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(54) TURBINE VANE CARRIER OF A GAS TURBINE AND A GAS TURBINE COMPRISING SUCH TURBINE VANE CARRIER

(57) Gas turbine for power plants, the gas turbine (1) having an axis (7) and comprising a compressor (2), a combustor (3) and a turbine (5); the turbine (5) comprising an inner rotor (4) provided with a plurality of blades (6) and an outer vane carrier (9) provided with a plurality of vanes (8) axially interposed between the blades (6); the vane carrier (9) comprising a casing (10) having an upstream end (11); the vane carrier (9) moreover comprising a circumferential front ring (13) centered at the axis (7) and coupled to the upstream end (11) of the casing (10) by a circumferential rail coupling (14).

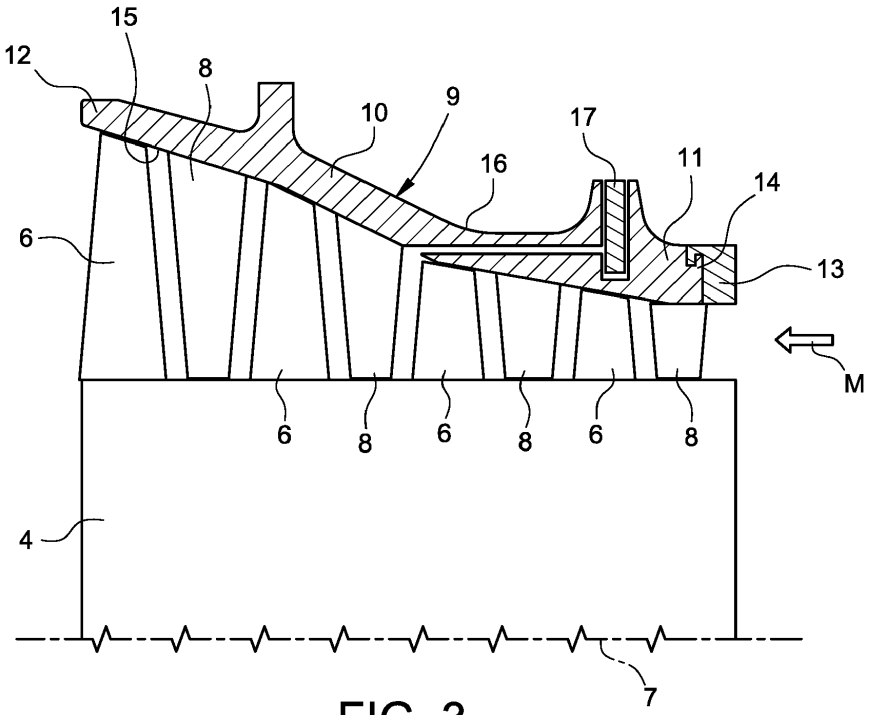

FIG. 3

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Description

Field of the Invention

[0001] The present invention relates to a gas turbine for power plants. In particular, the present invention relates to the turbine vane carrier configured for supporting a plurality of vanes interposed between a plurality of blades supported by the rotor.

Description of prior art

[0002] As known, a gas turbine for power plant (in the following only gas turbine) comprises a rotor having an axis and is provided with an upstream compressor sector, a combustor sector and a downstream turbine sector. The terms downstream and upstream refer to the direction of the main gas flow passing through the gas turbine whereas the terms radial, axial, circumferential, inner/inward and outer/outward refer to the gas turbine axis. In particular, the compressor sector comprises an inlet supplied with air and a plurality of blades connected to the rotor and configured for compressing the incoming air. The compressed air leaving the compressor flows into a plenum delimited by an outer casing and from there enters into the combustor. Inside the combustor the compressed air is mixed with at least one fuel and such resulting mixture of fuel and compressed air flows into a combustion chamber where this mixture is combusted. The resulting hot gas leaves the combustion chamber and expands in the turbine performing work on the rotor.

[0003] The turbine comprises a plurality of blades supported by the rotor and an outer vane carrier surrounding the rotor and supporting a plurality of vanes axially interposed between the blades. The vane carrier comprises a casing having an upstream end facing the combustor plenum and a downstream end at the last blade.

