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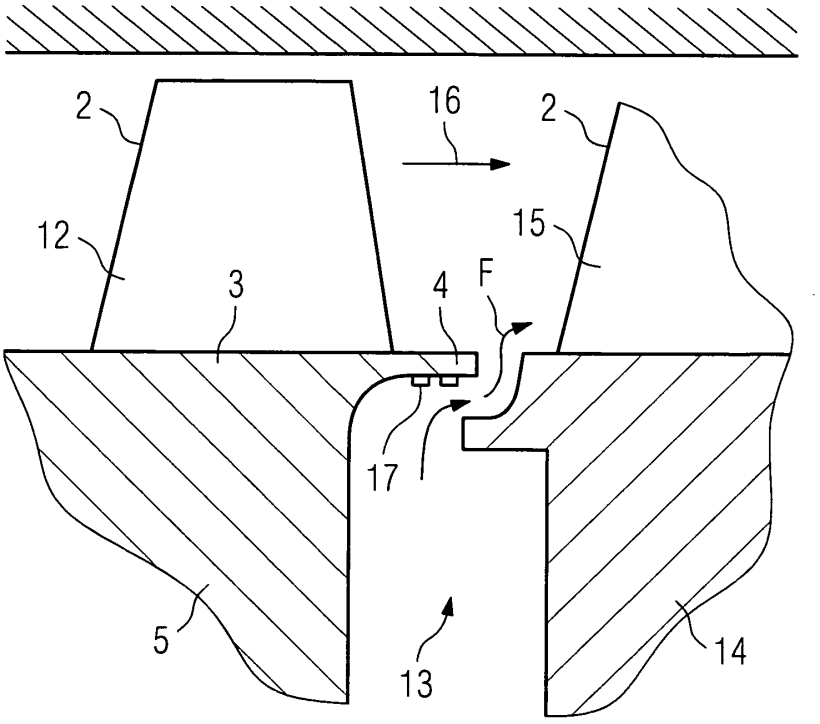
(54) **Turbine blade or vane with cooled platform**

(57) The present invention relates to a turbine component, in particular a vane (1) or a blade (12), comprising a platform (3), an airfoil portion (2) extending outwardly from said platform (3) and a shank portion (5) extending inwardly from said platform (3), whereby said platform (3) comprising an end zone (10) forming an platform trailing edge (4), whereby inwardly orientated surface of said trailing edge (4) is being ventilated by a flow (F) of a cooling medium streaming outwardly along said surface. It is an object of an invention to provide such a turbine component (1, 12), which permits enhanced cooling of the inwardly orientated surface of trailing edge (4). The problem is solved by associating said inwardly orientated surface with at least one surface enlargement element (17, 21).

FIG 2



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Description

[0001] The invention relates to a turbine component, in particular a vane or a blade, comprising a platform, an airfoil portion extending outwardly from said platform and a shank portion extending inwardly from said platform, whereby said platform comprising a end zone forming a platform trailing edge, whereby inwardly orientated surface of said trailing edge is being ventilated by a flow of a cooling medium streaming outwardly along said surface.

[0002] Aforesaid turbine component is known from EP 1 512 835 A2. The trailing edge of a turbine blade platform is very difficult to cool today. Increasing turbine inlet temperatures make it necessary to cool the blade platform more efficiently than it is done today. Blade platform side faces are cooled by coolant leakage flows today but the platform trailing edge should be cooled more intentionally. From DE 3248161 a cooled rotor blade for a gas turbine is known, which has a cooled airfoil portion, a shaft portion and a platform with a trailing edge. An analogous technical solution is known from a cooled rotor blade disclosed in DE 12 47 072. However, in the known construction of cooled blade airfoil portion is cooled only. The platform and the trailing edge are not cooled and therefore they may suffer overheating damage.

[0003] Said deficiency is eliminated to a large extent in another known construction of a cooled blade or vane, which is known from DE 26 39 511. In this construction the airfoil portion is cooled and the platform is cooled, too. Platform cooling is carried out by air flow below the platform, discharging through exhaust holes, which are situated at the shaft wall below the trailing edge. In this construction it is possible, due to the cooling of the platform, to provide acceptable temperature and lifetime of the platform.

