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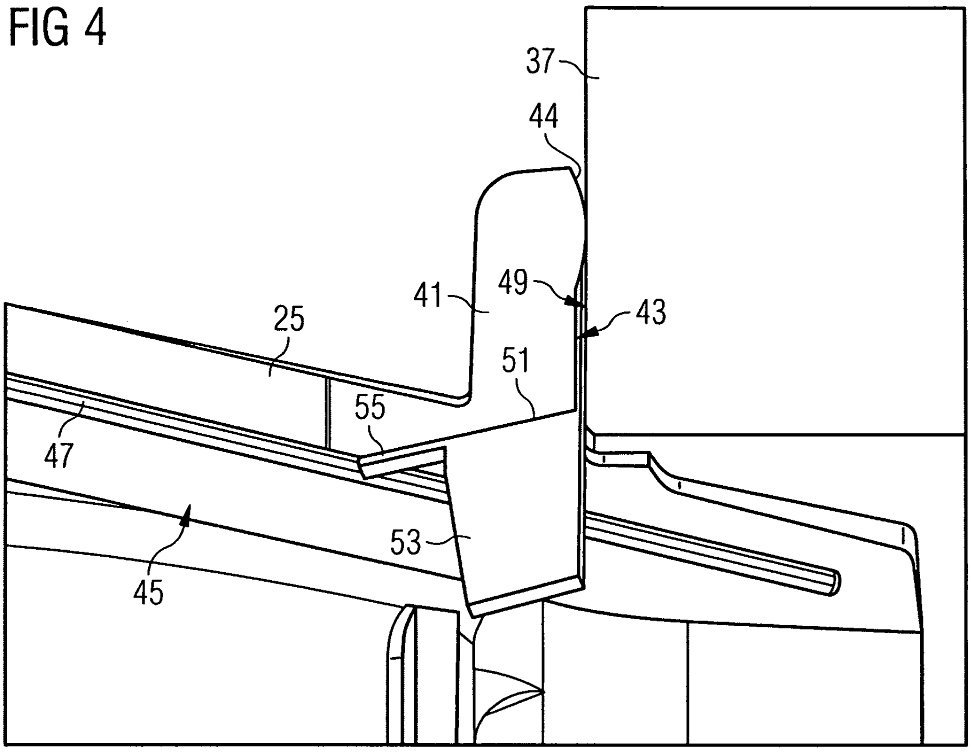
(54) **Gas turbine nozzle arrangement and gas turbine**

(57) A gas turbine nozzle arrangement has an axial direction (A) defining a flow direction of hot combustion gas there through and a radial direction (R). The nozzle arrangement comprises an outer carrier ring (37), an inner carrier ring (39), and nozzle segments each having an outer and an inner platform (25,27) and at least one guide vane (17) extending between the outer platform (25) and the inner platform (27). In the nozzle arrangement, the outer/inner platforms (25,27) each are connected to the outer/inner carrier ring. The outer/inner carrier ring has an axially facing outer/inner carrier ring surface; and

- the outer/inner platform (25,27) has an axially facing outer/inner platform surface located in axial opposition and at a distance to the axially facing outer/inner carrier ring surface. In addition, the nozzle arrangement comprises an outer/inner notch extends in a direction towards the centre of the nozzle arrangement at an inclination angle with respect to the radial direction into the body of the outer/inner platform (25,27). An outer/inner seal strip is inserted into the outer/inner notch, the outer/inner seal strip being dimensioned such that it projects over the outer/inner notch and contacts the outer/inner carrier ring surface.

FIG 4



EP 2 187 002 A1

Description

[0001] The present invention relates to a gas turbine nozzle arrangement comprising an outer carrier ring, an inner carrier ring and nozzle segments each having an outer platform and inner platform and at least one guide vane extending between the outer platform and the inner platform, where the outer platforms each are connected to the outer carrier ring and the inner platforms each are connected to the inner carrier ring. In addition, the invention relates to a gas turbine including at least one such nozzle arrangement.

[0002] Typically, gas turbine engines include a compressor for compressing air, a combustor for mixing the compressed air with fuel and igniting the mixture, and a turbine blade assembly for producing power. The turbine blade assembly usually comprises a number of rings of turbine blades between which nozzle arrangements comprising a number of guide vanes are located.

[0003] A nozzle arrangement typically comprises an outer carrier ring or support ring, an inner carrier ring or support ring, and a number of nozzle segments each comprising a radial outer platform, a radial inner platform and at least one vane extending from the radial outer platform to the radial inner platform. The nozzle arrangement forms an annular flow path for hot and corrosive combustion gases from the combustor.

[0004] Combustors often operate at high temperatures that may exceed 1350°C. Typical turbine combustor configurations expose turbine vane and blade arrangements to these high temperatures. As a result, turbine vanes and blades must be made of materials capable of withstanding such high temperatures. In addition, turbine vanes and blades often contain cooling systems for prolonging the lifetime of the vanes and the blades and for reducing the likelihood of failure as a result of excessive temperatures.

