Abstract: Airfoil arrangement comprising a sealing element made of metal foam. An airfoil arrangement (100) for a gas turbine comprises a first airfoil device (110), a second airfoil device (120), and a sealing element (210). The first airfoil device (110) comprises a first root section (112) with which the first airfoil device (110) is mountable to an airfoil disc (200). The first root section (112) comprises a first platform (214), a first leading edge side (215) and a first trailing edge side (213). The second airfoil device (120), which has generally the same structural elements as the first airfoil device (110), comprises a second cavity, wherein the first airfoil devices (110, 120) are mountable to the airfoil disc (200) such that the first root section (112) adjoins to the second root section and the first cavity (111) and the second cavity form a common cavity. The sealing element (210) comprising a metal foam is located inside the common cavity such that the sealing element (210) covers a gap (101) between the first root section (112) and the second root section.

AIRFOIL ARRANGEMENT COMPRISING A SEALING ELEMENT MADE OF METAL FOAM
Published:

— with international search report (Art. 21(3))
DESCRIPTION

Airfoil arrangement comprising a sealing element made of metal foam

Field of invention

The present invention relates to an airfoil arrangement for a gas turbine and to an airfoil system for a gas turbine. Furthermore, the present invention relates to a method for sealing a gap between a first root section of a first airfoil device of a gas turbine and a second root section of a second airfoil device of a gas turbine.

Art Background

In gas turbines, airfoil devices are mounted in order to guide a working fluid through a gas turbine. The airfoil devices may comprise blades which are mounted to a rotating turbine shaft or vanes which are mounted for example to a housing of the gas turbine. The airfoil devices are mounted in a circumferential direction around the turbine shaft one after another. A gap may exist between adjoining airfoil devices such that leakage occurs. For this reason, a sealing arrangement is required between adjacent airfoil devices. By attaching a sealing arrangement between adjacent airfoil devices, an injection of hot working gas into inner cavities of the airfoil devices is prevented. Moreover, cooling air which flows through cavities inside the airfoil devices is prevented from disappearing out into the mainstream flow of the hot working gas before being put to use. Moreover, a sealing arrangement is beneficial because the working fluid is guided through the airfoil passage without losing energy through the gaps between adjacent sealing devices.
Fig. 6 illustrates a conventional sealing arrangement between two airfoil devices. The conventional airfoil device 600 comprises a conventional airfoil 601 that is mounted to a conventional platform 606. At the opposed face of the platform 606 to which the conventional airfoil 601 is mounted, a conventional cavity 602 is formed. Through the conventional airfoil disk 610 cooling air may flow into the conventional airfoil 601, for example. Between the inner face of the conventional platform 606 and the conventional cavity 602, a conventional seal wire 603 is attached into an adapted groove inside the conventional platform 606. The conventional seal wire 603 is further attached to an adjacent further conventional platform of a further conventional airfoil device (not shown in Fig. 6). A gap between the conventional platform 606 and the further adjacent conventional platform is sealed by the conventional seal wire 603.

The conventional airfoil device is mounted to a conventional airfoil disc 610. In order to attach the conventional airfoil device 600 fixedly to the conventional airfoil disc 610 a conventional lock strip 605 is used preventing the airfoil device from moving forward i.e. against the flow direction of the hot working gas. Between the conventional lock strip 605 and the conventional airfoil device 600, a conventional seal strip 604 is mounted, wherein the conventional seal strip 604 is adapted for sealing a gap between a front face of the conventional airfoil device 600 and a further front face of a further adjoining conventional airfoil device. Furthermore, the upstream face of the root of the airfoil device may have a tang that prevents the airfoil device from being pushed backwards i.e. in the flow direction of the hot working gas.

An alternative way of securing the airfoil device to the airfoil disc is disclosed in GB 712,112. An axial extension of a root of a blade forms a circumferential groove on a downstream side. Into the groove a wire is attached for preventing an axial movement of the blade. A tang is used here as well.
Fig. 7 shows a turbine rotor comprising two conventional airfoil discs 610 wherein each comprises a plurality of grooves that extend along a generally axial direction 102 of the gas turbine. The grooves are distributed one after another along a circumferential direction 103 of the conventional airfoil disc 610. To each groove a conventional airfoil device 600 may be mounted as shown in Fig. 6.

WO 2009/053169 A1 shows a turbine blade assembly for a gas turbine, wherein a seal strip is mounted between a platform and a root cavity. The seal strip is further in contact with a locking plate for locking the airfoil to an airfoil disc.

WO 2008/046684 A1 discloses a turbine blade assembly for a gas turbine. A seal strip is attached to a respective platform of adjacent turbine blades in order to minimize the leakage of hot working gas into the space under the platforms.

EP 1 600 606 A1 discloses a turbine stage, wherein between platforms a seal strip is attached for providing a damping and a sealing of the adjacent blades.

