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

(11) EP 2 679 770 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.01.2014 Bulletin 2014/01

(51) Int Cl.:
F01D 5/08 *(2006.01)* ***F01D 5/30*** *(2006.01)*
F01D 11/00 *(2006.01)*

(21) Application number: **12173650.8**

(22) Date of filing: **26.06.2012**

(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

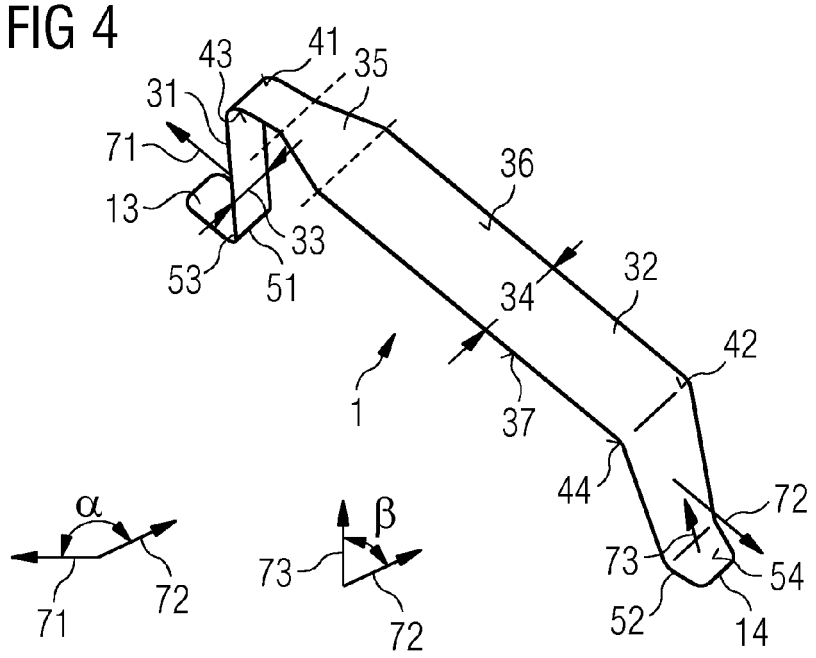
(71) Applicant: **Siemens Aktiengesellschaft**
80333 München (DE)

(72) Inventor: **Headland, Paul**
Lincoln, LN1 1NA (GB)

(54) Platform seal strip for a gas turbine

(57) A platform seal strip (1), in particular for use in a gas turbine blade assembly, is described. It comprises an upper side (36), a lower side (37), a first portion (31) and a second portion (32). The width (33) of the first portion (31) is smaller than the width (34) of the second portion (32). The first portion (31) and the second portion (32) are at least partially bent downwards such that the upper side (36) comprises a convex surface portion (41, 42) and the lower side (37) comprises a concave surface portion (43, 44).

FIG 4



EP 2 679 770 A1

Description

Field of the Invention

[0001] The present invention relates to a platform seal strip, a turbine blade assembly and a gas turbine. It further relates to a method for assembling a turbine blade assembly, for example a gas turbine blade assembly.

Background Art

[0002] The documents EP 2 053 285 A1 and EP 2 053 286 A1 describe a seal strip with varying width that is bent at one end and locked by the locking plate in the assembly.

[0003] In the document US 3,918,842 a sealing member such as a wire is mounted in a groove between blade platforms of a gas turbine engine to seal between the adjacent platforms.

[0004] US 6,561,764 B1 describes a gas turbine rotor comprising blade platforms with recesses into which insert strips are inserted. The recess reaches as far as the disc-side base of the blade platform and the insert strip to have a form fit to the disc, which protects against axial displacement in a direction of inserting of the gas turbine blade.

[0005] US 3,834,831 disclosures gas turbine engine, wherein cooling fluid may escape through radially directed passageways within the turbine blade or through a space between the adjacent blade platforms.

[0006] It has been accepted that a leakage flow will occur between the adjacent blade platforms of gas turbine blades. The air is used to cool the underside of the platforms before it leaks into the gas path. Excessive cooling air leakage wastes valuable cooling air and has an impact on the engine efficiency. Currently the sealing of a blade root can have up to 3 small seals to cover the two vertical joints and the one horizontal joint making them difficult to assemble and prone to leaking when all components are hot.

Description of the invention

[0007] It is a first objective of the present invention to provide an advantageous seals strip, in particular for use in a gas turbine blade assembly. A second objective of the present invention is to provide an advantageous turbine blade assembly and an advantageous gas turbine. A third objective of the present invention is to provide an advantageous method for assembling a turbine blade assembly, for example a gas turbine blade assembly.

[0008] The first objective is solved by a platform seals strip as claimed in claim 1. The second objective is solved by a turbine blade assembly as claimed in claim 5 and by a gas turbine as claimed in claim 11. The third objective is solved by a method for assembling a turbine blade assembly as claimed in claim 12. The depending claims define further developments of the present invention.

[0009] The inventive platform seals strip, in particular for use in a gas turbine blade assembly, comprises an upper side and a lower side. It further comprises a first portion and a second portion. The width of the first portion is smaller than the width of the second portion, which means that the width of the first portion has a smaller value than the width of the second portion. The first portion and the second portion are at least partially bent downwards such that the upper side comprises a convex surface portion and the lower side comprises a concave surface portion. In other words, the first portion and the second portion are bent towards the lower side.

[0010] "Downward" may mean, once the seal strip is installed, in direction of an axis of rotation of the machine. "Downward" also defines the orientation of the bend in respect of the upper side and the lower side, meaning that "downward" is a motion in direction of the lower side.

[0011] "Upper" and "lower" may merely define two opposite sides of the seal platform strip. Particularly "upper" may also mean, once the seal strip is installed, a direction away from of the axis of rotation of the machine. "Lower" may mean, once the seal strip is installed, a direction directed to the axis of rotation of the machine.

