

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
13.11.2013 Bulletin 2013/46

(51) Int Cl.: **C23C 4/08** ^(2006.01) **C23C 28/00** ^(2006.01)

(21) Application number: **12167245.5**

(22) Date of filing: 09.05.2012

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

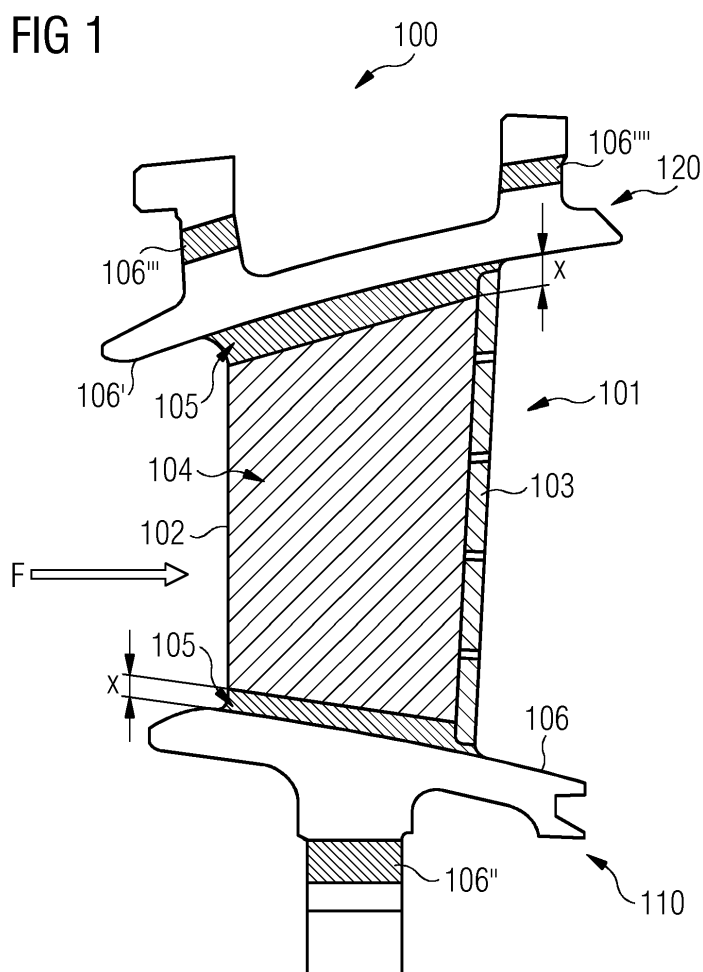
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(54) **A use of Oxide dispersion strengthened alloys for bladings**

(57) The present invention relates to an airfoil arrangement (100) for a gas turbine. The airfoil arrangement (100) comprises an airfoil device (101, 110, 120) comprising a coated surface section (104, 106, 106') which represents at least a part of the total surface of the

airfoil arrangement (100). The coated surface section (104, 106, 106') is coated with a bond coating (302) which comprises an oxide dispersion strengthened alloy. The bond coating (302) is coated with a thermal barrier coating (303).



Description

Field of invention

[0001] The present invention relates to an airfoil and to an airfoil arrangement for a gas turbine with a bond coating comprising an oxide dispersion strengthened alloy. Furthermore, the present invention relates to a method for manufacturing an airfoil arrangement for a gas turbine.

Art Background

[0002] The stator vanes and the rotor blades in a gas turbine are exposed to the high temperature of the working fluid passing the vanes and the blades. Due to the high temperature oxidation of a base alloy e. g. at a leading edge of an airfoil of the stator vane or the rotor blade, or at platforms of an inner shroud or an outer shroud of the stator vane or the rotor blade occur. Such an oxidation may be the life limiting mechanism on this component.

[0003] Material used for such hot turbine components will exhibit increasing oxidation rates as temperatures increase above 800deg C. The increasing oxidation rate becomes more significant as turbine operating temperatures increase in order to improve the overall efficiency of the turbine.