[0004] Such a construction of a cooling system has a substantial deficiency, though, which lies in the following: In spite of platform cooling the trailing edge does not have any cooling or has very low cooling. The reason of this lack of cooling is in parallel disposition of trailing edge and mentioned exhaust holes axis, said disposition does not result in effective cooling of the trailing edge because there is not air jet impingement. Due to that trailing edge overheating may occur and the latter results in trouble of the trailing edge and limits the lifetime and the reliability of vane or blade component.

[0005] US 2007/0009359 A1 discloses a gas turbine blade with film cooling channels permitting air to flow from a shank cavity through the platform exterior to the airfoil. As stated in paragraph [0017] of this document, mentioned film cooling channels can be used also to purge a trailing edge undercut as disclosed in US 2005/0135936 A1. The combination of these documents misses any teaching for design of precise channel duct.

[0006] EP 1 512 835 A2 discloses a gas turbine blade comprising a platform, an airfoil portion extending outwardly from said platform and a shank portion extending inwardly from said platform, whereby said platform comprising a rear side forming a platform trailing edge, and whereby inwardly orientated surface of said trailing edge is being ventilated by a flow of a cooling medium streaming outwardly along said surface. The stream of cooling medium discharges from an exhaust hole situated on the rear side of the shank portion. Said exhaust hole is fed by a channel connecting exhaust hole with an internal cavity provided within the shaft portion and supplied with coolant. The exhaust hole is directed towards the inwardly orientated surface of said trailing edge, to permit edge ventilating flow of cooling medium to stream from exhaust hole towards said surface. However, since the velocity of stream near the trailing edge is comparatively high, a effective heat carriage from surface to cool to stream of medium is missed.

[0007] In view of this prior art it is an object of the present invention, to provide a turbine component of kind defined at the beginning, which permits enhanced cooling of the inwardly orientated surface of trailing edge. The aim of the invention is to increase the lifetime and the reliability of vanes and blades.

[0008] According to this invention the problem is solved by associating said inwardly orientated surface with at least one surface enlargement element.

[0009] A basic idea of this invention is to enhance the heat transfer between platform surface and the coolant by promoting coolant flow turbulence and thus increase the heat transfer coefficient and heat flux. Surface enlargement elements according to this invention act as turbulators to promote coolant flow turbulence. Therefore, an improved cooling is achieved. Due to the fact that platform trailing edge temperature is reduced, this results in an increase of the lifetime and reliability of the blade or vane.

[0010] Surface enlargement elements that could be used for this purpose include: a plurality of dimples depressed into surface or pimples extending from surface. Extending elements could either be pin-shaped fins or ribs with rectangular cross section, both spaced to another. A preferred embodiment is equipped with ribs designed in a criss-cross pattern. This would also give additional mechanical strength. All these heat transfer surface enlargement elements may also be combined to further enhance heat transfer.

[0011] Another preferred embodiment is characterized in that enlargement element extending from surface is a hook-shaped portion of trailing edge directed to the axis of the turbine. Preferably this embodiment is combined with channel fed exhaust holes, whereby the axis of said hole and/or channel is inclined to the trailing edge and directed to the end zone of the trailing edge. In this construction there is jet impingement cooling of the end part of the trailing edge (which has, as a rule, the most severe thermal conditions and the highest probability of overheating if no cooling). Enlargement element in sense of this invention may also be a perforated plate mounted upstream from said surface regarding flow of cooling me-

dium, said plate extending substantially parallel to said surface, whereby stream of cooling medium is flowing through perforation of plate. The plate could be attached to the shaft portion of the component to be cooled or to the shaft portion of the adjacent component. The perforation in the plate acts as additional impingement cooling for the bottom of the platform thus improving cooling of the trailing edge. This perforated plate is expected to increase the thermal flux about 20 to 40 percent.

