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

(11) EP 2 921 649 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
23.09.2015 Bulletin 2015/39

(51) Int Cl.:
F01D 5/18 *(2006.01)*

(21) Application number: **14160697.0**

(22) Date of filing: **19.03.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) Airfoil portion of a rotor blade or guide vane of a turbo-machine

(57) An airfoil portion (100) having an outer wall that defines a cavity for receiving cooling air. At least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion. The insert further comprises a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto. A portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall. A second insert (200) forms the trailing edge channel at the end of the main insert (106).

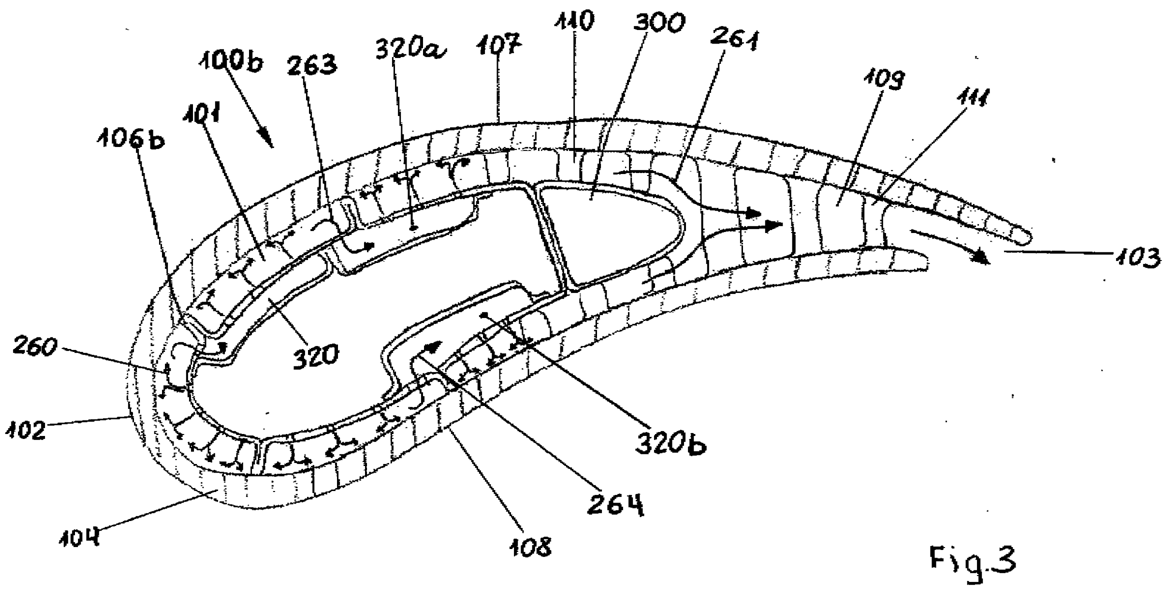

Fig.3

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Description

[0001] The present invention relates to the field of rotor blades or guide vanes of a turbomachine, especially of a gas or steam turbine. The final aim of the present invention is providing adequate cooling in a rotor blade or guide vane airfoil improving the cooling flow control and enabling insert fits.

[0002] Accordingly, the present invention relates to a rotor blade or guide vane airfoil assembling of a gas or steam turbine and refers fundamentally to a specific or modular arrangement of airfoil inserts within the cavity of the respective airfoil portion.

[0003] Basically, the specific or modular arrangement of airfoil inserts within the cavity of the respective airfoil portion consisting of replaceable and/or non-replaceable inserts. Besides the used airfoil inserts, the rotor blade or guide vane comprising additionally substitutable and non-substitutable flow-applied and no flow-applied elements.

[0004] Accordingly, the present invention relates to a turbine blade, namely as rotor blade or guide vane, with a hollow airfoil portion having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, a convex suction side, a concave pressure side. At least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion. The insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto.

Background of the invention

[0005] US 8,182,203 B2 discloses a turbine blade including an airfoil; a supply channel extending through the interior of the airfoil in the span direction, through which cooling fluid flows; a pin fin channel extending from the supply channel along the center line of the airfoil toward the trailing edge of the airfoil and opening at the trailing edge to the exterior of the airfoil; a plurality of gap pin fins projecting from a pair of opposing inner walls that constitute the pin fin channel at a region at the supply channel side of the pin fin channel and forming a gap there between extending in the span direction; pin fins connecting the pair of opposing inner walls at a region at the trailing edge side of the pin fin channel; and an insertion portion disposed in the gap to decrease the area of the channel of the cooling fluid at the region at the supply channel side of the pin fin channel.

[0006] With the turbine blade and the gas turbine of the present disclosure, the insertion portion is disposed in the gap formed between the gap pin fins. Therefore, the cross-sectional area of the channel at the supply channel side of the pin fin channel, through which cooling fluid flows, decreases as compared with a case in which the insertion portion is not disposed, so that the velocity of the cooling fluid at the region at the supply channel side increases. This increases the cooling efficiency at the region at the supply channel side, which improves the cooling efficiency of the pin fin channel, thus improving the cooling performance of the turbine blade.

[0007] Referring to EP 2 492 442 A2 a vane is provided for directing hot gases in a gas turbine engine. The vane includes a hollow aerofoil portion, which in use spans the working gas annulus of the engine. The vane further includes an impingement tube which forms a covering over the interior surface of the aerofoil portion and which has jet-forming apertures formed therein for the production of impingement cooling jets. The impingement tube includes two tube portions which are separately insertable into position into the aerofoil portion to form the covering. The impingement tube further includes an expansion member which, when the tube portions are in position in the aerofoil portion, is locatable in the aerofoil portion to urge each tube portion outwardly and thereby holds the tube portions in position against the aerofoil portion.

[0008] Referring to US 8,231,329 B2 a turbine blade with a generally hollow airfoil having an outer wall that defines a chamber for receiving cooling air, the airfoil comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, a convex suction side, a concave pressure side, and an insert disposed within the chamber that is configured to initially receive at least a portion of the cooling air entering the chamber and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall, the insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto, wherein the chamber and insert narrow as they extend toward the trailing edge, the insert eventually terminating and the chamber eventually terminating at a pin array section,; wherein a first distance exists that comprises the generally axial distance between the position of downstream termination point of the insert and the position of an upstream beginning point of the pin array section, wherein the pin array section, at a downstream end, comprises a plurality of openings that define an inlet to a plurality of trailing edge cooling apertures, and wherein the chamber, the insert, and the pin array section are configured such that the first distance is approximately minimized.

