

(19)



(11)

EP 3 441 564 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.02.2019 Bulletin 2019/07

(51) Int Cl.:
F01D 5/14 (2006.01) **F01D 9/04** (2006.01)
F01D 11/00 (2006.01)

(21) Application number: **17185905.1**

(22) Date of filing: **11.08.2017**

(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
Designated Validation States:
MA MD

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(54) **TURBINE COMPONENT COMPRISING A PLATFORM WITH A DEPRESSION**

(57) A component (300, 400) for use in a turbomachine is provided. The component (300, 400) comprises a platform (310, 410) having a leading end (312, 412) longitudinally spaced apart from a trailing end (312, 412), an aerofoil portion (320, 420) extending from the platform (310, 410), the aerofoil portion (320, 420) having a leading edge (322, 422) and a trailing edge (314, 414). The

platform (310, 410) further comprises a leading end region (315, 415) between the leading end (312, 412) of the platform (310, 410) and the leading edge (322, 422) of the aerofoil portion (320, 420), and a depression (330, 430) which extends into the platform (310, 410), and is located in the leading end region (315, 415).

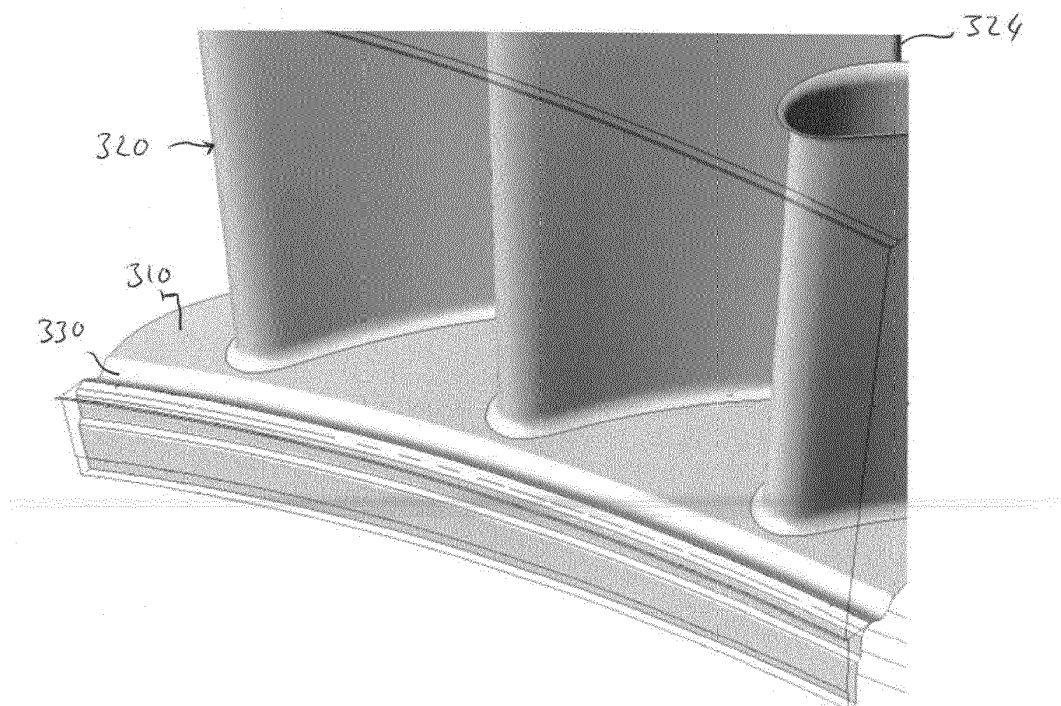


Figure 7

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Description

[0001] The present disclosure relates to a component for a turbomachine.

Background

[0002] Gas turbine engines, which are a specific example of turbomachines, generally include a rotor with a number of rows of rotating rotor blades which are fixed to a rotor shaft and rows of stationary vanes between the rows of rotor blades which are fixed to the casing of the gas turbine.

[0003] When a hot and pressurized working fluid flows through the rows of vanes and blades in the main passage of a gas turbine, it transfers momentum to the rotor blades and thus imparts a rotary motion to the rotor while expanding and cooling. Working fluid may expand through clearance gaps upstream of blades and vanes. This is known as hot gas ingestion or hot gas ingress.

[0004] Temperature control is crucial to preventing material failure of the components of a gas turbine and, therefore, controlling the path of hot gas is crucial. That is to say, a reduction of hot gas ingress is highly desirable. Hence certain clearance gaps are fitted with seals to obstruct such ingress. Other cavities, such as the upstream hub cavity of a nozzle guide vane, may not be suitable for a physical seal and common practice is to rely on cold purge flow exiting through the clearance gap for cooling and reducing hot gas ingress.

[0005] However, purge flow is known to reduce cycle efficiency of gas turbine engines, and may lead to thermal stresses at the interface between cold gas and hot gas flows.

[0006] Hence a component for a turbomachine configured to reduce or prevent hot gas ingress without increasing cold purge flow is highly desirable.

Summary

[0007] According to the present disclosure there is provided an apparatus as set forth in the appended claims. Other features of the invention will be apparent from the dependent claims, and the description which follows.

[0008] Accordingly there may be provided a component 300, 400 for use in a turbomachine, the component 300, 400 comprising: a platform 310, 410 having a leading end 312, 412 longitudinally spaced apart from a trailing end 312, 412; an aerofoil portion 320, 420 extending from the platform 310, 410, the aerofoil portion 320, 420 having a leading edge 322, 422 and a trailing edge 314, 414; wherein the platform 310, 410 further comprises: a leading end region 315, 415 between the leading end 312, 412 of the platform 310, 410 and the leading edge 322, 422 of the aerofoil portion 320, 420, and a depression 330, 430 which : extends into the platform 310, 410, and is located in the leading end region 315, 415.

[0009] The depression 330, 430 may have a profile

comprising: a lead-in region 332 and a lead-out region 334 spaced apart in the longitudinal direction; the lead-in region 332 having a first gradient, the lead-out region 334 having a second gradient, the first gradient being less than the second gradient.

[0010] The lead-in region 332 may be spaced apart from the leading edge 322, 422 of the aerofoil portion 320, 420 by the lead out region 334; and the lead out region 334 is spaced apart from the leading end 312, 412 of the platform 310, 410 by the lead-in region.

[0011] The profile of the depression 330, 430 may be generally half ovoid.

[0012] The depression 330, 430 may span a greater distance transversely than the aerofoil portion 320, 420.

[0013] The depression 330, 430 may span the width of the aerofoil portion 320, 420.

[0014] The depression 330, 430 may have a maximum depth corresponding to about 15% to 30% of the maximum width of the depression 330, 430 in the longitudinal direction.

[0015] The maximum depth of the depression 330, 430 may correspond to about 1% to 5% of the height of the aerofoil portion 320, 420.

[0016] The depression 330, 430 may be elongate and extends generally parallel to the leading end 312, 412 of the platform 310, 410.

[0017] The depression 330, 430 may have a substantially uniform cross-sectional shape in a transverse direction.

[0018] The platform 310, 410 may have side edges 316, 318, 416, 418 extending longitudinally between the leading end 312, 412 and trailing end 314, 414; and the depression 330, 430 may extend all of the way between the platform side edges 316, 318, 416, 418.

[0019] The depression 330, 430 may extend between transverse ends 336, 338, 436, 438, and may reduce in depth from its maximum depth towards each of its transverse ends 336, 338, 436, 438.

