(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 489 466 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.05.2019 Bulletin 2019/22

(51) Int Cl.:
F01D 11/24 *(2006.01)* ***F01D 25/14*** *(2006.01)*

(21) Application number: **17203661.8**

(22) Date of filing: **24.11.2017**

(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

(71) Applicant: **Ansaldo Energia Switzerland AG**
5401 Baden (CH)

(72) Inventors:
- **SISTANINIA, Meisam**
  5200 BRUGG (CH)
- **RUEDEL, Uwe Wolfgang**
  5406 BADEN (CH)
- **LOTT, Phillipe**
  68480 BIEDERTHAL (FR)
- **OLMES, Sven**
  5210 WINDISCH (CH)
- **HENNEL, Hyazinth Immanuel**
  5610 WOHLEN (CH)
- **TAHENY, Oliver Joseph**
  8046 ZÜRICH (CH)

(74) Representative: **Andreotti, Erika et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

(54) **GAS TURBINE ASSEMBLY**

(57) A gas turbine assembly is provided with at least one vane carrier (10; 20) extending along a longitudinal axis (A) and comprising at least one annular seat (27) and with at least one governing ring (28; 128) housed in the annular seat (27) and comprising at least one clearance control cavity (29; 140) which extends transversally with respect to the longitudinal axis (A).

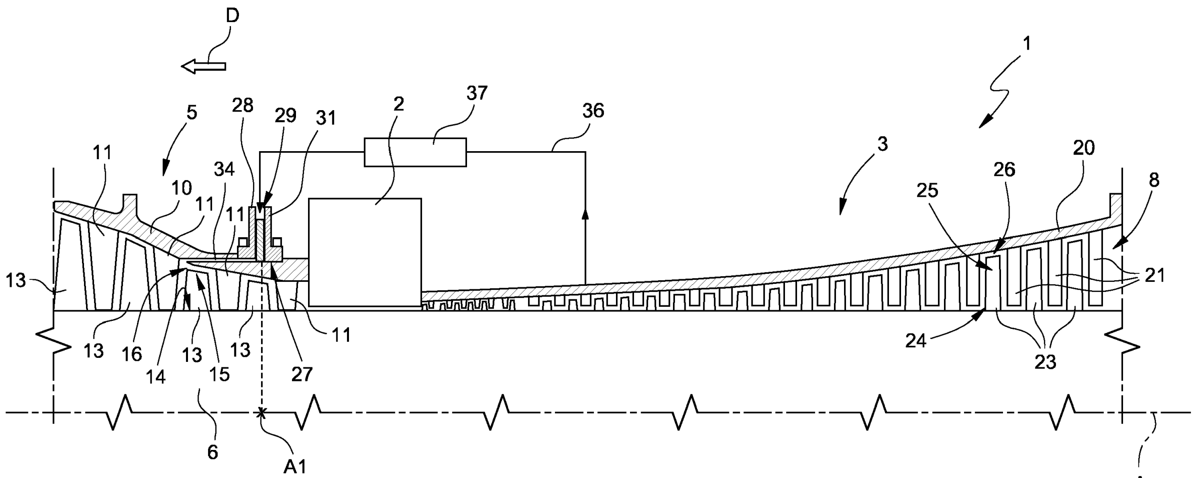

FIG. 1

EP 3 489 466 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a gas turbine assembly. In particular, the gas turbine assembly is part of an electric power production plant.

BACKGROUND

[0002] Gas turbine assemblies normally comprise a compressor, a combustion chamber and a gas turbine.

[0003] In particular, the compressor comprises an inlet supplied with air and a plurality of rotating blades 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. In the turbine the hot gas expansion moves rotating blades connected to a rotor.

[0004] Both the compressor and the turbine comprises a plurality of vanes axially interposed between the rotating blades. Rotating blades are supported by a rotor rotating about a main axis, while the vanes of the gas turbine are supported by a gas turbine vane carrier and the vanes of the compressor are supported by a compressor vane carrier.

[0005] As is known, in gas turbines assemblies a clearance between rotating blades tips and the respective stator vane carrier is required in order to enable the relative movement between rotor blades tips and the stator vane carrier.

[0006] However, during the operation of the gas turbine assembly, rotor parts and stator parts have different responses to temperature changes due to the fact that they are made of different materials and also due to the fact that they are exposed to different temperature gradients, especially in the gas turbine.

[0007] For these reasons, clearances between rotating blades tips and the stator vane carrier need to be designed such that they are maintained under any operation conditions.

[0008] In other words, under most operation conditions the tip clearances are larger than required in order to guarantee safe operation and avoid contact between rotating and stationary parts.

[0009] However leakage flows occurring between blade tips and stator vane carrier through said clearances cause a loss in terms of efficiency as said flows do not provide useful work for the gas turbine assembly.

[0010] Therefore an active regulation of the clearance is required in order to find a balanced solution which avoids contacts and, at the same time, minimize leakages between said blades and stator vane carrier.

[0011] Examples of active control clearance solutions are disclosed in documents US 2006/0225430 or EP3023600.

[0012] However these solutions are not sufficiently efficient.

SUMMARY

[0013] The object of the present invention is therefore to provide a gas turbine assembly wherein the described drawbacks are avoided or at least mitigated.

[0014] In particular, it is an object of the present invention to provide a gas turbine assembly which is provided with an efficient active control clearance system.

[0015] According to the present invention, there is provided a gas turbine assembly comprising at least one vane carrier extending along a longitudinal axis and provided with at least one annular seat and at least one governing ring housed in the annular seat and provided with at least one clearance control cavity which extends transversally with respect to the longitudinal axis.

