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(54) **Turbine blade**

Turbinenschaufel

Aube de turbine

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(56) References cited:
EP-A- 1 124 038
JP-A- 7 310 502
US-A- 1 719 415
US-A- 3 986 793
US-A- 5 160 242
US-A- 5 242 270

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EP 1 898 049 B1

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Description

[0001] The present invention relates to a turbine blade comprising a platform section, an airfoil section and a root section.

[0002] From US 5,242,270, US 5,160,242, US 3,986,739 and JP 07310502 turbine blades are known in which the platform section has a first side, a second side opposite the first side, and, extending from the first side to the second side, a leading side, a trailing side and peripheral sides extending from the leading side to the trailing side. An airfoil section extends from the platform section's first side, and a root section extends from the platform section's second side. The root section and the peripheral sides of the platform section follow a curved path.

[0003] EP 1 124 038 A1 describes turbine blades in which the peripheral sides of the platform sections follow a curved path while the root section follows a straight path.

[0004] With respect to the mentioned prior art, it is an objective of the present invention to provide an advantageous turbine blade.

[0005] This objective is solved by a turbine blade according to claim 1. The depending claims define further developments of the inventive turbine blade.

[0006] The inventive turbine blade comprises a platform section, an airfoil section and a root section. The platform section has a first side, a second side opposite to the first side, and, extending from the first side to the second side, a leading side, a trailing side and peripheral sides. The peripheral sides extend along a curved path from the leading side to the trailing side. Further, an airfoil section extends from the first side of the platform section and a root section extends from the second side of the platform section. The root section of the turbine blade extends along a path from the leading side to the trailing side that is straight. In the inventive turbine blade the platform section has a larger width than the root section in a direction which is perpendicular to the direction of the platform section extending from the leading side to the trailing side.

[0007] By combining the curved peripheral sides of the platform section with a root section extending straight an interlocking of neighbouring turbine blades fixed to a rotor can be achieved.

[0008] Usually turbine blades are fixed by introducing their root sections into notches in a rotor or in a rotor disc of a turbine engine. Although the shape of the notches and the shape of the roots are adapted to each other, roots do not usually fit tightly into the notches. In other words, tolerances between the outer wall of the roots and the inner wall of the notches are present. Such tolerances reduce the risk of damage due to different thermal expansion during operation of the gas turbine engine. In addition, it simplifies introducing the roots into the notches. The shape of the roots and the notches is such that the roots will be held tight in the notches due to centrifugal forces when the gas turbine is in operation, i.e. when the rotor to which the turbine blades are fixed rotates with operation speed. However, if the rotational speed is less, e.g. when the turbine engine is started or barred, the centrifugal force is not strong enough to hold the roots tight in the notches. With turbine blades according to the state of the art this may lead to small movements between the roots and the notches which can cause wear. The movement of a root in the notch can be in a longitudinal direction of the notch or in a direction perpendicular thereto.

[0009] With the inventive turbine blade the interlocking of neighbouring turbine blades can be achieved due to the fact that the root extends straight while the peripheral sides extend along a curved path. Hence, a longitudinal movement of the blade in a notch will be restricted by the difference in the curvatures of the peripheral sides of the platform section and the root section.

[0010] In contrast thereto, in the turbine blades according to the cited prior art, the peripheral sides of the platform section and the root section show the same curvature. Hence, movement of the turbine blade along the longitudinal direction of the notches is not restricted.

[0011] Moreover, in the inventive turbine blade, the difference in the curvature of the platform's peripheral sides and the root section provides a better strength of the blade and increases the stress/strain distribution during gas turbine operation.

[0012] The root portion may, in particular, extend along a path that is perpendicular to the leading side of the platform section. In addition, the leading side and the trailing side may be parallel to each other.

[0013] In order to enable the turbine blade to be held tight by centrifugal force, the root portion's cross section may have, e.g., a fir tree shape, a bulb shape or a hammer shape.

[0014] The inventive turbine blade may be, in particular, a gas turbine blade or a steam turbine blade.

[0015] Further features, properties and advantages of the present invention will become clear from the following description of an embodiment of the invention in conjunction with the accompanying drawings.

Figure 1 shows a turbine blade from the leading edge.

Figure 2 shows the turbine blade from the airfoil section.

Figure 3 shows the turbine blade in a perspective view onto the root section and the peripheral side of the platform section.

[0016] An embodiment of an inventive turbine blade will now be described with respect to Figures 1 to 3. The figures show a turbine blade from different sides.

