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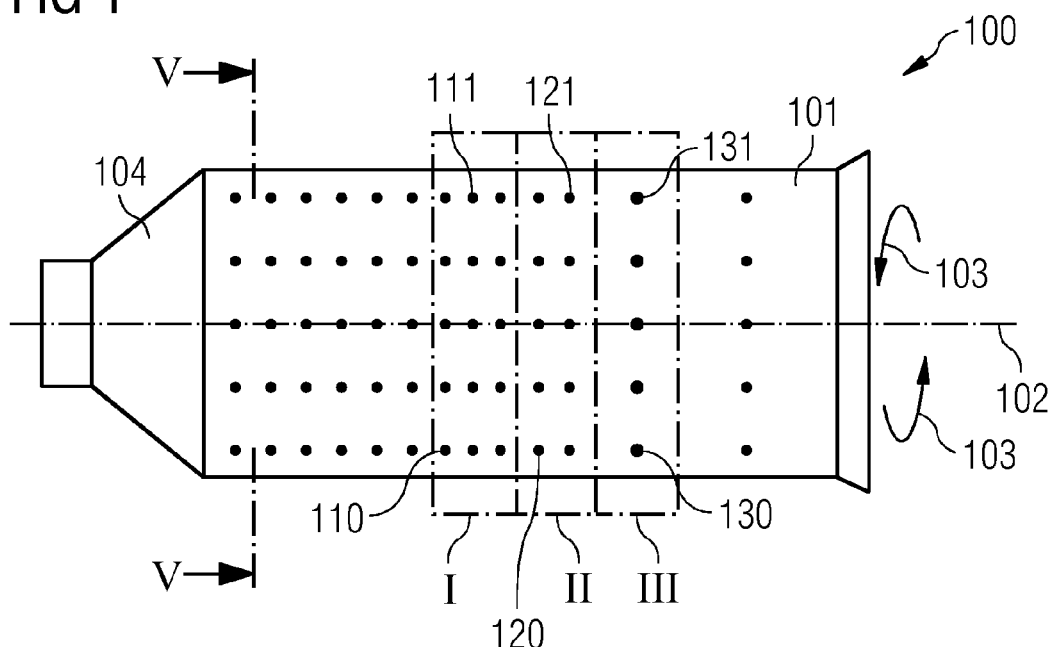
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(54) **An improved hole arrangement of liners of a combustion chamber of a gas turbine engine with low combustion dynamics and emissions**

(57) The present invention relates to a housing for a combustion chamber (100) for a gas turbine. The housing comprises a wall element (101) which comprises a first hole arrangement (I) and a second hole arrangement (II). The first hole arrangement (I) comprises first holes (110) through which first holes (110) fluid is streamable, where-

in the first holes (110) are arranged in a first areal density. The second hole arrangement (II) comprises second holes (120) through which second holes (120) fluid is streamable, wherein the second holes (120) are arranged in a second areal density. The first areal density differs from the second areal density.

FIG 1



Description

Field of invention

[0001] The present invention relates to a housing for a combustion chamber for a gas turbine and to a method for producing a combustion chamber of a gas turbine.

Art Background

[0002] In a field of gas turbine technology it is an aim to reduce the production of environmental pollutants such as various oxides of nitrogen (NO_x), carbon monoxide (CO) and unburned hydrocarbons (UHC). Therefore, it is an aim to achieve a reliable and stable lean-burn combustion process in a combustion chamber of a gas turbine.

[0003] In order to provide a lean-burn combustion process more air is directed in particular close to the front end of the combustion chamber (where the combustion process is initiated) to be mixed with fuel in the burner. This is achieved by rebalancing the effective areas, that is the accumulated hole area of the combustion can and that of the burner i.e. swirler. However, directing more air flow through the front end, the combustion chamber promotes combustion instabilities which is an inherent problem associated with the lean-burn combustion.

[0004] In order to damp the combustion instabilities and in particular the combustion dynamics inside the combustion chamber the wall elements of the combustion chamber housings are provided with holes through which a gas exchange takes place.

[0005] GB 2 309 296 A discloses a gas turbine engine combustor wherein the combustor comprises an inner combustor wall and an outer combustor wall. To the combustor wall damping holes are formed. The damping holes are arranged uniformly over the wall section, i.e. the damping holes have the same distances between each other.

[0006] EP 1 104 871 A1 discloses a combustion chamber for a gas turbine engine, wherein the combustion chamber is a twin wall combustion chamber. An inner wall and an outer wall of the twin wall combustion chamber comprise effusion holes in order to provide an impingement cooling. The effusion holes are uniformly distributed over the effective inner wall or outer wall.

[0007] EP 1 321 713 A2 discloses an improved flame tube of a combustion chamber of a gas turbine. Cooling air is guidable through apertures of the respective walls of the flame tube.

Summary of the Invention

[0008] It may be an object of the present invention to provide a combustion chamber with reduced combustion instabilities and lower emissions.

[0009] This object may be solved by a housing for a combustion chamber for a gas turbine, by a combustion

chamber for a gas turbine and by a method for producing a combustion chamber for a gas turbine according to the independent claims.

[0010] According to a first aspect of the present invention a housing for a combustion chamber for a gas turbine is presented. The housing comprises a wall element which comprises a first hole arrangement and a second hole arrangement. The first hole arrangement comprises first holes through which first holes fluid is streamable. The first hole arrangement further comprises a first areal density of the first holes. The second hole arrangement comprises second holes through which second holes fluid is streamable. The second hole arrangement further comprises a second areal density of the second holes. The first areal density differs from the second areal density.

[0011] According to further aspects of the present invention a combustion chamber for a gas turbine is presented. The combustion chamber comprises an inner housing which comprises the features of the above described housing and an outer housing which may also comprise the features of the above described housing. The outer wall element of the outer housing at least partially envelopes the inner wall element of the inner housing such that a gap between the inner wall element and the further outer wall element is formed.

