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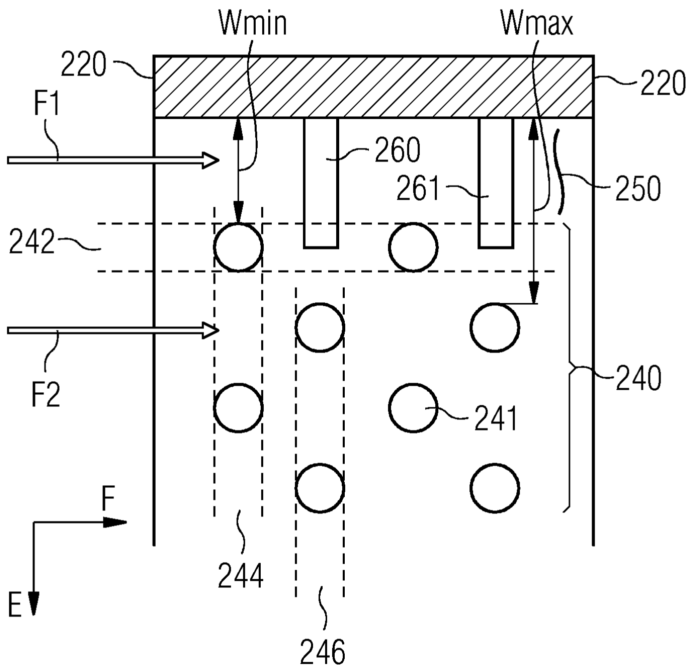
(54) **INTERNALLY-COOLED TURBOMACHINE COMPONENT**

(57) An internally-cooled turbomachine component, comprising a main body (200) comprising a first end wall (210), a second end wall (212) spaced apart from the first end wall (210), and a sidewall (220) which extends between the first end wall (210) and the second end wall (212) such that the first end wall (210), second end wall (212) and sidewall (220) define a cooling passage (230) extending between a fluid inlet (202) and a fluid outlet (204), a pedestal bank (240) comprising a plurality of pedestals (241) which span the cooling passage (230) between the first end wall (210) and the second end wall (212), wherein the pedestal bank (240) is spaced from the sidewall (220) to define a flow channel (250) therebetween; and a low-rise turbulator (260) located in the flow channel (250), wherein the low-rise turbulator (260) extends partway between the first end wall (210) and the second end wall (212).

FIG 5



EP 3 492 700 A1

Description

[0001] The present disclosure relates to an internally-cooled turbomachine component.

[0002] In particular the disclosure is concerned with a turbomachine component which may be provided as an aerofoil component.

Background

[0003] Gas turbines generally include rows of stationary vanes fixed to the casing of the gas turbine and a rotor with a number of rows of rotating rotor blades fixed to a rotor shaft. Hot and pressurised working fluid flows through the rows of vanes and blades, thus imparting momentum to the rotor blades but also transferring a significant amount of heat to the vanes and blades in particular.

[0004] Internally-cooled turbomachine components, such as the vanes or blades, may include a cooling passage extending through the component. In order to improve heat transfer to a cooling flow through the cooling passage, it is known to provide a bank of pedestals in the cooling passage. The pedestal bank comprises individual pedestals distributed in the cooling passage in a regular arrangement, because the absence of pedestals in a particular location generates a void which allows the cooling flow to circumvent certain pedestals or the pedestal bank altogether. Thus the presence a void may result in an overall reduction in cooling and may lead to increased temperature gradients. Such a void may be a particular concern in the region between the pedestal bank and a sidewall which bounds the cooling passage.

[0005] Conventionally this problem is in part overcome with the provision of half pedestals, i.e. generally semi-cylindrical pedestals, are formed on the sidewall to extend into the cooling passage. The half pedestals resemble the pedestals and so reduce the size of the void between the sidewall and the pedestal bank. Thus cooling flow is distributed more evenly through the pedestal bank. It may not always be possible, however, to form half pedestals because of, for example, limitations of the particular alloys from which the component is formed which may result in structural defects. It may be desirable to avoid the need of the half pedestals, especially where the component is cast because this would simplify the ceramic core and improve the casting yield. Yet dispensing with half pedestals adversely affects the cooling flow.

[0006] Hence an internally-cooled turbomachine component possessing an improved cooling passage arrangement 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 an internally-cooled turbomachine component, comprising a main body (200) comprising a first end wall (210), a second end wall (212) spaced apart from the first end wall (210), and a sidewall (220) which extends between the first end wall (210) and the second end wall (212) such that the first end wall (210), second end wall (212) and sidewall (220) define a cooling passage (230) extending between a fluid inlet (202) and a fluid outlet (204), a pedestal bank (240) comprising a plurality of pedestals (241) which span the cooling passage (230) between the first end wall (210) and the second end wall (212), wherein the pedestal bank (240) is spaced from the sidewall (220) to define a flow channel (250) therebetween; and a low-rise turbulator (260) located in the flow channel (250), wherein the low-rise turbulator (260) extends partway between the first end wall (210) and the second end wall (212).

[0009] The internally-cooled turbomachine component possesses improved cooling features in the form of the low-rise turbulators 260 provided in the flow channel 250 between the sidewall 220 and the pedestal bank 240. More efficient cooling is achieved because the low-rise turbulator 260 improves heat transfer coefficients in the flow channel 250 and increases cooling flow through the pedestal bank 240.