[0020] The platform 310, 410 may have side edges 316, 318, 416, 418 extending longitudinally between the leading end 312, 412 and trailing end 312, 412; and the depression 330, 430 may extend part, but not all, of the way between the platform side edges 316, 318, 416, 418, the transverse ends 336, 338, 436, 438 of the depression 330, 430 being spaced apart from the platform side edges.

[0021] The component 300, 400 may be annular, and a plurality of depressions 330, 430 may be provided around the circumference of the component 300, 400.

[0022] The component 300, 400 may be annular, and the depression 330, 430 may extend around the circumference of the platform 310, 410.

[0023] The component 300, 400 may form at least part of a nozzle guide vane. The component 300, 400 may be a nozzle guide vane.

[0024] The component 300, 400 may form at least part of a rotor blade. The component 300, 400 may be a rotor blade.

[0025] There may be provided a gas turbine engine comprising a component 300, 400 as above.

[0026] Hence there is provided a component, for example a turbine stator vane, stator vane assembly, nozzle guide vane, rotor blade or rotor blade assembly, configured for enhanced cooling and to improve sealing therebetween.

Brief Description of the Drawings

[0027] Examples of the present disclosure will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a schematic representation of an example of a turbomachine;

Figure 2 shows an enlarged region of a section of a turbine of the turbomachine shown in Figure 1;

Figure 3 shows an end view of the rotor blades shown in Figures 1 and 2;

Figure 4 shows a partial perspective view of a known component;

Figure 5 shows another partial perspective view of the known component;

Figure 6 shows a partial perspective view of a component according to the present disclosure;

Figure 7 shows a partial perspective view of a plurality of components according to the present disclosure;

Figure 8 shows a partial cross-sectional view of a component according to the present disclosure;

Figure 9 shows a partial perspective view of another example of a component according to the present disclosure; and

Figure 10 shows a partial perspective view of a plurality of components according to the other example.

Detailed Description

[0028] The present disclosure relates to a component, for example a rotor blade or nozzle guide vane, for use in a turbomachine, such as a gas turbine.

[0029] By way of context, Figures 1 to 5 show known arrangements, described for contrast with examples of the present invention, and to which the features of the present invention may be applied.

[0030] Figure 1 shows an example of a gas turbine engine 60 in a sectional view, which illustrates the nature of rotor blades and the environment in which they oper-

ate. The gas turbine engine 60 comprises, in flow series, an inlet 62, a compressor section 64, a combustion section 66 and a turbine section 68, which are generally arranged in flow series and generally in the direction of a longitudinal or rotational axis 70. The gas turbine engine 60 further comprises a shaft 72 which is rotatable about the rotational axis 70 and which extends longitudinally through the gas turbine engine 60. The rotational axis 70 is normally the rotational axis of an associated gas turbine engine. Hence any reference to "axial", "radial" and "circumferential" directions are with respect to the rotational axis 70.

[0031] The shaft 72 drivingly connects the turbine section 68 to the compressor section 64. In operation of the gas turbine engine 60, air 74, which is taken in through the air inlet 62 is compressed by the compressor section 64 and delivered to the combustion section or burner section 66. The burner section 66 comprises a burner plenum 76, one or more combustion chambers 78 defined by a double wall can 80 and at least one burner 82 fixed to each combustion chamber 78. The combustion chambers 78 and the burners 82 are located inside the burner plenum 76. The compressed air passing through the compressor section 64 enters a diffuser 84 and is discharged from the diffuser 84 into the burner plenum 76 from where a portion of the air enters the burner 82 and is mixed with a gaseous or liquid fuel. The air/fuel mixture is then burned and the combustion gas 86 or working gas from the combustion is channelled via a transition duct 88 to the turbine section 68.

[0032] The turbine section 68 may comprise a number of blade carrying discs 90 or turbine wheels attached to the shaft 72. In the example shown, the turbine section 68 comprises two discs 90 which each carry an annular array of turbine assemblies 12, which each comprises an aerofoil 14 embodied as a turbine blade 100. Turbine cascades 92 are disposed between the turbine blades 100. Each turbine cascade 92 carries an annular array of turbine assemblies 12, which each comprises an aerofoil 14 in the form of guiding vanes (i.e. stator vanes 96), which are fixed to a stator 94 of the gas turbine engine 60.

[0033] Figure 2 shows an enlarged view of a stator vane 96 and rotor blade 100, which are particular examples of components of the gas turbine engine 60. Arrows "A" indicate the direction of flow of combustion gas 86 past the aerofoils 96, 100 along a main (i.e. core) flow passage 97. Arrows "B" show cavity purge air flow passages (cavity 211) provided for sealing, as will be described with reference to Figure 4 below. Arrows "C" indicate cooling air flow paths for passing through the stator vanes 96. Arrows "P" indicate cavity 211 cooling air purge flow upstream of the stator vane 96, as will also be described with reference to Figure 4 below. Cooling flow passages 101 may be provided in the rotor disc 90 which extend radially outwards to feed an air flow passage 103 in the rotor blade 100.

[0034] The combustion gas 86 from the combustion

chamber 78 enters the turbine section 58 and drives the turbine blades 100 which in turn rotate the shaft 72 to drive the compressor. The guiding vanes 96 serve to optimise the angle of the combustion or working gas 86 on to the turbine blades.

[0035] Figure 3 shows a view of the rotor blades 100 looking upstream, facing the flow "A" shown in Figure 2.

[0036] Each rotor blade 100 comprises an aerofoil portion 104, a root portion 106 and a platform 108. The platform 108 is located between the aerofoil portion 104 and the root portion 106. The rotor blades 100 are fixed to the rotor disc 102 by means of their root portions 106. The root portions 106 have a shape that corresponds to notches (or grooves) 109 in the rotor disc 90, and are configured to prevent the rotor blade 100 from detaching from the rotor disc 102 in a radial direction as the rotor disc 102 spins.

[0037] Figures 4, 5 show a partial perspective view of a further known component 200. The component 200 may form part of a nozzle guide vane or rotor blade, for example as shown in Figures 1 to 3. Features of the component which are not relevant to the invention of the present disclosure have been omitted for clarity.

[0038] The component 200 comprises a platform 210. In a gas turbine, the platform provides an inner boundary of the annular main passage, defined by the compressor, combustor and turbine as shown in Figure 1, through which working fluid flows.

[0039] In the example shown in Figures 4, 5, the platform 210 comprises a leading end 212 longitudinally spaced apart from a trailing end 214, thus defining a longitudinal direction of the platform in particular and the component 200 in general. That is, the leading end is an upstream region of the platform, while the trailing end is a downstream region of the platform. The leading end and the trailing end delimit the platform, i.e. they are physical ends of the platform. With respect to the gas turbine, the leading end and the trailing end delimit the platform along the axial direction.

[0040] The platform 210 further comprises an aerofoil portion 220 extending from the platform 210. With respect to the gas turbine, the aerofoil portion extends from the platform along the radial direction. The aerofoil portion has a height, as measured along the radial direction, from the platform to the tip of the aerofoil portion. In use, the aerofoil portion extends radially from the radially inner boundary of the annular main passage to a radially outer boundary of the annular main passage.

[0041] The aerofoil portion 220 has a leading edge 222 and a trailing edge 224. The leading edge is located towards the leading end 212 of the platform 210, while the trailing edge is located towards the trailing end of the platform.