EP 1 467 066 B1 discloses a corrugated seal. An annular member comprises an S-shape profile wherein to a radially inwards extending portion of the annular member a lining is arranged which consists of metal foam, a porous sintered metal or a non-metallic material.

Summary of the Invention

It may be an objective of the present invention to provide a proper seal between adjacent airfoil devices of a gas turbine.
This objective is solved by an airfoil arrangement for a gas turbine, an airfoil system for a gas turbine and by a method for sealing a gap between a first root section of a first airfoil device and a second root section of a second airfoil device according to the independent claims.

According to a first aspect of the present invention, an airfoil arrangement for a gas turbine is presented. The airfoil arrangement comprises a first airfoil device, a second airfoil device and a sealing element. The first airfoil device comprises a first root section with which the first airfoil device is mountable to an airfoil disc. The first root section comprises a first platform, a first leading edge side and a first trailing edge side. The first root section has a first cavity which is partially surrounded by the first platform, the first leading edge side and the first trailing edge side.

The second airfoil device comprises a second root section with which the second airfoil device is mountable to the airfoil disc. The second root section comprises a second platform, a second leading edge side and a second trailing edge side. The second root section has a second cavity which is partially surrounded by the second platform, the second leading edge side and the second trailing edge side.

The first airfoil device and the second airfoil device are mountable to the airfoil disc such that the first root section adjoins to the second root section and the first cavity and the second cavity form a common cavity.

The sealing element for partially sealing the common cavity is located inside the first cavity and the second cavity such that the sealing element covers a gap between the adjoining first root section and the second root section. The sealing element comprises metal foam.
According to a further aspect of the present invention, an airfoil system for a gas turbine is presented, wherein the airfoil system comprises an airfoil disc and the above-described airfoil arrangement. The first airfoil device and the second airfoil device are mounted to the airfoil disc such that the first root section adjoins the second root section and the first cavity and the second cavity form the common cavity.

According to a further aspect of the present invention, a method for sealing a gap between a first root section of a first airfoil device of a gas turbine and a second root section of a second airfoil device of the gas turbine is presented. The first airfoil device comprises a first root section with which the first airfoil device is mountable to an airfoil disc. The first root section comprises a first platform, a first leading edge side and a first trailing edge side. The first root section has a first cavity which is partially surrounded by the first platform, the first leading edge side and the first trailing edge side. The second airfoil device comprises the second root section with which the second airfoil device is mountable to the airfoil disc. The second root section comprises a second platform, a second leading edge side and a second trailing edge side.

The second root section has a second cavity which is partially surrounded by the second platform, the second leading edge side and the second trailing edge side. The first airfoil device and the second airfoil device are mountable to the airfoil disc such that the first root section adjoins to the second root section and the first cavity and the second cavity form a common cavity.

According to the method the gap between the first root section and the second root section is covered by a sealing element for partially sealing the common cavity, wherein the sealing element is located inside the first cavity and the
second cavity and wherein the sealing element comprises a metal foam.

The airfoil device comprises an airfoil which is e.g. a rotating blade for a gas turbine. The airfoil extends from the platform of the airfoil device into the mainstream flow of the hot working gas. The airfoil device comprises the root section which extends from the platform in opposite direction in comparison to the airfoil. The root section of the airfoil device is mountable to the airfoil disc. The airfoil disc is e.g. a blade carrier device.

In the following, the root section comprises the platform, the first leading edge side, the first trailing edge side and a mounting (bottom) section (which comprises e.g. a mounting plug which may be formed in a fir tree shape or a rail) . The platform has a first surface which faces to a mainstream flow channel of the gas turbine and a second surface which faces to an opposite region of the platform in comparison to the first surface. The airfoil, such as a blade, is attachable to the first surface.

The platform extends generally along a circumferential direction and an axial direction of the gas turbine and/or a radial direction. The thickness of the platform i.e. its extension along the normal of the surface, e.g. along the radial direction, is generally smaller in comparison to the other extensions, e.g. to the extensions along the axial and circumferential direction.

The terms axial direction, circumferential direction and radial direction refer to directions with respect to a turbine shaft of the gas turbine. The circumferential direction describes a run around the turbine shaft, the radial direction describes a run through a point of the rotating axis of the turbine shaft and the axial direction describes a run parallel to the rotating axis of the turbine shaft. The axial direction and the radial direction are
orientated in particular perpendicular with respect to each other.