[0010] The low-rise turbulator (260) may extend less than halfway between the first end wall (210) and the second end wall (212).

[0011] The low-rise turbulator (260) may extend one tenth of the distance between the first end wall (210) and the second end wall (212).

[0012] The low-rise turbulator (260) may extend from the first end wall (210).

[0013] An additional low-rise turbulator (260) may extend from the second end wall (212), aligned with or offset from the low rise turbulator on the first end wall (210).

[0014] The low-rise turbulator (260) may extend from the sidewall (220) to a free end (261).

[0015] The low-rise turbulator (260) may have an elongate shape defining a length and a width, and the low-rise turbulator (260) may be orientated to extend in a direction (E) generally perpendicular to the nominal flow direction (F) between the fluid inlet (202) and the fluid outlet (204).

[0016] The low-rise turbulator (260) may extend towards an adjacent pedestal (241) of the pedestal bank (240), and the adjacent pedestal (241) may have a width which is greater than the width of the low-rise turbulator (260).

[0017] A plurality of low-rise turbulators (260) may be provided in the flow channel (250).

[0018] The plurality of low-rise turbulators (260) may be sequentially arranged along the flow channel (250).

[0019] The low-rise turbulators (260) may have a pitch to height ratio between 5:1 and 10:1.

[0020] A first low-rise turbulator (260) of the plurality of turbulators may have a first length and a second low-rise turbulator (260) of the plurality of turbulators has a second length, and wherein the first length is different from the second length.

[0021] The turbomachine component may be provided as an aerofoil component, and wherein: the main body (200) is provided as an aerofoil portion, the first end wall (210) is provided as a suction-side wall, the second end wall (212) is provided as a pressure-side wall, and the cooling passage (230) is provided as a cavity in the aerofoil portion.

[0022] The aerofoil component may be provided as a nozzle guide vane.

[0023] According to another example there may be provided a ceramic core for casting of an internally-cooled turbomachine component as described above.

Brief Description of the Drawings

[0024] 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 is a schematic perspective view of a main body of an exemplary turbomachine component;

Figure 4 is a partial broken-away perspective view of the main body;

Figure 5 is a partial broken-away plan view of the main body; and

Figure 6 is a partial broken-away plan view of another main body.

Detailed Description

[0025] The present disclosure relates to a component, for example a stator vane or a rotor blade, for use in a turbomachine, such as a gas turbine.

[0026] By way of context, Figures 1 and 2 show known arrangements to which features of the present disclosure may be applied.

[0027] 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 operate. 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.

[0028] The shaft 72 drivingly connects the turbine section 68 to the compressor section 64.

[0029] 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.

[0030] 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 (shown in Figure 2). 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, shown in Figure 2), which are fixed to a stator 94 of the gas turbine engine 60.

[0031] Figure 2 shows an enlarged view of a stator vane 96 and rotor blade 100. Arrows "A" indicate the direction of flow of combustion gas 86 past the aerofoils 96,100. Arrows "B" show air flow routes provided for sealing. Arrows "C" indicate cooling air flow paths through a flow inlet 202 to a flow outlet 204 via a cooling passage 230 in the stator vane 96. Cooling flow passages 101 may be provided in the rotor disc 90 which extend radially outwards to feed and air flow passage 103 the rotor blade 100. The air flow passages 103 feed a flow inlet 202 to a cooling passage 230 which exhausts at a flow outlet 204 which (in the example shown) is in the tip of the blade.

[0032] Also shown in Figure 2 is a heatshield 140 which defines a part of the turbine flow path "A". It may also be provided with a flow inlet 202, cooling passage 230 and flow outlet 204 to promote cooling.

[0033] The combustion gas 86 from the combustion chamber 78 enters the turbine section 68 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.

[0034] Figure 3 shows a perspective view of an internally-cooled turbomachine component, such as a rotor blade 100, a stator vane 96 and/or heatshield 140 as shown in Figure 2.

[0035] Each of the examples of a rotor blade 100, stator vane 96 and/or heatshield 140 (i.e. "the component") comprises a main body 200 having a fluid inlet 202 and a fluid outlet 204. The terminology 'fluid inlet' and 'fluid outlet' may be taken to mean a single inlet and/or outlet, or a plurality of inlets and/or outlets, for example a plurality of apertures arranged to form a single inlet/outlet.

[0036] The main body 200 comprises a first end wall 210 and a second end wall 212. The first end wall 210 and the second end wall 212 define opposite ends of the main body 200 along a first direction indicated by arrow "D" in Figure 3. Hence in the example a rotor blade 100 or stator vane 96, the first end wall 210 and second end wall 212 may be walls which define the suction side and pressure side of the aerofoil. In the example of the heatshield 140, the first end wall 210 and second end wall 212 may define radially inner and outer surfaces of the heatshield 140, as shown in Figure 2.

[0037] The main body 200 comprises a first sidewall 220 and second sidewall 222. The sidewalls 220, 222 are formed at either side of the main body 200 and thus define opposite sides of the main body 200 along a second direction, as indicated by arrow "E" in Figure 3, which is perpendicular to the first direction "D". Hence in the example a rotor blade 100 or stator vane 96, the first sidewall 220 and second sidewall 222 may define the leading edge or trailing edge, or (depending on the desired direction of flow) the tip or a platform, or form another part of an internal structure of the vane 96 or blade 100. In the example of the heatshield 140, the first sidewall 220 and second sidewall 222 may define circumferentially spaced apart edge walls the heatshield 140.

