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(54) **CAN COMBUSTOR FOR A GAS TURBINE AND GAS TURBINE COMPRISING SUCH A CAN COMBUSTOR**

(57) A can combustor (4) for a gas turbine (1), the can combustor (4) comprising: at least a burner (5, 20, 22); at least a liner (7) defining a combustion chamber (6, 21, 23) having a combustor axis (24); wherein the liner (7) comprises: an inner tubular body (30); an outer

tubular body (31) overlapping at least in part the inner tubular body (30) and spaced from the inner tubular body (30) for defining a cooling air gap (32); wherein the outer tubular body (31) comprises a upstream end (34) coupled with an intermediate portion of the inner tubular body (30).

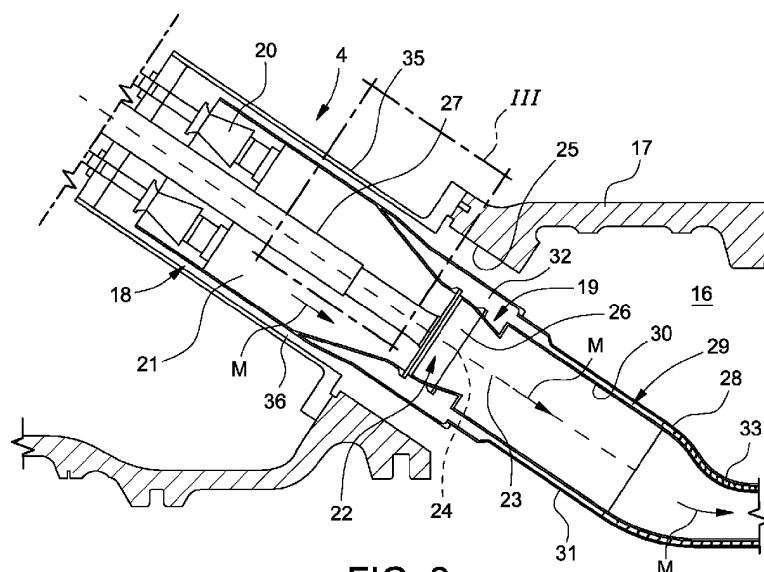


FIG. 2

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Description

Cross-Reference To Related Applications

[0001] This application claims priority from Russian Patent Application No. 2017145745 filed on December 26, 2017.

Field of the Invention

[0002] The present invention relates to a can combustor for a gas turbine for power plants. In particular, the present invention relates to the interface, i.e. a sealed interface, between the cold shell and the hot shell forming a cooled liner of a can combustor for a gas turbine for power plants.

[0003] Moreover, the present invention refers to a gas turbine for power plants comprising the above mentioned can combustor.

Description of prior art

[0004] As known, a gas turbine assembly for power plants (in the following only gas turbine) comprises a rotor having an axis and provided with an upstream compressor sector, a combustor sector and a downstream turbine sector. The terms downstream and upstream refer to the direction of the main gas flow passing through the gas turbine. In particular, the compressor comprises an inlet supplied with air and a plurality of blades compressing the passing air. The compressed air leaving the compressor flows into a plenum, i.e. a closed volume delimited by an outer casing, and from there into the combustor. Inside the combustor, the compressed air is mixed with at least one fuel. The mixture of fuel and compressed air flows into a combustion chamber where this mixture are combusted. The resulting hot gas leaves the combustor and is expanded in the turbine performing work on the rotor.

[0005] In order to achieve a high efficiency, a high turbine inlet temperature is required. However, due to this high temperature, high NO_x emissions are generated.

[0006] In order to reduce these emissions and to increase operational flexibility, today is known a particular kind of gas turbines performing a sequential combustion cycle.

[0007] In general, a sequential gas turbine comprises two combustors in series wherein each combustor is provided with the relative burner and combustion chamber. Following the main gas flow direction, the upstream combustor is called "premix" combustor and is fed by the compressed air. The downstream combustor is called "sequential" or "reheat" combustor and is fed by the hot gas leaving the first combustion chamber. According to a first kind of sequential gas turbines, the two combustors are physically separated by a stage of turbine blades, called high pressure turbine.

