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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**

VERBESSERTE LOCHANORDNUNG VON AUSKLEIDUNGEN EINER BRENNKAMMER EINES GASTURBINENMOTORS MIT NIEDRIGER VERBRENNUNGSDYNAMIK UND NIEDRIGEN EMISSIONEN

AGENCEMENT DE TROUS AMÉLIORÉ DE REVÊTEMENTS D’UNE CHAMBRE DE COMBUSTION D’UN MOTEUR À TURBINE GAZ AVEC FAIBLE DYNAMIQUE DE COMBUSTION ET FAIBLES ÉMISSIONS

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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 (NOx), 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. 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.

[0005] 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.

[0006] 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.

[0007] US 2007/209366 A1 discloses a combustion chamber for a gas turbine, the combustion chamber comprising an inner housing and an outer housing, wherein the inner housing comprises an inner wall element which comprises a first hole arrangement (upstream) and a second hole arrangement (downstream), wherein the inner wall element envelopes a burner volume of the combustion chamber, wherein the first hole arrangement comprises first holes through which first holes fluid is streamable, wherein the first holes are arranged in a first areal density, wherein the second hole arrangement comprises second holes through which second holes fluid is streamable, wherein the second holes are arranged in a second areal density, and wherein the first areal density differs from the second areal density, and wherein the outer wall element of the outer housing envelops the inner wall element of the inner housing such that a gap between the inner wall element and the outer wall element is formed, wherein the outer housing comprises an outer wall element which comprises a further first hole arrangement (upstream) and a further second hole arrangement (downstream), wherein the further first hole arrangement comprises further first holes through which further first holes fluid is streamable, wherein the further first holes are arranged in a further first areal density, wherein the further second hole arrangement comprises further second holes through which further second holes fluid is streamable, and wherein the further second holes are arranged in a further second areal density.

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] 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 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 though 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] The inner wall of the inner housing of a double skin liner envelopes a burner volume of the combustion chamber. Around the inner housing and consequently around the burner volume, an outer wall of an outer housing surrounds the inner wall of such the double skin liner in such a way that a gap is provided. Consequently, the gap also surrounds the burner volume. A cooling fluid stream is streamable through the respective holes of the outer wall into the gap. The cooling fluid streams further from the gap between the two wall elements through the holes of the inner wall into the burner volume of the combustion chamber.

[0018] 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 (NOx) 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 (NOx) 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.

[0019] 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.

[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. 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.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] In particular, according to a further exemplary embodiment, the second angle between the second direction and the circumferential direction is between approximately 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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 distribution 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.

[0032] 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.

[0033] 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

[0034] 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

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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 long further first rows 211. The further first rows 211 extend along the first direction 201. Between the first direction 201 und the circumferential direction 103, the first angle $\alpha 1$ is defined.

[0052] 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 $\alpha 2$ is defined.

[0053] 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.

[0054] 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.

[0055] 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.

[0056] 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.

[0057] 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 form 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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).

[0064] 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.

[0065] 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.

[0066] 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).

[0067] 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.

[0068] 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.

[0069] 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. Combustion chamber (100) for a gas turbine, the combustion chamber (100) comprising

an inner housing and an outer housing,
wherein the inner housing comprises an inner wall element (501) which comprises a first hole arrangement (I) and a second hole arrangement (II), wherein the inner wall element (501) envelopes a burner volume of the combustion chamber (100),
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, and
wherein the outer housing comprises an outer wall element (502) which comprises a further first hole arrangement (I) and a further second hole arrangement (II), 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,
wherein the further first hole arrangement (I) comprises further first holes (110) through which further first holes (110) fluid is streamable, wherein the further first holes (110) are arranged in a further first areal density,
wherein the further second hole arrangement (II) comprises further second holes (120) through which further second holes (120) fluid is streamable, wherein the further second holes (120) are arranged in a further second areal density, **characterised in that** the further first areal density differs from the further second areal density.

2. Combustion chamber (100) according to claim 1, wherein the inner wall element (501) extends along a circumferential direction (103) around a central axis (102) of the combustion chamber (100), and/or wherein the outer wall element (502) extends along the circumferential direction (103) around the central axis (102) of the combustion chamber (100).

3. Combustion chamber (100) according to claim 1, wherein the inner wall element (501) extends along a circumferential direction (103) around a central axis (102) of the gas turbine, and/or
wherein the outer wall element (502) extends along the circumferential direction (103) around the central axis (102) of the gas turbine.

4. Combustion chamber (100) according to claim 2 or 3, wherein the first holes (110) of the first hole arrangement (I) are formed into the inner wall element (501) one after another along the circumferential direction (103) for forming at least one first row (111) of first holes (110), and/or wherein the further first holes (110) of the further first hole arrangement (I) are formed into the outer wall element (502) one after another along the circumferential direction (103) for forming at least one further first row (111) of further first holes (110).

5. Combustion chamber (100) according to one of the claims 2 to 4,
wherein the second holes (120) of the second hole arrangement (II) are formed into the inner wall element (501) one after another along the circumferential direction (103) for forming at least one second row (121) of second holes (120), and/or wherein the further second holes (120) of the further second hole arrangement (II) are formed into the outer wall element (502) one after another along the circumferential direction (103) for forming at least one further second row (121) of further second holes (120).