The leading edge side and the trailing edge side are attached to the platform. The leading edge side and the trailing edge side run from the second surface of the platform along a substantially radial direction. The leading edge side is located more upstream with respect to the trailing edge side, wherein "upstream" and "downstream" describe a location of a part along a flow direction of the main stream of the working fluid of the gas turbine. Hence, the platform, the trailing edge side and the leading edge side may form a U-shape inside of which the cavity is formed. The above-described structure of the airfoil device is valid for the described first airfoil device, second airfoil device and any further airfoil device described in the present application. The cavity may be flushed with cooling air, wherein the cooling air may be fed from the hollow airfoil or the blade root for cooling purposes. The cavity may also be surrounded additionally by a bottom side which is connected to the trailing edge side and the leading edge side and which bottom side is located on the opposite side of the cavity in comparison to the second surface of the platform. Furthermore, when installed in the airfoil disc, the radially outward facing part of the airfoil disc may be generally parallel to and may have an equal shape as the second side of the platform. Alternatively, the outward facing part of the airfoil disc may form at least part of the bottom side which surrounds partially the cavity.

A plurality of airfoil devices are mounted adjacent to each other to the airfoil disc along the circumferential direction. In particular, the first platform and the second platform abut against each other, wherein, for example due to assembly tolerances and growth allowance (centrifugal and thermal) during operation, small gaps exist between both platforms.
The sealing element, which may have a rectangular or oval cross section, is during operation in contact with the walls (leading edge sides, trailing edge sides, platform sides) of the first cavity and the second cavity. The sealing element covers the gap and at least partially the first platform and the second platform. There may be protrusions e.g. casted on the side of the first and second platform in the cavity on the otherwise substantially flat surface that centres the sealing element and prevented it from circumferentially moving to one of the first airfoil device or the second airfoil device. This allows the width of the sealing element to be reduced generally or locally and thereby reducing the load from centrifugal force that the airfoil device has to carry during operation.

The sealing element comprises a metal foam. A metal foam is a porous metallic structure which has a significantly reduced density compared to a solid metal piece of the same material. A metal foam is a cellular structure consisting of a metal material containing a large volume fraction of gas-filled pores. The pores can be sealed (close-cell foam) or they can form an interconnection network (open-cell foam). The defining characteristic of metal foams is a very high porosity. The porosity or void fraction is a measure of the void spaces in a material, and is a fraction of the volume of voids over the total volume, i.e. between 0 - 1 or between 0 % - 100 % (percent). The porosity of the metal foam of the sealing element is approximately 75 % - 95%, i.e. 75 % - 95% of the volume consists of void spaces. The strength of foamed metal possesses a power law relationship to its density, i.e. a 20% denser material is more than twice as strong as a 10% denser material. Metal foam may be based on many different metals, such as aluminium or nickel.

By the present invention a sealing element between two airfoil devices is used which is at least partially or completely made of a metal foam. Hence, the sealing element is lighter than a sealing element made of a solid material.
By using a foam metal, the stability of the seal element is not reduced dramatically in comparison to the solid metal. By using such a lightweight but stable seal element made of metallic foam, the sealing element may be larger in comparison to a solid metal seal. It is also possible to reduce the number of fixation elements in the assembly and the machined sections in the airfoil device, because due to the large size of sealing element made of metallic foam, the sealing element may be self-supporting.

Depending on the application and the size of the gap between the adjacent airfoil devices different types of metallic foam may be used. In a situation where it is beneficial to release a controlled amount of cooling air through the gap to cool the surfaces facing the hot working gases open-cell foam may be used. Where there is no need to release cooling air close-cell foam is preferable.

According to a further exemplary embodiment, the sealing element is located inside the first cavity and the second cavity such that the sealing element abuts partially on the first platform, partially on the first leading edge side, partially on the first trailing edge side, partially on the second platform, partially on the second leading edge side and partially on the second trailing edge side.

Hence, the sealing element may comprise for example a U-shaped cross-section comprising two sides which are combined by a base section. Alternatively, the sealing element may comprise for example a polygonal or an oval cross-section. The U-shaped cross-section lies within a cross-section plane, wherein the normal of the cross-section plane runs along or is parallel to the circumferential direction. The base section is alignable onto the respective platforms and the two sides are abuttable onto the respective leading edge sides and the respective trailing edge sides. The angle of the sides of the sealing element with respect to the base section of the sealing element may be larger than the angle
of the respective trailing edge sides and leading edge side sides to the platform. Hence, the U-shaped sealing element may be clamped inside the cavity such that the sealing element forms a clamping fixation and a press-fit connection within the cavity of the respective airfoil device. Further fixation means are not necessary, i.e. there is no support underneath the seal in the direction of the thickness of the seal extending from the bottom surface (i.e. the airfoil disc surface) of the airfoil disc. Hence, an easy and fast manufacturing method may be achieved.