[0016] In this way the governing ring can obtain a controlled thermal behaviour of the vane carrier so as to control the clearance in the turbine or in the compressor. Moreover the clearance control cavity can be oriented so as to optimize the occupation of the available space in the specific portion of the governing ring which can influence better the thermo-mechanical behaviour of the vane carrier. Said solution therefore brings more flexibility and considerable benefits in terms of design space.

[0017] Lastly, advantageously, for obtaining a thermal expansion of the governing ring a significantly less amount of fluid is required than for obtaining the same thermal expansion directly in the vane carrier. As a result, the governing ring design is more effective and more controllable with respect to solutions which try to obtain a thermal expansion directly on the vane carrier.

[0018] According to a preferred embodiment of the present invention, the clearance control cavity extends radially with respect to the longitudinal axis.

[0019] According to a preferred embodiment of the present invention, the governing ring comprises at least one plurality of clearance control cavities distributed along a circumferential direction. In this way the clearance control is active along the entire circumferential portion of the vane carrier and the influence of the thermo-mechanical behaviour of the vane carrier is more effective.

[0020] According to a preferred embodiment of the present invention, the plurality of clearance control cavities are evenly distributed along a circumferential direction. In this way a circumferentially homogeneous temperature field is obtained in the vane carrier.

[0021] According to a preferred embodiment of the present invention, the clearance control cavity is a through hole made into the governing ring. In this way the clearance control cavities are obtainable in a rapid, simple and economic way, for example by drilling the governing ring.

[0022] According to a preferred embodiment of the present invention, the governing ring is made by at least two parts coupled together. In this way the governing ring can be advantageously housed in the annular seat without requiring any dismantling of the vane carrier.

[0023] According to a preferred embodiment of the present invention, the clearance control cavity has at least one inlet connected to a source of control fluid.

[0024] In this way the clearance control cavity is supplied with a control fluid.

[0025] According to a preferred embodiment of the present invention, the clearance control cavity has at least one outlet connected to a respective discharge conduit.

[0026] According to a preferred embodiment of the present invention, the vane carrier comprises at least a portion of the discharge conduit; the discharge conduit flowing into a working channel of the gas turbine assembly provided with vanes. In this way the control fluid discharged in the working channel can provide further useful work for the assembly.

[0027] According to a preferred embodiment of the present invention, the gas turbine assembly comprises at least one insert which is arranged inside at least one clearance control cavity. In this way the thermal exchange between the control fluid and the governing ring can be controlled in order to optimize the heat transfer and reduce the amount of control fluid required.

[0028] In particular according to a preferred embodiment of the present invention, the insert is hollow and preferably provided with an inlet hole and with a plurality of outlet holes on its surface. In this way the passage of control fluid through the insert is allowed and an impingement effect on the inner wall of the control cavity is obtained. Consequently a further optimization of the heat transfer and a reduction of the amount of control fluid required is obtained.

[0029] According to a preferred embodiment of the present invention, the governing ring and the vane carrier may be made of different materials.

[0030] In this way the governing ring can be made by a particular material that is too expensive for realizing the entire vane carrier.

[0031] According to a preferred embodiment of the present invention, the radial dimensions of the governing ring are greater than the radial dimensions of the vane carrier at the annular seat. In this way, the governing ring can control the radial expansion of the vane carrier more effectively.

[0032] According to a preferred embodiment of the present invention, the governing ring can be coupled to the vane carrier by releasable coupling elements. In this way the replacement of the governing ring is easier.

[0033] According to a preferred embodiment of the present invention, the gas turbine assembly comprises a compressor, a combustor and a gas turbine; wherein the gas turbine comprises the vane carrier and the compressor clearance control cavity is connected to an extraction line, which is configured to extract air from the compressor and feed it to the clearance control cavity. In this way the governing ring can be used for controlling the turbine clearance.

[0034] According to a preferred embodiment of the present disclosure, the gas turbine assembly comprises a compressor, a combustor and a gas turbine; wherein the compressor comprises the vane carrier and the compressor clearance control cavity is connected to a further extraction line, which is configured to extract air from the compressor, cool it preferably by means of an external cooler and feed it to the clearance control cavity. In this way the governing ring can be used for controlling the compressor clearance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The present invention will now be described with reference to the accompanying drawings, which illustrate some non-limitative embodiment, in which:

- Figure 1 is a lateral schematic representation of a gas turbine assembly according to the present invention, with parts in section and parts removed for clarity;
- Figure 2 is a section lateral view of a first detail of the assembly of figure 1, with parts in section and parts removed for clarity;
- Figure 3 is a section front view of a second detail of the assembly of figure 1, with parts in section and parts removed for clarity;
- Figure 4 is a lateral schematic view of the third detail of the assembly of figure 1, with parts in section and parts removed for clarity;
- Figure 5 is a perspective schematic view of the third detail of figure 4, with parts removed for clarity.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0036] In figure 1 reference numeral 1 indicates a gas turbine assembly for an electrical energy production plant extending along a longitudinal axis A (for the sake of simplicity only an half of the assembly is illustrated in figure 1 as the assembly being symmetrical with respect to axis A).

[0037] The assembly 1 comprises a combustor 2, a compressor 3 and a gas turbine 5.

[0038] The gas turbine 5 extends along the longitudinal axis A and is provided with a shaft 6 (also extending along axis A) to which compressor 3 is also connected.

[0039] Gas turbine 5 comprises a working expansion channel 7 wherein the hot gas working fluid coming from the combustor 2 flows in a direction D. The working expansion channel 7 has a section which radially increases along the axis A in the direction D.

[0040] Compressor 3 comprises a working compression channel 8 wherein external air is compressed and flows in direction D. The end of the working compression channel 8 is connected to combustor 2. The working compression channel 8 has a section which radially decreases along the axis A in the direction D.

