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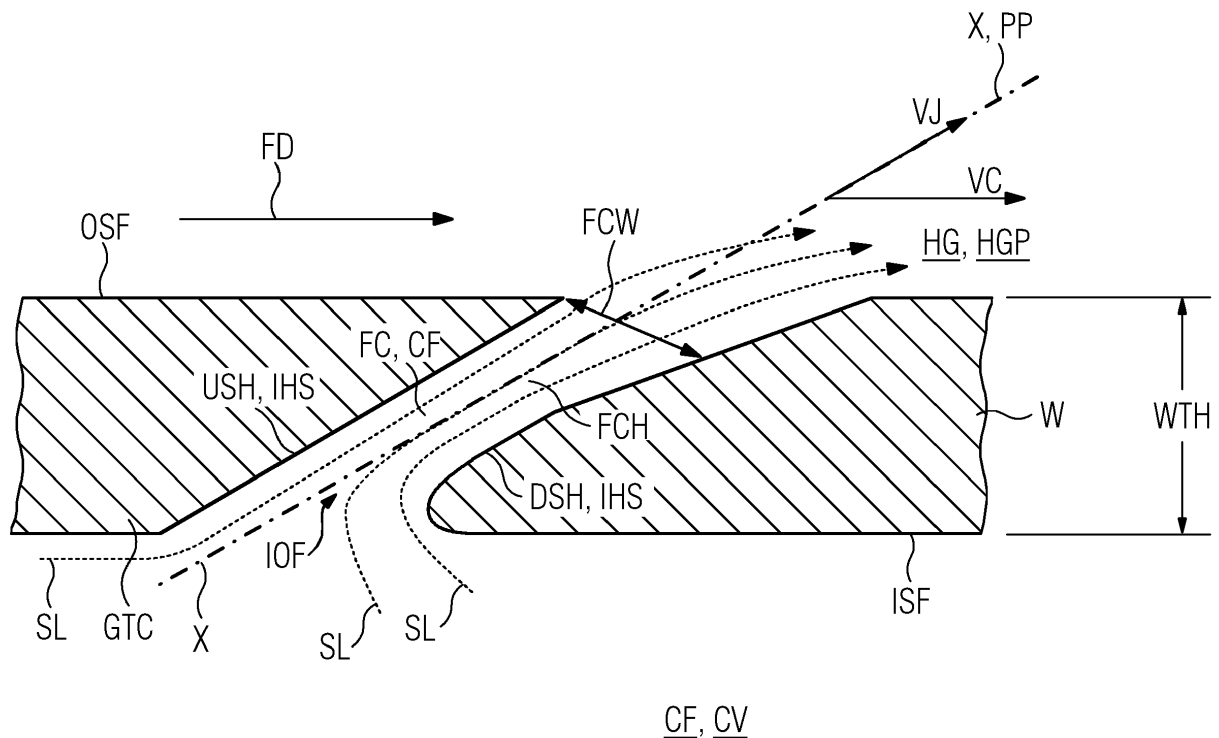
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BA ME(71) Applicant: **Siemens Aktiengesellschaft****80333 München (DE)**(72) Inventor: **Utriainen, Esa****60580 Svartinge (SE)**(54) **Gas-turbine-component**

(57) Gas-turbine-component (GTC) to be exposed to a hot-gas (HG) comprising at least one film-cooling-hole (FCH) joining into a hot-gas-path (HGP) at an outer surface (OSF) of the gas-turbine-component (GTC), wherein the film-cooling-hole (FCH) is a channel (FC) through a wall-thickness (WTH) of a wall (W) extending from an inner surface (ISF) to said outer surface (OSF), wherein the cooling channel (FC) extends along an axis (X), wherein said cooling fluid (CF) is ejected into said

hot-gas-path (HGP), comprising a velocity component (VC) into said flow direction (FD). To improve the cooling-efficiency at least the part of the edge of said inner orifice (IOF) of the cooling channel (FC) joining the inner surface (ISF), which has an angle (α) smaller 90° with said wall's inner surface (ISF) is made blunt by widening the inner orifice (IOF) such that the cooling fluid (CF) entering the channel (FC) is accelerated and deflected more moderately than without the widening.

