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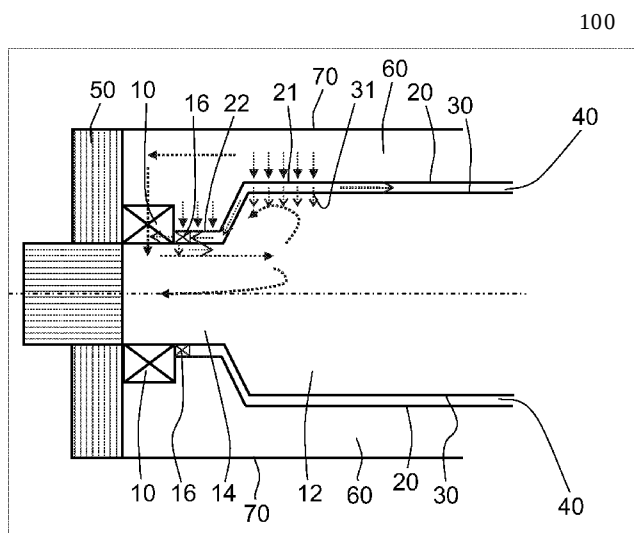


FIG 2

(57) Abstract: The present invention discloses a combustion apparatus (100), which comprises a combustion chamber (12), in which combustion of a fuel/oxidant mix takes place, a pre-chamber (14) located upstream of the combustion chamber (12), a first device (10) for mixing a fuel with an oxidant, the first device (10) located upstream of the pre-chamber (14), wherein the combustion chamber (12) and the pre-chamber (14) comprise a common first wall (20) and a common second wall (30) spaced to each other building a cavity (40), the first wall (20) exhibits at least one first opening (21) in the area of the combustion chamber (12) for introducing a coolant into the cavity (40), a channel (60) for feeding the oxidant to the first device (10), whereby the channel (60) is formed by a housing element (70) of the combustion apparatus (100) and the common first wall (20) of the combustion chamber (12) and the pre-chamber (14), and wherein the at least one first opening (21) is located in the area of the combustion chamber (12), and wherein the first wall (20) exhibits at least one second opening (22) for introducing the coolant into the cavity (40), wherein the at least one second opening (22) is located in the area of the pre-chamber (14).

Description

A combustion apparatus and gas turbine engine

5 The present invention relates to a combustion apparatus. More particularly the present invention relates to a cooling system of a combustion apparatus. Furthermore, the present invention relates to a gas turbine engine using a combustion apparatus .

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The development of gas turbines will continue the demand for higher operating temperatures. In known cooling systems a current parallel cooling approach leads to higher flame temperatures due to the lack of available air to the primary
15 zone. Higher flame temperatures have a direct adverse impact on the NOx emissions.

It is known to apply a double skin arrangement for a combustion chamber of a combustion apparatus. I.e. the combustion
20 chamber exhibits a first wall and a second wall spaced to each other building a cavity. The first wall, which is the outer skin of the combustion chamber exhibits holes so that a coolant can enter the cavity between the first and the second wall of the combustion chamber. The second wall of the combustion chamber, which is the inner layer, also exhibits
25 openings, in particular perforations or a series of small holes, so that the coolant can enter from the cavity into the combustion chamber cooling the inner layer of the combustion chamber. The perforations or small holes in the inner layer
30 are smaller than those on the outer skin and provide for cooling and acoustic damping.

A combustion apparatus with a double skin arrangement is known from EP 0 896 193 A2. The combustion-chamber and the
35 pre-chamber exhibits a first wall and a second wall spaced to each other building a cavity. In the first wall are openings for introducing coolant into the cavity. From WO 2008/028621 A1 is also such a combustion apparatus known. A channel for

guiding air to a swirler is disclosed in US 2009/0120094 A. Within the channel a double skin arrangement around the combustion-chamber is provided. EP 0 725 253 A2 discloses a combustion apparatus with a double skin arrangement, as well.

5 An object of the present invention is to improve the cooling of a combustion apparatus. A further object of the present invention is to reduce the NOx emissions of a combustion apparatus. These objects are achieved by a combustion apparatus according to claim 1 of the present invention and by a gas
10 turbine engine according to claim 14 of the present invention. Advantageous embodiments are disclosed in the dependent claims of the present invention.

More particularly according to the present invention there is
15 provided a combustion apparatus which comprises a combustion chamber in which combustion of a fuel/oxidant mix takes place, a pre-chamber which is located upstream of the combustion chamber, a first device for mixing a fuel with an oxidant, the first device located upstream of the pre-chamber.
20 The combustion chamber and the pre-chamber of the combustion apparatus comprise a common first wall and a common second wall spaced to each other building a cavity. Further the first wall exhibits at least one first opening in the area of the combustion chamber for introducing a coolant into the
25 cavity. The combustion apparatus comprises a channel for feeding the oxidant to the first device, whereby the channel is formed by a housing element of the combustion apparatus and the common first wall of the combustion chamber and the pre-chamber. The at least one first opening is located in the
30 area of the combustion chamber. The first wall exhibits at least one second opening for introducing the coolant into the cavity, wherein the at least one second opening is located in the area of the pre-chamber.

35 In the present invention the term upstream means the direction from the combustion chamber towards the pre-chamber. The first wall is the outer wall, which faces the outer casing of the combustion apparatus. A second wall is the inner wall,

which faces the center of the combustion apparatus and which therefore faces the combustion flame. The at least one first opening can be realized by holes in the first wall in the area of the combustion chamber. Thereby the cavity is a continuous cavity which extends from the area of the pre-chamber to the area of the combustion chamber. Throughout the invention the term common can also have the meaning of one of the following terms: combined, joint or corporate.