[0042] The aerofoil portion 220 comprises a pressure side 226 and a suction side 228. That is, the shape of the aerofoil portion is such that a difference in pressure is generated in use between the pressure side, which will be at a higher pressure, and the suction side, which will

be at a lower pressure. Accordingly, the flow of working fluid about the aerofoil portion will have a higher average velocity at the suction side and a lower average velocity at the pressure side.

[0043] The platform 210 further comprises a leading end region 215. The leading end region is a region of the platform located between the leading end 212 of the platform 210 and the leading edge 322 of the aerofoil portion 320. Accordingly, the leading end region is provided downstream relative to the leading end 212 of the platform 210, and upstream relative to the leading edge 222 of the aerofoil portion 220. The leading end region is generally flat (i.e. planar).

[0044] The platform 210 may further comprise side edges 216, 218 extending longitudinally between the leading end 212 and the trailing end 214. The side edges correspond to a pressure-side end 216 and a suction-side end 218. The pressure-side end is located at the pressure side of the aerofoil portion 226, while the suction-side end is located at the suction side 228 of the aerofoil portion. In relation to the gas turbine, the pressure-side end and the suction-side end delimit the platform along a circumferential direction (i.e. when assembled in an engine). The pressure-side end and the suction-side end may correspond to physical boundaries of the component.

[0045] Alternatively the component 200 may be integrally formed with a plurality of other, substantially identical components (for example, with reference to Figure 7). Hence each component may be considered as a sub-unit of a larger component, each sub unit comprising a region corresponding to a pressure-side edge/end of the platform and a suction-side edge/end of the platform on either side of their respective aerofoil portion, even if the side edges are not physically present because they are integrally formed with the side edges of adjacent sub-units. That is to say, the pressure-side end and a suction-side end may not correspond to physical boundaries of the component, although they may define a boundary (i.e. limit) between repeated sub-units of the component design.

[0046] According to the present example, the component 200 is provided as a first turbine nozzle guide vane. In use, upstream from the leading end 212 of the platform 210 a hub cavity 211 is formed. A purge flow travels along the radial direction, relative to the gas turbine, in the direction indicated by arrows P.

[0047] In this example, the hub cavity 211 is unsuitable for a seal and is therefore 'open'. Where no seal is provided, hot gas ingress is conventionally reduced only by means of purge flow injection P.

[0048] Figure 6 shows a partial perspective view of a component 300 according to the present disclosure.

[0049] Some features of the component 300 are common to those of the known component 200, and hence are not described in any further detail.

[0050] The component 300 comprises a platform 310 having a leading end 312 and, opposite thereto, a trailing

end 314 (illustrated in Figure 5). An aerofoil portion 320 extends from the platform, the aerofoil portion having a leading edge 322 and a trailing edge. The platform further comprises a leading end region 312 between the leading end of the platform and the leading edge of the aerofoil portion. The component, unlike the known component 200, comprises a depression 330 which extends into the platform and is located in the leading end region.

[0051] The depression 330 is configured to generate a low-pressure region which draws in hot gas passing along the main passage (e.g. exhaust gas passing from the combustor through the turbine) to thereby reduce hot gas ingress upstream of the rows of blades and vanes of the turbine.

[0052] The depression 330 may be elongate. The depression has a length and a width, where the length is greater than the width. The length of the depression is measured along the leading end 312 of the platform 310. That is, the length of the depression is understood as the length of a projection onto the leading end. Similarly, the width is measured along the pressure-side end 316 or the suction-side end 318, i.e. the width is a projection on either circumferential end. Equally, the width may be measured along an axis perpendicularly extending from the leading end of the platform to the trailing end of the platform. That is, the width of the depression may be measured along the axial direction of the gas turbine. A maximum possible value of the width is defined by the available space, as provided by the width of leading end region 312, which is delimited by the leading end and the leading edge 322.

[0053] Particularly where the depression 330 is elongate, the depression may alternatively be referred to as a groove or a trough.

[0054] The depression 330 is arranged to extend generally parallel to the leading end 312 of the platform 310. That is, with respect to the gas turbine the depression extends circumferentially.

[0055] The depression 330 has a length which is greater than the length of the aerofoil portion 320. The length of the aerofoil portion is measured along the leading end 312 of the platform 310. That is to say, the depression may span at least the width of the aerofoil portion. In other words, the depression spans a greater distance transversely than the aerofoil portion. In some examples, this is irrespective of the particular location of the aerofoil portion. In other examples, the depression spans the aerofoil portion, i.e. is located 'in front' (i.e. upstream) of the aerofoil portion, but may span a greater distance than just the aerofoil portion. The depression may span the aerofoil portion, i.e. is located 'in front' (i.e. upstream) of the aerofoil portion, but may not extend the full width of the platform (for example as shown in Figures 9, 10).

[0056] According to the present example, the depression 330 extends from the pressure-side end 316 of the platform 310 to the suction-side end 318 of the platform.

[0057] Figure 7 shows a partial perspective view of a plurality of components 300. The plurality of components

is integrally formed.

[0058] As can be seen in Figure 7, the depression 330 of an individual component 300 is arranged to form a continuous depression with an adjacent component 300.

That is, according to the present example the depression is axisymmetric. The depression extends along the leading end 312 and across the entire platform 310.

[0059] Figure 8 shows a partial cross-sectional view of the component 300 along line A:A shown in Figure 6.

[0060] The depression 330 has a cross-sectional profile comprising a lead-in region 332, a lead-out region 334, and a maximum-depth region 335 located therebetween. In other words, the lead-in region is spaced apart from the leading edge by the lead-out region, and the lead-out region is spaced apart from the leading end by the lead-in region.

[0061] According to the present example, the depression has a substantially uniform profile, or cross-sectional shape, in the transverse (i.e. circumferential) direction (i.e. perpendicular to the longitudinal direction). The depression also comprises a pair of transverse ends 336, 338, which according to the example of Figures 6, 7 coincide with the side edges 316, 318 of the platform 310.

[0062] The lead-in region 332 and the lead-out region 334 are spaced apart in the longitudinal direction. These are transition regions where the generally flat platform 310 transitions to the generally curved depression 330. A portion of the lead-in region may be at substantially the same height as the leading end region 312 of the platform 310. Similarly, a portion of the lead-out region is at substantially the same height as the leading end region.

[0063] The lead-in region 332 is arranged to lead a flow of working fluid into the depression 330, while the lead-out region 334 is arranged to lead a flow of working fluid out of the depression. The lead-in region faces the leading end 312 of the platform, i.e. faces an upstream direction, while the lead-out region faces the leading edge 322 of the aerofoil portion 320, i.e. faces a downstream direction.

[0064] The lead-in region 332 of the depression profile may have a gentle slope, while the lead-out region 334 of the depression profile has a steep slope. In other words, the lead-in region has a first gradient and the lead-out region has a second gradient, where the first gradient may be less than the second gradient. In other examples, the first gradient may be more than the second gradient, or the gradients may be equal.

[0065] The depression 330 has profile created from a plurality of circular arcs with continuous tangency. As shown in Figure 8, four circular arcs are used. The lead-in region 332 may be formed using a first circular arc, the lead-out-region 334 may be formed using a second circular arc, the maximum-depth region 335 may be formed using a third circular arc and a fourth circular arc.

[0066] The first circular arc is used to create a smooth transition region from the generally flat platform 310 into the depression 330. The origin or centre of the first circular is located inwards from the platform in relation to

the radial direction of the gas turbine.

[0067] Similarly, the second circular arc is used to create a smooth transition region into the maximum-depth region 335. The centre of the second circular arc is outwards from the platform along the radial direction of the gas turbine.