[0008] Today a second kind of sequential gas turbines

is known wherein this kind of gas turbines is not provided with the high pressure turbine and the premix and the reheat burner are arranged directly one downstream the other inside a common can-shaped casing. According to this kind of sequential gas turbines, a plurality of can combustors are provided arranged as a ring around the rotor axis. Each can-combustor is provided with a liner, i.e. the casing limiting the combustion chambers, divided in two portions respectively upstream and downstream with respect to the reheat burner. The upstream portion of the liner is called premix liner whereas the downstream portion is called sequential liner and is downstream connected with a flange, called picture frame, facing the turbine. Usually, the sequential liner and the picture frame are realized as a single piece called transition duct configured for guiding the hot gas leaving the combustor toward the turbine, in particular toward the first vane of the turbine. For instance, the reheat burner can be realized in form of a plurality of single or dual fuel injector fingers extending across the flow channel. Preferably, these injector fingers can be realized in form of a streamline body having preferably a lobed trailing edge. Due to the high hot gas temperature, the reheat burner is not provided with any sparkers and the combustion starts as a self combustion.

[0009] Of course, according to the prior art practice it is possible to realize a can combustor with a single combustion stage and accordingly comprising a single burner and a single liner defining a single combustion chamber.

[0010] The above described different kinds of gas turbines, i.e. the can combustor with a single or two combustion stages, have been cited because the present invention can be applied in all these two different kinds of can combustors.

[0011] The liner of a can combustor is defined by an inner tubular body, called hot shell and limiting the combustion chamber, and an outer tubular body called cold shell. This cold shell outwardly covers at least part of the hot shell, is spaced from the hot shell for realizing a cooling air channel and defines the outer liner diameter. In particular, the cold and hot shell are fixed to each other at the downstream ends, i.e. such downstream ends are fixed to a common structure that typically is the picture frame, whereas the upstream portion of the cold shell overlaps with a sliding feature an intermediate portion of the hot shell. The can combustor comprises a combustor outer casing configured to be coupled with a relative portal hole provided in the gas turbine outer casing. Between the combustor liner and the combustor outer casing a gap is present that allows the compressed air to reach the burner, in particular the premix burner, coupled to the upstream end of the hot shell. Such a gap is therefore inwardly limited downstream by the cold shell and upstream by the hot shell. The above mentioned sliding coupling between the upstream end of the cold shell and the hot shell allows relative movements of these elements that are working at a very different temperatures.

[0012] According to the prior art practice, some differ-

ent kinds of sealing are provided at the sliding interface between the upstream end of the cold shell. For instance, US7007482 discloses a so called "hula seal" fixed to the outer surface of the hot shell and sliding coupled to the upstream end of the cold shell. Alternatively, instead of the hula seal it is known provided the sliding interface with a piston ring between the upstream end of the cold shell and the hot shell. By keeping constant the combustion chamber diameter defined by the hot shell and the inner diameter of the combustor outer casing, the above foregoing described solutions of the prior art lead to the drawback of reducing the gap present between the combustor liner and the combustor outer casing due to the presence of the hula seal or the piston ring acting as a spacer between the hot and cold shell. The consequence of this gap size reduction is the increasing of the pressure drop of the compressed air passing through the gap. Unfortunately, in order to enlarge the gap size it is not possible to increase the diameter of the combustor outer casing, indeed the dimension of this component depends on the dimension of the portal hole configured for supporting the can combustor. Moreover, in order to enlarge the gap size it is not possible to reduce the diameter of the hot shell. Indeed, a smaller hot shell involves a higher hot gas velocity that reduces the combustion performance of the combustor.

[0013] Starting from this prior art, there is today the need to improve the foregoing described sealed sliding interface between the end of the cold shell and the hot shell in order to not affect the air gap between the liner and the outer combustor casing.

Summary Of The Invention

[0014] A primary object of the present invention is to provide a can combustor for a gas turbine wherein the can combustor comprises:

- at least a burner;
- at least a liner defining a combustion chamber having a combustor axis.

[0015] The liner comprises:

- an inner tubular body, or hot shell; and
- an outer tubular body, or cold shell, overlapping at least in part the inner tubular body and spaced from the inner tubular body for defining a cooling air gap.

[0016] In this configuration, the outer tubular body comprises a upstream end coupled with an intermediate portion of the inner tubular body.

[0017] The above listed can combustor features are known in state of the art and refer both to a can combustor having a single combustion stage and to a can combustor having two sequential combustion stages. According to this second kind of can combustors having two sequential combustion stages, in series along the hot gas direction

the each combustor comprises a first burner, a first combustion chamber, a second burner, a second combustion chamber and a transition duct facing the turbine sector. As known, the hot shell extends from the downstream end of the transition duct, called picture frame, to the first burner. The cold shell extends from the picture frame, or very near to the picture frame and ends connected to the hot shell in an intermediate position between the first and the second burner along an air gap between the liner and the outer combustor casing.

