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(54) STATOR ASSEMBLY FOR A GAS TURBINE AND GAS TURBINE COMPRISING SAID STATOR ASSEMBLY

(57) A stator assembly (22) for a gas turbine comprising is provided with:
• a stator ring (24), which extends about a longitudinal axis (A) and comprises an inner edge and an outer edge (29); the outer edge being provided with an annular groove (30); the annular groove (30) defining a leading wall (34) and a trailing wall (35); the trailing wall (34) being provided with an annular trailing radial face (36a) and with an annular trailing axial face (36b);
• a plurality of stator vanes (25) radially arranged and coupled alongside one another to the outer edge (29) of the stator ring (24) so as to close the annular grove (30) and define an annular cooling channel (32);
the stator ring (24) being provided with at least one trailing cooling hole (39) having an inlet (40) facing the annular cooling channel (32) and an outlet (41) arranged on the annular trailing radial face (36b).

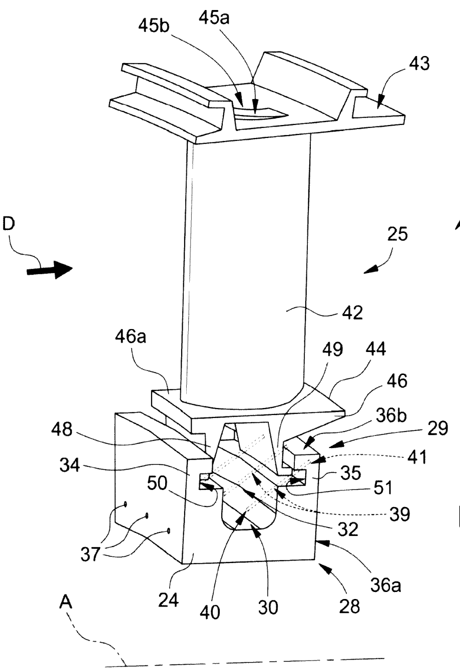

FIG. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to a stator assembly for a gas turbine and to a gas turbine comprising said stator assembly. In particular, the gas turbine of the present invention is part of a plant for the production of electrical energy.

BACKGROUND

[0002] As is known, a gas turbine for power plants comprises a compressor, a combustor and a turbine.

[0003] In particular, the compressor comprises an inlet supplied with air and a plurality of rotating blades compressing the passing air. The compressed air leaving the compressor flows into a plenum, i.e. a closed volume delimited by an outer casing, and from there into the combustor. Inside the combustor, the compressed air is mixed with at least one fuel and combusted. The resulting hot gas leaves the combustor and expands in the turbine. In the turbine the hot gas expansion moves rotating blades connected to a rotor, performing work.

[0004] Both the compressor and the turbine comprise a plurality of stator assemblies axially interposed between rotor assemblies.

[0005] Each rotor assembly comprises a rotor disk rotating about a main axis and a plurality of blades supported by the rotor disk.

[0006] Each stator assembly comprises a plurality of stator vanes supported by a respective vane carrier and a stator ring arranged about the rotor.

[0007] A plurality of inter-assembly cavities is defined between the stator assemblies and the rotor assemblies.

[0008] In the turbine, sealing air is normally bled from the compressor and introduced in said inter-assembly cavities in order to avoid or limit the hot gas ingestion from the hot gas path in the inter-assemblies cavities.

[0009] The minimization of the amount of air spent to seal and cool the inter-assembly cavities is beneficial to the power plant performance. However, said minimization implies the use of expensive advanced materials and/or the adoption of arrangements having a very complex geometry.

SUMMARY

[0010] The object of the present invention is therefore to provide a stator assembly for a gas turbine, which enables avoiding or at least mitigating the described drawbacks.

[0011] In particular, it is an object of the present invention to provide a stator assembly having an improved structure able to minimize the amount of sealing air and preserving, at the same time, the thermal conditions of the stator and rotor parts.

[0012] According to said objects the present invention relates to a stator assembly for a gas turbine comprising:

- a stator ring, which extends about a longitudinal axis and comprises an inner edge and an outer edge; the outer edge being provided with an annular groove; the annular groove defining a leading wall and a trailing wall; the trailing wall being provided with an annular trailing radial face and with an annular trailing axial face;
- a plurality of stator vanes radially arranged and coupled alongside one another to the outer edge of the stator ring so as to close the annular grove and define an annular cooling channel;
- the stator ring being provided with at least one trailing cooling hole having an inlet facing the annular cooling channel and an outlet arranged on the annular trailing radial face.

[0013] Advantageously, the presence of trailing cooling holes creates a sealing flow in the trailing inter-assembly cavity interacting with the hot gas flow deriving from the ingestion.

[0014] According to a variant of the present invention, each stator vane comprises an airfoil, an outer shroud and an inner shroud coupled to the stator ring; the inner shroud comprising a platform.

[0015] Preferably, the radial distance between the center of the outlet of the trailing cooling hole and the inner edge of the stator ring being comprised in the range $0{,}45 \cdot DP$ and $0{,}75 \cdot DP$, wherein DP is the radial distance between the outer face of the platform and the inner edge of the stator ring.

[0016] According to a variant of the present invention, the trailing cooling hole extends along an extension axis; on a longitudinal axial plane defined by the longitudinal axis and a radial direction orthogonal to the longitudinal axis and intersecting the extension axis, a first angle defined by the projection of the extension axis on the longitudinal axial plane (A-R) and the radial direction is comprised between 0° and 50°.

