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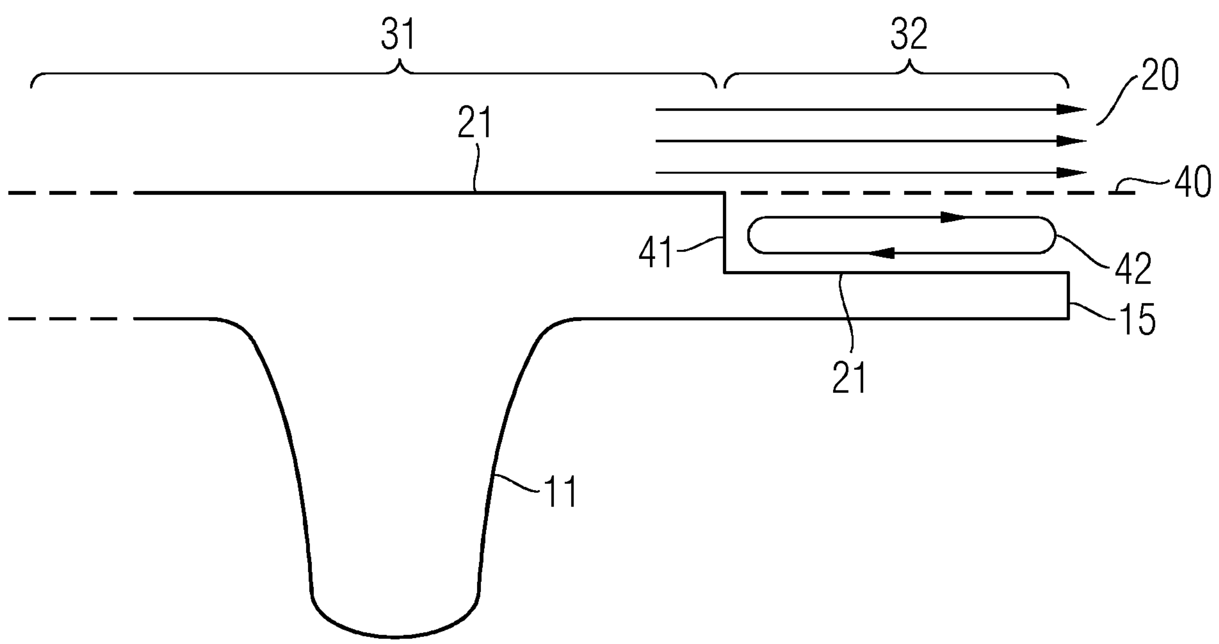
(54) **Turbine nozzle segment**

(57) A turbine nozzle segment of a turbo machine is provided. The turbine nozzle segment includes a platform for supporting one or more aerofoils. The platform has a guiding surface for guiding a main fluid flow of the turbo machine. A first section of the platform is formed so as to provide guidance of the main fluid flow along a flow path given by the shape of the guiding surface. A second downstream section of the platform is configured such that the guiding surface is at least at a trailing edge spaced apart from an extrapolation of the guiding surface in the first section in the direction of the main fluid flow.

FIG 4



EP 2 631 428 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a turbine nozzle segment of a turbo-machine, in particular to a stator vane platform, and to a gas turbine comprising such turbine nozzle segment.

BACKGROUND OF THE INVENTION

[0002] In a gas turbine engine, hot gas is routed from at least one combustor to a turbine section, in which stator vanes or nozzle guide vanes are designed to direct hot combustion gases onto rotor blades resulting in a rotational movement of a rotor to which the rotor blades are connected. Typically, the turbine section comprises one or more stator vane assemblies and one or more rotor blade assemblies which are arranged in an alternating order. The vanes within the same stator vane assembly and the blades within the same rotor blade assembly are usually identical or similar to each other. The vanes include an aerofoil portion, a radial inner platform portion and a radial outer platform portion. The platform portions form an annular passage into which the aerofoils of the stator vanes extend and through which a hot fluid, heated in an upstream combustor(s), will be guided. A stator vane assembly can comprise several segments which are put together to form said annular passage, the passage being bordered by the segments of the inner platform and the segments of the outer platform, each platform forming a circumferentially continuous face in the assembled state.

[0003] The platform portions and other parts within the gas turbine engine may be affected by the above mentioned hot fluids. For example, a hot gas stream contacting the platform or the vane or blade may lead to an oxidation of the respective material. To prevent damage to the material, the respective components may be actively cooled, or a thermally protective coating, such as a thermal barrier coating may be applied.

[0004] Methods for cooling the components of the stator vane assembly comprise impingement cooling, in which jets of cooling air are impinging the non-flow path side of the component, e.g. on the side of a platform facing away from the annular passage, or film cooling, by which cooling air is allowed to enter the flow path of the hot fluid through holes in the wall of the respective component, thereby creating a film of cooler air on the surface on the component. These conventional methods for preventing degradation of the components can have negative effects on the performance of the turbine. The methods generally result in a loss of performance, since the cooling air needs to be provided at high pressure and thus contains some of the energy from the compressor of the gas turbine. Film cooling further causes mixing losses as the cooling air enters the main flow path. The use of a thermal barrier coating is only effective if the non-flow path side of the respective component, i.e. its backside facing away from the annular passage, is actively cooled, e.g. by impingement cooling. Besides negative effects on performance, providing such cooling features may furthermore result in an increased cost of production of the respective gas turbine component.

[0005] A further problem is the presence of regions which are difficult to cool by such conventional methods. These are for example regions in which the flow path velocity of the hot fluid is very high. In such region, film cooling would be rather difficult to introduce, and due to a high heat transport coefficient, substantial mixing losses will be experienced. Also, such regions may be difficult to access by means of impingement cooling, and accordingly, a thermal barrier coating will be rather ineffective. The regions of the component which are difficult to cool are in consequence prone to accelerated detoriation. In particular, oxidation of the material results in a shortened lifetime of the component.

[0006] It is desirable to prolong the lifetime of gas turbine components which are exposed to such hot fluid streams, for example by preventing oxidization due to excess temperatures. In particular, it is desirable to provide an efficient cooling of such components, while at the same time keeping production costs low. The efficiency of the gas turbine should furthermore not be compromised.

Summary

[0007] Accordingly, there is a need for providing improved cooling of a gas turbine component, and to obviate at least some of the drawbacks mentioned above.

[0008] This need is met by the features of the independent claims. The dependent claims describe embodiments of the invention.