[0018] It is important that the coupling between the upstream end of the cold shell and the hot shell to be a sealed coupling. According to the state of the art, as foregoing mentioned, this coupling is performed by welding each other's the two shells or by an interposition of a seal element (a hula seal or a piston ring) between the inner surface of the cold shell and the outer surface of the hot shell. The first prior art does not allow relative movements of the shells but does not affect the dimension of the gap. The second prior art allows relative movements of the shells but reduces the gap and increases the pressure drop.

[0019] The mains scope of the present invention is to allow the relative movements of the shells without affecting the dimension of the gap. According the general definition of the invention, the coupling between the upstream end of the outer tubular body and the inner tubular body is a direct surface contact coupling. In other words, the inner surface of the upstream end of the outer tubular body rests on the outer surface of the inner tubular body without any constrain for a relative sliding of the outer tubular body with respect to the inner tubular body at least along a axial direction parallel to the combustor axis. The direct surface contact coupling according to the invention is configured to realize a sealed coupling.

[0020] Advantageously, according the above solution, that can be applied in combustor having a single of two sequential combustion stages, at one side allows the relative movements of the shell suitable to compensate the different working temperatures, indeed the end of the cold shell is simply resting on the hot shell without any axial sliding constrain, and at another side the invention does not affect the dimension of the gap, indeed the sealed coupling is not provided with any additional sealing element between the shells. Moreover, this sealing element may be subject to wear with a consequent abnormal behavior of the relative can combustor and this single "bad" can combustor may drives the emission performance of the entire gas turbine plant.

[0021] According to another aspect of the invention, the direct surface contact coupling comprises at least a cooling air channel configured for connecting the combustion chamber with a plenum volume, i.e. the gap between the liner and the outer combustor casing, arranged outwardly the liner. Indeed, the direct surface contact coupling defines a portion of the hot shell that is covered by the cold shell and therefore this overlapping portion requires an additional cooling feature. According to the

invention, the cooling air channel is configured to remain open independently on the axial relative sliding of the outer tubular body with respect to the inner tubular body. For this reason according to a preferably embodiment the cooling air channel comprises a plurality of passing slots having at least an axial extent obtained in the upstream end of the outer tubular body and at least a channel obtained in a portion the inner tubular body radially corresponding with the slot. This cooling feature allows to realize a sealed coupling with a known leakage ratio independent on the relative sliding of the outer tubular body with respect to the inner tubular body and that does not vary from combustor to combustor and over the entire operational time.

[0022] According to another aspect of the invention, the direct surface contact coupling is also free to have a relative sliding of the outer tubular body with respect to the inner tubular body also along a circumferential direction centered at the combustor axis. Consequently, the cooling air channel is configured to remain open also independently on the circumferential relative sliding of the outer tubular body with respect to the inner tubular body. For this reason, according to a preferably embodiment, each channel obtained in the inner tubular body comprises a circumferential groove obtained in the outer surface of the inner tubular body and a plurality of effusion holes connecting the circumferential groove with the combustion chamber. Preferably, the effusion holes are inclined with respect to the radial direction centered at the combustor axis to realize a film cooling along the inner surface of the inner tubular body.

[0023] The present invention can be preferably used in sequential can combustor wherein the fuel is supplied to the second burner via a central lance extending inside the first combustion chamber along the combustor axis. Indeed, in this case the combustion chamber diameter cannot be limited due to the presence of the lance that already deprives the combustion chamber of available volume. However, the present invention can be applied also in other kinds of sequential can combustors, for instance a sequential can combustor wherein the fuel supply of the sequential burner is arranged outside the combustion chamber.

[0024] The invention has been foregoing described as referring to the can combustor. However, the present invention refers also to a gas turbine for power plants comprising such a can combustor wherein preferably this can combustor is a sequential can combustor.

[0025] 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.

Brief Description Of Drawings

[0026] 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.

[0027] 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 schematic view of a gas turbine for power plants provided with a can combustor having a single combustion stage;
- figure 2 is a schematic view of a can combustor for a gas turbine for power plants provided in series with a premix and a reheat burner;
- figure 3 is an enlarged view of the portion labelled with the reference III in figure 2;
- figure 4 is an enlarged view of the portion labelled with the reference IV in figure 3;
- figure 5 is an enlarged view of the portion labelled with the reference V in figure 4;
- figures 6 and 7 are other views of the portion disclosed in figure 5.

Detailed Description Of Drawings

[0028] In cooperation with the attached drawings, the technical contents and detailed description of the present invention are described thereafter according to preferable 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.

[0029] Reference will now be made to the enclosed drawings to describe the present invention in detail.