[0017] The turbine blade comprises a platform section 1, an airfoil section 3 and a root section 5 and is made

from a nickel (Ni) based alloy or a cobalt (Co) based alloy. The surface of the airfoil section 3 and parts of the surface of the platform section 1 may be provided with a coating, such as a so-called MCrAlY where M stands for an element of the group consisting of iron (Fe), cobalt (Co) and nickel (Ni), Y stands for yttrium and/or silicon and/or at least one element of the rare earths or hafnium (Hf). Such materials are known, e.g., from EP 0 486 489 B1, EP 0 786 917 B1, EP 0 412 397 B1 or EP 1 306 454 A1. On the MCrAlY coating a further coating, a so-called thermal barrier coating (TBC), may be present. Such a thermal barrier coating may, e.g., comprise ZrO_2 or Y_2O_3-ZrO_2, i.e. Zirconium dioxide coating which is not stabilised, partly stabilised or fully stabilised by yttrium oxide and/or calcium oxide and/or magnesium oxide.

[0018] The turbine blade may be solid or hollow. If the turbine blade is to be cooled during operation of the gas turbine engine, it is hollow and comprises cooling film openings where applicable in order to allow for the production of a cooling air film over the surface of the turbine blade.

[0019] The platform section 1 of the turbine blade comprises a first side, a second side opposite the first side, a leading side 14, a trailing side 16 and two peripheral sides 15 which extend from the leading side 14 to the trailing side 16. The airfoil section 3, which comprises a leading edge 31 and a trailing edge 33, extends from the first side 11 of the platform section 1, and the root section 5 extends from the second side 13 of the platform section 1.

[0020] The platform section 1 shows a curvature in its peripheral sides 15 whereas the root section extends along a straight line from the leading side 14 of the platform to the trailing side 16 of the platform.

[0021] The cross-sectional shape of the root section is, in the present embodiment, a fir tree shape 51 (Figures 1 and 3) and may be of a bulb shape, respectively. However, the root section may also have a different cross-sectional shape which is suitable for allowing the turbine blade to be held tight in a notch of a rotor during operation of a gas turbine engine.

[0022] Note that although the leading side 14 of the platform section 1 is parallel to the trailing side 16 in the shown embodiments this does not necessarily need to be so. Instead, the sides 14, 16 could include an angle relative to each other. Moreover, according to the invention, the centre line of the straight root section 5 as described with respect to Figures 1 to 3 is not perpendicular to the leading and/or trailing side of the platform.

[0023] With the inventive design of a turbine blade the interlocking of adjacent blades during assembly of a turbine blade with a rotor or a rotor disc is possible. Moreover, the stress/strain distribution through the plates can be improved which in turn leads to an increased strength of the blades. This offers the possibility of increasing the chord of the airfoil section without negative impact to the overall strength of the turbine blade.

Claims

1. A turbine blade comprising:

- a platform section (1) having a first side (11), a second side (13) opposite the first side (11) and, extending from the first side (11) to the second side (13), a leading side (14), a trailing side (16) and peripheral sides (15) extending along a curved path from the leading side (14) to the trailing side (16);
- an airfoil section (3) extending from the first side (11) of the platform section (1); and
- a root section (5) extending from the second side (13) of the platform section (1);

wherein the root section (5) extends along a path from the leading side (14) to the trailing side (16) of the platform section (1) that is straight,
characterised in that
the platform section (1) has a larger width than the root section in a direction which is perpendicular to the direction of the platform section (1) extending from the leading side (14) to the trailing side (16).

2. The turbine blade as claimed in claim 1 **characterised in that** the root section (1) extends along a path that is perpendicular to the leading side (14).

3. The turbine blade as claimed in claim 1 or claim 2 **characterised in that** the leading side (14) and the trailing side (16) are parallel to each other.

4. The turbine blade as claimed in any of the claims 1 to 3 **characterised in that** the root section (5) has a fir tree shape, a bulb shape or a hammer shape.

5. The turbine blade as claimed in any of the claims 1 to 4 **characterised in that** it is a gas turbine blade or a steam turbine blade.