6. Combustion chamber (100) according to one of the claims 2 to 5,
wherein the first holes (110) of the first hole arrangement (I) are formed into the inner wall element (501) 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),
wherein the further first holes (110) of the further first hole arrangement (I) are formed into the outer wall element (502) one after another along a further first direction (201),
wherein the further first direction (201) differs from the circumferential direction (103) for forming at least one further outer first row (211) of further first holes (110).

7. Combustion chamber (100) according to claim 6,
wherein a first angle ($\alpha 1$) between the first direction (201) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60°, and/or
wherein a further first angle ($\alpha 1$) between the further first direction (201) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60°.

8. Combustion chamber (100) according to one of the claims 2 to 7,
wherein the second holes (120) of the second hole arrangement (II) are formed into the inner wall element (501) 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), and/or
wherein the further second holes (120) of the further

second hole arrangement (II) are formed into the outer wall element (502) one after another along a further second direction (202), wherein the further second direction (202) differs from the circumferential direction (103) for forming at least one further outer second row (221) of further second holes (120).

9. Combustion chamber (100) according to claim 8, wherein a second angle ($\alpha 2$) between the second direction (202) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60° and/or wherein a further second angle ($\alpha 2$) between the further second direction (202) and the circumferential direction (103) is between 10° and 80°, in particular between 30° and 60°.

10. 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, and wherein the inner wall element (501) envelopes a burner volume of the combustion chamber (100), 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, 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, **characterised in that** the further first areal density differs from the further second areal density.

11. Method according to claim 10, 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).

Patentansprüche

1. Brennkammer (100) für eine Gasturbine, wobei die Brennkammer (100) umfasst:

ein inneres Gehäuse und ein äußeres Gehäuse, wobei das innere Gehäuse ein inneres Wandelement (501) umfasst, welches eine erste Lochanordnung (I) und eine zweite Lochanordnung (II) umfasst, wobei das innere Wandelement (501) ein Brennervolumen der Brennkammer (100) umhüllt,
wobei die erste Lochanordnung (I) erste Löcher (110) umfasst, wobei durch diese ersten Löcher (110) das Strömen von Fluid bewirkt werden kann, wobei die ersten Löcher (110) mit einer ersten Flächendichte angeordnet sind,
wobei die zweite Lochanordnung (II) zweite Löcher (120) umfasst, wobei durch diese zweiten Löcher (120) das Strömen von Fluid bewirkt werden kann, wobei die zweiten Löcher (120) mit einer zweiten Flächendichte angeordnet sind, und
wobei sich die erste Flächendichte von der zweiten Flächendichte unterscheidet, und
wobei das äußere Gehäuse ein äußeres Wandelement (502) umfasst, welches eine weitere erste Lochanordnung (I) und eine weitere zweite Lochanordnung (II) umfasst, wobei das äußere Wandelement (502) des äußeren Gehäuses wenigstens teilweise das innere Wandelement (501) des inneren Gehäuses umhüllt, so dass ein Zwischenraum zwischen dem inneren Wandelement (501) und dem äußeren Wandelement (502) gebildet wird,
wobei die weitere erste Lochanordnung (I) weitere erste Löcher (110) umfasst, wobei durch diese weiteren ersten Löcher (110) das Strömen von Fluid bewirkt werden kann, wobei die wei-

teren ersten Löcher (110) mit einer weiteren ersten Flächendichte angeordnet sind,
wobei die weitere zweite Lochanordnung (II) weitere zweite Löcher (120) umfasst, wobei durch diese weiteren zweiten Löcher (120) das Strömen von Fluid bewirkt werden kann, wobei die weiteren zweiten Löcher (120) mit einer weiteren zweiten Flächendichte angeordnet sind,
dadurch gekennzeichnet, dass sich die weitere erste Flächendichte von der weiteren zweiten Flächendichte unterscheidet.

2. Brennkammer (100) nach Anspruch 1,
wobei sich das innere Wandelement (501) entlang einer Umfangsrichtung (103) um eine Mittelachse (102) der Brennkammer (100) erstreckt, und/oder
wobei sich das äußere Wandelement (502) entlang der Umfangsrichtung (103) um die Mittelachse (102) der Brennkammer (100) erstreckt.

3. Brennkammer (100) nach Anspruch 1,
wobei sich das innere Wandelement (501) entlang einer Umfangsrichtung (103) um eine Mittelachse (102) der Gasturbine erstreckt, und/oder
wobei sich das äußere Wandelement (502) entlang der Umfangsrichtung (103) um die Mittelachse (102) der Gasturbine erstreckt.

4. Brennkammer (100) nach Anspruch 2 oder 3,
wobei die ersten Löcher (110) der ersten Lochanordnung (I) in dem inneren Wandelement (501) hintereinander entlang der Umfangsrichtung (103) ausgebildet sind, um wenigstens eine erste Reihe (111) von ersten Löchern (110) zu bilden, und/oder wobei die weiteren ersten Löcher (110) der weiteren ersten Lochanordnung (I) in dem äußeren Wandelement (502) hintereinander entlang der Umfangsrichtung (103) ausgebildet sind, um wenigstens eine weitere erste Reihe (111) von weiteren ersten Löchern (110) zu bilden.