[0004] US 5,449,536 A discloses a method for the application of coatings of oxide dispersion strengthened metals by laser powder injection. A laser in a spray apparatus forms a hot zone at a distance above a substrate sufficient to prevent the substrate from melting. An oxide dispersion strengthened metal powder coating material is injected into the hot zone to heat the coating material such that it will be in a plastic state when it impinges against the substrate. The coating material has an initial microstructure before it is injected into the hot zone. The coating material is caused to impinge against the substrate to form a uniform coating on the substrate, wherein the micro structure of the coating on the substrate is substantially identical to the coating material's initial microstructure.

Summary of the Invention

[0005] It may be an object of the present invention to provide an airfoil for a gas turbine, which is more robust during operation in areas of the gas turbines exposed to hot conditions.

[0006] The subject may be solved by an airfoil for a gas turbine, an airfoil arrangement and by a method for manufacturing an airfoil for a gas turbine.

[0007] According to a first aspect of the present invention, an airfoil arrangement comprising an airfoil device for a gas turbine is presented. The airfoil device comprises a coated surface section (e.g. a coated "patch") which represents at least a part of the total surface of the airfoil device. The coated surface section is coated with a bond

coating which comprises an oxide dispersion strengthened alloy. The bond coating maybe coated with a thermal barrier coating.

[0008] The airfoil device may comprise an airfoil and an inner shroud. The airfoil device may in addition comprise an outer shroud. The airfoil is arranged between the inner shroud and the outer shroud.

[0009] According to a further aspect of the present invention a method for manufacturing an airfoil arrangement for a gas turbine is presented, wherein the airfoil arrangement comprises an airfoil device. A surface section of the airfoil device is coated with a bond coating which comprises an oxide dispersion strengthened alloy. The coated surface section represents at least a part of the total surface of the airfoil. The bond coating maybe coated with a thermal barrier coating.

[0010] An airfoil arrangement may describe a rotor blade arrangement or a stator vane arrangement. In a stator vane arrangement, the airfoil as described above is e.g. a vane, wherein the stator vane arrangement is fixed to a casing of the gas turbine.

[0011] A rotor blade arrangement is fixed to a rotary shaft of the gas turbine and rotates with respect to the stator vane device. The airfoil of a rotor blade arrangement is a blade which is driven by the working fluid of the gas turbine.

[0012] The airfoil comprises a leading edge and a trailing edge. At the leading edge, the airfoil has a maximum curvature, for example. Generally, the fluid which flows against the airfoil contacts firstly the leading edge and the fluid is separated in a first part which flows along a suction side of the airfoil and in a second part which flows along a pressure side of the airfoil. The suction side is generally associated with higher velocity and thus lower static pressure. The pressure side has a comparatively higher static pressure than the suction side.

[0013] The trailing edge defines the edge of the airfoil where the fluid flowing along the suction surface and the fluid flowing along the pressure surface is emerged again.

[0014] The airfoil device may comprise one airfoil or a plurality of further airfoils which are spaced apart from each other along a circumferential direction with respect to a rotary axis of the gas turbine.

[0015] The airfoil device further comprises an inner shroud. The airfoil extends from the inner shroud. The inner shroud is located closer to the rotary axis of the gas turbine than the airfoil. The inner shroud comprises a first inner platform.

[0016] The airfoil device further comprises an outer shroud. The airfoil is arranged between the inner shroud and the outer shroud. In particular, the leading edge and the trailing edge extend between the inner shroud and the outer shroud.

[0017] The inner shroud is located closer to the rotary axis of the gas turbine than the outer shroud. The outer shroud comprises a second inner platform, wherein respective inner surfaces of the inner and outer shroud face

the inner volume of the gas turbine through which inner volume the hot working gas streams. Hence, the respective inner surfaces of the inner and outer shroud are gas-washed by the hot working gas of the gas turbine.