[0012] The invention is described in more detail below by examples of its construction, which do not, however, limit the scope of possible ways of construction, and by illustrations, which show:

Fig. 1: A longitudinal section of a first embodiment of a guide vane with hook-shaped portion;
Fig. 2: A longitudinal section of a second embodiment of a rotor blade with rib-shaped elements;
Fig. 3a - e: Miscellaneous embodiments of surface enlargement elements;
Fig. 4: A longitudinal section of a third embodiment of a rotor blade with upstream mounted plate;
Fig. 5: A longitudinal section of a forth embodiment of a rotor blade with upstream mounted plate.

[0013] The guide vane 1, shown in Fig. 1, has the airfoil portion 2 and the platform 3 with the trailing edge 4. Platform 3 is connected with the shaft portion 5. A cavity 6 within the shaft portion 2 below the platform 3 is connected with coolant (as a rule, cooling air) source 7. The shaft portion 5 is provided with channel-like exhaust holes 8 connected with the cavity 6. The axis 9 of this holes respectively of the channel are directed to the end zone 10 of the trailing edge. To provide enhanced impingement cooling the end zone of the trailing edge 4, the latter has a end portion shaped like a hook 11, directed to the axis A of the turbine. There is jet impingement cooling of the hook shaped end portion of the trailing edge 4. Although, the example chosen for illustration is a guide vane 1, the same can be applied to a rotor blade of a gas turbine.

[0014] The gas turbine works in such a way that hot gas flows through a channel between the guide vane 1, getting a circumferential component of its velocity. Then said velocity provides the power of a turbine, exerting the circumferential force of the blades. The coolant flows from the source 7 into the inner cavity 6 cooling the platform 3. Then the coolant discharges through the exhaust hole 8 as a flow F towards the bottom surface of platform 3 to be cooled. Since the axis 9 of the hole 8 is directed to the end zone of the trailing edge 4, this provides jet impingement cooling of the trailing edge. Said cooling results in effective cooling of the edge and increases the lifetime and reliability of the vane and the turbine. The hook-shaped end portion 11 in zone 10 of the inward orientated surface of the platform 3 promotes a better air jet braking, thus increases the jet impingement effectiveness.

[0015] Figure 2 shows yet another embodiment of the present invention relating to a blade 12 of a gas or steam turbine. Here, the coolant is not fed from within the shank portion but rather from a rotor/stator cavity 13 defined between the shank portion 5 of the blade 12 and the shank portion 14 of the adjacent vane 15. Since the pressure in rotor/stator cavity 13 is higher than the pressure in the gas / steam path 16, the coolant flow F is coming up from the rotor/stator cavity 13 passing platform trailing edge 4. The latter is equipped with a plurality of surface enlargements elements 17, extending from the inwardly orientated surface of the trailing edge 4. These elements 17 improve heat transfer between the blade surface and the coolant flow F coming up from the cavity 13. The elements act also as turbulators further increasing effectiveness of impingement cooling.

[0016] Figures 3a to 3e show miscellaneous embodiments of surface enlargement elements 17, each in sectional view as well as in perspective view. In Figure 3a, a plurality of dimples 18 are depressed into inwardly orientated surface of the platform 3. Contrary to dimples a plurality of pimples may extend from surface. Extending elements could either be pin-shaped fins 19 (Figure 3b) or ribs 20 with rectangular cross section (Figure 3c and 3d), both spaced to another. In Figure 3c ribs 20 are directed transverse to the flow F of the coolant. In Figure 3d ribs 20 are arranged interrupted and directed longitudinal to the flow F of the coolant. A preferred embodiment is equipped with ribs 20 designed in a criss-cross pattern as shown in Figure 3e. This would also give additional mechanical strength. All these heat transfer surface enlargement elements may also be combined to further enhance heat transfer.

[0017] Figure 4 shows a third embodiment of the invention characterized in a perforated plate 21. This plate 21 is mounted to the shank portion 5 of blade 12 in a manner, that it extends substantially parallel to bottom surface of blade platform 3 to be cooled. In a region adjacent to blade shank portion 5 plate 21 is bent in a way following the face of shank portion 5. Regarding flow F of cooling medium, said plate is arranged upstream. The stream of cooling medium is flowing through the perforation of the plate 21. Thus, perforation in the plate acts as additional impingement cooling for the bottom of the platform. This perforated plate is expected to increase the thermal flux about 20 to 40 percent.