[0009] An embodiment of the invention provides a turbine nozzle segment of a turbo machine comprising a platform, in particular a stator vane platform, for supporting one or more aerofoils. The platform comprises a guiding surface for guiding a main fluid flow of the turbo machine, the guiding surface being located on the side of the platform which is to support the one or more aerofoils, and a first and a second section, wherein the second section is a downstream section located downstream of the first section with respect to the main fluid flow. The platform further has a trailing edge with respect to the main fluid flow, wherein the trailing edge of the platform is part of the second section. The first section of the platform is formed so as to provide guidance of the main fluid flow along a flow path given by the shape of the guiding surface. The second section of the platform is formed such that the guiding surface of the second section is at least at the trailing edge spaced apart from an extrapolation of the guiding surface in the first section towards the trailing edge. The spacing is in a direction away from the main fluid flow such that in the second section of the platform, the main fluid flow separates from the guiding surface in operation.

[0010] By providing in the second section a flow separation of the main fluid flow from the guiding surface, the heat transfer coefficient between the main fluid flow and the guiding surface can be reduced by reducing the flow velocity local to the wall. An excessive heating of the region of the platform adjacent to the trailing edge, which is generally difficult to cool, can thus be prevented. Accordingly, oxidation of this region of the platform can be avoided or at least be delayed, thereby prolonging the lifetime of the turbine nozzle segment. Since no additional measures have to be taken, such as providing additional holes or the like in the component, the improved cooling can be implemented cost efficiently. Also, additional cooling air, which could result in a loss of efficiency, is not required.

[0011] In an embodiment, the guiding surface in the second section of the platform is shaped such that an area of recirculation of the main fluid flow is formed adjacent to the guiding surface in said second section, wherein the area of recirculation separates the main fluid flow from the guiding surface. By promoting the formation of an area of recirculation, the local velocity of the fluid flow next to the guiding surface can be reduced significantly in the second section of the platform, resulting in a reduction of the heat transfer coefficient. As a part of the main fluid flow re-circulates, it may thermally insulate the guiding surface in the second section from the main fluid flow. The re-circulation may for example occur by a fraction of the main fluid moving in a direction backwards with respect to the main fluid flow. In particular, a vortex like flow may form adjacent to the guiding surface in the second section in which a fraction of the main fluid circulates. The re-circulation may effectively provide a wall of the fluid which reduces the transfer of heat from the main fluid flow to the guiding surface of the platform in the second section.

[0012] In an embodiment, the second section of the platform may comprise a discontinuity in the guiding surface or in the curvature of the guiding surface for providing the above mentioned spacing. The discontinuity may be sharp enough so as to cause an area of recirculation. The discontinuity may for example be a step, a kink, a bend, a sharp corner or the like.

[0013] By reducing the heat transfer to the guiding surface of the platform, the amount of cooling that is required to achieve a satisfactory temperature of the platform in operation can be reduced.

[0014] The discontinuity may extend substantially parallel to the trailing edge of the platform. This may be advantageous if the discontinuity comprises a sudden change in curvature such as a kink or a sharp corner, since it can facilitate the manufacturing of the platform.

[0015] The discontinuity may extend substantially perpendicular to the flow path of the main fluid flow (in particular the flow path at the position of the discontinuity). Such configuration may facilitate the generation of an area of recirculation of the main fluid, thereby reducing the heat transfer from the main fluid to the platform.

[0016] In other embodiments, the discontinuity may have any angle between the above defined positions, i.e. between being parallel to the trailing and being perpendicular to the flow path of the main fluid flow. The configuration may thus be designed in accordance with the requirements of the particular application.

[0017] In another embodiment, the discontinuity may extend between the downstream parts of adjacent aerofoils. Between the aerofoils, it may again extend perpendicular to the direction of the main fluid flow, or perpendicular to the trailing edge, or at any angle in between.

[0018] Note that the discontinuity of the guiding surface does not need to be continuous in circumferential direction of the platform, it may for example have a saw tooth shape, e.g. when extending perpendicular to the main fluid flow between adjacent aerofoils.

[0019] In an embodiment, the second section of the platform may comprise a step in the guiding surface for providing the spacing, the step extending towards the trailing edge. Providing a step as a discontinuity in the guiding surface may have the advantage that an area of re-circulation can be generated rather effectively. A step may for example be provided by the platform being thicker in the first section and thinner in the second section.

[0020] In another embodiment, the second section of the platform may comprise a sharp corner in the guiding surface, wherein downstream the sharp corner, the guiding surface is sloping away from the flow path of the main fluid flow for providing the spacing. The change in the guiding surface is less abrupt than when using a step, which may result in a lower aerodynamic resistance, while the sharp corner may still provide for an effective generation of an area of recirculation.

[0021] In a further embodiment, the second section of the platform may comprise a change in the curvature of the guiding surface with respect to the curvature of the guiding surface in the first section. The change in curvature is such that the guiding surface is sloping away from the flow path of the main fluid flow for providing the spacing. Providing a smooth transition between the first and the second sections of the platform may result in an improved efficiency of the turbo machine.

[0022] The platform may comprise a coating on the guiding surface, and the coating may be provided such that the spacing between the extrapolated flow path and the guiding surface at the trailing edge is achieved by a variation of the thickness of the coating in the second section of the platform. Referring to the above examples, the coating may for example comprise a step within the second section, it may become thinner towards the trailing edge so as to provide a sharp corner within the second section or so as to change the curvature of the guiding surface within the second section. The coating may comprise within the first section a layer of a first thickness, and within the second section a layer of a second, reduced thickness, or a layer of a changing thickness for providing said spacing.

[0023] In other embodiments, the spacing may be provided by forming or casting the platform in accordance with any of the above examples in the manufacturing process, or by machining the second section of the platform accordingly.

[0024] The first section and/or the second section of the platform may for example comprise a thermal barrier coating and/or an oxidation coating, such as AL_2O_3. Such coating may provide thermal isolation, may reduce the oxidation of the platform and may furthermore provide the above mentioned discontinuity or change in curvature of the guiding surface.

[0025] The turbine nozzle segment may comprise further means for cooling. The platform may comprise film cooling holes for injecting a film cooling fluid. Impingement cooling may be provided, wherein a surface of the platform located substantially opposite to the guiding surface may be impingement cooled by being subjected to a stream of cooling fluid.

[0026] In an embodiment, the platform is an inner platform. An inner platform is located radially inwards with respect to the main fluid flow, e.g. in a direction towards a main shaft of the turbo machine.

[0027] In an embodiment, the guiding surface is spaced apart from the extrapolation of the flow path over the whole of the second section. The second section may for example extend over at least 10 %, preferably at least 15 % of the guiding surface in the direction of the main fluid flow. The guiding surface may be a cylindrical or a frusto conical surface, or a segment thereof, having an axial direction. The second section may extend over at least 10 %, preferably at least 15 % of the guiding surface in this axial direction.

[0028] The guiding surface may generally extend from a leading edge to the trailing edge of the platform.