[0030] Reference is now made to Fig. 1 that is a schematic view of a gas turbine for power plants that can be provided with a burner according to the present invention. In particular, figure 1 discloses a gas turbine 1 having an axis 9 and comprising a compressor 2, a combustor sector 4 and a turbine 3. As known, the compressor comprises an inlet fed by ambient air that, once compressed, leaves the compressor 2 and enters in a plenum 16, i.e. a volume define by an outer casing 17. From the plenum 16, the compressed air enters in the combustor sector that comprises a plurality of can combustors 4 annularly arranged around the axis 9. The terms downstream and upstream refer to the gas main flow direction. Each can combustor 4 comprises at least a burner 5 where the compressed air is mixed with at least a fuel. This mixture is then combusted in a combustion chamber 6 and the resulting hot gas flows in a transition duct 7 downstream connected to the turbine 3. The turbine 3 comprises a plurality of vanes 12, i.e. stator blades, supported by a vane carrier 14, and a plurality of blades 13, i.e. rotor blades, supported by a rotor 8. In the turbine 3, the hot gas expands performing work on the rotor 8 and leaves the turbine 3 in form of exhaust gas 11.

[0031] Reference is now made to figure 2 that is schematic view of a can combustor that can be applied in the gas turbine of figure 1 and that could be provided with the present invention. In particular, figure 2 discloses a can combustor 4 comprising a combustor outer casing 35 connected to a relative portal hole 25 of an outer casing 17 defining the plenum 16 where the compresses air are delivered by the compressor 2. The can combustor 4 has an axis 24 and comprises in series along the gas flow M a first combustor, or premix combustor 18, and a second combustor, or reheat combustor 19. In particular, the first combustor 18 comprises a first or premix burner 20 and a first combustion chamber 21. The reheat combustor 19 comprises a reheat burner 22 and a second combustion chamber 23. The reheat burner can comprise a plurality of fuel injectors 26, in particular dual fuel and carrying air injectors, arranged across the burner for injecting the fuel in the passing hot gas. According to the embodiment of figure 2, the fuel is fed to the fuel injectors 26 by a fuel lance 27 axially extending through the first combustion chamber 21 up to the reheat burner 22. Downstream the second combustion chamber 23 the can combustor 4 comprises a transition duct 28 for guiding the hot gas flow to the turbine 3. Alternatively, the fuel lance 27 may be arranged outside the combustion chamber 21.

[0032] The combustion chambers 21 23 are delimited by a liner 29 comprising an inner tubular body 30, or hot shell, having an inner surface directly in contact and heated by the hot gas flow, and an outer tubular body 31, or cold shell, covering at least in part the hot shell. Between the hot 30 and cold shell 31 a cooling air gap 32 is present. According to the disclosed embodiment of figure 2, the cooling air is part of the compressed air that from the plenum passes through cooling holes 33 obtained in the downstream portion of the cold shell 31. The terms "downstream" with reference to the liner refer to the portions near to the turbine whereas the term "upstream" refers to the portion near to the premix burner 20. As disclosed, the upstream end 34 of the cold shell 31 is coupled to an intermediate portion of the hot shell 30 facing the outer combustor casing 35. The kind of the coupling between the upstream end 34 of the cold shell 31 and the hot shell 30 will be describe in detail in the following. Between the outer combustor casing 35 and the liner a gap 36 is present for allowing the compressed air to reach the premix burner 20 from the plenum 16. Such a gap 36 is downstream defined by the cold shell 31 and the outer combustor casing 35 and upstream by the hot shell 30 and the outer combustor casing 35.

[0033] Reference is now made to figure 3 that is an enlarged view of the portion labelled with the reference III in figure 2. In particular, figure 3 discloses in an enlarged view the gap 36 and the upstream end 34 of the cold shell 31 connected to an intermediate portion of the hot shell 30. The arrow M defines the hot gas direction inside the combustor.

[0034] Reference is now made to figure 4 that is an

enlarged view of the portion labelled with the reference IV in figure 3. In particular, figure 4 discloses the coupling between the upstream end 34 of the cold shell 31 and the hot shell 30. This coupling consists in a sliding contact coupling wherein the inner surface of the upstream end 34 of the cold shell 31 is outwardly resting on the outer surface of the hot shell 30 without any sliding constrain at least along the axial direction parallel to the combustor axis 24. The axial sliding has been represented in figure 4 by the reference R. The arrow C' represents the cooling air flow.

[0035] According to the invention, the contact between the inner surface of the upstream end 34 of the cold shell 31 and the outer surface of the hot shell 30 is a direct contact without the interposition of any other element, for instance a seal element like a hula seal or a piston ring.