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Description

[0001] The invention relates to a gas-turbine-component to be exposed to a hot gas comprising at least one film-cooling-hole joining into a hot-gas-path at an outer surface of the gas-turbine-component, wherein during operation of the gas-turbine the hot gas flows along the surface in a flow direction, wherein the film-cooling-hole is a channel through a wall-thickness extending from an inner surface to said outer surface extending along an axis, which is defined by the centroids of the cross-section areas of respective openings of said film-cooling channel at said inner surface and said outer surface, wherein said axis is inclined with regard to said flow direction such that cooling fluid is ejected into said hot-gas-path comprising a positive velocity component into said flow direction.

[0002] Film-cooling is a standard method to decrease thermal load from hot-gas-path-components of a, such as nozzle guide-vanes, rotor-blades or heat-shields or static shrouds. The incipiently defined geometry of a film-cooling-hole is normally referred to as the so called laid-back fan-shaped film-cooling-hole and is extensively used by many gas-turbine manufactures to give an efficient film-cooling coverage of the gas-turbine engine components surface. The fan-shape of the outlet of the film-cooling-hole generates a lower outlet velocity which reduces the mixing of the film-cooling fluid - mostly air - with the main hot gas flow thus giving a better film coverage effect close to the surface.

[0003] The conventional film-cooling-channel-geometry, however, leads to several disadvantages which are normally compensated by a bigger size of the film-cooling-hole reducing velocity of the film-cooling-fluid ejected and therefore reducing the penetration-length into the hot-gas-path. This conventional solution goes along with a higher secondary-air-consumption (higher mass flow of cooling-fluid respectively cooling-air), which significantly reduces the overall gas-turbine-efficiency.

[0004] It is one object of the invention to improve the cooling-efficiency by modifying the incipiently defined film-cooling-hole-geometry.

[0005] In accordance with the invention a gas-turbine-component of the incipiently defined type is provided, wherein at least the part of the edge of the orifice of the cooling-channel joining said inner surface, which has angle α smaller than 90° is made blunt by widening said orifice of the inner surface and the adjacent cooling channel portion such that the cooling fluid entering the channel is more moderately accelerated and deflected.

[0006] One essential factor according to the invention is not only the overall velocity of the cooling fluid in the cooling channel but especially the velocity distribution in the cooling channel, which conventionally led to high peak-velocities along certain streamlines in the channel, which made the ejected cooling fluid penetrate the hot-gas-path more deeply and decreased the area covered by said cooling-film per cooling-film-hole. Especially in

the area of the sharp edge the local coolant flow formed a separation bubble and led to a flow-contraction similar to a vena-contracta increasing a peak-kinetic-energy of a certain streamline. The invention successfully eliminates this effect to a significant degree and homogenizes the velocity distribution in the cooling channel. The ejection of the coolant does not penetrate the hot-gas-path as deeply as conventional film-cooling-jets.

[0007] Another embodiment of the invention provides a gas-turbine-component, wherein said channel is defined by an inner hole surface, which consists of a more upstream portion and a more downstream portion with regard to said flow direction (of the hot gas) further being defined by a partition plane extending basically along the centroids of all channel cross-section areas along the channel, wherein the downstream half defines a tapering enlarging the channel widths towards the outer surface, wherein the tapering extends between 70% to 10% of said wall-thickness. This feature especially with the geometry according to the invention leads to a more homogeneous velocity distribution providing a laminar cooling-film layer covering an enlarged area of the gas-turbine-components surface.

[0008] Still another preferred embodiment of the invention provides a cooling channel, wherein the widening towards the inner surface extends along 5% to 40% of the wall-thickness.

[0009] Preferably the gas-turbine-component according to the invention might be manufactured by laser-sintering or by electro-dynamic-machining or by water-jet-drilling, latter wherein towards the inner surface a contour-element is provided which is deflecting the water-jet against the inner surface in the area of said orifice-edge is to be made blunt, respectively widened, respectively flared.

[0010] The above mentioned attributes and other features and advantages of this invention and the manner of attaining them will become apparent and the invention itself will be better understood by reference to the following description of the currently best mode of carrying out the invention taken in conjunction with the accompanying drawing, wherein

Figure 1 shows a schematic depiction of a cross-section through a wall of a gas-turbine-component according to the invention.