5. Brennkammer (100) nach einem der Ansprüche 2 bis 4,
wobei die zweiten Löcher (120) der zweiten Lochanordnung (II) in dem inneren Wandelement (501) hintereinander entlang der Umfangsrichtung (103) ausgebildet sind, um wenigstens eine zweite Reihe (121) von zweiten Löchern (120) zu bilden, und/oder
wobei die weiteren zweiten Löcher (120) der weiteren zweiten Lochanordnung (II) in dem äußeren Wandelement (502) hintereinander entlang der Umfangsrichtung (103) ausgebildet sind, um wenigstens eine weitere zweite Reihe (121) von weiteren zweiten Löchern (120) zu bilden.

6. Brennkammer (100) nach einem der Ansprüche 2 bis 5,
wobei die ersten Löcher (110) der ersten Lochanordnung (I) in dem inneren Wandelement (501) hintereinander entlang einer ersten Richtung (201) ausgebildet sind,
wobei sich die erste Richtung (201) von der Umfangsrichtung (103) unterscheidet, um wenigstens eine weitere erste Reihe (211) von ersten Löchern (110) zu bilden,
wobei die weiteren ersten Löcher (110) der weiteren ersten Lochanordnung (I) in dem äußeren Wandelement (502) hintereinander entlang einer weiteren ersten Richtung (201) ausgebildet sind,
wobei sich die weitere erste Richtung (201) von der Umfangsrichtung (103) unterscheidet, um wenigstens eine weitere äußere erste Reihe (211) von weiteren ersten Löchern (110) zu bilden.

7. Brennkammer (100) nach Anspruch 6,
wobei ein erster Winkel ($\alpha 1$) zwischen der ersten Richtung (201) und der Umfangsrichtung (103) zwischen 10° und 80° beträgt, insbesondere zwischen 30° und 60°, und/oder wobei ein weiterer erster Winkel ($\alpha 1$) zwischen der weiteren ersten Richtung (201) und der Umfangsrichtung (103) zwischen 10° und 80° beträgt, insbesondere zwischen 30° und 60°.

8. Brennkammer (100) nach einem der Ansprüche 2 bis 7,
wobei die zweiten Löcher (120) der zweiten Lochanordnung (II) in dem inneren Wandelement (501) hintereinander entlang einer zweiten Richtung (202) ausgebildet sind,
wobei sich die zweite Richtung (202) von der Umfangsrichtung (103) unterscheidet, um wenigstens eine weitere zweite Reihe (221) von zweiten Löchern (120) zu bilden, und/oder
wobei die weiteren zweiten Löcher (120) der weiteren zweiten Lochanordnung (II) in dem äußeren Wandelement (502) hintereinander entlang einer weiteren zweiten Richtung (202) ausgebildet sind,
wobei sich die weitere zweite Richtung (202) von der Umfangsrichtung (103) unterscheidet, um wenigstens eine weitere äußere zweite Reihe (221) von weiteren zweiten Löchern (120) zu bilden.

9. Brennkammer (100) nach Anspruch 8,
wobei ein zweiter Winkel ($\alpha 2$) zwischen der zweiten Richtung (202) und der Umfangsrichtung (103) zwischen 10° und 80° beträgt, insbesondere zwischen 30° und 60°, und/oder
wobei ein weiterer zweiter Winkel ($\alpha 2$) zwischen der weiteren zweiten Richtung (202) und der Umfangsrichtung (103) zwischen 10° und 80° beträgt, insbesondere zwischen 30° und 60°.

10. Verfahren zur Herstellung einer Brennkammer (100) für eine Gasturbine, wobei das Verfahren umfasst:

Ausbilden einer ersten Lochanordnung (I), welche erste Löcher (110) umfasst, in einem inneren Wandelement (501) eines inneren Gehäuses der Brennkammer (100), wobei durch die ersten Löcher (110) das Strömen von Fluid bewirkt werden kann, wobei die ersten Löcher (110) mit einer ersten Flächendichte angeordnet sind, und

Ausbilden einer zweiten Lochanordnung (II), welche zweite Löcher (120) umfasst, in dem inneren Wandelement (501), wobei durch die zweiten Löcher (120) das Strömen von Fluid bewirkt werden kann, wobei die zweiten Löcher (120) mit einer zweiten Flächendichte angeordnet sind,

wobei sich die erste Flächendichte von der zweiten Flächendichte unterscheidet, und

wobei das innere Wandelement (501) ein Brennervolumen der Brennkammer (100) umhüllt,

Anordnen eines äußeren Wandelements (502) eines äußeren Gehäuses der Brennkammer (100) bezüglich des inneren Wandelements (501) derart, dass das äußere Wandelement (502) das innere Wandelement (501) wenigstens teilweise umhüllt, und derart, dass ein Zwischenraum zwischen dem inneren Wandelement (501) und dem äußeren Wandelement (502) gebildet wird,

Ausbilden einer weiteren ersten Lochanordnung (I), welche weitere erste Löcher (110) umfasst, in dem äußeren Wandelement (502), wobei durch diese weiteren ersten Löcher (110) das Strömen eines weiteren Fluids bewirkt werden kann, wobei die weiteren ersten Löcher (110) mit einer weiteren ersten Flächendichte angeordnet sind, und

Ausbilden einer weiteren zweiten Lochanordnung (II), welche weitere zweite Löcher (120) umfasst, in dem äußeren Wandelement (502), wobei durch diese weiteren zweiten Löcher (120) das Strömen von weiterem Fluid bewirkt werden kann, wobei die weiteren zweiten Löcher (120) mit einer weiteren zweiten Flächendichte angeordnet sind,

dadurch gekennzeichnet, dass sich die weitere erste Flächendichte von der weiteren zweiten Flächendichte unterscheidet.