[0017] According to a variant of the present invention, the trailing cooling hole extends along an extension axis; on a tangential plane defined by the longitudinal axis and a circumferential direction, which is orthogonal to the longitudinal axis and orthogonal to a radial direction in turn orthogonal to the longitudinal axis, a second angle is defined by the projection of the extension axis on the tangential plane and the axial direction is comprised between 20° and 70°.

[0018] Thanks to the radial position and inclination of the trailing cooling holes, the sealing cooling air coming from the trailing cooling holes is directed towards the entrance of the trailing inter-assembly cavity.

[0019] In this way, the sealing cooling air coming from the trailing cooling holes penetrates the hot flow ingested favoring a more adequate sealing/cooling of the trailing inter-assembly cavity.

[0020] According to a variant of the present invention, the inlet of the trailing cooling hole has a diameter comprised between 1 mm and 5 mm.

[0021] According to a variant of the present invention, the trailing cooling hole has a constant cross section.

[0022] According to a variant of the present invention, the stator ring is provided with a plurality of trailing cooling holes.

[0023] According to a variant of the present invention, the outlets of the plurality of trailing cooling holes are evenly distributed along the annular trailing radial face.

[0024] According to a variant of the present invention, the number of trailing cooling holes is comprised in the range 0,5·NV -2·NV; wherein NV is the number of stator vanes of the stator assembly.

[0025] According to a variant of the present invention, the inner shroud comprises a leading flange and a trailing flange, both extending radially inward from the platform; the leading flange being coupled to the leading wall and the trailing flange being coupled to the trailing wall; the trailing flange being coupled to the trailing wall so as to leave a trailing radial gap between the trailing wall and the platform and to define a trailing surface of the trailing flange facing said trailing radial gap.

[0026] According to a variant of the present invention, the trailing flange is provided on the trailing surface with at least one secondary cooling hole in fluid communication with the annular cooling channel.

[0027] According to a variant of the present invention, the trailing flange is provided on the trailing surface with a plurality of secondary cooling holes circumferentially aligned.

[0028] According to a variant of the present invention, the secondary cooling holes are evenly distributed.

[0029] It is also an object of the present invention to provide a gas turbine which is reliable and wherein the consumption of sealing air is reduced. According to said objects the present invention relates to a gas turbine as claimed in claim 15.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] 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 schematic sectional front view, with parts removed for clarity, of a gas turbine electric power plant according to the present invention;
- Figure 2 is a schematic sectional front view, with parts removed for clarity, of a first detail of Figure 1;
- Figure 3 is a schematic perspective view, with parts in section and parts removed for clarity, of a second detail of Figure 1;
- Figure 4 is a different schematic perspective view, of the second detail of figure 3;
- Figure 5 is a schematic sectional lateral view, with parts removed for clarity, of a third detail of Figure 1;
- Figure 6 is a schematic perspective view, with parts in section and parts removed for clarity, of a fourth detail of Figure 4.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0031] In figure 1 reference numeral 1 indicates a gas turbine electric power plant (schematically shown in Figure 1).

[0032] The plant 1 comprises a compressor 3, a combustion chamber 4, a gas turbine 5 and a generator (for simplicity, not shown in the attached figures).

[0033] The compressor 3, turbine 5 and generator (not shown) are mounted on the same shaft to form a rotor 8, which is housed in stator casings 9 and extends along an axis A.

[0034] In greater detail, the rotor 8 comprises a front shaft 10, a plurality of rotor assemblies 11 and a rear shaft 13.

[0035] Each rotor assembly 11 comprises a rotor disk 15 and a plurality of rotor blades 16 coupled to the rotor disk 15 and radially arranged.

[0036] The plurality of rotor disks 15 are arranged in succession between the front shaft 10 and the rear shaft 13 and preferably clamped as a pack by a central tie rod 14. As an alternative, the rotor disks may be welded together.

[0037] A central shaft 17 separates the rotor disks 15 of the compressor 3 from the rotor disks 15 of the turbine 5 and extends through the combustion chamber 4.

[0038] Further, stator assemblies 22 are alternated with the compressor rotor assemblies 11.

[0039] Each stator assembly 22 comprises a stator ring 24 and a plurality of stator vanes 25, which are radially arranged and coupled to the stator ring 24 and to the respective stator casing 9.

[0040] In figure 2 an enlarged view of a stator assembly 22 between two rotor assemblies 11 in the turbine 5 is shown.

[0041] Arrow D indicates the direction of the hot gas flow flowing in a hot gas channel 18 of the turbine 5.

[0042] Between the rotor assemblies 11 and the stator assembly 22 inter-assembly cavities 27 are arranged.

[0043] In particular, each stator assembly 22 defines a leading inter-assembly cavity 27a and a trailing inter-assembly cavity 27b, wherein the leading inter-assembly cavity 27a is upstream the trailing inter-assembly cavity 27b along the hot gas flow direction D.

[0044] With reference to figure 3 and figure 4, the stator ring 24 (only a part of which is visible in figures 3 and 4) extends about the longitudinal axis A and comprises an inner edge 28 and an outer edge 29, which is provided with an annular groove 30.

[0045] The plurality of stator vanes 25 are coupled alongside one another to the outer edge 29 of the stator ring 24 so as to close the annular groove 30 and define an annular cooling channel 32.

[0046] The annular cooling channel 32 is fed with air preferably coming from the compressor 3.

[0047] The annular groove 30 defines a leading wall 34 and a trailing wall 35. The leading wall 34 is upstream the trailing wall 35 along the hot gas flow direction D.

[0048] The trailing wall 35 is also provided with an annular trailing radial face 36a and with an annular trailing axial face 36b.