[0004] Since the upstream end of the turbine vane carrier is in contact with the combustor plenum, the temperature of such portion in higher than the temperature of the remaining parts of the vane carrier. Due to this high temperature gradient the hotter part of the turbine vane carrier tries to expand whereas the colder part tries to contract. This thermal stresses lead to a radial distortion of the turbine vane carrier.

Disclosure of the invention

[0005] Accordingly, a primary object of the present invention is to provide a gas turbine for power plants able to overcome the above described problems of the current state of the art. In particular, primary object of the present invention is to provide a turbine vane carrier suitable for reducing the distortion of the part due to the temperature gradient between the upstream portion in contact with the combustor plenum and the downstream portion.

[0006] In order to achieve the objective problem mentioned above, the present invention provides a gas turbine having an axis and comprising (following the main gas flow direction) a compressor, a combustor and at least a turbine. The gas turbine moreover comprises an outer casing defining a plenum fed by the compressed air leaving the compressor. The combustor is at least in part housed in the plenum. For instance, the outer casing is provided with a plurality of portal holes for supporting a plurality of can-combustors concentrically arranged around the axis of the gas turbine.

[0007] Downstream the combustor, the turbine comprises an inner rotor provided with a plurality of blades and an outer vane carrier provided with a plurality of vanes axially interposed between the blades. The vane carrier comprises a casing having an upstream end supporting the first vane and located near the combustor plenum and an opposite downstream end at the last blade.

[0008] According to the main aspect of the invention, the vane carrier moreover comprises a circumferential front ring centered at the gas turbine axis and coupled to the upstream end of the casing.

[0009] Advantageously, according to the invention the front portion of the turbine vane carrier is mechanically separated from the remaining part of the casing. In this way the hotter portion of the vane carrier is separated from the cooler portion and therefore each portion is free to deform independent from the other according to the local temperature. This configuration allows reducing the distortion of the vane carrier.

[0010] Moreover, since the front part of the vane carrier is made as a separated piece with respect to the remaining part of the casing, such front ring can be made by a particular material that is too expensive for realizing the entire vane carrier. For instance the front ring could be made by a so called "low thermal expansion material" or low "CTE" (coefficient of Thermal expansion) that allows to better control the clearances between the front ring and the casing. With the rail coupling according the invention it is possible to decouple the upstream and downstream of the turbine vane carrier.

[0011] In particular, the front ring is coupled to the upstream end of the casing by a circumferential rail coupling. Preferably, at such circumferential rail coupling gaps are present between the casing and the front ring.

[0012] Advantageously, in this way the front ring can freely deform within the rail gaps before coming into contact with the casing.

[0013] According to an embodiment, the circumferential rail coupling is realized in form of a single rail and configured to limit only the radial inward displacement of the front ring with respect to the casing.

[0014] Advantageously, in this way the front ring can freely deform along radial outward direction.

[0015] Preferably, the circumferential front ring comprises two halves bolted at the relative split line and no gap is provided at the split line.

[0016] Preferably, the vane carrier moreover comprises a plurality of axial supports protruding from the up-

stream end of the casing and housed in relative seat in the front ring.

[0017] Advantageously, the axial supports avoid the decoupling of front ring from the casing during the assembly of the vane carrier.

[0018] Preferably, the gas turbine comprises a device for cooling the casing downstream the front ring. In particular, the casing comprises an inner and an outer surface; downstream the upstream end the outer surface of the casing is provided with at least a bore fed by cooling air. This embodiment can be considered as an alternative of the embodiment where the front ring is realized in low CTE alloy. In such last case, the rail coupling is configured to allow a free radial inner displacement of the front ring with respect to the casing.

[0019] Advantageously, the present invention allow to better control the thermal expansion/contraction of the casing that indeed is no more integral with the hot part facing the combustor plenum.

[0020] The invention has been above foregoing defined as a gas turbine comprises the inventive turbine van carrier with a separated front ring. However, the present invention relates moreover to the single turbine vane carrier. Indeed, this element can be integrated with current gas turbines in order to reach to the claimed solution.