11. Verfahren nach Anspruch 10, wobei das Verfahren ferner umfasst:

Bewirken des Strömens des Fluidstroms (503) durch die erste Lochanordnung (I) und die zweite Lochanordnung (II),

Bewirken des Strömens des weiteren Fluidstroms (504) durch die weitere erste Lochanordnung (I) und die weitere zweite Lochanordnung (II),

Bestimmen eines Durchflussparameters des Fluidstroms (503) und/oder des weiteren Fluidstroms (504), und

Ändern der ersten Flächendichte, der weiteren ersten Flächendichte, der zweiten Flächendichte und/oder der weiteren zweiten Flächendichte, bis die gemessenen Werte des Durchflussparameters des Fluidstroms (503) und/oder geometrischen Parameters der Brennkammer (100) entsprechenden Nennwerten des Durchflussparameters und/oder geometrischen Parameters der Brennkammer (100) entsprechen.

Revendications

1. Chambre de combustion (100) pour turbine à gaz, la chambre de combustion (100) comprenant :

un logement interne et un logement externe,

étant entendu que le logement interne comprend un élément formant paroi interne (501) qui comprend un premier agencement (I) de trous et un second agencement (II) de trous, l'élément formant paroi interne (501) enveloppant un volume formant brûleur de la chambre de combustion (100) ;

étant entendu que le premier agencement (I) de trous comprend des premiers trous (110), premiers trous (110) par lesquels du fluide peut s'écouler, les premiers trous (110) étant agencés suivant une première densité aréolaire ;

étant entendu que le second agencement (II) de trous comprend des seconds trous (120), seconds trous (120) par lesquels du fluide peut s'écouler, les secondes trous (120) étant agencés suivant une seconde densité aréolaire, et

étant entendu que la première densité aréolaire diffère de la seconde densité aréolaire, et

étant entendu que le logement externe comprend un élément formant paroi externe (502) qui comprend un autre premier agencement (I) de trous et un autre second agencement (II) de trous, l'élément formant paroi externe (502) du logement externe enveloppant au moins partiellement l'élément formant paroi interne (501) du logement interne de telle sorte qu'un espace soit formé entre l'élément formant paroi interne (501) et l'élément formant paroi externe (502) ;

étant entendu que l'autre premier agencement (I) de trous comprend d'autres premiers trous (110), autres premiers trous (110) par lesquels du fluide peut s'écouler, les autres premiers trous (110) étant agencés suivant une autre première densité aréolaire ;

étant entendu que l'autre second agencement (II) de trous comprend d'autres seconds trous (120), autres seconds trous (120) par lesquels du fluide peut s'écouler, les autres seconds

trous (120) étant agencés suivant une autre seconde densité aréolaire,
caractérisée en ce que l'autre première densité aréolaire diffère de l'autre seconde densité aréolaire.

2. Chambre de combustion (100) selon la revendication 1, étant entendu que l'élément formant paroi interne (501) s'étend suivant une direction circonférentielle (103) autour d'un axe central (102) de la chambre de combustion (100), et/ou
étant entendu que l'élément formant paroi externe (502) s'étend suivant une direction circonférentielle (103) autour de l'axe central (102) de la chambre de combustion (100).

3. Chambre de combustion (100) selon la revendication 1, étant entendu que l'élément formant paroi interne (501) s'étend suivant une direction circonférentielle (103) autour d'un axe central (102) de la turbine à gaz, et/ou étant entendu que l'élément formant paroi externe (502) s'étend suivant une direction circonférentielle (103) autour de l'axe central (102) de la turbine à gaz.

4. Chambre de combustion (100) selon la revendication 2 ou 3,
étant entendu que les premiers trous (110) du premier agencement (I) de trous sont pratiqués dans l'élément formant paroi interne (501) l'un après l'autre suivant la direction circonférentielle (103) afin de former au moins une première rangée (111) de premiers trous (110), et/ou
étant entendu que les autres premiers trous (110) de l'autre premier agencement (I) de trous sont pratiqués dans l'élément formant paroi externe (502) l'un après l'autre suivant la direction circonférentielle (103) afin de former au moins une autre première rangée (111) d'autres premiers trous (110).

5. Chambre de combustion (100) selon l'une des revendications 2 à 4,
étant entendu que les seconds trous (120) du second agencement (II) de trous sont pratiqués dans l'élément formant paroi interne (501) l'un après l'autre suivant la direction circonférentielle (103) afin de former au moins une seconde rangée (121) de seconds trous (120), et/ou
étant entendu que les autres seconds trous (120) de l'autre second agencement (II) de trous sont pratiqués dans l'élément formant paroi externe (502) l'un après l'autre suivant la direction circonférentielle (103) afin de former au moins une autre seconde rangée (121) d'autres seconds trous (120).

