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(54) **Stator vane and corresponding assembly**

(57) A stator vane 100 and assembly 200 for a turbine engine is described. The stator vane 100 includes outer and inner platforms 102, 104, and a vane aerofoil portion 112 extending between the outer and inner platforms 102, 104. The inner platform 104 has first and second opposed side edges 106, 108. The first side edge 106 includes an engaging member 110, and the second side edge 108 includes a complementary engaging member 112. The engaging member 110 and the complementary engaging member 112 are engagable so as, when mounted, to be axially restrained thereby but so as to allow its radial and circumferential freedom, preventing torsion of the vane aerofoil portion 112.

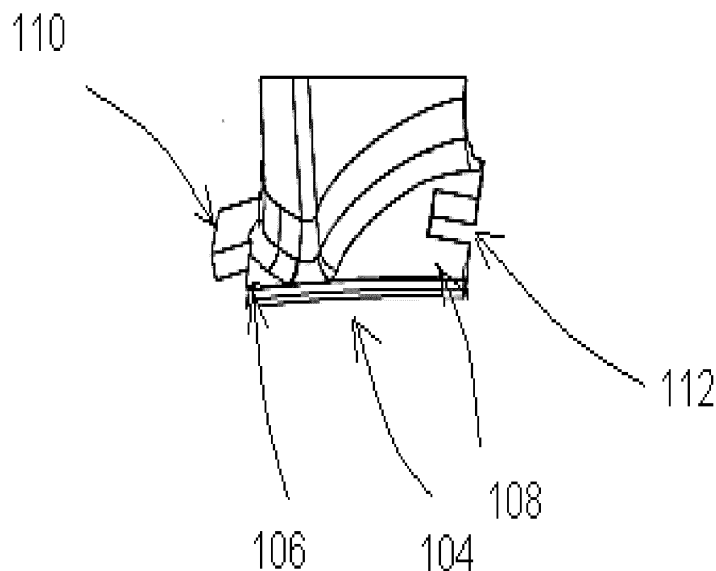


FIG. 2A

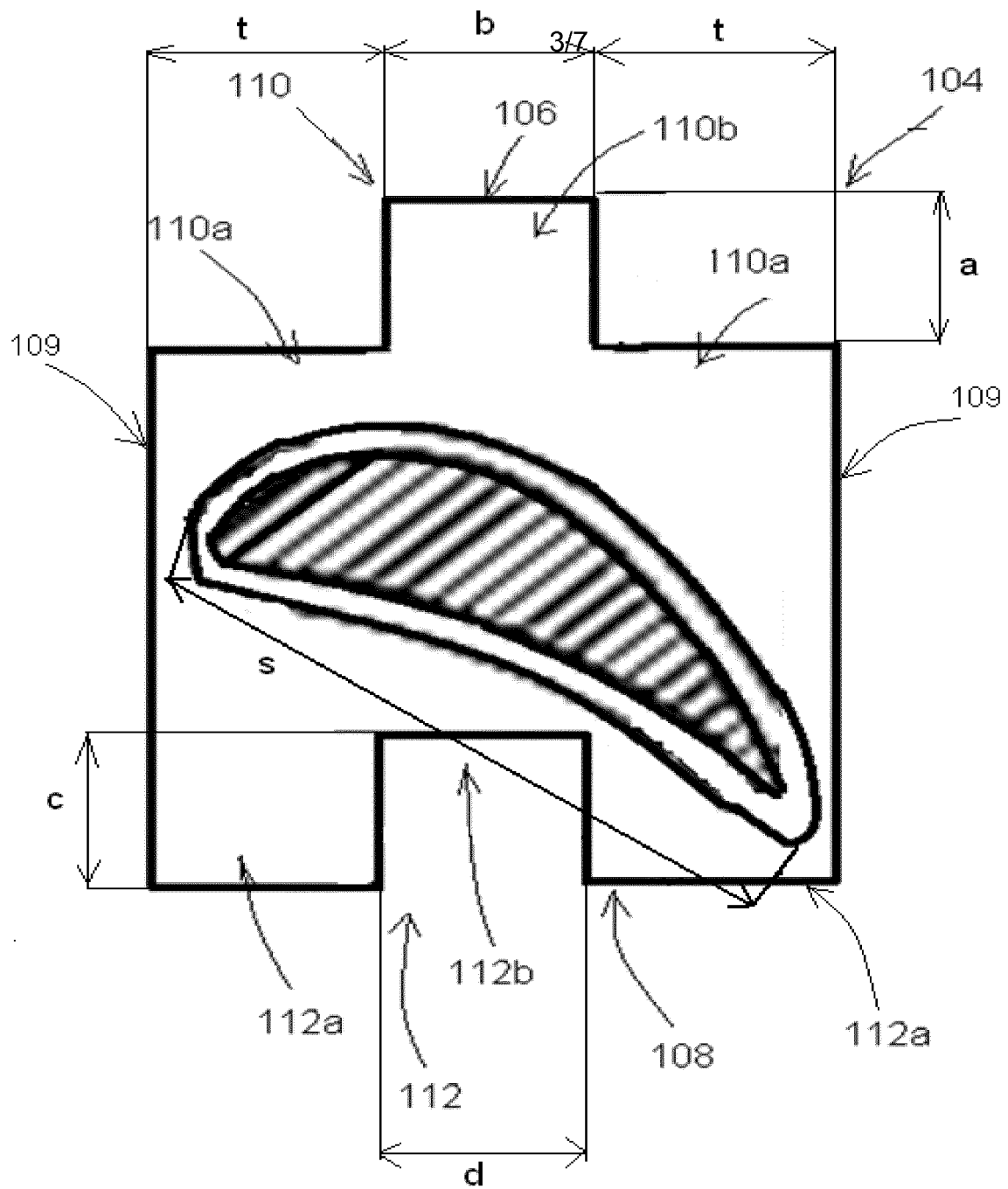


FIG. 2B

Description

BACKGROUND

Field of Endeavor

[0001] The present disclosure relates to a field of turbines, and, more particularly, to stator and vanes assembly of the turbines.

Brief Description of the Related Art

[0002] Turbines are essentially utilized to convert steam or gas energy firstly into mechanical energy, in the form of rotational energy, and then into electrical energy. Multiple rows, which are termed stages, of turbine blades or vanes are used to rotate a turbine shaft. Each turbine stage alternately consists of stationary and rotating components. The stationary components are rows of turbine vanes mounted to the inside of a turbine stator while the rotating components are rows of turbine blades mounted to a turbine rotor.