[0018] Between the coated surface section and the inner shroud on the one side and/or between the coated surface section and the outer shroud on the other side a thinning out section (transition section) may be formed onto a surface of the airfoil. In the thinning out section, the thickness of the thermal barrier coating, i.e. the ceramic-based coating, is smoothly reduced from the edge of the coated surface section to the inner and the outer shroud, respectively. In other words, the thickness of the thermal barrier coating is thinning out (in particular till zero thickness) from the edge of the coated surface section to the inner and the outer shroud, respectively, so that i.e. the first inner platform and/or the second inner platform which is/are washed by working fluid of the turbine is/are free of a thermal barrier coating.

[0019] The bond coating and the thermal barrier coating (TBC), which covers the bond coating on the airfoil surface (coated surface section), reduce the temperature on the airfoil surface under operation of the turbine and hence increases the lifetime of the airfoil.

[0020] If the bond coating is used in connection with the thermal barrier coating (TBC) the bond coating enforces the bonding of the ceramic coating (i.e. the thermal barrier coating (TBC)) to the surface of the airfoil in comparison to a direct coating of the thermal barrier coating (TBC) to the surface of the airfoil device. Hence, the bond coating is located beneath the thermal barrier coating, i.e. between the airfoil and the thermal barrier coating.

[0021] The bond coating comprising the oxide dispersion strengthened alloy provides the airfoil with a corrosion resistance and high temperature oxidation protection. The bond coating may be used without a thermal barrier coating on features or sections of the airfoil arrangement, which operate e.g. at a lower temperature than the airfoils.

[0022] Summarizing, the thermal barrier coating (TBC) may reduce the temperature of the airfoil. The (ceramic) thermal barrier coating however may require a bond coat to enable it to adhere to the surface of the airfoil. In this case the bond coating is used as described above. The bond coat acts as an interface between the TBC coating and the base material of the airfoil. Additionally, there may be an internal further coating of the aerofoil to further provide oxidation and corrosion protection.

[0023] The coated surface section covers the airfoil of the airfoil device from the leading edge to the trailing edge along the suction side and/or the pressure side of the airfoil. In particular, the coating life at the leading edge of the airfoil is increased. Furthermore, by providing the airfoil surface with the coated surface section, additional efficient protection against oxidation is achieved.

[0024] The bond coating comprising the oxide dispersion strengthened alloy coating may be coated onto the coated surface section by application methods such as

electro-plating, thermal spray techniques and/or Electron Beam Vapour Deposition (EPPVD).

[0025] During or after coating of the airfoil at the coated surface section, the airfoil may be exposed to a heat treatment, so that a partial diffusion between the coated layers occurs. Additionally, a final ageing heat treatment may be applied for the airfoil substrate material.

[0026] Finally, if required, a post coating surface finish may be applied to the coated surface section in order to achieve a desired roughness of the coating.

[0027] Oxide dispersion strengthened (O.D.S.) alloys may comprise in particular iron (with the chemical symbol Fe) and/or nickel (Ni) constituents (e.g. primary constituents). Additionally or alternatively oxide dispersion strengthened alloys may also comprise chrome (Cr), aluminium (Al), titanium (Ti), molybdenum (Mo), tungsten (W), carbon (C) and/or yttrium (Y), in particular Yttrium (III) oxide (Y2O3) constituents (first and/or second constituents).

[0028] For example oxide dispersion strengthened alloys based on iron (Fe) may have an oxidation resistance superior to that of the aluminide based coatings of approximately five times better than the base material of the airfoil.

[0029] Hence, the use of oxide dispersion strengthened alloys as a bond coating will result in a significant increase in the service life of the airfoil for the common operating temperatures or in an increase in operating temperatures thus improving engine efficiency. Moreover, the oxide dispersion strengthened alloy may also be used as a bond coat for the thermal barrier coating which increases the coating life for the same operational temperature of the gas turbines.

