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DESCRIPTION

FIELD OF THE INVENTION

[0001] The present invention relates to a propulsion unit nozzle for being arranged around a propeller in a propulsion unit, comprising: a load bearing core structure extending in a circumference of the propulsion unit nozzle; and a plurality of hydrodynamic elements mounted on and enclosing the core structure thereby defining the outer and the inner surfaces of the propulsion unit nozzle. The invention further relates to a propulsion unit for a vessel comprising a propulsion unit nozzle and to a method for the manufacture of a propulsion unit nozzle.

BACKGROUND OF THE INVENTION

[0002] Propulsion units, such as azimuth thrusters, are widely used in the maritime industry as primary or secondary means of propulsion for a broad range of vessel types.

[0003] Propulsion units are often provided with a propulsion unit nozzle arranged around the propeller and designed to increase the efficiency of the propulsion unit. The propulsion unit nozzle or propulsion unit nozzle affects the flow of water past the propeller and transfers hydrodynamic forces to the vessel. Propeller nozzles are used in connection with both pushing and pulling propulsion system.

[0004] Traditionally, propeller nozzles have been of a simple standardised design suitable for manufacturing as welted construction. However, with increased focus on efficiency and reduced emission, a need for propeller nozzles with improved hydrodynamic characteristics has arisen. Improved hydrodynamic characteristics may for example be achieved by designing propeller nozzles according to vessel and propulsion system characteristics and use. To be able to achieve such desirable hydrodynamic characteristics it is often necessary to design propeller nozzles with more complex surface geometries, such as surfaces of double and triple curvatures.

[0005] As traditional welding based manufacturing processes are not suitable for producing such surfaces of double and triple curvature, it would be advantageous with constructions that are easier and more effective in terms of design and manufacturing. Additionally, it would be advantageous to achieved improved manufacturing processes.

[0006] Some prior art include:

- US 4789302 relates to a propeller nozzle. The nozzle section is designed with continuously curved inside and outside surface to create maximum lift and minimum drag, as a number of straight airfoil segments forming a polygon approximating circular ring.

- US 5799394 relates to a marine speed nozzle assembly to be disposed in surrounding relation about a vessels propeller. The speed nozzle assembly includes an interior shell portion and an exterior shell portion, with the interior shell portion being structured in a circular configuration, so as to define an interior ring, and being disposed in concentrically surrounding relation about the propeller such that fluid propelled by the propeller flows from the interior shell portion's bow end towards its aft end and its generally hydrofoil-like interior longitudinal profile substantially increases a thrust produced by the propeller at low speeds.
- GB 1070743 relates to a nozzle for a ship's propeller having the form of a ring made of one or more weldable steel castings, an intermediate cylindrical portion serving as a shroud ring for the blades of the propeller, a tubular or solid ring forming the outlet or exit end axially-extending bars to stiffen the wall, longitudinal webs, and a ring or circumferential member joining adjacent webs to one another, contiguous parts of the nozzle being connected by welding.

OBJECT OF THE INVENTION

[0007] An object of the present invention is to provide an alternative to the prior art.

[0008] In particular, it may be seen as a further object of the present invention to provide a propulsion unit nozzle, more specifically a propeller nozzle that solves the above-mentioned problems of the prior art with regard to design and manufacturing.

SUMMARY OF THE INVENTION

[0009] Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a propulsion unit nozzle for being arranged around a propeller in a propulsion unit, the propulsion unit nozzle being defined by an outer surface and an inner surface, wherein the propulsion unit nozzle comprises: a load bearing core structure extending in a circumference of the propulsion unit nozzle between the outer surface and the inner surface; and a plurality of hydrodynamic elements mounted on and enclosing the core structure thereby providing the outer surface and the inner surface of the propulsion unit nozzle; characterized in that each of the hydrodynamic elements extends along the entire width of the propulsion unit nozzle, and one or more of the hydrodynamic elements comprises a leading part and a trailing part adapted to be assembled on the load bearing structure to provide a hydrodynamic element.

[0010] The invention is particularly, but not exclusively, advantageous for obtaining propulsion unit nozzles that are more efficient in terms of design and manufacturing, especially when the design includes surfaces of double and triple curvatures.