[0003] Pressurised steam or gas enters the turbine axially and gradually moves from alternating stationary and rotating rows of vanes and blades to causes the turbine rotor to rotate and the steam or gas to expand slightly. In such a scenario, it may be one of an essential requirement with respect to vanes design and configurations in such turbine stator to be optimized to deal with the pressure and volume of the steam or gas to preclude torsion of long vanes, optimizing gas force flow at the vanes and controlling axial movement of the vanes. Various optimization methods and designs may generally be implemented in the vanes, in the form of coupling rings, fixtures, and shrouds etc., to the vanes' inner platform, which may require various couplers and tools for coupling with the vanes.

[0004] Such conventional designs may be quite in practice, and may have generally been considered satisfactory for their intended purposes, but may be unsatisfactory in terms of preventing long vanes torsion, optimizing gas force flow at the vanes and controlling various directional movements of the vanes. Further, such tools and couplers in coupling the conventional designs of the coupling rings, fixtures, and shrouds may add to further cumbersomeness.

[0005] Accordingly, there exists a need to improve vanes design to preclude or minimize various associated problems in an economical and adaptable manner.

SUMMARY

[0006] The present disclosure describes a stator vane and assembly for a turbine engine, that will be presented in the following simplified summary to provide a basic understanding of one or more aspects of the disclosure that are intended to overcome the discussed drawbacks, but to include all advantages thereof, along with providing

some additional advantages. This summary is not an extensive overview of the disclosure. It is intended to neither identify key or critical elements of the disclosure, nor to delineate the scope of the present disclosure. Rather, the sole purpose of this summary is to present some concepts of the disclosure, its aspects and advantages in a simplified form as a prelude to the more detailed description that is presented hereinafter.

[0007] An object of the present disclosure is to describe a stator vane for a turbine engine, which may be adaptable in terms of preventing long vanes torsion, optimizing gas force flow at the vanes and controlling various directional movements of the vanes. Another object of the present disclosure is to describe an assembly of the various such stator vanes, which may be adaptable in terms of preventing long vanes torsion, optimizing gas force flow at the vanes and controlling various directional movements of the vanes are assembled in an effective and economical way without a requirement of tooling and couplers. Various other objects and features of the present disclosure will be apparent from the following detailed description and claims.

[0008] The above noted and other objects, in one aspect, may be achieved by a stator vane for a turbine engine. In other aspects, above noted and other objects, may be achieved by a stator vane assembly for a turbine engine. Examples of the turbines, where such stator vanes may be utilized, including but not limited to, gas turbines and steam turbines etc.. While the disclosure will be described in conjunction with the gas turbine blades for the purpose of better understanding, the scope of the disclosure will extend to all such turbine blades where the present vanes and assembly thereof may be successfully utilized.

[0009] According to the above aspects of the present disclosure, a stator vane for a turbine engine is described. The stator vane includes outer and inner platforms, and a vane aerofoil portion extending between the outer and inner platforms. The inner platform has first and second opposed side edges. The first side edge includes an engaging member, and the second side edge includes a complementary engaging member. The engaging member and the complementary engaging member are engagable so as, when mounted, to be axially restrained thereby but so as to allow its radial and circumferential freedom, preventing torsion of the vane aerofoil portion.

[0010] The engaging member and the complementary engaging member are being configured across the entire thickness of the first side edge and the second side edge, respectively, so as to allow the radial and circumferential freedom while restraining axial.

[0011] In one embodiment of the present disclosure, the engaging member includes a tongue wedge face, and a tongue configured on the tongue wedge face. The complementary engaging member includes an undercut wedge face; and an undercut configured on the undercut wedge face. In this embodiment, the engaging and complementary engaging member may include a U-shaped

structure, i.e. U-shaped tongue and corresponding U-shaped undercut.

[0012] However, without departing from the scope of the present disclosure, in other embodiments, the engaging and complementary engaging member may include other structures, such as a Z-shaped structure, a wave-shaped structure, or any other Zigzag-shaped structure. Further, any person skilled in the art will appreciate that any further variations and/or alterations to the structure of the engaging and complementary engaging member may be possible and all such variation are contemplated to be within the scope of the present disclosure.

[0013] The engaging member and the complementary engaging member are abutly engagable so as, when mounted, to substantially correspond the tongue and the undercut, in such a manner that an axial gap and a circumferential gap are adapted to be configured to be maintained between the engaging member and the complementary engaging member to allow its radial and circumferential freedom while restraining axial.

[0014] In another aspect of the present disclosure, a stator vane assembly for a turbine engine is described. The stator vane assembly includes a plurality of stator vanes. Each of the stator vanes includes outer and inner platforms, and a vane aerofoil portion extending between the outer and inner platforms. The inner platform includes first and second opposed side edges. The first side edge comprises an engaging member, and the second side edge comprises a complementary engaging member. The plurality of stator vanes are positively mounted in a manner that each of the engaging member and complementary engaging member of the respective stator vanes being engagable to the adjacent stator vanes thereof so as to be axially restrained thereby but so as to allow its radial and circumferential freedom, preventing torsion of each of the vane aerofoil portions.

[0015] These together with the other aspects of the present disclosure, along with the various features of novelty that characterize the present disclosure, 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 DRAWINGS

[0016] 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:

[0017] FIG. 1 illustrates an example perspective view of a stator vane, in accordance with an exemplary embodiment of the present disclosure;

[0018] FIG. 2A illustrates an enlarged perspective view

of an inner platform depicting engaging features of the stator vane of FIG. 1, in accordance with an exemplary embodiment of the present disclosure;

[0019] FIG. 2B illustrates a bottom view of an inner platform depicting engaging features of the stator vane of FIG. 1, in accordance with an exemplary embodiment of the present disclosure;

[0020] FIG. 3 illustrates an example perspective view of a stator vane assembly, in accordance with an exemplary embodiment of the present disclosure;

[0021] FIGS. 4A and 4B illustrate enlarged perspective views of inner platforms depicting engaging features engagement of the stator vane assembly of FIG. 3, respectively, from a pressure side and a suction side, in accordance with an exemplary embodiment of the present disclosure;

[0022] FIGS. 5A and 5B illustrate bottom views of inner platforms depicting engaging features engagement of the stator vane assembly of FIG. 3 along axis x-x', specifically, FIG. 5B illustrates enlarged view of an encircled portion of FIG. 5A, in accordance with an exemplary embodiment of the present disclosure; and

[0023] FIGS. 6A and 6B illustrate various other examples of the shapes of stator vanes, in accordance with an exemplary embodiment of the present disclosure.