[0049] Preferably, the leading wall 34 is provided with a plurality of leading cooling holes 37 in fluidic communication with the annular cooling channel 32.

[0050] Preferably, the cooling openings 37 are arranged in the proximity of the inner edge 28.

[0051] In the non-limiting example here disclosed and illustrated, the cooling openings 37 are circumferentially aligned and evenly distributed.

[0052] The trailing wall 35 is provided with at least one trailing cooling hole 39 in fluidic communication with the annular cooling channel 32.

[0053] In more detail, each trailing cooling hole 39 passes through the trailing wall 35 and has an inlet 40 facing the annular cooling channel 32 and an outlet 41 arranged on the annular trailing radial face 36a facing, in use, the trailing inter-assembly cavity 27b.

[0054] Each stator vane 25 comprises an airfoil 42, an outer shroud 43 and an inner shroud 44 coupled to the stator ring 24.

[0055] The airfoil 42 is provided with a cooling air duct 45a fed by a dedicated opening 45b on the outer shroud 43.

[0056] The outer shroud 43 is coupled to the respective stator casing 9.

[0057] The inner shroud 44 comprises a platform 46, a leading flange 48 and a trailing flange 49 extending radially inward from the platform 46. The leading flange 48 is upstream the trailing flange 49 along the hot gas flow direction D.

[0058] The leading flange 48 is coupled to the leading wall 34, while the trailing flange 49 is coupled to the trailing wall 35.

[0059] In the non-limiting example here disclosed and illustrated, the leading flange 48 engages a respective annular seat 50 of the leading wall 34, while the trailing flange 49 engages a respective annular seat 51 of the trailing wall 35.

[0060] With reference to figure 5, the leading flange 48 is coupled to the leading wall 34 so as to leave a leading radial gap 53 between the leading wall 34 and the platform 46 and to define a leading surface 54 of the leading flange 48 facing said leading radial gap 53.

[0061] The trailing flange 49 is coupled to the trailing wall 35 so as to leave a trailing radial gap 55 between the trailing wall 35 and the platform 46 and to define a trailing surface 56 of the trailing flange 49 facing said trailing radial gap 55.

[0062] The leading flange 48 is provided, on the leading surface 54, with at least one primary cooling hole 60 in fluid communication with the annular cooling channel 32.

[0063] Preferably, the leading flange 48 is provided, on the leading surface 54, with a plurality of primary cooling holes 60 circumferentially aligned.

[0064] The trailing flange 49 is provided, on the trailing surface 56, with at least one secondary cooling hole 61 in fluid communication with the annular cooling channel 32.

[0065] Preferably, the trailing flange 49 is provided, on the trailing surface 56, with a plurality of secondary cooling holes 61 circumferentially aligned.

[0066] In the non-limiting example here disclosed and illustrated, the secondary cooling holes 61 are evenly distributed.

[0067] According to the non-limitative embodiment here disclosed and illustrated, the secondary cooling holes 61 have a passage section smaller than the passage section of the primary cooling holes 60.

[0068] With reference to figures 3 and 4, the stator assembly 22 preferably comprises a plurality of trailing cooling holes 39, which are evenly distributed and preferably circumferentially aligned on the annular trailing radial face 36a.

[0069] Preferably, the number of trailing cooling holes 39 is comprised in the range $0,5 \cdot NV - 2 \cdot NV$; wherein NV is the number of stator vanes 25 of the stator assembly 22.

[0070] In particular, the distance DH between the centre of the outlet 41 of the cooling hole 39 and the inner edge 28 of the stator ring 24 is comprised in the range 0.45*(DP) e 0.75*(DP), wherein DP is the radial distance between the outer face 46a of the platform 46 and the inner edge 28 of the stator ring 24.

[0071] With reference to figure 6, the inlet 40 of the trailing cooling hole 39 has preferably a diameter d comprised between 1 mm and 5 mm.

[0072] Preferably, the trailing cooling hole 39 has a constant cross section.

[0073] The trailing cooling hole 39 extends along an extension axis O; on a longitudinal axial plane A-R defined by the longitudinal axis A and a radial direction R orthogonal to the longitudinal axis A and intersecting the extension axis O, a first angle α defined by the projection of the extension axis O on the longitudinal axial plane A-R and the axial direction is comprised between 0° and 50°. The angle α is measured from the axial direction A to the projection of the extension axis O in a counterclockwise direction looking in a tangential direction having on the left the compressor side.

[0074] While, on a tangential plane defined by the longitudinal axis A and a circumferential direction C, which is orthogonal to the longitudinal axis A and orthogonal to a radial direction R in turn orthogonal to the longitudinal axis A, a second angle β is defined by the projection of the extension axis on the tangential plane and the axial direction A.

[0075] Preferably, the trailing cooling hole 39 has a tangential inclination (defined by angle β), which is concordant with the direction of rotation of the machine W (counter-clock wise around axis A looking from the compressor side).

[0076] Said second angle β is preferably comprised between 20° and 70°.

[0077] The angle β is measured from the axial direction A to the projection of the extension axis O in a counter-clockwise direction looking in a tangential direction having on the left the compressor side.

[0078] In use, the hot gas flowing in the hot gas channel 18 is ingested in the trailing inter-assembly cavity 27b. however, thanks to the radial position and inclination of the trailing cooling holes 39, the sealing cooling air coming from the trailing cooling holes 39 is directed towards the entrance of the trailing inter-assembly cavity 27b.

[0079] In this way, the sealing cooling air coming from the trailing cooling holes 39 penetrates the hot flow ingested favoring a more adequate sealing/cooling of the trailing inter-assembly cavity 27b.

