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(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**  
**80333 München (DE)**

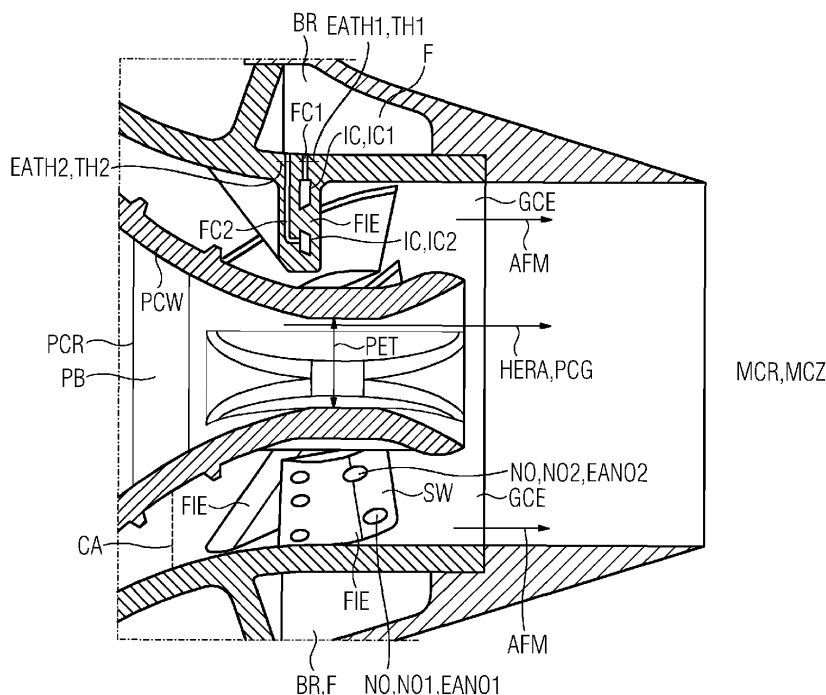
(72) Inventors:  
• **Karlsson, Andreas**  
**91532, ROBERTSFORS (SE)**  
• **Milosavljevic, Vladimir**  
**60226, Norrköping (SE)**

(54) **Gas turbine burner**

(57) The present invention refers to a gas turbine burner (GTB) comprising:  
- a main combustion room (MCR) containing a main combustion zone (MCZ) for burning a mixture of air and fuel (AFM),  
- at least one gas channel (GC) for supplying a stream of oxygen containing gas (OCG) to the main combustion zone (MCZ) through a gas channel exit (GCE), which gas channel (GC) is confined by channel walls (CW),  
- at least one fuel injection element (FIE) protruding from

the channel wall (CW), comprising an inner cavity (IC) being supplied with fuel (F), which inner cavity (IC) joins into at least one nozzle opening (NO) of at least one nozzle (NO) of the fuel injection element (FIE) to inject fuel (F) into the gas channel (GC). To enhance especially stability and efficiency and to lower emissions it is proposed to provide said fuel injection element (FIE) with at least two separate inner cavities (IC), a first inner cavity (IC1) joining into at least a first nozzle opening (NO1) and a second inner cavity (IC2) joining into at least a second nozzle opening (NO2).

**FIG 2**



## Description

### Field of the invention

**[0001]** The present invention refers to a gas turbine burner comprising:

- a main combustion room containing a main combustion zone for burning a mixture of air and fuel,
- at least one gas channel for supplying a stream of oxygen containing gas to the main combustion zone through a gas channel exit, which gas channel is confined by channel walls.

### Technical background

**[0002]** Gas turbine engines comprising a gas turbine burner of the incipiently mentioned type are employed in a variety of applications, for example stationary power generation, military automotive application, marine application and as industrial drives to name only some examples. Some major fields of development deal with respectively the decreasing of fuel consumption, lowering emissions - especially NO<sub>x</sub> (nitrogen oxides) or reducing noise, improving fuel flexibility, lengthening lifetime of the components of the gas turbine and increasing reliability and availability of the gas turbine and its components. Most of the above objectives are depending on one to another and reveal to be contradictory. For example: the efficiency may be increased by an increase of the operating temperature, which on the other hand has the effect that NO<sub>x</sub> emissions are increased and the expected lifetime of the hot gas components is reduced.