[0036] In order to cool the portion of the hot shell 30 covered by and in contact with the upstream end 34 of the cold shell 31, this overlapping sliding contact coupling comprises also a particular cooling feature suitable for ensure a cooling effect independently on the relative sliding movements between the hot 30 and the could shell 31.

[0037] Reference is made to figure 5 that is an enlarged view of the portion labelled with the reference V in figure 4. In this figure the arrow R refers to the radial direction with respect to the combustor axis 24. Figure 5 discloses two grooves 10 realized in the outer surface of the hot shell 30 in contact with the upstream end 34 of the could shell 31. Moreover, figure 5 discloses the presence of effusion holes 15 connecting the grooves 10 with the combustion chamber limited by the hot shell 30. According to the embodiment disclosed the effusion holes 15 are inclined with respect to the radial direction R, in particular with an inclination directed towards the main hot gas direction M.

[0038] Reference is made to figures 6 and 7 that are other views of the portion disclosed in figure 5. In particular these figures allows to understand how the air can reach the grooves 10 from the gap 36 even if the cold shell 31 is resting against the hot shell 30 and how this cooling feature is performed independent on the relative sliding between the hot 30 and the could shell 31. According to the embodiment of figure 6 the grooves 10 are circumferential grooves 10 extending along the circumferential direction (represented in figure 6 with the arrow C) centered on the combustor axis 24. The upstream end 34 of the cold shell 31 comprises a plurality of passing slots 37 extending along the axial direction M from the edge of the upstream end 34 beyond the grooves 10. According to this solution, the air can freely reach the grooves 10 passing through the slots 37 and from the grooves 10 can reach the combustion chamber passing through the effusion holes 15. In particular, as disclosed in figure 7 the effusion holes 15 are also inclined with respect to the axial direction M. Therefore, the cooling of the portion of the hot shell 30 is ensured by the impingement of cooling air in the grooves 10 passing by the slots

37, by convective cooling inside the grooves 10 and by a film cooling at the inner surface facing the combustion chamber. The cooling feature is independent on the relative sliding in the axial direction between the hot 30 and could shell 31 because in case of an axial sliding the slots 37 disclose an axial extension so that the grooves 10 are in any case accessible from the gap 36. Of course, also in case of a relative sliding in the circumferential direction the grooves 10 are in any case accessible from the gap 36. Preferably, the grooves 10 are milled grooves and the effusion holes 15 are laser drilled effusion holes.

[0039] 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 scope of the invention.

Claims

1. A can combustor for a gas turbine (1), the can combustor (4) comprising:

- at least a burner (5, 20, 22);
- at least a liner (7, 26) defining a combustion chamber (6, 21, 23) having a combustor axis (24);

wherein the liner (7, 26) comprises:

- an inner tubular body (30);
- an outer tubular body (31) overlapping at least in part the inner tubular body (30) and spaced from the inner tubular body (30) for defining a cooling air gap (32);

wherein the outer tubular body (31) comprises a upstream end (34) coupled with an intermediate portion of the inner tubular body (30);

characterized in that

the coupling between the upstream end (34) of the outer tubular body (31) and the inner tubular body (30) is a direct surface contact coupling (38) of the inner surface of the upstream end (34) of the outer tubular body (31) resting on the outer surface of the inner tubular body (30),

wherein the direct surface contact coupling (38) is configured for allowing a relative sliding of the outer tubular body (31) with respect to the inner tubular body (30) at least along a axial direction (M) parallel to the combustor axis (24) and for realizing a sealed coupling with a leakage ratio independently on the relative sliding.

2. Can combustor as claimed in claim 1, wherein the

direct surface contact coupling (38) comprises at least a cooling air channel configured for connecting the combustion chamber (6, 21, 23) with a plenum volume (36) arranged outwardly the liner (7, 26), the cooling air channel being configured to be open independently on the axial relative sliding of the outer tubular body (31) with respect to the inner tubular body (30).

3. Can combustor as claimed in claim 2, wherein the cooling air channel comprises a plurality of axial passing slots (37) obtained in the upstream end (34) of the outer tubular body (31) and at least a channel (10, 15) obtained in a portion the inner tubular body (30) corresponding with the slot (37).

4. Can combustor as claimed in claim 3, wherein the axial passing slots (37) start from the end edge of the upstream end (34) of the outer tubular body (31).

5. Can combustor as claimed in claim 3 or 4, wherein the direct surface contact coupling (38) allows a relative sliding of the outer tubular body (31) with respect to the inner tubular body (30) also along a circumferential direction (C) centered at the combustor axis (24).

6. Can combustor as claimed in claim 5, wherein each channel (10, 15) obtained in the inner tubular body (30) comprises a circumferential groove (10) obtained in the outer surface of the inner tubular body (30) and a plurality of effusion holes (15) connecting the circumferential groove (10) with the combustion chamber (6, 21, 23).