[0005] In order to prevent the platforms of the nozzle segments, which form the walls of the flow path for the hot and corrosive combustion gases, from damage due to the hot combustion gases the platforms are cooled with compressor air. However, the pressure of the compressor air used for cooling the platforms is higher than the pressure of the combustion gases flowing downstream of the nozzle arrangement. Moreover, the cooling air used for cooling the platforms, in particular their downstream ends, will be discharged into the flow part of the hot combustion gases. Hence, the flow of air into the flow path needs to be restricted to a minimum in order to preserve overall turbine efficiency. In order to restrict the flow of compressor air into the flow path of the hot combustion gas seals are provided between the radial outer platform of the nozzle segments and the outer carrier ring as well as between the radial inner platform of the nozzle segments and the inner carrier ring. Examples of such seals are disclosed in US 2008/0101927 A1, US 6,641,144, US 6,572,331, US 6,637,753, US 6,637,751, US 2005/0244267 A1, EP 1 323 890 B1, EP 1 323 896 B1, EP 1 323 898 B1, US 6,752,331, and US 2003/012398 A1.

[0006] With respect to the mentioned prior art it is an objective of the present invention to provide an advantageous gas turbine nozzle arrangement and an advantageous gas turbine.

[0007] This objective is solved by a gas turbine nozzle arrangement as claimed in claim 1 as well as by a gas turbine as claimed in claim 5.

[0008] An inventive gas turbine nozzle arrangement has an axial direction defining a flow direction of hot combustion gas there through and a radial direction. The nozzle arrangement comprises an outer carrier ring, an inner carrier ring, and nozzle segments. Each nozzle segment has an outer platform forming an outer wall segment of a flow channel for the hot combustion gas, an inner platform forming an inner wall segment of a flow channel for the hot combustion gas, and at least one guide vane extending between the outer platform and the inner platform. The outer platforms are each connected to the outer carrier ring and the inner platforms are each connected to the inner carrier ring. Furthermore, the outer carrier ring has an axially facing outer carrier ring surface and/or the inner carrier ring has an axially facing inner carrier ring surface. In addition, the outer platform has an axially facing outer platform surface located in axial opposition and at a (small) distance to the axially facing outer carrier ring surface and/or the inner platform has an axially facing inner platform surface located in axial opposition and at a (small) distance to the axially facing inner carrier ring surface. An outer notch extends in a direction towards the centre of the nozzle arrangement at an inclination angle with respect to the radial direction from the outer platform surface into the body of the outer platform. Additionally or alternatively, an inner notch extends in a direction towards the centre of the nozzle arrangement at an inclination angle with respect to the radial direction from the outer platform surface into the body of the inner platform. An outer seal strip is inserted into the outer notch, the outer seal strip being dimensioned such that it projects over the outer platform surface and contacts the outer carrier ring surface, and/or an inner seal strip is inserted into the inner notch, the inner seal strip being dimensioned such that it projects over the inner platform surface and contacts the inner carrier ring surface.

[0009] In particular, a number of outer seal strips may be present forming together a conical outer seal strip ring where each outer seal strip is inserted into the outer notches of two or more neighbouring outer platforms. Alternatively or additionally, a number of inner seal strips may be present forming together a conical inner seal strip ring where each inner seal strip is inserted into the inner notches of two or more neighbouring inner platforms. Providing a number of seal strips forming together a conical seal strip ring simplifies the assembling of a nozzle segment with a conical seal strip ring.

[0010] The inventive design of the nozzle segment allows for sealing the leak path between the nozzle segment and the carrier ring with very little complexity and cost. It is suitable for sealing the leak path between the nozzle segment and the outer carrier ring as well as for sealing the leak path between the nozzle segment and the inner carrier ring.

[0011] In a further development of the inventive gas turbine nozzle arrangement, the outer platforms and the inner platforms each have peripheral surfaces facing substantially in circumferential direction of the gas turbine nozzle arrangement and being in opposition to a peripheral surface of circumferentially neighbouring ones of the outer platforms and the inner platforms, respectively. A gap is formed between each two of such neighbouring peripheral surfaces. Seals extend in substantially axial direction between the peripheral surfaces of neighbouring outer platforms and/or between the peripheral surfaces of neighbouring inner platforms. In this development, the outer seal strip comprises seal strip sections which extend into the gaps between two neighbouring peripheral surfaces of the outer platforms and which are dimensioned such that they contact the axially extending seals between the peripheral surfaces of neighbouring outer platforms and extend over the gap in circumferential direction. Alternatively or additionally, the inner seal strip comprises seal strip sections which extend into the gaps between to neighbouring peripheral surfaces of the inner platforms and which are dimensioned such that they contact the axially extending seals between the peripheral surfaces of neighbouring inner platforms and extend over the gap in circumferential direction. In the described development of the gas turbine nozzle arrangement the seal strip has a dual function, namely to seal the potential leak between the nozzle and the carrier ring and to seal the leak path between adjacent nozzles segments without a need for additional parts.