[0029] The platform may be an inner stator platform. The turbine nozzle segment may comprise an outer stator platform, and the inner and outer stator platforms may define an annular space there between, e.g. a segment of an annulus. The annular space provides a flow path for the main fluid flow. One or more aerofoils may extend between the inner stator platform and the outer stator platform. The aerofoil may be part of a nozzle guide vane comprised in the turbine nozzle segment. The main fluid flow is generally substantially perpendicular to a radial direction of the annular space.

[0030] In a further embodiment, the turbine nozzle segment is a stator vane segment, the stator vane segment comprising at least one aerofoil.

[0031] A further embodiment provides a gas turbine comprising a turbine nozzle segment according to any of the above mentioned embodiments. In such gas turbine, advantages similar to the ones outlined further above can be achieved. In particular, the cooling of the platform of the turbine nozzle segment and thus the lifetime thereof may be improved.

[0032] The features of the embodiment of the invention mentioned above and those yet to be explained below can be combined with each other unless noted to the contrary.

Brief description of the drawings

[0033] The foregoing and other features and advantages of the invention will become further apparent from the following detailed description read in conjunction with the accompanying drawings. In the drawings, like reference numerals refer to like elements.

Figure 1 is a schematic drawing showing a sectional side view of a turbine nozzle segment.

Figure 2 is a schematic drawing showing a sectional side view of a segment of a stator vane assembly and a segment of a rotor blade assembly.

Figure 3 is a schematic drawing showing a top view of the turbine nozzle segment of figure 1.

Figure 4 is a schematic drawing showing a sectional side view of a downstream section of a turbine nozzle segment in accordance with an embodiment of the invention.

Figure 5 is a schematic drawing showing a sectional side view of a downstream section of a turbine nozzle segment in accordance with a further embodiment of the invention.

Figure 6 is a schematic drawing showing a sectional side view of a downstream section of a turbine nozzle segment in accordance with a further embodiment of the invention.

Detailed description

[0034] In the following, embodiments of the present invention will be described in detail with reference to the accompanying drawings. It is to be understood that the following description of the embodiments is given only for the purpose of illustration and is not to be taken in a limiting sense.

[0035] It should be noted that the drawings are to be regarded as being schematic representations only, and that elements in the drawings are not necessarily to scale with each other. Rather, the representation of the various elements is chosen such that their function and general purpose become apparent to a person skilled in the art.

[0036] Figure 1 shows a sectional side view of a turbine nozzle segment 10 of a type which may be employed with embodiments of the present invention. The turbine nozzle segment 10 then comprises an inner platform 11, in particular an inner stator platform, and an outer platform 12. It further comprises an aerofoil 13 which is supported between the inner platform 11 and outer platform 12. Aerofoil 13 may be part of a stator vane, and accordingly, the turbine nozzle segment 10 may be a stator vane segment.

[0037] Inner platform 11 and outer platform 12 are segments of a ring shaped inner and outer assembled platform, respectively, with the centre of such ring being located at the rotational axis (e.g. axis A) of a neighbouring rotor segment. Accordingly, between the inner platform 11 and the outer platform 12, an annular space is formed, through which the aerofoil 13 extends. The annular space provides a flow channel for a main fluid flow 20. Main fluid flow 20 generally originates from an upstream combustion chamber, in which fuel for operating the turbo machine is burned. Main fluid flow 20 may accordingly comprise a stream of hot combustion gases, and may comprise a mixture of fuel exiting the combustor. Turbine nozzle segment 10 is part of a stator vane assembly, having a number of aerofoils 13 distributed circumferentially between the assembled inner and outer platforms. One or more such stator vane assemblies may be arranged alternately with rotor blade assemblies in a turbine section of the turbo machine.

[0038] This is schematically illustrated in figure 2, in which downstream of the turbine nozzle segment 10, a rotor blade segment 50 is arranged. Rotor blade segment 50 comprises an inner platform 51, and optionally an outer platform 52, with the aerofoil 53 of a rotor blade extending between inner and outer platforms 51 and 52. Rotor blade segment 50 forms a rotor blade assembly which extends circumferentially around the axis of rotation of the rotor blade assembly, and includes a plurality of rotor blades distributed in the circumferential direction. Accordingly, by an alternating arrangement of stator vane assemblies and rotor blade assemblies, an annular flow channel is formed for the main fluid flow 20, in particular for hot combustion gases. Note that although an outer platform 52 is shown in the present example, the rotor blade assembly may be implemented without such platform, wherein for example an inner housing part of a turbine section may provide the annular flow channel.

[0039] Turning back to figure 1, the different axes are indicated in the lower part of the figure. r denotes the radial direction, whereas a denotes the axial direction parallel to the rotational axis A of the shaft of the turbo machine. C denotes the circumferential direction, which in figure 1 is directed perpendicular to the sectional plane. Inner platform 11 means that when the turbine nozzle segment 10 is assembled to a stator vane assembly, the platform 11 is located radially inwards, i.e. in the direction of axis A shown in the lower part of figure 1. Outer platform 12 is correspondingly located in radial direction r outwards of inner platform 11.

[0040] When the turbine nozzle segment 10 is assembled in a turbo machine and in operation, the main fluid flow 20 is guided through the annulus formed by inner and outer platforms 11 and 12. The fluid washed surface 21 of the inner platform 11 is thus considered to be a guiding surface for the main fluid flow 20. The main fluid flow 20 will enter the annulus at the leading edge 14 of the inner platform 11, and will leave the annulus at the trailing edge 15. In proximity to the inner platform 11, the guiding surface 21 which extends between the leading edge 14 and the trailing edge 15 defines a flow path, with the main fluid flow 20 being essentially parallel to this flow path in proximity to inner platform 11. Further downstream in the main fluid flow 20, the main fluid flow 20 will be guided by the inner platform 51 of the adjacent rotor blade assembly (see figure 2).

[0041] The inner platform 11 comprises a section 32 which is located downstream of the remaining part of inner platform 11 with respect to the main fluid flow 20. While the remaining section of inner platform 11 is considered to be a first section, the downstream section or trailing section 32 is considered to be a second section within the meaning of the application. The downstream section 32 of the inner platform 11 may begin at an axial position at which the main part of the aerofoil 13, e.g. more than two thirds (2/3) or more than three quarters (3/4) of the axial extension of the aerofoil 13 are comprised in the first section of platform 11, i.e. located upstream of the downstream section 32. Downstream section 32 may accordingly comprise the remaining part of the aerofoil 13, or it may only comprise a section of platform 11 located downstream of the aerofoil 13.