[0021] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed. Other advantages and features of the invention will be apparent from the following description, drawings and claims.

[0022] The features of the invention believed to be novel are set forth with particularity in the appended claims.

Brief description of drawings

[0023] Further benefits and advantages of the present invention will become apparent after a careful reading of the detailed description with appropriate reference to the accompanying drawings.

[0024] The invention itself, however, may be best understood by reference to the following detailed description of the invention, which describes an exemplary embodiment of the invention, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view of a gas turbine for a power plant;
Fig. 2 is a schematic prospective view of the turbine section;
Fig. 3 is a schematic sectional view of the turbine section of figure 2;
Fig. 4 is a schematic enlarged view of a particular of figure 3;
Fig. 5 is a schematic sectional view of an alternative embodiment of the turbine section of figure 2.

Detailed description of preferred embodiments of the invention

[0025] In cooperation with attached drawings, the technical contents and detailed description of the present invention are described thereinafter according to preferred embodiments, being not used to limit its executing scope. Any equivalent variation and modification made according to appended claims is all covered by the claims claimed by the present invention.

[0026] Reference will now be made to the drawing figures to describe the present invention in detail.

[0027] Reference is made to Fig. 1 that is a schematic view of a gas turbine for a power plant. According to the example of figure 1, the gas turbine 1 has an axis 7 and comprises a compressor 2, a combustor 3 and a turbine 5. As known, the coming air is compressed by the compressor 2 and then enters into a plenum (not shown in figure 1) defined by an outer casing of the gas turbine. From the plenum the compressed air enters the combustor 3. In the combustor 3 the air is mixed with at least a fuel and this mixture is combusted. The hot gas leaving the combustor stage 3 is expanded in the turbine 5 performing work on the rotor 4 along the axis 7.

[0028] Fig. 2 is a schematic prospective view of the turbine of figure 1. According to the figure 2, the turbine comprises a rotor 4 along the axis 7 provided with a plurality of blades 6. Around the rotor 4 a turbine vane carrier 9 is provided. This vane carrier 9 supports a plurality of vanes 8 and comprises a casing 10 and a front ring 13 coupled to the upstream portion 13 of the casing 10. Both the front ring 13 and the casing 10 are realized in two halves bolted each other at a split line 18.

[0029] Fig. 3 is a schematic sectional view of the turbine section of figure 2. According to figure 3 the casing 10 comprises an inner 15 and outer surface 16 connecting the upstream portion 13 with the downstream portion 12. The inner surface 15 supports a plurality of vanes 8 interposed by the rotor blades 6. As disclosed in figure 3, the front ring 13 is not integral with the casing 9 and is coupled to the upstream portion 11 by a circumferential rail coupling 14 centered at the axis 7. Figure 3 discloses moreover a bore 17 realized in the outer surface of the casing 10 and configured for receiving cooling air. The reference M in figure 3 represent the main flow direction of the hot gas. In this embodiment, the front ring 13 may be realized by conventional alloy and it ends substantially at the first vane.

[0030] Fig. 4 is a schematic enlarged view of a particular of figure 3. In particular, figure 4 discloses a preferred embodiment of the circumferential rail coupling 14 between the front ring 13 and the upstream portion 10 of the casing 9. According to this embodiment, the radial inward displacement of the front ring 13 with respect to the casing 9 is limited. In particular, the front ring 13 comprises a hook portion 19 oriented toward the axis 7 and housed in a corresponding seat 20 obtained in the outer surface 16 of the casing 10.

[0031] Fig. 5 is a schematic sectional view of an alternative of the turbine section of figure 2. In this embodiment the casing 9 is not provided with the cooling bore but the front ring 13 is realized by a low CTE (coefficient of Thermal expansion) alloys. In this embodiment, the front ring 13 ends substantially at the middle of the vane carrier 9.

[0032] In particular, in the embodiment of fig. 5 the rail coupling is configured to limit the radial outward displacement and to allow the radial inward displacement of the front ring 13 with respect to the casing 10. Indeed, in this embodiment the front ring made of low CTE material expands less than the remaining part of the casing.