### Summary of the invention

**[0003]** One objective of the invention is the reduction of emissions without lowering the efficiency. A further objective is the increase of stability without increasing fuel consumption. Still a further objective of the invention is to increase fuel flexibility with regard to the amount of fuel consumed by the burner.

**[0004]** The above objectives are at least partly full filled by a gas turbine burner of the incipiently mentioned type with the further features of the characterizing portion of claim 1.

**[0005]** The main combustion room according to the invention is an enclosure confined by main combustion room walls comprising means for supply of oxygen containing gas and fuel. The oxygen containing gas can be air and can be premixed with the fuel before entering the main combustion room and burning in the main combustion zone contained by the main combustion room. Further the main combustion room comprises an exhaust for ejecting the hot combustion gas preferably in a downstream located turbine for conversion of the kinetic energy contained in the hot combustion gas into the motion of a turbine rotor. The main combustion room can com-

prise a recirculation zone, by which at least a part of the combustion gas generated in the main combustion zone is recirculated with a fresh mixture of fuel and oxygen containing gas to generate further hot combustion gas to be processed in the downstream turbine.

**[0006]** The gas channel according to the invention needs not to be the only fuel and oxygen containing gas supply to the main combustion zone but preferably is only one of several possible fuel and gas supplies. The fuel injection element according to the invention is basically a protrusion from the confining channel wall and can be of any shape. An essential feature of said fuel injection element is that at least two nozzles respectively two sets of nozzles are supplied with fuel to be injected into the fuel gas channel from two different and separate cavities. Each one of said cavities supplies fuel - preferably a gaseous fuel to a specific set of nozzles. By dividing the fuel distribution in such a way, fuel is distributed more homogeneously compared to the conventional mode of fuel injection. The pressure in the cavities can be adjusted individually to obtain the best possible fuel distribution downstream the fuel injection elements. Depending on said pressure, the specific geometry and location of the nozzles and the geometric specifications of the channel as well as the aerodynamic parameters of the flow of said oxygen containing gas may be the input for a computational fluid dynamic analysis leading a person with ordinary skill in the art to the specific geometric design based on the idea of the invention.

**[0007]** The dependent claims comprise features of preferred embodiments of the invention.

**[0008]** The first inner cavity may advantageously be connected to a buffer room by a first fuel channel and the second inner cavity may advantageously be connected to said buffer room by a second fuel channel, wherein the first fuel channel is provided with a first throttle and the second fuel channel is provided with a second throttle to imprint a certain pressure drop on the flow through said first and second fuel channel respectively. Said respective throttles provided in said fuel channels conducting fuel to the inner cavities maybe of fixed cross sectional area size and chosen according to a specific operation point intended for the gas turbine burner. To obtain a higher degree of flexibility these throttles maybe adjustable. One preferred embodiment is a manually adjustable throttle. To adjust the throttle during operation to specific conditions the throttles maybe provided as automatic valves controlled by a specific control unit.

**[0009]** Preferably the cross section area of the opening of the throttle is chosen or adjusted such that an exit area of the respective throttle is at least three times bigger than the sum of the exit areas of the nozzles in which the respective connected inner cavity joins into. Accordingly said control unit can be made to fulfill this design rule, too. The exit area of the throttle is hereby defined as the smallest cross sectional area with regard to the flow direction through the throttle. Referring to the sum of the exit areas of the nozzles, this parameter can be deter-

mined as the sum of the respective smallest cross section with regard to the flow through the set of nozzles assigned to a specific inner cavity. Said proportion of the exit areas leads to a sufficient pressure drop during the ejection of the fuel into said gas channel, which leads to better predictability of fuel pressures in the inner cavities respectively.