[0012] The invention seal strip may for example have an U-shape or a shape like an U. Convex surface portion or concave surface portion means that at least part of the surface has a curvature or bending which is convex if seen from the upper side or upper surface and which is concave if seen from the lower side or lower surface of the first portion or of the second portion. As a result of the bending the first portion may comprise an upper surface portion with a surface normal and the second portion may comprise an upper surface portion with a surface normal which includes an angle α with the surface normal of the first portion between 0° and 180°, which means $0° < \alpha \leq 180°$, advantageously between 90° and 180°.

[0013] The inventive seal strip has the advantage that inter seal leakage, for example between two adjacent blade platforms can be overcome by using a single piece seals strip.

[0014] Advantageously the inventive seal strip comprises a transition portion which is located between the first portion and the second portion. The width of the transition portion increases from the first portion to the second portion. Preferably the width of the transition portion continuously increases from the first portion to the second portion.

[0015] Generally the platform seal strip may comprise metal or may consist of metal.

[0016] Preferably the inventive seal strip comprises at least one nose. The nose may be located at the first portion or at the second portion. Advantageously one nose is located the first portion and an additional nose is located at the second portion. The nose is at least partially bent upwards such that the upper side of the seals strip with the nose comprises a concave surface portion and the lower side of the seal strip with the nose comprises a convex surface portion.

[0017] In the context of the present invention the term nose describes a portion of the seal strip which is bent with respect to the adjacent first or second portion. For example, the nose may have a surface portion with a surface normal. The first portion or the second portion may comprise a surface adjacent to the nose. This surface may have a surface normal which may include an angle β with the surface normal of the nose portion between 0° and 180°, which means $0° < \beta < 180°$, preferably between 60° and 90°.

[0018] The inventive turbine blades assembly comprises a number of platform seal strip, as previously described, a disc and a number of blades. Each blade comprises a blade platform. The blades are connected to the disc, for example loaded onto the disc. Each seal strip is placed in a gap between the blade platforms of adjacent blades.

[0019] The disc may comprise a rotation axis. The platform of each blade may comprise a side surface with a surface normal which includes a right angle with the rotation axis, especially when the blade is loaded onto a disc. The side surface of the platform may comprise a slot and part of the second portion of the seal strip engages in the slot.

[0020] Furthermore, the platform may comprise a leading edge side or upstream side and a trailing edge side or downstream side. The slot preferably extents up to the trailing edge side or downstream side. Generally the leading edge side of the platform is defined such that it corresponds to the leading edge of the aerofoil portion of the blade and the trailing edge side of the platform is defined such that it corresponds to the trailing edge of the aerofoil portion of the blade.

[0021] The disc can comprise a front face or upstream side and a rear face or downstream side, which are defined with respect to a hot gas flow through the turbine. A first cover plate or cover disc may be attached to the rear face of the turbine disc and/or a second cover plate may be attached to the front face of the turbine disc. Adding cover plates or cover discs to the front and/or rear face of the turbine disc assembly allows for making more efficient use of the cooling air. The cover plates or discs contain and direct cooling air in a more efficient manner than previously used, since they may comprise fluid channels for guiding cooling air.

[0022] By means of the describe seal strip the sealing at the plate platform is improved. For example, the seal strip may comprise a nose which engages into a groove of the first cover plate or into a groove the second cover plate. Advantageously the seal strip comprises a first nose at the first portion and a second nose at the second portion. The first nose can engage into a groove of the cover plate at the front face and the second nose can engage into a groove of the cover plate at the rear face.

[0023] Preferably only one seal strip is located between two adjacent blades. This reduces the number of necessary components to be assembled and reduces the time for assembling.

[0024] The cover discs, especially the second cover discs or forward cover disc which is attached to the front face, may comprise a seal means, for example a C-seal or 0-ring or rope seal as appropriate. The seal means my comprise metal or may consist of metal. The seal means is preferably located such that it faces the leading edge side or the trailing edge side of the platform of the blade or the blade root.

[0025] The inventive gas turbine comprises a turbine blade assembly as previously described. It generally has the same properties and advantages as described in conjunction with the inventive seal strip and the inventive turbine blade assembly.

[0026] The inventive method for assembling a turbine blade assembly is related to a turbine blade assembly as previously described. The method comprises the steps of loading the number of blades onto the disc leaving a gap between the platforms of adjacent blades, inserting a seal strip into the gap between the platforms of two adjacent blades, and retaining the seal strips by attaching a first cover plate to the disc.

[0027] Advantageously a second cover plate, for example a forward cover disc, may be attached to the disc before loading the blades onto the turbine disc. If the second cover plate is identical with a forward cover disc, than the first cover plate is identical with an aft cover disc. The forward cover disc may be connected to the front face of the disc and the aft cover disc may be connected to the rear face of the disc.

[0028] Preferably a seal strip with at least one nose is used and the at least one nose is inserted into a groove in the first or in the second cover plate. Advantageously the seal strip comprises two noses and a first nose is inserted into a groove in the forward cover disc and the second nose is inserted into a groove in the aft cover disc.

[0029] Moreover, a seal means can be positioned between the first cover plate, for example the aft cover disc, and the turbine disc. Additionally or alternatively a seal means can be positioned between the second cover plate, for example a forward cover disc, and the turbine disc. A C-seal or an 0-ring or a rope seal can be used as seal means. The used seal means may comprise metal or may consist of metal.

[0030] The present invention improves the sealing of turbine hot blade components. By improving the sealing also the cooling of a turbine blade can be improved. Furthermore, the amount of cooling air consumed by the turbine blades can be reduced. Moreover, the lifetime of the components is increased, leakages are reduced and the cooling air efficiency is improved. Furthermore, the part count and assembly time is reduced.

Description of embodiments

[0031] Further features, properties and advantages of the present invention will become clear from the following description of embodiments in conjunction with the accompanying drawings. The embodiments do not limit the

scope of the present invention which is determined by the appended claims. All described features are advantageous as separate features or in any combination with each other.