[0012] The outer notch may be elongated in the peripheral surfaces of neighbouring outer platforms so as to reach to the axially extending seals between the respective peripheral surfaces and/or the inner notch is elongated in the peripheral surfaces of neighbouring inner platforms so as to reach the axially extending seals between the respective peripheral surfaces. These elongated notch sections are useful for guiding and holding the mentioned seal strip sections.

[0013] An inventive gas turbine comprises at least one inventive nozzle arrangement. The same advantages described with respect to the inventive nozzle arrangement are achieved by the inventive gas turbine, in particular sealing the potential air leak path between the nozzle and the carrier ring with little complexity and cost.

[0014] Further features, properties and advantages of the present invention will become clear from the following description of embodiments in conjunction with the accompanying drawings.

Figure 1 shows a gas turbine engine in a highly schematic view.

Figure 2 shows the turbine entry of a gas turbine engine.

Figure 3 shows a section a first embodiment of the inventive nozzle arrangement in a perspective view.

Figure 4 shows the section of figure 3 in a sectional view.

Figure 5 schematically shows an embodiment of a seal strip which may be used in the nozzle arrangement of figures 3 and 4.

Figure 6 schematically shows a second embodiment of the inventive nozzle arrangement.

[0015] Figure 1 shows, in a highly schematic view, a gas turbine engine 1 comprising a compressor section 3, a combustor section 5 and a turbine section 7. A rotor 9 extends through all sections and carries, in the compressor section 3, rings of compressor blades 11 and, in the turbine section 7, rings of turbine blades 13. Between neighbouring rings of compressor blades 11 and between neighbouring rings of turbine blades 13, rings of compressor vanes 15 and turbine vanes 17, respectively, extend from a housing 19 of the gas turbine engine 1 radially inwards towards the rotor 9.

[0016] In operation of the gas turbine engine 1 air is taken in through an air inlet 21 of the compressor section 3. The air is compressed and led towards the combustor section 5 by the rotating compressor blades 11. In the combustor section 5 the air is mixed with a gaseous or liquid fuel and the mixture is burnt. The hot and pressurised combustion gas resulting from burning the fuel/air mixture is fed to the turbine section 7. On its way through the turbine section 7 the hot pressurised gas transfers momentum to the turbine blades 13 while expanding and cooling, thereby imparting a rotation movement to the rotor 9 that drives the compressor and a consumer (not shown), e.g. a generator for producing electrical power or an industrial machine. The rings of turbine vanes 17 function as nozzles for guiding the hot and pressurised combustion gas so as to optimise the momentum transfer to the turbine blades 13. Finally, the expanded and cooled combustion gas leaves the turbine section 7 through an exhaust 23.

[0017] The entrance of the turbine section 7 is shown in more detail in Figure 2. The figure shows the first ring of turbine blades 13 and a first ring of turbine vanes 17. The turbine vanes 17 extend between radial outer platforms 25 and radial inner platforms 27 that form walls of a flow path for the hot pressurised combustion gas together with neighbouring turbine components 31, 33 and with platforms of the turbine blades 13. Also shown in the figure is the axial direction A and the radial direction R of the rings of turbine vanes and blades. Combustion gas flows through the flow path in the direction indicated in Figure 2 by the arrow 35. The turbine vanes, which form nozzle segments together with the outer and inner platform between which they extend, are held in place by an outer carrier ring 37 and an inner carrier ring 39 to which the outer platforms and the inner platforms, respectively, are connected. The outer carrier ring 37, the inner carrier ring 39 and the nozzle segments together form a nozzle arrangement of the turbine.

[0018] Note, that although each single guide vane 17 of the present embodiment forms a nozzle segment together with the outer platform 25 and the inner platform 27 other forms of nozzle segments may be possible. In an exemplary alternative nozzle segment, the outer platform and an inner platform could extend over a larger ring segment than in the depicted embodiment so that they could have a number of vanes, e.g., two or three vanes, extending between them. However, platforms extending over a smaller ring segment and having only one vane extending between them are advantageous as thermal expansion during gas turbine operation leads to less internal stress than with platforms extending over a larger ring segment.

[0019] Figures 3 and 4 show the nozzle arrangement depicted in Figure 2 in more detail. While Figure 3 shows a section of the nozzle arrangement in a perspective view Figure 4 shows the same section in a sectional view, including sections of the radial outer platform 25 and the outer carrier ring 37.

[0020] As can be seen in Figures 3 and 4, the radial outer platform 25 comprises a rail 41 with an axially facing platform surface 43. Furthermore, the outer platform 25 comprises peripheral surfaces 45 facing substantially in circumferential direction of the nozzle arrangement. In the nozzle arrangement, gaps are present between the peripheral surfaces 45 of neighbouring outer platforms. Furthermore, the peripheral surfaces 45 are equipped with grooves 47 for receiving seal strips extending between the neighbouring platforms for sealing the gap there between.

[0021] The carrier ring 37 comprises an axially facing surface 49 located in axial opposition to the axially facing surface 43 of the outer platforms rail 41. A bulge 44 may be part of the outer carrier rings axially facing surface 49 or, as in the present embodiment, may be part of the axially facing surface 43 of the rail. The bulge 44 provides for a defined distance between both opposed surfaces 43 and 49.