[0009] US 7,452,182 B2 relates to a modular guide vane assembly. The vane assembly includes an airfoil portion, an outer platform and an inner platform. The airfoil portion can be made of at least two segments. Preferably, the components are connected together so as to permit assembly and disassembly of the vane. Thus, in the event of damage to the vane, repair involves the replacement of only the damaged subcomponents as opposed to the entire vane. The modular design facilitates the use of various materials in the vane, including materials that are dissimilar. Thus, suitable materials can be selected to optimize component life, cooling air usage, aerodynamic performance, and cost. Because the vane is an assemblage of smaller subcomponents as opposed to one unitary structure, the individual components of the vane can be more easily manufactured and more intricate features can be included. According to this document, one end of the airfoil can be received within a recess in one of the inner and outer platforms. The assembly can further include a seal provided between the recesses and at least one of the radial ending of the airfoil and the outer peripheral surface of the airfoil proximate the radial end. As a result, hot gas infiltration or cooling air leakage can be minimized. In such case, one or more of the airfoil segments, the inner platform and/or the outer platform can be made of Intermetallics, Oxide Dispersion Strengthened (ODS) alloys, single-crystal metals, advanced Superalloys, metal matrix composites, ceramics or CMC.

Summary of the invention

[0010] The inventive idea of the present invention leaves the use of typical rotor blade or guide vanes assembling consisting of an airfoil portion, an inner and an outer platform, also called shroud, made in one piece as depicted and explained in connection with notorious state of the art.

[0011] Especially, by using a rotor blade or guide vane which can be assembled by at least two separate parts, i.e. a separate airfoil portion and outer platform and a separate inner platform, on the one hand preconditions are created to provide interchange ability or repairing and/or reconditioning of the identified separate parts, modules, elements without replacing the whole rotor blade or guide vane.

[0012] On the other hand, it is also possible to use rotor blades or guide vanes of three separable parts, i.e. outer platform, airfoil portion and inner platform. In a separate process the various parts or modules or elements of the guide vane may be repaired and/or reconditioned.

[0013] Additionally, the present invention describes an improved rotor blade or guide vane assembling of a gas or steam turbine on the basis of a modular structure comprising fundamentally an airfoil portion, inner platform, outer platform, whereas the airfoil portion and/or the platforms having at its one end means for the purpose of an interchangeable connection of rotor blade or vane guide elements, whereas the connection of rotor blade or guide vane elements having a permanent or semi-permanent fixation with respect to the airfoil portion in radially or quasi-radially extension and with respect to the axis of the gas or steam turbine, whereas the assembling of the airfoil portion in connection with platforms based on a friction-locked bonding actuated by adherence interconnecting, or the assembling of the airfoil portion in connection with platforms based on the use of a metallic and/or ceramic surface the fixing guide vane elements to each other, or the assembling of the airfoil portion in connection with platforms based on force closure means with a detachable or permanent connection, whereas at least the airfoil portion comprising at least one outer hot gas path liner encasing at least one part of the airfoil portion.

[0014] Moreover and basically, the present invention uses same or similar assemblies to determine the various possible connection of various configured airfoil inserts within the cavity of the airfoil portion. In order to decrease the size of the trailing edge channel inlet, at the end of the respective airfoil insert, one or more additional airfoil insert(s) can be used.

[0015] In this context, the additional airfoil insert(s) could be inserted and slide in the trailing edge region before to put in place a main airfoil insert. The additional airfoil insert(s) could optionally be cast in. The insertion of the airfoil additional insert(s) is performed by a cascade principle with respect to their size, namely:

[0016] The additional insert (see Figure 1, item 200) is inserted from the outside (see Figure 1, item 201) into the cavity (see Figure 1, item 202) and then moved (see Figure 1, item 202) in direction to the trailing edge (see Figure 1, item 103) and fixed to predetermined position.

[0017] At least one main airfoil insert may be inserted afterwards. It is also possible to proceed conversely.

[0018] Accordingly, at least one main insert comprising at least one additional insert which is inserted from the outside and transferred into the cavity at an intermediate position, and then moved in direction to the trailing edge and fixed to predetermined position, wherein the additional insert forms the size of the trailing edge channel inlet at the end of the main insert.

[0019] Moreover, at least one main insert comprising at least one additional insert which forms the size of the trailing edge channel inlet at the end of the main insert. This additional insert consists of a structured unitary body.

[0020] Different sized inserts can be arranged in the transverse direction of rotor blade or guide vane.

[0021] Various gaps between the airfoil inserts can be provided in all directions within the airfoil cavity on a case by case basis.

[0022] A joining assembling referring to airfoil inserts can be mechanically secured, or the joining assembling can use a shrinking process.

[0023] Fundamentally, the detachable or permanent connection comprising a force closure with bolt or rivet, or by HT brazing, active brazing, soldering. Additionally, an individual insert can be made of one piece or of a composite structure.

[0024] Furthermore, the inserts are able to resist the caloric and physical stresses, wherein the mentioned means are holistically or on their part interchangeable among one another.

[0025] Accordingly, one of the basic idea of the invention consists to split one or more inserts within the cavity of the airfoil portion in multiple inserts in order to better adapt at the rotor blade or guide vane geometries, regardless of whether the respective rotor blade or guide vane consist of a unique body or a modular structure.

[0026] In this context, the invention provides adequate cooling in the airfoil, improving the flow control and enabling the insert fits.

[0027] Having a multiple airfoil inserts configuration as the one proposed embodiment in this invention disclosure would allow improving the design flexibility and the part performance.

[0028] In order to decrease the size of the trailing edge channel inlet at the end of the insert one or more additional inserts can be used. The additional insert(s) could be inserted and slide in the trailing edge region before to put in place the main insert(s). The additional insert(s) could optionally be cast in.

[0029] In one embodiment of the present invention, the inserts can be made of the same material as the respective airfoil portion in which they are intercalated, such as IN939 alloy and ECY768 alloy. The inserts can be made of a material that may or may not have a greater resistance to heat compared to the material of the airfoil portion. For example, the inserts can be made of a material with a lower heat resistance than the material of the receiving airfoil portion. The inserts can be made from an inexpensive material so that the cost of a replacement insert would not significantly add to the overall costs over the life of the engine.