[0080] In particular, when the sealing cooling air coming from the trailing cooling holes 39 swirls in the direction of rotation, the difference of tangential velocity between the ingested hot gas and the sealing cooling air flow is reduced; this leads to a decrease of the shear-stress between the two interacting flows and facilitates the penetration of the sealing cooling air in the hot gas.

[0081] In this way, in the trailing inter-assembly cavity 27b the flow resulting from the interaction between the hot gas ingested flow and the sealing cooling air flow exhibits a more uniform swirl number distribution that ensures a significantly improved sealing / cooling capability.

[0082] In this way, the claimed solution allows to enhance the sealing effectiveness and the thermal state of the trailing inter-assembly cavity 27b and therefore to significantly reduce the total sealing air amount spent to seal the trailing inter-assembly cavity 27b, with a consequent improvement in engine performance.

[0083] Finally, it is clear that modifications and variants can be made to the stator assembly and to the gas turbine described herein without departing from the scope of the present invention, as defined in the appended claims.

Claims

1. Stator assembly (22) for a gas turbine comprising:

- a stator ring (24), which extends about a longitudinal axis (A) and comprises an inner edge and an outer edge (29); the outer edge being provided with an annular groove (30); the annular groove (30) defining a leading wall (34) and a trailing wall (35); the trailing wall (34) being provided with an annular trailing radial face (36a) and with an annular trailing axial face (36b);
- a plurality of stator vanes (25) radially arranged and coupled alongside one another to the outer edge (29) of the stator ring (24) so as to close the annular grove (30) and define an annular cooling channel (32);
- the stator ring (24) being provided with at least one trailing cooling hole (39) having an inlet (40) facing the annular cooling channel (32) and an outlet (41) arranged on the annular trailing radial face (36b).

2. Stator assembly wherein each stator vane (25) comprises an airfoil (38), an outer shroud (43) and an inner shroud (44) coupled to the stator ring (24); the inner shroud (44) comprising a platform (46).

3. Stator assembly according to claim 2, wherein the radial distance (DH) between the centre of the outlet (41) of the trailing cooling hole (39) and the inner edge (28) of the stator ring (24) being comprised in the range 0,45·DP e 0,75·DP, wherein DP is the radial distance between the outer face (46a) of the platform (46) and the inner edge (28) of the stator ring (24).

4. Stator assembly according to anyone of the foregoing claims, wherein the trailing cooling hole (39) extends along an extension axis (O); on a longitudinal axial plane (A-R) defined by the longitudinal axis (A) and a radial direction (R) orthogonal to the longitudinal axis (A) and intersecting the extension axis (O), a first angle (α) is defined by the projection of the extension axis (O) on the longitudinal axial plane (A-R) and the axial direction (A) and is preferably comprised between 0° and 50°.

5. Stator assembly according to anyone of the foregoing claims, wherein the trailing cooling hole (39) extends along an extension axis (O); on a tangential plane defined by the longitudinal axis (A) and a circumferential direction (C), which is orthogonal to the longitudinal axis (A) and orthogonal to a radial direction (R) in turn orthogonal to the longitudinal axis (A), a second angle (β) is defined by the projection of the extension axis (O) on the tangential plane and the axial direction (A) and is preferably comprised between 20° and 70°.

6. Stator assembly according to anyone of the foregoing claims, wherein the inlet (40) of the trailing cooling hole (39) has a diameter (d) comprised between 1 mm and 5 mm.

7. Stator assembly according to anyone of the foregoing claims, wherein the trailing cooling hole (39) has a constant cross section.

8. Stator assembly according to anyone of the foregoing claims, wherein the stator ring (24) is provided with a plurality of trailing cooling holes (39).

9. Stator assembly according to claim 5, wherein the outlets of the plurality of trailing cooling holes (39) are evenly distributed along the annular trailing radial face (36b).

10. Stator assembly according to claim 8 or 9, wherein the number of trailing cooling holes (39) is comprised in the range 0,5·NV -2·NV; wherein NV is the number of stator vanes of the stator assembly (24).

11. Stator assembly according to anyone of the claims from 2 to 10, wherein the inner shroud (40) comprises a leading flange (48) and a trailing flange (49), both extending radially inward from the platform (46); the leading flange (48) being coupled to the leading wall (34) and the trailing flange (49) being coupled to the trailing wall (35); the trailing flange (49) being coupled to the trailing wall (34) so as to leave a trailing radial gap (55) between the trailing wall (35) and the platform (46) and to define a trailing surface (56) of the trailing flange (49) facing said trailing radial gap (55).

12. Stator assembly according to claim 11, wherein the trailing flange (49) is provided on the trailing surface (56) with at least one secondary cooling hole (61) in fluid communication with the annular cooling channel (32).

13. Stator assembly according to claim 12, wherein the trailing flange (49) is provided on the trailing surface (56) with a plurality of secondary cooling holes (61) circumferentially aligned.

14. Stator assembly according to claim 13, wherein the secondary cooling holes (61) are evenly distributed.

15. Gas turbine extending along a longitudinal axis (A) and comprising:

a plurality of rotor assemblies (11), each of which comprises a rotor disk (15) and a plurality of rotor blades (16) radially arranged and coupled to the rotor disk (15);
a plurality of stator assemblies (22); the stator assemblies (22) and the rotor assemblies (11) are alternated along the axial direction (A);
at least one of the stator assemblies (22) being of the type claimed in anyone of the foregoing claims.