[0024] Like reference numerals refer to like parts throughout the description of several views of the drawings.

DETAILED DESCRIPTION OF THE PRESENT DISCLOSURE

[0025] For a thorough understanding of the present disclosure, reference is to be made to the following detailed description, including the appended claims, in connection with the above described drawings. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be apparent, however, to one skilled in the art that the present disclosure can be practiced without these specific details. In other instances, structures and apparatuses are shown in block diagrams form only, in order to avoid obscuring the disclosure. Reference in this specification to "one embodiment," "an embodiment," "another embodiment," "various embodiments," means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. The appearance of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but may not be of other embodiment's requirement.

[0026] Although the following description contains many specifics for the purposes of illustration, anyone skilled in the art will appreciate that many variations and/or alterations to these details are within the scope of the present disclosure. Similarly, although many of the features of the present disclosure are described in terms of each other, or in conjunction with each other, one skilled in the art will appreciate that many of these features can be provided independently of other features. Accordingly, this description of the present disclosure is set forth without any loss of generality to, and without imposing limitations upon, the present disclosure. Further, the relative terms, such as "first," "second," "inner," "outer" and the like, herein do not denote any order, elevation or importance, but rather are used to distinguish one element from another. Further, the terms "a" and "an" herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

[0027] Referring now to FIGS. 1 to 2B, various views of an example of a stator vane or a vane 100 for a turbine engine, such as gas turbine engine, are illustrated in accordance with an exemplary embodiment of the present disclosure. FIG. 1 illustrates a perspective view whereas FIGS. 2A and 2B illustrate various other views of the vane 100. In as much as the construction and arrangement of the stator vane 100, various associated elements may be well-known to those skilled in the art, it is not deemed necessary for purposes of acquiring an understanding of the present disclosure that there be recited herein all of the constructional details and explanation thereof. Rather, it is deemed sufficient to simply note that as shown in FIGS. 1 to 2B, in the stator vane 100, only those components are shown that are relevant for the description of various embodiments of the present disclosure.

[0028] The stator vane 100 includes an outer platform 102, an inner platform 104, and a vane aerofoil portion 114. The vane aerofoil portion 114 extends between the outer and inner platforms 102, 104 to configure the stator vane 100. The vane aerofoil portion includes an airfoil chord length 's'. The inner platform 104 of the stator vane 100, in one embodiment of the present disclosure, is configured to defined by a radius; however, without departing from the scope of the present disclosure, the inner platform 104 may be of any other shape, which enables circumferential and radial freedom of the stator vane 100, when assembled together.

[0029] As seen in FIG. 2A, the inner platform 104 includes first and second opposed side edges 106, 108. The first side edge 106 of the inner platform 104 includes an engaging member 110, and the second side edge 108 of the inner platform 104 includes a complementary engaging member 112.

[0030] Further, as seen in FIG. 2B, in one embodiment of the present disclosure, the engaging member 110 includes a tongue wedge face 110a and a tongue 110b configured thereon. The tongue 110b extends from the tongue wedge face 110a on the first side edge 106. The

tongue 110b includes a projected tongue length 'a' from the tongue wedge face 110a. Further, the tongue 110b may also be configured at a spaced-apart distance 't' from both distal lateral edges 109, (transverse to side edges 106, 108), of the inner platform 102.

[0031] In one embodiment of the present disclosure, a ratio of the tongue width 'b' to the distance 't'(b/t) is in a range of about:

$$0.2 \leq (b/t) \leq 7$$

[0032] In one embodiment of the present disclosure, a ratio of the airfoil chord length 's' to the projected tongue length 'a' is in a range of about:

$$3 \leq (s/a) \leq 30$$

[0033] In one embodiment of the present disclosure, a ratio of the projected tongue length 'a' to the tongue width 'b' (a/b) is in a range of about:

$$0.1 \leq (a/b) \leq 1.5$$

[0034] Such relations between the respective parameters enables reach suitable engagement.

[0035] The complementary engaging member 112, in one embodiment of the present disclosure, as shown in FIG. 2B, includes an undercut wedge face 112a and an undercut 112b. The undercut 112b is configured on the undercut wedge face 112a. The undercut 112b includes an undercut depth 'c', and an undercut width 'd,' on the undercut wedge face 112a.

[0036] The engaging member 110 and the complementary engaging member 112 are configured across the entire thickness of the first side edge 106 and the second side edge 108, respectively. Specifically, the feature tongue 110b of the engaging member 110, and the feature undercut 112b of the complementary member 112 are configured across the entire thickness of the first side edge 106 and the second side edge 108, respectively.

[0037] The engaging member 110 and the complementary engaging member 112 may be engagable so as, when mounted with another adjacent stator vanes, such as the vanes 100, to be axially restrained thereby but so as to allow its radial and circumferential freedom. In one embodiment of the present disclosure, the engaging member 110 and the complementary engaging member 112 being abutly engagable so as, when mounted, to substantially correspond the projected tongue length 'a' and the undercut depth 'c,' and the respective tongue and undercut widths 'b' and 'd,' in such a manner that an axial gap 116 and a circumferential gap 117 (as shown in FIGS. 5A and 5B) are adapted to be configured to be

maintained between the engaging member 110 and the complementary engaging member 112. In one embodiment of the present disclosure, the projected tongue length 'a' and the undercut depth 'c' are dimensioned to correspond each other in a manner that engagement between the engaging member 110 and the complementary engaging member 112 forms such axial and circumferential gaps 116 and 117 therebetween. In one form, 'a' may be substantially equal to 'c' with some tolerance, as per requirement. Similarly, the tongue and undercut widths 'b' and 'd' are dimensioned to correspond each other such that the axial and circumferential gaps 116 and 117 are configured between the engaging member 110 and the complementary engaging member 112. In one form, 'b' may be substantially equal to 'd' with some tolerance, as per requirement.

[0038] Such an engagement with the gaps 116 and 117, in combination, restrains axial movement while allowing its radial and circumferential freedom. In an example form, the configuration of the engaging member 110 and the complementary engaging member 112 across the entire thickness of the first side edge 106 and the second side edge 108 as described above, along with the gaps 116 and 117 restrain axial movement while allowing its radial and circumferential freedom. Such an engagement will be described in conjunction with the FIGS. 3 to 5B herein below.