[0011] Figure 1 schematically shows a depiction of the gas-turbine-component GTC according to the invention, which is exposed to a hot gas HG flowing along an outer surface OSF of the gas-turbine-component GTC along a hot-gas-path HGP in a flow-direction FD. The partly shown gas-turbine-component GTC comprises a wall W extending along a wall-thickness WTH from an inner surface ISF to said outer surface OFF. Said inner surface ISF defines a cavity CV containing a cooling-fluid CF, in particular air. The cooling-fluid CF in the cavity CV is pressurized and leaves the cavity CV through a film-cool-

ing-hole FCH in the wall W being ejected into said hot-gas-path HGP. The film-cooling-hole FCH is basically a channel FC through the wall W extending along an axis X, which axis X is defined by the centroids of the cross-section areas of the respective openings OP of said cooling channel FC at said inner surface ISF and said outer surface OSF. The orifice of the cooling channel FC on the inner surface ISF - the inner surface orifice IOF - is modified according to the invention compared to the conventional geometry.

[0012] The cooling channel FC is not perpendicular to the inner surface ISF and the outer surface OSF but inclined such, that the cooling fluid CF is ejected into the hot-gas-path HGP with an overall velocity VC defining the flow direction FD.

[0013] The cooling channel FC is defined by an inner hole surface IHS, which consists of a more upstream portion USH and a more downstream portion DSH respectively with regard to said flow direction FD of the hot gas HG further defined by a partition plane PP extending basically along the centroids of all channel cross-section areas along the channel FC (here basically coinciding with the axis X, but not necessarily), wherein the downstream portion defines a tapering enlarging the channel FC widths FCW towards the outer surface OSF, wherein the tapering extends between 10% to 70% of said wall-thickness WTH. The channel widths FCW is basically defined as the cross-section area perpendicular to axis X.

[0014] According to the invention at least the part of the edge of said inner orifice IOF of the cooling channel FC joining the inner surface ISF, which has an angle α smaller 90° , is made blunt by widening the inner orifice opening IOF such that the cooling fluid CF entering the channel FC is accelerated and deflected more moderately than without this widening.

[0015] The effect according to the invention can be illustrated by considering streamlines SL depicted in figure 1. These streamlines can be drawn for each cross section area basically with homogeneous distance to each. These streamlines are not indicating any turbulence but show a basically laminar velocity distribution.

Claims

1. Gas-turbine-component (GTC) to be exposed to a hot-gas (HG) comprising at least one film-cooling-hole (FCH) joining into a hot-gas-path (HGP) at an outer surface (OSF) of the gas-turbine-component (GTC), wherein during operation of the gas-turbine the hot-gas (HG) flows along the outer surface (OSF) in a flow direction (FD),
wherein the film-cooling-hole (FCH) is a channel (FC) through a wall-thickness (WTH) of a wall (W) extending from an inner surface (ISF) to said outer surface (OSF), wherein the cooling channel (FC) extends along an axis (X), which is defined by the centroids of the cross-section areas of respective open-