[0011] According to a further aspect, the propulsion unit nozzle is a propeller nozzle adapted to be arranged around the propeller of a marine propulsion unit. However, other uses of the nozzle may also be envisaged. In one embodiment, the propulsion unit nozzle may be adapted for use in propulsion unit using a water jet as an alternative to a propeller.
The invention further relates to a propulsion unit for a vessel comprising the above described propulsion unit nozzle and to a method for the manufacture of such propulsion unit nozzle.

[0012] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

[0013] The propulsion unit nozzle according to the invention will now be described in more detail with regard to the accompanying figures. The figures show one way of implementing the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 shows a prior art propulsion unit in the form of an azimuth thruster,

Figure 2 shows a propulsion unit nozzle according to one embodiment of the invention,

Figure 3 shows the propulsion unit nozzle of Fig. 1 seen from the side,

Figure 4 shows parts of hydrodynamic elements arranged on a load bearing core structure for illustrative purposes, and

Figure 5 illustrates how a propulsion unit nozzle may be assembled based on a core structure and a plurality of hydrodynamic elements.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0014] Figure 1 shows a traditional propulsion unit, in the form of an azimuth thruster. When mounted on a vessel the thruster is rotatable about a mount axis 101 to change a direction in which a propeller thrust is directed. The propeller 103 is rotatable about a propeller axis 102, and around the propeller, a propulsion unit nozzle 1 is provided to improve the hydrodynamic characteristics of the thruster. As seen the shape of the outer surfaces of the propulsion unit nozzle of Fig. 1 are quite simple and comprised primarily by surfaces of single curvature.

[0015] Figure 2 shows a propulsion unit nozzle according to one embodiment of the present invention. In comparison with the nozzle of Fig. 1, this propulsion unit nozzle comprises an exterior outer surface 13a and an exterior inner surface 13b, of a complex design including surfaces of multiple curvatures. The surface geometries of the nozzle also vary along the circumference of the propulsion unit nozzle. In figure 3, the same propulsion unit nozzle is viewed from the side, and it is seen that a width of the nozzle may vary along the circumference of the nozzle.

[0016] Referring to Figure 4 and 5, the construction of a propulsion unit nozzle according to one embodiment of the invention is described in further detail. The propulsion unit nozzle 1 comprises a core structure 11 adapted to extend in the circumference of the propulsion unit nozzle. In the shown embodiment, the core structure is a substantial circular structure, however other shapes may also be envisaged. The core structure 11 is a continuous structure extending in the full extension of the propulsion unit nozzle. However, in other embodiments the core structure may extend in only a part of the extension of the propulsion unit nozzle. The core structure may thus be discontinued along a section of the propulsion unit nozzle, such as in a lower most part wherein structural forces may be less dominant. The core structure may thus be a fully encircling structure or discontinue partial encircling structure.

[0017] The core structure is designed to be the primary load-bearing component of the propulsion unit nozzle and ensures structural integrity of the nozzle. Forces experienced by the propulsion unit nozzle are thus primarily obtained by the core structure, whereby other parts of the propulsion unit nozzle may be designed without the same considerations for structural integrity.

[0018] On the core structure a plurality of hydrodynamic elements 12 are mountable to enclose the core structure and thereby define the outer surface 13a and the inner surface 13b of the propulsion unit nozzle. By assembling a plurality of hydrodynamic elements, the surfaces of these hydrodynamic elements together constitutes the outer- and the inner surface of the propulsion unit nozzle. When the hydrodynamic elements are mounted on the core structure, the core structure thus extends between the outer surface and the inner surface of the nozzle.

[0019] As shown in Fig. 4 the core structure is provided with an indentation 111 in its outer surface extending around the core structure. Each of the hydrodynamic elements 12 comprises a protrusion 122 adapted to engage in a mating relationship with this indentation. Hereby, proper alignment and fixation of the hydrodynamic elements on the core structure is ensured.

[0020] Each of the hydrodynamic elements may comprise a leading part 12a and a trailing part 12b adapted to be assembled on the load bearing structure, seen from Fig. 5. The leading and trailing parts thus provide a hydrodynamic element extending along the entire width of the propulsion unit nozzle.