Due to the common first wall and common second wall of the pre-chamber and the combustion chamber coolant introduced through the at least one first opening into the cavity can also be supplied to the pre-chamber. Therefore, the pre-chamber of the combustion apparatus is also cooled.

In the above described combustion apparatus the at least one first opening is located in the area of the combustion chamber. Therefore, a part of the coolant, in particular air, can be introduced into the cavity from the first opening. Additionally the first wall exhibits at least one second opening which is adapted for introducing the coolant, in particular a second part of the coolant, into the cavity, as well, wherein the at least one second opening is located in the area of the pre-chamber .

The combustion apparatus comprises a first device for mixing a fuel with an oxidant, the first device located upstream of the pre-chamber. The first device is constructed in such a way that the fuel/oxidant-mixture is introduced from the first device into the pre-chamber.

The at least one first opening and at least one second opening in the first wall can be realized by a softwall or by at least one dilution hole or by a perforation of the first wall. Due to the provision of the at least one second opening in the first wall in the area of the pre-chamber an additional cooling of the pre-chamber can be provided.

The channel of the combustion apparatus serves for feeding the oxidant to the first device. The channel is formed by a housing element of the combustion apparatus and the common first wall of the combustion chamber and the pre-chamber.

5 That means the channel is arranged separate to the cavity. The advantage of the extra channel is that the oxidant can flow constant and undisturbed through the channel to the first device. Thus a very good supply of oxidant to the first device is guaranteed. Only a part of the oxidant is intro-
10 duced through the at least one first opening and the at least one second opening into the cavity for cooling the common second wall of the pre-chamber and the combustion chamber.

One advantage of such a combustion apparatus is that both a
15 constant and undisturbed supply of oxidant to the first device and an effective cooling of the common second wall of the pre-chamber and the combustion chamber are guaranteed. The introduction of coolant, in particular oxidant, through the at least one second opening into the cavity enables that
20 the coolant flows from the upstream end to the downstream end of the cavity and therefore enables an effective heat removal through the cavity. The specific arrangement of the cavity enables additionally to the cooling of the common second wall in the area of the combustion-chamber a cooling of the common
25 second wall in the area of the pre-chamber. The lifetime of the combustion apparatus can be increased by the better cooling of the common second wall. The arrangement of the channel and the cavity around the pre-chamber and the combustion-chamber ensures a perfect feeding of oxidant to the first de-
30 vice of the combustion apparatus and a good cooling of the common second wall which is covering the pre-chamber and the combustion-chamber. At the downstream end of the cavity the heated coolant can be deduced. The double common wall has the advantage that the oxidant which is guided through the chan-
35 nel to the first device is not heated up very strong in direction to the first device. Thus the part of the coolant/oxidant which enters the cavity is cool enough to provide an effective cooling of the common second wall.

In the above described combustion apparatus the common first wall and the common second wall have the same shape. Thereby the common first wall has a larger diameter than the common
5 second wall. The distance between the common first wall and the common second wall can be the same over the entire length of the cavity defined by both walls. In the above described combustion apparatus the common first and the common second wall can be arranged parallel to each other. This enables a
10 uniform flow of coolant through the cavity and saves installation space. The total combustion apparatus can be kept to a minimum.

In the above described combustion apparatuses the coolant is
15 the oxidant flowing through the channel and being introduced through the at least one first opening and the at least one second opening into the cavity. Alternative to that it is possible that the coolant which is introduced into the cavity is not the oxidant which is guided through the channel to the
20 first device of the combustion apparatuses.

In the above described combustion apparatus the second wall can exhibit at least one third opening adapted for outputting the coolant from the cavity to the combustion chamber and/or
25 the pre-chamber.

By a corresponding arrangement of at least one third opening in the second wall an optimized cooling of the second wall can be realized by the realization of a cooling film next to
30 the second wall. If more than one third opening is provided in the second wall then these openings can be located in the area of the pre-chamber and/or the area of the combustion chamber .

35 In the above described combustion apparatus the first device can be arranged in such a way that the coolant can be introduced from the cavity into the first device, wherein the

first device is adapted for receiving the coolant from the cavity .

By introducing the coolant into the first device the coolant is supplied to the pre-chamber and to the combustion chamber by the first device. Therefore, an effective cooling of the pre-chamber and the combustion chamber can be achieved. More particularly, an effective cooling of the inner face of the second wall along the pre-chamber and the combustion chamber is achieved.

In the two last described combustion apparatuses a second device can be provided between the first device and the cavity, wherein the second device is adapted for outputting the coolant to the first device and/or the pre-chamber.

Moreover, the second device can also be located in the cavity, the second device being adapted for outputting the coolant to the first device and/or the pre-chamber.

By introducing the coolant through the second device into the first device an optimized provision of the coolant to the first device can be realized. This coolant then is supplied to the pre-chamber and to the combustion chamber by the first device cooling the pre-chamber and the combustion chamber. It is also possible that the second device outputs the coolant directly into the pre-chamber. Thereby, an optimized cooling of the pre-chamber can be realized. More particularly, an effective cooling of the inner face of the second wall along the pre-chamber and the combustion chamber is achieved. It is furthermore possible that the output of the coolant through the second device is so chosen that it matches the flow induced from the first device. This avoids any potential shear layers which may result in flash backs.