[0033] Although the invention has been explained in relation to its preferred embodiment(s) as mentioned above, it is to be understood that many other possible modifications and variations can be made without departing from the scope of the present invention. It is, therefore, contemplated that the appended claim or claims will cover such modifications and variations that fall within the true scope of the invention.

Claims

1. Gas turbine for power plants, the gas turbine (1) having an axis (7) and comprising a compressor (2), a combustor (3) and a turbine (5); the turbine (5) comprising an inner rotor (4) provided with a plurality of blades (6) and an outer vane carrier (9) provided with a plurality of vanes (8) axially interposed between the blades (6); the vane carrier (9) comprising a casing (10) having an upstream end (11);
characterized in that
the vane carrier (9) moreover comprises a circumferential front ring (13) centered at the axis (7) and coupled to the upstream end (11) of the casing (10).

2. Gas turbine as claimed in claim 1, wherein the front ring (13) is coupled to the upstream end (11) of the casing (10) by a circumferential rail coupling (14).

3. Gas turbine as claimed in claim 2, wherein at the circumferential rail coupling (14) gaps are present between the casing (10) and the front ring (13).

4. Gas turbine as claimed in claim 2 or 3, wherein the circumferential rail coupling (14) is configured to limit the radial inward displacement of the front ring (13) with respect to the casing (10).

5. Gas turbine as claimed in claim 4, wherein the circumferential front ring (13) comprises two halves bolted at the relative split line (18), no gap is provided at the split line (18).

6. Gas turbine as claimed in claim 5, wherein the vane carrier (9) moreover comprises a plurality of axial support protruding from the upstream end (11) of the casing (10) and housed in relative seat in the front ring (13).

7. Gas turbine as claimed in any one of the foregoing claims, wherein the gas turbine comprises a device for controlling expansion of the casing (10) downstream the front ring (13).

8. Turbine vane carrier for a gas turbine for power plants wherein the gas turbine (1) has an axis (7) and comprises a compressor (2), a combustor (3) and a turbine (5); the turbine (5) comprising an inner rotor (4) provided with a plurality of blades (6); the turbine vane carrier (9) is configured for supporting a plurality of vanes (8) axially interposed between the blades (6) and comprising a casing (10) having an upstream end (11);
characterized in that
the turbine vane carrier (9) moreover comprises a circumferential front ring (13) centered at the axis (7) and coupled to the upstream end (11) of the casing (10)

9. Turbine vane carrier as claimed in claim 8, wherein the front ring (13) is coupled to the upstream end (11) of the casing (10) by a circumferential rail coupling (14).

10. Turbine vane carrier as claimed in claim 9, wherein at the circumferential rail coupling (14) gaps are present between the casing (10) and the front ring (13).

11. Turbine vane carrier as claimed in claim 9 or 10, wherein the circumferential rail coupling (14) is configured to limit the radial inward displacement of the front ring (13) with respect to the casing (10).

12. Turbine vane carrier as claimed in claim 11, wherein the circumferential front ring (13) comprises two halves bolted at the relative split line (18), no gap is provided at the split line (18).

13. Turbine vane carrier as claimed in claim 12, wherein the vane carrier (9) moreover comprises a plurality of axial support protruding from the upstream end (11) of the casing (10) and housed in relative seat in the front ring (13).

14. Turbine vane carrier as claimed in any one of the foregoing claims from 9 to 13, wherein the gas turbine comprises a device for controlling thermal expansion of the casing (10) downstream the front ring (13).

15. Turbine vane carrier as claimed in claim 14, wherein the casing (10) comprises an inner (15) and an outer

surface (16), downstream the upstream end (11) the outer surface (16) of the casing (10) is provided with at least a bore (17) fed by cooling air.