**[0010]** Another preferred embodiment may be provided with a reduction of the cross sectional area of the gas channel in downstream direction upstream of the fuel injection element. This way the gas is accelerated before the fuel is injected into the gas flow, leading to a better mixing.

**[0011]** Advantageously the gas channel may be provided with swirler wings to imprint a certain velocity distribution on the gas flow through the gas channel improving the mixing of fuel and said oxygen containing gas further. Said velocity distribution should comprise a swirl, preferably a circumferential velocity component with regard to a central axis. Further beneficial the imprinted velocity distribution might positively affect the mixing in the main combustion zone.

**[0012]** A further preferred embodiment provides the fuel injection elements as swirler wings itself to improve the mixing in the gas channel and in said main combustion zone downstream.

**[0013]** A still further preferred embodiment may provide the gas channel or gas channels as channels of annular cross section surrounding a pilot burner coaxially, which pilot burner may comprise a pilot combustion room, which is discharging a pilot combustion gas generated in the pilot combustion room through a constricted pilot exit throat into said main combustion room, wherein the pilot exit throat is coaxially surrounded by the annular shaped gas channel exit. The hot combustion gas from the pilot combustion room mixing with the fuel and oxygen containing gas from the surrounding gas channel exit stabilizes the combustion in the main combustion room.

**[0014]** The gas channel may advantageously be connected to an oxygen containing gas collector by a perforated channel wall, which perforation is made such that jets of oxygen containing gas hit the surrounded pilot burner for the purpose of heat exchange. This way the oxygen containing gas is preheated on the one hand and the pilot burner is cooled on the other hand, which increases the lifetime expectancy of the pilot burner exhibited to high temperatures from the pilot combustion zone.

#### Brief description of the drawings

**[0015]** The above mentioned attributes and other features and advantages of this invention and the manner of attaining them will become more apparent and the invention itself will be better understood by reference to the following description of the currently best mode of carrying out the invention taken in conjunction with the accompanying drawing, wherein

Figure 1 shows a schematic cross sectional depiction of a gas turbine burner according to the invention and

5 Figure 2 shows a schematic depiction of a detail of the gas turbine burner according to figure 1, showing the fuel injection elements in the gas channel enlarged.

#### 10 Description of the preferred embodiments

**[0016]** Figure 1 shows a gas turbine burner GTB comprising a main combustion room MCR containing a main combustion zone MCZ enclosed by main combustion room walls MCRW. The main combustion room MCR is supplied with a mixture of fuel F and air AE through a main supply MS. At a downstream end DE of the main combustion room MCR an exhaust EX is provided, through which exhaust combustion gas ECG is discharged. At an upstream end UE of the main combustion zone MCZ - respectively said main combustion room MCR - a forward stagnation point SP located on a central axis AX indicates the location, where recirculated combustion gas CG is axially decelerated to an axial velocity of 0.

**[0017]** A pilot burner PB is part of the gas turbine burner GTB and generates a mixture of fuel F and free radicals supplied as a hot gas meeting the recirculated combustion gas CG at the forward stagnation point SP. Said pilot burner PB comprises a pilot combustion room PCR containing a pilot combustion zone PCZ, generating heat and free radicals, which are discharged through a constricted pilot exit throat PET into the main combustion room MCR. A flame front FF starts at the forward stagnation point SP, where the recirculated combustion gas CG meets the heat and free radicals HERA generated by said pilot burner PB.

**[0018]** The pilot burner PB is surrounded coaxially by a gas channel GC of annular cross section, discharging an air fuel mixture AFM into the main combustion room MCR through an annular gas channel exit GCE arranged coaxially around the pilot exit throat PET.