[0038] By way of example, the details of the first sidewall 220 which will be referred to as 'the sidewall 220' for ease of reference. The description applies equally to the second sidewall 222.

[0039] According to the present example, the sidewall 220 is generally planar. That is to say, the sidewall 220 may as a whole be angled, inclined or curved relative to the other walls but there are no protrusions extending from or recesses extending into the sidewall 220 other than those described below.

[0040] The plurality of walls 210, 212, 220, 222 is configured to define the internal cooling passage (or "chamber") 230 extending through the main body 200. The cooling passage 230 extends between the fluid inlet 202 and the fluid outlet 204. A height of the cooling passage 230 is defined along the first direction "D", while a length of the cooling passage 230 is defined along the second direction "E". A width of the cooling passage 230 is defined along a direction indicated by arrow "F" in Figure 3, perpendicular to both the first direction "D" and the second direction "E".

[0041] In use heat is transferred from the main body 200 to a suitable cooling medium. The cooling medium may comprise air. The cooling flow enters the cooling passage 230 through the fluid inlet 202, generally following a flow direction "F" (or 'third direction'), which is perpendicular to the first direction "D" and the second direction "E", through the cooling passage 230, and ultimately exits through the fluid outlet 204. The flow direction is indicated by the arrows "F1", "F2", "F3".

[0042] A pedestal bank 240 is provided in the cooling passage 230 to optimise heat transfer between the main body 200 and the cooling flow. The pedestal bank 240 is configured to introduce serpentine flow paths and increase the surface area available for heat exchange.

[0043] Figure 4 shows a partially broken-away perspective view of the main body 200. The pedestal bank 240 comprises a plurality of individual spaced-apart pedestals 241. In the present example, the pedestals are arranged in rows and columns, as illustrated in Figure 5, including a first row 242, a first column 244 and a second column 246. Those pedestals 241 immediately adjacent and closest to the sidewall 220 make up the first row 242. Those pedestals immediately adjacent and closest to the fluid inlet 202 make up the first column 244, while those pedestals immediately adjacent and closest to the first column make up the second column 246. Thus each pedestal is part of one row and one column.

[0044] The pedestal bank 240 spans the cooling passage 230 between the first end wall 210 and the second end wall 212. That is, each pedestal of the pedestal bank 240 extends in the first direction "D", extending all of the way from the first end wall 210 to the second end wall 212. In other words, the height of the pedestals corresponds to the height of the cooling passage 230. Thus the serpentine flow paths are created by forcing the cooling flow impinging on the pedestal bank 240 around the individual pedestals.

[0045] A flow channel 250 (or 'void') is formed between the sidewall 220 and the first row 242 of pedestals, which is adjacent to the sidewall 220. That is to say, the pedestal bank 240 is spaced from the sidewall 220. The void is defined by the absence of features which may interrupt flow, for example pedestals beside the sidewall 220 and/or half pedestals formed on the sidewall 220.

[0046] The flow channel 250 is defined between the sidewall 220 and the pedestal bank 240. According to the present example, the pedestal bank 240 comprises columns 244, 246 which are offset relative to each other by half the pedestal spacing and, thus, the flow channel 250 possesses a maximal width Wmax and a minimal width Wmin. The maximal width Wmax may be equal to the spacing between adjacent pedestals 241 of the columns 244, 246 of the pedestal bank 240, and the minimal width Wmin may be about half the spacing between adjacent pedestals 241 of the columns 244, 246. The flow channel 250 may have its maximal width Wmax extending from the sidewall 220 to the second column 246 of pedestals 241, and may have its the minimal width Wmin extending from the sidewall 220 to the first column 244 of pedestals 241.

[0047] Hence a portion of the cooling flow which passes through the cooling passage 230 along the flow channel 250, generally following the arrow F1, encounters no pedestals 241. Accordingly, this portion of cooling flow passes through the cooling passage 230 unhindered by pedestals 241, whereas cooling flow following arrow F2 impinges on the pedestal bank 240. Thus a local high pressure area is formed as a result of the impingement and, in the absence of the features of the present invention, a local low pressure area is formed as a result of the unhindered flow through the flow channel 250.

[0048] A low-rise turbulator 260 is located in the flow channel 250. The low-rise turbulator 260 is configured to introduce turbulence into cooling flow passing through the flow channel 250. Thereby flow friction is locally increased to reduce cooling flow circumventing the pedestal bank 240. The resulting increased cooling flow through the pedestal bank 240 increases heat transfer in the pedestal bank 240. Moreover, turbulated cooling flow in the flow channel 250 improves heat transfer through the sidewall 220 and adjacent portions of the first end wall 210 and the second end wall 212. In other words, addition of the low-rise turbulator 260 to the flow channel 250 increases the flow friction in the region of the sidewall 220 giving a more uniform flow through the pedestal bank 240 and region about the sidewall 220 to improve cooling.

[0049] The low-rise turbulator 260 extends partway between the first end wall 210 and the second end wall 212, i.e. the turbulator extends only partway across the cooling channel 230. That is to say, the turbulator extends not more than partway between the first end wall 210 and the second end wall 212. A distinction is thus made between the pedestals 241, all of which span the cooling passage 230, and the low-rise turbulator 260 which does not span the cooling passage 230.