Moreover, by allowing the sealing element to cover for example the complete area of the leading edge side and trailing edge side of the root section and having support points between the respective adjacent leading edge sides and trailing edge sides of the adjacent airfoil device, a proper seal function and a good support/stability during assembly is achieved. Moreover, if the airfoil devices are rotating blade devices, centrifugal forces will press the sealing element against the respective (second surfaces of the) platforms such that a tight seal is achieved. During standstill of the gas turbine, the sealing element is kept in position by the clamping connection or a press-fit connection of the sealing element with the respective trailing edge sides and leading edge sides. In other words the ends of the sealing element may rest on the airfoil disc face at the same time as the sealing element is partially in contact with, or close to, leading edge sides, trailing edge sides and platform sides, which in combination with the width of the sealing element prevents it from moving away from the gap.

According to a further exemplary embodiment, each of the first platform, the first leading edge side, the first trailing edge side, the second platform, the second leading edge side and the second trailing edge side to which the sealing element abuts comprises a planar surface shape. In particular, if the sealing element is self supporting by abutting against the above described sides and platforms, the
sides may be formed planar, i.e. may be free of fixing means such as machined recesses, grooves or projections for fixing the sealing element. Hence, because no further machining of the sides and platforms is necessary for fixing the sealing element, a simpler and efficient manufacturing of the respective sides and platforms is achieved.

According to a further exemplary embodiment, the sealing element comprises a first section with a first porosity and a second section with a second porosity. The second porosity is higher (i.e. comprises a higher fraction of the volume of voids over the total volume of a respective section) than the first porosity. The sealing element is located inside the first cavity and the second cavity such that the first section of the sealing element covers the gap between the adjoining first root section and the second root section.

By varying the degree of porosity, the sealing element may be provided with a reduced weight without losing its sealing characteristic and its stability. If the porosity is lower, the sealing element is denser, wherein if the porosity is higher, the sealing element has a lesser density and more air may possibly migrate through the foam metal material of the sealing element in case an open-cell foam is used. In particular, the section of the sealing element with the first porosity is located with the sealing element in a region where the gap occurs in order to provide a good sealing characteristic.

According to a further exemplary embodiment, the sealing element comprises at least a cut-out section. In particular, the sealing element does not have a continuous section with material but have also cut-outs (through-holes), where material is taken away in order to reduce the weight of the sealing element. In particular, the cut-out sections are located at regions of the sealing element where no high stresses and gaps exist.
According to a further exemplary embodiment, the sealing element is coated with a corrosion protection coating, in particular with MCrAlY. Hence, corrosion of the sealing element may be reduced.

According to a further exemplary embodiment of the airfoil system, the sealing element comprises an (radial) end, wherein the airfoil disc comprises a groove or recess which is formed such that the end of the sealing element abuts inside the groove or recess.

The recess of the airfoil disc runs substantially along the circumferential direction of the gas turbine. The recess may have a U-formed, V-shaped, square-shaped or rectangular-shaped cross-section, so that the recess is fully formed and machined in the airfoil disc. The recess may also be machined in the airfoil disc such that the recess is formed by a ledge and has an L-form, squared-shape or rectangular-shaped cross-section. Hence, the edge (end) of the sealing element is placed inside the recess and the respective leading edge side or the trailing edge side presses the edge of the sealing element to the airfoil disc.

When the sealing element abuts inside the recess, a better sealing for fluid which streams along a substantially axial direction of the gas turbine is achieved. Moreover, the recess can be formed in such a way, that the end (edge) of the sealing element is clamped inside the recess between the airfoil device and the airfoil disc. In particular, the width of the recess is slightly smaller than the width of the end of the sealing element in order to achieve a clamping, press-fit connection of the end inside the recess. Hence, the sealing ability and the fixation stability of the sealing element inside the airfoil system are improved.

According to a further exemplary embodiment, the sealing element comprises a further (radial) end, wherein the further end comprises a seal lip which abuts onto the airfoil disc.
Hence, the sealing ability against fluids (e.g. cooling fluids) which streams along the surface of the airfoil disc inside the cavity may be improved. In particular, the seal lip may extend from the sealing or trailing edge side of the airfoil disc inside the cavity, such that the pressure of the fluid inside the cavity presses the seal lip against the surface of the airfoil disc.

According to a further exemplary embodiment, the seal lip is detachably mounted to the further end of the sealing element. The seal lip is for example a leaf-type seal which is attached to the end (edge) of the sealing element made of metallic foam.

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 application.

30 Brief Description of the Drawings

The aspects defined above and further aspects of the present invention are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The invention will be described in more detail hereinafter with reference to examples of embodiment but to which the invention is not limited.
Fig. 1 shows a perspective view of an airfoil arrangement comprising three airfoil devices according to an exemplary embodiment of the present invention;

Fig. 2 shows a schematic side view along a circumferential direction showing an airfoil arrangement comprising the sealing element according to an exemplary embodiment of the present invention;

Fig. 3 shows a schematic side view along a circumferential direction of an airfoil arrangement according to an exemplary embodiment of the present invention, wherein the sealing element comprises a seal lip;

Fig. 4 shows a schematic side view along a circumferential direction of an airfoil arrangement according to an exemplary embodiment of the present invention, wherein the seal lip is detachably mounted to the sealing element;

Fig. 5 shows a schematic view of a sealing element comprising cut-outs according to an exemplary embodiment of the present invention;

Fig. 6 shows a schematic view of a conventional airfoil device which is attached to a conventional airfoil disc; and

Fig. 7 shows a schematic view of a conventional airfoil disc.