[0039] Referring now to FIGS. 3 to 5B in order to describe an assembly 200. The assembly 200 may be configured by assembling a plurality of stator vanes, such as the stator vane 100, as described above. The plurality of stator vanes 100 are positively mounted in a manner that each of the engaging member 110 and complementary engaging member 112 of respective stator vanes 100 being engagable to adjacent stator vanes 100 thereof. As shown in example FIGS. 3 to 5B, three stator vanes 100a, 100b and 100c are positively mounted to configure the assembly 200. The engaging member 110 with the feature 110b₁ of the stator vane 100b coordinates with the feature 110c₂ of the complementary engaging member 110 of the adjacent stator vane 100c. Similarly, the complementary engaging member 110 with the feature 110b₂ of the stator vane 100b coordinates with the feature 110a₁ of engaging member 110 of the adjacent stator vane 100a, and so on. Such an engagement between the stator vanes 100a-100c configures the assembly 200 so as to be axially restrained thereby but so as to allow its radial and circumferential freedom. In FIGS. 3 to 5B only three stator vanes are illustrated for the purpose of the understanding the assembly 200, however, the assembly 200 is configured across the entire inner radial surface of a stator of the turbine engine for configuring rows stationary components with the stator.

[0040] Such engagement between the stator vanes 100a-100c to form the assembly 200 prevents the vane aerofoil portions 114a-114c from torsion as the inner platforms 104a-104c may be axially interlocked but, radially and circumferentially free due to the respective engaging

members 110a₁-110c₁ engaged with the respective complementary engaging members 110a₂-110c₂. The gaps 116 represent the axial level gap and ensure axial constrain. Further, the gaps 117 between the respective engagements ensure facilitating circumferential freedom of the stator vanes 100a-100c also prevents the vane aerofoil portions 114 from torsion. The gaps 116 and 117 do not constrain radial freedom, in turn enabling the radial freedom of the stator vanes 100a-100c. Such engagement prevents the vane aerofoil portions 114 from torsion, in turn also optimizes gas force flow at the stator vanes 100a-100c.

[0041] Although the foregoing description is described with the particular shape of the engaging and complementary engaging members 110, 112, as depicted in FIGS. 1 to 5B; without departing from the scope of the present disclosure, anyone skilled in the art will appreciate that many variations and/or alterations to the engaging and complementary engaging members 110, 112 are possible, and that such variations and/or alterations are considered within the scope of the present disclosure. Similarly, although many of the features of the engaging and complementary engaging members 110, 112 are described in terms of each other, or in conjunction with each other, one skilled in the art will appreciate that many features of the engaging and complementary engaging members 110, 112 can be provided independently of other features. Examples, including but not limited to, of applicable shapes and features of the engaging and complementary engaging members 110, 112 of a stator vane may be: Z-notch shape, as shown in FIG. 6A; and a wave-shape, as shown in FIG. 6B.

[0042] The stator vanes and the assembly therebetween of the present disclosure are advantageous in various scopes. The stator vanes and assembly are substantially advantageous in preventing long vanes torsion, optimizing gas force flow at the vanes, and controlling various directional movements of the vanes. Further, the assembly is easy to configure without any requirement of tools and couplers as required in conventional designs of the coupling rings, fixtures, and shrouds, thereby reducing the cumbersomeness and minimize various associated problems in an economical and adaptable manner. Further, the stator vanes and assembly are convenient to use and economical. Various other advantages and features of the present disclosure are apparent from the above detailed description and appendage claims.

[0043] The foregoing descriptions of specific embodiments of the present disclosure have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present disclosure to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the present disclosure and its practical application, to thereby enable others skilled in the art to best utilize the present disclosure and various embodiments with various modifica-

tions as are suited to the particular use contemplated. It is understood that various omission and substitutions of equivalents are contemplated as circumstance may suggest or render expedient, but such are intended to cover the application or implementation without departing from the spirit or scope of the claims of the present disclosure.

Reference Numeral List

[0044]

100	Stator vane
102	Outer platform
104	Inner platform
106	First side edge
108	Second side edge
109	Distal lateral edges
110	Engaging member
110a	Tongue wedge face
110b	Tongue
112	Complementary engaging member
112a	Undercut wedge face
112b	Undercut
114	Vane aerofoil portion
116	Axial gap
117	Circumferential gap
200	Assembly
'a'	Projected tongue length
'b'	Tongue width
'c'	Undercut depth
'd'	Undercut width
's'	airfoil chord length
't'	Distance from both distal lateral edges 109

Claims

1. A stator vane 100 for a turbine engine, the stator vane 100, comprising:
 - an outer platform 102;
 - an inner platform 104 having first and second opposed side edges 106, 108, wherein the first side edge 106 comprises an engaging member 110, and the second side edge 108 comprises a complementary engaging member 112; and
 - a vane aerofoil portion 114 extending between the outer and inner platforms 102, 104, the vane aerofoil portion 114 having an airfoil chord length 's,' wherein the engaging member 110 and the complementary engaging member 112 being engagable so as, when mounted, to be axially restrained thereby but so as to allow its radial and

circumferential freedom.

2. The stator vane 100 as claimed in claim 1, wherein the engaging member 110 comprises:

a tongue wedge face 110a; and
a tongue 110b configured on the tongue wedge face 110a, wherein the tongue 110b comprises a projected tongue length 'a' and a tongue width 'b,' and is spaced-apart at a distance 't' from both distal lateral edges 109 of the inner platform 102.

3. The stator vane 100 as claimed in claim 2, wherein a ratio of the tongue width 'b' to the distance 't'(b/t) is in a range of about:

$$0.2 \leq (b/t) \leq 7$$

4. The stator vane 100 as claimed in claim 2, wherein a ratio of the airfoil chord length 's' to the projected tongue length 'a' is in a range of about:

$$3 \leq (s/a) \leq 30$$

5. The stator vane 100 as claimed in claim 2, wherein a ratio of the projected tongue length 'a' to the tongue width 'b' (a/b) is in a range of about:

$$0.1 \leq (a/b) \leq 1.5$$

6. The stator vane 100 as claimed in claim 1, wherein the complementary engaging member 112 comprises:

an undercut wedge face 112a; and
an undercut 112b configured on the undercut wedge face 112a, wherein the undercut 112c comprises an undercut depth 'c' and an undercut width 'd.'

7. The stator vane 100 as claimed in any of preceding claims, wherein the engaging member 110 and the complementary engaging member 112 being abutly engagable so as, when mounted, to substantially correspond the projected tongue length 'a' and the undercut depth 'c,' and the respective tongue and undercut widths 'b' and 'd,' in such a manner that an axial gap 116 and a circumferential gap 117 are adapted to be configured to be maintained between the engaging member 110 and the complementary engaging member 112 to allow its radial and circumferential freedom while restraining axial.