**[0019]** In the main combustion room MCR said flame front FF progresses from the forward stagnation point SP along the gas channel exit GCE and along the main supply exits MSE, which are also arranged coaxially to the pilot exit throat PET. The main supply MS comprises several annular shaped exits MSE divided from each other by partition plates PP. The flame front FF establishes from the forward stagnation point SP extending along the gas channel exit GCE and the exit of the main supply MSE due to the increased oxygen concentration in these areas discharging into the main combustion zone MCZ.

**[0020]** The gas channel GC surrounding the pilot burner PB is supplied with an oxygen containing gas OCG, collected in an oxygen containing gas collector OCGC, which is preferably air AE through a perforation PF of channel walls CW confining said gas channel GC. Said

perforation PF of the channel wall CW is designed such that the oxygen containing gas OCG hits the surrounded pilot burner for the purpose of heat exchange. This way the oxygen containing gas OCG is preheated and the pilot burner wall is cooled accordingly. Downstream said perforation PF the oxygen containing gas OCG enters a part of the gas channel GC, which is reduced with regard to the cross section area CA leading to an acceleration of the oxygen containing gas OCG. Fuel injection elements FIE are provided as swirler wings SW injecting fuel into the accelerated flow of oxygen containing gas OCG and giving this flow a swirl before discharging into the main combustion zone MCZ.

**[0021]** As shown in figure 2 the fuel injection elements FIE comprise inner cavities IC, respectively a first inner cavity IC1 and a second inner cavity IC2 for each fuel injection element FIE respectively swirler wing SW. The inner cavities IC are respectively supplied with fuel F from a buffer room BR through a first fuel channel FC1 respectively a second fuel channel FC2. The inner cavities IC join into nozzles NO with nozzle openings NO1 respectively NO2. Through the nozzle openings NO1, NO2 fuel F is discharged into the gas channel GC to mix with the oxygen containing gas OCG which is simultaneously provided with a swirl from the swirler wings SW. The first fuel channel FC1 is provided with a first throttle TH1, through which a pressure drop from the buffer room BR to the first inner cavity IC1 is imprinted on the fuel flow. A second throttle TH2 is provided in the second fuel channel FC2 for an according purpose. An exit area EATH1 of the first throttle is at least three times bigger than the sum of the exit areas of said first nozzles NO1. The according relation is established between an exit area EAF2 of the second throttle TH2 with regard the sum of the exit areas of the second nozzle NO2 respectively set of second nozzles NO2.

**[0022]** The throttles TH1, TH2 can be provided as adjustable throttles or throttles of fixed size. Further the throttles TH1, TH2 can be manually adjustable or automatically adjustable.

## Claims

### 1. Gas turbine burner (GTB) comprising:

- a main combustion room (MCR) containing a main combustion zone (MCZ) for burning a mixture of air and fuel (AFM),
- at least one gas channel (GC) for supplying a stream of oxygen containing gas (OCG) to the main combustion zone (MCZ) discharging through a gas channel exit (GCE), which gas channel (GC) is confined by channel walls (CW), **characterized in that**
- at least one fuel injection element (FIE) protruding from the channel wall (CW), comprising an inner cavity (IC) being supplied with fuel (F),

which inner cavity (IC) joins into at least one nozzle opening (NO) of at least one nozzle (NO) of said at least one fuel injection element (FIE) to inject fuel (F) into the gas channel (GC),

- said at least one fuel injection element (FIE) comprises at least two separate inner cavities (IC), a first inner cavity (IC1) joining into at least a first nozzle opening (NO1) or a set of first nozzle openings (NO1) and a second inner cavity (IC2) joining into at least a second nozzle opening (NO2) or a set of second nozzle openings (NO2).