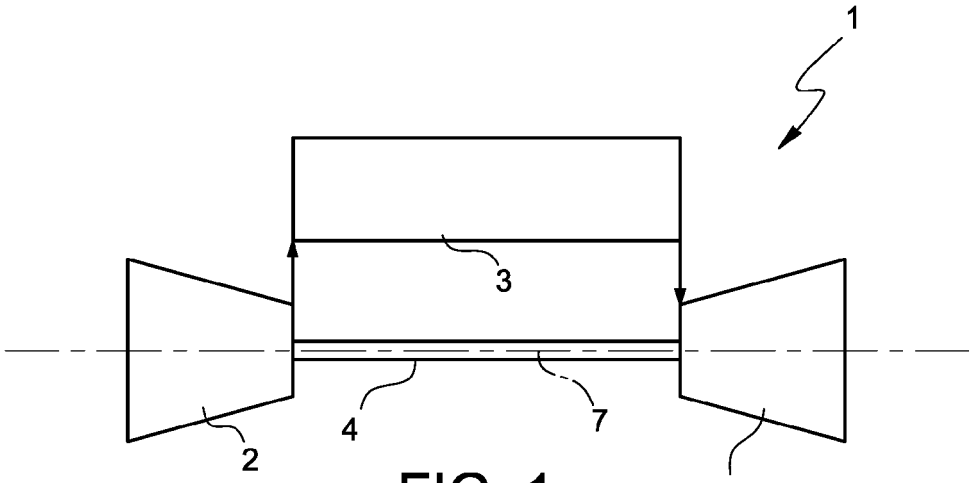

FIG. 1

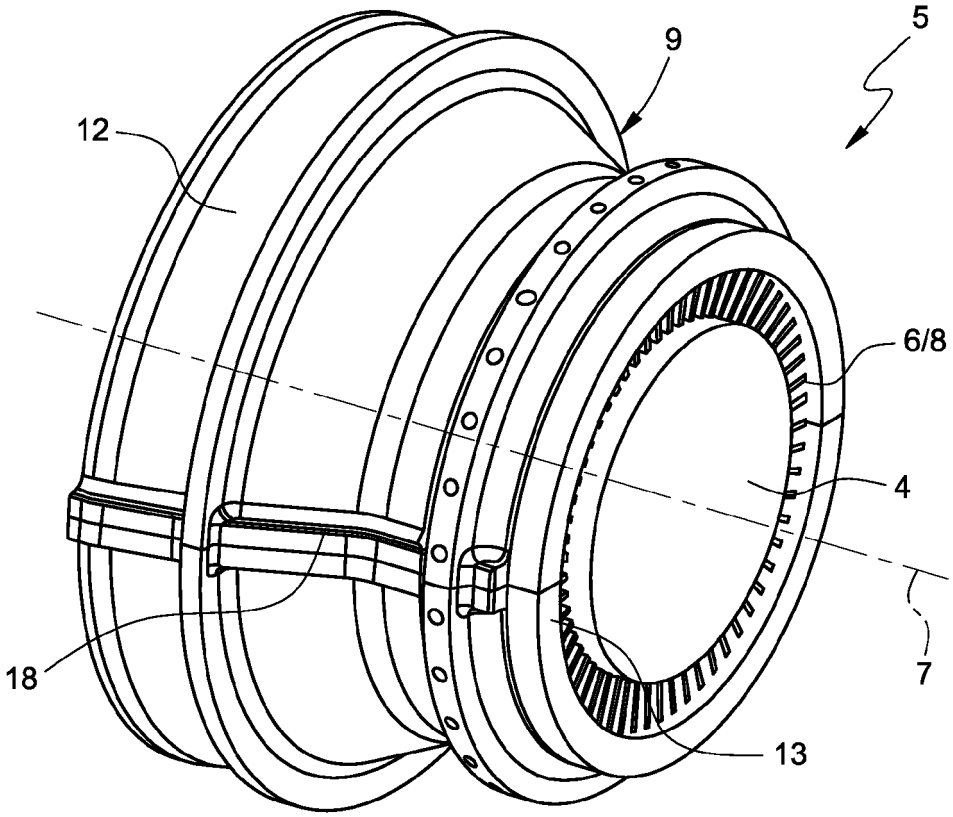

FIG. 2

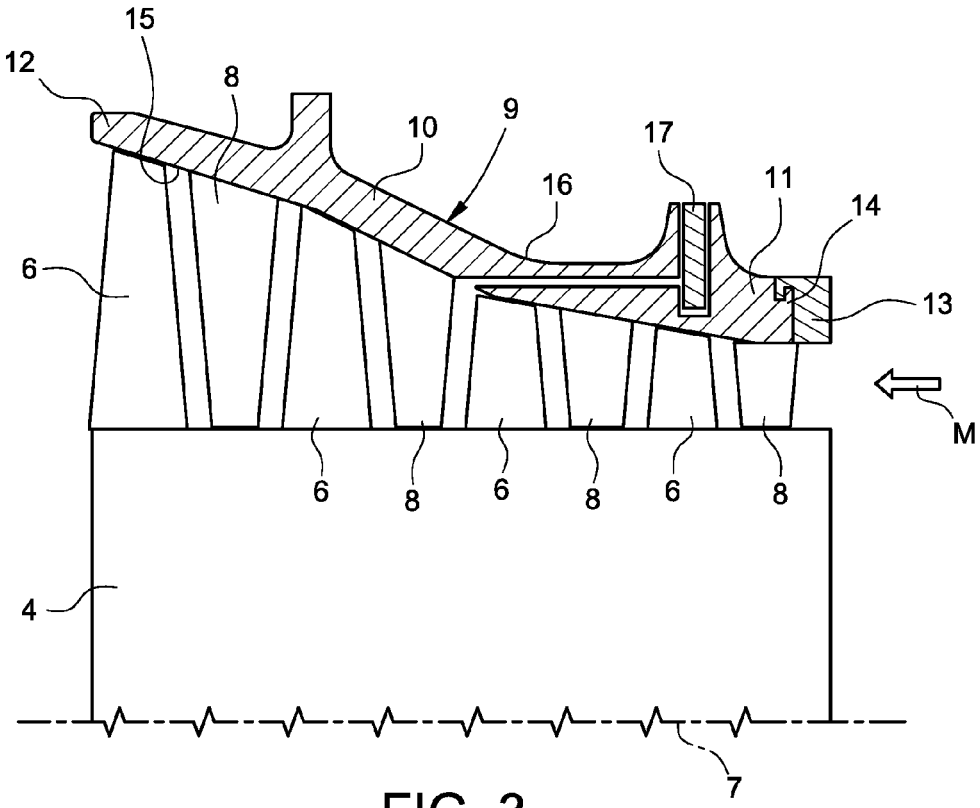

FIG. 3

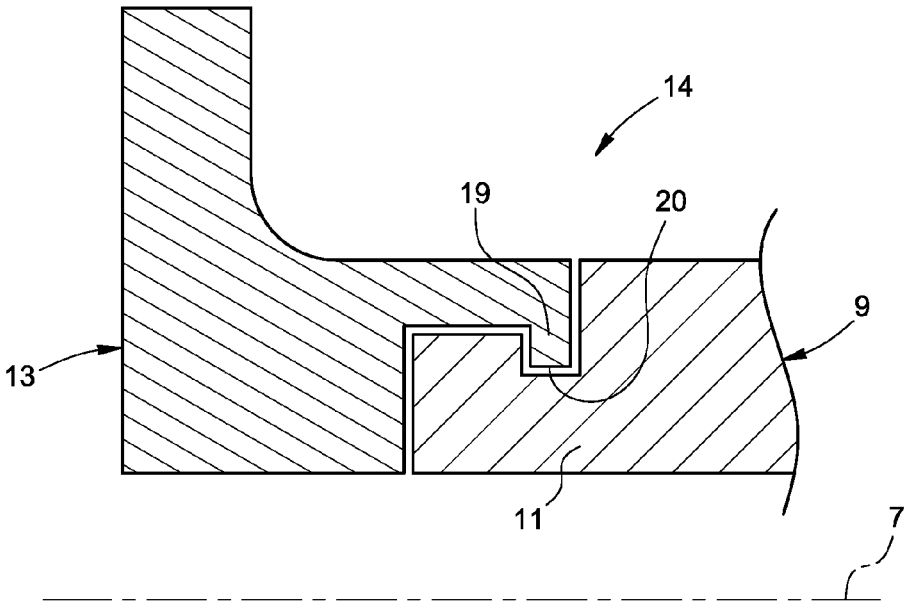

FIG. 4

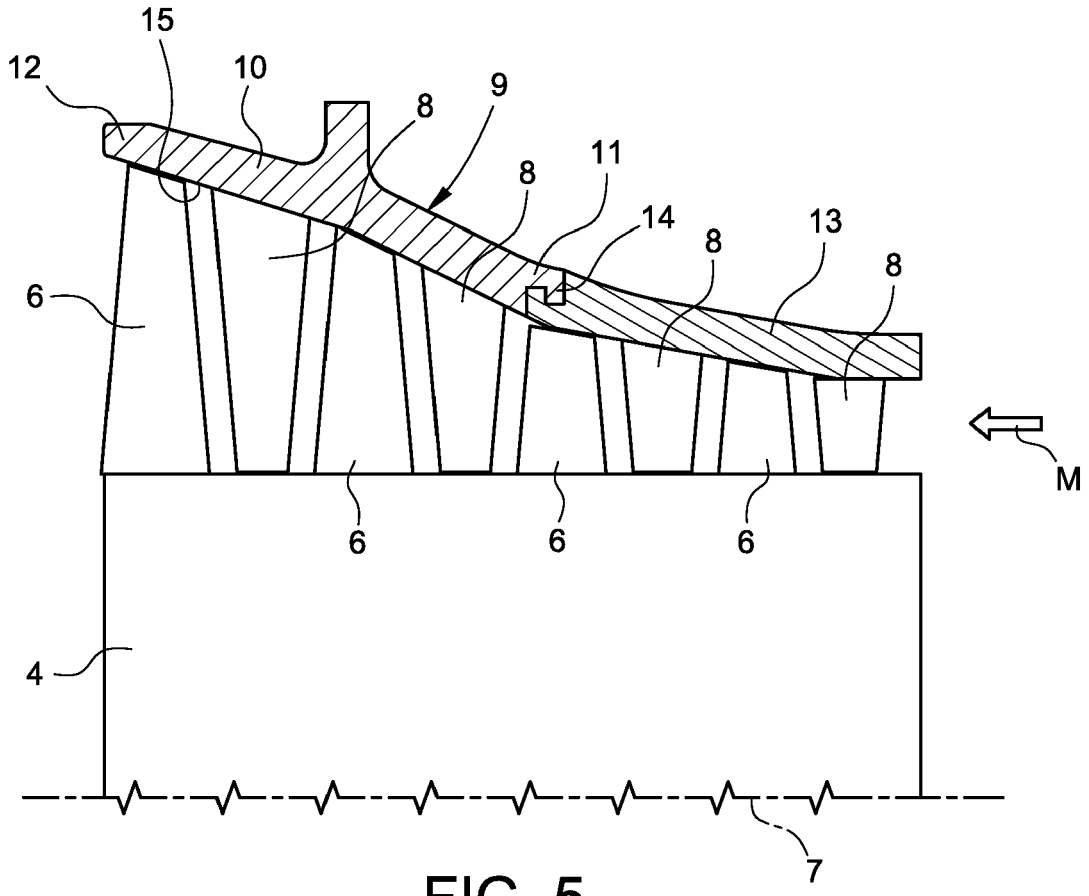

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 17 17 9138

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 Y	EP 2 196 628 A1 (SIEMENS AG [DE]) 16 June 2010 (2010-06-16) * paragraphs [0004] - [0013], [0020] - [0027]; figures 3,5 *	1-6,8-13 7,14,15	INV. F01D9/04 F01D25/24 F01D25/26
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X	WO 2007/068538 A1 (ALSTOM TECHNOLOGY LTD [CH]; BENZ URS [CH]; HURTER JONAS [CH]; MOTZKUS) 21 June 2007 (2007-06-21) * abstract; figure 4 *	1-4,6, 8-11,13	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 December 2017	Teusch, Reinhold

CATEGORY OF CITED DOCUMENTS

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