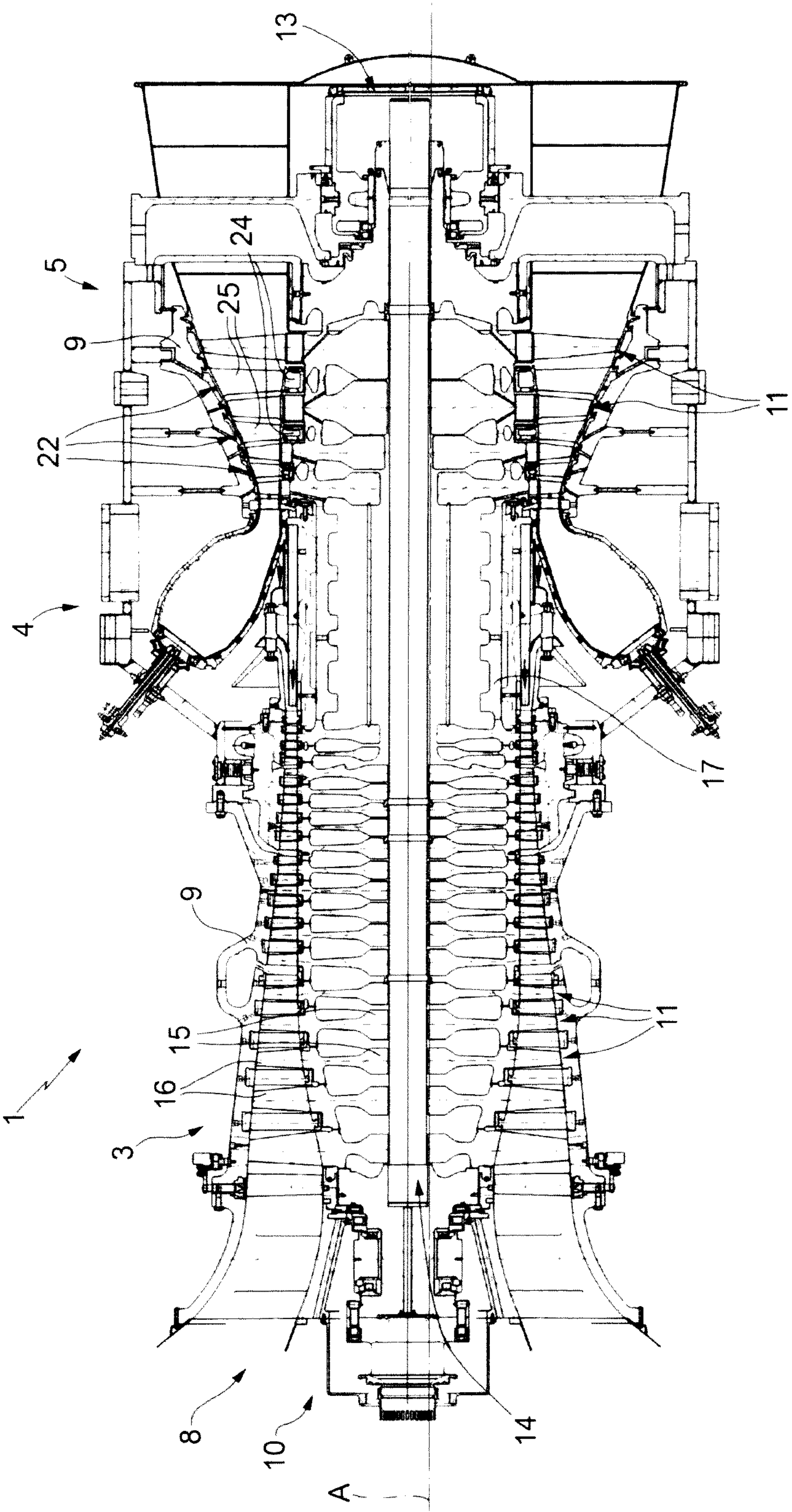

FIG. 1

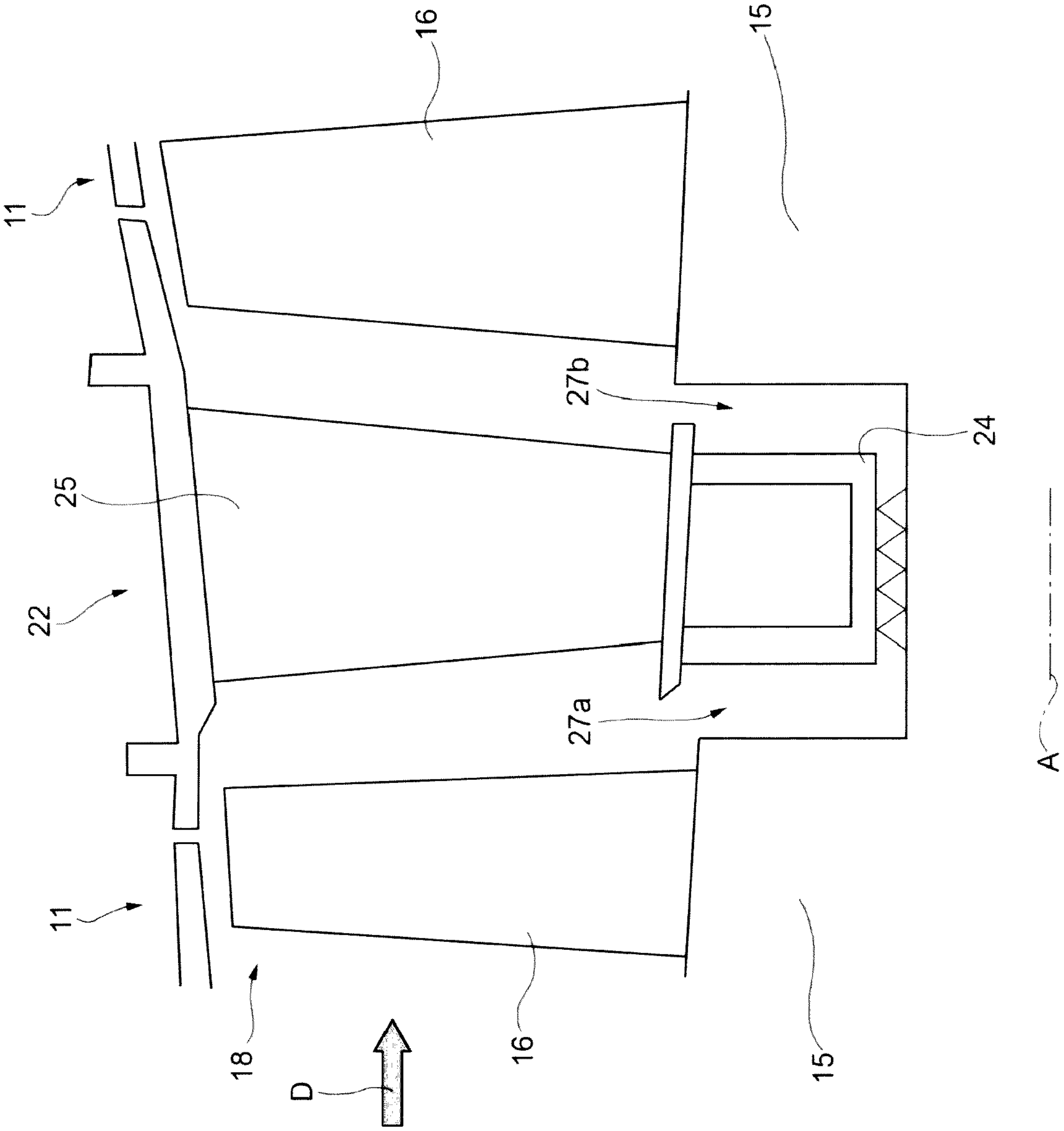

FIG. 2