[0012] The terms "inner" and "outer" relate to a relative position i.e. of the inner and outer wall elements with respect to the distance between the wall element and the flame volume in the combustion chamber. The center axis of the combustion chamber may be a symmetry line of a (e.g. cylindrically formed) combustion chamber (such as a can-type combustion chamber), i.e. passing through the flame region or it may be for example parallel or even coincide with the rotor centre line of the gas turbine (such as an annular combustion chamber).

[0013] According to a further aspect of the present invention a method for producing a combustion chamber of a gas turbine is presented. According to a method, a first hole arrangement which comprises first holes is formed into an inner wall element of an inner housing, wherein through the first holes fluid is streamable and wherein the first hole arrangement comprises a first areal density of the first holes. Furthermore, according to the method, a second hole arrangement which comprises second holes is formed into the inner wall element, wherein through the second holes fluid is streamable and wherein the second hole arrangement comprises a second areal density of the second holes. The first areal density differs from the second areal density.

[0014] The term "areal density" (surface density) defines the number of holes per unit area. If, for example, two adjacent hole arrangements comprise a different areal density, each of the adjacent hole arrangement comprise a different number of holes. This results in a non-uniform distribution of holes over the respective hole arrangements.

[0015] Hence, by the present invention a wall element

of a housing for a combustion chamber comprises the first hole arrangement with the first areal density and the second hole arrangement with the second areal density. Hence, the holes of a wall element are distributed non-uniformly and are particular adapted to respective flow characteristics of a respective fluid which flows along the wall element.

[0016] The housing for a combustion chamber of a gas turbine may be an inner housing which surrounds for example the combustion volume of the combustion chamber. The housing may further be an outer housing which partially surrounds the inner housing. Hence, by applying an inner housing and an outer housing, a twin-walled or double-walled combustion chamber (i.e. a double skin liner) may be formed. A gap may exist between the inner housing and the outer housing. A fluid, e.g. a cooling fluid/gas, which streams along the outer wall element, may enter through the first and second holes of the outer wall element into the gap for cooling purposes. The fluid may further flow from the gap through the first and second holes of the inner wall element into the combustion space of the combustion chamber for cooling purposes.

[0017] Hence, by a conventional approach of combustion chambers, holes of wall elements of housings for combustion chambers are distributed uniformly. In conventional approaches, the first hole arrangement and second hole arrangement comprise one and the same areal density of the respective holes. According to the present inventive approach of the present invention the holes are distributed non-uniformly in the (inner and outer) housing of the combustion chamber. Thereby, the distribution of the holes may be adapted and customized to the flow parameters of the (burned) fluid of the combustion chamber and to the flow parameters of the cooling gas. Thereby, the combustion dynamics inside the combustion chamber may be reduced. Hence, a longer life of the housing and other combustion components results due to e.g. the reduction of fluctuation in the temperature profile at the wall elements. Furthermore, by the reduced combustion dynamics of the wall sections, the turbine efficiency and the operating temperature of the turbine may be increased without affecting the life of the housing of the combustion chamber. Hence, also the nitrogen (NO_x) emissions may be reduced for example by operating the gas turbine with a lean-burn combustion, i.e. by a lower pilot fuel split inside the gas turbine. Summarizing, the distribution of the holes in a non-uniform manner and by arranging the pattern of the holes in a respective hole arrangement the combustion chamber may operate at lower nitrogen (NO_x) emissions because for example more air may be fed to the combustion process for providing a lean-burn combustion. Furthermore, the flame temperature is reduced due to the lean-burn combustion.

[0018] According to a further exemplary embodiment, the wall element is formed for at least partially extending along a circumferential direction around the central axis of the combustion chamber. Generally, the combustion

chamber is formed cylindrically (or conically). The central axis forms e.g. the symmetry axis of the combustion chamber, for example. According to a further exemplary embodiment, the first holes of the first hole arrangement are formed into the wall element one after another along the circumferential direction for forming at least one first row of the first holes.

[0019] According to a further exemplary embodiment, the second holes of the second hole arrangement are formed into the wall element one after another along the circumferential direction for forming at least one second row of second holes. The amount of first holes are equal for example to the amount of the second holes seen over the whole circumference, but the areal density for each row of holes varies between the first and second rows of holes.

[0020] According to a further exemplary embodiment, the second holes of the second hole arrangement are formed into the wall element one after another along the circumferential direction for forming at least one second row of second holes. Because the first holes in the first hole arrangement comprise a first areal density which differs from the second areal density of the second holes of the second hole arrangement, the amount of first holes differs for example to the amount of the second holes.

[0021] Regarding the above described exemplary embodiments comprising the first row and the second row, the amount of first rows differs from the amount of second rows. Additionally or alternatively, the amount of first holes in the first row differs from an amount of second holes of a second row. This results in a first areal density, which differs from the second areal density, and thus in a non-uniform distribution of first and second holes along the wall element.

[0022] According to a further exemplary embodiment, the first holes of the first hole arrangement are formed into the wall element one after another along a first direction. The first direction differs from the circumferential direction for forming at least one further first row of first holes.

[0023] In particular, according to a further exemplary embodiment, the first angle between first direction and the circumferential direction is between approximately 10° and approximately 80°, in particular between approximately 30° and approximately 60°. Hence, the first holes are arranged into the wall element such that the further first row runs in a spiral way along the respective (e.g. tubular) wall element.

[0024] According to a further exemplary embodiment, the second holes of the second hole arrangement are formed into the wall element one after another along a second direction. The second direction differs from the circumferential direction and/or from the first direction for forming at least one further second row of the second holes.

[0025] In particular, according to a further exemplary embodiment, the second angle between the second direction and the circumferential direction is between ap-

proximately 10° and approximately 80°, in particular between approximately 30° and approximately 60°. By the further first row and the further second row, the respective first and/or second holes are formed one after another along a respective first and second directions such that the respective further first row and the respective further second row may form a helical (i.e. spiral) run around the centre axis along the wall element.