[0021] In Fig. 4, only leading parts 12a are shown to be arranged on the core structure. Each of the hydrodynamic elements 12 comprises an exterior indentation 121, which may be provided on either the leading- or trailing part or on both parts. When the hydrodynamic elements are mounted on the core structure, the indentations 121 provide an outer track 16 extending along the periphery of the outer surface of the propulsion unit nozzle. The outer track 16 is adapted to receive an exterior fastening element 14, as shown in the lower right illustration of Fig. 5. The exterior fastening element secures or clamps the hydrodynamic elements to the core structure, and may be a band or the like extending around the nozzle. Further, the exterior fastening element may be secured directly to the core element by fastening elements extending through the hydrodynamic elements. By arranging the fastening element in an indentation, a smooth outer surface is provided and the fastening element is kept in place.

[0022] Similar to the exterior indentation described above, the hydrodynamic elements may comprise an interior indentation (not shown) providing an inner track (not shown) extending along the periphery of the inner surface of the propulsion unit nozzle. The inner track is adapted for receiving an interior fastening element 15, also shown in the lower right illustration of Fig. 5. The interior fastening element may also be secured directly to the core structure 11 by fastening elements.

[0023] As is seen from Fig. 5, the hydrodynamic elements 12 are mounted piece by piece on the core structure 11 to provide the geometry of the outer surfaces of the propulsion unit nozzle. By combining hydrodynamic elements of a varying geometry, the shape of the propulsion unit nozzle may vary along its periphery, as is seen in Fig. 2. A propulsion unit nozzle with such varying profile along its periphery may be advantageous because the water inflow velocity and angle often varies along the circumference of the propulsion unit nozzle. This may be due to other parts of the vessel, such as parts of the hull or a gearbox, arranged in front of the propulsion unit and therefore restricting the flow of water. As the optimal propulsion unit nozzle profile or geometry depends on water inflow velocity and angle it is advantageously to be able to design propulsion unit nozzles with a varying profile. Hereby, varying surface geometries may be obtained by combining a selection of standard components designed to be combined to provide different geometries. A further advantage of using a plurality of hydrodynamic elements mounted on a core structure is that one or more elements may be exchanged or replaced if changes in the nozzle profile is required or an element is defect.

[0024] As the core structure is the load bearing structure of the propulsion unit nozzle this should be manufactured from a material of a relatively high strength, such as a metallic material, for example steel or a composite material. As the core structure is of a relatively simple geometry manufacturing processes including forging, welding and milling can be utilized in an effective manner.

[0025] The hydrodynamic elements on the other hand, are of a more complex geometry and these may therefore advantageously be made using casting or moulding processes. Alternatively, the hydrodynamic elements may be of a material that can be shaped into complex geometries in an effective manner.

[0026] In one embodiment the hydrodynamic elements are of a casted material, such as a casted non-metallic material, for example a composite material or a polymer material. Materials may be a composite comprising glass or carbon fibres or polyurethane or a combination of these. As the core structure ensures the structural integrity of the propulsion unit nozzle, the hydrodynamic elements do not need any substantial load bearing capabilities. This increases design possibilities and ensures that materials that are advantageously in term of manufacturing can be used. A further advantage of using polymer materials, instead of steel, is that the surfaces of the propulsion unit nozzle may be designed with a lower coefficient of friction, thereby improving the flow of water over the surfaces.

[0027] Similar to the prior art propulsion unit nozzle shown in Fig. 1, the propulsion unit nozzle according to one embodiment of the present invention may be part of a propulsion unit for a vessel. The propulsion unit nozzle may be mounted on the thruster using traditional struts extending from the nozzle to a central hub part arranged close to the propeller axis 102. Such struts may be secured directly to the core structure 11 or one of the fastening elements 14, 15. However, the propulsion unit nozzle may also be fastened at the outer surface, for example via the outer fastening element.

[0028] As mentioned above, the construction of the propulsion unit nozzle, based a plurality of hydrodynamic elements mounted on a core structure, provides several advantages. In regards to manufacturing, the modular design also provides several opportunities.

[0029] The various elements constituting the nozzle, i.e. the core structure and the hydrodynamic elements, can be manufactured using standardised production processes and made to stock. In particular, the hydrodynamic elements can be made in a number of variations with varying geometry. Later on in the manufacturing process, the hydrodynamic elements may thus be assembled to provide a specified shaped for the outer- and inner surfaces of the nozzle. The core structure may also be made to stock either by completely finishing the core structure or by making a partly processed core structure, which can be further customized to a finished core structure according to specification.