[0030] For insertion or removal purpose of the airfoil portion inserts it is possible to handle the mentioned airfoil portion inserts only at its radially outwards directed end which is a remarkable feature for performing maintenance work at the turbine stage.

[0031] The term "radial," as used herein, is intended to mean radial to the turbine when the rotor blade or guide vane assembling is installed in its operational position.

[0032] Furthermore, a manner of attaching the airfoil portion and their insert portions to the inner respectively outer platform consists in doing the fact, that the radially end of the mentioned element can be received in a recess provided in the respective platform. The mentioned recesses can be substantially airfoil-shaped so as to correspond to the outer contour of the airfoil portion and airfoil inserts. Thus, the airfoil portion assembly, including optionally an outer shell arrangement, can be trapped between the inner platform and the outer platform.

[0033] One of the most important solutions of the invention is to provide at least one outer shell and, if necessary and needed and according to individual operative requirements or different operating regimes, at least one no flow-applied intermediate shell in connection with the airfoil inserts for modular variants of the original airfoil portion. Function of the airfoil carrier is to carry mechanical load from the airfoil module. In order to protect the airfoil carrier with respect to the high temperature and separate thermal deformation from the airfoil module, an outer and, additionally, an intermediate hot gas path shells are introduced.

[0034] If several superimposed shells with respect to the airfoil portion or their inserts are provided, they can be built with or without intermediate spaces between each other. The mentioned shells can be made of at least two segments. Preferably, the components forming the shell are connected together so as to permit assembly and disassembly of shell, shell components, airfoil portion and airfoil inserts of rotor blade or guide vane.

[0035] If the airfoil portion and airfoil inserts are internally cooled with a cooling medium at a higher pressure than the hot combustion gases, excessive cooling medium leakage into the hot gas path can occur. To minimize such concerns, one or more additional seals can be provided in connection with the shell arrangement. The seals can be at least one of rope seals, W-shaped seals, C-shaped seals, E-shaped seals, a flat plate, and labyrinth seals. The seals can be made of various materials including, for example, metals and ceramics.

[0036] The main advantages of the present invention are as follows:

- Improved cooling efficiency allowing achieve life time target reducing coolant consumption, and reducing design constraints between disciplines.
- A decoupling of modules, especially with respect to airfoil portion and airfoil inserts, improves part lifetime compared to integral design.
- Modules with different variants in cooling and/or material configuration can be selected to best fit to the different operating regimes.
- The assembled airfoil portion assembling comprising a single outer shell or interdependent shell components which can be selected in a manner to optimize component life, cooling usage, aerodynamic performance, and to increase the capability of resistance against high temperature stresses and thermal deformations.
- The introduction of various inserts within the cavity of the airfoil portion can be selected in a manner to optimize component life, cooling usage, aerodynamic performance, and to increase the capability of resistance against high temperature stresses and thermal deformations.
- Airfoil portion and airfoil inserts, inner and outer platform, and additional integrated elements can be completed with a selected thermal insulating material or a thermal barrier coating.
- The cooling of all above mentioned elements of rotor blade or guide vane consists mainly of a convective cooling, with selected superposition or integration of impingement and/or film/effusion cooling.

- The interchangeability of all elements of the rotor blade or guide vane, especially of airfoil inserts, to one another or with equivalent forms is given as a matter of principle.

- The fixation of airfoil inserts within the cavity of the airfoil portion with respect to the basic platform of rotor blade or guide vane or directly in connection with the inner surface or inner spar of the airfoil portion can be made by means of a friction-locked actuated by adherence or through the use of a metallic and/or ceramic surface coating, or by a force closure with bolt or rivet, or by HT brazing, active brazing or soldering.

- The platforms may be composed of individual parts, which being on the one hand actively connected to the airfoil portion and flow-applied shell elements, if available, and on the other hand being actively connected to airfoil inserts.

- The modular design of the airfoil portion and airfoil inserts facilitates the use of various materials including materials that are dissimilar in accordance with the different operating regimes. Additionally, the modular design of the mentioned elements facilitates the introduction of replaceable and non-replaceable resp. substitutable and non-substitutable elements.

- Summary, The rotor blade or guide vane airfoil having a pronounced or swirled aerodynamic profile in radially direction, is cast, machined or forged comprising additionally additive features with internal local grid structure for cooling or stiffness improvements. Furthermore, the mentioned airfoil portion may be coated and comprising flexible cooling configurations for adjustment to operation requirements like, base-load, peak-mode, partial load of the gas turbine.

- Summary, the airfoil portion is defined as under structure of at least one outer flow-applied shell assembling. The shell is interchangeable, pre-fabricated or variable manufactured, single or multi-piece, uncooled or cooled, using convective and/or film and/or effusion and/or impingement cooling structure, having an grid structure for cooling or stiffness improvement, and with respect to the airfoil body is joined using a shrinking joint

- Summary referring to joining, manufacturing, reconditioning, disassembling processes, namely with respect to airfoil inserts and outer shell(s):

  Outer shell may be shrunk to the core structure of the airfoil portion by using a magnet pulse effect (MPW/C Magnetic Pulse Welding/Crimping), explosion or hydro forming, and the joining process referring to airfoil inserts can be assisted thermal shrinkage in all directions referring to the cavity of the airfoil portion. Shrinkage means interference fit under all operation conditions. Joining process, especially referring to the outer shell, can be supported by selection of materials with different thermal expansion between airfoil portion and outer shell; a lower thermal expansion of the outer shell induces a forced fit of the shell to the airfoil portion structure at higher temperatures. Shrinking assembling process can be stiffened by local transparent, also called deep, welding steps (EB, laser, resistance welding) or by brazing or hipping or adhesive. Brazing process can take advantage of shrinking process with intermediate layer of braze-airfoil portion. Joining assembling referring to airfoil inserts can be mechanically secured.

[0037] The above explained statements together with the other aspects of the present disclosure, along with the various features that characterize the present invention, are pointed out with particularity in the present disclosure. For a better understanding of the present disclosure, its operating advantages, and its uses, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated exemplary embodiments of the present disclosure.