Detailed Description

The illustrations in the drawings are schematic. It is noted that in the figures, similar or identical elements are provided with the same reference signs.

Fig. 1 shows a perspective view of an airfoil arrangement 100 for a gas turbine according to an exemplary embodiment of the present invention. The airfoil arrangement 100 comprises
three airfoil devices, in particular a first airfoil device 110, a second airfoil device 120 and a further airfoil device 130. The airfoil devices 110, 120, 130 are mounted in a row along a circumferential direction 103 around a turbine shaft of the gas turbine.

The first airfoil device 110 comprises a first root section 112 with which the first airfoil device 110 is mountable to an airfoil disc 200 (see Fig. 2). The root section 112 comprises for example a radial extending plug with a fir tree cross-sectional shape for being mounted to a respective groove of the airfoil disc 200. Each plug extends along a radial direction 104 which is oriented substantially to a rotating axis of the turbine shaft of the turbine. Each airfoil device 110, 120, 130 comprises a respective platform, wherein between the plug and the platform a cavity 111 is formed. Through the root section 112 cooling air is feedable to the airfoils for cooling purposes. Some of the cooling air is injected into the cavity 111. Between two adjoining airfoil devices 110, 120; 120, 130 a gap 101 exists. Through the gap 101, cooling air from the cavity 111 may stream into the volume through which the hot working gas of the gas turbine flows along an axial direction 102. Due to pressure differences for example between the leading and trailing edge of the airfoil device, the hot working fluid may be ingested into the volume inside the cavity 111. In order to reduce these gas exchanges, a sealing element 210 (see Fig. 2) according to the present invention is attached into the airfoil arrangement 100 shown in Fig. 1.

Fig. 2 shows a side view along the circumferential direction 103 of the first airfoil device 110. Axial locking arrangements which fix the airfoil device 110, 120, 130 to an airfoil disc 200 are not shown for sake of clarity. The airfoil device 110 is mounted to the airfoil disc 200 by the first root section 112. In Fig. 2, the plug of the root section 112, which is shown in Fig. 1, is not shown in Fig. 2. The first root section 112 further comprises a first
platform 214, a first leading edge side 215 and a first trailing edge side 213. As shown in Fig. 1 and Fig. 2, the axial direction 102 is shown which is parallel to a rotating axis of the turbine shaft, wherein the hot working gas of the gas turbine streams substantially at least with one component along the axial direction 102. The side of the root section 112 which is located more upstream is denoted the leading edge side 215, whereas the side which is located more downstream in comparison to the axial direction 102 and in comparison to the leading edge side 215 is denoted trailing edge side 213. To the platform 214, an airfoil 212 is attached forming part of the airfoil device 110. The airfoil 212 may be formed with a hollow shape, wherein cooling fluid which streams through the root section 112 may be injected inside the inner volume of the hollow airfoil 212 for cooling purposes.

The respective feature of the first airfoil device 110 are also valid for the second airfoil device 120 or any further airfoil device 130, as shown for example in Fig. 1. Hence, the second airfoil device 120 and the further airfoil device 130 may comprise as well a respective root section with which the respective airfoil device 120, 130 is mounted to the airfoil disc 200. The second root section and the further root section comprise a respective platform, a respective leading edge side and a respective trailing edge side.

For example, the second root section has a second cavity which is partially surrounded by the second platform, the second leading edge side and the second trailing edge side. The first airfoil device 110 and the second airfoil device 120 are mounted to the airfoil device 200 such that the first root section 112 adjoins to the second root section and the first cavity 111 and the second cavity form a common cavity. Between the first root section 112 and the second root section the gap 101 exists. The sealing element 210 for partially sealing the common cavity is located inside the first cavity 111 and the second cavity such that the sealing
element 210 covers the gap 101 between the adjoining first root section 112 and the second root section. As shown in Fig. 1, the gap 101 occurs between two adjoining platforms 214 and in addition also between two adjoining trailing edge sides 213 and/or to adjoining leading edge sides 215.