[0018] Figure 5 shows a forth embodiment of the invention characterized in a perforated plate 21. The shape of plate 21 shown in Figure 5 is completely plain. It is associated to the platform trailing edge 4 of blade 12 in manner, that it extends substantially parallel to bottom surface of blade platform 3 to be cooled. On its right side it is suitably fixed to the shank portion 14 of the vane 15, e. g. by welding. On its left side it contacts shank portion 5 of blade 12 by a sealing element 22 of some sort to minimize leakage of coolant between the stationary plate 21 and the rotating rotor surface. Eventually, perforated plate 21 mounted upstream to be flushed with coolant effects similar to dimples 18 shown in Figure 3a.

Claims

1. A turbine component, in particular a vane (1) or a blade (12), comprising a platform (3), an airfoil portion (2) extending outwardly from said platform (3) and a shank portion (5) extending inwardly from said platform (3), whereby said platform (3) comprising an end zone (10) forming a platform trailing edge (4), whereby inwardly orientated surface of said trailing edge (4) is being ventilated by a flow (F) of a cooling medium streaming outwardly along said surface, **characterized in, that** said inwardly orientated surface is associated with at least one surface enlargement element (17, 21).

2. Turbine component according to claim 1, whereby said element is a matter of a plurality of dimples (18) depressed into the surface.

3. Turbine component according to claim 1, **characterized in, that** said element (17) protruding inwardly from the surface.

4. Turbine component according to claim 3, **characterized in, that** said element is a matter of a plurality of pinshapes fins (19).

5. Turbine component according to claim 3, **characterized in, that** said element is a matter of a plurality of ribs (20) with a substantially rectangular cross section.

6. Turbine component according to claim 5, **characterized in, that** said ribs (20) are separated from another.

7. Turbine component according to claim 5, **characterized in, that** said ribs (20) are designed as a crisscross pattern.

8. Turbine component according to claim 3, **characterized in, that** said element (17) is a hook-shaped portion (11) of trailing edge (4) directed to the axis (9) of the turbine.

9. Turbine component according to at least one of the aforesaid claims 1 to 8, **characterized in, that** said shank (5) portion is provided with an internal cavity (6) supplied with cooling medium and with at least one channel connecting said cavity (6) with an exhaust hole (8) situated on the rear side of the shank portion (5), whereby said channel and/or said exhaust hole (8) is/are directed towards the inwardly orientated surface of said trailing edge (4), to permit edge ventilating flow (F) of cooling medium to stream outwardly from said cavity (6) along said channel towards said surface.

10. Turbine component according to claim 1, **characterized in that** said element is a matter of a perforated plate (21), arranged regarding flow (F) of cooling medium upstream from said surface, said plate (21) extending substantially parallel to said surface, whereby stream of cooling medium flowing through perforation of plate (21).