[0032] It has to be noted that embodiments of the invention have been described with reference to different subject matters. In particular, some embodiments have been described with reference to apparatus type claims whereas other embodiments have been described with reference to method type claims. However, a person skilled in the art will gather from the above and the following description that, unless other notified, in addition to any combination of features belonging to one type of subject matter also any combination between features relating to different subject matters, in particular between features of the apparatus type claims and features of the method type claims is considered as to be disclosed with this document.

Fig. 1 schematically shows a gas turbine.

Fig. 2 schematically shows part of an inventive turbine blade assembly in a sectional and perspective view.

Fig. 3 schematically shows the cooling fluid flow in part of an inventive turbine blade assembly in a sectional and perspective view.

Fig. 4 schematically shows an inventive platform seal strip 1 in a perspective view.

Figs. 5 and 6 schematically show part of an inventive turbine blade assembly in a perspective view during the insertion of the platform seal strip.

Fig. 7 schematically shows part of an inventive turbine blade assembly in a sectional and perspective view when the assembling process is finished.

[0033] Figure 1 schematically shows a gas turbine. A gas turbine comprises a rotation axis with a rotor. The rotor comprises a shaft 107. Along the rotor a suction portion with a casing 109, a compressor 101, a combustion portion 151, a turbine 105 and an exhaust portion with a casing 190 are located.

[0034] The combustion portion 151 communicates with a hot gas flow channel which may have a circular cross section, for example. The turbine 105 comprises a number of turbine stages. Each turbine stage comprises rings of turbine blades. In flow direction 103 of the hot gas in the hot gas flow channel a ring of turbine guide vanes 117 is followed by a ring of turbine rotor blades 115. The turbine guide vanes 117 are connected to an inner casing of a stator. The turbine rotor blades 115 are connected to the rotor. The rotor is connected to a generator, for example.

[0035] During operation of the gas turbine air is sucked and compressed by means of the compressor 101. The compressed air is led to the combustion portion 151 and is mixed with fuel. The mixture of air and fuel is then combusted. The resulting hot combustion gas flows through a hot gas flow channel to the turbine guide vanes 117 and the turbine rotor blades 115 and actuates the rotor.

[0036] Figure 2 schematically shows part of an inventive turbine blade assembly in a sectional and perspective view. The turbine blade assembly comprises a disc 12, a number of rotor blades 151, a first cover plate or aft cover disc 7 and a second cover plate or forward cover disc 6. The rotor blades 151 are mounted onto the disc 12.

[0037] The disc 12 comprises a front face or upstream side 26 and a rear face or downstream side 27, which are defined with respect to the hot gas flow direction 103. Before loading the blades 151 onto the disc 12, the forward cover disc 6 is connected to the front face 26. The aft cover disc 7 is connected to the rear face 27. The aft cover disc 7 is fitted after the blades 151 and seal strips 1 are loaded to the disc 12.

[0038] A seal means 8 is placed between the forward cover disc 6 and the blades 151, for example part of the platforms 3 of the blades, especially for preventing a hot gas flow into the blade root cavity 15. A further seal means 16 is placed between the forward cover disc 6 and the front face 26 of the disc 12. The seal means 8 and/or the seal means 16 may comprise metal or may consist of metal. The seal means 8 and/or seal means 16 may be a C-seal or an 0-ring or a rope seal.

[0039] Moreover, between the aft cover disc 7 and the blades 151, for example part of the platform 3 of the blades 151, a seal means 9 is positioned, for example to prevent a hot gas flow into the blade root cavity 15. The seal means 9 may have the same properties as the previously described seal means 8 or seal means 16.

[0040] The blades 151 comprise an aerofoil portion 2, a blade platform 3 and a blade root 19, which is not shown in Figure 2. The blade platform 3 is located between the aerofoil portion 2 and the blade root 19. The blade aerofoil portion 2 comprises a leading edge 4 and a trailing edge 5.

[0041] When loaded onto the disc 12, a small gap occurs between the platforms 3 of the adjacent blades 151. To seal this gap an inventive platform seal strip 1 is inserted between the adjacent platforms 3. Preferably only one platform seal strip 1 is inserted between each two adjacent platforms 3.

[0042] Fig. 3 schematically shows the cooling fluid flow in part of an inventive turbine blade assembly in a sectional and perspective view. The blades 151 comprise a blade under platform cavity 15, which is located inside the blade 151 below the platform 3 towards the blade root 19. Through this blade under platform cavity 15 cooling fluid, for example cooling air, can be guided into the

aerofoil portion 2.

[0043] Between the disc 12 and the forward cover disc 6 a flow channel 17 is formed, through which cooling fluid can be guided into the blade under platform cavity 15. The direction of the cooling fluid flow is indicated by arrows 18.

[0044] The platform portion 3 of the blade 151 comprises a leading edge side 21, corresponding to the leading edge of the aerofoil portion 4, a trailing edge side 22, corresponding to the trailing edge 5 of the aerofoil portion 2, and a side surface 23. The side surfaces 23 of adjacent blades 151 are facing towards each other. The side surface 23 comprises a surface normal 25. The surface normal 25 includes a right angle with a rotation axis 102 of the disc 12. The rotation axis 102 of the disc 12 may correspond to the rotation axis 102 of a gas turbine.

[0045] The side surface 23 of the platform 3 comprises a slot 24. The slot runs nearly parallel to the rotation axis 102 and extends up to the trailing edge side 22. Part of the platform seal strip 1 engages into the slot 24.

[0046] The platform seal strip 1 comprises a first nose or rebate 13 and a second nose or rebate 14. The first nose 13 engages into a corresponding groove 10 in the forward cover disc 6. The second nose 14 engages into a corresponding groove 11 in the aft cover disc 7. This provides a very effective seal between the forward cover disc 6, the platform 3 and the aft cover disc 7, as well as between adjacent blade platforms 3.

