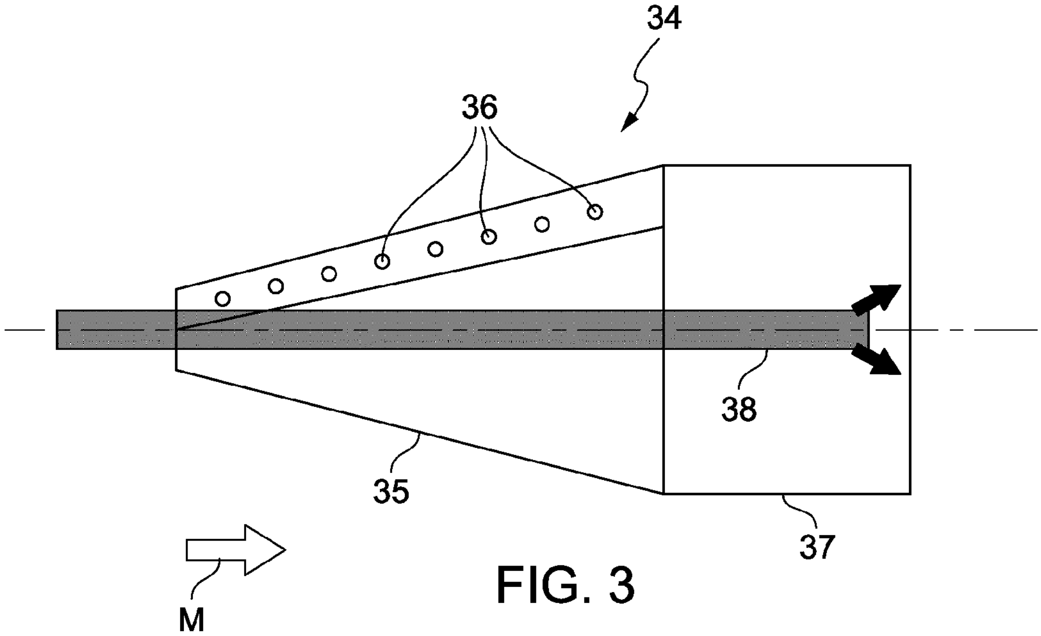

FIG. 3

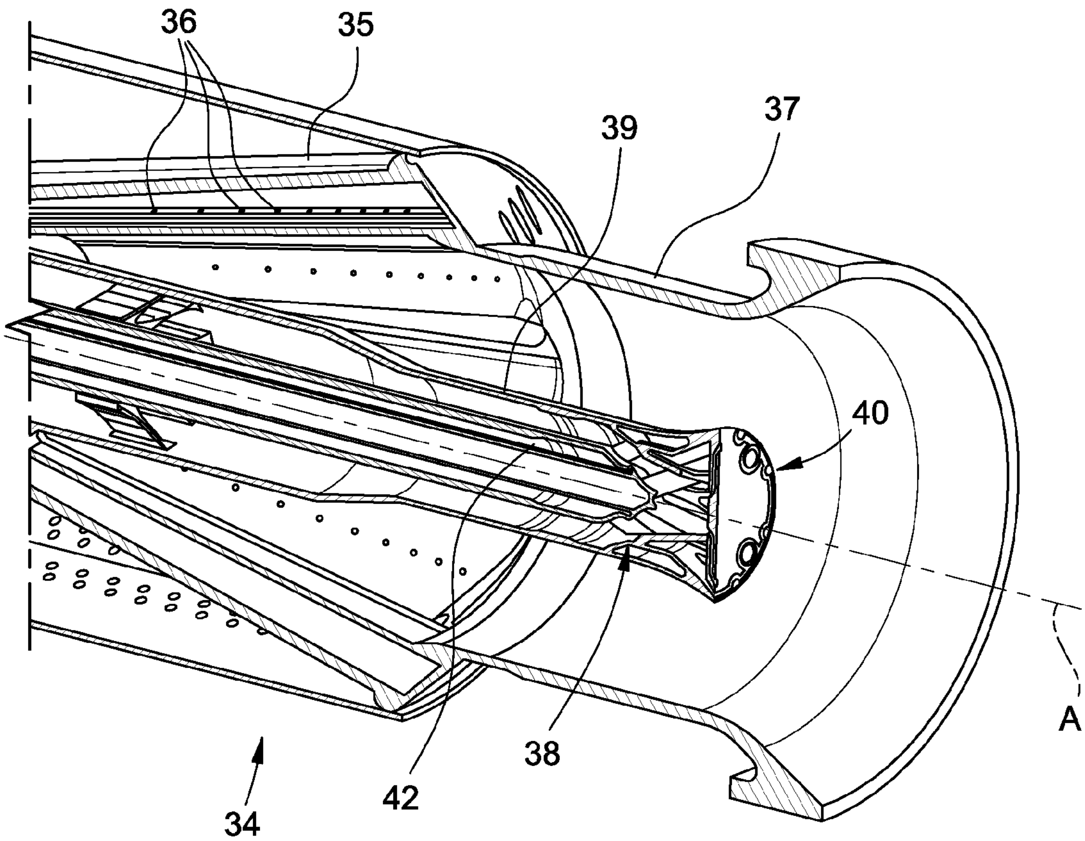

FIG. 4

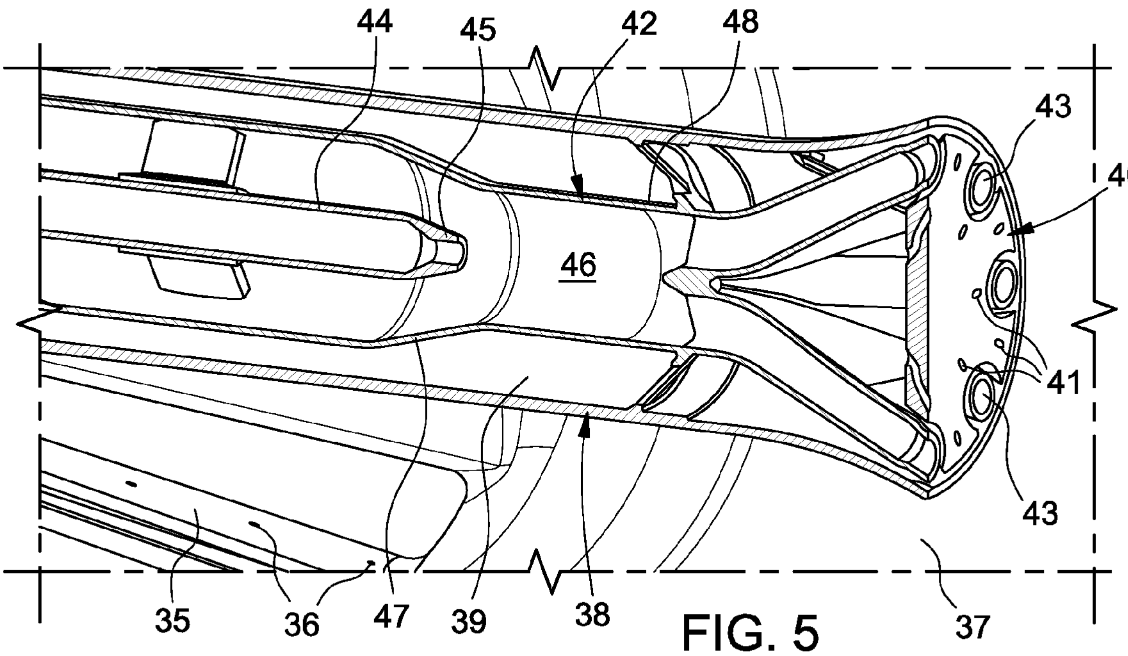

FIG. 5

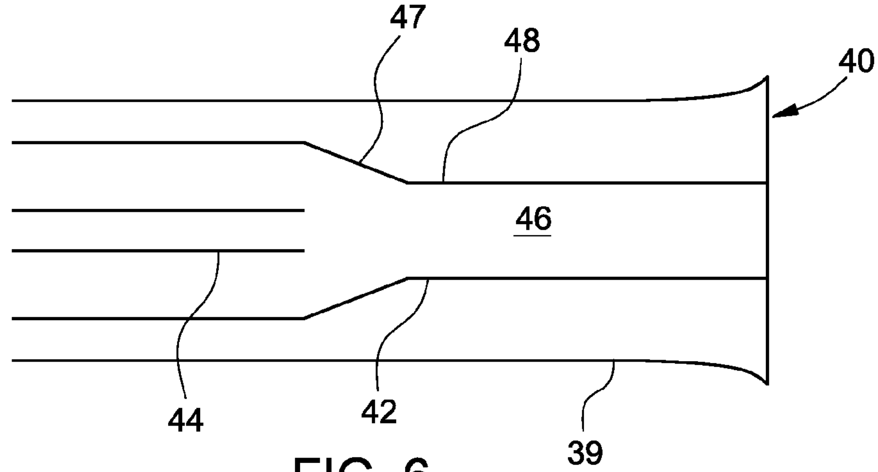

FIG. 6