[0030] 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

[0031] 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 schematically an airfoil arrangement for a stator vane according to an exemplary embodiment of the present invention;

Fig. 2 shows a perspective view of an airfoil arrangement for a stator vane according to an exemplary embodiment of the present invention; and

Fig. 3 shows a layer composition of an airfoil with respective coatings according to an exemplary embodiment of the present invention.

Detailed Description

[0032] The illustrations in the drawings are schematic. It is noted that in different figures, similar or identical elements are provided with the same reference signs.

[0033] Fig. 1 shows an airfoil arrangement 100, in particular a stator vane arrangement, for a gas turbine. The airfoil arrangement 100 comprises an airfoil device 101, 110, 120, comprising e.g. an airfoil 101 (e.g. a vane) with a leading edge 102 and a trailing edge 103. The leading edge 102 is covered by a coated surface section 104 which comprises a bond coating 302 (see Fig. 3). The airfoil device 101, 110, 120, may further comprise an inner shroud 110 and an outer shroud 120.

[0034] Furthermore, according to Fig. 1, the airfoil 101 is arranged between the inner shroud 110 and the outer shroud 120. The inner shroud 110 and the outer shroud 120 may comprise also a coated surface section 106, 106' which is coated with a bond coating 302 (see Fig. 3) comprising an oxide dispersion strengthened alloy. The bond coating 302 is coated with a thermal barrier coating 302 (see Fig. 3). The leading edge 102 and the trailing edge 103 extend between the inner shroud 110 and the outer shroud 120.

[0035] Fig. 1 further shows a flow direction F of a working fluid of the gas turbine. The working fluid flows against the leading edge 102. The working fluid streams along the surfaces of the airfoil 101, i.e. the pressure side and the suction side, and leave the airfoil 101 at the trailing edge 103.

[0036] In Fig. 1, the coated surface section 104 is shown which represents at least a part of the total surface of the airfoil 101. The coated surface section 104 is coated with a bond coating 302 (see Fig. 3) which comprises an oxide dispersion strengthened alloy. The bond coating 302 is coated with a thermal barrier coating 303 (see Fig. 3). The coated surface section 104 may be spaced apart from the respective inner shroud 110 or the outer shroud 120. Between the coated surface section 104 and the respective inner shroud 110 or the outer shroud 120 a transition section, i.e. a thinning out section 105, may be formed. The coated surface section 104 is spaced from the inner shroud 110 and/or the outer shroud 120 with a distance x. The distance x is measured e.g. by a length along a normal of a plane in which the inner surface of the inner shroud 110 or the inner surface of the outer

shroud 120, respectively, is located.

[0037] Furthermore, guiding rails are located at the inner shroud 110 and/or at the outer shroud 120. The guiding rails are needed for a fixation of the airfoil arrangement 100 to a respective housing of the turbine or for guiding cooling fluid. At selective sections of the inner shroud 110 and the outer shroud 120 further coated surface sections 106", 106"', 106"" are coated for example with a further anti-oxidation coating, e. g. a MCrAlY or a PtAl coating, a vapor phase aluminide coating and/or an oxide dispersion strengthened alloy coating.

[0038] Fig. 2 shows an exemplary embodiment of an airfoil arrangement 100 which comprises an airfoil device with the airfoil 101 and with further airfoils 201, 201', 201". The airfoils 101, 201, 201', 201" are arranged between the inner shroud 110 and the outer shroud 120. Furthermore, in Fig. 2 an inner surface 106 of the inner shroud 110 is shown. The inner surface 106 of the inner shroud faces the inner volume of the gas turbine through which the hot working fluid flows. Hence, the inner surface 106 is washed by the hot working fluid.

[0039] Specifically, the inner surface 106 of the inner shrouds 110 and/or the inner surface of the outer shrouds 120 may be coated with an oxidation and corrosion preventative coating in order to reduce oxidation and corrosion.

[0040] Seal slots, such as scallop seal slots, and machined surfaces of the airfoil arrangement 100 may be kept free from any coating in order to maintain the original dimensions.