[0030] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. In addition, the mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US4789302A [0006]
- US5799394A [0006]
- GB1070743A [0006]

Patentkrav

1. Fremdrivningsenhedsdyse (1) som skal indrettes rundt om en propel i en fremdrivningsenhed (10), idet fremdrivningsenhedsdysen (1) er defineret af en udvendig overflade (13a) og en indvendig overflade (13b), hvor fremdrivningsenhedsdysen (1) omfatter:

- en belastningsbærende kernestruktur (11) som strækker sig i en omkreds af fremdrivningsenhedsdysen (1) mellem den udvendige overflade (13a) og den indvendige overflade (13b); og
- en flerhed af hydrodynamiske elementer (12) monteret på og omsluttende kernestrukturen (11) for derved at tilvejebringe fremdrivningsenhedsdysens (1) udvendige overflade (13a) og indvendige overflade (13b), hver af de hydrodynamiske elementer (12) strækker sig langs hele fremdrivningsenhedsdysens (1) bredde, og

kendetegnet ved, at

- et eller flere af de hydrodynamiske elementer (12) omfatter en forreste del (12a) og en bageste del (12b), som separat element fra den forreste del (12a), beregnet til at blive monteret på den belastningsbærende struktur (11) for at tilvejebringe et hydrodynamisk element (12).

2. Fremdrivningsenhedsdyse (1) ifølge krav 1, hvor de hydrodynamiske elementer (12) er af et støbt materiale.

3. Fremdrivningsenhedsdyse (1) ifølge krav 1 eller 2, hvor de hydrodynamiske elementer (12) er af et støbt ikke-metallisk materiale.

4. Fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af kravene 1-3, hvor de hydrodynamiske elementer (12) er fremstillet af et kompositmateriale eller et polymermateriale.

5. Fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af de foregående krav, hvor den belastningsbærende struktur (11) er af et metallisk materiale.

6. Fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af de foregående krav, hvor de hydrodynamiske elementer (12) har en varierende geometri.

7. Fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af de foregående krav, hvor hver af de hydrodynamiske elementer (12) omfatter en udvendig fordybning (121) som tilvejebringer en ydre bane (16) som strækker sig langs omkredsen af fremdrivningsenhedsdysens (1) udvendige overflade, idet den ydre bane (16) er beregnet til at modtage et udvendigt fastgørelseselement (14).

8. Fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af de foregående krav, hvor hver af de hydrodynamiske elementer (12) omfatter en indvendig fordybning (121) som tilvejebringer en indre bane, som strækker sig langs omkredsen af fremdrivningsenhedsdysens (1) indvendige overflade (13b), idet banen er beregnet til at modtage et indvendigt fastgørelseselement (15).

9. Fremdrivningsenhedsdyse (1) ifølge krav 7 eller 8, hvor de hydrodynamiske elementer (12) er fastspændt på den belastningsbærende struktur (11) ved hjælp af det udvendige fastgørelseselement og/eller det indvendige fastgørelseselement (15), som er fastgjort på den belastningsbærende struktur (11).

10. Fremdrivningsenhed (10) til et fartøj omfattende en fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af de foregående krav.

11. Fremgangsmåde til fremstilling af en fremdrivningsenhedsdyse (1) ifølge et hvilket som helst af kravene 1-9, omfattende trinnene:

- at fremstille en kernestruktur (11),
- at fremstille en flerhed af hydrodynamiske elementer (12), og
- at montere de hydrodynamiske elementer (12) på kernestrukturen (11) for at opnå en ønsket geometri for fremdrivningsenhedsdysens (1) indvendige (13b) og udvendige overflade (13a).