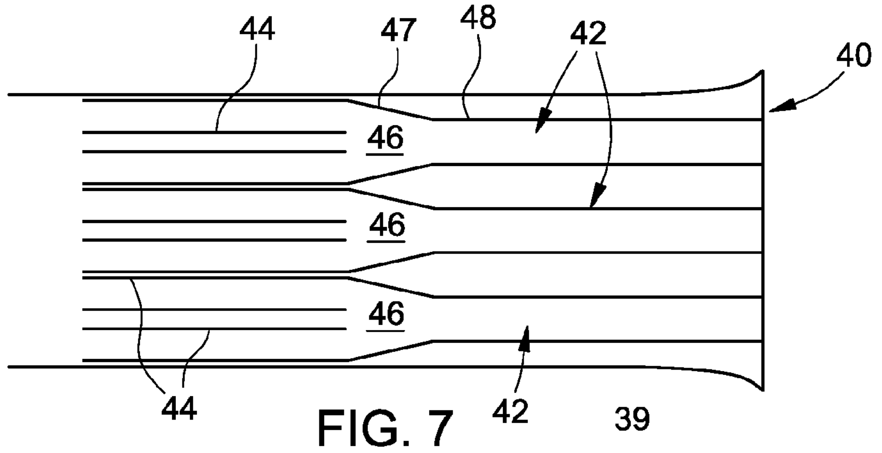

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 7779

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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