[0047] The inventive platform seal strip will now be described with reference to Figure 4. Figure 4 schematically shows an inventive platform seal strip 1 in a perspective view. The seal strip 1 comprises a first portion 31 and a second portion 32. The first portion 31 has a width 33. The second portion 32 has a width 34, which is larger than the width 33 of the first portion 31. Between the first portion 31 and the second portion 32 a transition portion 35 is located. The width of the transition portion 35 decreases continuously from the second portion 32 towards the first portion 31.

[0048] The platform seals strip 1 further comprises an upper side 36 and a lower side 37. The first portion 31 comprises a bending towards the lower side 37. As result the bending forms a convex surface portion 41 of the upper side 36 and a concave surface portion 43 of the lower side 37. The second portion 32 also comprises a bending towards the lower side 37. The bending forms a convex surface portion 42 of the upper side 36 and a concave surface portion 44 of the lower side 37. As a result of the two bending or curvatures of the platform seal strip 1 the first portion 31 comprises an upper side surface portion with an surface normal 71 and the second portion 32 comprises an upper side surface portion with a surface normal 72, which includes an angel α having a value between 0° and 180° ($0° < \alpha \leq 180°$). In Figure 4 the angle α has a value between 160° and 180°. Because of the bending of the first portion 31 and the second portion 32 the platform seal strip 1 has a shape of a U in a side view, as for example shown in Figure 3.

[0049] The first portion 31 further comprises a nose 13. The nose 13 is bent such that the upper side 36 comprises a concave surface portion 53 and the lower side 37 comprises a convex surface portion 51. The second portion 32 also comprises a nose 14, which is at least partially bent towards the upper side 36. The bending of the nose 14 forms a concave surface portion 54 at the upper side 36 and a convex surface portion 52 at a lower side 37.

[0050] For example, the noses 13 and 14 may have a surface portion with a surface normal. In Figure 4 the surface normal 73 of the nose 14 is shown as example. The first portion or the second portion may comprise a surface adjacent to the nose. This surface may have a surface normal, for example the surface normal 72 of the second portion, which includes an angle β with the surface normal 73 of the nose portion 14 between 0° and 180°, which means $0° < \beta < 180°$, preferably between 60° and 90°.

[0051] The inventive method for assembling a turbine blade assembly will now be described with reference to Figures 5, 6 and 7. Figures 5 and 6 schematically show part of an inventive turbine blade assembly in a perspective view during the insertion of the platform seal strip. Figure 7 schematically shows part of an inventive turbine blade assembly in a sectional and perspective view when the assembling process is finished.

[0052] At first the forward cover disc 6 was attached to the disc 12. Then, the blades 151 were loaded onto the disc 12, for example by inserting at least part of the blade root 19 into corresponding grooves 20 in the disc 12. Between adjacent platforms 151 a gap is left. After loading the blades 151 onto the disc 12 the seal strips 1 are inserted into the gap between the platforms 3 of adjacent blades 151. This is schematically shown in Figures 5 and 6. In Figure 5 the first portion 31 is inserted into the blade root cavity 15 via an opening between two adjacent blades 151 close to the slot 24 in the platforms 3. In doing so the seal strip 1 is canted over or turned. In Figure 6 the seal strip 1 is turned back into a correct position. The second portion 32 and part of the transition portion 35 slide into the slot 24.

[0053] The finished insertion is shown in Figure 7. Part of the second portion 32 and part of the transition portion 35 of the seals strip 1 engages into the slots 24 of the adjacent blades 151. The nose 13 of the first portion 31 is inserted into the corresponding groove 10 in the forward cover disc 6. For retaining the seal strips 1 and the blades 151 a first cover plate, in Figure 7 the aft cover disc 7, is attached to the disc 12. The nose 14 of the second portion 32 of the seal strip 1 is inserted or engages into the corresponding groove 11 of the aft cover disc 7.

[0054] Generally the present invention uses a single piece seal strip 1 to overcome inter seal leakage in order to make more efficient use of the cooling air. Cover discs 6 and 7 have been added to the front face 26 and the rear face 27 of the, for example CT, disc assembly. The cover discs 6 and 7 can contain and direct cooling air in

a more efficient manner then in previously known solutions. The present layout gives the opportunity to improve the sealing at the blade platform as shown in Figures 3 and 5 to 7.

[0055] The benefit of the invention is that the seal strip 1 is a single piece, for example of metal, eliminating leaks and joint inter faces and making assembly easier. The assembly of the single piece strip is allowed due to profile of the strip as shown in Figure 4. The narrow nose 13 allows it to be inserted into the gap between adjacent blades 151. The wider portion 32 of the strip then engages in the seal groove 24 machined into the side 23 of each blade 151, directly beneath the platform 3. The seal strip 1 is then pushed fully into the gap as shown in Figures 5 to 7. Following the insertion of seal strips 1 the aft cover plate 7 is attached to retain the strip 1.

[0056] To summarise, an embodiment of the invention is related to a platform seal strip 1, in particular for use in a gas turbine blade assembly, the platform seal strip 1 having sections that are substantially planar and sections that are curved. The platform seal strip 1 comprises an upper side 36 and a lower side 37. The platform seal strip 1 particularly being a sheet of metal that is three-dimensionally formed. The platform seal strip 1 comprises a first portion 31 - the first portion 31 being substantially planar - and a second portion 32 - the second portion 32 being substantially planar -, the width 33 of the first portion 31 being smaller than the width 34 of the second portion 32. The first portion 31 and the second portion 32 are connected via bent or curved sections, such that the upper side 36 comprises a convex surface portion 41, 42 and the lower side 37 comprises a concave surface portion 43, 44. The convex surface portion 41 and the concave surface portion 43 are opposite surfaces of the platform seal strip 1. The convex surface portion 42 and the concave surface portion 44 are also opposite surfaces of the platform seal strip 1. A first bend defined by the convex surface portion 42 and the concave surface portion 44 may be sharper than a second bend defined by the convex surface portion 41 and the concave surface portion 43. The first bend may have a substantially sharp edge whereas the second bend defines a smooth transition between the first portion 31 and the second portion 32.