The sealing element 210 comprises a metal foam such that the sealing element 210 comprises lesser weight and a good stability in comparison to a sealing element consisting of a conventional solid metal material. Because the sealing element 210 consists of a metal foam with less weight, a larger sealing element 210 may be applied without affecting the overall weight of the airfoil arrangement 100 dramatically. Hence, for example the sealing element 210 may fully or partially surround the sides of the inner cavity 111 for example. As shown in Fig. 2, such a lighter sealing element 210 may cover (at least partially) the trailing edge side 213, the leading edge side 215 and the platform 214, for example. In particular, the sealing element 210 comprises a U-shaped cross-section as shown in Fig. 2. Moreover, the lightweight sealing element 210 may extend along the circumferential direction 103 in such a way that the complete inner surface of the platform 214, the complete inner surface of the leading edge side 215 and the complete inner surface of the trailing edge side 213, which surround the cavity 111, may be covered by the sealing element 210.

For that reason, a proper sealing characteristic of the sealing element 210 is achieved, because the sealing element covers a wide area in the vicinity of the gap 101. Additionally, the stability of the sealing element 210 is improved such that further fixing means for the sealing element 210 may be obsolete. For example, due to the U-shaped profile of the sealing element 210, the sealing element 210 may be formed self-supporting. For example, the sealing element 210 may comprise edges (i.e. radial ends) which abut on a surface of the airfoil disc 200, such that the sealing element 210 may rest onto the airfoil disc 200 and is thus
stable and self-supporting. Moreover, if the sealing element 210 comprises a V- or a U-shape, the sides of the sealing element 210 which extend along the radial direction 104 may form a press-fit (clamping) connection with the trailing edge side 213 and the leading edge side 215 of the first and second root sections 112.

By making the sealing element 210 self-supporting the need to cast or machine conventional recesses at any parts of the platform or respective trailing/leading edge sides is no longer needed, which significantly reduces the cost of the component and the machining time. In other words there is no need to have supports inside the cavity 111 that prevents the sealing element from moving away from gap 101, e.g. moving radially inwardly away from the platform 214.

Furthermore, if the airfoil device 110 is a blade device which rotates together with the turbine shaft, the sealing element 210 is pressed due to centrifugal forces with its base section, which combines the two sides of the sealing element 210, onto the inner surface of the respective platform 214 and is thus stable.

As shown in Fig. 2, the airfoil disc 200 comprises a recess 201 which runs substantially along the circumferential direction 103 and in which the recess 201 corresponds substantially to a shape of the edge 211 of the sealing element 210. The edge 211 of the sealing element 210 abuts inside the recess 201 of the airfoil disc 200.

The recess 201 may be formed by a ledge or step which is machined into the airfoil disc 200. One side of the recess 201 may be covered by e.g. the leading edge side 215 (as shown in Fig. 2) or the trailing edge side 213 after assembly.

Fig. 3 shows a further exemplary embodiment of the airfoil system 100. Axial locking arrangements which fix the airfoil
device 110, 120, 130 to an airfoil disc 200 are not shown for sake of clarity. The airfoil device 110 in Fig. 3 has the same structural features as the airfoil device 110 shown in Fig. 2.

In Fig. 3, the sealing element 210 comprises at a further end a seal lip 311 which is adapted for being abutted onto a surface of the airfoil disc 200. The seal lip 311 may be formed integrally with the sealing element 210. In particular, as shown in Fig. 3, the seal lip 311 is formed in such a way, that a high pressure of the gas (cooling fluid) inside the cavity 111 presses the seal lip 311 onto the surface of the airfoil disc 200. Hence, the sealing element 210 may have during installation larger tolerances in order to provide an easy implementation of the sealing element 210, wherein during operation, the sealing function is achieved by an operating pressure of the cooling fluid inside the cavity 111 and the common cavity, respectively. Hence, the seal lip 311 as shown in Fig. 3 comprises beneficial properties during installation and during operation at the same time.

Fig. 4 shows an exemplary embodiment of the first airfoil device 110. The airfoil device 110 comprises the same structural features as the first airfoil device 110 shown in Fig. 2 and Fig. 3. Axial locking arrangements which fix the airfoil device 110, 120, 130 to an airfoil disc 200 are not shown for sake of clarity.

The sealing element 210 comprises the seal lip 311, wherein the seal lip 311 is a separate structural part in comparison to the seal element 210. For example, the seal element 210 may be formed of metal foam, whereas the separate seal lip 311 is formed of another sealing material, such as metal formed like a e.g. a leaf seal. Moreover, the seal lip 311 may be detachably mounted to the sealing element 210 such that the seal lip 311 may be exchanged for maintenance purposes, for example. The seal lip 311 may be present to allow a pre-loaded force to be applied to the seal element.
210. For this the seal lip 311 touching an opposing surface such that the seal element 210 may be clamped into position. This allows that the seal element 210 will be in close contact with the underside of the first platform 214 of the blade.