DRAWINGS

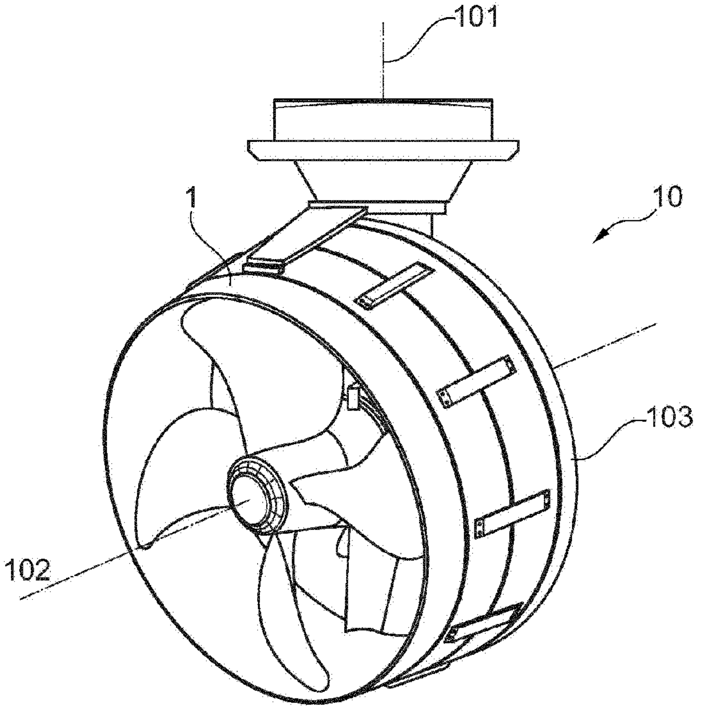

Fig. 1
(Prior art)