[0050] According to some examples, the low-rise turbulator 260 is configured to extend less than halfway between first end wall 210 and the second end wall 212. That is, the low-rise turbulator 260 has a height corresponding to less than the height of the cooling passage 230. According to further examples, the low-rise turbulator 260 has a height of a fifth, a sixth or an eighth of the height of the cooling passage 230. According to further examples, the low-rise turbulator 260 has a height of a tenth of the height of the cooling passage 230.

[0051] According to the present example, the low-rise turbulator 260 is joined to, and thus extends from, the first end wall 210. According to other examples, the turbulator 260 is joined to the second end wall 212, extending towards the first end wall 210.

[0052] In other examples (not shown), a further turbulator 260 extends from the second end wall 212, the further turbulator 260 being provided in addition to the turbulator 260 extending from the first end wall 210, each turbulator 260 provided in its respective flow channel 250. The turbulators 260 may be aligned in direction "D" That is to say, the first end wall turbulator may be on the opposite side of the flow channel 250 to the second end wall turbulator. Put another way, the first end wall turbulator may face the second end wall turbulator across the flow channel 250.

[0053] Alternatively, in another example in which turbulators are provided on the first end wall 210 and second end wall 212, the or each turbulator 260 of the first end wall 210 may be staggered relative to the or each turbulator on the second end wall 212. That is to say, a turbulator provided on the first end wall 210 may be between two adjacent turbulators on the second end wall 212. Put another way, first end wall turbulators may be offset from second end wall turbulators in the direction "F".

[0054] In examples in which turbulators are provided on the first end wall 210 and second end wall 212, the turbulators may be no less than about 10%, but no more than about 25% of the distance between the first end wall 210 and second end wall 212.The low-rise turbulator 260 may have any suitable shape, extending from the sidewall 220 to a free end 261. The free end 261 is spaced apart from any adjacent pedestals 241.

[0055] The turbulator 260 has an elongate shape defining a length and a width. According to the present example, the turbulator 260 is generally cuboid with a rectangular cross-section. The length of the turbulator 260 and the length of the cooling passage 230 are both defined along the second direction "E". In other words, the low-rise turbulator 260 is orientated to extend lengthwise (or 'longitudinally') in a direction generally perpendicular to the nominal flow direction between the fluid inlet 202 and the fluid outlet 204, as indicated by arrows F1, F2, F3. Particularly where the turbulator 260 is elongate, it may alternatively be referred to as a rib.

[0056] The width of the low-rise turbulator 260 and the width of the cooling passage 230 are both defined along the third direction "F". According to the present example, the low-rise turbulator 260 is oriented to extend towards an adjacent pedestal 241 of the pedestal bank 240, and the adjacent pedestal has a width which is greater than the width of the low-rise turbulator 260. Where a generally cylindrical pedestal 241 is provided, the width of the pedestal 241 may correspond to its diameter.

[0057] The height of the low-rise turbulator 260 is defined along the first direction "D". According to some examples, the height of the low-rise turbulator 260 is substantially equal to the width of the low-rise turbulator 260.

[0058] Figure 5 shows a partial broken-away plan view of the main body 200.

[0059] A plurality of low-rise turbulators 260 is provided in the flow channel 250. The plurality of low-rise turbulators 260 is sequentially arranged in the flow channel 250 with respect to the flow direction F1. According to the present example, the plurality of turbulators are arranged to have a constant pitch along the flow direction F1. That is, the turbulators are spaced apart with constant spacing. According to some examples, the pitch may in a range between approximately 5 to 10 times the height of the turbulators 260.

[0060] According to the present example, the pitch of the turbulators 260 matches the pitch of the pedestals of the first row 242 of pedestals. Moreover, the plurality of low-rise turbulators 260 possesses substantially identical lengths. Thus substantially identical gaps are formed between each low-rise turbulator 260 and adjacent pedestals.

[0061] Figure 6 shows an example wherein a first low-rise turbulator 260 has a first length and a second low-rise turbulator 262 has a second length, and wherein the first length is different from the second length. The second turbulator 262 has an adapted length to accommodate for a differently-sized pedestal 247. According to the example of Figure 6, the differently-sized pedestal 247 has a diameter which is greater than that of other pedestals 241. Accordingly, the second turbulator 262 is shortened as compared to the first low-rise turbulator 260 and thus forms a free end 263, similar to the free end 261 of the first low-rise turbulator 260.

[0062] Particularly where the pedestals 241 of the pedestal bank 240 possess different diameters, the pitch may be non-constant to match the location of the low-rise turbulators 260 to the resulting shape of the pedestal bank 240. That is to say, the spacing between the turbulators 260 may vary. For example, the turbulators 260 may be arranged to extend towards the pedestal bank 240 along sections of maximal width Wmax of the flow channel 250.

[0063] According to some examples, the main body 200 is manufactured through a casting process using a ceramic core. Manufacturing through casting may be particularly common where the component is provided as an aerofoil and the main body 200 corresponds to a rotor blade, a stator vane or heatshield.

[0064] The strength of the ceramic core is a factor determining the successful casting yield and hence immediately relates to time and cost efficiency of the manufacturing process. Conveniently, a ceramic core for casting the main body 200 forms a planar sidewall 220 beside which the sidewall 220 will be formed during casting. In particular, no grooves or notches extend along the full height of the planar sidewall 220. Instead a shallow recess is formed where the low-rise turbulator 260 is to be formed. This reduces the height of the ceramic core but may not substantially affect the strength of said core. Accordingly, a ceramic core for casting the main body 200 may possess improved strength as well as a less complex shape than would otherwise be required when forming half pedestals.