Brief description of the figures

[0038] The advantages and features of the present disclosure will be better understood with reference to the following detailed description and claims taken in conjunction with the accompanying drawing, wherein like elements are identified with like symbols, and in which:

Fig. 1 shows a perspective view illustrating the schematic structure of a rotor blade or guide vane;

Fig. 2 shows cross-sectional of a second rotor blade or guide vane;

Fig. 3 shows cross-sectional of a further blade or guide vane comprising a number of cavities;

Fig. 4 shows a triangular shaped multiple inserts;

Fig. 5 shows a longitudinal section of a further blade or guide vane comprising a number of inserts with different shapes and orientations.

Detailed description of exemplary embodiments

[0039] As shown in Figure 1, the airfoil portion 100 of a rotor blade or guide vane of a turbo-machinery is formed in a blade shape in cross section and extends in the span direction, namely in vertical direction of the blade.

[0040] The airfoil portion 100 has an integral cavity 101, which is a hollow formed at the leading edge 102 and extending in the flow direction of the airfoil portion 100 to the trailing edge 103. At least in the region of the leading edge 102 the external wall 104 of the airfoil portion 100 comprising a number of film-cooling holes 105 communicating with the front cavity 101. In other words, the airfoil portion 100 has, in its interior, a first integrally cavity 101 extending in the flow direction or the airfoil portion 100. The inner cavity 101 can be provided with at least one partition (not shown) in the manner that the partition may be divided the hollow portion into a front cavity and a rear cavity.

[0041] A cooling fluid derived from the exterior, for example compressed air extracted from the compressor, cools adequately the structure of the airfoil portion 100.

[0042] In the cavity 101 a main hollow (205) insert 106 is disposed at a predetermined space from the inner wall of the cavity 101. On the other hand, if the cavity is provided with partitions, in the rear cavity space a rear insert is also disposed at a predetermined space from the inner wall of the rear cavity.

[0043] As shown in Figure 1, the film-cooling holes 105 are through-holes that connect the front cavity 101 and the exterior of the airfoil portion 100 and are provided with such film-cooling holes at intervals in the direction in a suction surface 107 and pressure surface 108.

[0044] Furthermore, the film cooling holes 105 are formed from the front cavity 101 to the exterior as slanting holes inclined from the leading edge 102 to the trailing edge 103

[0045] Moreover, the rear cavity of the airfoil portion 100 is provided with a pin fin channel 109, which is a hollow extending from the rear cavity 101 toward the trailing edge 103 along a center line of the airfoil 100 (not shown) and which is a region in which gap pin fins 110 and pin fins 111 are provided.

[0046] The gap pin fins 110 are a plurality of substantially columnar members protruding from regions at the rear cavity side of the pin fin channel 109, the regions being a pair of inner walls constituting the pin fin channel 109. The amount of protrusion of the gap pin fins 110 from the above-described inner walls is set so as to form a gap between the gap pin fins 110 into which the end portion of the rear or additional insert 200 can be inserted.

[0047] The pin fins 111 are a plurality of substantially columnar members that connect regions at the trailing edge 103 side of the pin fin channel 109, the regions being the pair of inner walls constituting the pin fin channel 109. The shape and arrangement of the pin fins 111 can be known ones and are not particularly limited.

[0048] The pin fin channel 109 is a channel in the rear cavity in the region of the trailing edge 103, through which cooling fluid flows after being used for impinging cooling, and constitutes a structure related to pin fin cooling for cooling the vicinity of the trailing edge 103 of the airfoil portion 100 and opens to the exterior at the trailing edge 103.

[0049] As shown in Figure 1 additional pin fins 112 are provided, at least along the middle region of the airfoil portion, in the cavity between the inner wall of the airfoil portion 100 and the external wall of the main insert 106, along both the suction side 107 and the pressure side 108. Also the shape and arrangement of the pin fins 112 can be known ones and are not particularly limited.

[0050] The front of the main insert 106 constitutes a structure related to impinging cooling for cooling the leading edge 102 and the other inner wall of the airfoil portion 100, together with the front and the subsequent cavity 101. The front of the main insert 106 consists of a substantially cylindrical member having a cross-sectional form similar to the cross-sectional form of the front cavity 101. Furthermore, the front of the main insert 106 has a plurality of discharge holes 113 through which the cooling fluid flowing there through spouts against the inner wall of the front cavity 101

[0051] If the airfoil portion 100 is provided with partitions the rear part of the insert constitutes also a structure related to impinging cooling, like the front insert, for cooling the respective side of the airfoil portion 100. The rear insert consists also of a substantially cylindrical member having a cross-sectional form similar to the cross-sectional form of the rear part of the cavity.

[0052] In order to decrease the size of the trailing edge channel inlet 109, at the end of the respective airfoil main insert 106, an additional airfoil insert 200 is used.

[0053] One possibility consists in the fact that the additional airfoil insert 200 is inserted and slide in the trailing edge region 103 before to put in place the main airfoil insert 106. The additional airfoil insert 200 could optionally be cast in. The insertion of the airfoil additional insert 200 is performed by a cascade principle with respect to their size, namely:

[0054] The additional airfoil insert 200 is inserted from the outside 201 and transferred 201 a into the cavity 101 at an intermediate position 202, and then moved 202a in direction to the trailing edge 103 and fixed to predetermined position 203.

[0055] The main airfoil portion insert 106 may be inserted afterwards. But it is also possible to proceed conversely. In the last mentioned case, the additional insert 200 is provided with a transversally elasticity 204, so that it can be pushed over the end side constriction of the main insert 106 until it reaches its final position 203. The connection between the main 106 and the additional insert 200 is designed accordingly, even in the case in which the additional insert 200 does not have any transversally elasticity 204. Thus, the connection can be obtained mechanically, for example with introduction of fixing members (not shown), positioned in the region of the both inserts.

[0056] Furthermore, the additional insert 200 which is inserted from the outside 201 and transferred 201 a into the cavity 101 at an intermediate position, and then it can be moved alternatively in direction to the leading edge

102 and fixed to final predetermined position. Additionally, the additional insert 200 can be inserted from the underside of the airfoil portion or is an element of the cavity of the airfoil portion, and then it can be moved in the direction of the trailing edge or leading edge and fixed to final predetermined position. Accordingly, the additional insert 200 forms the size of the trailing edge cavity at the end of the main insert 106, or the additional insert forms the leading edge cavity between inner wall of the airfoil portion and subsequent main insert.