[0026] According to a further exemplary embodiment of the method, an outer wall element of an outer housing is arranged with respect to the inner wall element such that the outer wall element at least partially envelopes the inner wall element and such that a gap between the inner wall element and the outer wall element is formed.

[0027] According to a further exemplary embodiment of the method, a further first hole arrangement is formed into the outer wall element, wherein the further first hole arrangement comprises further first holes through which further first holes a further fluid (e.g. cooling fluid/gas) is streamable. The further first hole arrangement comprises a further first areal density of the further first holes. Furthermore, a further second hole arrangement which comprises further second holes is formed into the outer wall element, wherein through the further second holes a further fluid (e.g. cooling fluid/gas) is streamable, wherein the further second hole arrangement comprises the further second areal density of the second holes. The further first areal density differs from the further second areal density.

[0028] The total hole area for the inner and or outer wall is distributed over the wall such that bands or areas of different hole density emerges. The criteria for the distribution depend on the flow parameters which may be for example the temperature, the flow velocity, the flow direction and/or the turbulence of the fluid and/or a further fluid.

[0029] Hence, by the above described method, the arrangement of the first holes and the second holes are designed and formed while taking into account the flow parameters of the respective fluid. Hence, an effective hole distribution of the holes and hence an improved guidance of the fluid and the further fluid along the respective wall elements is provided. Thereby, also the efficiency of the combustion chamber due to the adapted hole arrangement is achieved.

[0030] For example, holes of hole arrangements in a wall element may be at the beginning of the method equally distributed and hence comprise an equal areal hole density. Next, some of the holes may be removed from the existing hole arrangements, such that a non-equal distribution and a non-equal hole density between the respective hole arrangements are formed. Next, it is measured how the total hole area is reduced in a flow test as confirmation. Next, it is calculated how to machine and arrange the respective holes to get the nominal flow parameters and to achieve a good damping characteristic. Next, the respective holes are distributed in the respective hole arrangements, so that an uneven distribu-

tion and/or an uneven areal density of holes is formed, in order to match up with calculated nominal flow parameters and the total effective flow area for the combustion chamber, respectively.

[0031] By the above described invention, combustion dynamics of the fluid inside the combustion chamber may be reduced. In other words, the inner wall elements and the outer wall elements are perforated with holes in a non-uniform and customized manner. Hence, due to the reduction of the combustion dynamics, the lifetime for the combustion chamber component and the downstream located turbine stage components as a result of reduced flame fluctuations and temperature profiles is achieved. Furthermore, the NOx emissions are reduced, because due to the reduced combustion dynamics a lower pilot fuel split (pilot fuel/[pilot fuel + main fuel]) may be applied.

[0032] It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this application.

Brief Description of the Drawings

[0033] The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.

Fig. 1 shows a housing of a combustion chamber with first and second rows of holes according to an exemplary embodiment of the present invention;

Fig. 2 shows a housing of a combustion chamber with first and second rows of holes according to an exemplary embodiment of the present invention;

Fig. 3 and Fig. 4 show abstract views of hole patterns in a respective housing of a combustion chamber according to an exemplary embodiment of the present invention;

Fig. 5 shows a schematical view of a combustion chamber comprising an inner housing and an outer; and

Fig. 6 shows a schematical view of a method for producing a housing according to an exemplary embodiment of the present invention.

Detailed Description

[0034] The illustrations in the drawings are schematical. It is noted that in different figures, similar or identical elements are provided with the same reference signs.

[0035] Fig. 1 shows a housing for a combustion chamber 100 for a gas turbine. The housing comprises a wall element 101 which comprises a first hole arrangement I and a second hole arrangement II. The first hole arrangement I comprises first holes 110 through which first holes 110 fluid is streamable. The first hole arrangement I comprises a first areal density of the first holes 110.

[0036] The second hole arrangement II comprises second holes 120 through which second holes 120 fluid is streamable. The second hole arrangement II comprises a second areal density of the second holes 120.

[0037] The first areal density differs from the second areal density. That is that the amount of first holes 110 per area unit differs from the amount of second holes 120 per area unit. In other words, the first holes 110 are distributed with a different pattern and/or with a different amount and/or with a different size (e.g. hole diameter) with respect to the second holes 120 in the second hole arrangement II.

[0038] For example, as can be taken from Fig. 1, the first hole arrangement I, the second hole arrangement II and for example a third hole arrangement III comprise the same areal size. Furthermore, the first hole arrangement I, the second hole arrangement II and the third hole arrangement III may define the areal unit which may define the respective first, second and/or third areal density of the holes.

[0039] In Fig. 1, the density of the first holes 110 within the first hole arrangement I is higher than the second areal density and third areal density of the respective second hole arrangement II and third hole arrangement III, respectively.

[0040] More holes may be arranged at the upstream front end of the wall element 101 because this is where the flame is located. For example as exemplarily shown in Fig. 1, the first hole arrangement I may have three first rows 111, the more downstream located second hole arrangement II may have two second rows 121 and the farther downstream located third hole arrangement III may have one third row 131.

[0041] In particular, as shown in Fig. 1, the combustion chamber 100 comprises a burner section 104 (e.g. a front end section) at an upstream location of the combustion chamber 100 with respect to a flow direction of the fluid along the central axis 102 of the combustion chamber 100. At the downstream end of the combustion chamber 100 with respect to a flow direction of the fluid along the central axis 102 the combustion gas exits the combustion chamber 100 and flows further to the turbine stages of

the gas turbine, for example. As can be taken from Fig. 1, the areal density of the respective holes 110, 120, 130 decreases from the upstream end to the downstream end of the combustion chamber 100. By the exemplary distribution of the holes 110, 120, 130 in Fig. 1, the first holes 110 of the first hole arrangement I are formed into the wall element 101 one after another along a circumferential direction 103 for forming first rows 111 of the first holes 110. Adjacent to the first rows 111 and along the downstream direction, the second holes 120 of the second hole arrangement II are formed into the wall element 101 one after another along the circumferential direction 103 for forming e.g. two second rows 121 of second holes 120. Furthermore, as shown in Fig. 1, the third holes 113 of the third hole arrangement III are formed into the wall element 101 one after another along the circumferential direction 103 for forming at least three third rows 131 of the third holes 130.