[0042] Guiding surface 21 is facing the main fluid flow 20. Accordingly, when the main fluid flow 20 comprises hot combustion gases, there will be a substantial heat transfer to the guiding surface 21. In particular in the downstream section 32, guiding surface 21 is difficult to cool. Due to the proximity to a neighbouring rotor blade assembly, the non-flow path side of platform 11 in section 32 indicated by reference symbol 22 does not enable an easy access for impingement cooling. Due to the proximity to the stator vanes and the trailing edge 15, film cooling is also difficult to implement.

[0043] This situation is illustrated in more detail in figure 3. Figure 3 is a sectional top view of the turbine nozzle segment 10 of figure 1 taken along the line B-B. In figure 3, the inner platform 11 is visible, and the arrangement of the aerofoils 13 can be readily recognized. The main fluid flow is again indicated by arrow 20. As can be seen by the axis indicated on the left hand side of figure 3, the radial direction now extends perpendicular to the drawing plane, whereas the circumferentially direction C extends in the drawing plane parallel to the trailing edge 15, and the axial direction a extends in the drawing plane perpendicular to the trailing edge 15.

[0044] The first section 31 and the second section 32 of the inner platform 11 are indicated. The view is radially inwards, so that guiding surface 21 is now seen from above i.e. from the direction of outer platform 12. In the downstream section 32 of the inner platform 11, the shaded area indicates where excessive heating of the inner platform 11 occurs due to the main fluid flow 20. While in the first section 31, the guiding surface 21 can be film cooled, e.g. by injecting cooled gas through holes provided in proximity to the leading edge of the inner platform

11, or can be impingement cooled on the non flowpath side of inner platform 11, such cooling is generally not possible for the shaded areas in the downstream section 32.

[0045] Note that by means of aerofoils 13, the main fluid flow deviates from the axial direction a. A subsequent rotor blade assembly may act on the main fluid flow in the opposite direction, so that an average, the main fluid flow remains essentially parallel to axial direction a.

[0046] To prevent the excessive heating of the inner platform 11 in the downstream section 32, embodiments of the invention provide configurations of the inner platform 11 in which the guiding surface 21 is spaced apart from the main fluid flow 20 in the second or downstream section 32. As can be seen from figure 1, the guiding surface 21 in the first section 31 of the inner platform 11 provides guidance along a flow path given by the shape of the guiding surface 21. This flow path or in particular the guiding surface within the first section 31 can now be extrapolated into the second section 32 in axial direction a. In the second section 32, the inner platform 11 is now formed so that the guiding surface is spaced apart from this extrapolation. In particular, it is spaced away from the main fluid flow so that in the second section of platform 11, the main fluid flow 20 separates from the guiding surface 21.

[0047] With reference to figures 4, 5 and 6, specific embodiments of how this separation can be achieved are described below, wherein these embodiments can be implemented in the turbine nozzle segments illustrated in figures 1, 2 and 3. Accordingly, the explanations given further above equally apply to the turbine nozzle segments described with respect to figures 4, 5 and 6. The description below is focused on providing possibilities of the spacing in the downstream section 32 of the inner platform 11, so that the figures and the description are only focused on the second section, wherein the remaining parts of the turbine nozzle segment may be configured as described above.

[0048] In the embodiments of figures 4 and 5, a discontinuity is provided in the guiding surface 21 or in the curvature of the guiding surface 21 respectively, for achieving the separation of the main fluid flow 20 from the guiding surface 21 in downstream section 32. Figure 4 shows a sectional side view of the downstream portion of the inner platform 11. The guiding surface 21 comprises a discontinuity 41 in from of a step within the downstream section 32. In downstream section 32, the guiding surface 21 is accordingly spaced apart from the extrapolation 40 of the guiding surface 21 in the first section 31 towards trailing edge 15. In operation, a flow separation of the main fluid flow 20 occurs. The step extends from the discontinuity 41 to the trailing edge 15. It is configured such that in operation, a part of the main fluid re-circulates in an area of recirculation 42. A fraction of the fluid thus moves backwards with respect to the main fluid flow in an area adjacent to surface 21 in the downstream section 32. The recirculation of the main fluid essentially creates an air wall which reduces the transfer of heat from main fluid flow 20 to the guiding surface 21 in the downstream section 32. In particular, the recirculation reduces the local velocity of the main fluid, and therefore, the heat transfer coefficient is reduced. The guiding surface 21 is thus in the downstream section 31 thermally isolated from the high velocity flow of the main fluid.

[0049] The discontinuity 41 is sharp enough so as to ensure that recirculation occurs. At the same time, the modification to the guiding surface 21 is small enough so that additional turbulences and therefore losses in the efficiency of the turbine can be kept small.

[0050] By providing the thermal isolation from the main fluid flow 20, the amount of cooling required for the downstream section 32 is reduced significantly. Accordingly, conventional cooling methods such as impingement cooling, film cooling and a thermal barrier coating are sufficient to reduce the temperature in downstream section 32 to acceptable levels. Accordingly, the lifetime of inner platform 11 can be prolonged.

[0051] The discontinuity 41 may extend substantially parallel to the trailing edge 15, i.e. parallel to the circumferential direction C, see figure 3. Depending on the requirements for thermal isolation, the downstream section 32 which comprises the step may start at an axial position which still comprises the downstream parts of aerofoils 13, or it may start in a region located downstream of aerofoils 13. In other embodiments, the discontinuity may extend substantially parallel to the flow of the main fluid as illustrated in figure 3. As an example, the discontinuity may extend parallel to the shading lines of figure 3, it may for example be located at the first line as seen from the direction of the main fluid flow 20. Accordingly, the discontinuity, e.g. the step or the sharp corner, may not be continuous in circumferential direction C, but it may have a sawtooth shape as in figure 3 or the like.

[0052] In the embodiment of figure 5, the downstream section 32 comprises a discontinuity in the curvature of the guiding surface 21 in form of a sharp corner or bend. Accordingly, the guiding surface 21 is spaced apart from the extrapolation 40 of the guiding surface 21 in the downstream section 32. As can be seen, also in this example, the spacing is provided over the whole downstream section 32, the spacing extending from the discontinuity 41 to the trailing edge 15. Again, an area of recirculation 42 forms adjacent to the guiding surface 21 in the second section 32. Due to the discontinuity 41 in form of a sharp corner, an efficient flow separation of the main fluid flow 20 from the guiding surface 21 can be achieved, so that the generation of an area of recirculation 42 is ensured. The additional flow resistance provided by the shape of the guiding surface 21 in the downstream section 32 is kept relatively low since the spacing to the extrapolation line 40 is increased smoothly with distance to the discontinuity 41.