[0068] The third circular arc is used to create a smooth transition region from the maximum-depth region 335. The centre of the second circular arc is outwards from the platform along the radial direction of the gas turbine. The radius defining the third circular arc may be smaller than the radius defining the second circular arc, so that the lead-out region 334 is steeper than the lead-in region 332.

[0069] The fourth circular arc is used to create a smooth transition region from the depression 330 to the leading end region 312. The centre of the fourth circular arc is inwards from the platform along the radial direction of the gas turbine. The radius defining the fourth circular arc may be smaller than the radius defining the first circular arc, so that the lead-out region 334 is steeper than the lead-in region 332.

[0070] According to the present example the first, second, third and fourth circular arcs have radii - r_1 , r_2 , r_3 and r_4 , respectively - chosen according to the following relationships: r_1 / r_2 is between 0.63 and 0.66; r_1 / r_3 is between 1.9 and 2.1; r_1 / r_4 is between 1.4 and 1.6. According to the present example, $r_1 / r_2 = 0.65$; $r_1 / r_3 = 2.1$; $r_1 / r_4 = 1.5$.

[0071] The depression 330 has a maximum depth, also denoted d , in the region of maximum depth 335. The maximum depth of the aerofoil portion may be between 1% and 5% of the height of the aerofoil portion 320. The maximum depth may be between 2% and 3% of the aerofoil portion. The maximum depth may be approximately 2.15% of the height of the aerofoil portion 320.

[0072] As shown in Figure 8, the maximum depth may be located at about 65% of the width of the depression 330, as measured from the leading end 312 of the platform 310. That is, the maximum depth is arranged to be closer to the leading edge 322 of the aerofoil portion 320 than the leading end of the platform.

[0073] A ratio of the width of the depression 330 over the maximum depth d may be between 3 and 8. Alternatively the ratio may be between 3.5 and 7.5. In another example, the ratio may be between 4.5 and 6.5. In the present example, the ratio has a value of 4.9 which has been found to be effective for reducing hot gas ingress.

[0074] As shown in the example of Figure 8, the profile of the depression has a generally half-ovoid shape. The profile may generally follow the curve of a drop shape. The shape may be known also as a 'raindrop shape' or a 'teardrop shape'.

[0075] A component according to the present disclosure is suitable for providing passive control of hot gas ingestion into an upstream cavity by having a depression in the platform leading end.

[0076] During operation of a gas turbine, a pressure

field is generated about the aerofoil portion 320. In particular, a static pressure variation is caused by the pressure field generated about the leading edge 322 of the aerofoil portion. The pressure field causes hot working fluid to enter the upstream cavity, following a resulting passage-to-cavity pressure gradient.

[0077] According to the present disclosure, the component 300 has the depression 330 located in the leading end region 312. The depression creates a region of low pressure upstream of the leading edge 322 of the aerofoil portion 320, and downstream of the leading end 312 of the platform 310. The low-pressure region reduces the passage-to-cavity (i.e. passage 97 to cavity 211) pressure gradient and thus reduces hot gas ingress into cavity 211.

[0078] More particularly, the low-pressure region in the depression 330 results in a flow of hot gas into the depression rather than into the cavity 211. This reduces the penetration depth of the hot gas in the cavity 211 also allows the cold gas P to more easily leave the cavity 211, thus also resulting in a wider cold gas egress from the cavity 211. According to the present example, an average of the cavity fluid total temperature may thus be reduced by approximately 90°C (degrees Celsius).

[0079] The depression 330 is configured to provide a local low-pressure region in which hot gas and cold gas are promoted to mix. Thereby successive hot and cold spots on the platform 310 may be smoothed/evened out. Thus, high temperature gradients on the platform as well as the resulting thermal stresses are reduced.

[0080] A component according to the present disclosure may be manufactured as an individual segment which carries a single aerofoil portion. The individual segment is joined to other, substantially identical components in a separate assembly step in order to form an array of, for example, rotor blades or stator vanes. In other words, the component may be arranged to abut against another component of substantially the same design. The component and the other component may be arranged to form a continuous depression extending along both components. Thereby, when assembled, a continuous annular groove or trough may be formed.

[0081] Alternatively, a plurality of components may be formed integrally. This would provide an extended segment carrying a plurality of aerofoils. In a separate assembly step, at least two extended segments are joined together to form, for example, a rotor disc or a stator ring.

[0082] The component may be integrally formed as a complete rotor or stator disc/ring. Put another way, the component may be formed integrally with a plurality of other components to form a single component. In one such an example, a plurality of depressions are provided spaced around the circumference of the component platform. In an alternative example, the depression extends around the complete circumference of the component platform.

[0083] According to other examples the component is annular and a plurality of depressions is provided around

the circumference of the component. For example the component may be integrally formed as a complete annular NGV, with a plurality of depressions provided spaced around the circumference of the NGV platform.

[0084] According to yet further examples, the component is annular, and the depression extends around the circumference of the platform. For example the component may be integrally formed as a complete annular NGV, with the depression extending around the whole circumference of the NGV platform.

[0085] In the examples described above, the maximum depth of the depression 330 is located at about 65% of the axial width of the depression, as measured from the leading end 312. This value has been found to be most preferable for an effective reduction in hot gas ingress. However, more generally the maximum depth may be located closer to the leading edge 322 of the aerofoil portion 320 than to the leading end of the platform 310, i.e. located at more than 50% of the width of the depression. More preferably, the maximum depth may be located between 60% and 75% of the width of the depression.

[0086] In the example described with reference to Figures 6 and 7, the depression 330 is configured to extend along the entire platform 310, i.e. all of the way between the platform side edges 316, 318. Accordingly, the combined depression formed in the gas turbine as axisymmetric. According to another example, there is provided a component 400 with a non-axisymmetric depression. That is, a depression which extends part, but not all, of the way between the platform side edges, the transverse ends of the depression being spaced apart from the platform side edges.

[0087] Figures 9 and 10 show partial perspective views of the component 400.

[0088] The component 400 comprises a platform 410 having a leading end 412 and, opposite thereto, a trailing end 414 (illustrated in Figure 5), an aerofoil portion 420 extending from the platform, the aerofoil portion having a leading edge 422 and a trailing edge 424. The platform further comprises a leading end region 415 between the leading end of the platform and the leading edge of the aerofoil portion. The component, unlike the known component 200, comprises a non-axisymmetric depression 430 which extends into the platform and is located in the leading end region. The depression 430 extends between transverse ends 436, 438 and reduces in depth from its maximum depth towards each of its transverse ends 436, 438. Hence, the depression may extend part, but not all, of the way between the platform side edges 416, 418 so that the transverse ends 436, 438 of the depression are spaced apart from the platform side edges.

[0089] As shown in the examples of Figures 9, 10, the depression 430 extends between the transverse ends 436, 438 so that its depth increases from the transverse ends to the maximum depth located centrally in the depression. The depth increases gradually when compared to the gradient of the lead-in region 332 or the lead-out

region 334. That is, from a transverse end towards the maximum depth the depression forms a comparatively gentle slope.

[0090] As shown in the examples of Figures 9, 10, a plurality of depressions 430 may be provided spaced apart from one another and aligned along the leading end region 415.

[0091] The non-axisymmetric depression 430 of the present example may result in a reduction of the average total fluid temperature in the cavity 211 of approximately 37°C.