[0041] The turbine 5 comprises an outer casing (not visible in the attached figures), a vane carrier 10, which extends about axis A and is static, a plurality of gas turbine stator vanes 11 fastened at least to the vane carrier 10 and divided into arrays, and a plurality of gas turbine rotor blades 13 divided into arrays coupled to the shaft 6 and arranged radially with respect to axis A. Each gas turbine rotor blade 13 is provided with an end 14 coupled to the shaft 6 and a free end 15 facing the vane carrier 10. The gap between the free end 15 and the vane carrier 10 defines a turbine clearance 16 (indicated schematically in figure 1).

[0042] Along the working expansion channel 7 radial arrays of rotor gas turbine blades 13 are alternated along axis A by radial arrays of stator gas turbine vanes 11.

[0043] Analogously the compressor 3 comprises at least one vane carrier 20, which extends about axis A and is static, a plurality of stator compressor vanes 21 fastened at least to the vane carrier 20 and divided into arrays, and a plurality of rotor compressor blades 23 divided into arrays coupled to the shaft 6 and arranged radially with respect to axis A. Each rotor compressor blade 23 is provided with an end 24 coupled to the shaft 6 and a free end 25 facing the vane carrier 20. The gap between the free end 25 and the vane carrier 20 defines a compressor clearance 26 (indicated schematically in figure 1).

[0044] Along the working compression channel 8 radial arrays of rotor blades 23 are alternated along axis A by radial arrays of stator vanes 21.

[0045] With reference to the non-limitative example illustrated in figures 1 and 2, the vane carrier 10 of the gas turbine 5 comprises at least one annular seat 27.

[0046] The gas turbine assembly 1 comprises at least one governing ring 28 housed in the annular seat 27 of the turbine vane carrier 10.

[0047] The governing ring 28 comprises at least one clearance control cavity 29 which extends transversally with respect to the longitudinal axis A for controlling the turbine clearance 16. In other words, the axis B of extension of the clearance control cavity 29 is transversal with respect to the longitudinal axis A.

[0048] The angular position of the axis B of the clearance control cavity 29 can vary from radially to axially (axially excluded) depending on the available space in the governing ring 28.

[0049] In the non-limiting example here disclosed and illustrated, the clearance control cavity 29 extends radially with respect to the longitudinal axis A (configuration illustrated in figures 2 and 3).

[0050] According to a variant not illustrated, also the vane carrier 20 of the compressor 3 can comprise at least one annular seat wherein at least one governing ring provided with at least one clearance control cavity is housed. Analogously to what stated for the turbine vane carrier the clearance control cavity of the governing ring housed in the seat of the compressor vane carrier extends transversally with respect to the longitudinal axis A for controlling the compressor clearance 26.

[0051] In the following, only the embodiment illustrated in figures 1, 2 and 3 regarding the presence of at least one annular seat 27 into the vane carrier 10 and the presence of at least one governing ring 28 housed in the annular seat 27 for controlling the turbine clearance 16 will be described in detail.

[0052] Obviously features described for the gas turbine 5 can be applied, mutatis mutandis, to the compressor 3 and in particular to at least one annular seat into the vane carrier 20 and to at least one ring housed in the annular seat of the vane carrier 20 of the compressor 3 for controlling the compressor clearance 26.

[0053] With reference to figure 1 and 2, the annular seat 27 is realized in correspondence of at least one axial position A1 of the vane carrier 10.

[0054] According to a variant not illustrated the vane carrier 10 can comprise more than one annular seat arranged at respective different axial positions. Each seat being configured to house at least one respective governing ring. In this way the thermo-mechanical behaviour of the vane carrier in different zones of the vane carrier is influenced.

[0055] With reference to figure 3, the governing ring 28 comprises a plurality of clearance control cavities 29 which are evenly or unevenly distributed along the circumferential direction.

[0056] In this way the thermo-mechanical behaviour of the vane carrier 10 at the axial position A1 is influenced by the presence of the clearance control cavities 29 in the governing ring 28 and the turbine clearance 16 can be opportunely controlled.

[0057] In the non-limiting embodiment here disclosed and illustrated, the plurality of clearance control cavities 29 are evenly distributed along the circumferential direction. The evenly distribution of the clearance control cavities 29 create a more homogeneous circumferential temperature field.

[0058] Preferably, the clearance control cavity 29 is a through hole made into the governing ring 28. In other words the clearance control cavity 29 is a channel extending from an outer surface 18 of the governing ring 28, which faces in use the outer casing 9 (see figure 3) and an inner surface 19 of the governing ring 28, which faces in use the annular seat 27 of the vane carrier 10.

[0059] According to a variant which is illustrated in figure 5 and will be described in detail later, the clearance control cavity can be a cylindrical blind hole.

[0060] Preferably the governing ring 28 is split into two half-rings 12a 12b which are connected one to the other at a split plane S (indicated in figure 3).

[0061] With reference to figure 3, each clearance control cavity 29 has an inlet 30 connected to an annular feeding common channel 31 which is made in the governing ring and is connected to a control fluid source preferably by means of a plurality of conduits.

[0062] With reference to figures 1 and 2 at least one of the plurality of the clearance control cavities 29 has also an outlet 33 connected to a discharge conduit 34.

[0063] In the non-limiting example here disclosed and illustrated the control fluid is air extracted from the compressor 3 by a dedicated extraction line 36 (illustrated in figure 1).

[0064] Along the extraction line 36 is preferably arranged a regulator 37 configured to regulate the temperature and/or the pressure and/or the flow rate of the control fluid before feeding it to the common manifold.

[0065] For example, the regulator 37 can regulate the temperature and the pressure of the control fluid in order to have a temperature and a pressure as required.