8. The stator vane 100 as claimed in claim 7, wherein the projected tongue length 'a' and the undercut depth 'c' being dimensioned in a manner that the engaging member 110 and the complementary engaging member 112, when engaged, the axial and circumferential gaps 116 and 117 are configured therebetween. 5
9. The stator vane 100 as claimed in claim 7, wherein the tongue and undercut widths 'b' and 'd' being dimensioned in a manner that the engaging member 110 and the complementary engaging member 112, when engaged, the axial and circumferential gaps 116 and 117 are configured therebetween. 10
10. The stator vane 100 as claimed in claim 1, wherein the engaging member 110 and the complementary engaging member 112 being configured across the entire thickness of the first side edge 106 and the second side edge 108, respectively, so as to allow the radial and circumferential freedom. 15 20
11. The stator vane 100 as claimed in claim 1, wherein the engaging member 110 and the complementary engaging member 112 being configured to comprise a Z-shaped structure. 25
12. The stator vane 100 as claimed in claim 1, wherein the engaging member 110 and the complementary engaging member 112 being configured to comprise a wave-shaped structure. 30
13. A stator vane assembly 200 for a turbine engine, the stator vane assembly 200, comprising: 35
- a plurality of stator vanes 100, each of the stator vane 100 having,
- an outer platform 102;
- an inner platform 104 having first and second opposed side edges 106, 108, wherein the first side edge 106 comprises an engaging member 110, and the second side edge 108 comprises a complementary engaging member 112; and 40
- a vane aerofoil portion 114 extending between the outer and inner platforms 102, 104, 45
- wherein the plurality of stator vanes 100 being positively mounted in a manner that each of the engaging member 110 and complementary engaging member 112 of respective stator vanes 100 being engagable to adjacent stator vanes 100 thereof so as to be axially restrained thereby but so as to allow its radial and circumferential freedom. 50
14. The stator vane assembly 200 as claimed in claim 13, wherein the engaging member 110 comprises: 55
- a tongue wedge face 110a; and
- a tongue 110b configured on the tongue wedge face 110a, wherein the tongue 110b comprises a projected tongue length 'a' and a tongue width 'b.'
15. The stator vane assembly 200 as claimed in claim 13, wherein the complementary engaging member 112 comprises: 5
- an undercut wedge face 112a; and
- an undercut 112b configured on the undercut wedge face 112a, wherein the undercut 112b comprises an undercut depth 'c' and a undercut width 'd.'
16. The stator vane assembly 200 as claimed in claims 13 to 15, wherein each of the engaging member 110 and the complementary engaging member 112 of respective stator vanes 100 being abutly engagable to adjacent stator vanes 100 thereof to substantially correspond the projected tongue length 'a' and the undercut depth 'c,' and the respective tongue and undercut widths 'b' and 'd,' in such a manner that an axial gap 116 and a circumferential gap 117 are adapted to be configured to be maintained between each of the engaging member 110 and the complementary engaging member 112 to allow its radial and circumferential freedom while restraining axial.