[0092] As shown in Figures 9, 10, the depression 430 may be pressure-side biased. That is, the depression is distributed on the leading end region 415 along a section which is perpendicularly upstream from the aerofoil portion 420. In other words, the component 400 has a depression 430 which is aligned with the aerofoil portion so that: every straight geometric line which (a) extends perpendicularly from the leading end along the platform and (b) intersects the aerofoil portion, also intersects the depression.

[0093] The examples described so far relate to a component provided as a stator vane and, in particular, a nozzle guide vane.

[0094] Alternatively, the component may be provided as a rotor blade. Although the leading end region of a rotor blade may be relatively narrow, which would limit the available space for a depression according to the present disclosure, the arrangement has been shown to provide a reduction in hot gas ingestion.

[0095] Although the examples described herein relate to components where an 'open' cavity is formed in the gas turbine, the present disclosure is equally applicable to cavity provided with a sealing configuration in order to further reduce hot gas ingress.

[0096] The example components described herein provide for a smoothing out of successive hot and cold spots as generated by hot gas and cold gas flows, respectively. Thereby thermal stresses are reduced, which may lead to substantial cost savings through an extended life of the component.

[0097] Some of the examples described herein are axisymmetric, which is intended to describe a continuous symmetry about the rotational axis of the gas turbine. Other examples are not axisymmetric in that a symmetry about the rotational axis may exist, but said symmetry may be a discrete rather than continuous. An axisymmetric depression may be particularly straightforward to design, manufacture and integrate with the platform.

[0098] Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0099] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process

so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0100] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0101] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A component (300, 400) for use in a turbomachine, the component (300, 400) comprising:

a platform (310, 410) having
a leading end (312, 412) longitudinally spaced apart from a trailing end (312, 412);
an aerofoil portion (320, 420) extending from the platform (310, 410),
the aerofoil portion (320, 420) having a leading edge (322, 422) and a trailing edge (314, 414); wherein the platform (310, 410) further comprises:

a leading end region (315, 415) between the leading end (312, 412) of the platform (310, 410) and the leading edge (322, 422) of the aerofoil portion (320, 420), and
a depression (330, 430) which :

extends into the platform (310, 410),
and
is located in the leading end region (315, 415).

2. The component (300, 400) as claimed in claim 1, wherein:

the depression (330, 430) has a profile comprising:

a lead-in region (332) and a lead-out region (334) spaced apart in the longitudinal direction;
the lead-in region (332) having a first gradient,
the lead-out region (334) having a second gradient,

the first gradient being less than the second gradient.

3. The component (300, 400) as claimed in claim 2, wherein:

the lead-in region (332) is spaced apart from the leading edge (322, 422) of the aerofoil portion (320, 420) by the lead out region (334); and
the lead out region (334) is spaced apart from the leading end (312, 412) of the platform (310, 410) by the lead-in region.

4. The component (300, 400) as claimed in claim 3, wherein:

the profile of the depression (330, 430) is generally half ovoid.

5. The component (300, 400) as claimed in any one of the preceding claims, wherein:

the depression (330, 430) spans a greater distance transversely than the aerofoil portion (320, 420).

6. The component (300, 400) as claimed in claim 5, wherein:

the depression (330, 430) spans the width of the aerofoil portion (320, 420).

7. The component (300, 400) as claimed in any one of the preceding claims, wherein:

the depression (330, 430) has a maximum depth corresponding to about 15% to 30% of the maximum width of the depression (330, 430) in the longitudinal direction.

8. The component (300, 400) as claimed in claim 7, wherein:

the maximum depth of the depression (330, 430) corresponds to about 1% to 5% of the height of the aerofoil portion (320, 420).

9. The component (300, 400) as claimed in any previous claim, wherein:

the depression (330, 430) is elongate and extends generally parallel to the leading end (312, 412) of the platform (310, 410).

10. The component (300, 400) as claimed in any one of claims 1 to 9, wherein:

the depression (330, 430) has a substantially

uniform cross-sectional shape in a transverse direction.

11. The component (300, 400) according any one of claims 1 to 10, wherein: 5

the platform (310, 410) has side edges (316, 318, 416, 418) extending longitudinally between the leading end (312, 412) and trailing end (314, 414); and 10
the depression (330, 430) extends all of the way between the platform side edges (316, 318, 416, 418).

12. The component (300, 400) as claimed in any one of claims 1 to 9, wherein: 15

the depression (330, 430) extends between transverse ends (336, 338, 436, 438), and reduces in depth from its maximum depth towards each of its transverse ends (336, 338, 436, 438). 20

13. The component (300, 400) as claimed in claim 12, wherein: 25

the platform (310, 410) has side edges (316, 318, 416, 418) extending longitudinally between the leading end (312, 412) and trailing end (312, 412); and 30
the depression (330, 430) extends part, but not all, of the way between the platform side edges (316, 318, 416, 418), the transverse ends (336, 338, 436, 438) of the depression (330, 430) being spaced apart from the platform side edges. 35

14. The component (300, 400) as claimed in any one of claims 1 to 13 wherein the component (300, 400) is a nozzle guide vane. 40

15. The component (300, 400) as claimed in any one of claims 1 to 13 wherein the component (300, 400) is a rotor blade.

16. A gas turbine engine comprising a component (300, 400) as claimed in any one of claims 1 to 15. 45

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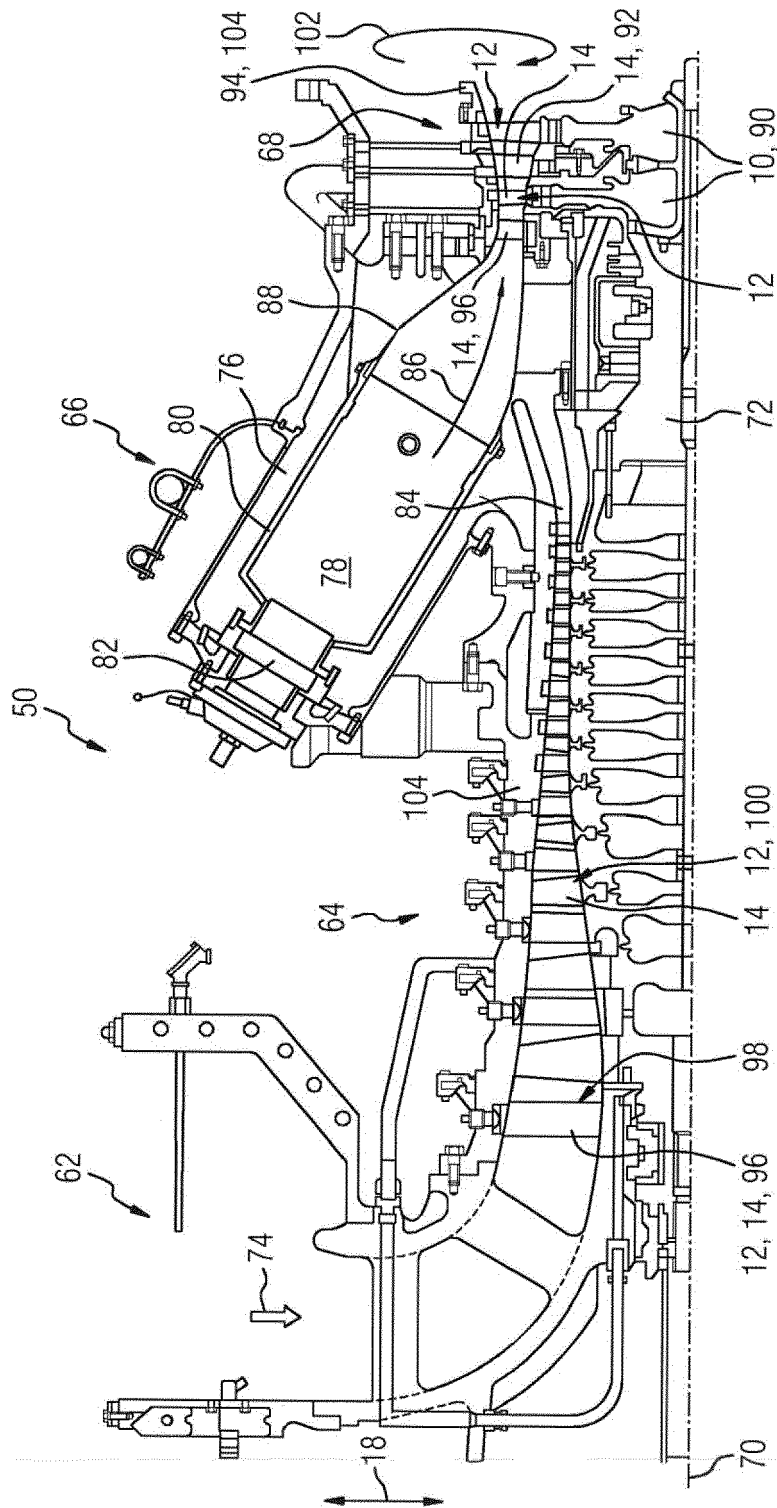