In the above described combustion apparatus the second device can output the coolant radially or axially into the pre-

chamber or can output the coolant axially into the first device .

5 Thereby, the term radially means the direction towards a center axis of the combustion apparatus and the term axially means a direction parallel to the center axis of the combustion apparatus. The second device therefore can be adapted to create a film that directs the flow along the pre-chamber wall. This coolant film is also realized by coolant outputted
10 by third openings in the second wall.

15 In the two last above described combustion apparatuses the second device can comprise a swirler, in particular a radial swirler or an axial swirler.

20 In the three last described combustion apparatuses the first device and the second device can be formed integrally, i.e. in one piece.

25 By integrally forming the first device and the second device the combined device can be realized in a compact form. Moreover, the production of an integrally formed first and second device eases the production and the matching of the flows from the first device and the second device can be easily
30 achieved.

35 In the described combustion apparatuses the first device can comprise a swirler. If the coolant, in particular air, is been exiting into the main swirler then an axial type swirler can be used, if the coolant, in particular air, is been exiting into the pre-chamber a radial type swirler can be used.

40 The swirler creates a swirling mix of the fuel and the oxidant, which travels along the pre-chamber to the combustion chamber. The swirler can be a radial swirler, i.e. the oxidant and/or the fuel/oxidant mix is outputted in a radial direction into the pre-chamber. But the present invention is not limited to a first device comprising a radial swirler.

The first device can also comprise an axial swirler outputting the oxidant and/or the fuel/oxidant mix in an axial direction into the pre-chamber.

- 5 In the above described combustion apparatuses the coolant can be an oxidant, in particular air.

In the above described combustion apparatuses a separation element is placed in the cavity dividing the cavity into a first cavity and a second cavity, the first cavity is formed by the first common wall and the separation element and the second cavity is formed by the separation element and the second common wall, wherein at the upstream side of the first cavity and the second cavity the cavities are connected with each other by a coolant communicating pathway, wherein the at least one first opening is arranged at the downstream end of the first cavity and wherein a fourth opening is arranged at the downstream end of the second cavity or vice versa. Such a construction of a combustion apparatus enables a very effective cooling of the common second wall of the pre-chamber and the combustion chamber. The upstream side of the first cavity and the second cavity is the side which is arranged around the pre-chamber. A coolant can be introduced at the downstream end of the cavities into the second cavity. Thus the coolant can flow through the first cavity, through the coolant communicating pathway into the second cavity and from there the heated up coolant can be deduced. Introducing oxidant through the second openings into the cavity enables a faster flow of the heated up coolant through the second cavity. Such a combustion apparatus ensures a very effective cooling of the common second wall of the pre-chamber and the combustion-chamber .

Furthermore, the present invention discloses a gas turbine engine, which comprises at least one of the above described combustion apparatuses.

The present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic cross-sectional side view of a combustion apparatus according to the prior art,

Figure 2 is a schematic cross-sectional side view of a combustion apparatus according to the present invention and

Figure 3 is a schematic cross-sectional side view of a further combustion apparatus according to the present invention .

Figure 1 of the present invention shows a schematic cross-sectional side view of a combustion apparatus according to the prior art. The combustion apparatus shown in Figure 1 comprises a combustion chamber 12, a pre-chamber 14 located upstream of the combustion chamber 12, a first device 10 for mixing a fuel with an oxidant, wherein the first device 10 is located upstream of the pre-chamber 14. Moreover, the combustion apparatus according to the prior art also comprises a back plate 50 and an outer casing. The combustion chamber 12 exhibits a first wall 20 and a second wall 30, wherein the first wall 20 is spaced to the second wall 30. Therefore, the first wall 20 and the second wall 30 build a cavity 40. The first wall 20 exhibits a first opening for introducing a coolant into the cavity 40. Furthermore, the second wall 30 exhibits at least one opening 21 for outputting the coolant from the cavity 40 into the combustion chamber 12. Thereby, a cooling of the combustion chamber 12 is achieved.

An oxidant, such as e.g. air, is supplied by a not shown compressor to the first device 10. The flow direction of the oxidant is indicated by dotted arrows shown in the upper part of Figure 1. The first device 10 is adapted for mixing a fuel, which can be supplied by fuel galleries through the back plate 50, with the oxidant supplied by the not shown

compressor. The first device 10 outputs the oxidant or the fuel/oxidant mix into the pre-chamber 14. In the case shown in Figure 1 the combustion apparatus exhibits a cylindrical geometry so that the first device 10 outputs the oxidant or the fuel/oxidant mix towards the center axis of the combustion apparatus and the first device 10 respectively.

According to the radial output of the oxidant or the fuel/oxidant mix from the first device 10 a central recirculation is generated in the pre-chamber 14. The flow structure having a central recirculation extends from the pre-chamber 14 into the combustion chamber 12. The flow structure having the central recirculation is indicated by the dotted arrows extending from the pre-chamber 14 into the combustion chamber 12. The recirculation is an aerodynamic feature of highly swirling flow. The recirculating flow is generally hot combustion products and it is this which heats the pre-chamber and incoming fluids. The not combusted oxidant and/or fuel/oxidant mix interacts with the wall of the pre-chamber 14 and therefore heats the pre-chamber 14.