[0042] For example, if the respective hole arrangement I, II, III comprise the same defined area, the amount of holes 110, 120, 130 and the amount of rows 111, 121, 131 decrease along the direction from the upstream end of the combustion chamber 100 to the downstream end of the combustion chamber 100. In other words, the distance between the two second rows 121 is smaller than the distance between the third rows 131, for example. For example, the distance between the first rows 121 at an upstream end of the combustion chamber 100 may be half of the distance between the third rows 131 at the downstream section of the combustion chamber 100.

[0043] In Fig. 1, the hole arrangement I, II, III as shown in Fig. 1 may be applied to an inner wall element 501 (see Fig. 5) (inner liner). Due to the non-uniform hole distribution along the central axis 102 from an upstream end of the combustion chamber 100 to a downstream end of the combustion chamber 100 the areal density at the downstream part is lower than the areal density of the holes at an upstream part of the combustion chamber. Furthermore, also a proper effusion cooling in particular at the upstream part of the wall element 101 compared to a uniform arranged hole arrangement is achieved. Furthermore, by the hole distribution as shown in Fig. 1 proper damping characteristics of the combustion dynamics within the combustion chamber 100 is achieved. The arrangement of the axial rows 111, 121, 131 results on the basis of a desired reduction of the combustion chamber effective area and a desired mass flow of the cooling fluid through the respective holes 110, 120, 130 through the inner wall, respectively.

[0044] Fig. 2 shows the combustion chamber 100, wherein the wall element 101 comprises the first hole arrangement I and the second hole arrangement II. The first holes 110 of the first hole arrangement I are formed into the wall element 101 one after another along a first direction 201. The first direction 201 differs from the circumferential direction 103 for forming at least one further first row 211 of first holes 110.

[0045] Additionally or alternatively the second holes

120 of the second hole arrangement II are formed into the wall element 101 one after another along a second direction 202. The second direction 202 differs from the circumferential direction 103 for forming at least one further second row 221 of second holes 120.

[0046] As can be taken from Fig. 2, the further first rows 211 may comprise for example two first holes 110. The further second row 221 comprises for example three second holes 120. Hence, the areal density of the second holes 120 in the second hole arrangement II is higher than the areal density of the first holes 110 in the first hole arrangement I.

[0047] Furthermore, as shown in Fig. 2, by arranging the respective holes 110, 120 along the first and second direction, a helical (spiral) run around the center axis 102 along the wall element 101 is formed. In other words, the respective holes 110, 120 in Fig. 2 are arranged in a diagonal manner (in a spiral pattern) with respect to the circumferential direction 103.

[0048] In particular, the housing comprising the hole pattern as shown in Fig. 2 may be applied for an outer housing with an outer wall element 502 (see Fig. 5). In particular, the first direction and the second direction of the diagonal further first rows 211, 221 may be in the same direction as a spiral and helical motion of the combustion gases inside the combustion chamber 100. Furthermore, the spacing between two adjacent diagonal further rows 211, 221 may either be uniform or non-uniform along the circumferential direction 103, depending on the required flow parameters through the respective holes 110, 120, 130.

[0049] A combustion chamber 100 which comprises the inner housing shown in Fig. 1 and the outer housing shown in Fig. 2 has the surprising effects of efficient cooling properties, efficient damping of flame dynamics and stable flame characteristics in the combustion chamber.

[0050] Fig. 3 shows a more abstract view of the hole pattern as shown in Fig. 2. In Fig. 3 in particular a hole pattern of an outer wall 502 (see Fig. 5) of an outer housing of the combustion chamber 100 is shown. In Fig. 3 exemplarily the first hole arrangement I and the second hole arrangement II are shown. The first holes 110 are arranged one after another along further first rows 211. The further first rows 211 extend along the first direction 201. Between the first direction 201 and the circumferential direction 103, the first angle α_1 is defined.

[0051] The second holes 120 are arranged in the second hole arrangement II one after another along the second direction 202 and form the further second rows 221. Between the second direction 202 and the circumferential direction 103 the second angle α_2 is defined.

[0052] As shown in Fig. 3, the further first rows 211 and the further second rows 221 have a spiral (diagonal) run with respect to the circumferential direction 103. In particular, as shown in Fig. 3, along the circumferential direction 103 the distance between the respective further rows 211, 221 are different between each other. For example, as shown in the first hole arrangement I, the first

hole arrangement I comprises three pairs of further first rows 211, wherein between each pair of further first rows 211 a larger distance exists than between each of the two further first rows 211 which defines a respective pair of further first rows 211.

[0053] In comparison to that, as shown in the second hole arrangement II, the second hole arrangement II comprises two pairs of further second rows 221 and one further second row arrangement comprising three further second rows 221.

[0054] Hence, along the circumferential direction, the distance between each further row 211, 221 vary such that a non-uniform distribution of holes 110, 120 is provided.

[0055] Fig. 4 shows an abstract view of a hole pattern as shown in schematically in Fig. 1. In particular, a hole pattern shown in Fig. 4 may be beneficial when being applied to an inner wall 501 (see Fig. 5) of an inner housing of the combustion chamber 100. First rows 111 of first holes 110 and second rows 121 of second holes 120 are arranged one after another along the axial direction 102, wherein the first rows 111 and the second rows 121 are parallel with respect to the circumferential direction 103. The distance between the first rows 111 in the first hole arrangement I are smaller than the distances between the second rows 121 of the second hole arrangement II.