[0066] Obviously the turbine clearance 16 can be controlled by adjusting the temperature, the pressure and the flow rate of the control fluid fed to the clearance control cavity 29.

[0067] In other words, the regulator 37 is configured to regulate the temperature and/or the pressure and/or the flow rate of the control fluid on the basis of the assembly parameters in order to keep the turbine clearance 16 at the desired values.

[0068] For example the regulator 37 is configured to regulate the temperature and/or the pressure and/or the flow rate of the control fluid on the basis of at least one parameter such as local temperature and/or clearance measurements and/or load condition of the turbine 5 and/or the speed of load variations of the turbine 5 and/or temperature at the turbine inlet, etc.

[0069] According to the non-limitative embodiment disclosed in figure 2, the discharge conduit 34 connected to the outlet 33 of at least one of the clearance control cavities 29 extends substantially axially and flows into the working expansion channel 7. According to a variant not illustrated the discharge conduit 34 does not extend axially and is inclined at an angle with respect to the axis A.

[0070] The vane carrier 10 comprises at least a portion of the discharge conduit 34.

[0071] In the non-limiting example here disclosed and illustrated the discharge conduit 34 is completely realized in the vane carrier 10 and extends from the annular seat 27 to the expansion channel 7.

[0072] In particular the discharge conduit 34 discharges the control fluid into the expansion channel 7 through a discharge port 38.

[0073] According to an embodiment not illustrated, part of the discharge conduit 34 can be realized also in the governing ring 28.

[0074] Thanks to the discharge conduits 34 the control fluid discharged in the expansion channel 7 can provide a further useful work in the turbine 5, improving the overall efficiency of the assembly 1.

[0075] Preferably, discharge port 38 is arranged on the vane carrier 10 between a radial array of rotor gas turbine blades 13 and a radial array of stator gas turbine vanes 11.

[0076] According to a variant not illustrated at least one of the discharge conduits can discharge the control fluid directly or indirectly into components requiring cooling, such as vanes, stator platforms (not illustrated in the attached figures), heat shields (not illustrated in the attached figures). In this way the control fluid can be used for save dedicated cooling air (generally extracted from the compressor) thus improving the overall efficiency of the assembly 1.

[0077] According to another variant not illustrated at least one of the discharge conduits can discharge the control fluid directly or indirectly into selected stator cavities (not illustrated in the attached figures) needing purging air for preventing entrance of hot fluid coming from the expansion channel 7.

[0078] Preferably, the governing ring 28 and the vane carrier 10 are separated pieces made of different materials.

[0079] For example, the governing ring can be made by a particular material that is too expensive for realizing the entire vane carrier 10. For instance a material with better lifetime as the governing ring 28 needs to withstand more severe load cycles since it is exposed to alternating temperatures.

[0080] Preferably the governing ring 28 has radial dimensions greater than the radial dimensions of the vane carrier 10 at the annular seat 27 (i.e. substantially at the axial position A1). In this way the governing ring 28 has a radial stiffness higher than the radial stiffness of the vane carrier 10.

[0081] On the other hand, the governing ring 28 has a thermal delay lower than the thermal delay of the vane carrier 10 in order to be able to response to the clearance controller faster.

[0082] Preferably, the governing ring 28 and the vane carrier 10 are separated pieces coupled together with a permanent joint (i.e. welding) or with a releasable joint (i.e. releasable coupling elements such as bolts 40 shown in figure 2).

[0083] The coupling with a releasable joint allows an easy replacement of the governing ring 28.

[0084] With reference to figures 1-3, preferably at least one insert 41 is arranged inside at least a portion of the clearance control cavity 29.

[0085] Said insert 41 can be shaped in order to guide the flow of the control fluid inside the clearance control cavity 29 allowing freedom in designing the position of the inlet 30 and of the outlet 33 along the axis B of the clearance control cavity 29.

[0086] Said insert 41 can furthermore enhance the heat transfer between the control fluid flowing in the clearance control cavity 29 and the material of the governing ring 28 in order to influence the temperature of the governing ring 28 and consequently of the vane carrier 10. The insert 41, in fact, allow to operate with moderate flow quantities of the control fluid.

[0087] Insert 41 can be one of the inserts disclosed in EP 3023600.

[0088] In the non-limiting example here disclosed and illustrated in figure 2 and 3, the insert 41 has mainly the shape of a cylindrical hollow tube so as the flow of control fluid can pass through the insert 41, in order to limit the heat transfer with the governing ring 28, and in a gap 42 defined between the insert 41 and the respective inner surface of the clearance control cavity 29, in order to keep the maximum heat transfer area and increase the flow velocity.

[0089] Preferably the gap 42 defined between the insert 41 and the respective inner surface of the clearance control cavity 29 has a thickness (intended as the measure along a direction perpendicular to the axis B) which is a function of the diameter of the clearance control cavity 29. Preferably the ratio between the diameter of the clearance control cavity 29 and the thickness is comprised between 1:200 to 1:2.

[0090] In figures 4 and 5, another embodiment of a governing ring 128 is shown. In particular the governing ring 128 differs from the governing ring 28 of figures 1-3 for having a different clearance control cavity 140 and a different insert 141.

[0091] With reference to figure 4, the clearance control cavity 140 is a blind hole made into the governing ring 128 having an outlet 133 connected to a discharge channel 134 and an inlet 133 connected to an annular feeding common channel 131.

[0092] The insert 141 has mainly the shape of a cylindrical hollow body which is provided with a plurality of holes 142 on its surface.

[0093] With reference to figure 5, the insert 141 is provided with first outlet holes 142a on the bottom surface 143 of the cylindrical hollow body and a plurality of second outlet holes 142b on the lateral surface 144 of the cylindrical hollow body which faces, in use, the inner surface of the clearance control cavity 29. The insert 141 is further provided with a main inlet hole 145 (see figure 4) on the top surface 146 which faces, in use, the annular feeding common channel 31.