[0065] Additionally, the core may define fillet radii for forming connecting adjacent surfaces of the tabulators 260 and the end wall from which they extend.

[0066] Hence there is provided a component with improved cooling features in the form of the low-rise turbulators 260 provided in the flow channel 250 between the sidewall 220 and the pedestal bank 240. More efficient cooling is achieved because the low-rise turbulator 260 improves heat transfer coefficients in the flow channel 250 and increases cooling flow through the pedestal bank 240.

[0067] Additionally a method of manufacture (for example casting) of the component may be improved because a ceramic core required for casting need not have features which define pedestals in the region of sidewalls 220, which thus increases integrity of the core.

[0068] The example embodiment described above relates to any fluid/air-cooled component for a turbomachine. The embodiment may be provided as, for example, an aerofoil or a heatshield for example for a turbine shroud.

[0069] 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.

[0070] 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.

[0071] 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.

[0072] 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. An internally-cooled turbomachine component, comprising:

a main body (200) comprising:

a first end wall (210),
a second end wall (212) spaced apart from the first end wall (210), and
a sidewall (220) which extends between the first end wall (210) and the second end wall (212)
such that the first end wall (210), second end wall (212) and sidewall (220) define

a cooling passage (230)
extending between a fluid inlet (202) and a fluid outlet (204),

a pedestal bank (240) comprising a plurality of pedestals (241) which span the cooling passage (230) between the first end wall (210) and the second end wall (212),

wherein the pedestal bank (240) is spaced from the sidewall (220) to define a flow channel (250) therebetween; and

a low-rise turbulator (260) located in the flow channel (250),

wherein the low-rise turbulator (260) extends partway between the first end wall (210) and the second end wall (212).

2. The turbomachine component according to any previous claim, wherein the low-rise turbulator (260) extends less than halfway between the first end wall (210) and the second end wall (212).

3. The turbomachine component according to claim 2, wherein the low-rise turbulator (260) extends one tenth of the distance between the first end wall (210) and the second end wall (212).

4. The turbomachine component according to any previous claim, wherein the low-rise turbulator (260) extends from the first end wall (210).

5. The turbomachine component according to claim 4 wherein an additional low-rise turbulator (260) extends from the second end wall (212), aligned with or offset from the low rise turbulator on the first end wall (210).

6. The turbomachine component according to any previous claim, wherein the low-rise turbulator (260) extends from the sidewall (220) to a free end (261).

7. The turbomachine component according to any previous claim, wherein the low-rise turbulator (260) has an elongate shape defining a length and a width, and wherein the low-rise turbulator (260) is orientated to extend in a direction (E) generally perpendicular to the nominal flow direction (F) between the fluid inlet (202) and the fluid outlet (204).

8. The turbomachine component according to claim 7, wherein
the low-rise turbulator (260) extends towards an adjacent pedestal (241) of the pedestal bank (240), and wherein the adjacent pedestal (241) has a width which is greater than the width of the low-rise turbulator (260).

9. The turbomachine component according to any previous claim, wherein a plurality of low-rise turbulators (260) are provided in the flow channel (250).

10. The turbomachine component according to claim 9, wherein the plurality of low-rise turbulators (260) is sequentially arranged along the flow channel (250).

11. The turbomachine component according to claim 10, wherein the low-rise turbulators (260) have a pitch to height ratio between 5:1 and 10:1.

12. The turbomachine component according to any one of claims 9 to 11, wherein a first low-rise turbulator (260) of the plurality of turbulators has a first length and a second low-rise turbulator (260) of the plurality of turbulators has a second length, and wherein the first length is different from the second length.

13. The turbomachine component according to any previous claims, wherein the turbomachine component is provided as an aerofoil component, and wherein:

the main body (200) is provided as an aerofoil portion,
the first end wall (210) is provided as a suction-side wall,
the second end wall (212) is provided as a pressure-side wall, and
the cooling passage (230) is provided as a cavity in the aerofoil portion.