[0022] The outer platform 25 is provided with a notch 51 in the axially facing surface 43 of the rail 41. This notch extends circumferentially through the axially facing surface 43. In addition, the notch extends along a direction that is inclined towards the flow path through the nozzle arrangement, i.e. towards the centre of the nozzle arrangement, with respect to the radial direction of the nozzle arrangement into the body of the outer platform 25. Its depth is elongated in the peripheral surfaces 45 of the platform 25 so that it reaches the grooves 47 in the peripheral surfaces and itself forms inclined grooves in these surfaces.

[0023] The nozzle arrangement further comprises seal strips 53 fitted into the notch 51. The dimension of a seal strip 53 is chosen such that it projects over the axially surface 43 of the rail 41 when it is inserted into the notch 51 by such an amount that it contacts the axially facing surface 49 of the outer carrier ring 37 and, hence, seals the gap between the opposing surfaces of the outer carrier ring 37 and the rail 41. A number of such seal strips 53 forms a conical seal strip ring of the nozzle arrangement.

[0024] A seal strip 53, which is schematically shown in Figure 5, further comprises elongated seal strip sections 55 which extend into the gaps between neighbouring outer platforms 25 and which are dimensioned such that they contact the seals extending between the peripheral surfaces 45 of neighbouring outer platforms 25 with their axial ends 57. In other words, the seal strip 53 comprises extended sections distributed over its circumferential direction, the lengths of which are chosen such as to reach the seal between neighbouring platforms when inserted into the notch and the width of which correspond to the sum of the gap width between neighbouring platforms and the depth of the elongated sections of the grooves in opposing peripheral surfaces 45.

[0025] While the seal strip of the embodiment shown in figure 5 extends over more than two platforms 25 of a nozzle segment (for example three or four platforms) it may be advantageous in view of assembling a nozzle segment with a conical seal ring if the seal strip ring is composed of shorter seal strips which only extend over two circumferentially neighbouring platforms. An embodiment with several shorter seal strips extending only over two neighbouring platforms is schematically shown for the inner platforms 27 of a nozzle segment in figure 6.

[0026] Figure 6 shows a number of inner platforms 27 which form an inner platform ring. A seal strip ring composed of a number of seal strips 153A, 153B, 153C is inserted into notches of the inner platforms 27. Each seal strip 153A, 153B, 153C extends over half of a platform's 27 circumferential extension. Each seal strip 153A, 153B, 153C looks roughly like the form of the letter T. For a better understanding a not assembled seal strip 53 is shown in figure 6 on the right hand side next to the assembled ones to show the proportions.

[0027] Small gaps 131 may be present between the seal strips 153A, 153B, 153C in circumferential direction when inserted into the notches of the inner platform 27 to allow for thermal expansion. However, if thermal expansion is negligible or can be accounted for by other means such gaps may be omitted.

[0028] Each seal strip 153A, 153B, 153C comprises an elongated seal strip section 155A, 155B, 155C which is located at the seals strip's centre and extends into a gap between two neighbouring inner platforms 27. The seal strip section 155A, 155B, 155C is dimensioned such that it contacts seals 159 extending between the peripheral surfaces of neighbouring inner platforms 27 with their axial ends 157. The seals 159 and the elongated seal strip sections 155A, 155B, 155C may both end at the same spot indicated by reference sign 157 (not shown) or the seals 159 may be of longer length and for example end at position 162, whereas the elongated seal strip section 155A, 155B, 155C end at position 157.

[0029] Dashed lines 160 indicate grooves (reference sign 47 in figure 4) that hold the contacts seals 159 between two neighbouring inner platforms 27 and hold the elongated seal strip section 155A, 155B, 155C.

[0030] The further dashed lines 161 indicate notches (reference signs 51 in the previous figures) to hold the circumferential part of the seal strips 153A, 153B, 153C.

[0031] Please note that although the embodiments shown in figures 3 to 5 have been described with respect to the outer carrier ring and the outer platform of a nozzle segment, and the embodiment shown in figure 6 has been described with respect to the inner platforms of a nozzle segment the same inventive concept can as well be used at the respective other one of the radial inner and outer platforms and carrier rings of the nozzle arrangement.

[0032] Besides, it has to be noted that the terms "outer", "inner", "centre" throughout this document are meant in the sense, that the gas turbine engine is substantially rotational symmetric around an axis as indicated by X in figure 1 and that "inner" means closer to the axis X of rotation, "outer" means further away from the axis X of rotation and "centre" means the area close to the axis X of rotation.