Claims

1. A platform seal strip (1), in particular for use in a gas turbine blade assembly, comprising an upper side (36), a lower side (37), a first portion (31) and a second portion (32), the width (33) of the first portion (31) being smaller than the width (34) of the second portion (32),
   characterised in that
   the first portion (31) and the second portion (32) are at least partially bent downwards such that the upper side (36) comprises a convex surface portion (41, 42) and the lower side (37) comprises a concave surface portion (43, 44).

2. The platform seal strip (1) as claimed in claim 1, **characterised in that**
   it comprises a transition portion (35) which is located between the first portion (31) and the second portion (32), wherein the width of the transition portion (35) increases from the first portion (31) to the second portion (32).

3. The platform seal strip (1) as claimed in claim 1 or claim 2,
   characterised in that
   it comprises metal.

4. The platform seal strip (1) as claimed in any of the claims 1 to 3,
   characterised in that
   it comprises at least one nose (13, 14) located at the first portion (31) or at the second portion (32) which is at least partially bent upwards such that the upper side (36) comprises a concave surface portion (53, 54) and the lower side (37) comprises a convex surface portion (51, 52).

5. A turbine blade assembly comprising a number of platform seal strips (1) as claimed in any of the claims 1 to 4, a disc (12) and a number of blades (151), each blade (151) comprising a blade platform (3), wherein the blades (151) are connected to the disc (12) and each platform seal strip (1) is placed in a gap between the blade platforms (3) of adjacent blades (151).

6. The turbine assembly as claimed in claim 5,
   wherein the disc (12) comprises a rotation axis (102) and the platform (3) of each blade (151) comprises a side surface (23) with a surface normal (25) which includes a right angle with the rotation axis (102),
   characterised in that
   the side surface (23) comprises a slot (24) and part of the second portion (32) of the platform seal strip (1) engages in the slot (24).

7. The turbine assembly as claimed in claim 6,
   characterised in that
   the platform (3) comprises a leading edge side (21) and a trailing edge side (22) and the slot (24) extends up to the trailing edge side (22).

8. The turbine assembly as claimed in any of the claims 5 to 7,
   characterised in that the disc (12) comprises a front face (26) and a rear face (27) and a first cover plate (7) is attached to the rear face (27) and/or a second cover plate (6) is attached to the front face (26).

9. The turbine assembly as claimed in claim 8, **characterised in that** the platform seal strip (1) comprises a nose (13, 14) which engages into a groove (11) of the first cover plate (7) or into a groove (10) of the second cover plate (12).

10. The turbine assembly as claimed in any of the claims 5 to 9, **characterised in that** only one platform seal strip (1) is located between two adjacent blades (151).

11. A gas turbine comprising a turbine blade assembly as claimed in any of the claims 5 to 10.

12. A method for assembling a turbine blade assembly as claimed in any of the claims 5 to 10, comprising the steps of:

- loading the number of blades (151) onto the disc (12) leaving a gap between the platforms (3) of adjacent blades (151),
- inserting a platform seal strip (1) into the gap between the platforms (3) of two adjacent blades (151), and
- retaining the platform seal strips (1) by attaching a first cover plate (7) to the disc (12).

13. The method as claimed in claim 12, **characterised in** attaching a second cover plate (6) to the disc (12) before loading the blades (151) onto the disc (12).

14. The method as claimed in claim 12 or claim 13, **characterised in** using a platform seal strip (1) as claimed in claim 4 and inserting the at least one nose (13, 14) into a groove (10, 11) in the first (7) or second cover plate (6).

15. The method as claimed in any of the claims 12 to 14, **characterised in** positioning a seal means (9) between the first cover plate (7) and the disc (12) and/or positioning a seal means (8, 16) between the second cover plate (6) and the disc (12).