14. The turbomachine component according to claim 13, wherein the aerofoil component is provided as a nozzle guide vane.

15. A ceramic core for casting of an internally-cooled turbomachine component according to any one of claims 1 to 14.

FIG 1

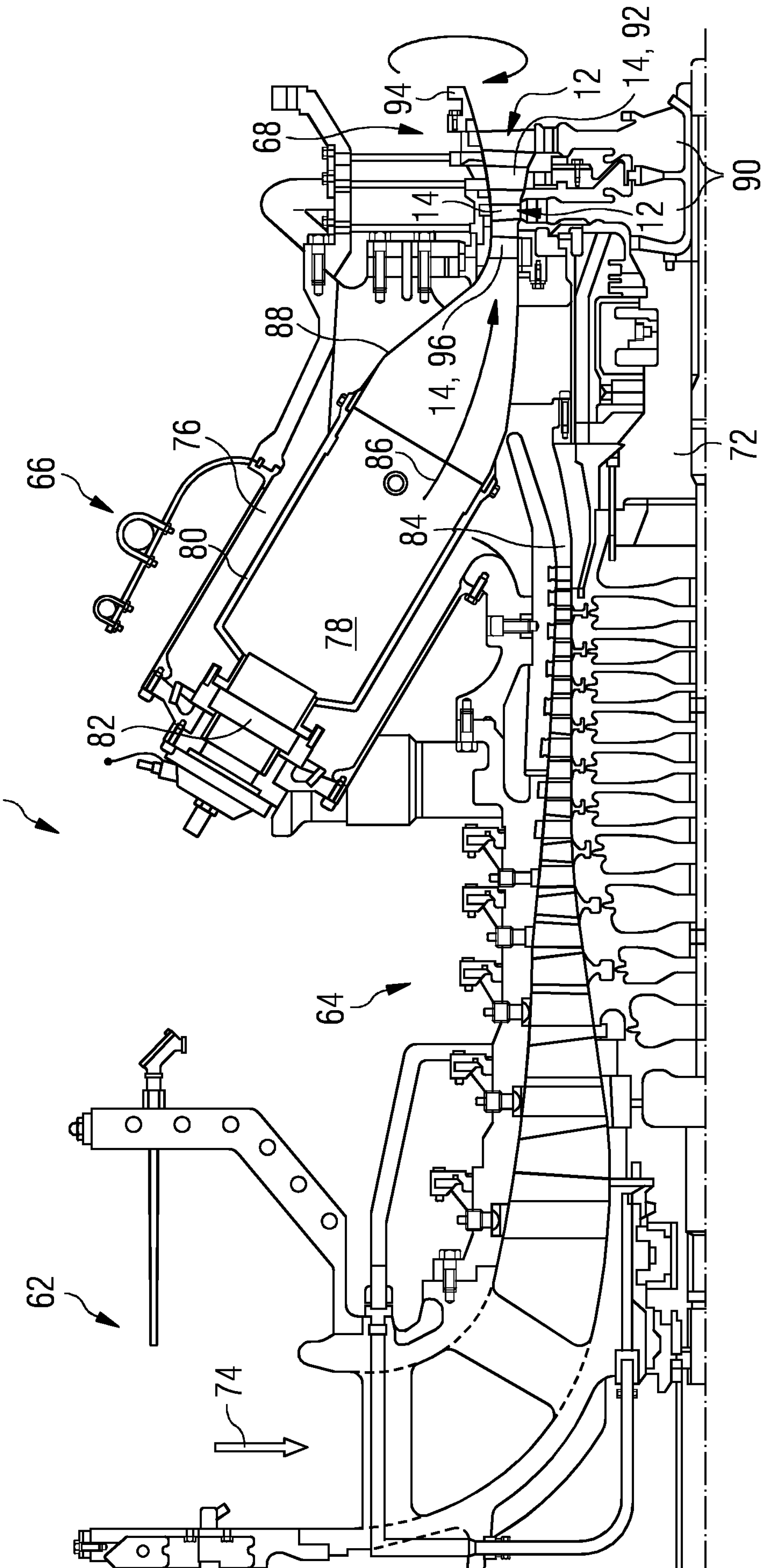
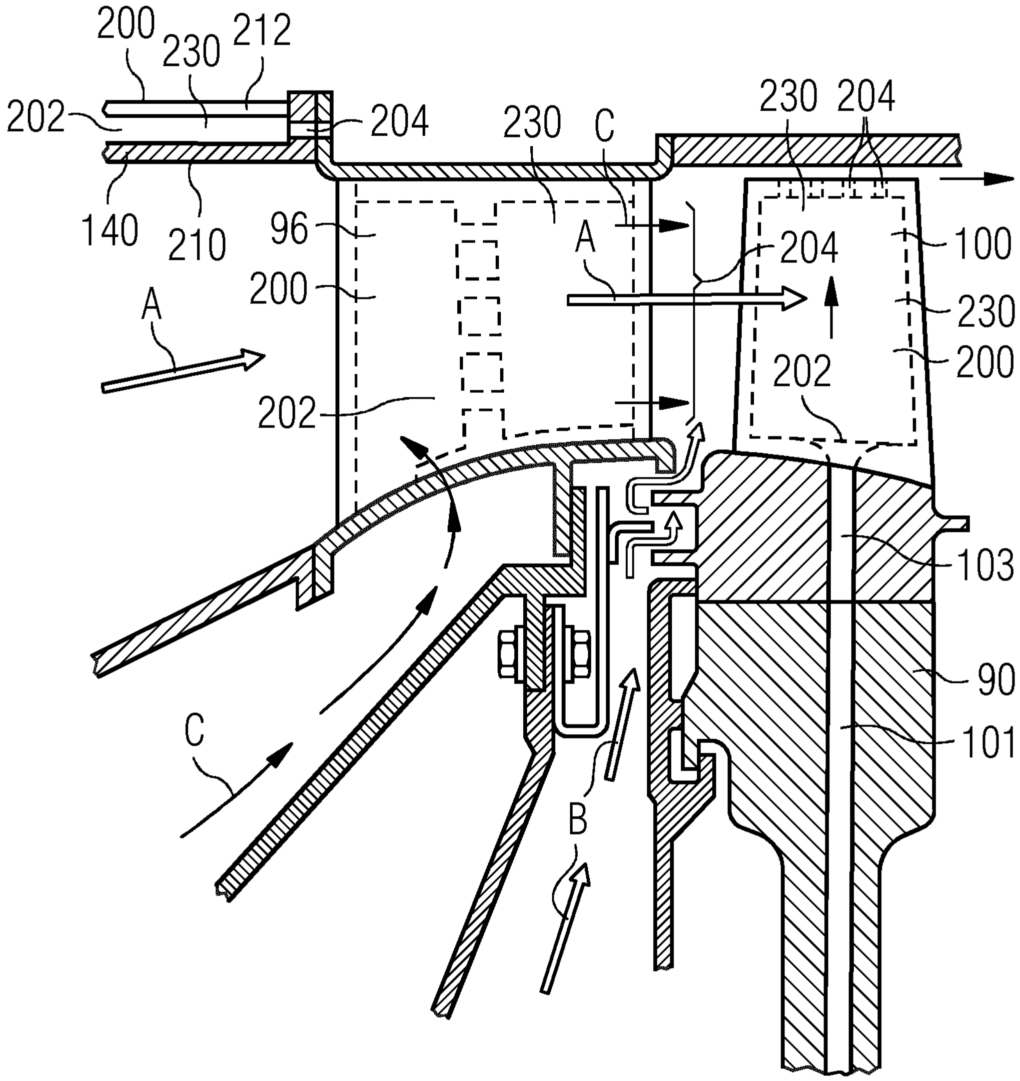