[0053] Figure 6 shows a further embodiment in which the spacing between the extrapolation 40 of guiding surface 21 and the trailing edge 15 is provided by a smooth change in curvature of the guiding surface 21 in the downstream section 32. This "curved corner" provides a spacing of the guiding surface 21 to the main fluid flow 20 that is large enough to cause a separation of the main fluid flow 20 from the guiding surface, thereby generating the area of recirculation 42. Due to the smooth change of curvature, the additional flow resistance provided by the shape of the guiding surface 21 in the downstream section 32 can be reduced even further.

[0054] It should be clear that the examples illustrated in figures 4 to 6 are only given for the purpose of illustration, and that other shapes of the guiding surface 21 in the downstream section 32 can be implemented for providing the spacing to the extrapolation 40 of the guiding surface 21 in the first section 31, so that the main fluid flow 20 separates from the guiding surface and the area of recirculation 42 is generated. As an example, the step of figure 4 may be provided in form of a smooth step having smooth edges, or an additional curvature may be provided further downstream from the step. Similarly, in the example of figure 5, there may be provided an additional curvature of the guiding surface 21 within the downstream section 32. It should also be noted that in the figures 4 to 6, the spacing of the guiding surface 21 to the main fluid flow 20 in the second section 32 is exaggerated for the purpose of illustration. Generally, the modification in the shape of the guiding surface 21 in downstream section 32 will be kept as small as possible to keep any effects on flow resistance low. The dimensions of the step, sharp corner or bending are chosen such that the recirculation takes place and a re-circulating air wall is generated. Suitable dimensions may for example be determined using numerical simulations of the system.

[0055] The shaded areas of figure 3 are difficult to cool since the flow path velocity in these areas is very high. This results in high losses of film cooling, and film cooling is difficult to introduce. The flow path heat transfer coefficient is very high, and film cooling will result in high mixing losses.

[0056] By providing the area of recirculation in accordance with any of the embodiments disclosed herein, the required amount of cooling can be reduced significantly for these areas, and accordingly, losses introduced by the cooling can be reduced.

[0057] The guiding surface 21 may be provided both in sections 31 and 32 with a thermal barrier coating and/or with an oxidation coating, such as AL_2O_3. Thermal isolation from the main fluid flow and protection against oxidation can thus both be improved.

[0058] Inner platform 11 can be manufactured in different ways for providing the above mentioned spacing. One possibility includes providing the discontinuity or the change in curvature by means of a coating, which has a different thickness in the first section 31 and in the second section 32. The coating, which may for example be the thermal barrier coating, may be applied with different thickness to the first and second sections 31, 32 or it may have a changing thickness within section 32, so as to achieve the spacing as illustrated in any of figures 4 to 6. Other possibilities of providing the spacing in inner platform 11 comprise the machining of the desired shape into the second section 32 of inner platform 11, or casting the inner platform 11 in the desired shape, thus already including the discontinuity or change in curvature within the second section by changing the shape of the base component material.

[0059] Note that recirculation may not develop at all operating points of the turbo machine, e.g. during start up or shut down. It may also depend on the velocity of the main fluid flow 20 and the pressure of the main fluid flow 20.

[0060] In some embodiments, the turbine nozzle segment 10 may be manufactured as a single piece, for example by casting, while in other embodiments, aerofoil 13 and platforms 11 and 12 may be separate pieces that are assembled. The turbine nozzle segment 10 may define a segment of the annular fluid duct, and two or more segments may be arranged adjacent to each other around the axis A to form the whole annulus. In other embodiments, the annulus may not be segmented, and the platforms 11 and 12 may have a continuous ring shape around axis A. Surface 21 may have a cylindrical or frusto conical shape, yet other shapes, such as slightly curved shapes are also conceivable. Turbine nozzle segment 10 can be part of a turbine section of a turbo machine, in particular of a gas turbine. In other embodiments, the invention may be applied to other types of machines through which a hot fluid is guided. Such include gas turbine engines, compressors, steam turbine engines and the like. With respect to gas turbine engines, the invention may be applied to components located in a turbine section and/or within a combustion section.

[0061] While specific embodiments are disclosed herein, various changes and modifications can be made without departing from the scope of the invention. The present embodiments are to be considered in all respects as illustrative and non restrictive, and all changes coming within the meaning at equivalency range of the appended claims are intended to be embraced therein.

Claims

1. A turbine nozzle segment of a turbo-machine comprising a platform (11), in particular a stator vane platform, for supporting one or more airfoils (13), wherein the platform (11) comprises:

   - a guiding surface (21) for guiding a main fluid flow (20) of the turbo machine, the guiding surface being located on the side of the platform (11) which is to support the one or more aerofoils (13);
   - a first section (31) and a second section (32),

wherein the second section (32) is a downstream section located downstream of the first section (31) with respect to the main fluid flow (20); and

- a trailing edge (15) with respect to the main fluid flow, wherein the trailing edge (15) of the platform is part of the second section (32),

wherein the first section (31) of the platform is formed so as to provide guidance of the main fluid flow (20) along a flow path given by the shape of the guiding surface (21), and wherein the second section (32) of the platform is formed such that the guiding surface (21) of the second section (32) is at least at the trailing edge (15) spaced apart from an extrapolation (40) of the guiding surface (21) of the first section (31) in the direction of the main fluid flow (20) towards the trailing edge (15),
wherein the spacing is in a direction away from the main fluid flow (20) such that in the second section (32) of the platform (11), the main fluid flow (32) separates from the guiding surface (21) in operation.

2. The turbine nozzle segment according to claim 1, wherein the guiding surface in the second section of the platform is shaped such that an area of recirculation (42) of the main fluid flow (20) is formed adjacent to the guiding surface (21), said area of recirculation (42) separating the main fluid (20) flow from the guiding surface (21).

3. The turbine nozzle segment according to any of the preceding claims, wherein the second section (32) of the platform comprises a discontinuity (41) in the guiding surface (21) or in the curvature of the guiding surface (21) for providing said spacing.

4. The turbine nozzle segment according to claim 3, wherein said discontinuity (41) extends substantially parallel to the trailing edge (15) of the platform.

5. The turbine nozzle segment according to claim 3 wherein the discontinuity (41) extends substantially perpendicular to the flow path of the main fluid flow (20).

6. The turbine nozzle segment according to any of claims 3-5, wherein the discontinuity (41) extends between the downstream parts of adjacent aerofoils (13).

7. The turbine nozzle segment according to any of the preceding claims, wherein the second section (32) of the platform comprises a step in the guiding surface (21) for providing said spacing, the step extending to the trailing edge (15).

8. The turbine nozzle segment according to any of the preceding claims, wherein the second section (32) of the platform comprises a sharp corner in the guiding surface (21), wherein downstream the sharp corner, the guiding surface (21) is sloping away from the said flow path of the main fluid flow (20) for providing said spacing.