[0094] In use, the flow of control fluid enters inside the insert 141 through the main hole 145 on the top surface 146 and exits through the plurality of first outlet holes 142a and through the second outlets 142b in order to impinges on the inner surface of the clearance control cavity 140.

[0095] The flow of control fluid can pass also in the substantially annular gap 147 defined between the insert 141 and the respective inner surface of the clearance control cavity 140.

[0096] According to a variant not shown the insert can be provided with turbulators on the outer surface in order to create turbulence inside the gap. In this way the flow velocity and the heat transfer is improved.

[0097] For example said turbulators may be helicoidally bended ribs protruding from the outer surface of the insert.

[0098] According to a variant not shown the insert is provided with According to a variant not shown the insert is not cylindrical and has a shape defined by a combination of conical and cylindrical part so that the thickness T of the gap 42 can vary along the length of the insert.

[0099] According to a variant not shown the insert is provided with damping means configured to resist vibrations.

[0100] According to a variant not shown the clearance control cavity comprises also a dirt trap configured to accumulate dirt.

[0101] Insert 41 and 141 can be fixed in the respective clearance control cavity 29 either by screwing it in the clearance control cavity 29 (in this case the insert and the clearance control cavity have respective threaded portions) or by shrinking it to the clearance control cavity 29 or by caulking it with the clearance control cavity 29 or by fixing it to the clearance control cavity 29 with a locking screw, or by welding it to the clearance control cavity 29 or by press fitting it into the clearance control cavity 29.

[0102] Finally, it is clear that modifications and variants can be made to the assembly described herein without departing from the scope of the present invention, as defined in the appended claims.

Claims

1. Gas turbine assembly comprising:

at least one vane carrier (10; 20) extending along a longitudinal axis (A) and provided with at least one annular seat (27) and at least one governing ring (28; 128) housed in the annular seat (27) and provided with at least one clearance control cavity (29; 140) which extends transversally with respect to the longitudinal axis (A).

2. Gas turbine assembly according to claim 1, wherein the clearance control cavity (29; 140) extends radially with respect to the longitudinal axis (A).

3. Gas turbine assembly according to anyone of the foregoing claim, wherein the governing ring (28; 128) comprises at least one plurality of clearance control cavities (29; 140) distributed along a circumferential direction.

4. Gas turbine assembly according to claim 3, wherein the plurality of clearance control cavities (29; 140) are evenly distributed along a circumferential direction.

5. Gas turbine assembly according to anyone of the foregoing claims, wherein the clearance control cavity (29) is a through hole made into the governing ring (28).

6. Gas turbine assembly according to anyone of the foregoing claims, wherein the governing ring (28; 128) is made by at least two parts (12a, 12b) coupled together.

7. Gas turbine assembly according to anyone of the foregoing claims, wherein the clearance control cavity (29; 140) has at least one inlet (30) connected to a source of control fluid (31, 16, 3).

8. Gas turbine assembly according to anyone of the foregoing claims, wherein the clearance control cavity (29; 140) has at least one outlet (33) connected to a respective discharge conduit (34).

9. Gas turbine assembly according to claim 8, wherein the vane carrier (10; 20) comprises at least a portion of the discharge conduit (34); the discharge conduit (34) flowing into a working channel (7; 8) of the gas turbine assembly provided with vanes (11; 21).

10. Gas turbine assembly according to anyone of the foregoing claims, comprising at least one insert (41; 141) which is arranged inside at least one clearance control cavity (29; 140).

11. Gas turbine assembly according to claim 10, wherein the insert (41; 141) is hollow and preferably provided with an inlet hole (145) and a plurality of outlet holes (142a, 142b) on its surface (143, 144).

12. Gas turbine assembly according to anyone of the foregoing claims, wherein the governing ring (28; 128) and the vane carrier (10;20) are made of different materials.

13. Gas turbine assembly according to anyone of the foregoing claims, wherein the radial dimensions of the governing ring (28; 128) are greater than the radial dimensions of the vane carrier (10; 20) at the annular seat(27).

14. Gas turbine assembly according to anyone of the foregoing claims, wherein the governing ring (28; 128) is coupled to the vane carrier (10; 20) by releasable coupling elements (40).

15. Gas turbine assembly according to anyone of the foregoing claims, comprising a compressor (3), a combustor (4) and a gas turbine (5); wherein the gas turbine comprises the vane carrier (10) and the compressor clearance control cavity (29; 140) is connected to an extraction line (36), which is configured to extract air from the compressor (3) and feed it to the clearance control cavity (29; 140).