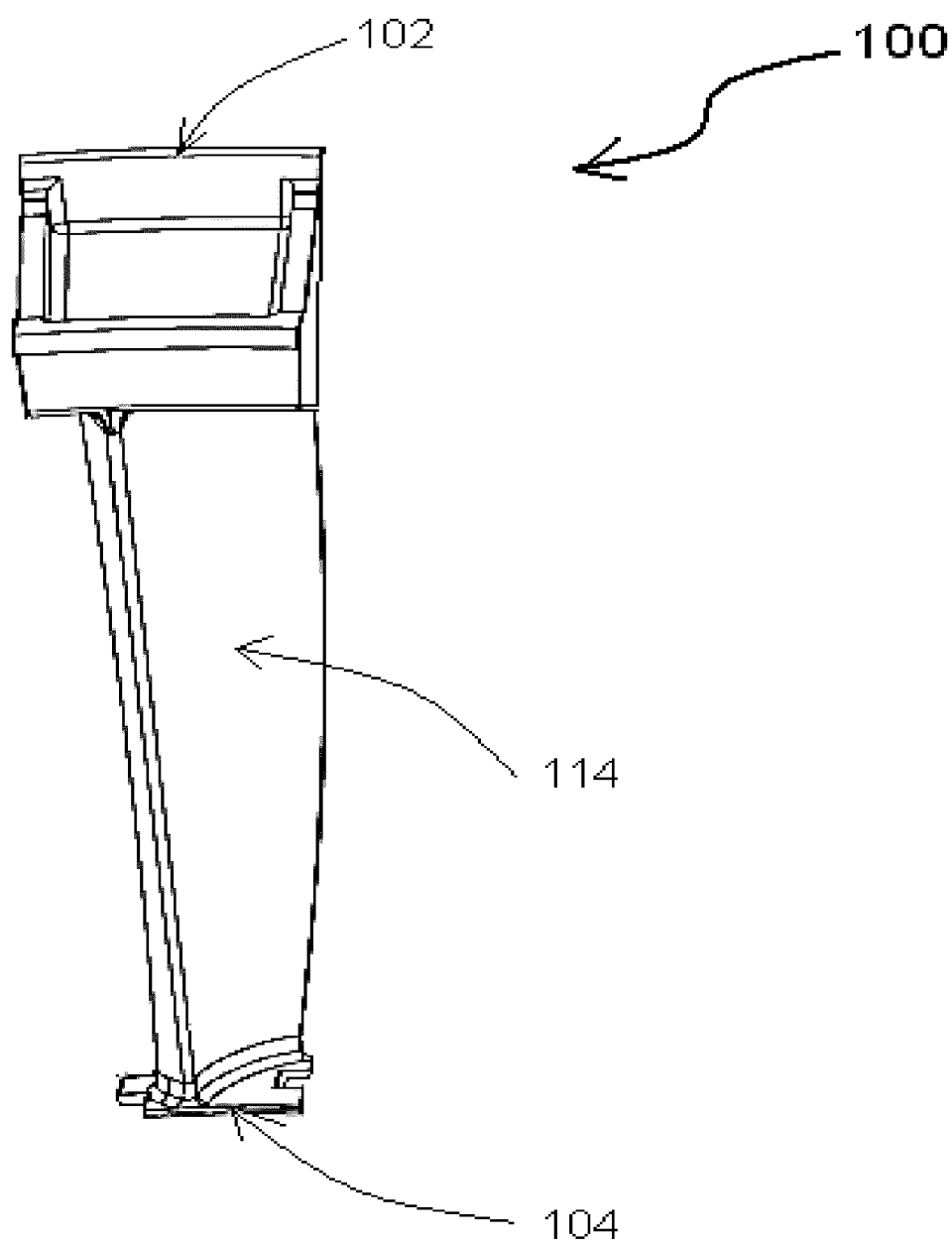


FIG. 1

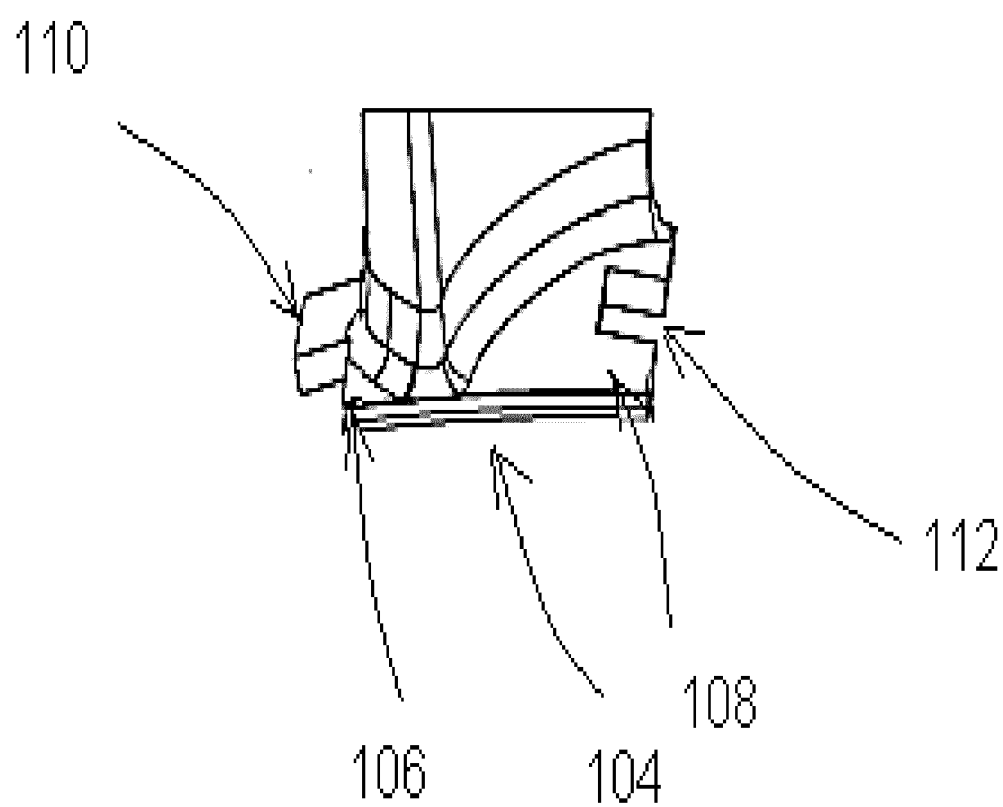


FIG. 2A

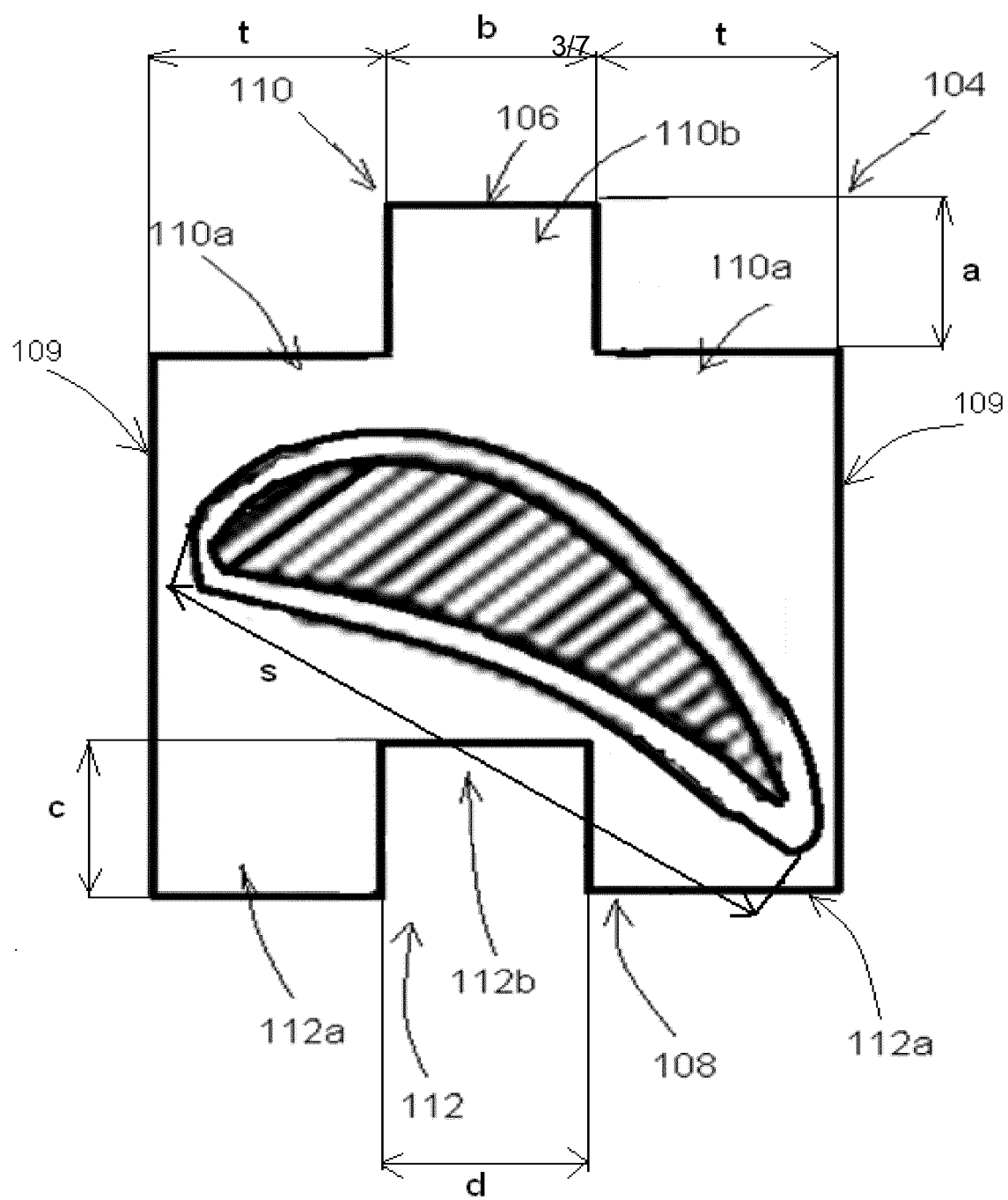


FIG. 2B

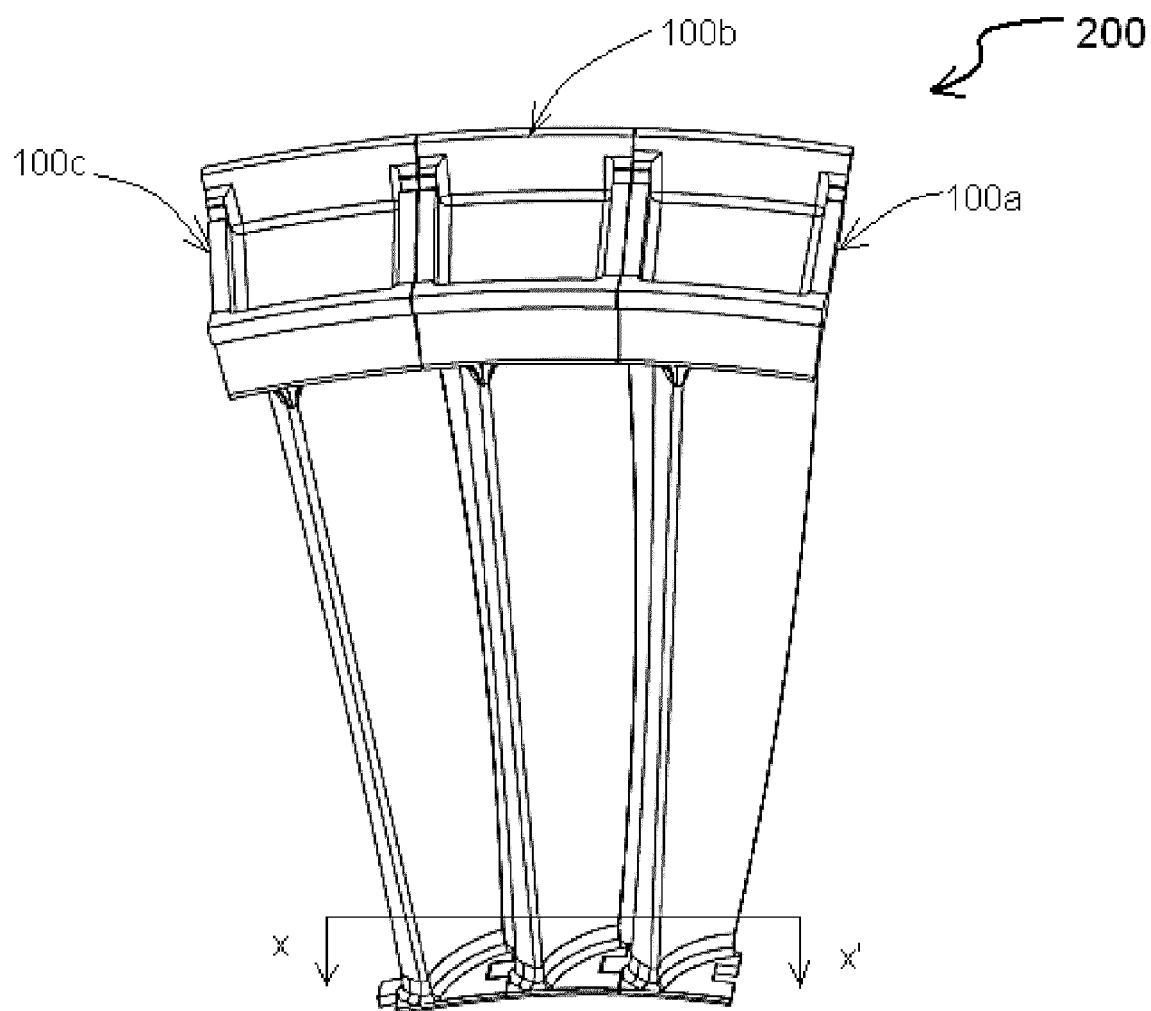


FIG. 3

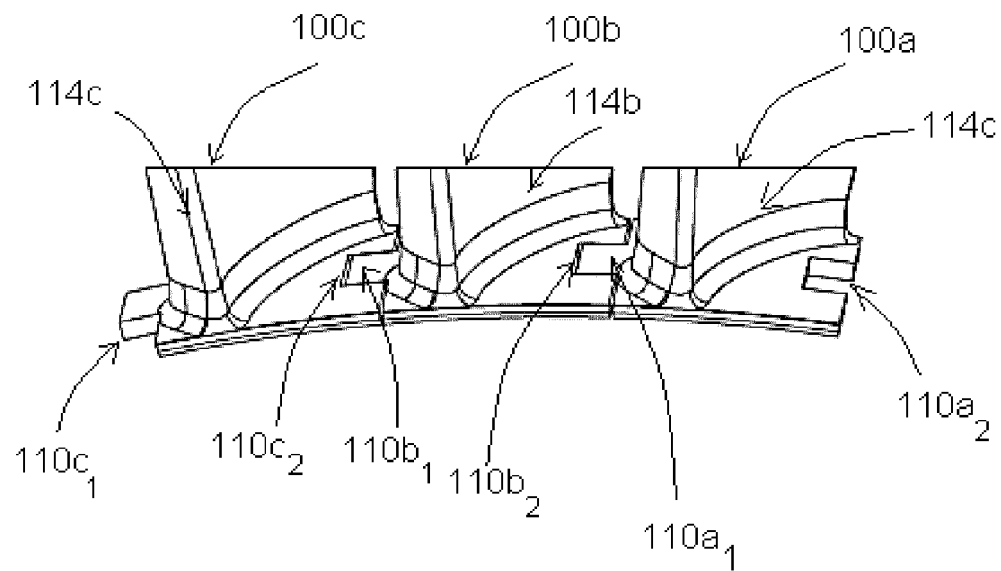


FIG. 4A