7. Can combustor as claimed in claim 6, wherein the circumferential groove (10) extends along the entire inner tubular body (30).

8. Can combustor as claimed in claim 6 or 7, wherein the circumferential groove (10) are realized by milling.

9. Can combustor as claimed in one of the foregoing claims from 6 to 8, wherein the effusion holes (15) are inclined with respect to the radial direction (R) centered at the combustor axis (24).

10. Can combustor as claimed in claim 9, wherein the effusion holes (15) has an inclination directed towards the main hot gas direction (M).

11. Can combustor as claimed in one of the foregoing claims from 6 to 10, wherein the effusion holes (15) are realized by laser drilling.

12. Can combustor as claimed in one of the foregoing claims, wherein the can combustor comprises is se-

ries a first burner (20), a first combustion chamber (21), a second burner (22), a second combustion chamber (23) and a transition duct (28); the outer tubular body (31) extending from the downstream end of the transition duct (28) up to an intermediate position between the first (20) and the second burner (22). 5

13. Can combustor as claimed in claim 12, wherein the can combustor comprises an outer combustor casing (35) configured to be coupled with a portal hole (25) of the gas turbine; the liner (26) and the outer combustor casing (35) being spaced in order to realize a gap (36). 10

14. Can combustor as claimed in claim 12 or 13, wherein the can combustor comprises a fuel lance (27) extending inside the first combustion chamber (21) along the combustor axis (24) for feeding fuel to the second burner (22). 15 20

15. A gas turbine for power plant; the gas turbine (1) having an axis (9) and comprising following the gas flow direction: 25

- a compressor sector (2) for compressing ambient air,
- a combustor sector (4) for mixing and combusting the compressed with at least a fuel
- at least a turbine sector (3) for expanding the combusted hot gas flow leaving the combustors (4) and performing work on a rotor (8); 30

wherein the combustor sector (4) comprises at least a can combustor according to any one of the foregoing claims. 35

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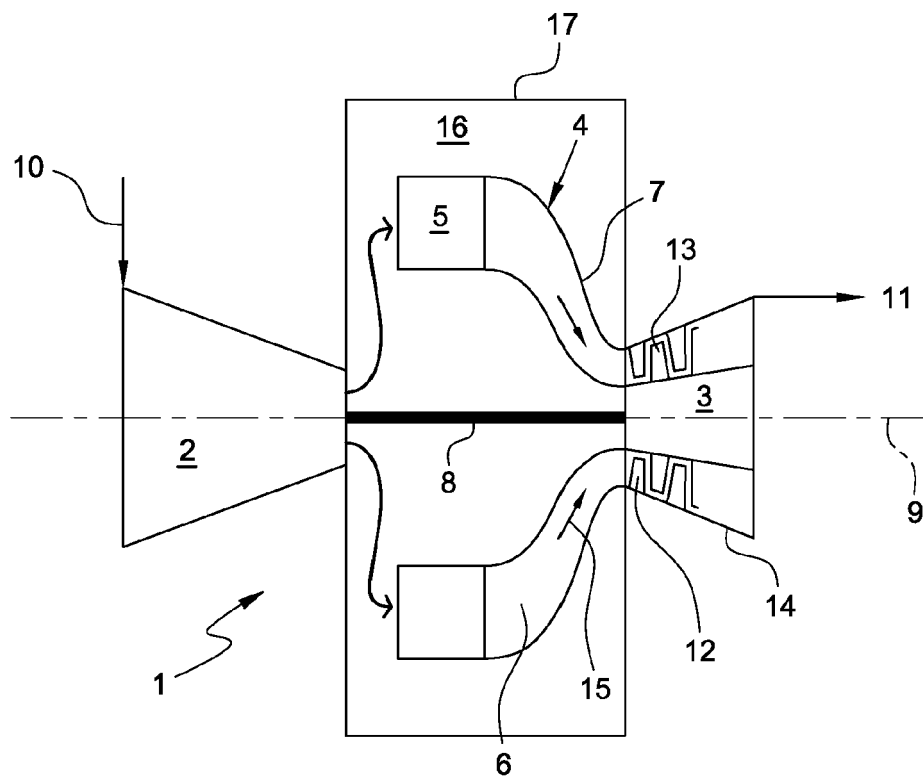