[0056] Fig. 5 shows for a better overview a cross-section of a double wall can type of combustion chamber 100. An inner wall 501 of an inner housing envelopes a burner volume of the combustion chamber 100. Around the inner housing, an outer wall 502 of an outer housing surrounds the inner wall 501 in such a way that a gap is provided. A cooling fluid stream 503 is streamable through the respective holes 110, 120 of the outer wall 502 into the gap. The cooling fluid stream 503 forms at least a part of the cooling fluid stream 504 streaming from the gap between the two wall elements 501, 502 through the holes of 110, 120, 130 of the inner wall 501 into the combustion chamber 100. The cooling fluid stream 504 may be smaller or greater than the cooling fluid stream 503 depending on if cooling fluids has been added or removed in the gap between the two wall elements 501 and 502.

[0057] As shown in Fig. 5, the inner wall 501 and the outer wall 502 surround the center axis 102 and thereby form a tubular shaped section of the combustion chamber 100.

[0058] Fig. 6 shows a method of calibrating and arranging a desired hole arrangement I, II, III of an inner wall element 501 and an outer wall element 502. In step 601, the initial combustion chamber design is defined. The initial combustion chamber design may comprise an uniform or non-uniform distributed hole pattern in the inner wall element 501 and/or in the outer wall element 502.

[0059] Next, the combustion chamber is operated, measured or analysed under nominal operating conditions such that the inner wall element 501 and the outer

wall element 502 are exposed to the cooling fluid stream 503 and to the further cooling fluid stream 504, respectively. The cooling fluid flows with its respective operating flow parameter through the respective holes of the inner wall element 501 and outer wall elements 502.

[0060] Next, in step 602, the hole arrangements I, II, III of the inner wall element 501 is decided. The effective area of the inner wall element 501 is determined by the total number of holes 110, 120, 130 of the inner wall element 501. Similarly, in step 603, the hole arrangements I, II, III of the outer wall element 502 is decided. The effective area of the outer wall element (outer liner) 502 is determined by the total number of holes 120, 130, 140 on the wall of the outer wall element 502.

[0061] Next, in step 605, the total combustion chamber 100 effective area is determined on a basis of the hole arrangements I, II, III of the inner wall element 501 and the hole arrangements I, II, III of the outer wall element 502.

[0062] Furthermore, the flow parameters of the fluid (e.g. the velocity of the further cooling fluid stream 504) exiting the inner wall element 501 into the combustion space of the combustion chamber 100 is determined (see step 604) .

[0063] Next, in step 606, the determined value of the flow parameters of the cooling fluid 503, 504 and the geometric parameter of the combined inner and outer wall elements 501, 502 (i.e. the combustion chamber 100) are compared to nominal values of e.g. velocity of the cooling fluid 503, 504 and the effective area of the combustion chamber 100.

[0064] If the measured flow parameters and/or the nominal value of the geometric parameter of the combustion chamber 100 do not correspond to the respective nominal values, in step 607, the first areal density, the further first areal density, the second areal density and/or the further second areal density of the respective holes in the inner wall element 501 and/or the outer wall element 502 and thus the respective hole pattern is individually amended until the nominal values of the flow/geometric parameters are reached.

[0065] If the nominal values are achieved, the final design of the hole pattern of the inner wall element 501 and the outer wall element 502 is achieved (see step 608).

[0066] Hence, by the above described method as shown in Fig. 6, a customized and optimized wall pattern of the inner wall element 501 and the outer wall element 502 is achieved under real operating conditions of the combustion chamber, so that an optimized fluid flow and an effective combustion chamber 100 is designed. In conventional approaches, the hole pattern is calculated and distributed equally over a given surface. By the present approach, the hole pattern within the given surface are determined balancing the requirements on damping with that of distributing cooling air over a surface using an iterative process as shown in Fig. 6 and as described above. In other words, the hole patterns are customized to the operating conditions of the combustion

chamber 100 and the gas turbine to which the combustion chamber 100 is mounted.

[0067] For sake of clarity, not all holes 110, 120, 130, and rows 111, 121, 131, 211, 221 are identified with a respective reference sign in the above described figures.

[0068] It should be noted that the term "comprising" does not exclude other elements or steps and "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. Housing for a combustion chamber (100) for a gas turbine, the housing comprising a wall element (101) which comprises a first hole arrangement (I) and a second hole arrangement (II), wherein the first hole arrangement (I) comprises first holes (110) through which first holes (110) fluid is streamable, wherein the first holes (110) are arranged in a first areal density, wherein the second hole arrangement (II) comprises second holes (120) through which second holes (120) fluid is streamable, wherein the second holes (120) are arranged in a second areal density, and wherein the first areal density differs from the second areal density.
2. Housing according to claim 1, wherein the wall element (101) extends along a circumferential direction (103) around a central axis (102) of the combustion chamber (100).
3. Housing according to claim 1, wherein the wall element (101) extends along a circumferential direction (103) around a central axis (102) of the gas turbine.
4. Housing according to claim 2 or 3, wherein the first holes (110) of the first hole arrangement (I) are formed into the wall element (101) one after another along the circumferential direction (103) for forming at least one first row (111) of first holes (110).
5. Housing according to one of the claims 2 to 4, wherein the second holes (120) of the second hole arrangement (II) are formed into the wall element (101) one after another along the circumferential direction (103) for forming at least one second row (121) of second holes (120).
6. Housing according to one of the claims 2 to 5, wherein the first holes (110) of the first hole arrangement (I) are formed into the wall element (101) one

after another along a first direction (201), wherein the first direction (201) differs from the circumferential direction (103) for forming at least one further first row (211) of first holes (110) .