[0041] Fig. 3 shows a layer composition of the coated section 104 of the airfoil 101 with respective coatings according to an exemplary embodiment of the present invention.

[0042] In Fig. 3, the bond coating 302 is used in connection with a thermal barrier coating (TBC) 303. The bond coating 302 comprises an oxide dispersion strengthened alloy and functions as a bond coat for e.g. ceramic coatings (i.e. the thermal barrier coating 303). Hence, the bond coating 302 is located beneath the thermal barrier coating 303, i.e. between the airfoil surface 301 and the thermal barrier coating 303. The thermal barrier coating 303 forms metaphorically a "feathered section" onto the bond coating 302.

[0043] 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. Airfoil arrangement (100) for a gas turbine, the airfoil arrangement (100) comprising an airfoil device (101, 110, 120) comprising a coated

surface section (104, 106, 106') which represents at least a part of the total surface of the airfoil device (101, 110, 120), wherein the coated surface section (104, 106, 106') is coated with a bond coating (302) which comprises an oxide dispersion strengthened alloy, wherein the bond coating (302) is coated with a thermal barrier coating (303).

coating (303).

2. Airfoil arrangement (100) according to claim 1, wherein the thermal barrier coating comprises a ceramic component. 10
3. Airfoil arrangement (100) according to claim 1 or 2, wherein the oxide dispersion strengthened alloy comprises an iron-base alloy and/or a nickel-base alloy. 15
4. Airfoil arrangement (100) according to one of the claims 1 to 3, wherein the airfoil device (101, 110, 120) comprises an airfoil (101). 20
5. Airfoil arrangement (100) according to one of the claims 1 to 4, wherein the airfoil device (101, 110, 120) comprises an inner shroud (110). 25
6. Airfoil arrangement (100) according to one of the claims 1 to 5, wherein the airfoil device (101, 110, 120) comprises an outer shroud (120). 30
7. Airfoil arrangement (100) according to claim 5, wherein the inner shroud (110) comprises an inner platform which is washed during operation of the gas turbine by working fluid of the turbine. 35
8. Airfoil arrangement (100) according to claim 6, wherein the outer shroud (120) comprises an outer platform which is washed during operation of the gas turbine by working fluid of the turbine. 40
9. Airfoil arrangement (100) according to claims 4, wherein the airfoil (101) is a stator vane or a rotor blade. 45
10. Method for manufacturing an airfoil arrangement (100) for a gas turbine, wherein the airfoil arrangement (100) comprises an airfoil (101), the method comprising coating a surface section (104, 106, 106') of the airfoil device (101, 110, 120) with a bond coating (302) which comprises an oxide dispersion strengthened alloy, wherein the coated surface section (104, 106, 106') represents at least a part of the total surface of the airfoil device (101, 110, 120), and coating the bond coating (302) with a thermal barrier 50

11. Method according to claim 10, wherein the bond coating (302) is coated by a deposit electric plating process or by a low pressure plasma spray process. 55