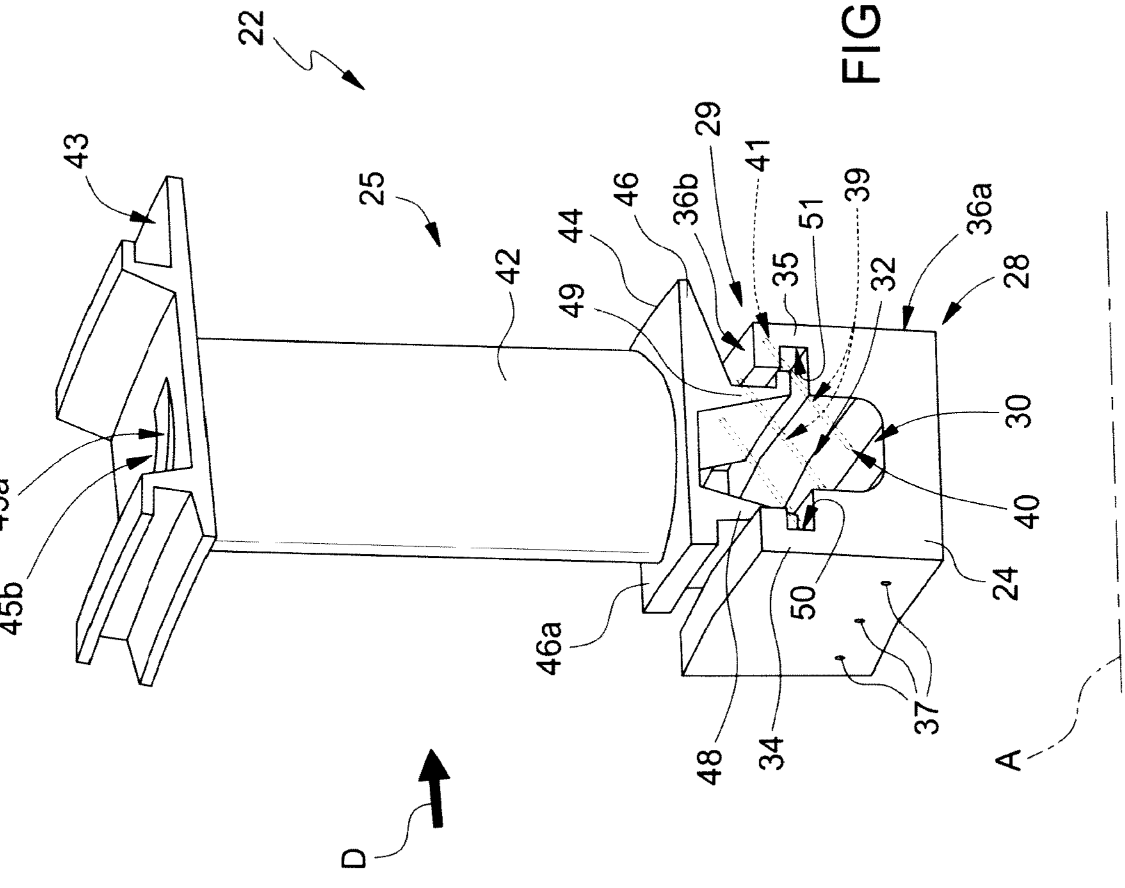
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FIG. 3