Claims

1. A gas turbine nozzle arrangement having an axial direction (A) defining a flow direction of hot combustion gas there through and a radial direction (R), the nozzle arrangement comprising an outer carrier ring (37), an inner carrier ring (39), and nozzle segments each having an outer platform (25) forming an outer wall segment of a flow channel for the hot combustion gas, an inner platform (27) forming an inner wall segment of a flow channel for the hot combustion gas, and at least one guide vane (17) extending between the outer platform (25) and the inner platform (27), wherein

   - the outer platforms (25) each are connected to the outer carrier ring (37) and the inner platforms (27) each are connected to the inner carrier ring (39);
   - the outer carrier ring (37) has an axially facing outer carrier ring surface (49) and/or the inner carrier ring (39) has an axially facing inner carrier ring surface; and
   - each outer platform (25) has an axially facing outer platform surface (43) located in axial opposition and at a distance to the axially facing outer carrier ring surface (49) and/or each inner platform (27) has an axially facing inner platform surface located in axial opposition and at a distance to the axially facing inner carrier ring surface;

   characterised in that

   - an outer notch (51) extends in a direction towards the centre of the nozzle arrangement at an inclination angle with respect to the radial direction from the outer platform surface into the body of the outer platform (25), and/or an inner notch extends in a direction towards the centre of the nozzle arrangement at an inclination angle with respect to the radial direction from the outer platform surface into the body of the inner platform (27); and
   - at least one outer seal strip (53) is inserted into the outer notch (51), the outer seal strip (53) being dimensioned such that it projects over the outer platform surface (43) and contacts the outer carrier ring surface (49), and/or at least one inner seal strip (153) is inserted into the inner notch, the inner seal strip (153) being dimensioned such that it projects over the inner platform surface and contacts the inner carrier ring surface.

2. The gas turbine nozzle arrangement as claimed in claim 1,
   characterised in that

   - the outer platforms (25) and the inner platforms (27) each have peripheral surfaces (45) facing substantially in circumferential direction of the gas turbine nozzle arrangement and being in opposition to a peripheral surface (45) of a circumferentially neighbouring one of the outer platforms (25) and inner platforms (27), respectively, with a gap formed between each two of such neighbouring peripheral surfaces;
   - seals extend in a substantially axial direction between the peripheral surfaces (45) of neighbouring outer platforms (25) and/or between the peripheral surfaces of neighbouring inner platforms (27); and
   - the outer seal strip (53) comprises at least one seal strip section (55) which extends into a gap between two neighbouring peripheral surfaces (45) of the outer platforms (25) and which is dimensioned such that it contacts the axially extending seal between the peripheral surfaces (45) of neighbouring outer platforms (25) and extends over the gap in circumferential direction and/or the inner seal strip (153) comprises at least one seal strip section (155) which extends into a gap between two neighbouring peripheral surfaces of the inner platforms (27) and which

is dimensioned such that it contacts the axially extending seal (129) between the peripheral surfaces of neighbouring inner platforms (27) and extends over the gap in circumferential direction.

3. The gas turbine nozzle arrangement as claimed in claim 2,
characterised in that
the outer notch (51) is elongated in the peripheral surfaces (45) of neighbouring outer platforms (25) so as to reach the axially extending seals between the respective peripheral surfaces (45) and/or the inner notch is elongated in the peripheral surfaces of neighbouring inner platforms (27) so as to reach the axially extending seals (159) between the respective peripheral surfaces.

4. The gas turbine nozzle arrangement as claimed in any of the claim 1 to 3,
characterised in that
a number of outer seal strips (53) is present forming together a conical outer seal strip ring, each outer seal strip (53) being inserted into the outer notches (51) of two neighbouring outer platforms (25), and/or a number of inner seal strips (153) is present forming together a conical inner seal strip ring, each inner seal strip (153) being inserted into the inner notches of two neighbouring inner platforms (27).