Figure 2 of the present invention shows a schematic cross-sectional side view of a combustion apparatus 100 according to the present invention. The combustion apparatus 100 shown in Figure 2 comprises a combustion chamber 12 in which combustion of a fuel/oxidant mix takes place, and a pre-chamber 14 located upstream of the combustion chamber 12. The combustion chamber 12 and the pre-chamber 14 comprise a common first wall 20 and a common second wall 30, wherein the first wall 20 and the second wall 30 are spaced to each other, so that they build a cavity 40. The cavity 40 therefore extends from the combustion chamber 12 to the pre-chamber 14. Moreover, the first wall 20 of the combustion apparatus 100 exhibits at least one first opening 21 which is adapted for introducing a coolant into the cavity 40.

The common first wall 20 of the combustion chamber 12 and the pre-chamber 14 is the outer skin or the outer wall of the

combustion chamber 12 and the pre-chamber 14. The common second wall 30 of the combustion chamber 12 and the pre-chamber 14 is the inner skin of the combustion chamber 12 and the pre-chamber 14 facing the center of the combustion apparatus 100 and therefore facing the center of the combustion chamber 12 and the pre-chamber 14.

The at least one first opening 21 in the first wall 20 can e.g. be realized by a soft wall, a dilution hole or simply by a perforation of the first wall. The position of the first opening 21 in the first wall 20 is completely variable. E.g. the first opening 21 in the first wall 20 can be located in the area of the combustion chamber 12, as shown in Figure 2. Nevertheless, the present invention is not limited to this arrangement. The first opening 21 of the first wall 20 can also be located in the area of the pre-chamber 14.

Coolant introduced into the cavity 40 through the first opening 21 in the first wall 20 spreads in the cavity 40 as indicated by the dotted arrows inside the cavity 40. Therefore, in addition to a cooling of the combustion chamber 12 also a cooling of a pre-chamber 14 is realized.

In Figure 2 it is shown that the at least one first opening 21 in the first wall 20 is located in the area of the combustion chamber 12. But this is not a limitation of the present invention. The at least one first opening 21 can of course also be a plurality of first openings 21, which can be arranged in the first wall 20. This arrangement of the plurality of first openings 21 in the first wall 20 can be adapted by the person skilled in the art as required.

In the combustion apparatus 100 shown in Figure 2 the first wall 20 additionally exhibits at least one second opening 22. The at least one second opening 22 is also adapted for introducing the coolant into the cavity 40. In Figure 2 of the present invention it is shown that the at least one second opening 22 is located in the area of the pre-chamber 40. Nev-

ertheless, the present invention is not limited to this arrangement. The at least one second opening 22 in the first wall 20 can also be located in another area of the double skin arrangement of the combustion chamber 12 and the pre-chamber 14. In Figure 2 it is shown that coolant introduced through the second opening 22 is directly coupled into the cavity 40 in the area of the pre-chamber 14. Therefore, a more effective cooling of the pre-chamber 14 is realized.

In Figure 2 of the present invention it is indicated by the dotted arrows in the area of the pre-chamber 14 directing into the direction of the center axis of the combustion apparatus 100 that the at least one second opening 22 is realized by three second openings 22 in the first wall 20. Nevertheless, the present invention is not limited to this arrangement. Any arbitrary number of second openings 22 in the first wall 20, which applies useful for the person skilled in the art to reach an optimized cooling of the pre-chamber 14 and the combustion chamber 12, is possible.

The at least one second opening 22 in the first wall 20 can be realized e.g. by a softwall or by at least one dilution hole or simply by a perforation of the common first wall 20 of the combustion chamber 12 and the pre-chamber 14.

The oxidant, which can be the coolant, is guided through a channel 60 to the first device 10 which is advantageously a swirler. The channel 60 of the combustion apparatus 100 feeds the oxidant to the first device 10. The channel 60 is formed by a housing element 70 of the combustion apparatus 100 and the common first wall 20 of the combustion chamber 12 and the pre-chamber 14. The channel 60 is arranged separate to the cavity 40. The advantage of the extra channel 60 is that the oxidant can flow constant and undisturbed through the channel 60 to the first device 10. An efficient supply of oxidant to the first device 10 is guaranteed by the channel 60. Only a part of the oxidant is introduced through the at least one first opening 21 and the at least one second opening 22 into

the cavity 40 for cooling the common second wall 30 of the pre-chamber 14 and the combustion chamber 12.

Such a combustion apparatus 100 enables both a constant and
5 undisturbed supply of oxidant to the first device 10 and an effective cooling of the common second wall 30 of the pre-chamber 14 and the combustion chamber 12 are guaranteed. The introduction of coolant, in particular oxidant, through the
10 at least one second opening 22 into the cavity 40 enables that the coolant flows from the upstream end to the downstream end of the cavity 40 and therefore enables an effective heat removal through the cavity 40. The specific arrangement of the cavity 40 enables additionally to the cooling of the common second wall 30 in the area of the combustion-chamber 12 a cooling of the common second wall 30 in the
15 area of the pre-chamber 14. The lifetime of the combustion apparatus 100 can be increased by the better cooling of the common second wall 30. The arrangement of the channel 60 and the cavity 40 around the pre-chamber 14 and the combustion-chamber 12 ensures a perfect feeding of oxidant to the first
20 device 10 of the combustion apparatus 100 and a good cooling of the common second wall 30 which is covering the pre-chamber 14 and the combustion-chamber 12. At the downstream end of the cavity 40 the heated coolant can be deduced. The
25 double common wall 20, 30 has the advantage that the oxidant which is guided through the channel 60 to the first device 10 is not heated up very strong in direction to the first device 10. Thus the part of the coolant/oxidant which enters the cavity 40, in particular through the second openings 22 is
30 cool enough to provide an effective cooling of the common second wall 30.