[0057] Summary, an airfoil portion 100 of a rotor blade or guide vane of a turbo-machinery having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, suction side, a pressure side. At least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion. Furthermore, the insert comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto. A portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall and/or a portion of the cooling fluid exits the airfoil at the trailing edge. At least one main insert 106 comprising at least one additional insert 200 which is inserted as a first option from the outside 201 and transferred 201 a into the cavity 101 at an intermediate position 202, and then the additional insert is moved 202a in direction to the trailing edge 103 or leading edge 102 and fixed to final predetermined position 203. A second option consists in the fact that the additional insert 200 can be inserted from the underside of the airfoil portion or consists of an element of the cavity of the airfoil portion. Accordingly, the additional insert is moved in the direction of the trailing edge or leading edge and fixed to final predetermined position, wherein the additional insert 200 forms at least one size of the trailing edge cavity at the end of the main insert 106, or the additional insert forms at least one leading edge cavity between inner wall of the airfoil portion and subsequent disposed main insert.

[0058] As shown in Figure 2, the airfoil portion 100a comprising a main insert 106a and an additional insert 250. The additional insert is cast in.

[0059] Figure 2 illustrates a conventional air-cooled airfoil portion 100a. As shown, the airfoil 100a includes an external wall 104, and has a leading edge 102, a pressure side 108 a suction side 107 and a trailing edge 103. The airfoil 100a is generally hollow and, is divided into a main insert 106a and an attached no-hollow insert 250 in a preselected position. The cooling structure is in generally the same like Figure 1. High pressure cooling air from the turbine compressor is directed into the main insert 106a per conventional systems and methods, and is exhausted through a number of discharge holes 113 to form jets of air striking the inner walls of the chambers 205 for impingement cooling 260. More particularly, the discharge holes 113 of main insert 106a in the cavity 101 are located to impinge on the external wall 104 opposite the main insert 106a. The cooling air forced into the chamber 205 and through the main insert 106a is exhausted after a convective cooling 261 through radially spaced rows of film cooling 262 apertures 105 that pass through the external wall 104 of the airfoil portion 100a.

[0060] Summary, an airfoil portion 100a of a rotor blade or guide vane of a turbo-machinery having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, a convex suction side, a concave pressure side, and at least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion. The insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto. Additionally, a portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall and/or a portion of the cooling fluid exits the airfoil at the trailing edge. At least one main insert 106a comprising at least one additional insert 250 which forms the size of the trailing edge cavity at the end of the main insert 106a and/or at least one main insert comprising at least one additional insert which form the size of the leading edge cavity at the initiation of the main insert.

[0061] As shown in Figure 3 an airfoil portion 100b of a rotor blade or guide vane of a turbo-machinery having an outer wall 104 that defines a cavity (see also Figures 1 and 2) for receiving cooling air. The airfoil portion comprising a leading edge 102 that resides in an upstream direction, a trailing edge 103 that resides in a downstream direction, a suction side and a pressure side. Other design features can be taken from Figures 1 and 2.

[0062] With respect to embodiments according to Figures 1 and 2, the main insert 106b, together with a downstream side predisposed additional insert 300 (see also Figure 2), a number of inside predisposed additional inserts 320, 320a, 320b forming various cavities in which the flow of the cooling medium ensures an individual or subsequent and/or multiple cooling 263, 264 along these cavities.

[0063] Summary, an airfoil portion 100b of a rotor blade or guide vane of a turbo-machinery having an outer wall 104 which defines the cavity (see also Figures 1 and 2) in which cooling air is provided. The airfoil portion comprising a leading edge 102 that resides in an upstream direction, a trailing edge 103 that resides in a downstream direction, a convex suction side, a concave pressure side. Other design features can be taken from Figures 1 and 2. At least one main insert 106b is disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion. The main insert 106b further comprising a configuration of a number of additional inserts 320, 320a, 320b that generally conforms to the inside contour of the main insert 106b. The internal side of additional inserts 320, 320a, 320b forming a number of sub-cavities of the main insert 106b.

[0064] The main and/or additional inserts extend to radially or quasi-radially and/or transversally or quasi-transversally direction of the airfoil portion and are sectioned and having different shapes or profiles along one or more orientations of the airfoil portion, see Figures 4 and 5, item 401, 402; 501-504. The mentioned different shapes correspond to a regular or irregular triangular (see Figure 4), quadrangular, pentagonal, tapered body.

[0065] The airfoil portion having in radially or quasi-radially direction compared to the axis of the turbo-machinery a pronounced or swirled or tailored aero-dynamic profile. (see Figure 5, item 500).

[0066] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment(s), but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as permitted under the law. Furthermore it should be understood that while the use of the word preferable, preferably, preferred or advantageously in the description above indicates that feature so described may be more desirable, it nonetheless may not be necessary and any embodiment lacking the same may be contemplated as within the scope of the invention, that scope being defined by the claims that follow. In reading the claims it is intended that when words such as "a," "an," "at least one" and "at least a portion" are used, there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. Further, when the language "at least a portion" and/or "a portion" is used the item may include a portion and/or the entire item unless specifically stated to the contrary.

Reference numeral list

[0067]

100	Airfoil portion
100a	Airfoil portion
100b	Airfoil portion
101	Cavity
102	Leading edge
103	Trailing edge
104	External wall
105	Film cooling holes or apertures
106	Main hollow insert, referring to 100
106a	Main hollow insert, referring to 100a
106b	Main hollow insert, referring to 100b
107	Suction surface
108	Pressure surface
109	Pin fin channel
110	Gap pin fins
111	Pin fins
112	Additional pin fins
113	Air discharge holes
200	Additional airfoil insert
201	Outside position
201a	Transferred way
202	Intermediate position
202a	mowing way
203	Final position
204	Transversally elasticity
250	Additional insert, referring to 100a
260	Impingement cooling
261	Convective cooling
262	Film cooling
263	Cooling
264	Cooling
300	Additional insert, referring to 100b
320	Cavity
320a	Cavity
320b	Cavity
401	Insert
402	Insert
500	Tailored blade or vane
501	Insert
502	Insert
503	Insert
504	Insert

Claims

1. An airfoil portion (100) of a rotor blade or guide vane of a turbomachine having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, suction side, a pressure side, and at least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion, the insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto, wherein a portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall and/or a portion of the cooling fluid exits the airfoil at the trailing edge, wherein at least one main insert (106) comprising at

least one additional insert (200) which is inserted from the outside (201) and transferred (201 a) into the cavity (101) at an intermediate position (202), and then moved (202a) in direction to the trailing edge (103) or leading edge (102) and fixed to final predetermined position (203), or the additional insert (200) is inserted from the underside of the airfoil portion or the additional insert is an element of the cavity of the airfoil portion and subsequently the additional insert is moved in the direction of the trailing edge or leading edge and fixed to final predetermined position, wherein the additional insert (200) forms at least one size of the trailing edge cavity at the end of the main insert (106), or the additional insert forms at least one leading edge cavity between inner wall of the airfoil portion and subsequent disposed main insert.