FIG 1

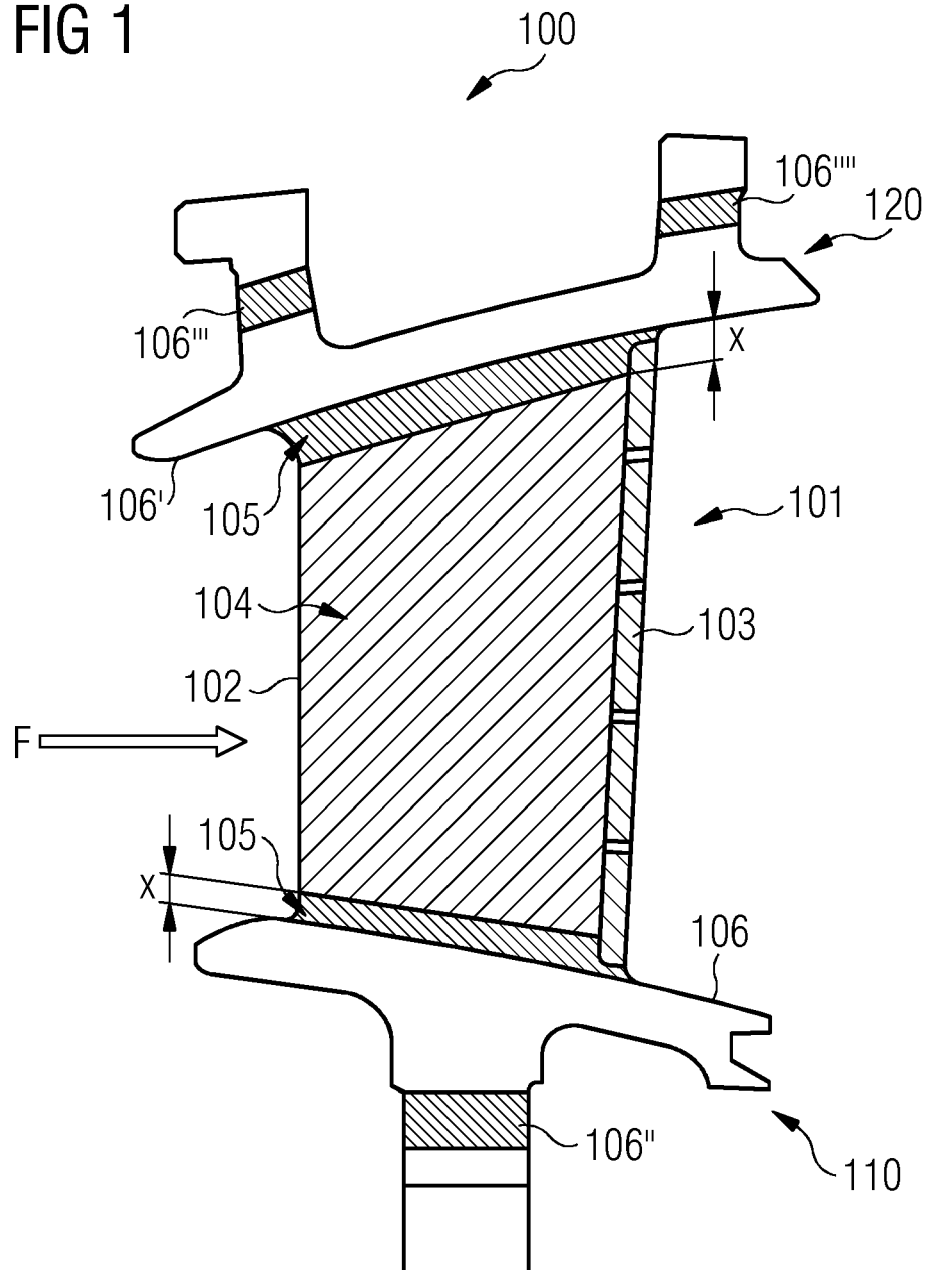


FIG 2

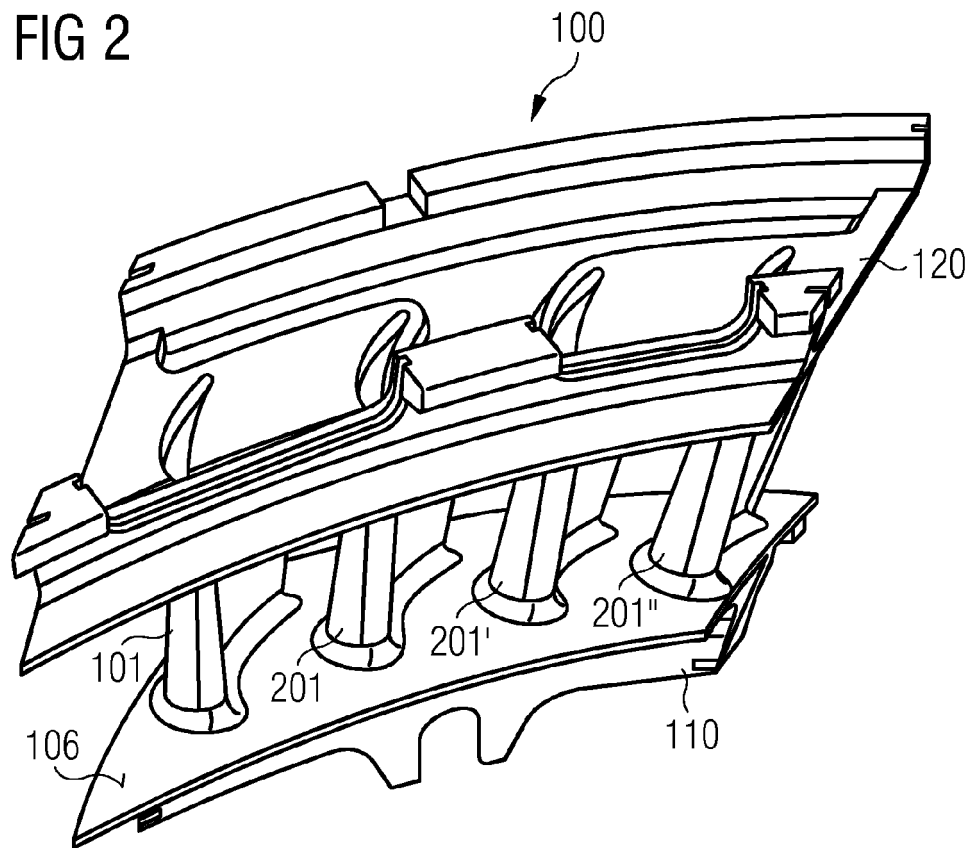
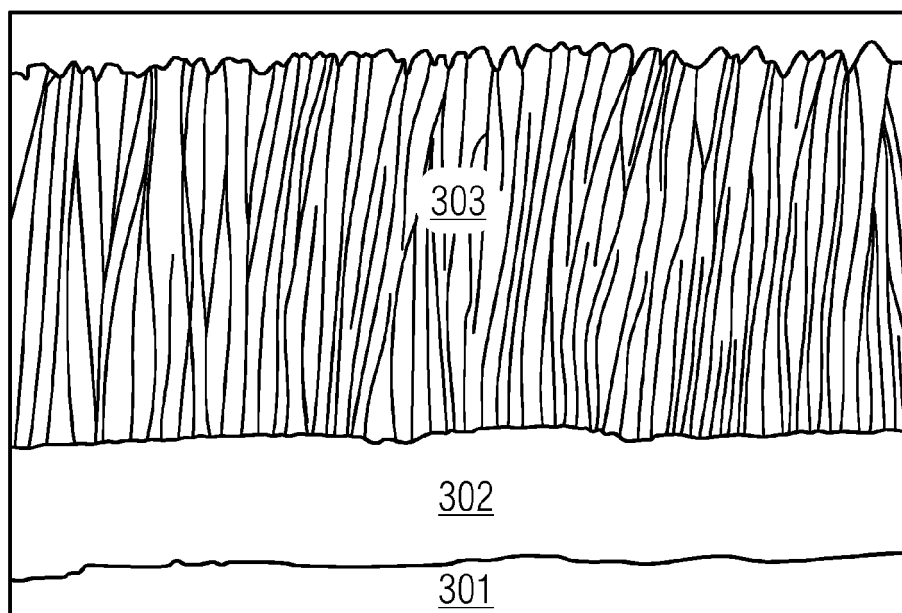


FIG 3





EUROPEAN SEARCH REPORT

Application Number
EP 12 16 7245

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Place of search The Hague		Date of completion of the search 26 June 2012	Examiner Chalaftris, Georgios
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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.
The members are as contained in the European Patent Office EDP file on
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