9. The turbine nozzle segment according to any of claims 1-2, wherein the second section (32) of the platform comprises a change in the curvature of the guiding surface (21) with respect to the curvature of the guiding surface in the first section (31), the change in curvature being such that the guiding surface (21) is sloping away from the said flow path of the main fluid flow (20) for providing said spacing.

10. The turbine nozzle segment according to any of the preceding claims, wherein the platform (11) comprises a coating on the guiding surface (21), wherein the coating is provided such that said spacing at the trailing edge (15) is formed by a variation of the thickness of the coating in the second section (32) of the platform.

11. The turbine nozzle segment according to any of the preceding claims, wherein the first section (31) and/or the second section (32) of the platform (11) comprises a thermal barrier coating and/or an oxidation coating.

12. The turbine nozzle segment according to any of the preceding claims, wherein the guiding surface (21) is for the whole of the second section spaced apart from said extrapolation of the guiding surface, the second section extending over at least 10%, preferably at least 15% of the platform (11) in the direction of the main fluid flow (20).

13. The turbine nozzle segment according to any of the preceding claims, wherein the platform (11) is an inner stator platform, the turbine nozzle segment (10) further comprising an outer stator platform (12), the inner and the outer stator platforms defining an annular space therebetween, said annular space providing a flow path for said main fluid flow (20) .

14. The turbine nozzle segment according to any of the preceding claims, wherein the turbine nozzle segment (10) is a stator vane segment, the stator vane segment comprising at least one aerofoil (13).