2. The airfoil portion according to claim 1, **characterized in that** the additional insert 200 is provided with a transversally elasticity (204) or with the help of fixing means for connecting additional insert to the main insert (106).

3. An airfoil portion (100a) of a rotor blade or guide vane of a turbo-machinery having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, suction side, a pressure side, and at least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion, the insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto, wherein a portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall and/or a portion of the cooling fluid exits the airfoil at the trailing edge, wherein at least one main insert (106a) comprising at least one additional insert (250) which forms the size of the trailing edge cavity at the end of the main insert (106a) and/or at least one main insert comprising at least one additional insert which form the size of the leading edge cavity at the initiation of the main insert.

4. The airfoil portion according to claim 3, **characterized in that** the additional insert (250) consists of a structured unitary body.

5. An airfoil portion (100b) of a rotor blade or guide vane of a turbo-machinery having an outer wall that defines a cavity for receiving cooling air, the airfoil portion comprising a leading edge that resides in an upstream direction, a trailing edge that resides in a downstream direction, a suction side, a pressure side, and at least one insert disposed within the cavity that is configured to initially receive at least a portion of the cooling air entering the chamber of the insert and direct the cooling air through a plurality of insert apertures to cool the inner surface of the outer wall of the airfoil portion, the insert further comprising a configuration that generally conforms to the contour of the outer wall of the chamber but in spaced relation thereto, wherein a portion of the cooling air exits the airfoil portion through a plurality of film cooling apertures formed through the outer wall and/or a portion of the cooling fluid exits the airfoil at the trailing edge, wherein at least one main insert (106b) comprising at least one additional insert (300) and/or a multiple insert configuration through the internal side, wherein the multiple insert configuration forming sub-cavities with respect to the main insert.

6. The airfoil portion according to claim 5, **characterized in that** at least two sequential disposed sub-cavities through the internal side of the main insert reusing the same cooling medium and operating as sequential or quasi-sequential cooling.

7. The airfoil portion according to one or more of claims 1 to 6, **characterized in that** the cavity within the airfoil portion comprising at least one main insert or multiple main inserts and/or at least one or a combination of additional inserts.

8. The airfoil portion according to one or more of claims 1 to 7, **characterized in that** main and/or additional inserts extend to radially or quasi-radially and/or transversally or quasi-transversally direction of the airfoil portion.

9. The airfoil portion according to one or more of claims 1 to 8, **characterized in that** main and/or additional inserts are sectioned and having different shapes or profiles along one or more orientations of the airfoil portion.

10. The airfoil portion according to claim 9, **characterized in that** different shapes correspond to a regular or irregular triangular, quadrangular, pentagonal, tapered body.

11. The airfoil portion according to one or more of claims 1 to 10, **characterized in that** a cavity 101 with a supply internal channel extending through the interior of the airfoil portion (100, 100a) in the flow direction, through which cooling fluid flows.

12. The airfoil portion according to one or more of claims 1 to 11, **characterized in that** a pin fin channel extending from the supply channel along the center line

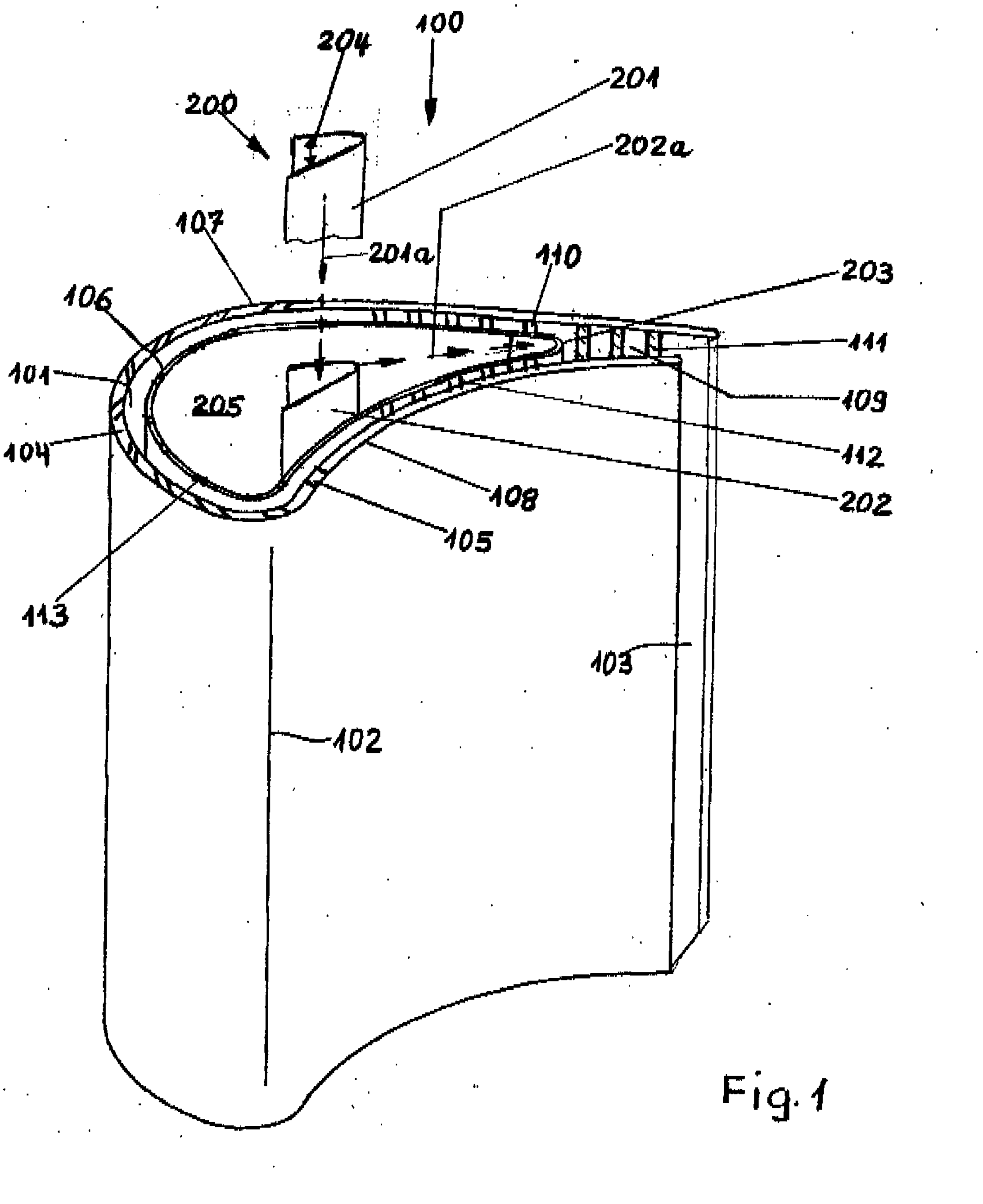
of the airfoil toward the trailing edge of the airfoil portion and opening at the trailing edge (103) to the exterior of the airfoil portion.