FIG 1

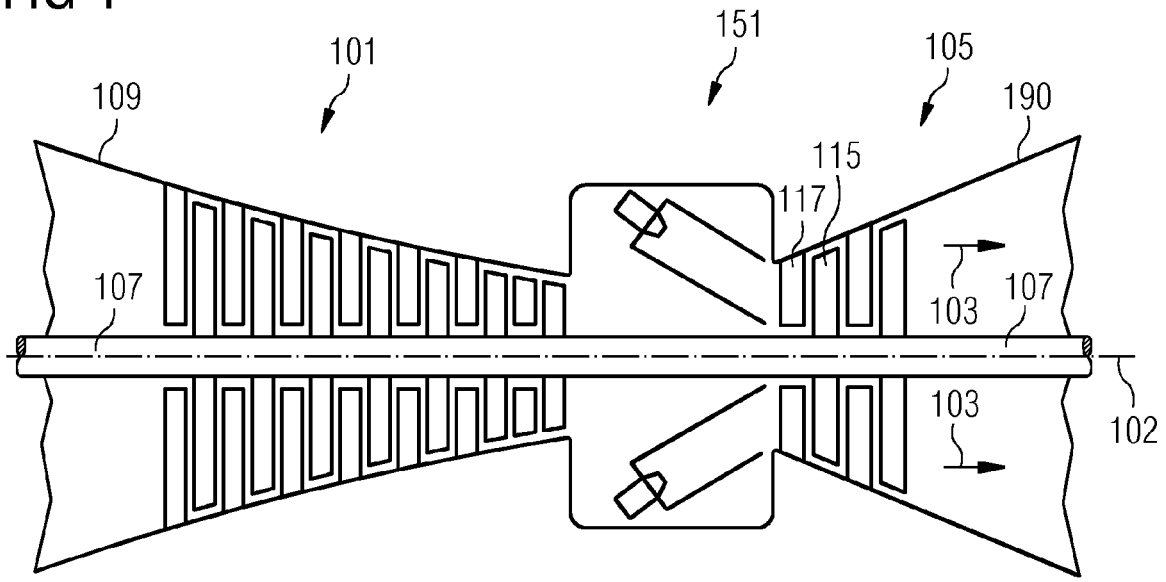

101
151
105
109
190
115
117
107
103
107
103
102

FIG 2

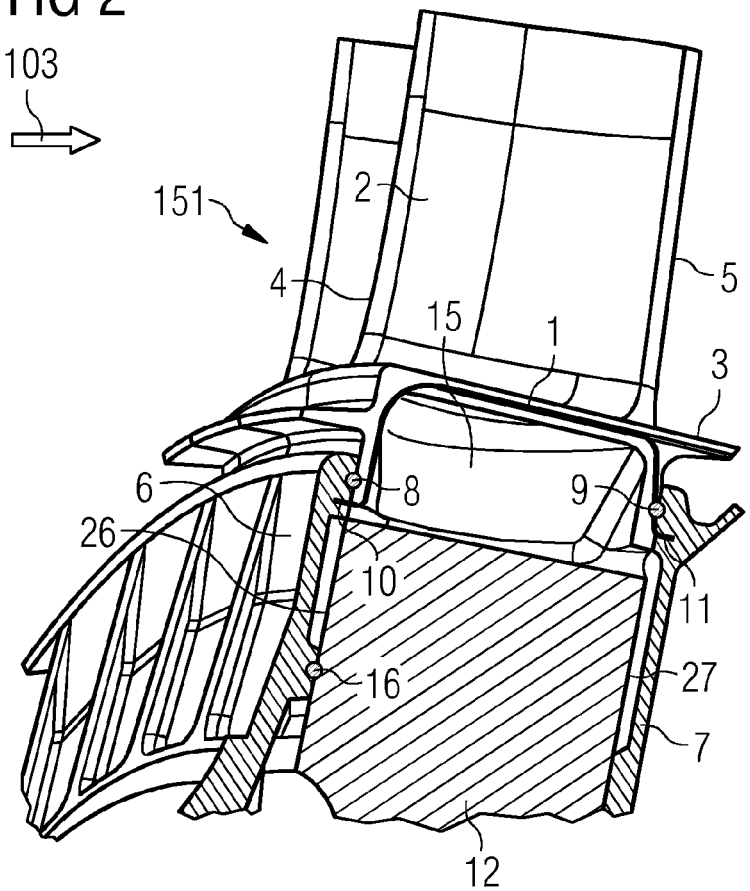

103
151
2
4
5
15
1
3
6
8
9
26
10
11
16
27
7
12

FIG 3

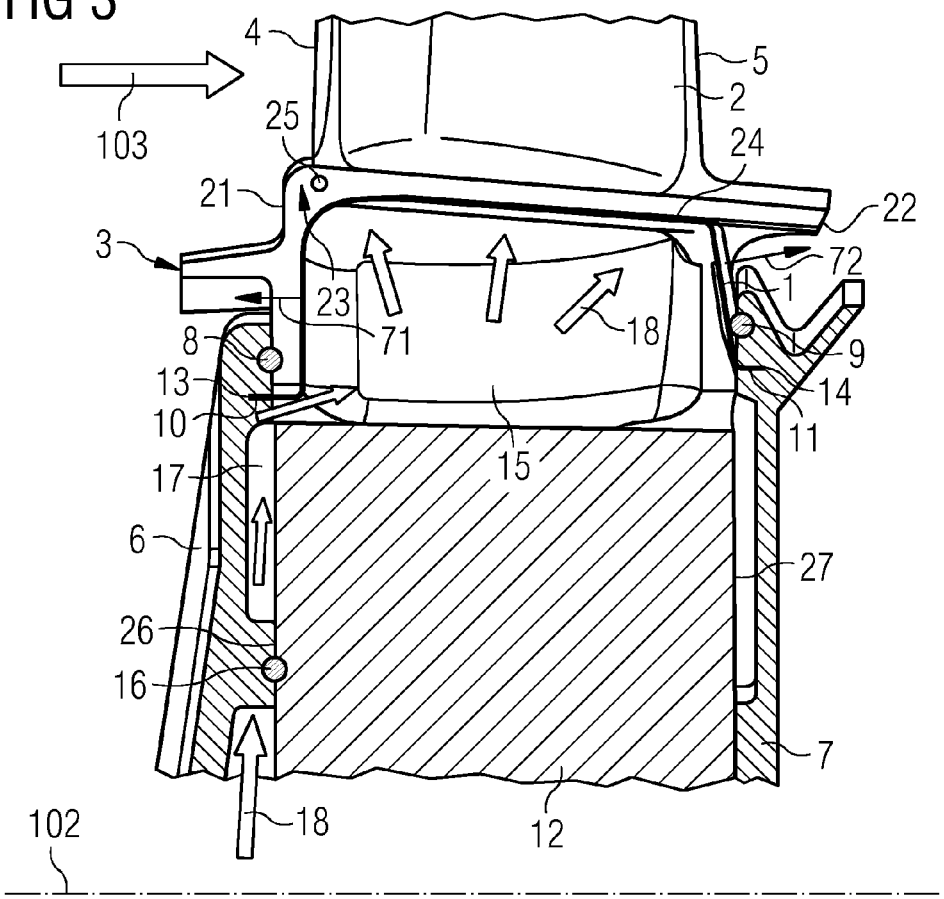

4
5
2
103
25
24
21
22
3
72
1
23
71
18
8
9
13
14
10
11
15
17
6
27
26
16
7
18
12
102