6. Chambre de combustion (100) selon l'une des revendications 2 à 5,
étant entendu que les premiers trous (110) du premier agencement (I) de trous sont pratiqués dans l'élément formant paroi interne (501) l'un après l'autre suivant une première direction (201) ;
étant entendu que la première direction (201) diffère de la direction circonférentielle (103) afin de former au moins une autre première rangée (211) de premiers trous (110) ;
étant entendu que les autres premiers trous (110) de l'autre premier agencement (I) de trous sont pratiqués dans l'élément formant paroi externe (502) l'un après l'autre suivant une autre première direction (201) ;
étant entendu que l'autre première direction (201) diffère de la direction circonférentielle (103) afin de former au moins une autre première rangée externe (211) d'autres premiers trous (110).

7. Chambre de combustion (100) selon la revendication 6,
étant entendu qu'un premier angle ($\alpha 1$) entre la première direction (201) et la direction circonférentielle (103) fait entre 10° et 80°, en particulier entre 30° et 60°, et/ou étant entendu qu'un autre premier angle ($\alpha 1$) entre l'autre première direction (201) et la direction circonférentielle (103) fait entre 10° et 80°, en particulier entre 30° et 60°.

8. Chambre de combustion (100) selon l'une des revendications 2 à 7,
étant entendu que les seconds trous (120) du second agencement (II) de trous sont pratiqués dans l'élément formant paroi interne (501) l'un après l'autre suivant une seconde direction (202) ;
étant entendu que la seconde direction (202) diffère de la direction circonférentielle (103) afin de former au moins une autre seconde rangée (221) de seconds trous (120), et/ou
étant entendu que les autres seconds trous (120) de l'autre second agencement (II) de trous sont pratiqués dans l'élément formant paroi externe (502) l'un après l'autre suivant une autre seconde direction (202) ;
étant entendu que l'autre seconde direction (202) diffère de la direction circonférentielle (103) afin de former au moins une autre seconde rangée externe (221) d'autres seconds trous (120).

9. Chambre de combustion (100) selon la revendication 8,
étant entendu qu'un second angle ($\alpha 2$) entre la seconde direction (202) et la direction circonférentielle (103) fait entre 10° et 80°, en particulier entre 30° et 60°, et/ou
étant entendu qu'un autre second angle ($\alpha 2$) entre l'autre seconde direction (202) et la direction circonférentielle (103) fait entre 10° et 80°, en particulier entre 30° et 60°.

10. Procédé de production d'une chambre de combustion (100) pour turbine à gaz, le procédé consistant :

à réaliser un premier agencement (I) de trous qui comprend des premiers trous (110) dans un élément formant paroi interne (501) d'un logement interne de la chambre de combustion (100), étant entendu que du fluide peut s'écouler par les premiers trous (110), les premiers trous (110) étant agencés suivant une première densité aréolaire, et
à réaliser un second agencement (II) de trous qui comprend des seconds trous (120) dans l'élément formant paroi interne (501), étant entendu que du fluide peut s'écouler par les seconds trous (120), les seconds trous (120) étant agencés suivant une seconde densité aréolaire ;
étant entendu que la première densité aréolaire diffère de la seconde densité aréolaire, et
étant entendu que l'élément formant paroi interne (501) enveloppe un volume formant brûleur de la chambre de combustion (100) ;
à agencer un élément formant paroi externe (502) d'un logement externe de la chambre de combustion (100) par rapport à l'élément formant paroi interne (501) de telle sorte que l'élément formant paroi externe (502) enveloppe au moins partiellement l'élément formant paroi interne (501) et de telle sorte qu'un espace soit formé entre l'élément formant paroi interne (501) et l'élément formant paroi externe (502) ;
à réaliser dans l'élément formant paroi externe (502) un autre premier agencement (I) de trous qui comprend d'autres premiers trous (110), autres premiers trous (110) par lesquels un autre fluide peut s'écouler, les autres premiers trous (110) étant agencés suivant une autre première densité aréolaire, et
à réaliser dans l'élément formant paroi externe (502) un autre second agencement (II) de trous qui comprend d'autres seconds trous (120), autres seconds trous (120) par lesquels un autre fluide peut s'écouler, les autres seconds trous (120) étant agencés suivant une autre seconde densité aréolaire, **caractérisé en ce que** l'autre première densité aréolaire diffère de l'autre seconde densité aréolaire.

11. Procédé selon la revendication 10, le procédé consistant par ailleurs :

à faire s'écouler le courant de fluide (503) par le premier agencement (I) de trous et par le second agencement (II) de trous ;
à faire s'écouler l'autre courant de fluide (504) par l'autre premier agencement (I) de trous et par l'autre second agencement (II) de trous ;
à déterminer un paramètre d'écoulement du courant de fluide (503) et/ou de l'autre courant de fluide (504), et
à modifier la première densité aréolaire, l'autre première densité aréolaire, la seconde densité aréolaire et/ou l'autre seconde densité aréolaire jusqu'à ce que les valeurs mesurées du paramètre d'écoulement du courant de fluide (503) et/ou le paramètre géométrique de la chambre de combustion (100) soient conformes aux valeurs nominales correspondantes du paramètre d'écoulement et/ou du paramètre géométrique de la chambre de combustion (100).