The same shape of the common first wall 20 and the common second wall 30 is the same in figure 2. The common first wall
35 20 has a larger diameter than the common second wall 30. Alternative to that the distance between the common first wall 20 and the common second wall 30 can be different over the length of the cavity 40.

In Figure 2 it is shown that the common second wall 30 of the combustion chamber 12 and the pre-chamber 14 exhibits at least one third opening 31. This at least one third opening 31 is adapted for outputting the coolant from the cavity 40 to the combustion chamber 12 and/or the pre-chamber 14.

This at least one third opening 31 in the common second wall 30 of the combustion chamber 12 and the pre-chamber 14 can also be a plurality of third openings 31. In Figure 2 of the present invention it is shown that the at least one third opening 31 in the second wall 30 is positioned in the area of the combustion chamber 12. Nevertheless, the present invention is not limited to this arrangement. The at least one third opening 31 can also be located in other areas of the second wall 30, which apply useful for the person skilled in the art for an optimized cooling of the combustion chamber 12 and/or the pre-chamber 14.

Coolant which is outputted by the at least one third opening 31 into the combustion chamber 12 and/or the pre-chamber 14 can build a cooling film next to the common second wall 30 of the combustion chamber 12 and the pre-chamber 14. Therefore, an optimized cooling of the combustion chamber 12 and the pre-chamber 14 can be realized.

The at least one third opening 31 can be realized e.g. by a softwall or by at least one dilution hall or simply by a perforation of the second wall 30.

In Figure 2 of the present invention it is shown that the combustion apparatus 100 comprises a first device 10, which is adapted for mixing a fuel with an oxidant. The first device 10 is located upstream of the pre-chamber 14. Oxidant, which is supplied by a not shown compressor, is supplied to the first device 10. The flow direction of the oxidant is indicated by dotted arrows in the upper left part of Figure 2.

In Figure 2 it is shown that the oxidant is outputted by the first device into a radial direction towards the center axis of the first device 10 and the combustion apparatus 100, respectively. It is possible that fuel is injected into the pre-chamber 14 by injection holes where the injected fuel is mixed with the oxidant supplied by the first device 10. Nevertheless, the present invention is not limited to this arrangement. It is also possible that fuel is inserted into the first device 10 by e. g. fuel galleries or fuel injection holes so that mixing of the oxidant and the inserted fuel is already conducted in the first device 10. This fuel/oxidant mix is then outputted by the first device into the pre-chamber 14.

Even though it is shown in Figure 2 of the present invention that a second device 16 is located between the first device 10 and the cavity 40 the present invention is not limited to this arrangement. It is also possible that the second device 16 is omitted. In case of omitting the second device 16 coolant introduced into the cavity 40 is directed towards the first device 10. The first device 10 is adapted for receiving the coolant from the cavity 40. This coolant then is outputted to the pre-chamber 14 where it is spread also into the direction of the combustion chamber 12. Therefore, an optimized cooling of the pre-chamber 14 and the combustion chamber 12 and also of the combustion flame itself can be realized.

In Figure 2 of the present invention it is shown that in the combustion apparatus 100 a second device 16 is located between the first device 10 and the cavity 40. The second device 16 is adapted for outputting the coolant introduced into the cavity 40 to the first device 10 and/or the pre-chamber 14.

In case of an outputting of the cooling from the second device 16 to the first device 10 optimized supplies of the coolant to the first device 10 and therefore to the pre-

chamber 14 and the combustion chamber 12 are realized. In the case of outputting of the coolant by the second device 16 into the pre-chamber 14 also an optimized cooling of the pre-chamber 14 and therefore also of the combustion chamber 12 can be realized.

By a suitable outputting of the coolant by the second device 16 into the pre-chamber 14 a matching can be achieved with the flow structure induced by the first device 10.

Therefore, any potential shear layers, which may result in flash backs of the combustion flame can be avoided.

In the case that the second device 16 outputs the coolant into the pre-chamber 14 the second device 16 can output the coolant radially or axially. That is, the second device 16 can output the coolant parallel to the center axis of the combustion apparatus 100 or radially towards the center axis of the combustion apparatus 100.

The second device 16 can comprise a swirler. This swirler may either be a radial swirler or an axial swirler. Moreover, the first device 10 can also comprise a swirler, which also may either be a radial swirler or an axial swirler. In case of an axial swirler, which is comprised by a first device 10, the axial swirler 10 has to be introduced into the pre-chamber 14. Moreover, it is possible that the first device 10 and the second device 16 are integrally formed.

With the combustion apparatus 100 according to the present invention an improvement of the cooling of the pre-chamber 14 and the combustion chamber 12 and also of the combustion flame itself is realized. Thereby, the emissions (NO_x) are lowered. The provision of a cavity 40 realized by a common first wall 20 and a common second wall 30 of the pre-chamber 14 and the combustion chamber 12 optimizes the cooling of the pre-chamber 14 and the combustion chamber 12 and the combustion flame itself.

It has to be noted, with "common" wall for a pre-chamber and a main combustion chamber, a wall is meant that continues along both chamber sections, the pre-chamber and the main combustion chamber. For example the common wall may be a single sheet of metal pressed into the wanted form such that a pre-chamber and a main combustion chamber are built. The first common wall and the second common wall may have separators between each other but otherwise should not be joined such that the cavity between the two walls would be blocked. Over the whole length of the walls, the cavity should have a width to let pass cooling fluid without major interruptions. Specifically no larger areas of the two walls should touch or should be bonded to each other to form a blockage for the cooling fluid.