Fig. 5 illustrates an exemplary embodiment of the sealing element 210. As shown in Fig. 5, the sealing element 210 comprises a U-shaped profile. Onto the surface of the sealing element 210, a projection line of the gap 101 is shown for clarity purposes. In an installed status of the sealing element 210 inside the common cavity, the gap 101 would run along the projected line 502. In regions of the sealing element 210 that do not cover the gap 101 when being installed cut-outs 501 are machined to the sealing element 210. Hence, the overall weight of the sealing element 210 may be further reduced without reducing the sealing or positioning characteristics of the sealing element 210. Moreover, in a vicinity of the projection line 502, the sealing element 210 may comprise a section with a foam metal that comprises a lower porosity than the adjacent sections of the sealing element 210. Hence, if the porosity of the metal foam in the region of the projection line 502 is lower, a higher density and thus better sealing characteristics of the sealing element 210 in the region of the gap 101 (projection line 502) are achieved.

Moreover, depending on the application and the size of the gap 101 between the adjacent airfoil devices 110, 120, 130, different types of metallic foam may be used in the common sealing element 210. In a situation where it is beneficial to release a controlled amount of cooling air through the gap 101 in order to cool the surfaces facing the hot working gases the sealing element 210 comprises an open-cell foam section in the region of the gap 101 (projection line 502). Where there is no need to release cooling air the sealing element 210 comprises a close-cell foam section in the region of the gap 101 (projection line 502).
It should be noted that the term "comprising" does not exclude other elements or steps and "a" or "an" does not exclude a plurality. Also elements described in association with different embodiments may be combined. It should also be noted that reference signs in the claims should not be construed as limiting the scope of the claims.
CLAIMS

1. Airfoil arrangement (100) for a gas turbine, the airfoil arrangement (100) comprising
   a first airfoil device (110) which comprises a first root section (112) with which the first airfoil device (110) is mountable to an airfoil disc (200), wherein the first root section (112) comprises a first platform (214), a first leading edge side (215) and a first trailing edge side (213), wherein the first root section (112) has a first cavity (111) which is partially surrounded by the first platform (214), the first leading edge side (215) and the first trailing edge side (213),
   a second airfoil device (120) which comprises a second root section with which the second airfoil device (120) is mountable to the airfoil disc (200), wherein the second root section comprises a second platform, a second leading edge side and a second trailing edge side, wherein the second root section has a second cavity which is partially surrounded by the second platform, the second leading edge side and the second trailing edge side, and wherein the first airfoil device (110) and the second airfoil device (120) are mountable to the airfoil disc (200) such that the first root section (112) adjoins to the second root section and the first cavity (111) and the second cavity form a common cavity, and
   a sealing element (210) for at least partially sealing the common cavity,
   wherein the sealing element (210) is located inside the common cavity such that the sealing element (210) covers a gap (101) between the first root section (112) and the second root section, and
   wherein the sealing element (210) comprises a metal foam.

2. Airfoil arrangement (100) according to claim 1,
wherein the sealing element (210) abuts partially on the first platform (214), partially on the first leading edge side (215), partially on the first trailing edge side (213), partially on the second platform, partially on the second leading edge side and partially on the second trailing edge side.

3. Airfoil arrangement (100) according to claim 2,
wherein each of the first platform (214), the first leading edge side (215), the first trailing edge side (213), the second platform, the second leading edge side and the second trailing edge side to which the sealing element (210) abuts comprises a planar surface shape.

4. Airfoil arrangement (100) according to one of the claims 1 to 3,
wherein the sealing element (210) comprises a U-shaped cross section.

5. Airfoil arrangement (100) according to one of the claims 1 to 4,
wherein the sealing element (210) comprises a first section with a first porosity and a second section with a second porosity,
wherein the second porosity is higher than the first porosity,
wherein the first section of the sealing element (210) covers the gap (101) between the adjoining first root section (112) and the second root section.

6. Airfoil arrangement (100) according to one of the claims 1 to 5,
wherein the sealing element (210) comprises a cut-out section (501).

7. Airfoil arrangement (100) according to one of the claims 1 to 6,
wherein the sealing element (210) is coated with a corrosion protection coating, in particular with MCrAlY.

8. Airfoil system for a gas turbine, the airfoil system comprising
an airfoil disc (200), and
an airfoil arrangement (100) as set forth in one of the claims 1 to 7,
wherein the first airfoil device (110) and the second airfoil device (120) are mounted to the airfoil disc (200) such that the first root section (112) adjoins the second root section and the first cavity (111) and the second cavity form the common cavity.

9. Airfoil system according to claim 8,
wherein the sealing element (210) comprises an end (211),
wherein the airfoil disc (200) comprises a recess (201),
wherein a profile of the recess (201) corresponds to a shape of the end (211) such that the end (211) of the sealing element (210) abuts inside the recess (201).

10. Airfoil system according to claim 8 or 9,
wherein the sealing element (210) comprises a further end,
wherein the further end comprises a seal lip (311) for being abutted onto the airfoil disc (200).