FIG 4

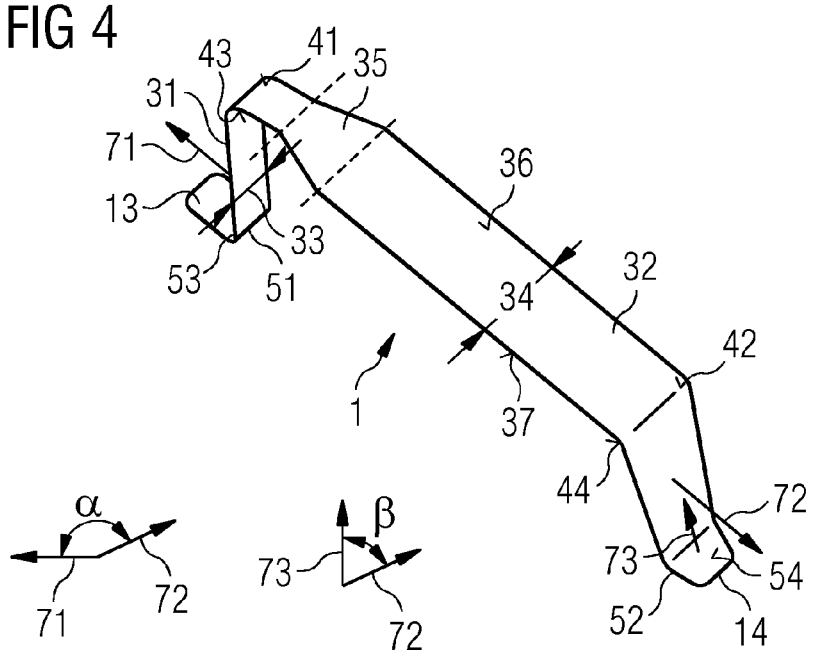

43
41
35
31
71
36
13
33
32
53
51
34
42
1
37
44
72
α
β
73
54
71
72
73
72
52
14

FIG 5

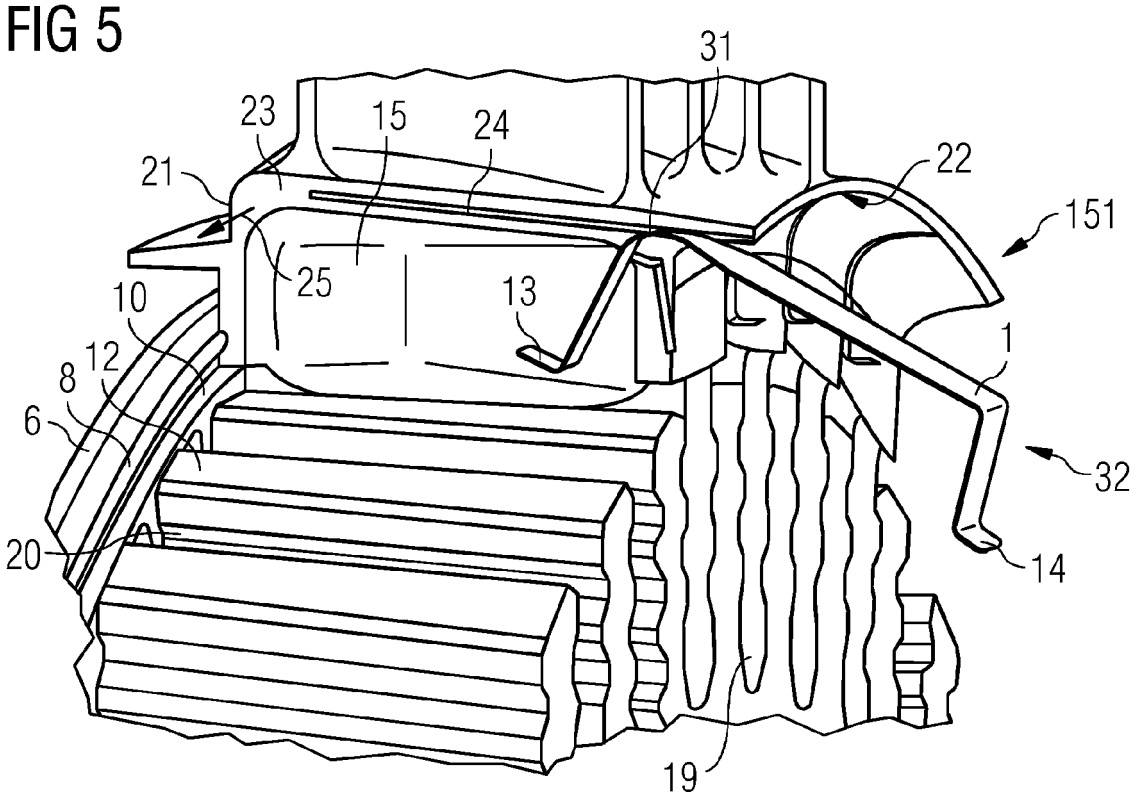


FIG 6

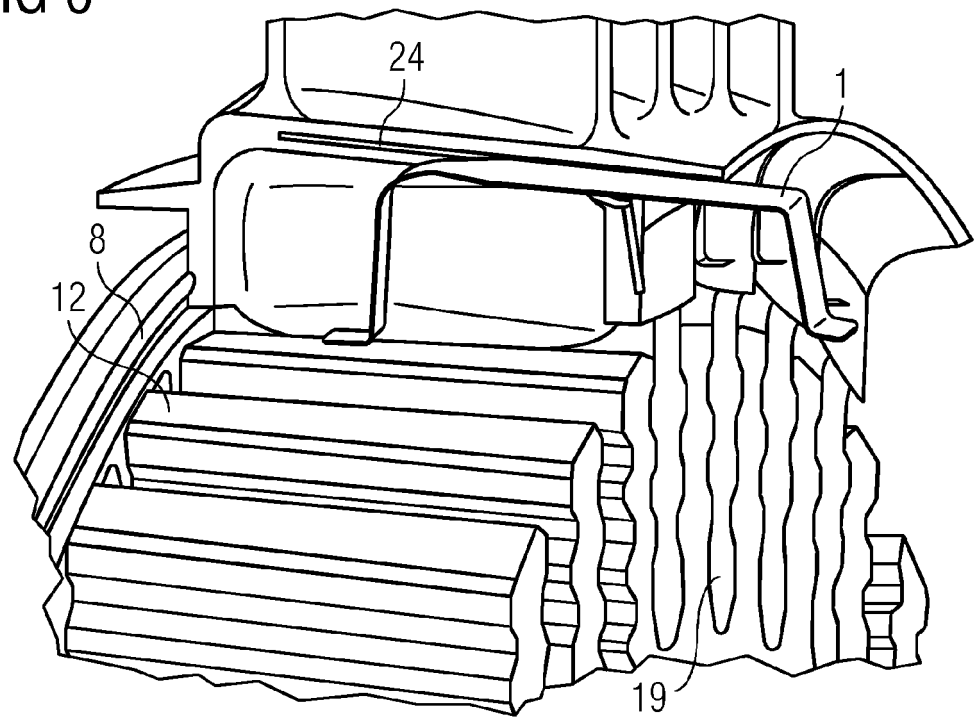
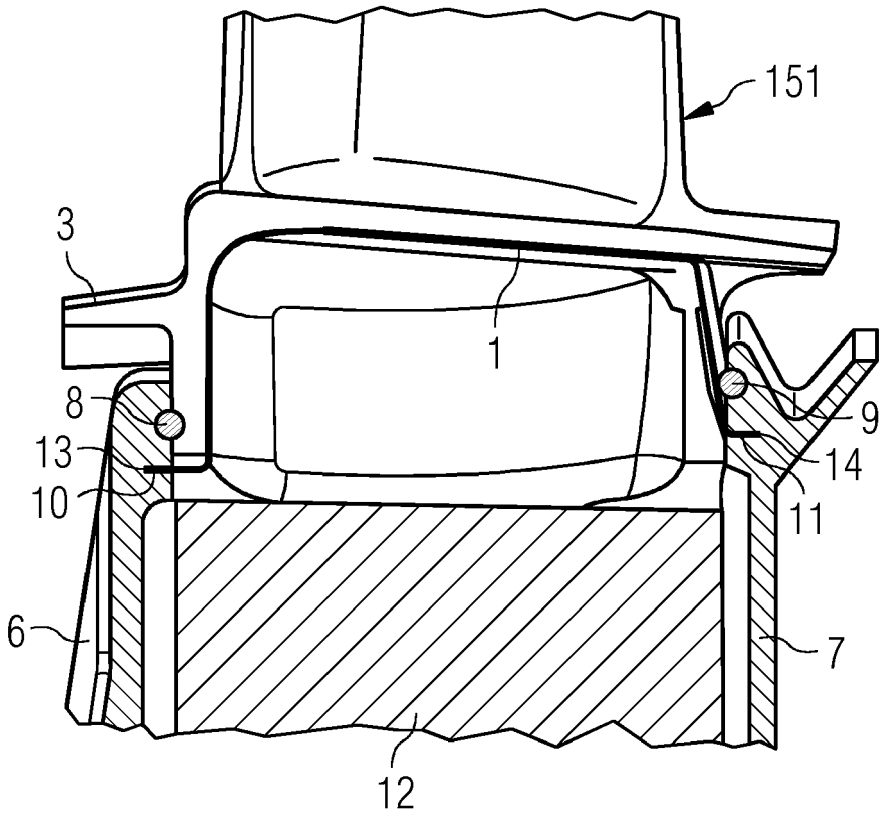


FIG 7



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 17 3650

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,D	EP 2 053 286 A1 (SIEMENS AG [DE]) 29 April 2009 (2009-04-29)	1,3-8, 10,12, 13,15	INV. F01D5/08 F01D5/30
A	* paragraphs [0007] - [0010], [0022] - [0035] * * figures 1-8 *	2,9,14	F01D11/00
X	EP 0 816 638 A2 (UNITED TECHNOLOGIES CORP [US]) 7 January 1998 (1998-01-07) * columns 5-10 * * figures 1,2,5-7 *	1-6,10, 11	
X	EP 1 635 037 A2 (UNITED TECHNOLOGIES CORP [US]) 15 March 2006 (2006-03-15) * paragraphs [0015] - [0021] * * figures 1-4 *	1,3,5,6, 10,11	
X	US 5 281 097 A (WILSON PAUL S [US] ET AL) 25 January 1994 (1994-01-25) * column 3, line 15 - column 4, line 50 * * figures 1-7 *	1-3,5,6, 8,10,11	
			TECHNICAL FIELDS SEARCHED (IPC)