5. A gas turbine comprising at least one gas turbine nozzle arrangement as claimed in any one of the claims 1 to 4.

FIG 1

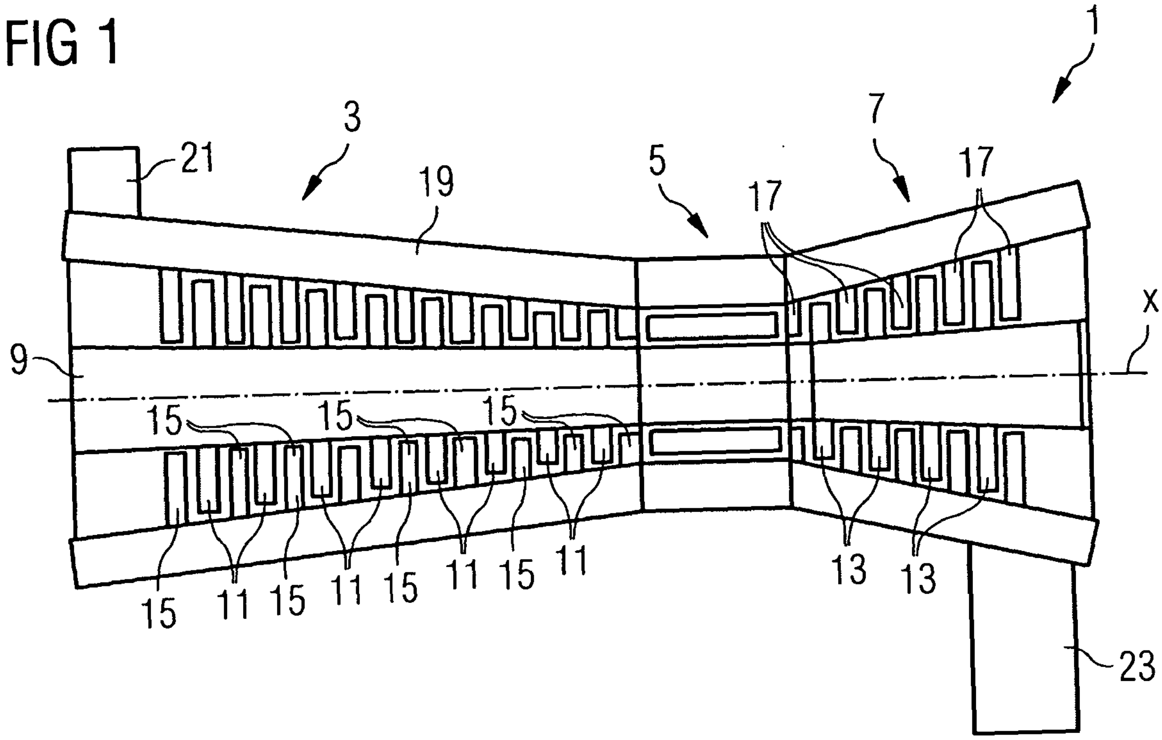

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FIG 2

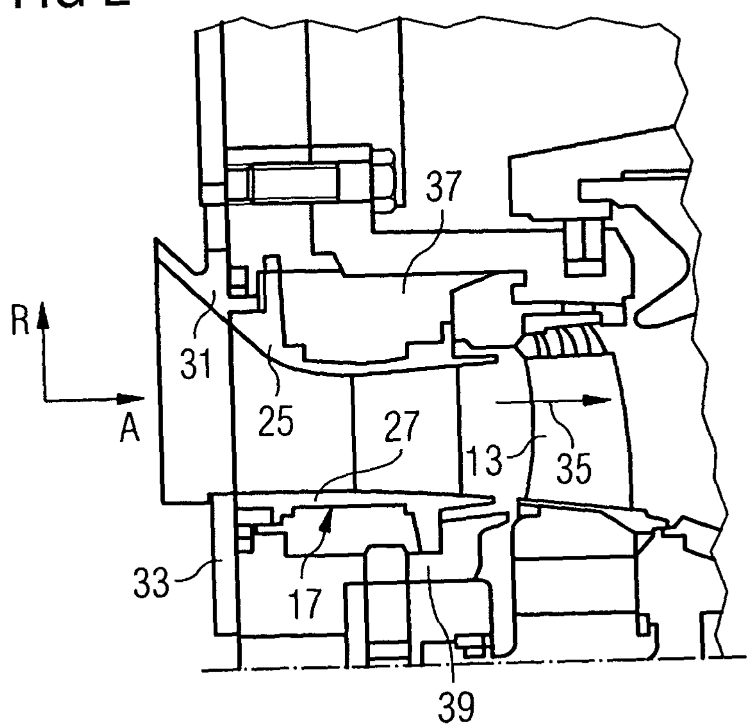
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FIG 3