FIG 2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230
212
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140
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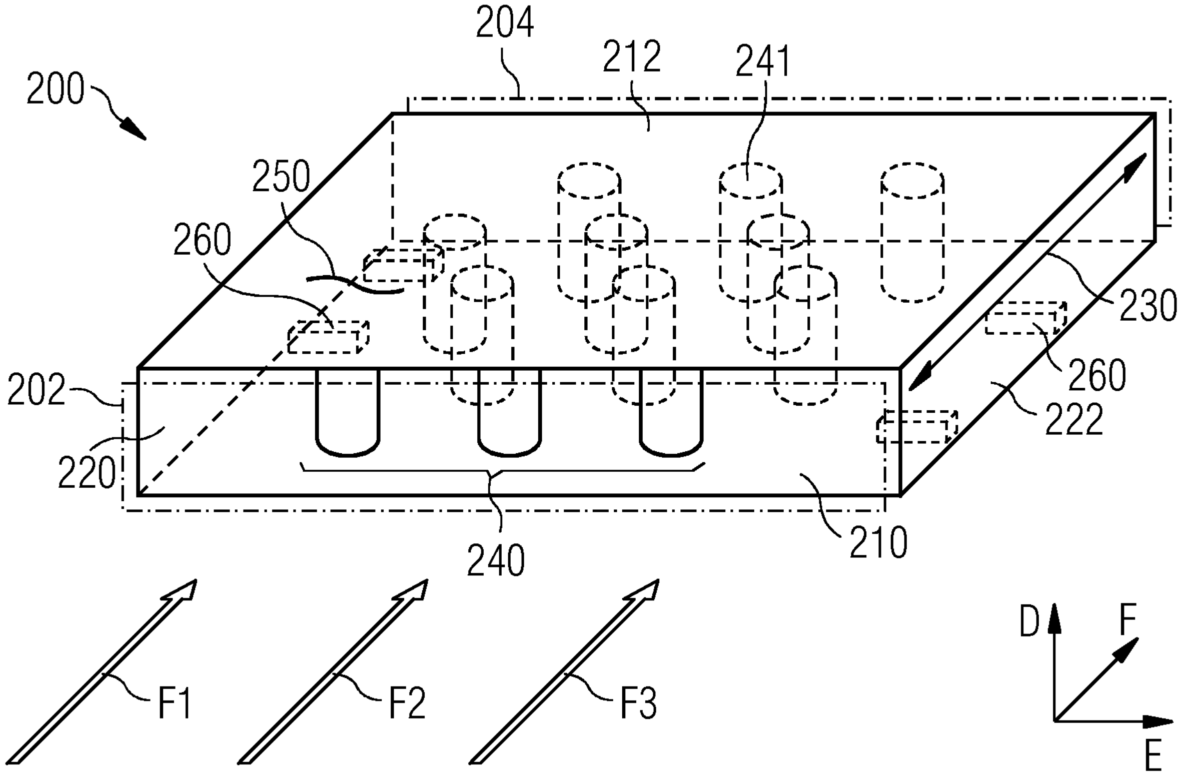
230
200
202
103
90
101
C
B

FIG 3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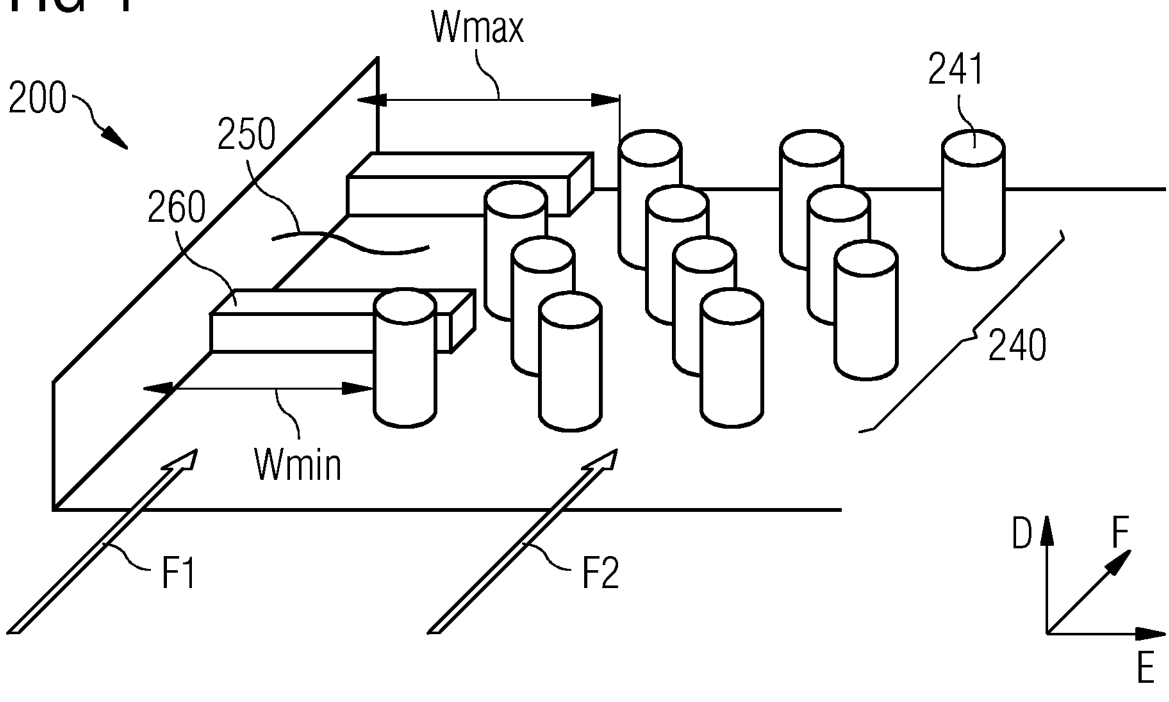
F1
F2
F3
D
F
E