FIG 1

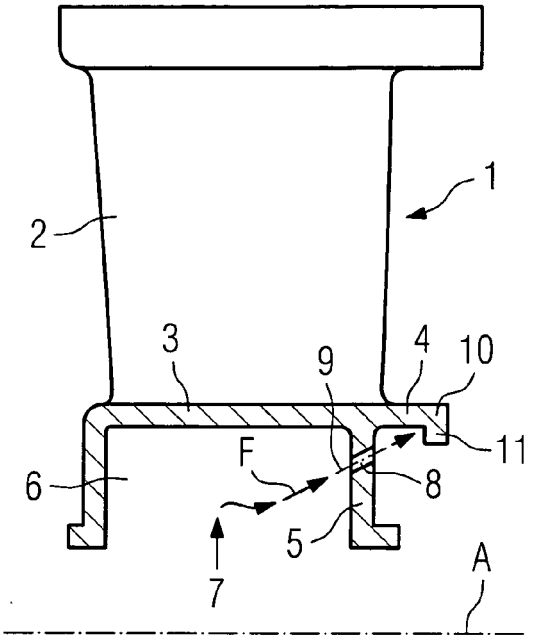


FIG 2

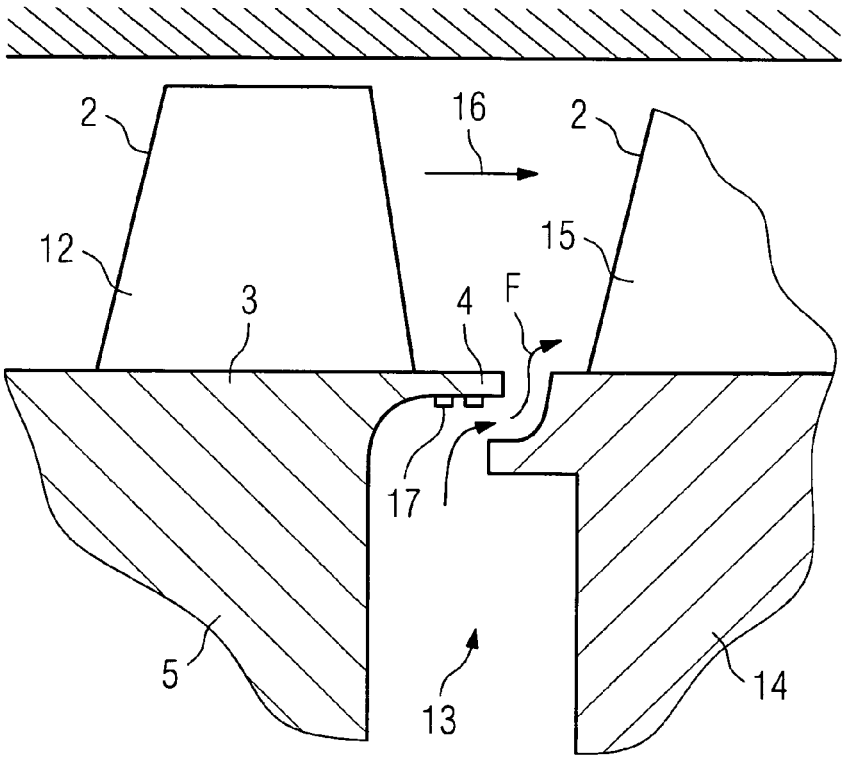


FIG 3A

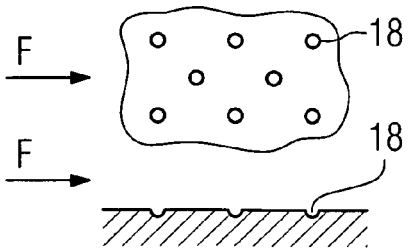


FIG 3B

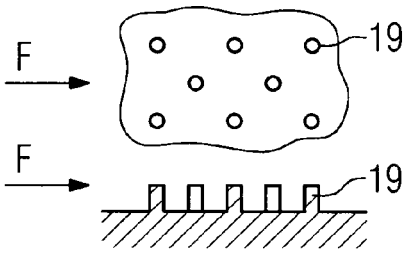


FIG 3C

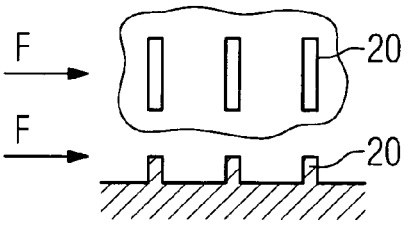


FIG 3D

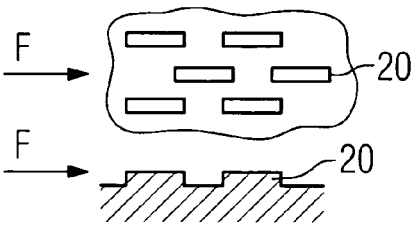


FIG 3E

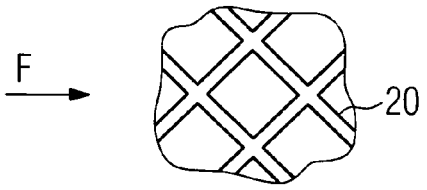