FIG 1

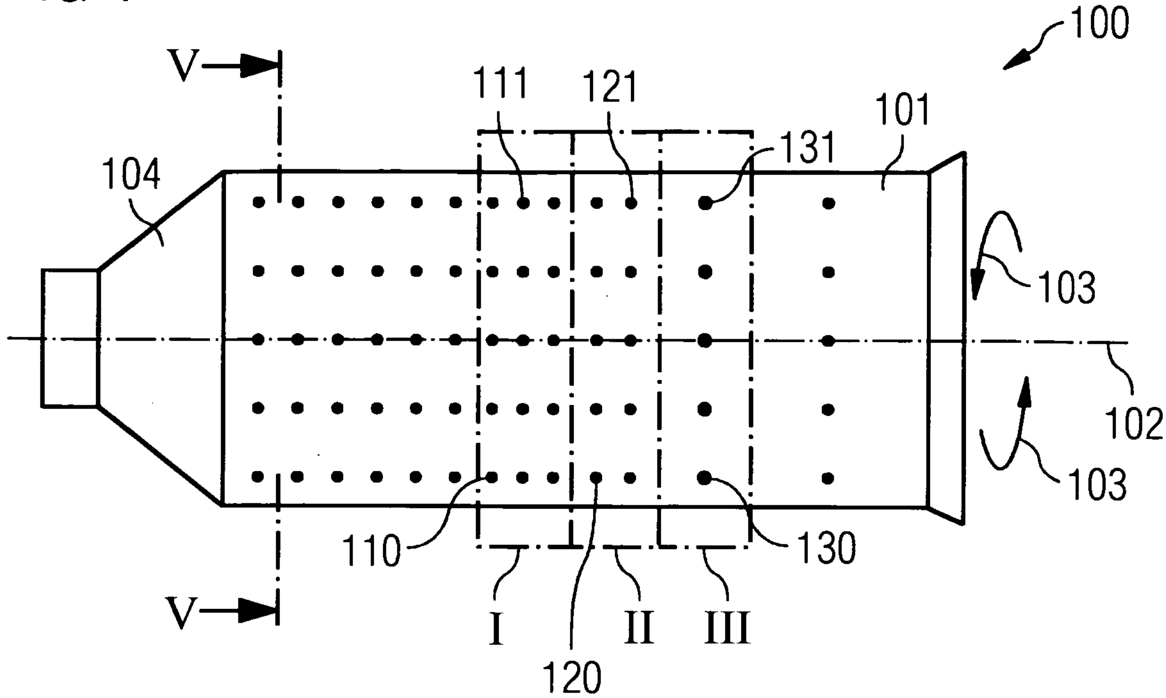

100
V
V
111
121
101
131
104
103
102
103
110
130
I
II
III
120

FIG 2

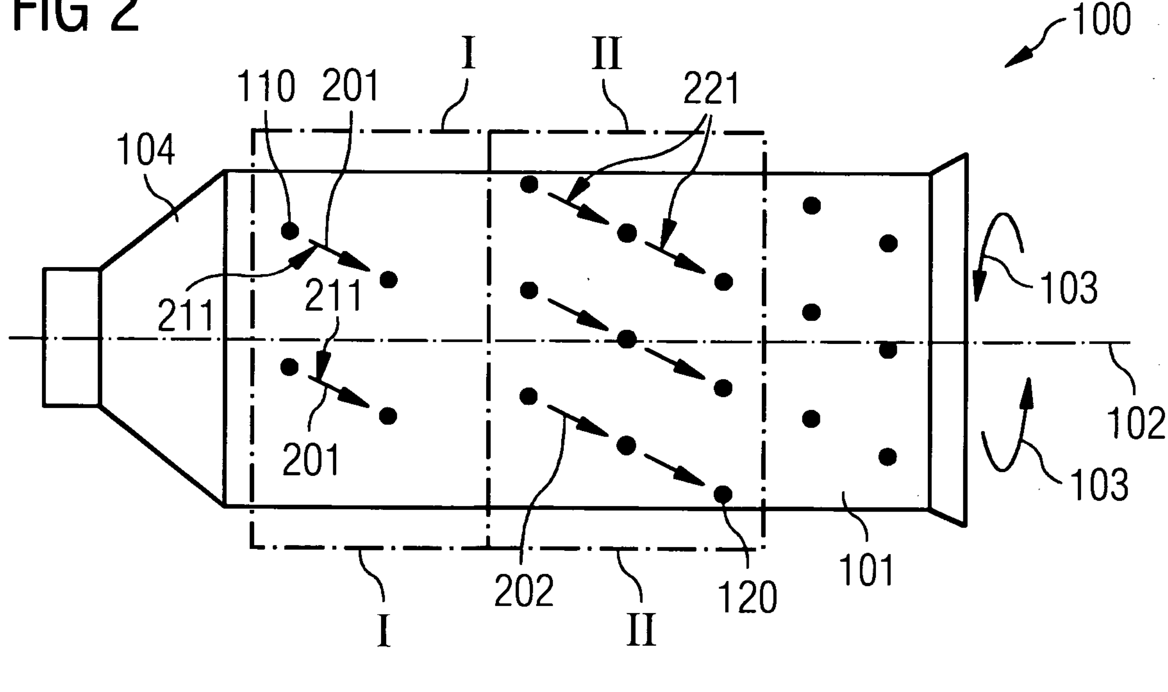

100
I
II
110
201
221
104
211
211
103
102
201
103
202
120
101
I
II

FIG 3