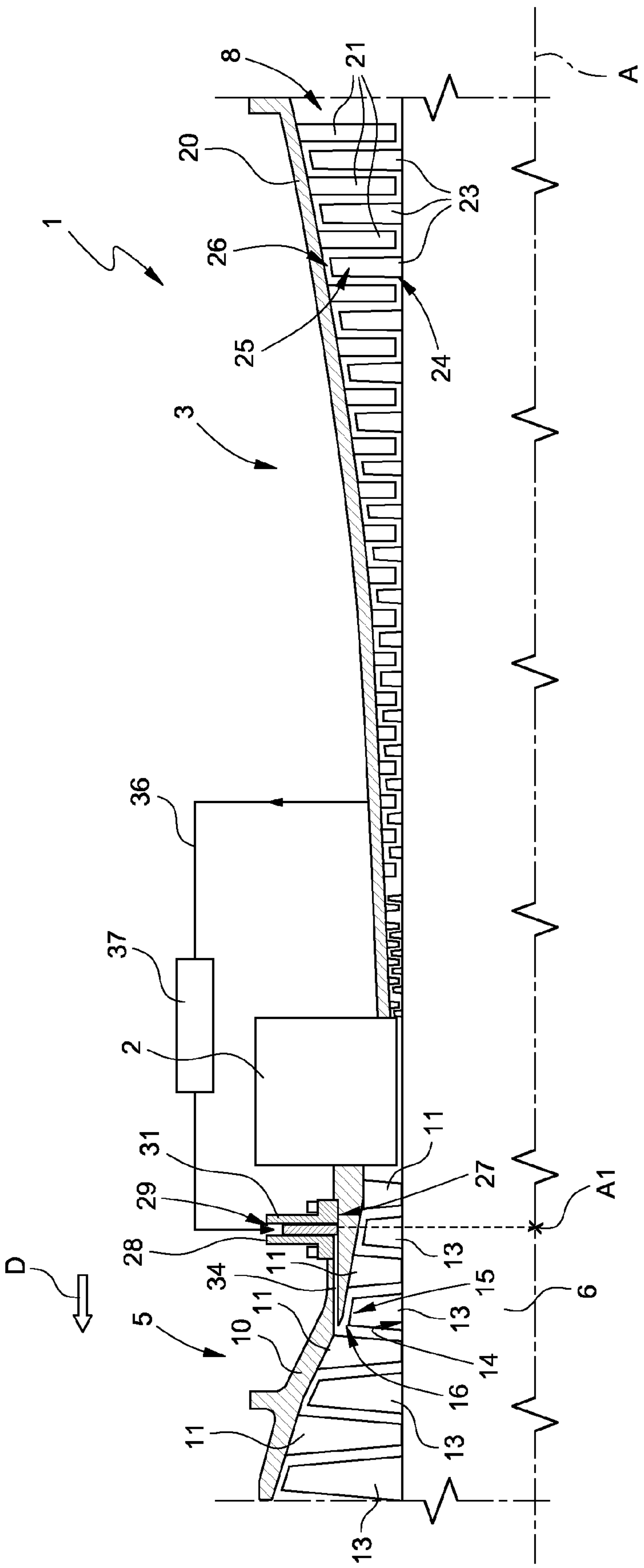

FIG. 1

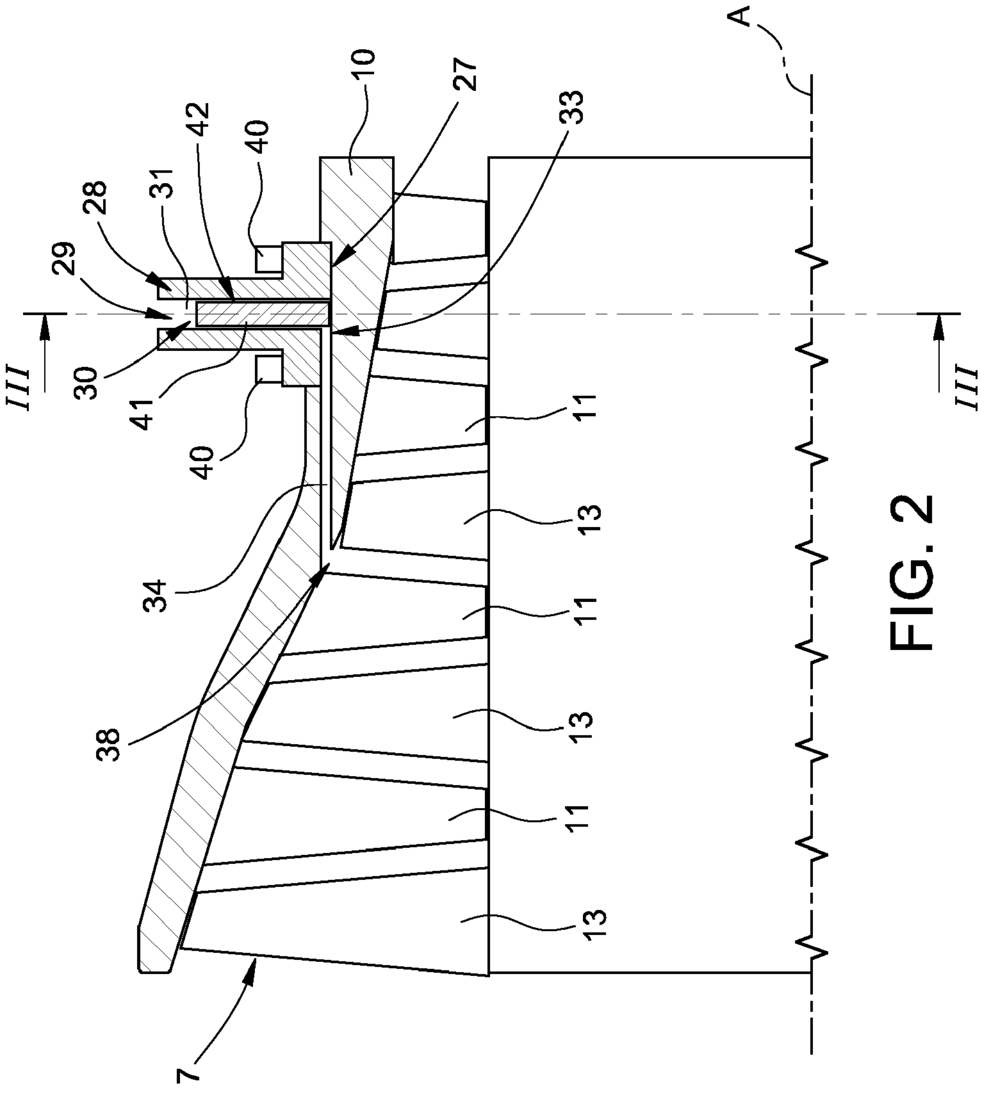

FIG. 2

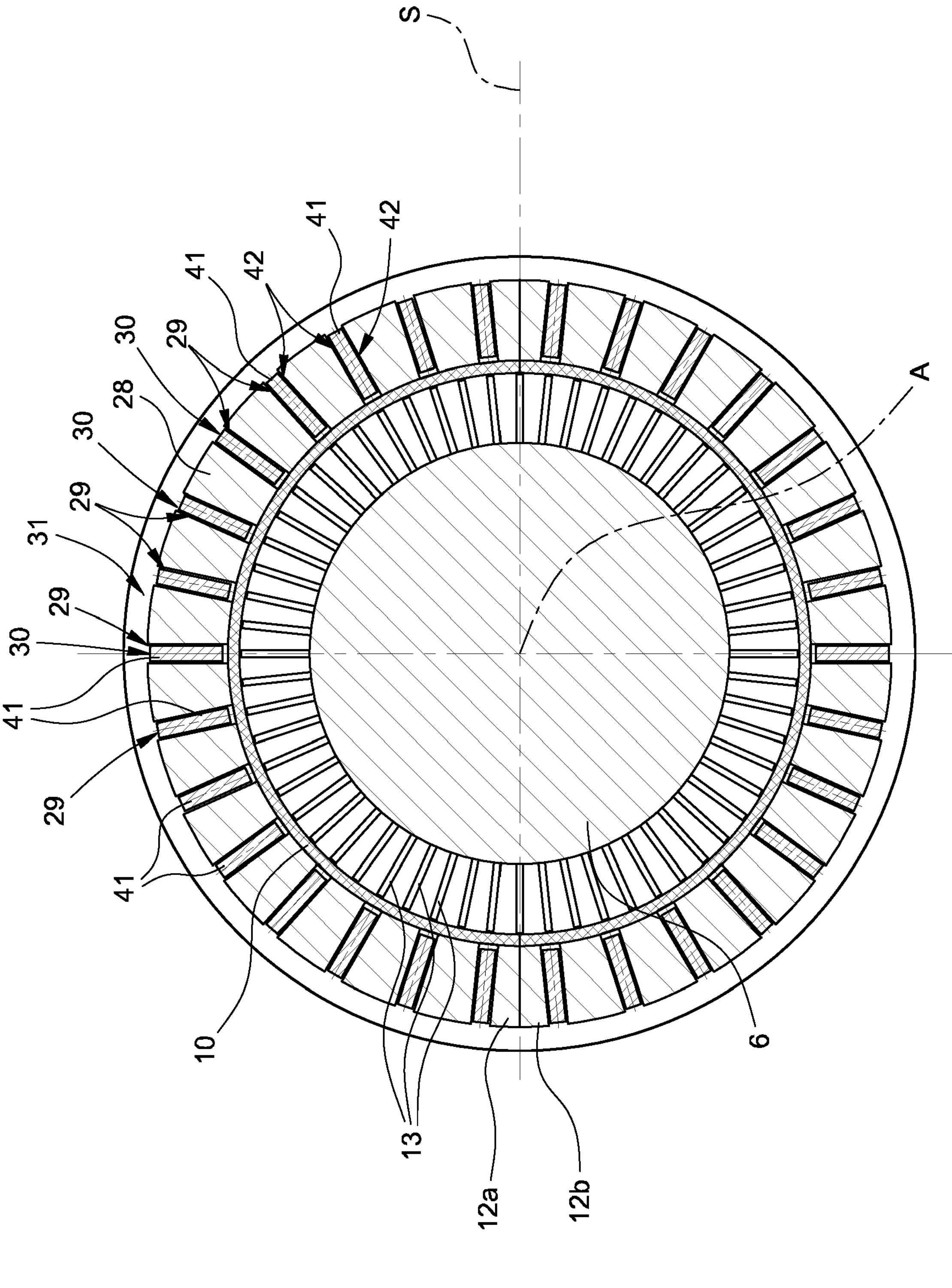

FIG. 3

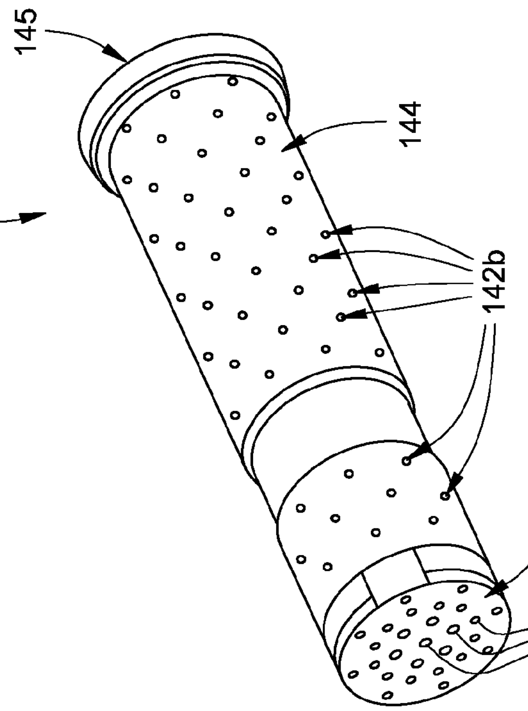
145
144
141
142b
143
142a

FIG. 5

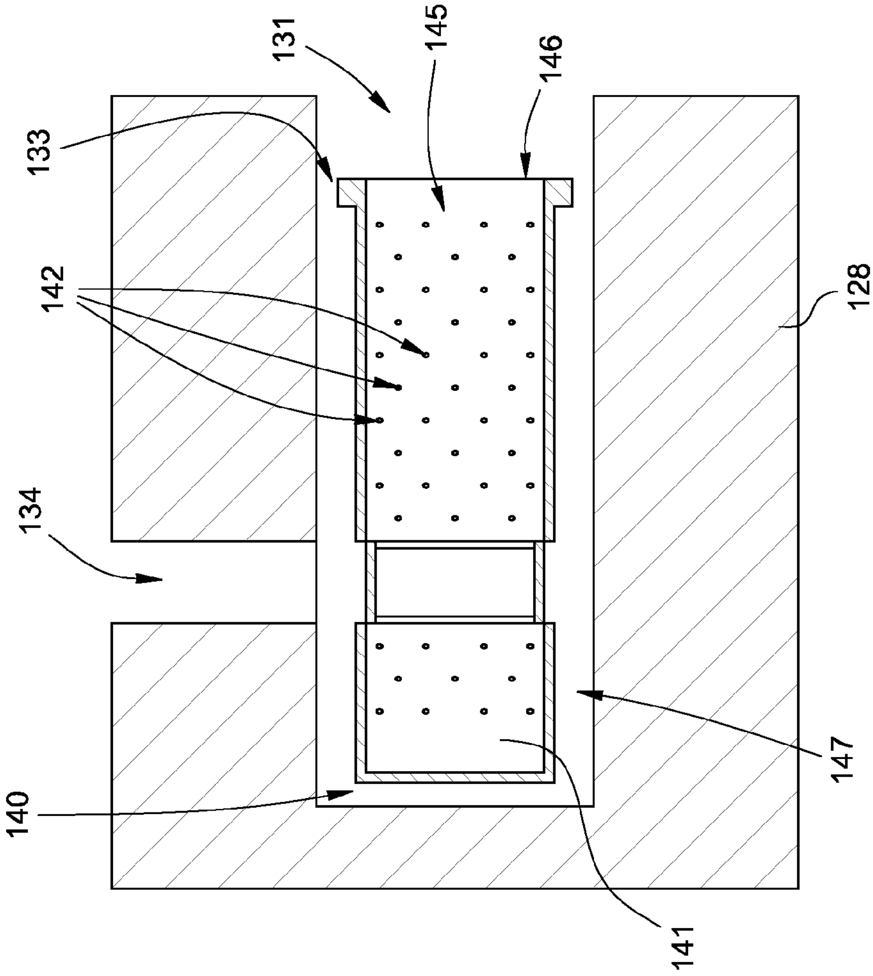
131
145
146
133
142
134
128
140
147
141

FIG. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 20 3661

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	US 2013/156541 A1 (ELEFTHERIOU ANDREAS [CA] ET AL) 20 June 2013 (2013-06-20) * page 2, paragraph 16 - page 2, paragraph 18; figures 1-4 *	1,2,6-9, 12,14,15 3,4,10, 11,13	INV. F01D11/24 F01D25/14
X	WO 2014/123654 A1 (GEN ELECTRIC [US]) 14 August 2014 (2014-08-14) * page 7, paragraph 42 - page 9, paragraph 50; figure 2 *	1,2,5-7, 12,14,15	
X	EP 2 770 168 A2 (PRATT & WHITNEY CANADA [CA]) 27 August 2014 (2014-08-27) * column 4, paragraph 14 - column 7, paragraph 27; figures 1-3 *	1,2,6,7, 12,14,15	