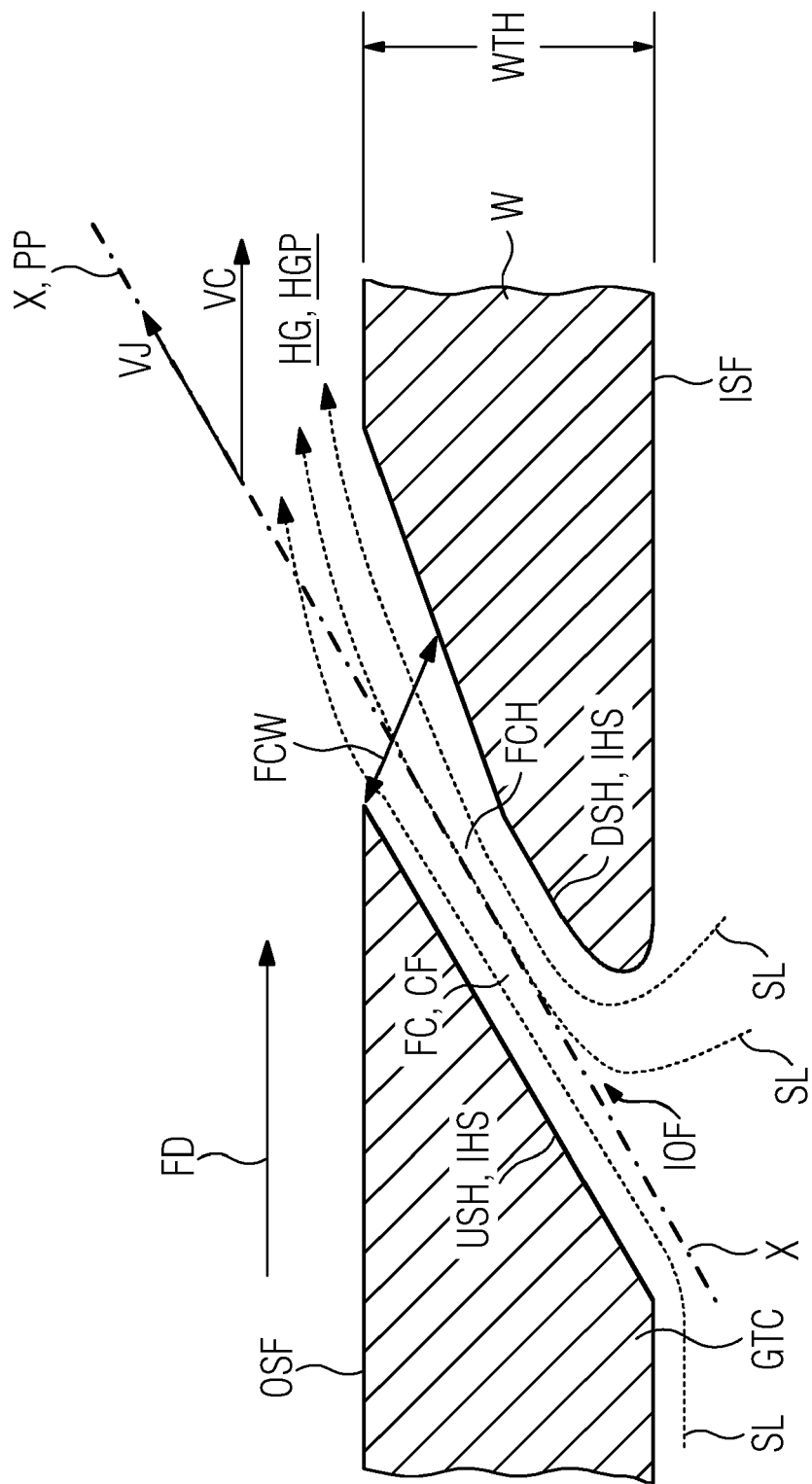
ings of said channel (FC) at said inner surface (ISF) and said outer surface (OSF),

wherein the opening of said channel (FC) at said inner surface (ISF) is an inner orifice (IOF),

wherein said axis (X) is inclined with regard to said flow direction (FD) such that cooling fluid (CF) is ejected into said hot-gas-path (HGP), comprising a velocity component (VC) into said flow direction (FD), **characterized in that**

at least the part of the edge of said inner orifice (IOF) of the cooling channel (FC) joining the inner surface (ISF), which has an angle (α) smaller 90° with said wall's inner surface (ISF) is made blunt by widening the inner orifice (IOF) such that the cooling fluid (CF) entering the channel (FC) is accelerated and deflected more moderately than without the widening.

2. Gas-turbine-component (GTC) according to claim 1, wherein said cooling channel (FC) is defined by an inner hole surface (IHF), which consists of a more upstream portion (USH) and a more downstream portion (DSH) with regard to the flow direction (FD) of the hot gas (HG) further defined by a partition plane (PP) extending basically along the centroids of all channel cross-section areas along said channel (FC),
wherein said downstream portion (DSH) defines a tapering enlarging the channel widths (FCW) towards said outer surface (OSF),
wherein the tapering extends between 10% to 70% of said wall-thickness (WTH).
3. Gas-turbine-component according to at least one of the claims 1, 2,
wherein the widening extends along 5% to 40% of said wall-thickness (WTH).





EUROPEAN SEARCH REPORT

Application Number
EP 11 18 0912

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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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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