FIG 4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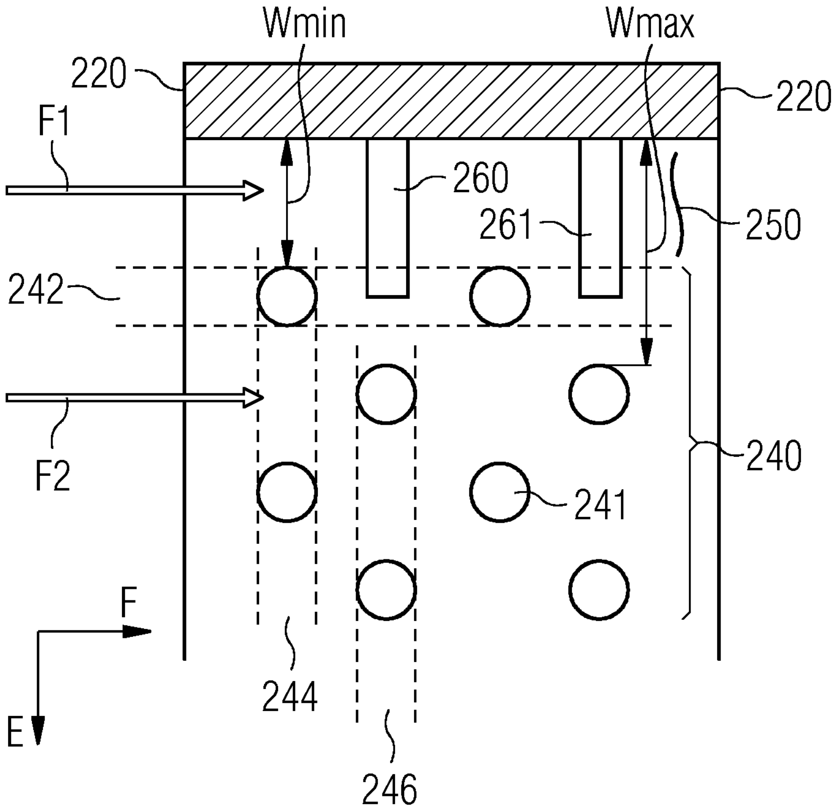
Wmin
F1
F2
D
F
E

FIG 5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Wmax
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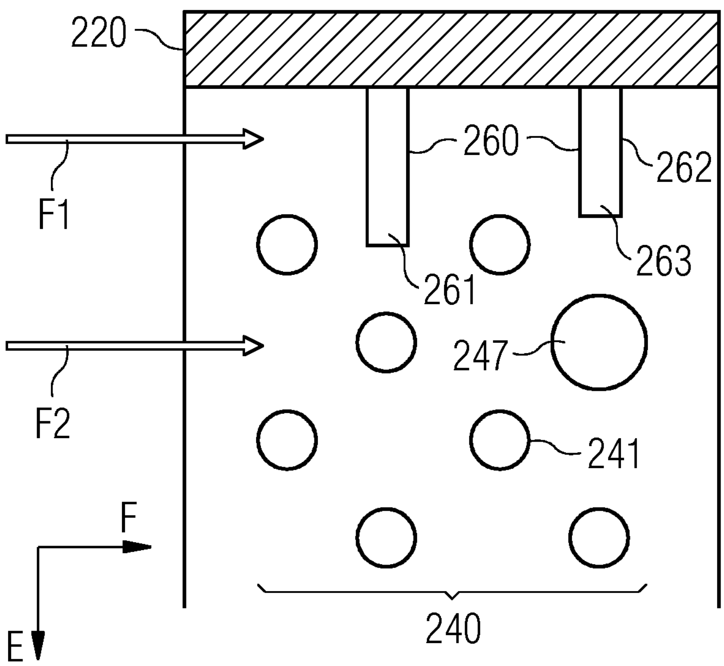
F2
240
241
F
E
244
246

FIG 6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262
F1
261
263
247
F2
241
F
E
240

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 4416

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Place of search	Date of completion of the search	Examiner
Munich	20 March 2018	Giorgini, Gabriele

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