2. Gas turbine burner (GTB) according to claim 1, wherein said first inner cavity (IC1) is connected to a buffer room (BR) by a first fuel channel (FC1), said second inner cavity (IC2) is connected to said buffer room (BR) by a second fuel channel (FC2), wherein said first fuel channel (FC1) is provided with a first throttle (TH1) and said second fuel channel (FC2) is provided with a second throttle (TH2) to imprint a certain pressure drop on the flow through said first fuel channel (FC1) and said second fuel channel (FC2) respectively.
3. Gas turbine burner (GTB) according to claim 2, wherein an exit area (EATH1) of said first throttle (TH1) is at least three times bigger than the sum of exit areas of the first nozzle opening (EANO1) or the sum of exit areas of a set of said first nozzle openings (EANO1) and/or an exit area (EATH2) of said second throttle (TH2) is at least three times bigger than the exit area of said second nozzle opening (EANO2) or the sum of exit areas of a set of second nozzle openings (NO2).
4. Gas turbine burner (GTB) according to any of the preceding claims 1 to 3, wherein a cross section area (CA) of said gas channel (GC) is reduced in downstream direction upstream of said fuel injection element (FIE).
5. Gas turbine burner (GTB) according to at least one of the preceding claims 1 to 4, wherein said gas channel (GC) is provided with at least one swirler wing (SW) to imprint a certain velocity distribution on the gas flow through said gas channel (GC).
6. Gas turbine burner (GTB) according to claim 5, wherein said at least one fuel injection element (FIE) itself is made as said at least one swirler wing (SW).
7. Gas turbine burner (GTB) according to at least one of the preceding claims 1 to 6, wherein said gas channel (GC) is a channel of annular cross section surrounding coaxially a pilot burner (PB) comprising a pilot combustion room

(PCR), which is discharging a pilot combustion gas (PCG) generated in said pilot combustion room (PCR) through a constricted pilot exit throat (PET) into said main combustion room (MCR), wherein said pilot exit throat (PET) is coaxially surrounded by said annular shaped gas channel exit (GCE). 5

8. Gas turbine burner (GTB) according to claim 7, wherein said gas channel (GC) is connected to an oxygen containing gas collector (OCGC) by a perforated channel wall (CW), which perforation (PF) is made such that jets of oxygen containing gas (OCG) hit said surrounded pilot burner (PB) for the purpose of heat exchange. 10