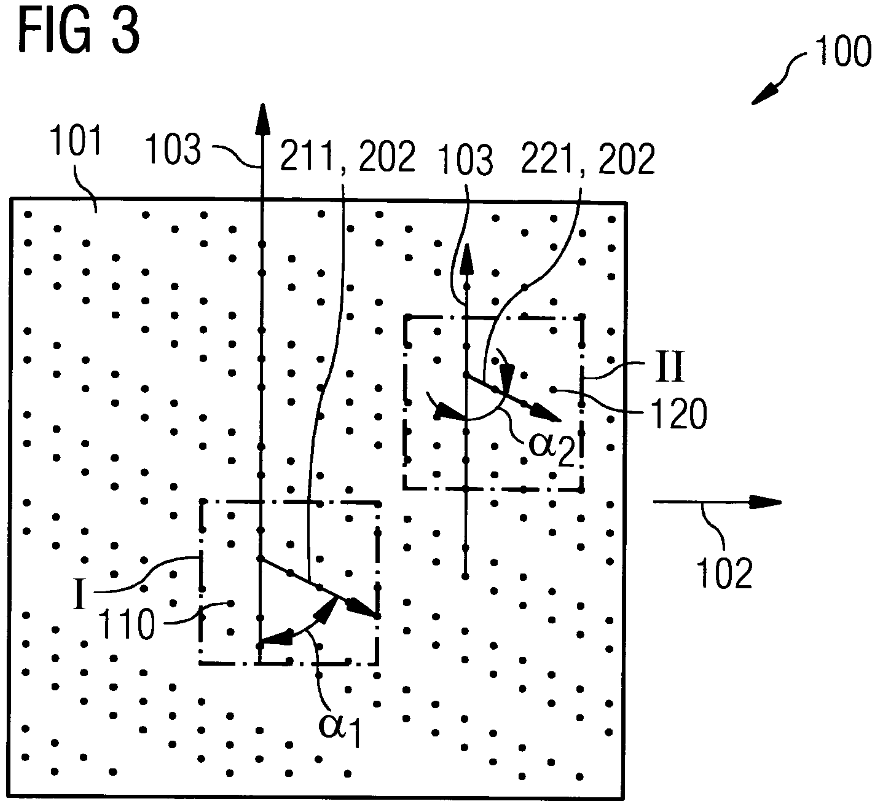

100
101
103
211, 202
103
221, 202
II
120
α_2
102
I
110
α_1

FIG 4

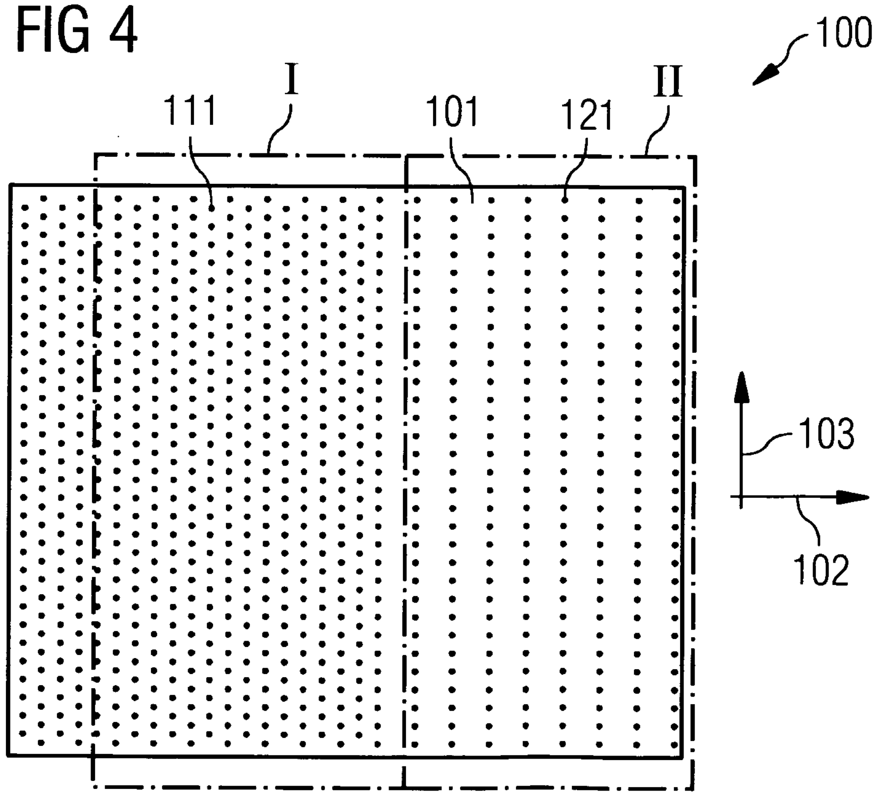

100
I
II
111
101
121
103
102

FIG 5 V-V

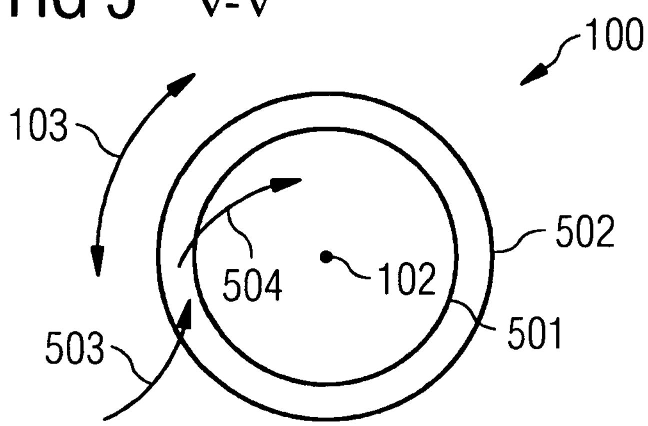
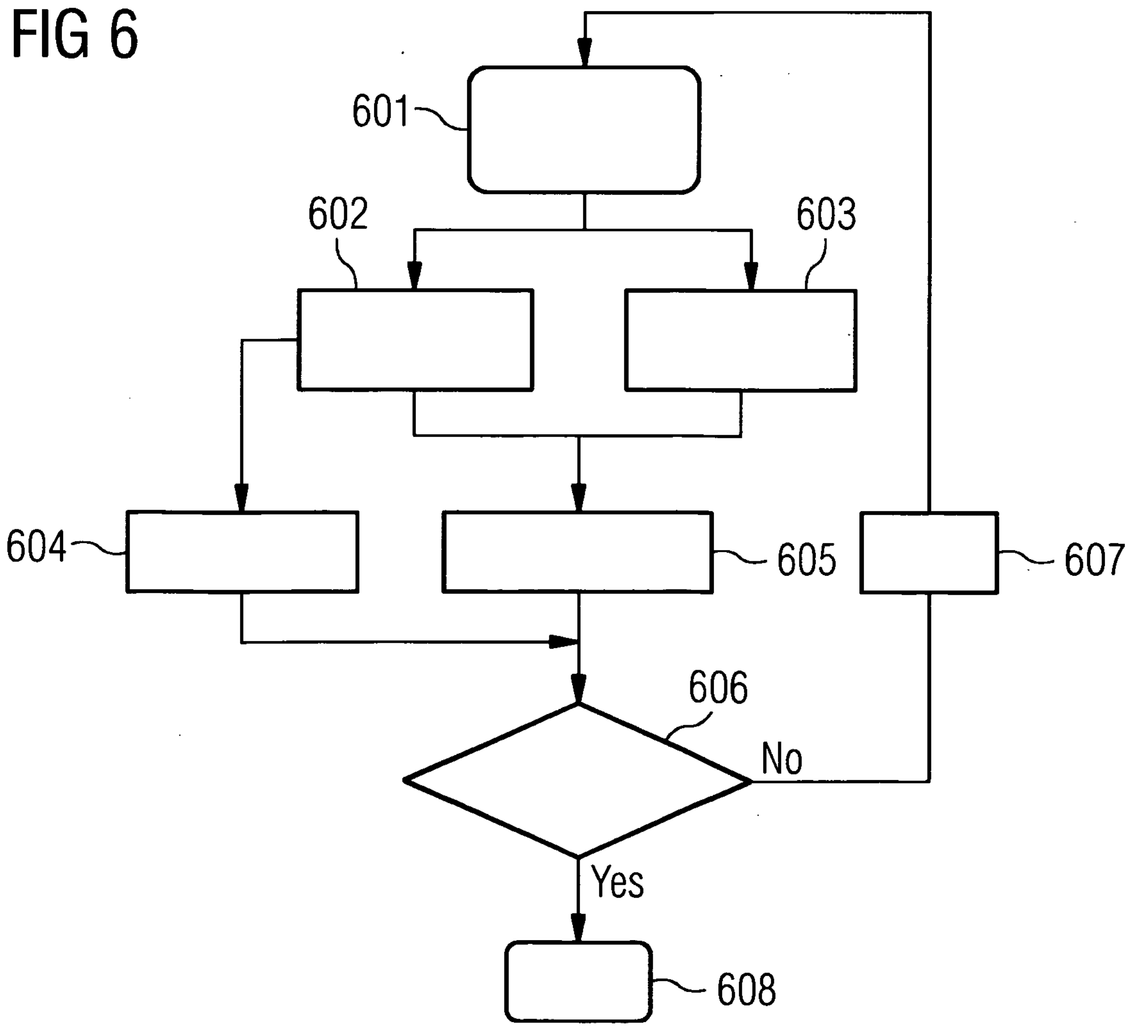

100
103
502
504
102
503
501

FIG 6


601
602
603
604
605
607
606
No
Yes
608

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- GB 2309296 A **[0004]**
- EP 1104871 A1 **[0005]**
- EP 1321713 A2 **[0006]**
- US 2007209366 A1 **[0007]**