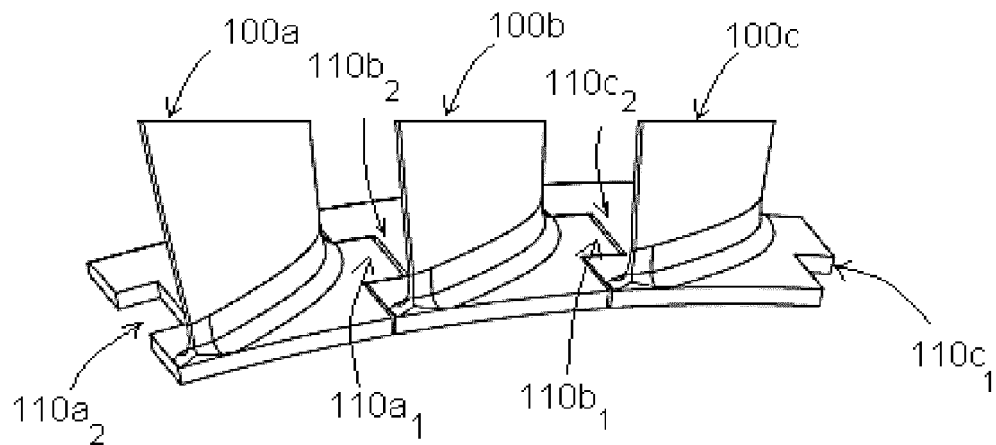


FIG. 4B

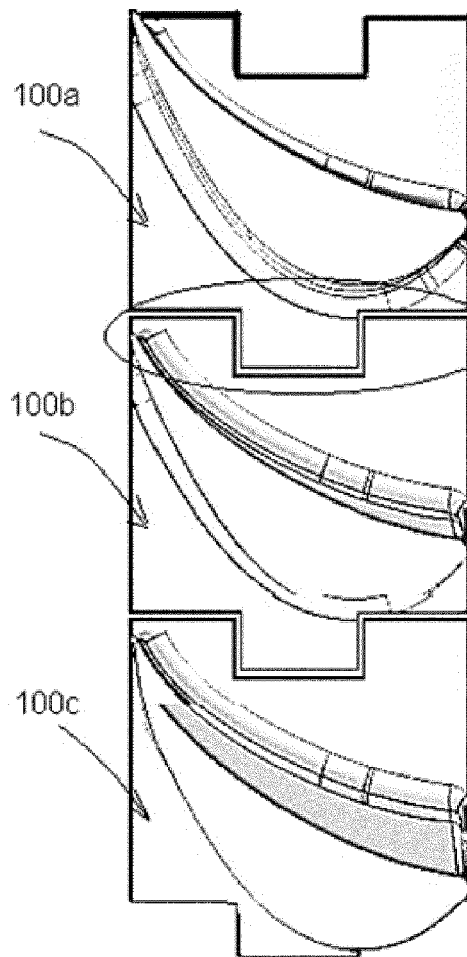


FIG. 5A

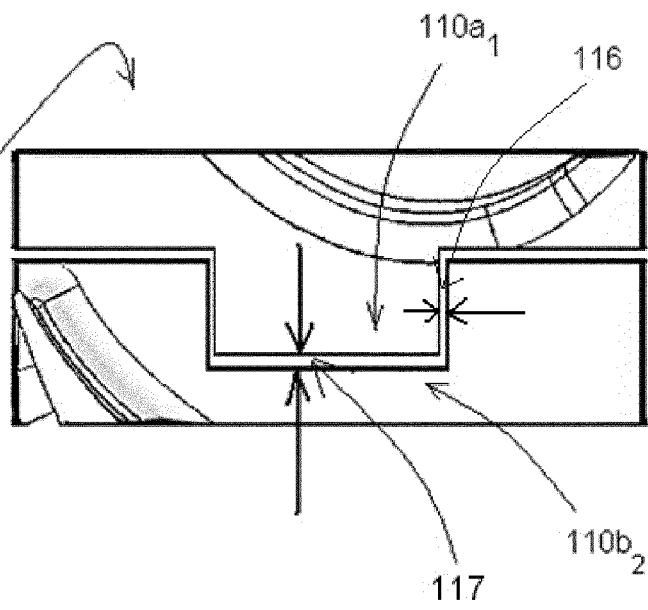


FIG. 5B

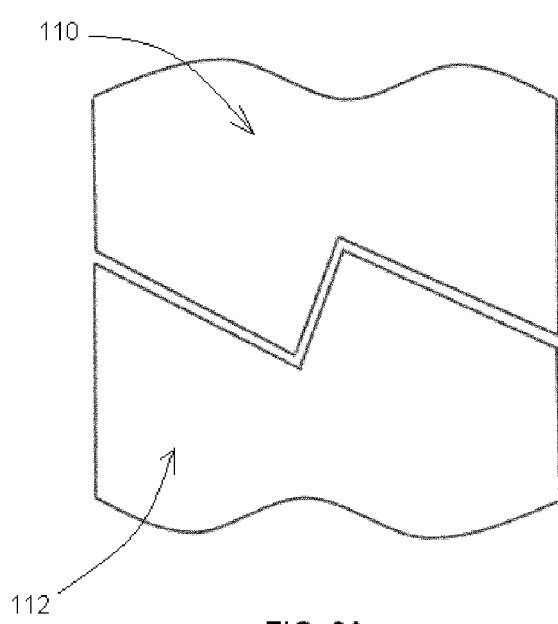


FIG. 6A

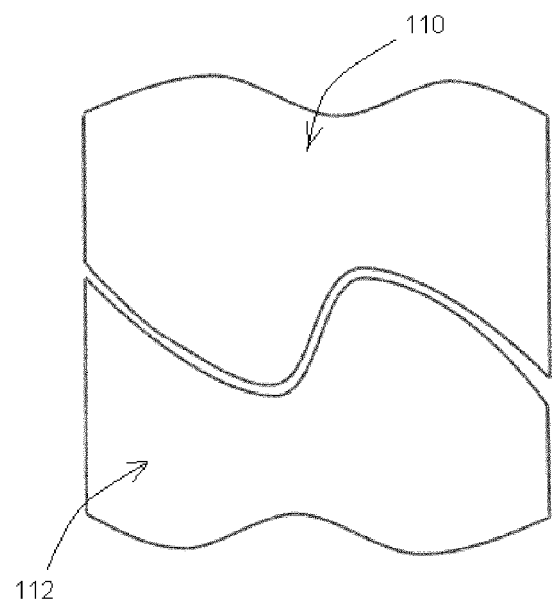


FIG. 6B



EUROPEAN SEARCH REPORT

Application Number
EP 13 16 9712

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 485 833 C (J A MAFFEI A G) 8 November 1929 (1929-11-08) * figure 3 *	1-10, 13-16	INV. F01D9/04
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