Patentansprüche

1. Turbinenschaufel, welche umfasst:

- einen Plattformabschnitt (1), der eine erste Seite (11), eine der ersten Seite (11) gegenüberliegende zweite Seite (13) und, sich von der ersten Seite (11) zu zweiten Seite (13) erstreckend, eine Vorderseite (14), eine Hinterseite (16) und Randseiten (15) aufweist, die sich entlang eines gekrümmten Weges von der Vorderseite (14) zur Hinterseite (16) erstrekken;
- einen Schaufelblattabschnitt (3), der sich von der ersten Seite (11) des Plattformabschnitts (1) aus erstreckt; und
- einen Schaufelfußabschnitt (5), der sich von

der zweiten Seite (13) des Plattformabschnitts (1) aus erstreckt;

wobei sich der Schaufelfußabschnitt (5) entlang eines Weges von der Vorderseite (14) zur Hinterseite (16) des Plattformabschnitts (1), welcher gerade ist, erstreckt, **dadurch gekennzeichnet, dass** der Plattformabschnitt (1) eine größere Breite als der Schaufelfußabschnitt in einer Richtung aufweist, welche senkrecht zu der Richtung des Plattformabschnitts (1) ist, die sich von der Vorderseite (14) zur Hinterseite (16) erstreckt.

2. Turbinenschaufel nach Anspruch 1, **dadurch gekennzeichnet, dass** sich der Schaufelfußabschnitt (1) entlang eines Weges erstreckt, welcher senkrecht zur Vorderseite (14) ist.

3. Turbinenschaufel nach Anspruch 1 oder Anspruch 2, **dadurch gekennzeichnet, dass** die Vorderseite (14) und die Hinterseite (16) zueinander parallel sind.

4. Turbinenschaufel nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Schaufelfußabschnitt (5) eine Tannenbaumform, eine Wulstform oder eine Hammerform aufweist.

5. Turbinenschaufel nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** sie eine Gasturbinenschaufel oder eine Dampfturbinenschaufel ist.

Revendications

1. Aube de turbine comprenant :

- une section de plate-forme (1) ayant un premier côté (11), un deuxième côté (13) opposé au premier côté (11) et, s'étendant du premier côté (11) jusqu'au deuxième côté (13), un côté d'attaque (14), un côté de fuite (16) et des côtés périphériques (15) s'étendant le long d'un chemin incurvé du côté d'attaque (14) jusqu'au côté de fuite (16) ;
- une section de profil aérodynamique (3) s'étendant à partir du premier côté (11) de la section de plate-forme (1) ; et
- une section d'emplanture (5) s'étendant à partir du deuxième côté (13) de la section de plate-forme (1) ;

dans laquelle la section d'emplanture (5) s'étend le long d'un chemin du côté d'attaque (14) jusqu'au côté de fuite (16) de la section de plate-forme (1) qui est rectiligne,
caractérisée en ce que
la section de plate-forme (1) a une largeur plus grande que la section d'emplanture dans un sens qui est perpendiculaire au sens de la section de plate-forme (1) s'étendant du côté d'attaque (14) jusqu'au côté de fuite (16).

2. Aube de turbine selon la revendication 1 **caractérisée en ce que** la section d'emplanture (1) s'étend le long d'un chemin qui est perpendiculaire au côté d'attaque (14).

3. Aube de turbine selon la revendication 1 ou la revendication 2 **caractérisée en ce que** le côté d'attaque (14) et le côté de fuite (16) sont parallèles l'un à l'autre.

4. Aube de turbine selon l'une quelconque des revendications 1 à 3 **caractérisée en ce que** la section d'emplanture (5) a une forme de sapin, une forme de bulbe ou une forme de marteau.

5. Aube de turbine selon l'une quelconque des revendications 1 à 4 **caractérisée en ce qu'**il s'agit d'une aube de turbine à gaz ou d'une aube de turbine à vapeur.