7. Housing according to claim 6, wherein a first angle (α_1) between the first direction (201) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60°.
8. Housing according to one of the claims 2 to 7, wherein the second holes (120) of the second hole arrangement (II) are formed into the wall element (101) one after another along a second direction (202), wherein the second direction (202) differs from the circumferential direction (103) for forming at least one further second row (221) of second holes (120) .
9. Housing according to claim 8, wherein a second angle (α_2) between the second direction (202) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60°.
10. Combustion chamber (100) for a gas turbine, the combustion chamber (100) comprising an inner housing being a housing according to one of the claims 1 to 8, and/or an outer housing being a housing according to one of the claims 1 to 8, wherein the outer wall element (502) of the outer housing at least partially envelops the inner wall element (501) of the inner housing such that a gap between the inner wall element (501) and the outer wall element (502) is formed.
11. Method for producing a combustion chamber (100) for a gas turbine, the method comprising forming a first hole arrangement (I) which comprises first holes (110) into an inner wall element (501) of an inner housing of the combustion chamber (100), wherein through the first holes (110) fluid is streamable, wherein the first holes (110) are arranged in a first areal density, and forming a second hole arrangement (II) which comprises second holes (120) into the inner wall element (501), wherein through the second holes (120) fluid is streamable, wherein the second holes (120) are arranged in a second areal density, wherein the first areal density differs from the second areal density.
12. Method according to claim 11, further comprising arranging an outer wall element (502) of an outer housing of the combustion chamber (100) with respect to the inner wall element (501) such that the outer wall element (502) at least partially envelops

the inner wall element (501) and such that a gap between the inner wall element (501) and the outer wall element (502) is formed.

13. Method according to claim 12, further comprising forming into the outer wall element (502) a further first hole arrangement (I) which comprises further first holes (110) through which further first holes (110) a further fluid is streamable, wherein the further first holes (110) are arranged in a further first areal density, and forming into the outer wall element (502) a further second hole arrangement (II) which comprises further second holes (120) through which further second holes (120) further fluid is streamable, wherein the further second holes (120) are arranged in a further second areal density, wherein the further first areal density differs from the further second areal density.
14. Method according to claim 13, the method further comprises streaming the fluid stream (503) through the first hole arrangement (I) and the second hole arrangement (II), streaming the further fluid stream (504) through the further first hole arrangement (I) and the further second hole arrangement (II), determining a flow parameter of the fluid stream (503) and/or the further fluid stream (504), and amending the first areal density, the further first areal density, the second areal density and/or the further second areal density until the measured values of the flow parameter of the fluid stream (503) and/or geometric parameter of the combustion chamber (100) comply with corresponding nominal values of the flow parameter and/or geometric parameter of the combustion chamber (100) .