11. Airfoil system according to claim 10,
wherein the seal lip (311) is detachably mounted to the further end.

12. Method for sealing a gap (101) between a first root section (112) of a first airfoil device (110) of a gas turbine and a second root section of a second airfoil device (120) of the gas turbine,
wherein the first airfoil device (110) comprises the first root section (112) with which the first airfoil device (110) is mountable to an airfoil disc (200), wherein the first root section (112) comprises a first platform (214), a first leading edge side (215) and a first trailing edge side (213), wherein the first root section (112) has a first cavity (111) which is partially surrounded by the first platform (214), the first leading edge side (215) and the first trailing edge side (213), wherein the second airfoil device (120) comprises the second root section with which the second airfoil device (120) is mountable to the airfoil disc (200), wherein the second root section comprises a second platform, a second leading edge side and a second trailing edge side, wherein the second root section has a second cavity which is partially surrounded by the second platform, the second leading edge side and the second trailing edge side, and wherein the first airfoil device (110) and the second airfoil device (120) are mountable to the airfoil disc (200) such that the first root section (112) adjoins to the second root section and the first cavity (111) and the second cavity form a common cavity, the method comprising covering the gap (101) between the first root section (112) and the second root section by a sealing element (210) for at least partially sealing the common cavity, wherein the sealing element (210) is located inside the common cavity, and wherein the sealing element (210) comprises a metal foam.
FIG 7

PRIOR ART

103

102

610
### A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC:

#### INV.

F01D/00

#### ADD.

F01D

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols): F01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used):

EPO-Internal

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>wo 03/102380 AI (SNECMA MOTEURS [FR] ; GIOT CHANTAL [FR] ; MARCHI MARC [FR] ; GOSSELIN CHR) 11 December 2003 (2003-12-11) page 1, lines 3-28 the whole document</td>
<td>1-12</td>
</tr>
<tr>
<td>A</td>
<td>US 2004/179937 AI (KREIS ERHARD [CH] ET AL) 16 September 2004 (2004-09-16) column 3, line 1 - column 4, line 5; figures 1-6</td>
<td>1-12</td>
</tr>
<tr>
<td>A</td>
<td>EP 2 295 722 AI (ALSTOM TECHNOLOGY LTD [CH]) 16 March 2011 (2011-03-16) paragraph [0035]; figures 1-3</td>
<td>1-12</td>
</tr>
</tbody>
</table>

[Cross-reference symbol X] Further documents are listed in the continuation of Box C.


* Special categories of cited documents:
  * "A" document defining the general state of the art which is not considered to be of particular relevance
  * "E" earlier application or patent but published on or after the international filing date
  * "L" document which may throw doubts on priority claim(s) one of which is cited to establish the publication date of another citation or other special reason (as specified)
  * "O" document referring to an oral disclosure, use, exhibition or other means
  * "P" document published prior to the international filing date but later than the priority date claimed

* Extra categories of cited documents:
  * "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  * "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  * "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  * "A" document member of the same patent family

Date of the actual completion of the international search: 2 August 2012

Date of mailing of the international search report: 10/08/2012

Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax. (+31-70) 340-3016

Authorized officer:

Souris, Chri stophe
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 2007/122269 A1 (MEIER REINHOLD [DE] ET AL) 31 May 2007 (2007-05-31) paragraphs [0004], [0005], [0007], [0027], [0033], [0034], [0040]; figure 6</td>
<td>1-12</td>
</tr>
<tr>
<td>A</td>
<td>US 6 561 764 B1 (TIEMANN PETER [DE]) 13 May 2003 (2003-05-13) column 6, line 18 - column 8, line 22; figures 1,4a</td>
<td>1-12</td>
</tr>
<tr>
<td>A</td>
<td>EP 0 816 638 A2 (UNITED TECHNOLOGIES CORP [US]) 7 January 1998 (1998-01-07) figure 7</td>
<td>1-12</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>WO 03102380</td>
<td>11-12-2003</td>
<td>AU 2003249424</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2487471</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1507960</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2840352</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2005528550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RU 2313671</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA 81764</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2005175463</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wo 03102380</td>
</tr>
<tr>
<td>US 2004179937</td>
<td>16-09-2004</td>
<td>EP 1448874</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2004179937</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wo 03027445</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2011058497A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2011058953</td>
</tr>
<tr>
<td>US 2007122269</td>
<td>31-05-2007</td>
<td>CA 2547619</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 10360164</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1702138</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2007122269</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wo 2005061855</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1163427</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2003526039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6561764</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wo 0057031</td>
</tr>
<tr>
<td>EP 0816638</td>
<td>07-01-1998</td>
<td>DE 69727727</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69727727</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69736570</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0816638</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1291492</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 4017216</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 10082301</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5827047</td>
</tr>
</tbody>
</table>