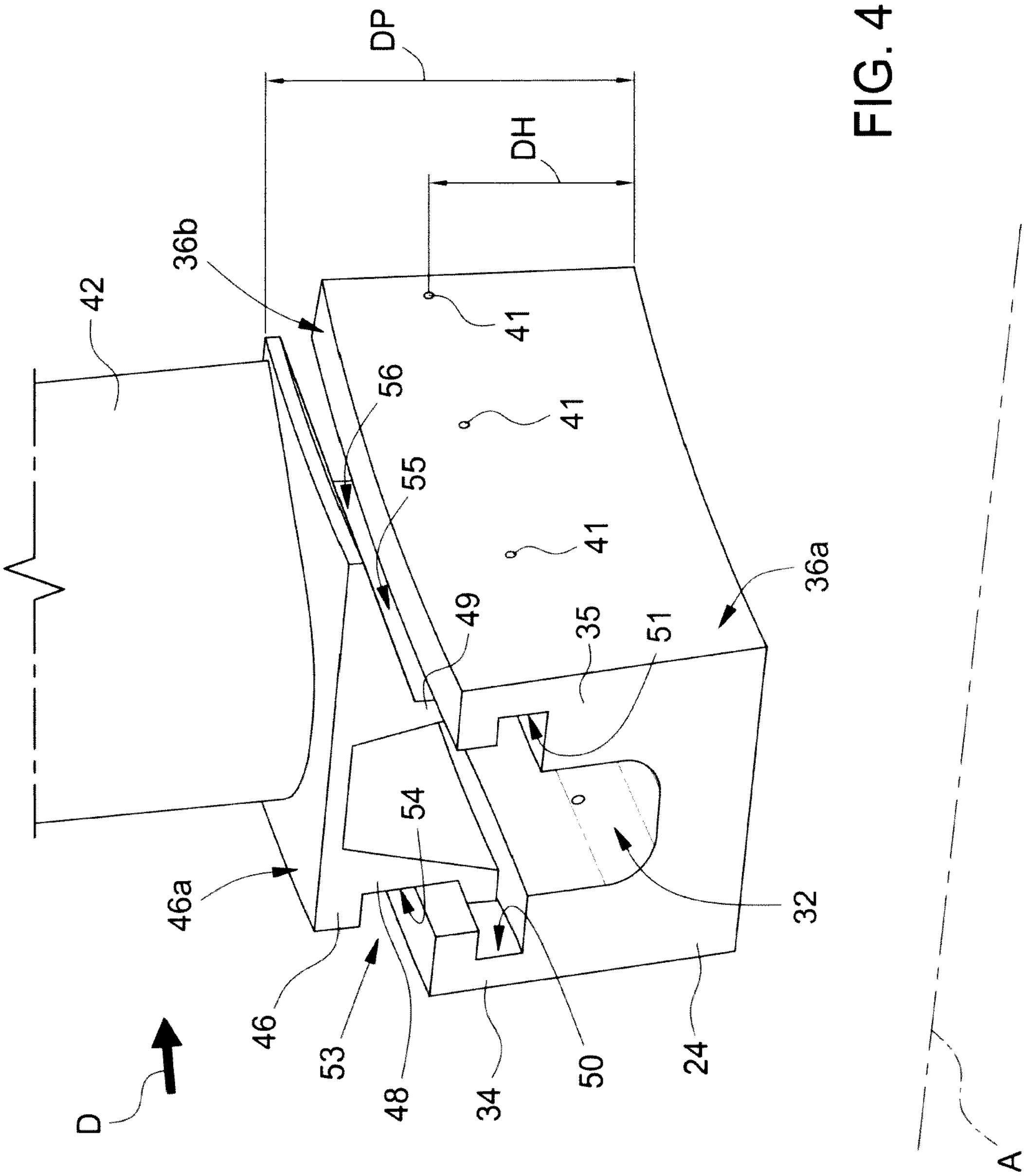

FIG. 4

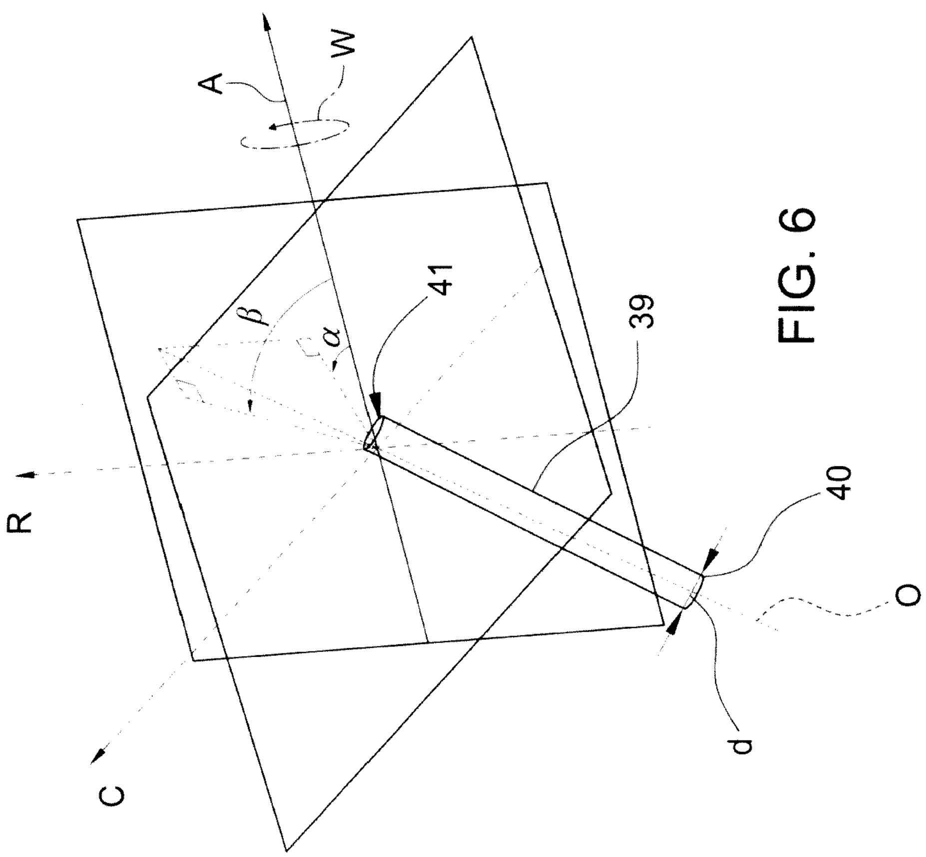

FIG. 6

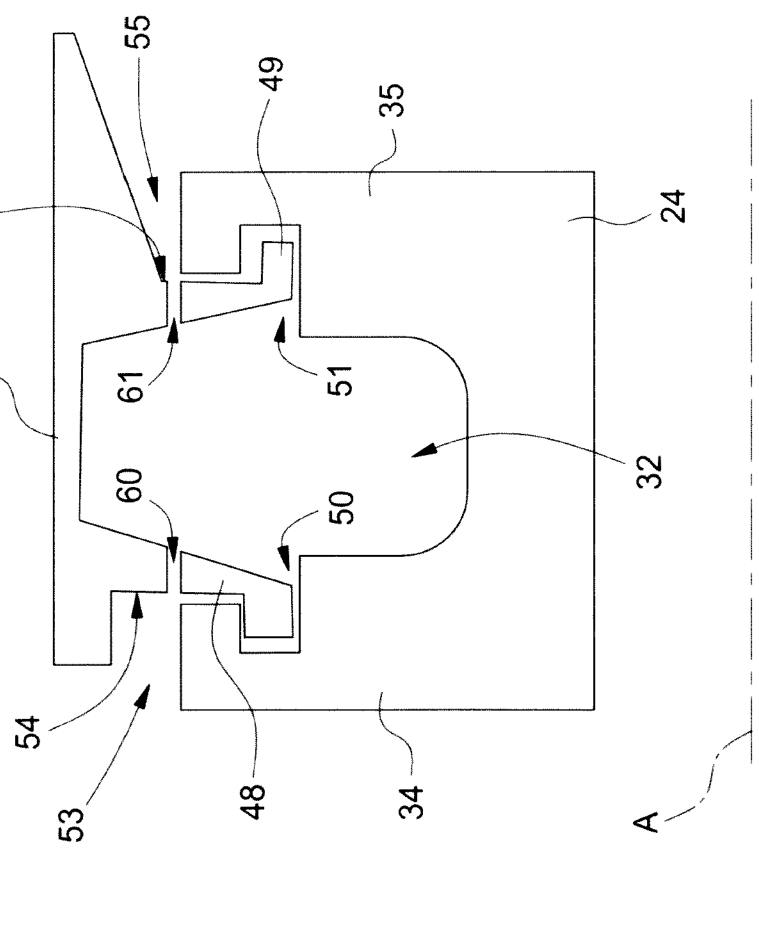

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 19 42 5077

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 A	US 2019/211698 A1 (KIM DONG HWA [KR]) 11 July 2019 (2019-07-11) * paragraphs [0114] - [0116]; figures 1, 3 *	1-11,15 12-14	INV. F01D11/04 F01D11/00 F01D5/30 F01D9/04 F01D9/06
X A	JP H10 26003 A (HITACHI LTD) 27 January 1998 (1998-01-27) * paragraphs [0001], [0002], [0023], [0025]; figure 1 *	1-10,15 11-14	
Y	US 2010/008760 A1 (MORRIS MARK C [US] ET AL) 14 January 2010 (2010-01-14) * paragraphs [0022] - [0031]; figures 1-3 *	4,5	
Y	US 6 481 959 B1 (HONEYWELL INT INC [US]) 19 November 2002 (2002-11-19) * column 5, line 53 - line 57; figure 5 *	4,5	
A	DE 11 2015 003047 T5 (MITSUBISHI HITACHI POWER SYS [JP]) 16 March 2017 (2017-03-16) * figure 6 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F01D
A	US 9 771 820 B2 (GEN ELECTRIC [US]) 26 September 2017 (2017-09-26) * column 8, line 60 - column 9, line 16; figures 7-9 *	1-15	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	31 March 2020	Georgi, Jan

CATEGORY OF CITED DOCUMENTS

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31-03-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019211698 A1	11-07-2019	KR 20190084465 A	17-07-2019
		US 2019211698 A1	11-07-2019
JP H1026003 A	27-01-1998	JP 3182343 B2	03-07-2001
		JP H1026003 A	27-01-1998
US 2010008760 A1	14-01-2010	NONE	
US 6481959 B1	19-11-2002	NONE	
DE 112015003047 T5	16-03-2017	CN 106460534 A	22-02-2017
		DE 112015003047 T5	16-03-2017
		JP 6344869 B2	20-06-2018
		JP WO2016002602 A1	27-04-2017
		KR 20170003989 A	10-01-2017
		US 2017198594 A1	13-07-2017
		WO 2016002602 A1	07-01-2016
US 9771820 B2	26-09-2017	CN 205744003 U	30-11-2016
		DE 102015122928 A1	30-06-2016
		JP 2016125486 A	11-07-2016
		US 2016186665 A1	30-06-2016

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