FIG 4

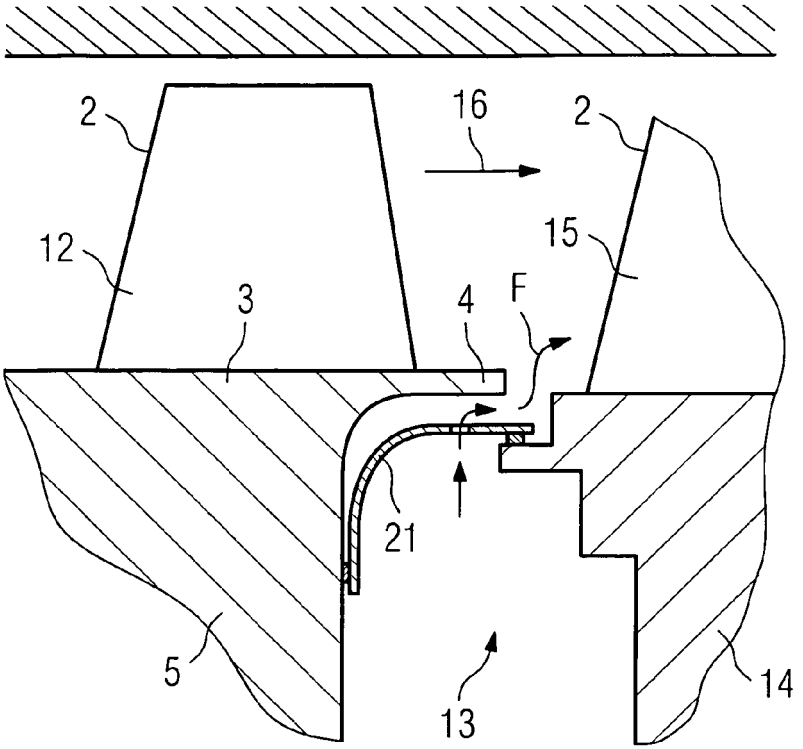
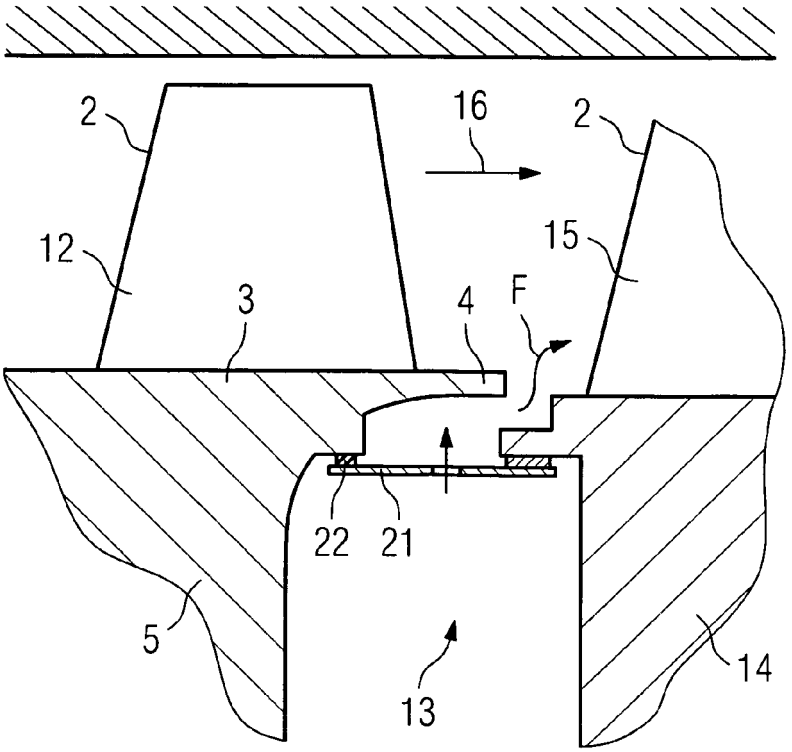


FIG 5



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Application Number
EP 08 00 3397

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 July 2008	Raspo, Fabrice

CATEGORY OF CITED DOCUMENTS

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