A	FR 2 710 103 A1 (SNECMA [FR]) 24 March 1995 (1995-03-24) * the whole document *	1-15	F01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 November 2012	de la Loma, Andrés

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

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 17 3650

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.

27-11-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2053286 A1	29-04-2009	NONE	
EP 0816638 A2	07-01-1998	DE 69727727 D1	01-04-2004
		DE 69727727 T2	02-12-2004
		DE 69736570 T2	13-09-2007
		EP 0816638 A2	07-01-1998
		EP 1291492 A1	12-03-2003
		JP 4017216 B2	05-12-2007
		JP 10082301 A	31-03-1998
		US 5827047 A	27-10-1998
EP 1635037 A2	15-03-2006	AU 2005202260 A1	30-03-2006
		CA 2507086 A1	13-03-2006
		CN 1749531 A	22-03-2006
		EP 1635037 A2	15-03-2006
		JP 2006077759 A	23-03-2006
		KR 20060048029 A	18-05-2006
		SG 121034 A1	26-04-2006
		US 2006056974 A1	16-03-2006
US 5281097 A	25-01-1994	NONE	
FR 2710103 A1	24-03-1995	NONE	

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

- EP 2053285 A1 **[0002]**
- EP 2053286 A1 **[0002]**
- US 3918842 A **[0003]**
- US 6561764 B1 **[0004]**
- US 3834831 A **[0005]**