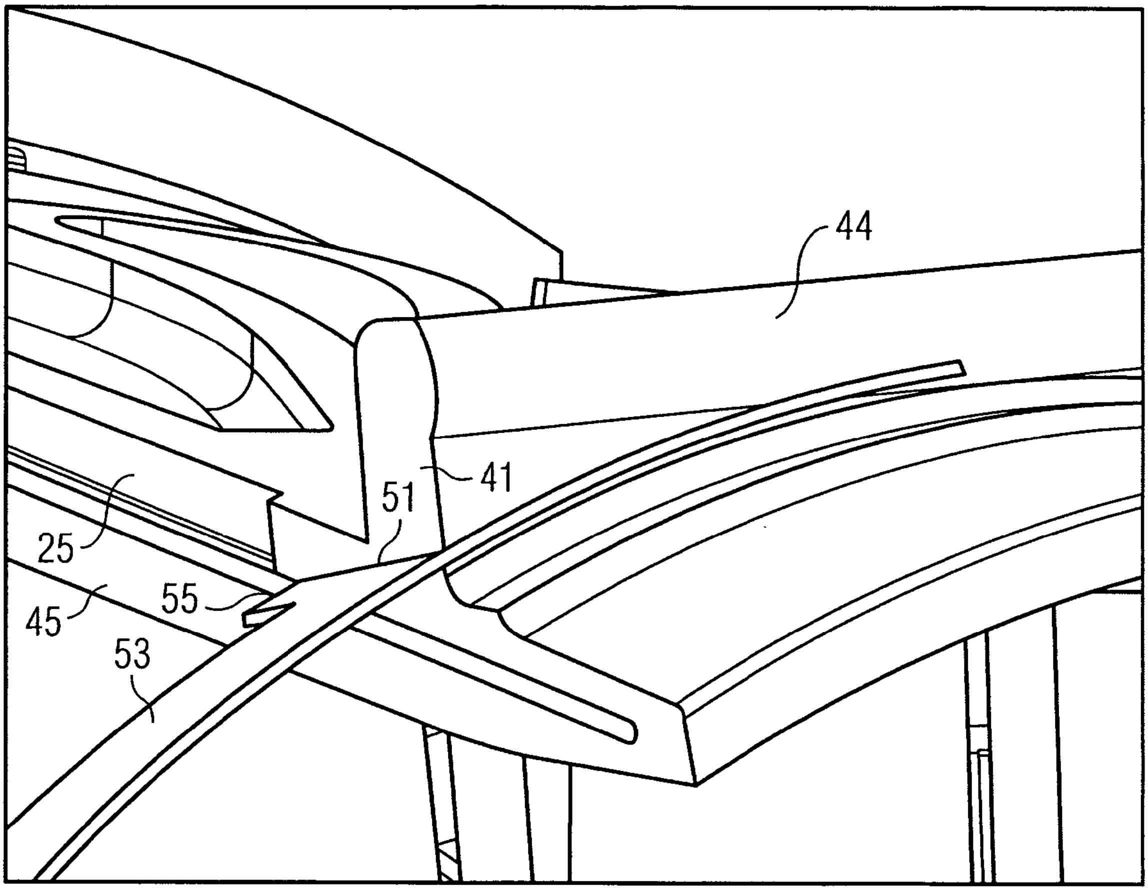


FIG 4

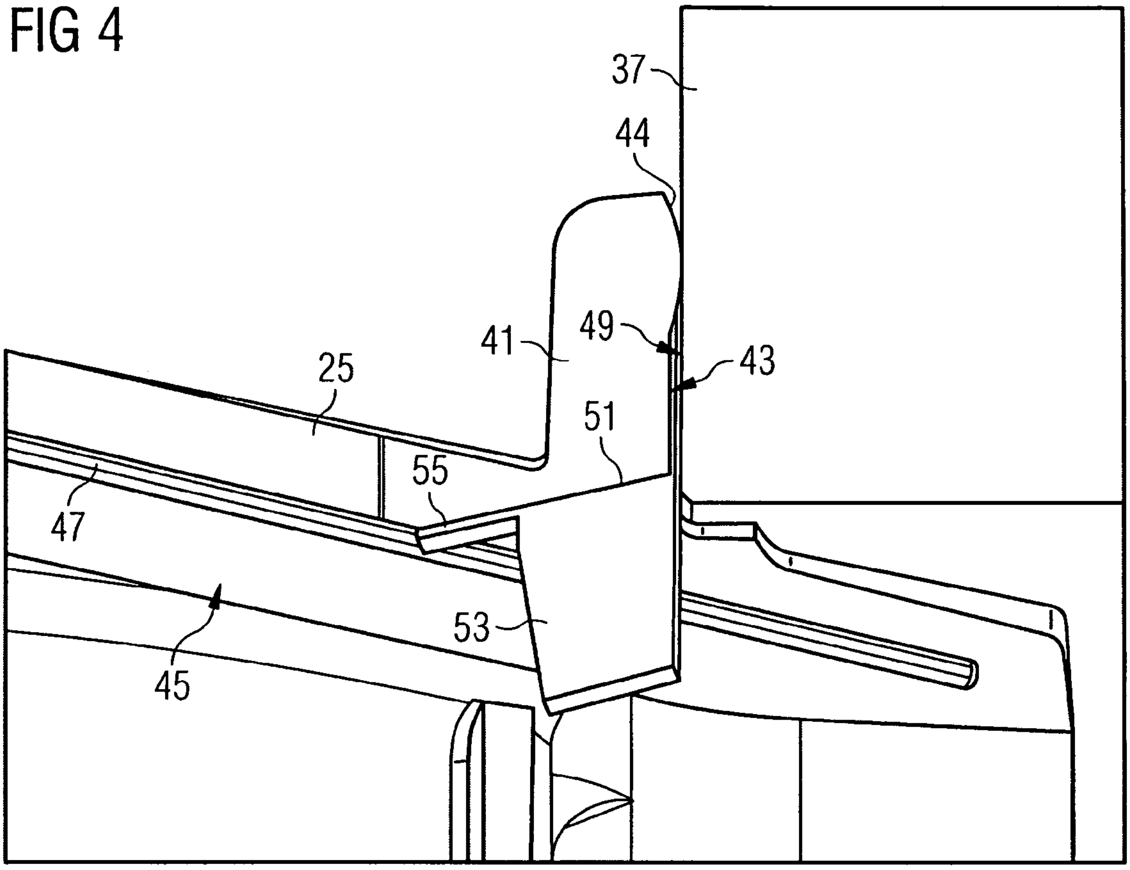


FIG 5

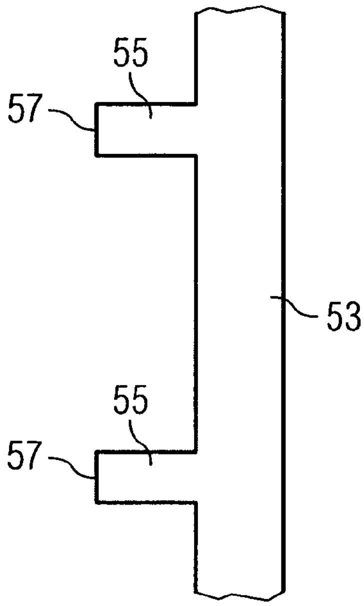
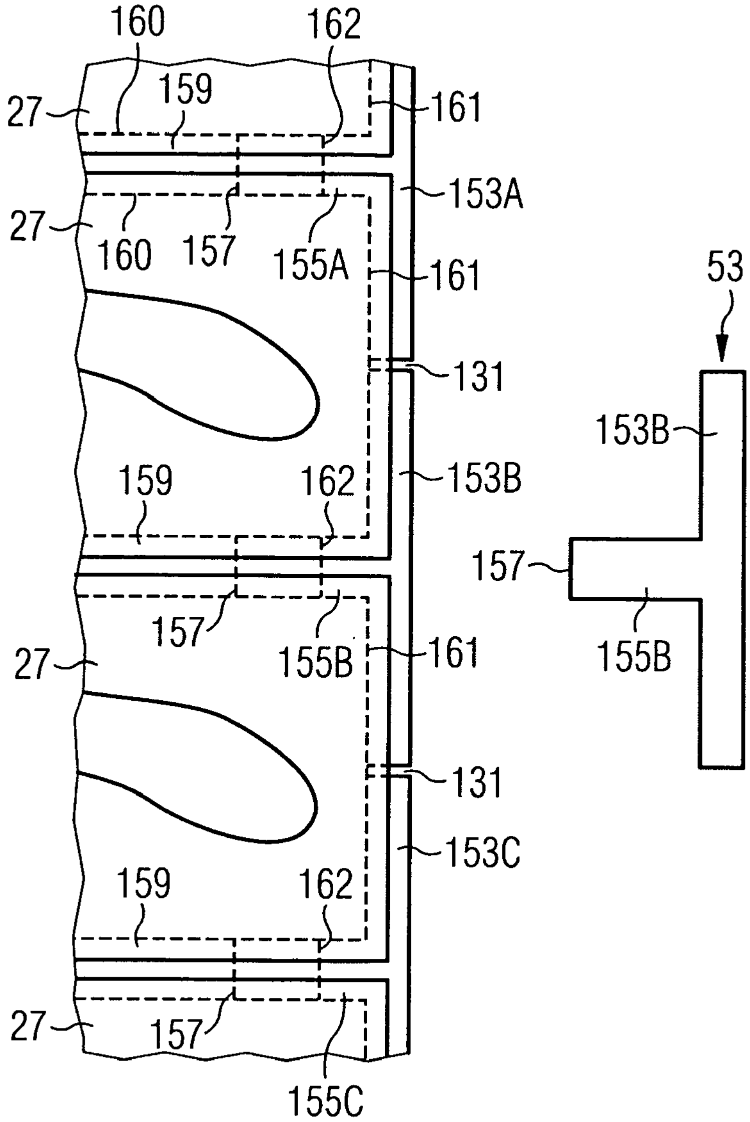


FIG 6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EUROPEAN SEARCH REPORT

Application Number
EP 08 01 9756

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 00/12870 A (GEN ELECTRIC [US]) 9 March 2000 (2000-03-09) * page 4, line 18 - page 9, line 24; figures 1-4 * -----	1,5	INV. F01D11/00 F16J15/08
X	US 6 164 656 A (FROST WILSON [US]) 26 December 2000 (2000-12-26) * column 3, line 3 - column 4, line 40; figures 2-6 * -----	1,5	
A,D	EP 1 323 896 A (GEN ELECTRIC [US]) 2 July 2003 (2003-07-02) * column 4, line 35 - column 6, line 19; figures 1-7 * -----	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01D F16J

The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	10 June 2009	Rau, Guido

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10-06-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0012870 A	09-03-2000	BR 9906936 A	03-10-2000
		CA 2308400 A1	09-03-2000
		CN 1277651 A	20-12-2000
		DE 69932501 T2	15-02-2007
		EP 1045959 A1	25-10-2000
		ES 2268879 T3	16-03-2007
		JP 2002523708 T	30-07-2002
		NO 20002325 A	27-06-2000
		PL 340398 A1	29-01-2001
		RU 2233985 C2	10-08-2004
		US 6199871 B1	13-03-2001
US 6164656 A	26-12-2000	NONE	
EP 1323896 A	02-07-2003	DE 60213946 T2	06-09-2007
		JP 4130579 B2	06-08-2008
		JP 2003227354 A	15-08-2003
		US 2003123980 A1	03-07-2003

EPO FORM P0459

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20080101927 A1 **[0005]**
- US 6641144 B **[0005]**
- US 6572331 B **[0005]**
- US 6637753 B **[0005]**
- US 6637751 B **[0005]**
- US 20050244267 A1 **[0005]**
- EP 1323890 B1 **[0005]**
- EP 1323896 B1 **[0005]**
- EP 1323898 B1 **[0005]**
- US 6752331 B **[0005]**
- US 2003012398 A1 **[0005]**