FIG. 1

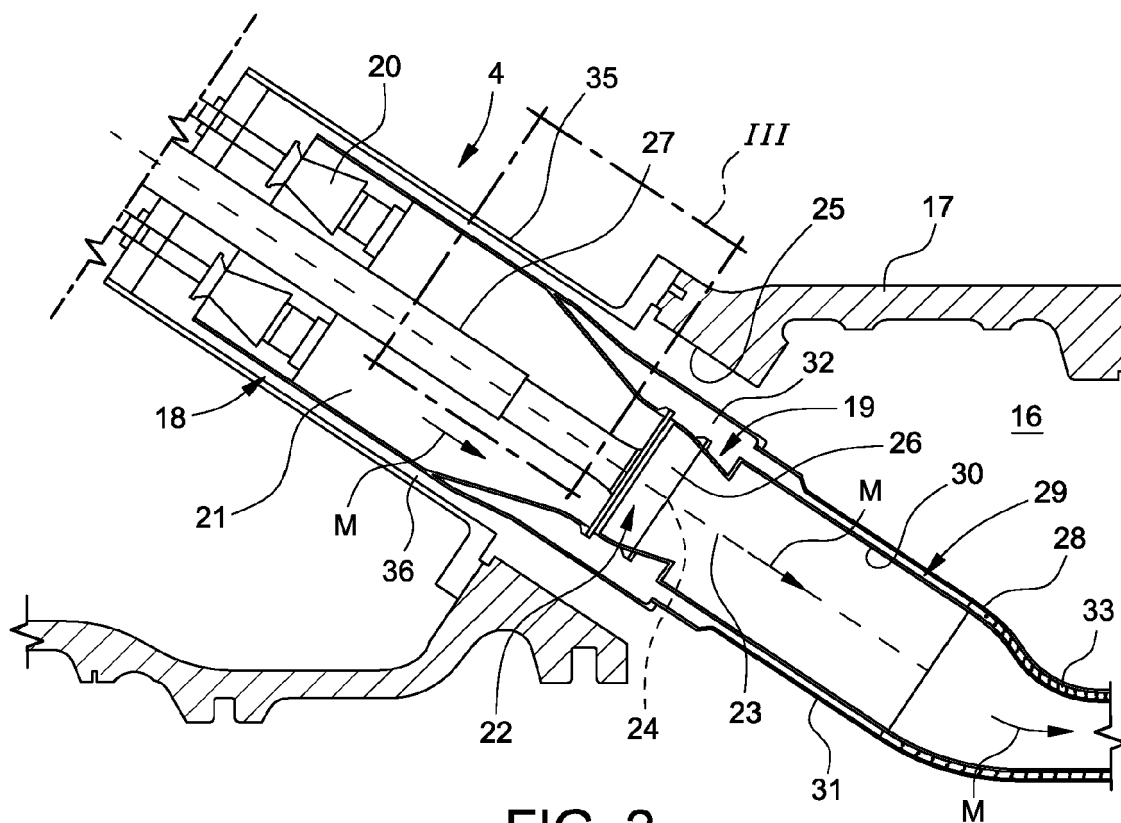
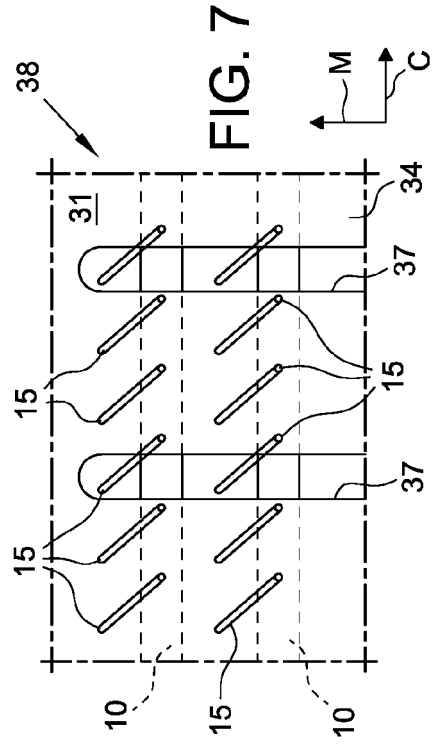
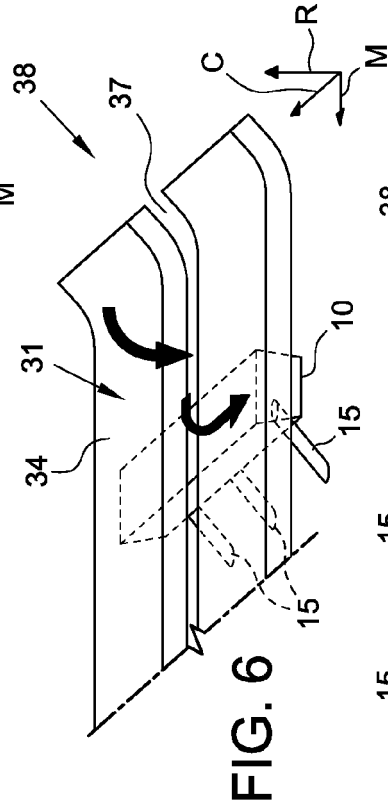
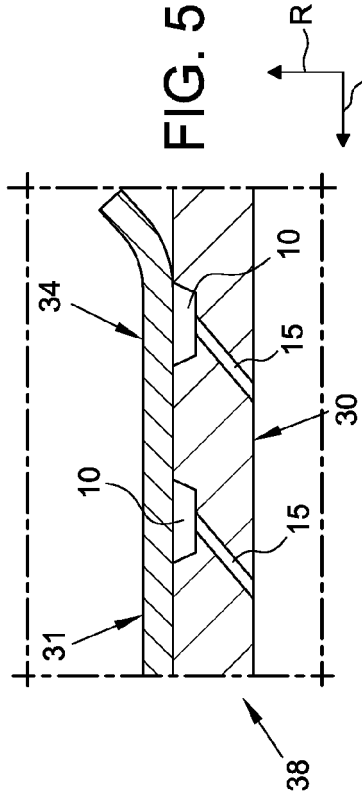
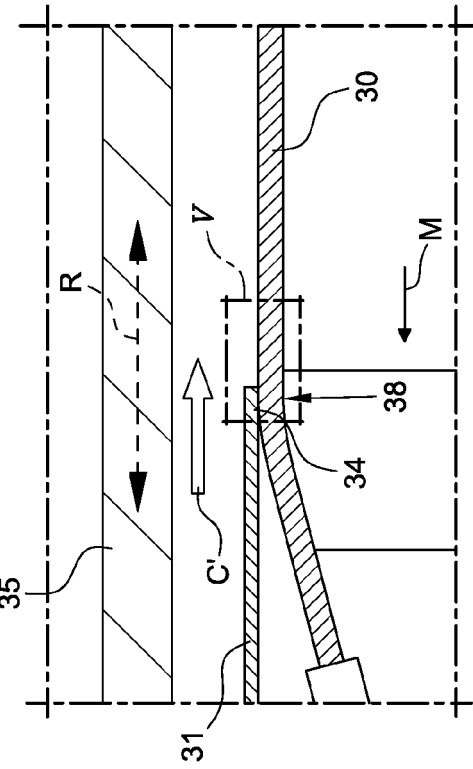
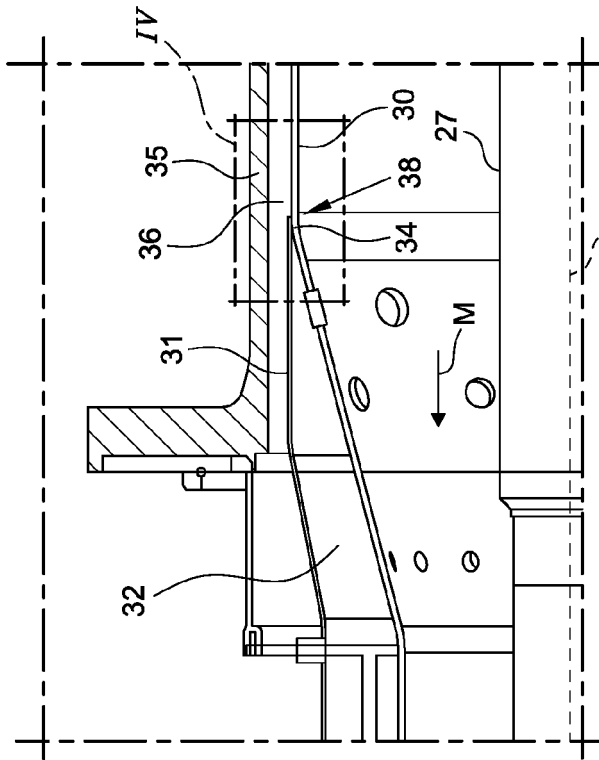


FIG. 2





EUROPEAN SEARCH REPORT

Application Number
EP 18 21 5866

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/282833 A1 (HESSLER WILLIAM K [US] ET AL) 19 November 2009 (2009-11-19) * figures 1, 5 * * paragraph [0018] * * paragraph [0027] *	1-15	INV. F01D9/02 F23R3/00 F23R3/06 F23R3/34 F23R3/46
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			TECHNICAL FIELDS SEARCHED (IPC)
			F23R F01D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 April 2019	Examiner Fernandez Ambres, A
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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