13. The airfoil portion according to one or more of claims 1 to 12, **characterized in that** a plurality of gap pin fins projecting from a pair of opposing inner walls that constitute the pin fin channel at a region at the supply channel side of the pin fin channel and forming a gap there between extending in the flow direction of the airfoil portion.

14. The airfoil portion according to one or more of claims 1 to 13, **characterized in that** pin fins connecting the pair of opposing inner walls at a region at the trailing edge side of the pin fin channel.

15. The airfoil portion according to one or more of claims 1 to 14, **characterized in that** at least one partition portion disposed in the gap to decrease the area of the channel of the cooling fluid at the region at the supply channel side of the pin fin channel.

16. The airfoil portion according to one or more of claims 1 to 15, **characterized in that** the airfoil portion having in radially or quasi-radially direction with respect to the axis of the turbo-machinery a pronounced or swirled or tailored aerodynamic profile.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100
200
201
202a
107
201a
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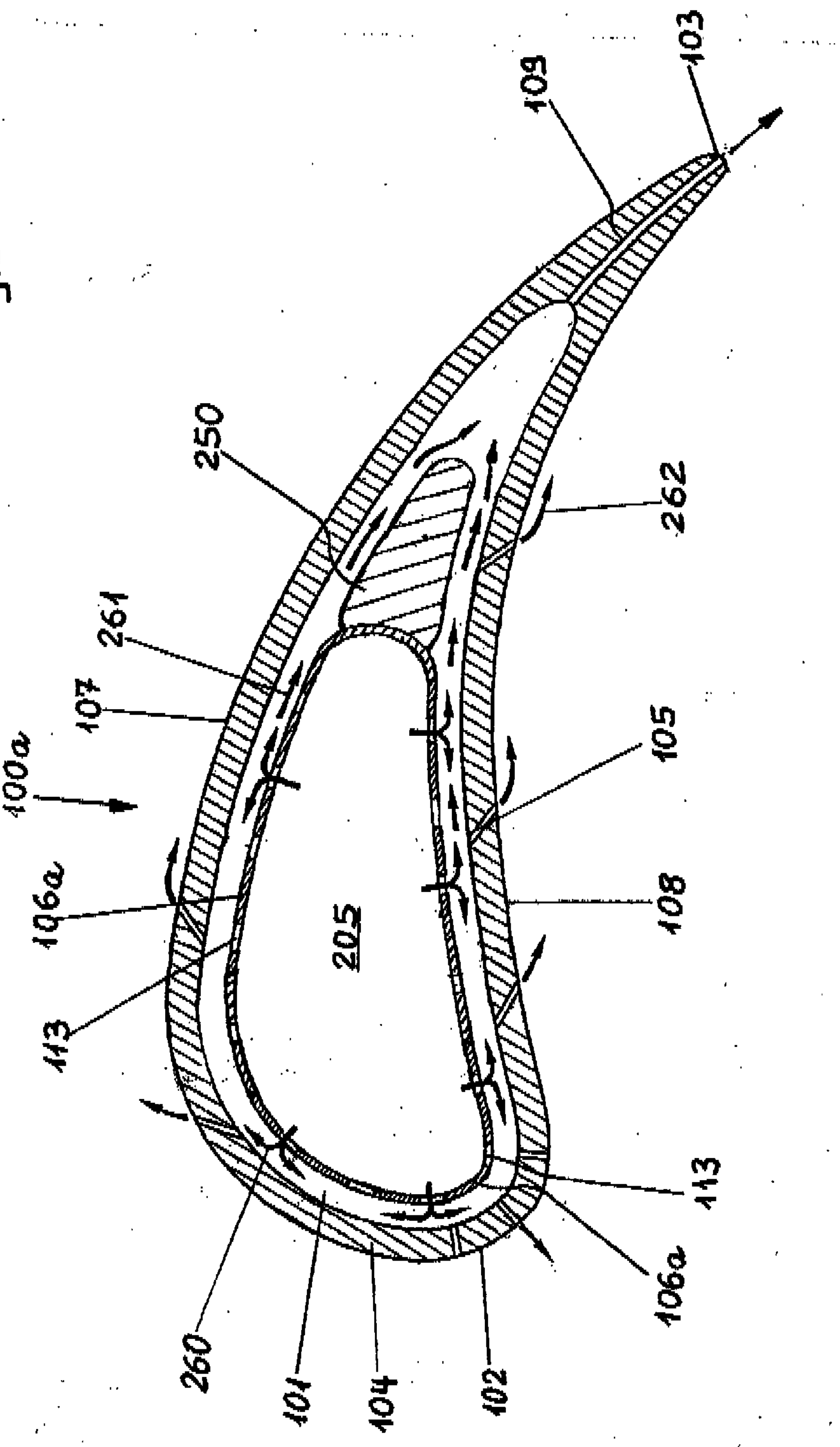
102