FIG 1

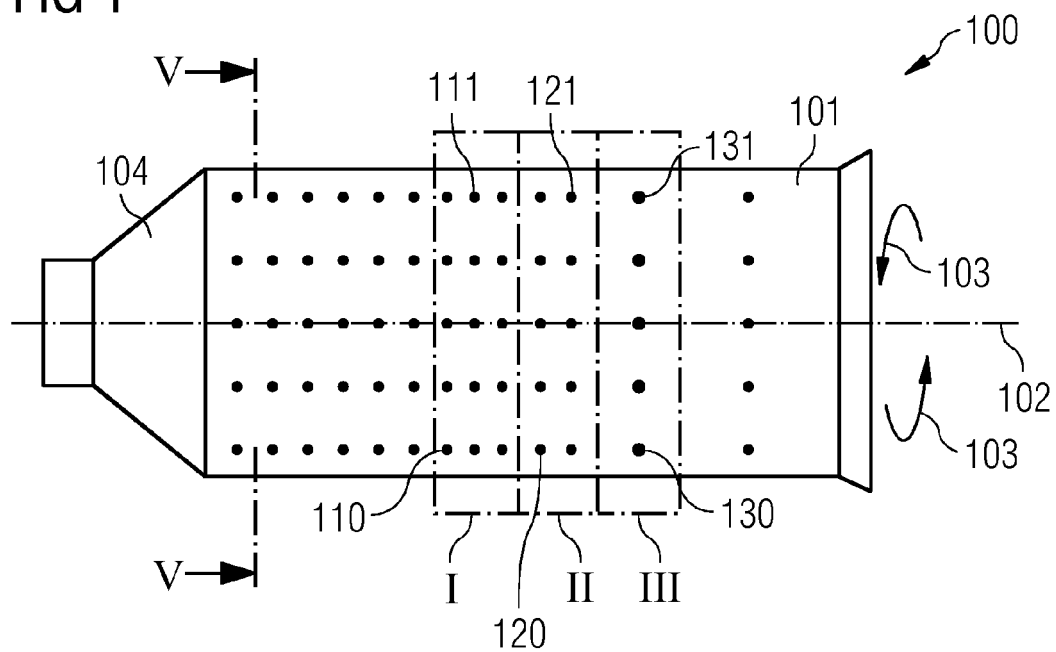


FIG 2

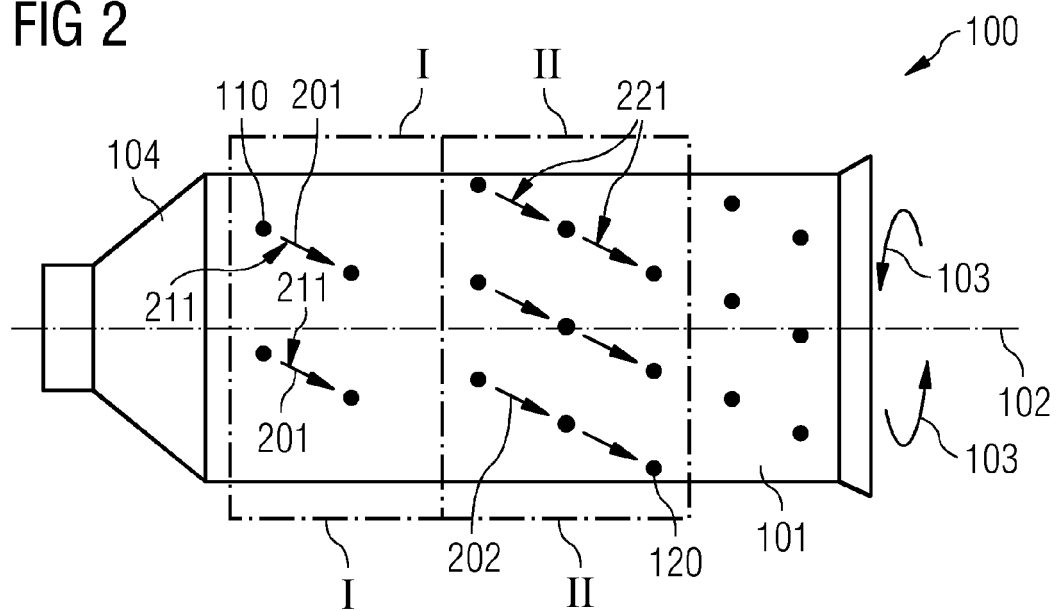


FIG 3

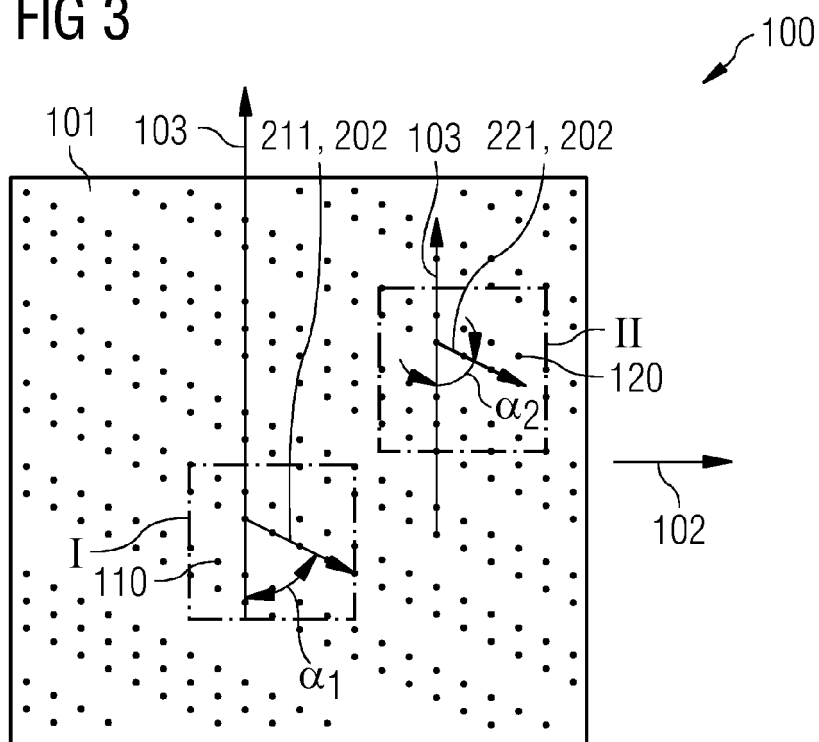


FIG 4

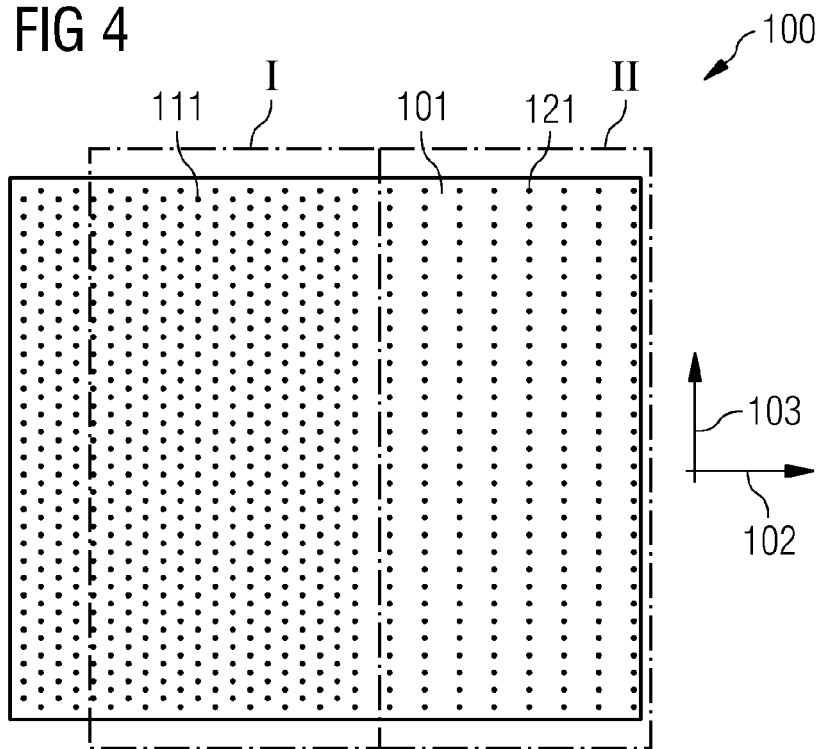


FIG 5 V-V

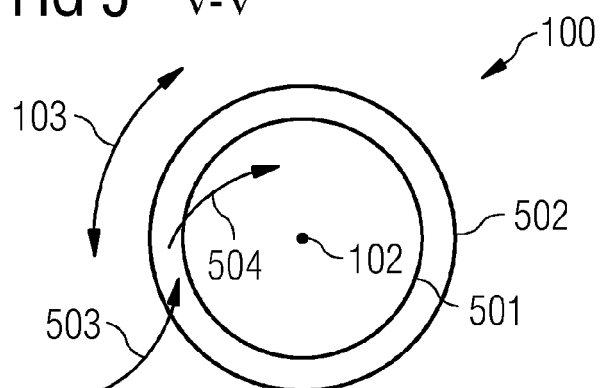
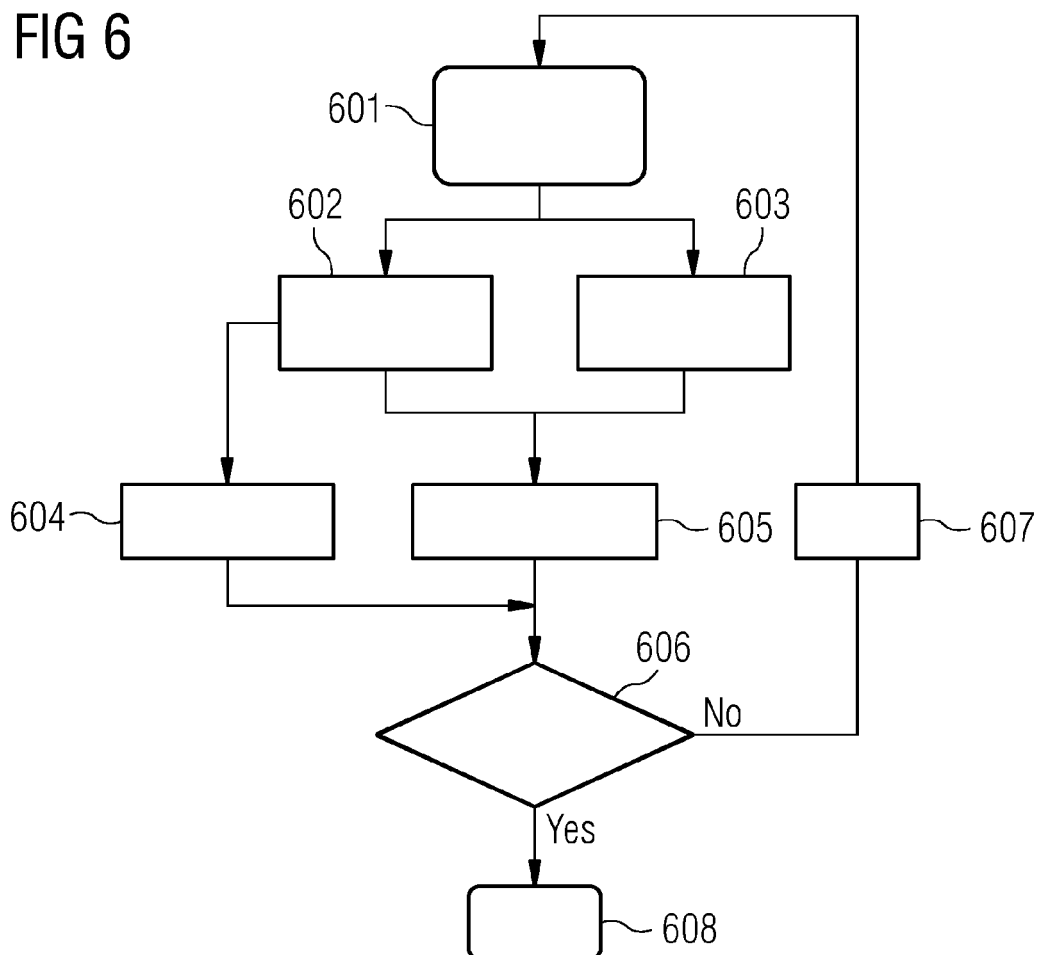


FIG 6





EUROPEAN SEARCH REPORT

Application Number
EP 12 16 1509

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 2007/271926 A1 (ALKABIE HISHAM [US] ALKABIE HISHAM [CA]) 29 November 2007 (2007-11-29) * page 1, paragraph 17 - page 2, paragraph 25 * * page 3, paragraph 35 - paragraph 36 * * claims 10, 14; figures 1-3B * -----	1-14	INV. F23R3/06
X	US 2006/196188 A1 (BURD STEVEN W [US] ET AL) 7 September 2006 (2006-09-07) * page 1, paragraph 21 - paragraph 22 * * page 2, paragraph 29 - page 3, paragraph 35 * * figures 1,6-9 * -----	1-5, 10-14	
X	US 2009/013530 A1 (RUDRAPATNA NAGARAJA [CA] ET AL) 15 January 2009 (2009-01-15) * page 1, paragraph 14 - page 2, paragraph 16 * * figures 1,2 * -----	1-5, 10-14	
X	US 2010/077763 A1 (ALKABIE HISHAM [CA]) 1 April 2010 (2010-04-01) * page 1, paragraph 11 - paragraph 17 * * page 2, paragraph 24 - paragraph 30 * * figures 1-3B * -----	1-5, 10-14	TECHNICAL FIELDS SEARCHED (IPC) F23R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 July 2012	Examiner Gavriliu, Costin
CATEGORY OF CITED DOCUMENTS 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		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 & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

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

EP 12 16 1509

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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19-07-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007271926 A1	29-11-2007	CA 2587058 A1	26-11-2007
		US 2007271926 A1	29-11-2007
US 2006196188 A1	07-09-2006	EP 1705426 A1	27-09-2006
		JP 2006242561 A	14-09-2006
		US 2006196188 A1	07-09-2006
US 2009013530 A1	15-01-2009	CA 2694064 A1	15-01-2009
		EP 2014987 A2	14-01-2009
		US 2009013530 A1	15-01-2009
		WO 2009006725 A1	15-01-2009
US 2010077763 A1	01-04-2010	CA 2664056 A1	26-03-2010
		US 2010077763 A1	01-04-2010

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 2309296 A [0005]
- EP 1104871 A1 [0006]
- EP 1321713 A2 [0007]