Figure 1

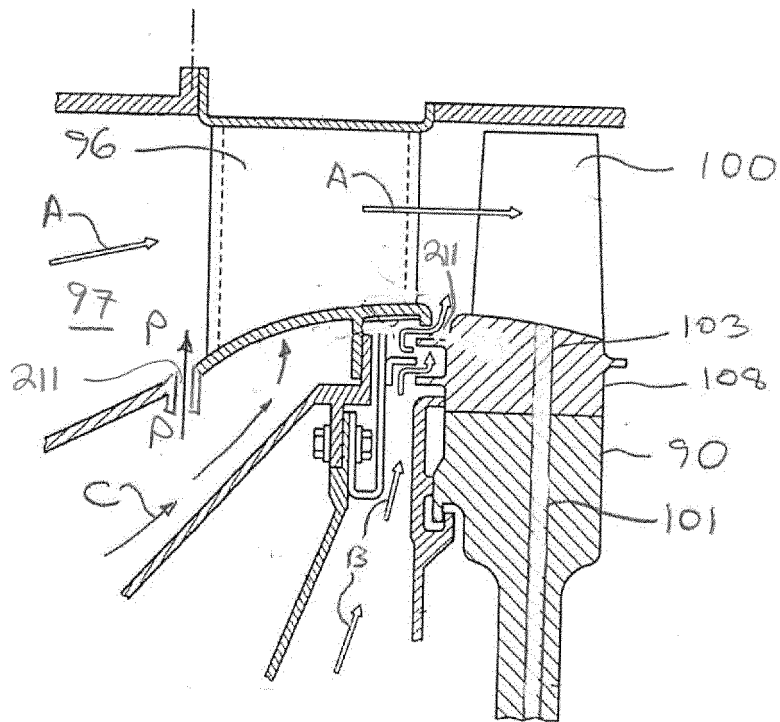


Figure 2

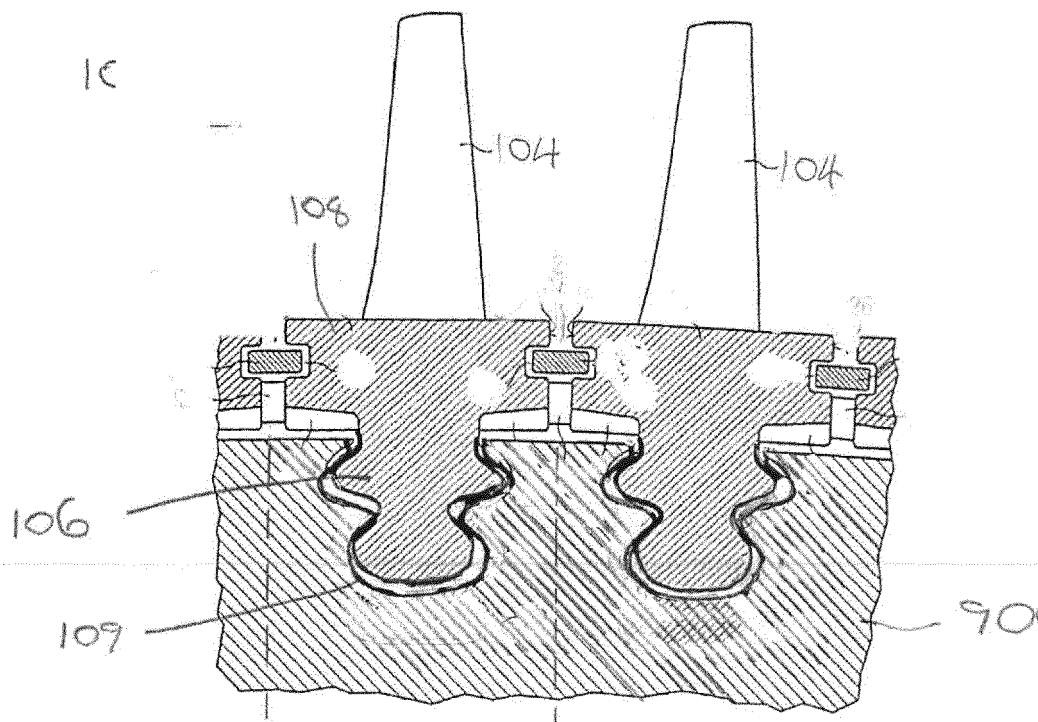


Figure 3

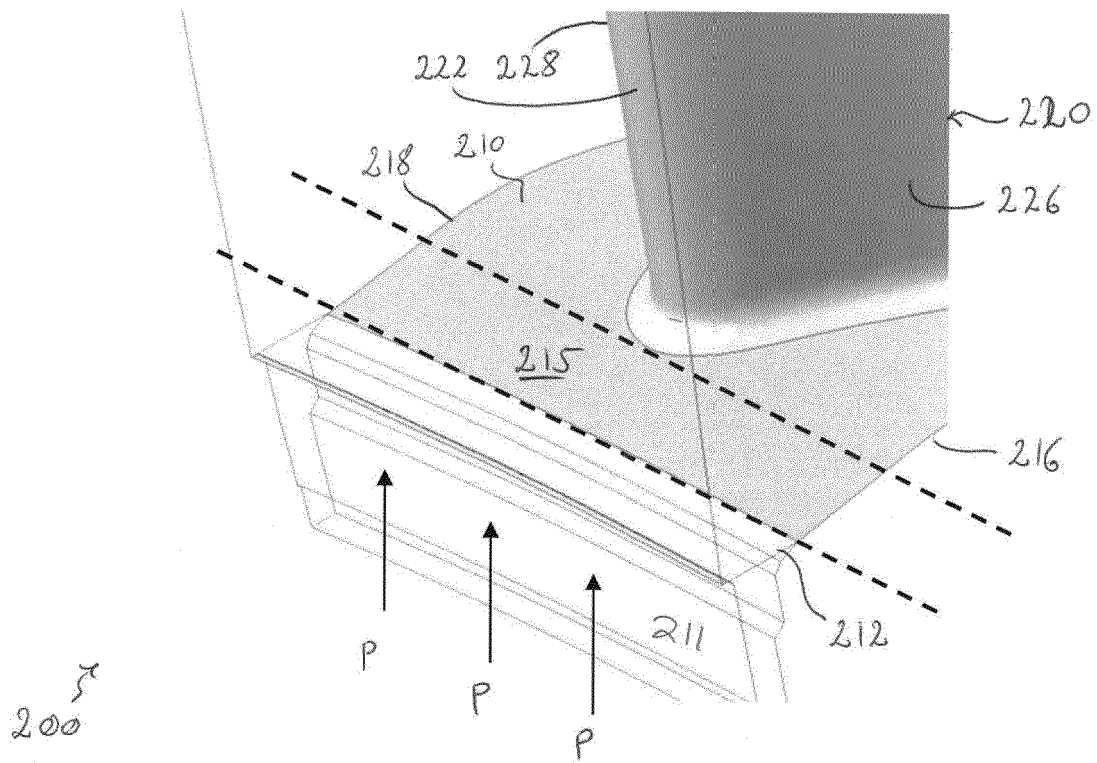


Figure 4

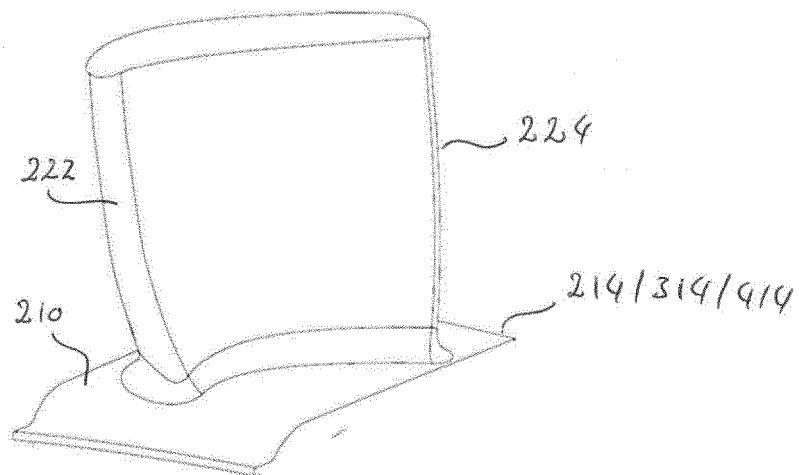


Figure 5

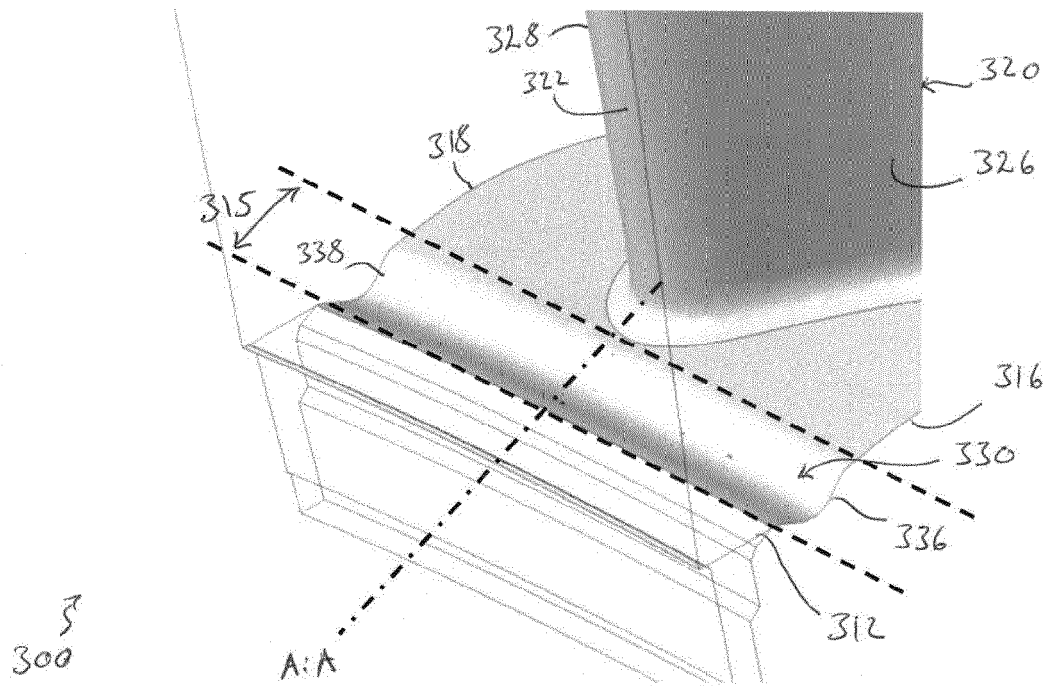


Figure 6

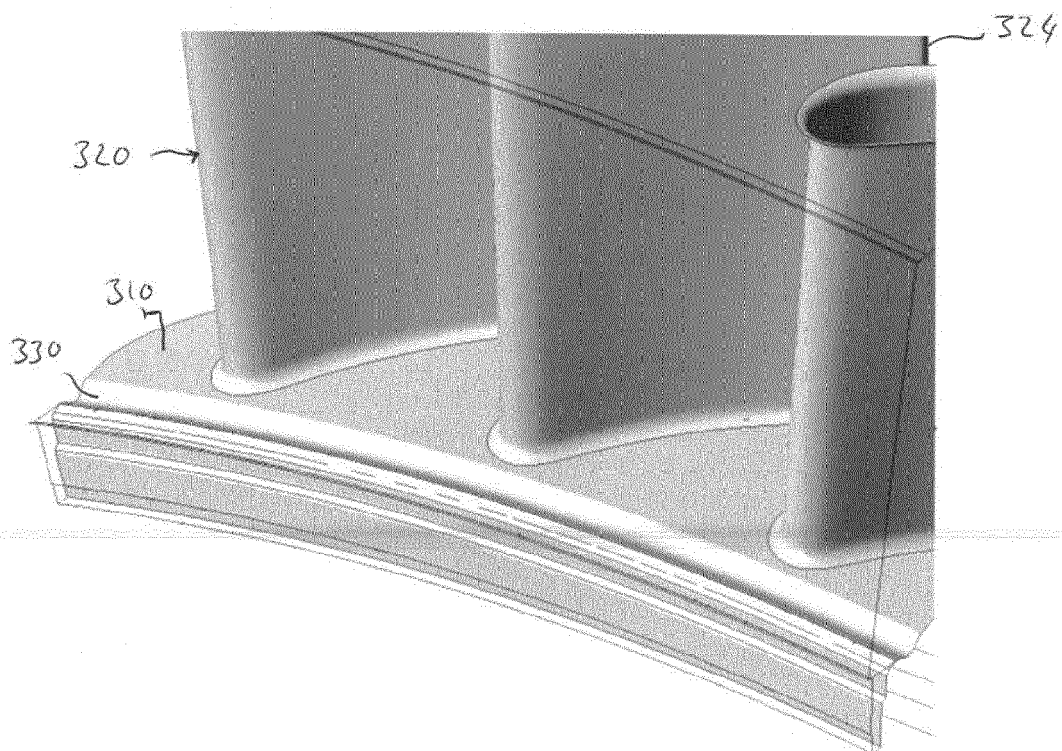


Figure 7

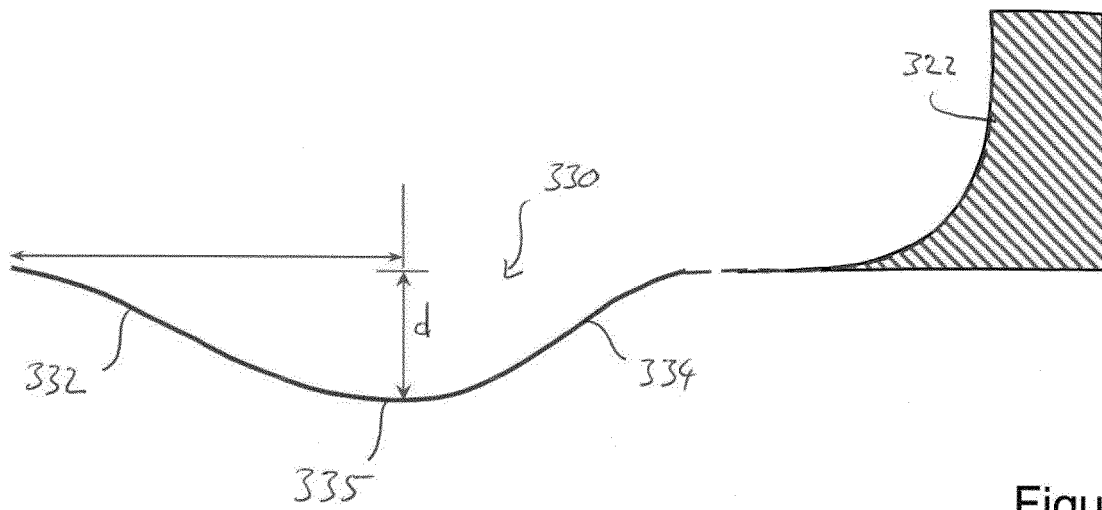


Figure 8