Y	US 2009/053035 A1 (ZHANG HUA [US] ET AL) 26 February 2009 (2009-02-26) * column 2, paragraph 24 - column 4, paragraph 41; figures 1-7 *	3,4	
Y	EP 2 960 441 A1 (GEN ELECTRIC [US]) 30 December 2015 (2015-12-30) * column 10, paragraph 35 - column 10, paragraph 36; claim 1; figures 1-3,4A,4B *	13	TECHNICAL FIELDS SEARCHED (IPC) F01D
Y,D	EP 3 023 600 A1 (ALSTOM TECHNOLOGY LTD [CH]) 25 May 2016 (2016-05-25) * page 8, paragraph 42 - page 11, paragraph 50; figures 3-9 *	10,11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 April 2018	Rau, Guido

2

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 17 20 3661

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-04-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013156541 A1	20-06-2013	NONE	
WO 2014123654 A1	14-08-2014	BR 112015018957 A2	18-07-2017
		CA 2899895 A1	14-08-2014
		CN 104956035 A	30-09-2015
		EP 2954173 A1	16-12-2015
		JP 2016507695 A	10-03-2016
		US 2015369077 A1	24-12-2015
		WO 2014123654 A1	14-08-2014
EP 2770168 A2	27-08-2014	CA 2842137 A1	25-08-2014
		EP 2770168 A2	27-08-2014
		US 2014241854 A1	28-08-2014
US 2009053035 A1	26-02-2009	CH 697808 A2	27-02-2009
		CN 101382087 A	11-03-2009
		DE 102008044435 A1	26-02-2009
		JP 5451003 B2	26-03-2014
		JP 2009052547 A	12-03-2009
		US 2009053035 A1	26-02-2009
EP 2960441 A1	30-12-2015	BR 102015015174 A2	06-03-2018
		CA 2895531 A1	24-12-2015
		CN 105386799 A	09-03-2016
		EP 2960441 A1	30-12-2015
		JP 2016027259 A	18-02-2016
		US 2016003086 A1	07-01-2016
EP 3023600 A1	25-05-2016	CN 106065789 A	02-11-2016
		EP 3023600 A1	25-05-2016
		JP 2016104988 A	09-06-2016
		US 2016146036 A1	26-05-2016

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20060225430 A **[0011]**
- EP 3023600 A **[0011] [0087]**