15. A gas turbine comprising a turbine nozzle segment (10) according to any of claims 1-14.

FIG 1

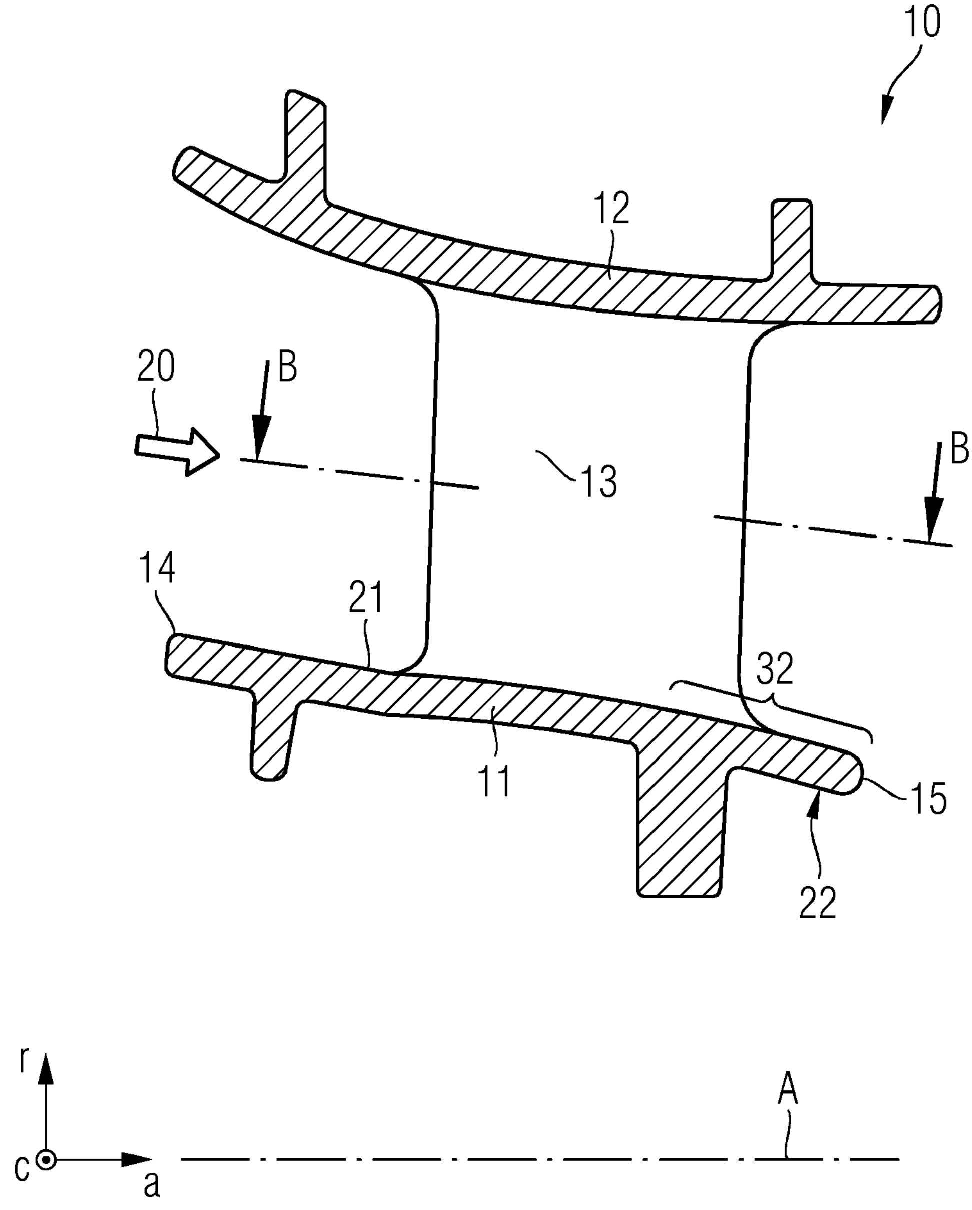


FIG 2

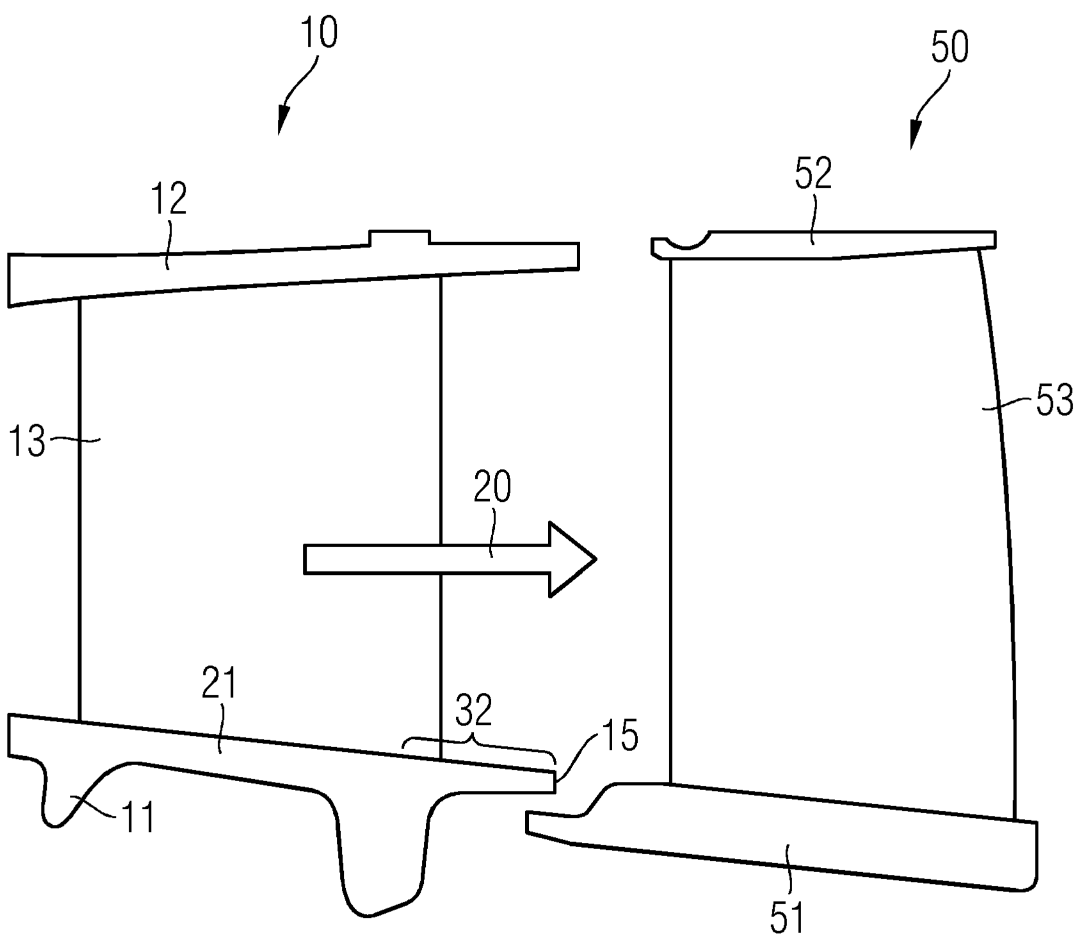


FIG 3

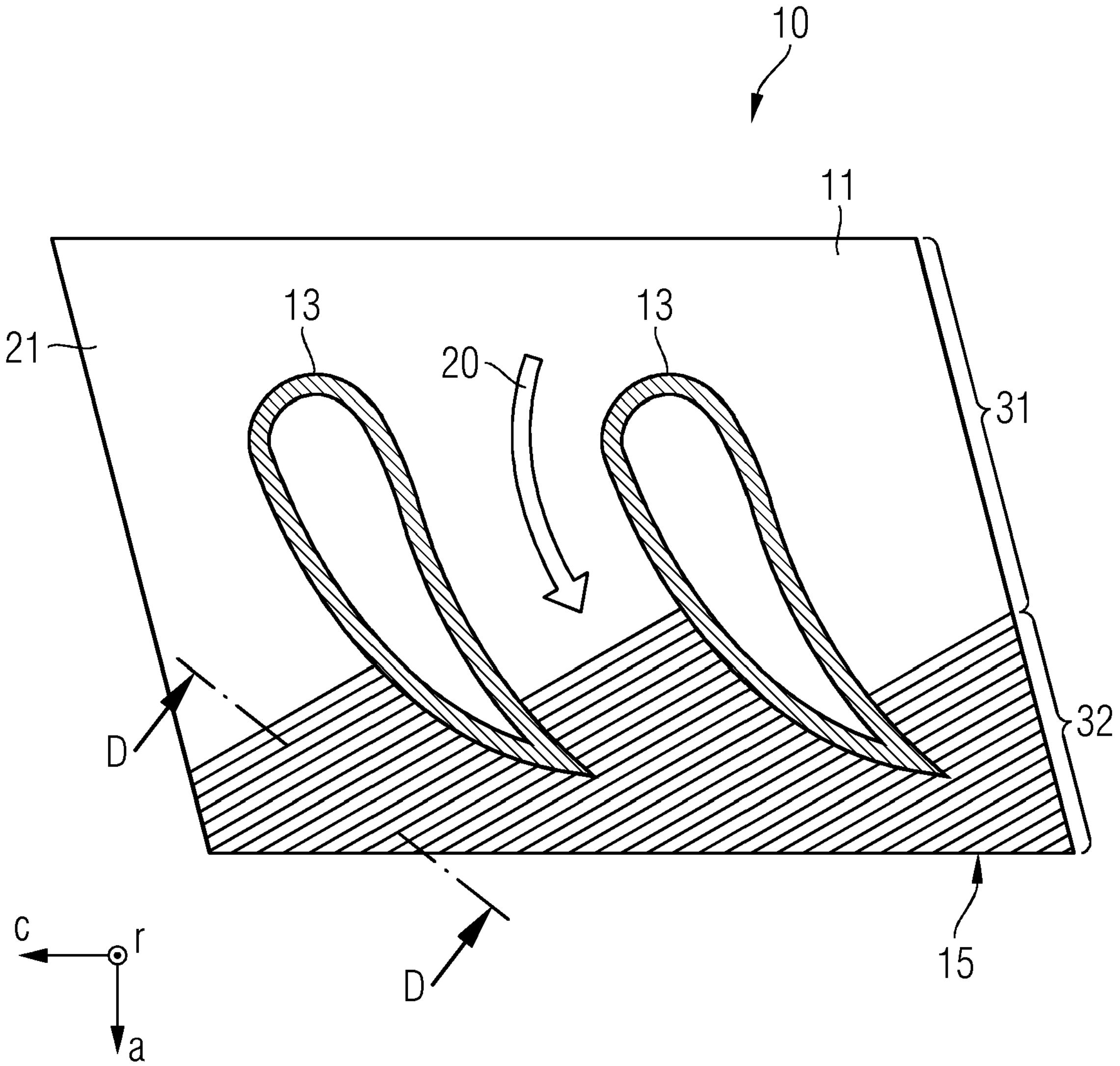


FIG 4

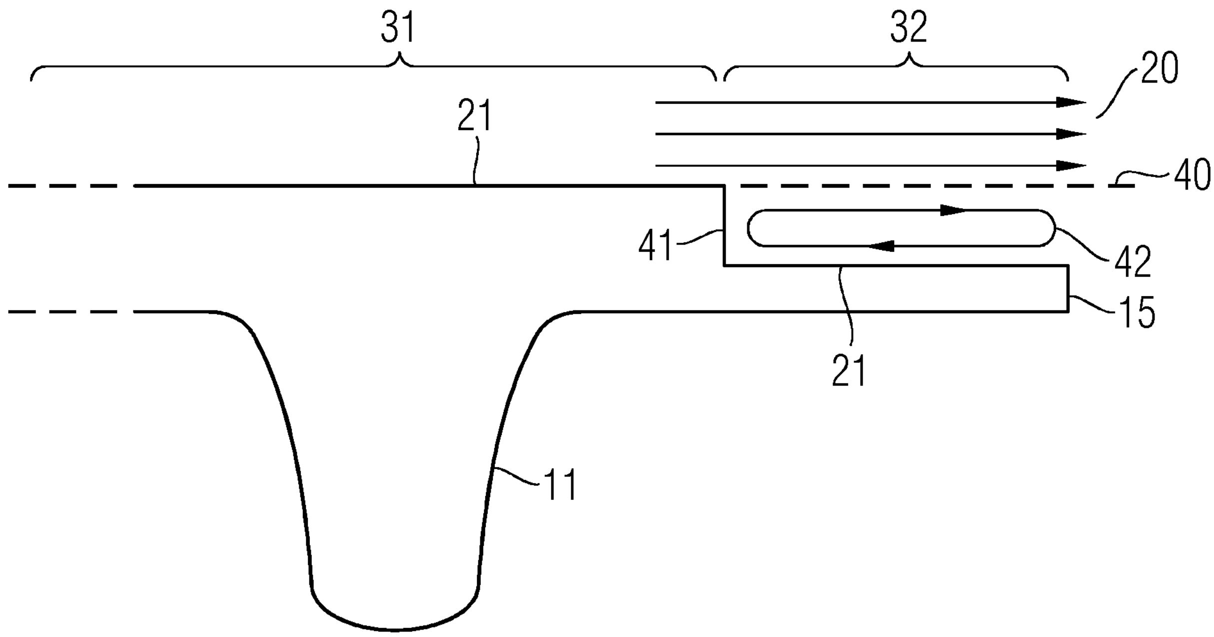


FIG 5