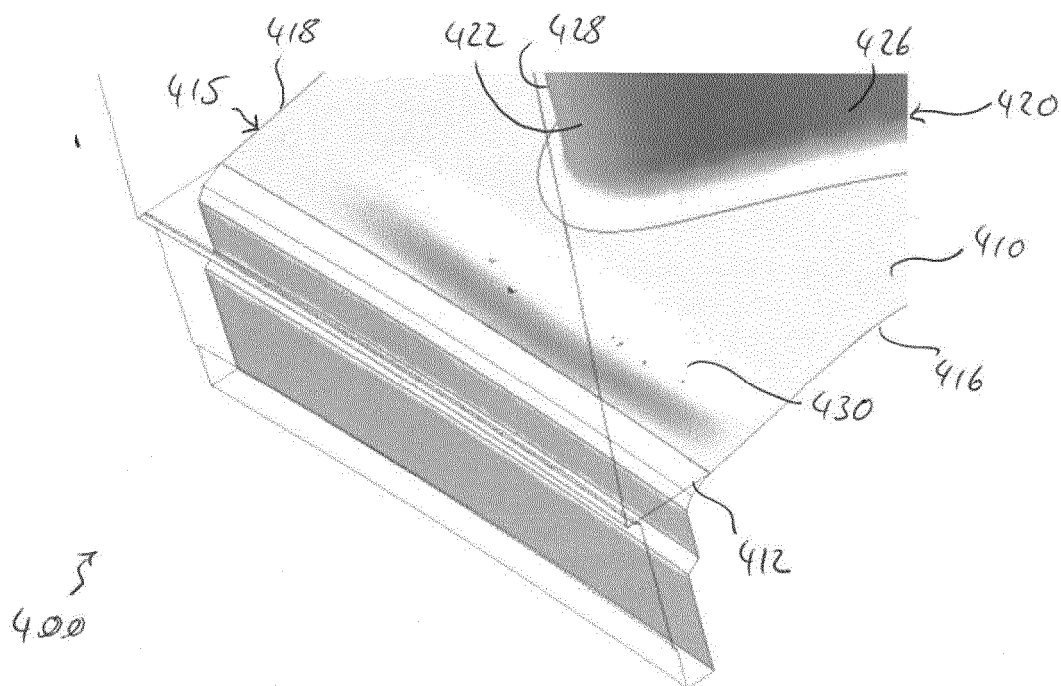


Figure 9

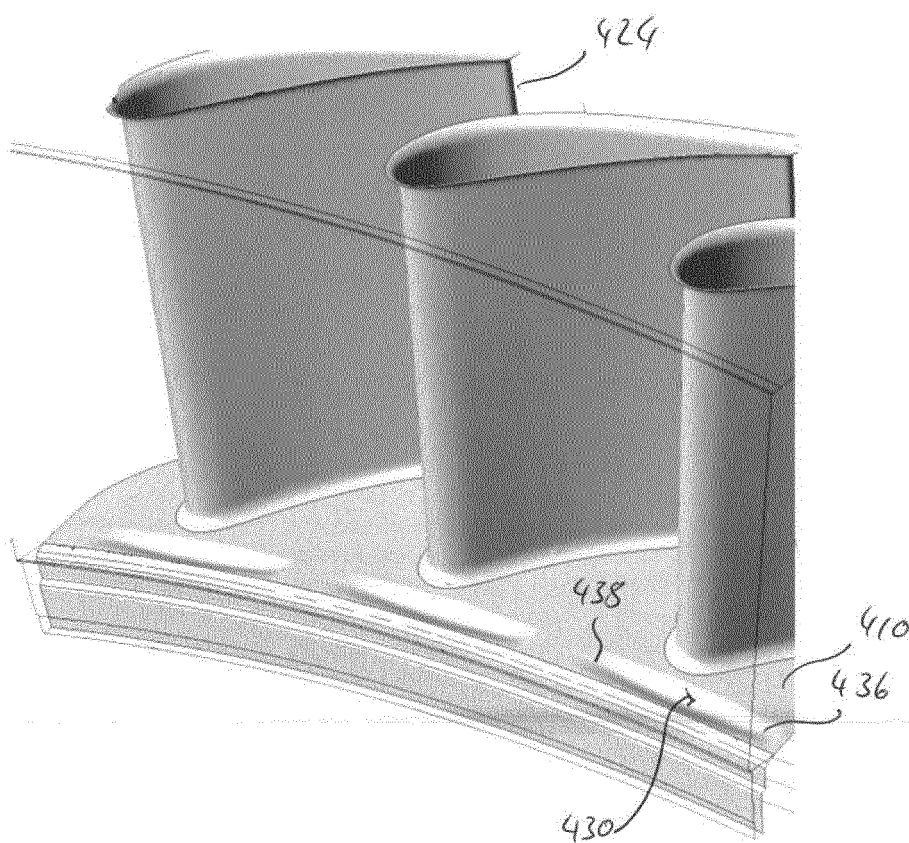


Figure 10



EUROPEAN SEARCH REPORT

Application Number
EP 17 18 5905

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X	US 2016/115972 A1 (TAYLOR JAMES VINCENT [GB]) 28 April 2016 (2016-04-28) * paragraph [0042]; figures 2-4 * * paragraph [0003] - paragraph [0007] * * paragraphs [0001], [0039], [0041] *	1-16	
X	EP 3 078 804 A1 (ROLLS ROYCE DEUTSCHLAND [DE]) 12 October 2016 (2016-10-12) * paragraphs [0001], [0002]; figure 6 *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 January 2018	Examiner Klados, Iason
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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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82