Thus the two common walls with the cavity in between form a double skin pre-chamber leading into a double skin combustion chamber .

Figure 3 shows schematically a cross-sectional side view of a further combustion apparatus 100 according to the present invention. In this combustion apparatus 100 a separation element 44 is placed in the cavity 40 dividing the cavity 40 into a first cavity 41 and a second cavity 42. The first cavity 41 is formed by the common first wall 20 and the separation element 44 and the second cavity 42 is formed by the separation element 44 and the second common wall 30. At the upstream side of the first cavity 41 and the second cavity 42, which means near the first device 10, the cavities 41, 42 are connected with each other by a coolant communicating pathway 45. The at least one first opening 21 is arranged at the downstream end of the first cavity 41 and a fourth opening 23 is arranged at the downstream end of the second cavity 42. Such a construction of a combustion apparatus 100 enables a very effective cooling of the common second wall 30 of the pre-chamber 14 and the combustion chamber 12. The upstream sides of the first cavity 41 and the second cavity 42 are these sides which are arranged around the pre-chamber 14. The

coolant can be introduced through the first opening 21 at the downstream end of the first cavity 41. Thus the coolant can flow through the first cavity 41, through the coolant communicating pathway 45 into the second cavity 42 and from there the heated up coolant can be deduced. Introducing oxidant through the second openings 22 into the cavity 40 enables a faster flow of the heated up coolant through the second cavity 42. Such a combustion apparatus 100 ensures a very effective cooling of the common second wall 30 of the pre-chamber 14 and the combustion-chamber 12. The coolant which is introduced through the first opening 21 into the first cavity 41 can be oxidant from the same oxidant source which is introduced into the channel 60. Alternative to that the coolant can be different to the oxidant which is introduced into the channel 60. In this case it is possible to introduce relative cold coolant into the cavity 40 to cool wall of the combustion-chamber 12 and the pre-chamber, respectively. It is also possible to introduce coolant through the fourth opening 23 into the second cavity 42. The coolant flows through the second cavity 42, through the coolant communicating pathway 45 into the first cavity 41 and from there the heated up coolant can be deduced.

Claims

1. A combustion apparatus (100) comprising:

a combustion chamber (12) in which combustion of a

5 fuel/oxidant mix takes place;

a pre-chamber (14) located upstream of the combustion chamber (12) ;

a first device (10) for mixing a fuel with an oxidant, the first device (10) located upstream of the pre-chamber (14);

10 wherein

the combustion chamber (12) and the pre-chamber (14) comprise a common first wall (20) and a common second wall (30) spaced to each other building a cavity (40);

15 the first wall (20) exhibits at least one first opening (21) in the area of the combustion chamber (12) for introducing a coolant into the cavity (40);

20 a channel (60) for feeding the oxidant to the first device (10), whereby the channel (60) is formed by a housing element (70) of the combustion apparatus (100) and the common first wall (20) of the combustion chamber (12) and the pre-chamber (14); and

25 wherein the at least one first opening (21) is located in the area of the combustion chamber (12), and wherein the first wall (20) exhibits at least one second opening (22) for introducing the coolant into the cavity (40), wherein the at least one second opening (22) is located in the area of the pre-chamber (14) .

2. The combustion apparatus (100) according to claim 1,

30 wherein the common first wall (20) and the common second wall (30) have the same shape.

3. The combustion apparatus (100) according to claim 1 or 2,

35 wherein the coolant is the oxidant flowing through the channel (60) and being introduced through the at least one first opening (21) and the at least one second opening (22) into the cavity (40).

4. The combustion apparatus (100) according to claim 1 to 3, wherein the second wall (30) exhibits at least one third opening (31) for outputting the coolant from the cavity (40) to the combustion chamber (12) and/or the pre-chamber (14) .

5

5. The combustion apparatus (100) according to any of the claims 1 to 4, wherein the first device (10) is arranged in such a way that the coolant can be introduced from the cavity (40) into the first device (10), wherein the first device (10) is adapted for receiving the coolant from the cavity (40) .

10

6. The combustion apparatus (100) according any of the claims 1 to 5, further comprising a second device (16) located between the first device (10) and the cavity (40), the second device (16) being adapted for outputting the coolant to the first device (10) and/or the pre-chamber (14) .

15

7. The combustion apparatus (100) according to one of the claims 1 to 6, further comprising a second device (16) located in the cavity (40), the second device (16) being adapted for outputting the coolant to the first device (10) and/or the pre-chamber (14) .

20

8. The combustion apparatus (100) according to claim 6 or 7, wherein the second device (16) outputs the coolant radially or axially into the pre-chamber (14) or outputs the coolant axially into the first device (10) .

25

9. The combustion apparatus (100) according to one of the claims 6 to 8, wherein the second device (16) comprises a swirler, in particular a radial swirler or an axial swirler.

30

10. The combustion apparatus (100) according to any one of the claims 6 to 9, wherein the first device (10) and the second device (16) are integrally formed.

35

11. The combustion apparatus (100) according to any of the claims 1 to 10, wherein the first device (10) comprises a swirler .

5 12. The combustion apparatus (100) according to any of the claims 1 to 11, wherein a separation element (44) is placed in the cavity (40) dividing the cavity into a first cavity (41) and a second cavity (42), the first cavity (41) is formed by the first common wall (20) and the separation ele-
10 ment (44) and the second cavity (42) is formed by the separation element (44) and the second common wall (30), wherein at the upstream side of the first cavity (41) and the second cavity (42) the cavities (41, 42) are connected with each other by a coolant communicating pathway (45), wherein the at
15 least one first opening (21) is arranged at the downstream end of the first cavity (41) and wherein a fourth opening (23) is arranged at the downstream end of the second cavity (42) or vice versa.