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FIG 1

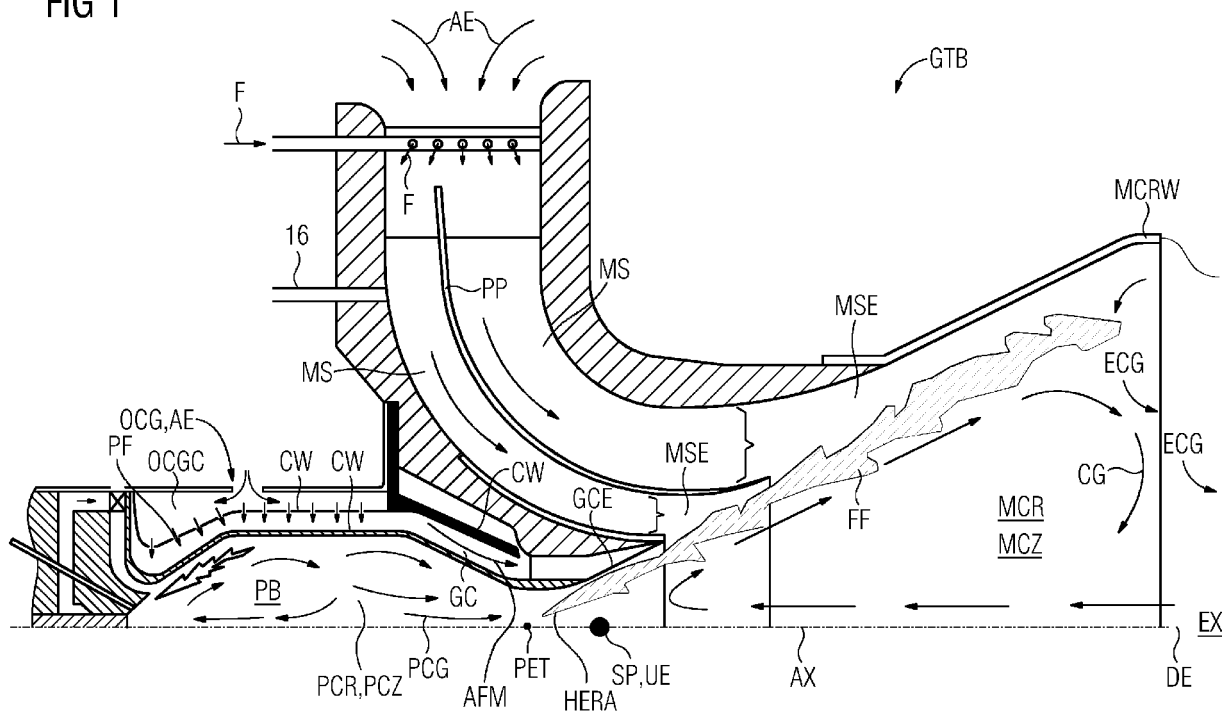
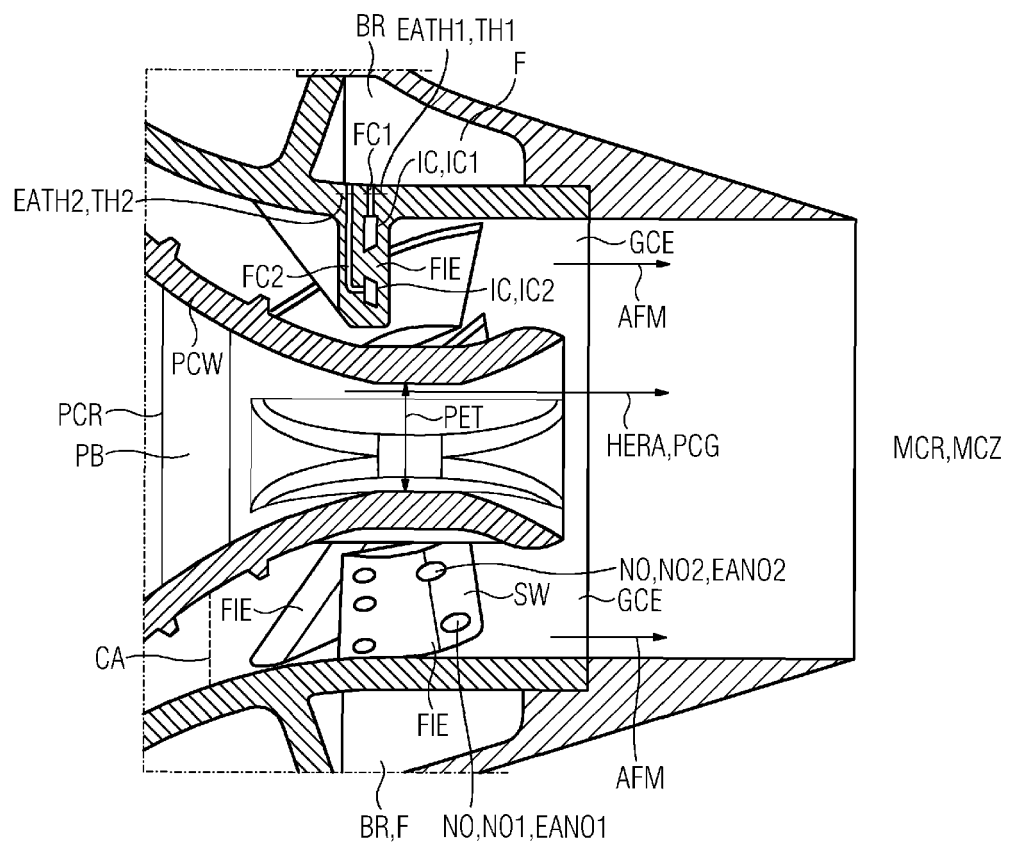


FIG 2





## EUROPEAN SEARCH REPORT

Application Number  
EP 11 15 9121

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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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