Fig. 1

Fig.2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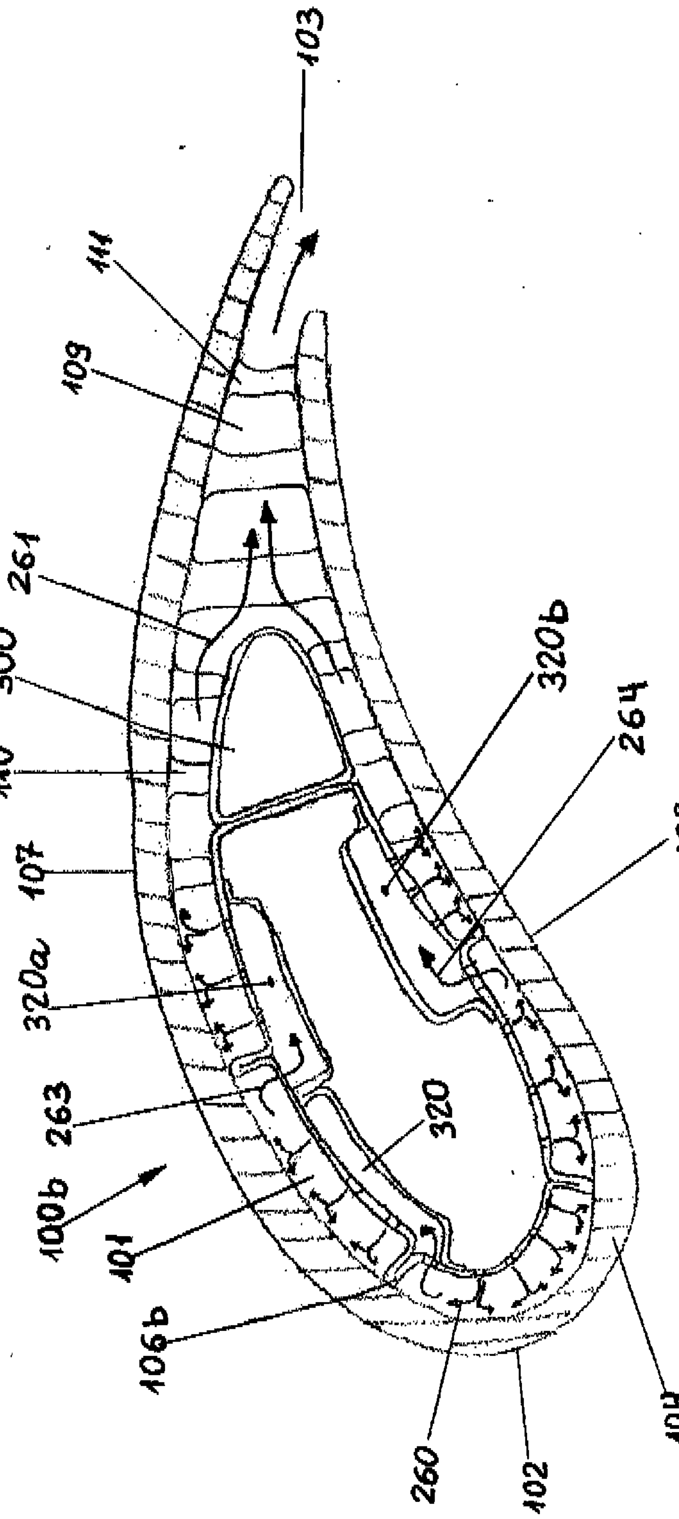
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106b
260
102
104

Fig.3

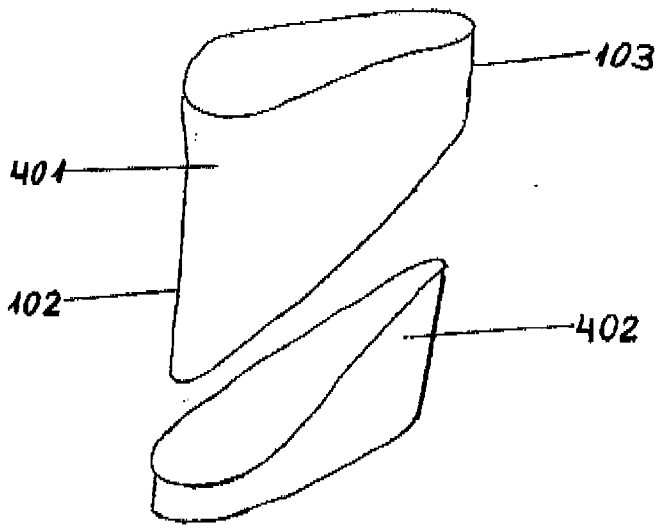

Fig.4

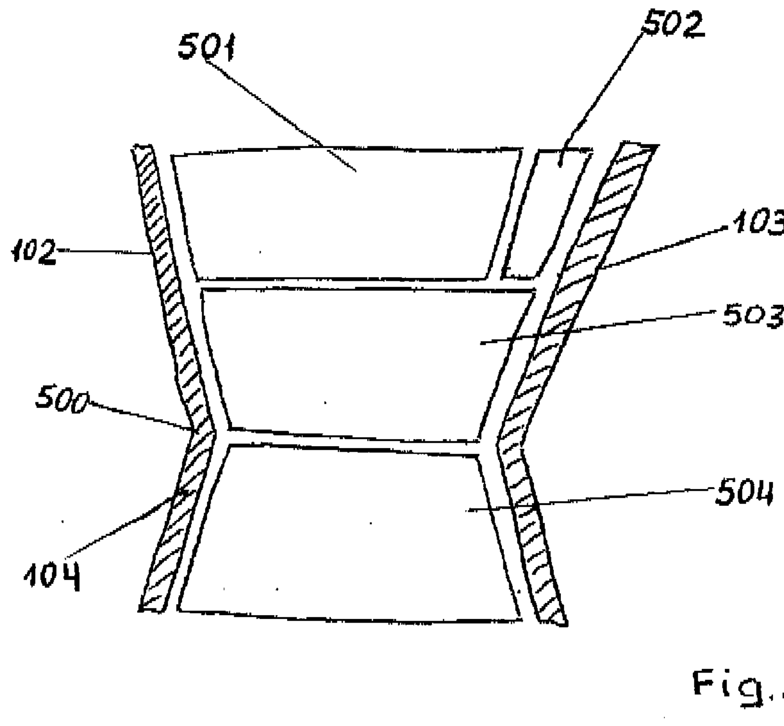

Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 0697

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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	29 July 2014	Rolé, Florian

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