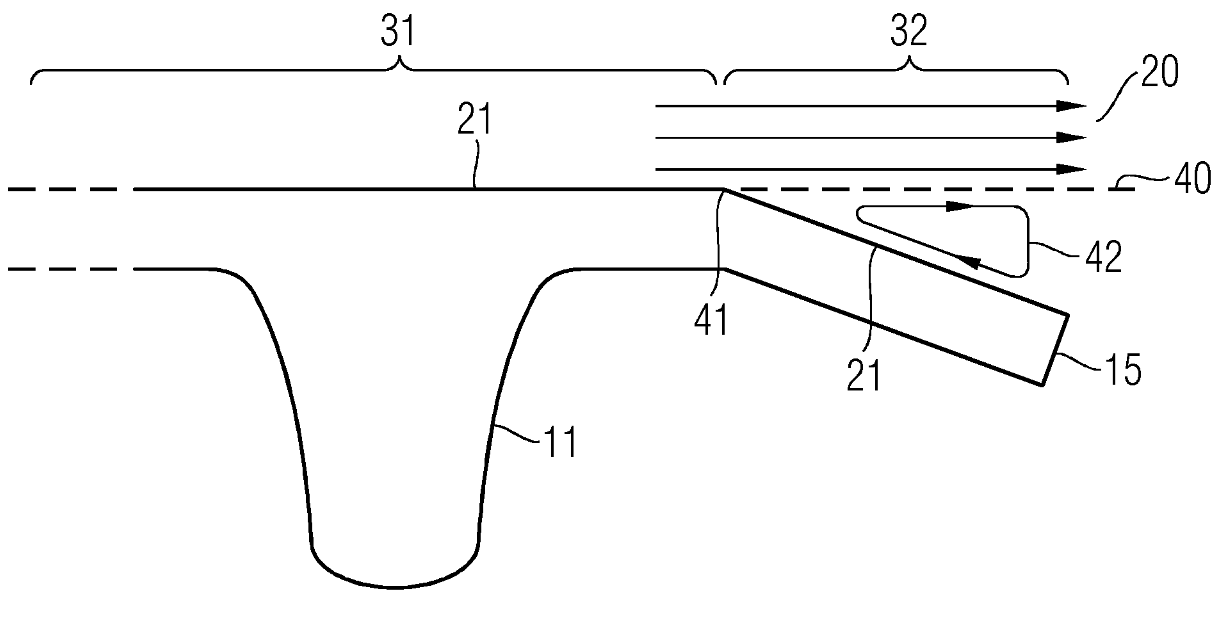
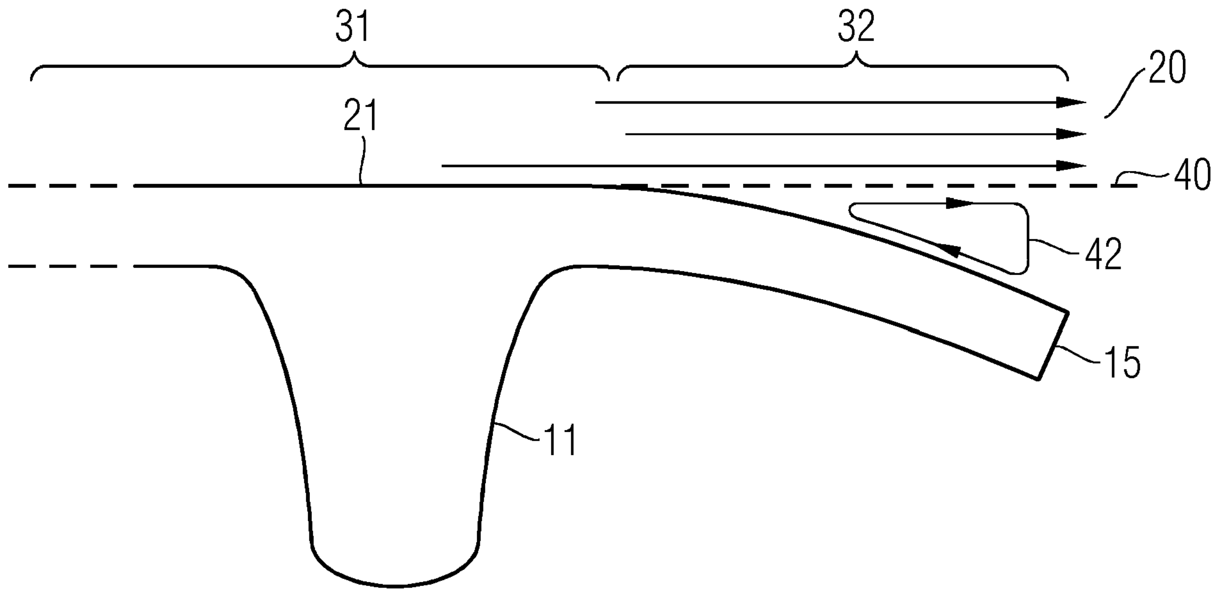


FIG 6



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Application Number
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Place of search	Date of completion of the search	Examiner
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