FIG 1

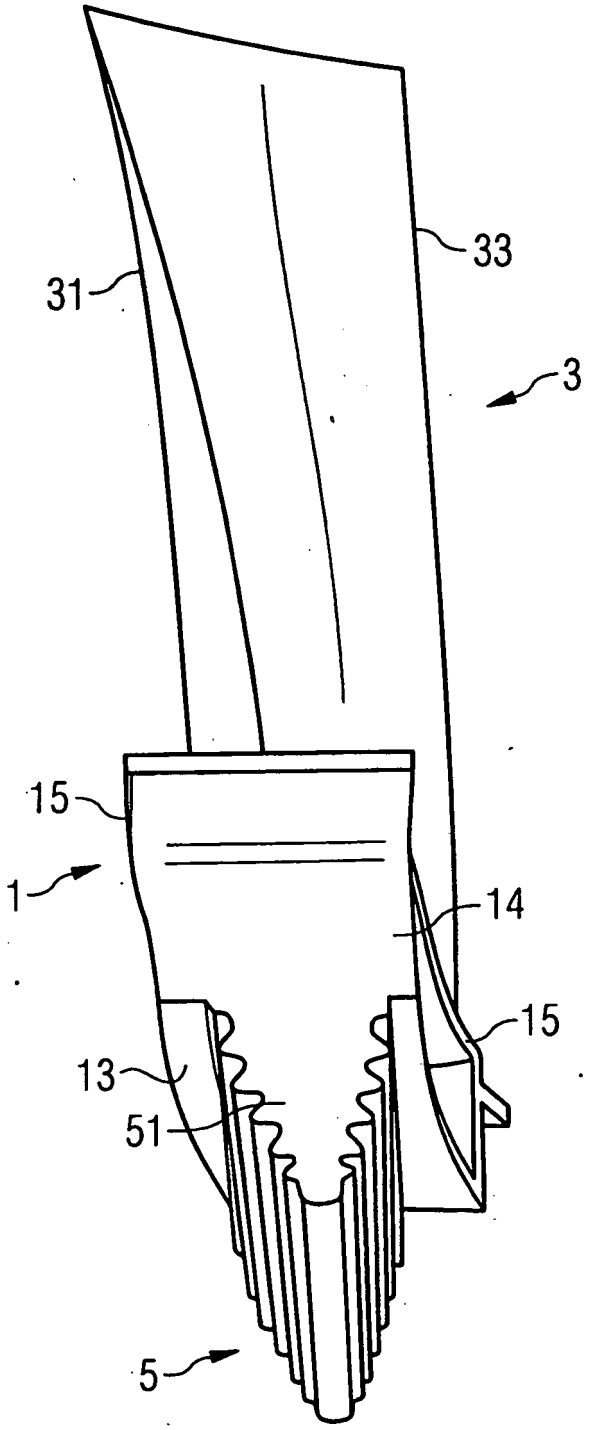


FIG 2

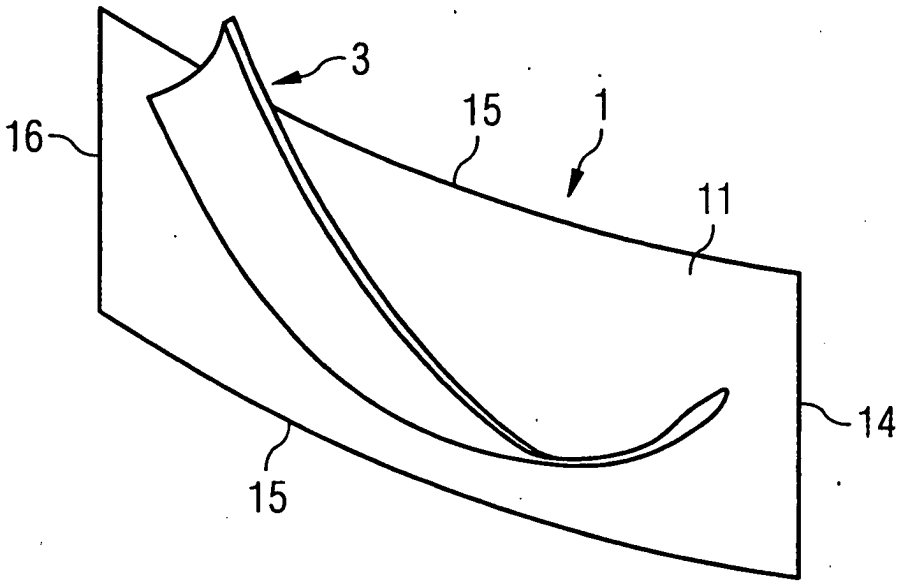


FIG 3

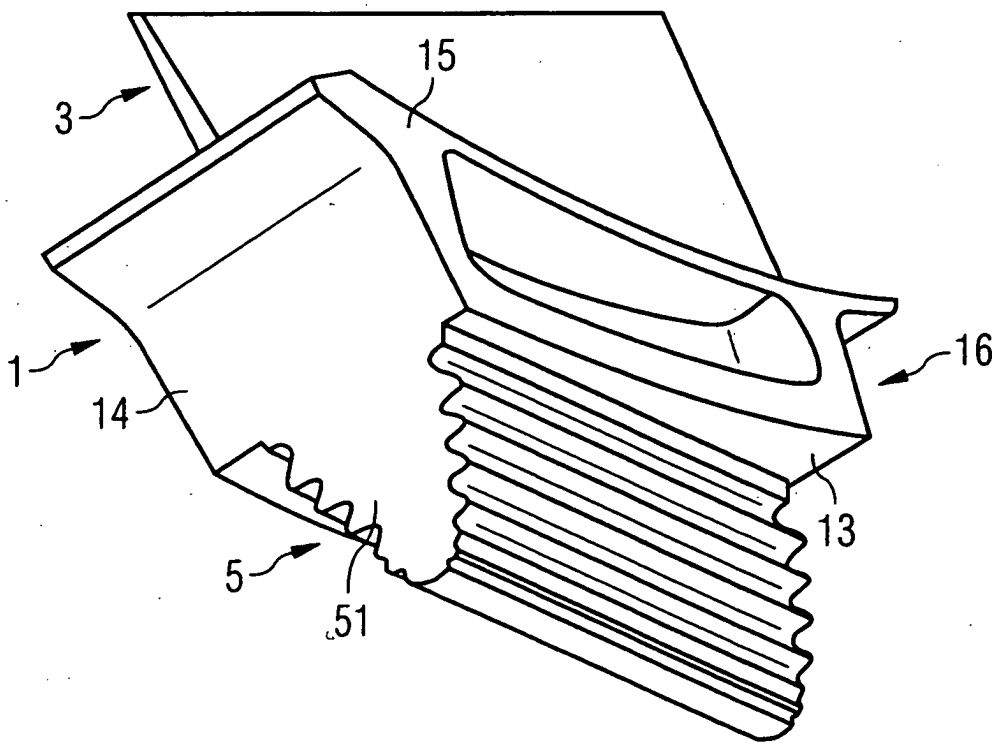
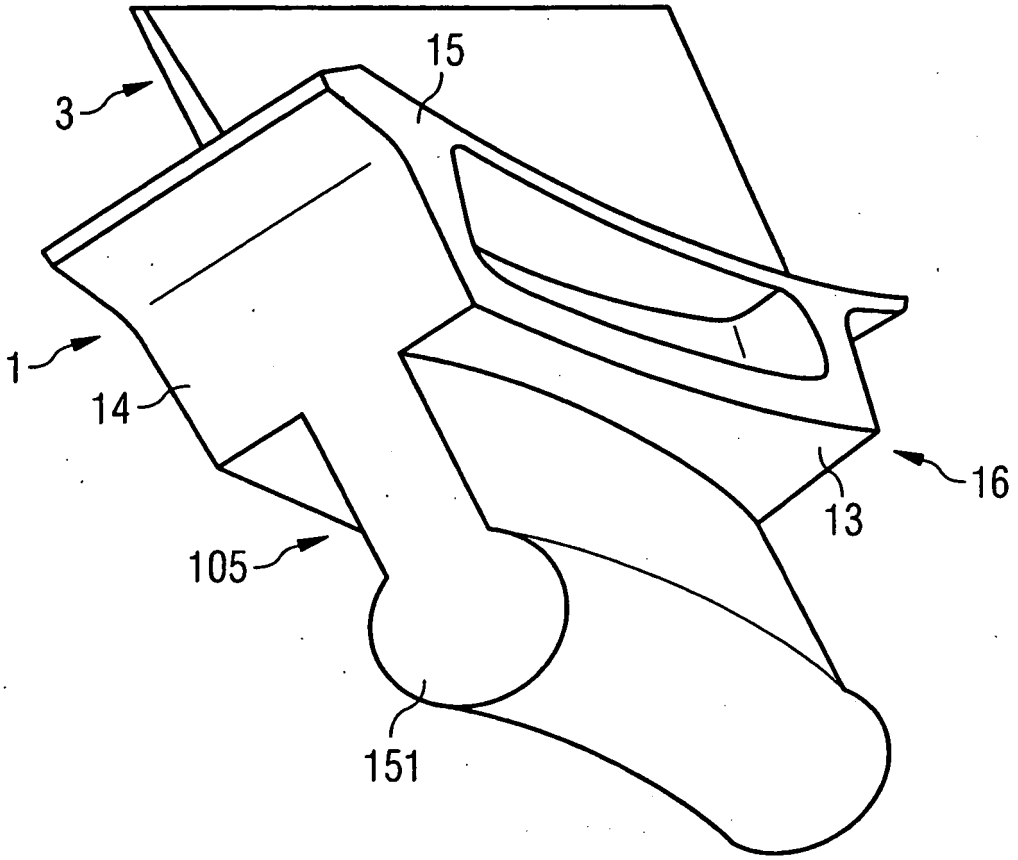


FIG 4



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5242270 A **[0002]**
- US 5160242 A **[0002]**
- US 3986739 A **[0002]**
- JP 07310502 B **[0002]**
- EP 1124038 A1 **[0003]**
- EP 0486489 B1 **[0017]**
- EP 0786917 B1 **[0017]**
- EP 0412397 B1 **[0017]**
- EP 1306454 A1 **[0017]**