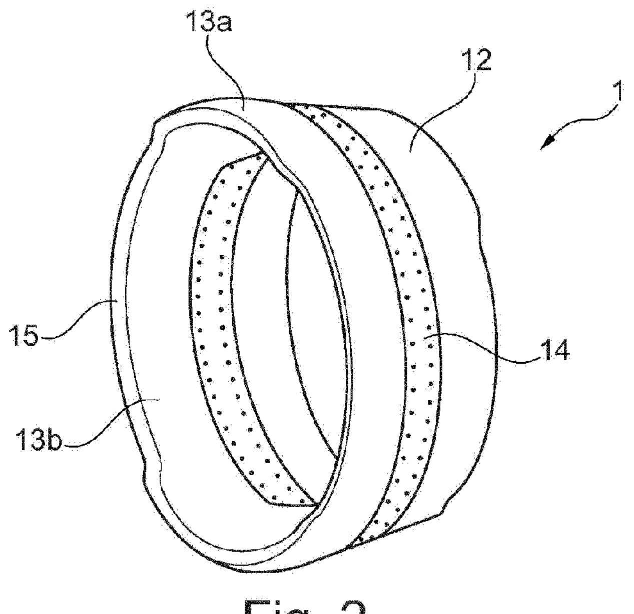

Fig. 2

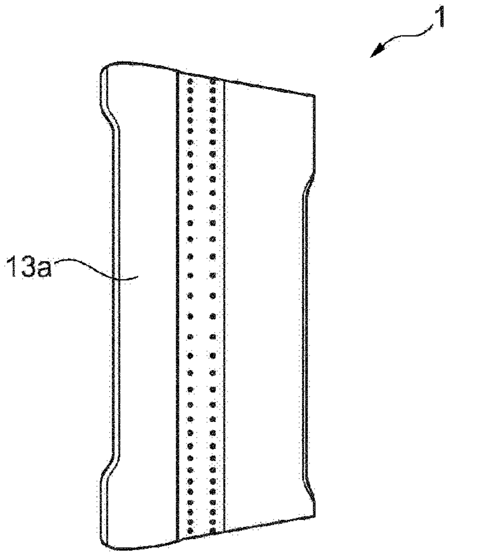

Fig. 3

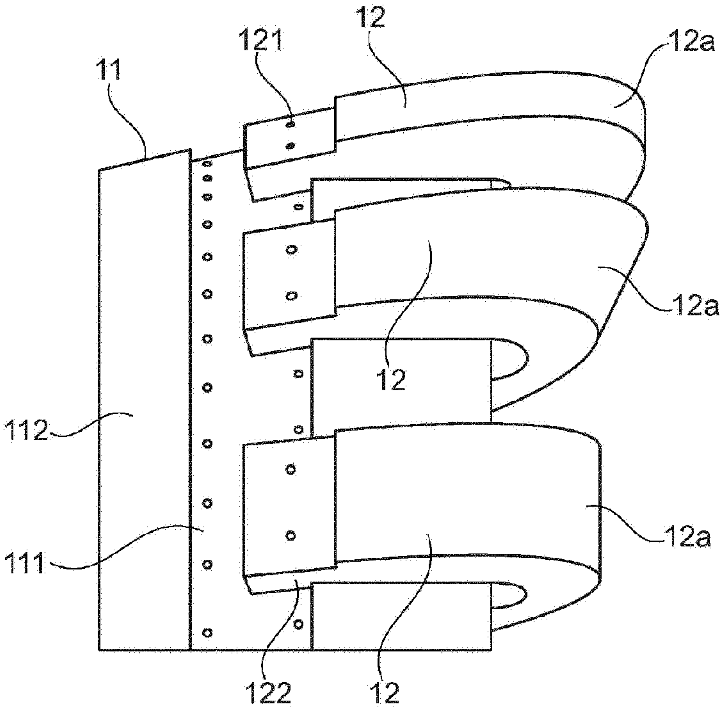

Fig. 4

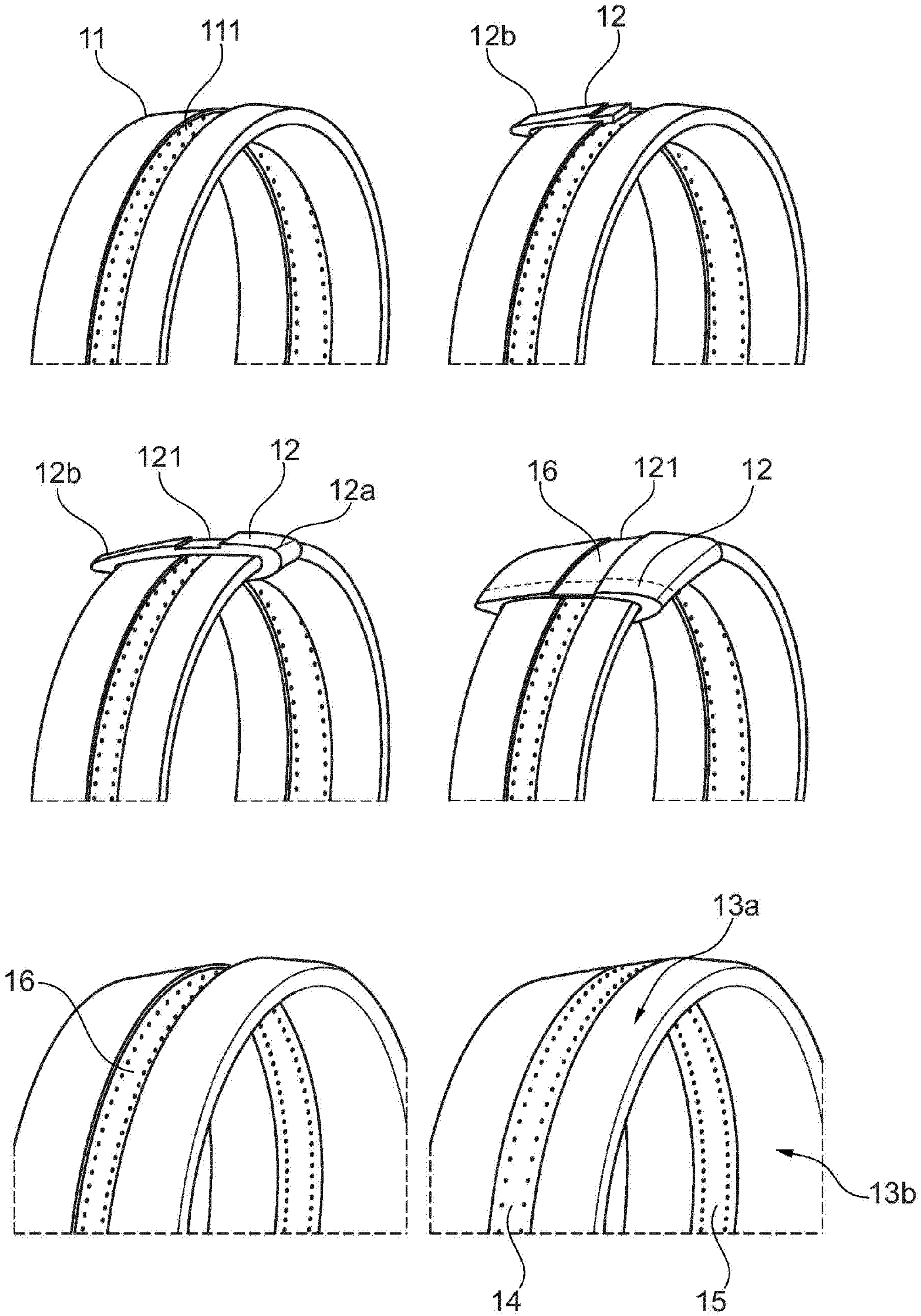

Fig. 5