20 13. The combustion apparatus according to any of the claims 1 to 12, wherein the coolant is an oxidant, in particular air.

14. A gas turbine engine comprising a combustion apparatus according to any one of the preceding claims.

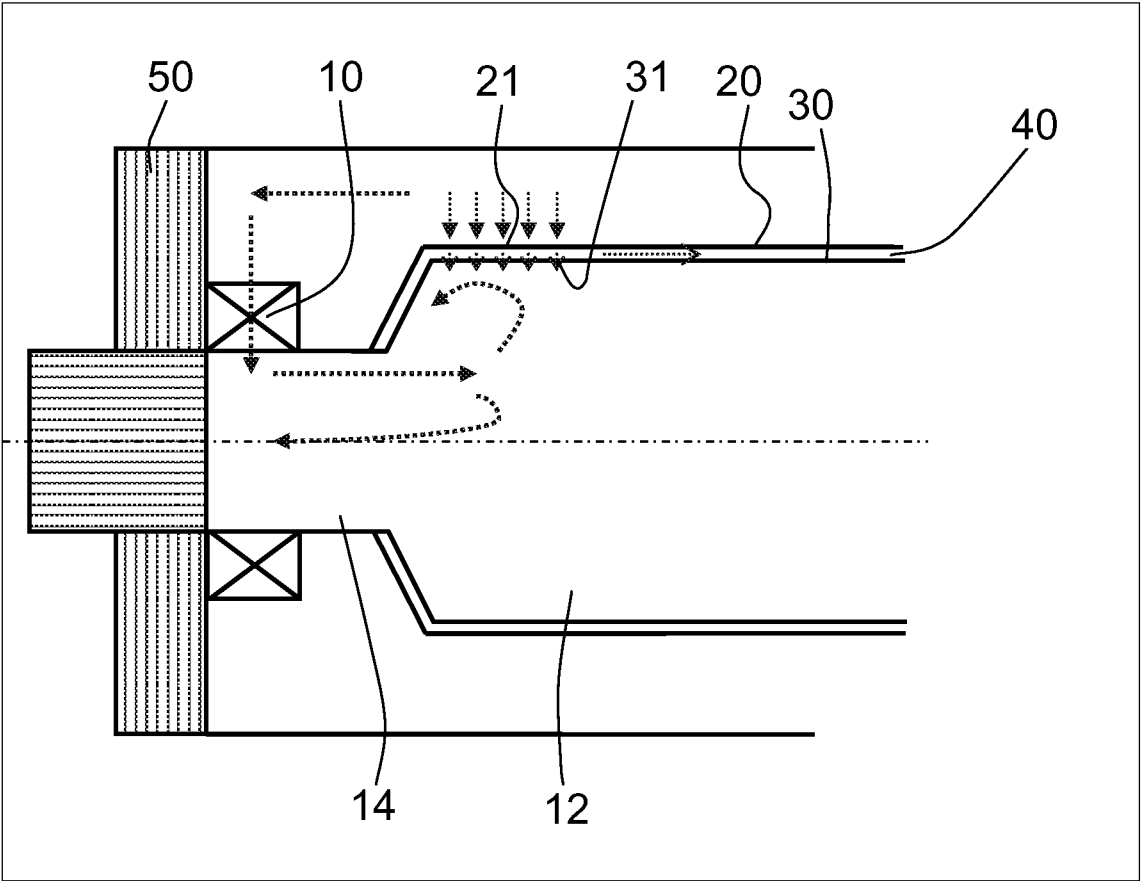


FIG 1

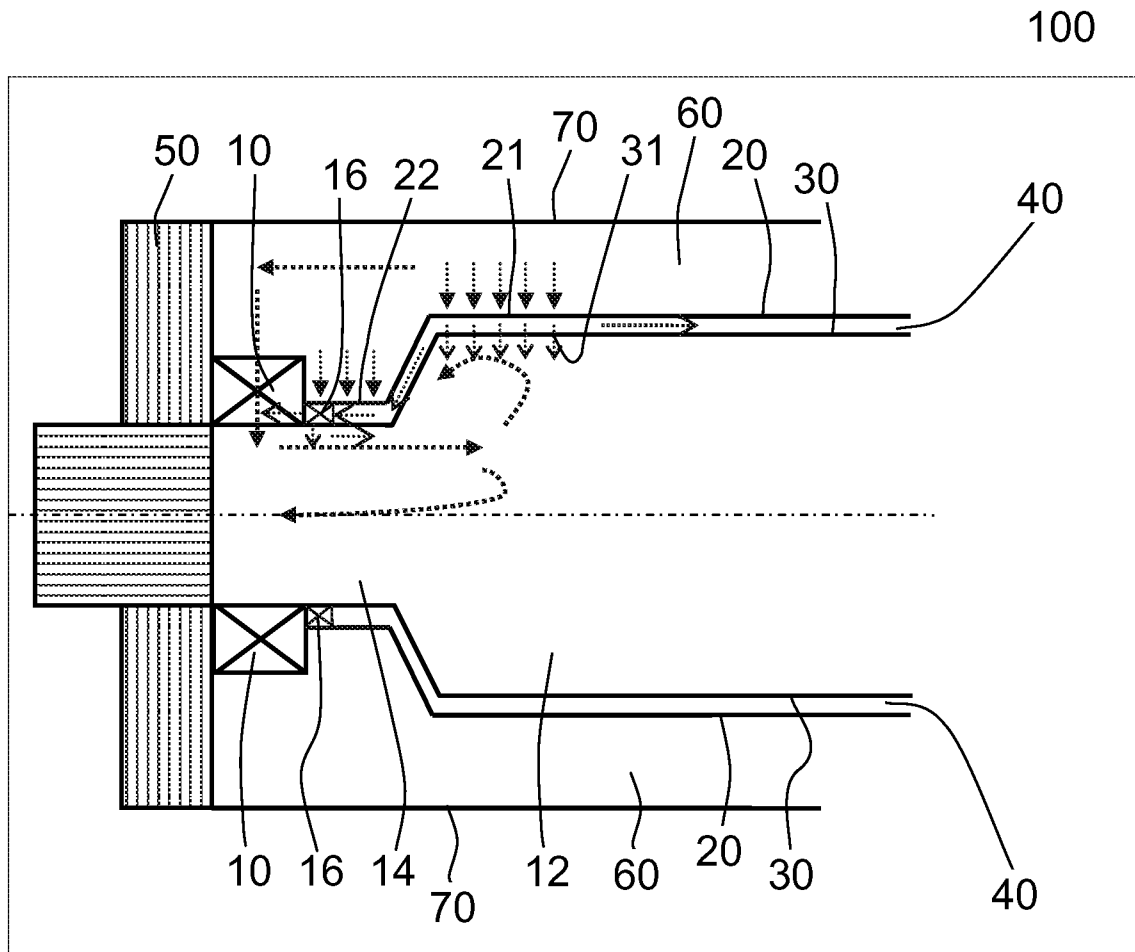


FIG 2

100

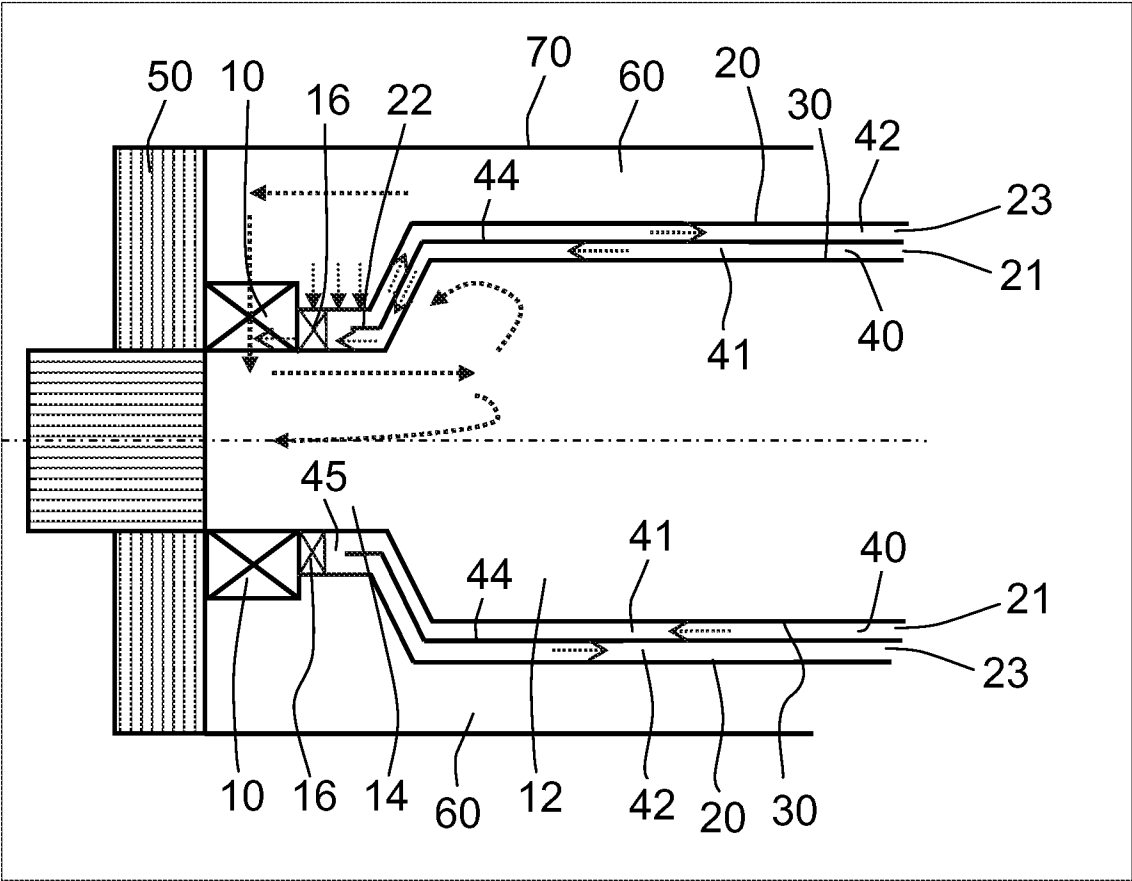


FIG 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/060492

A. CLASSIFICATION OF SUBJECT MATTER INV. F23R3/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) F23R		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	W0 2008/028621 A1 (MAN TURBO AG [DE] ; BRINKMANN RAINER [DE] ; HUITENGA HOLGER [DE] ; NORSTE) 13 March 2008 (2008-03-13) page 3, line 30 - page 6; figure 1 -----	1-14
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search 5 October 2011		Date of mailing of the international search report 14/10/2011
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Munteh , Louis

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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