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(54) Title: A BULKHEAD FOR AN AEROGENERATOR BLADE ROOT

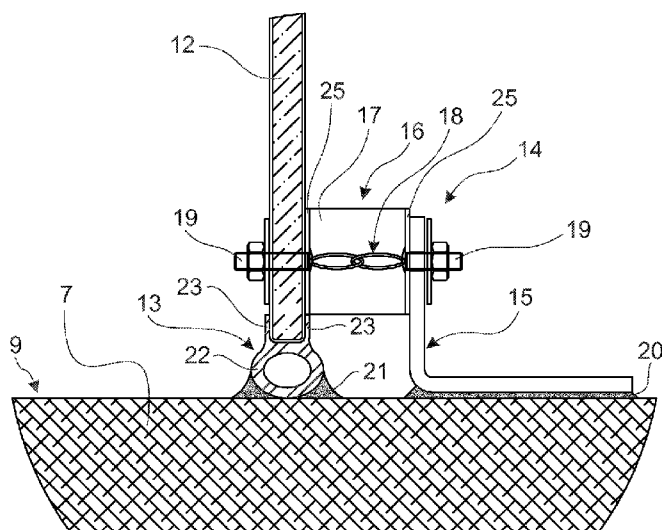


FIG. 4

(57) Abstract: A bulkhead for an aerogenerator blade root having a bulkhead panel disposed within the blade, the blade having a wall with an internal surface; a means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall; a bracket for attaching the bulkhead panel to the blade root wall, the bracket being characterized by comprising: a tab support with a first and a second portion; an interface device; wherein the first portion of the tab support is configured to be secured to the internal surface of the blade root wall and the second portion of the tab support is configured to be secured to the interface device, and wherein the interface device provides the connection between the tab support and the bulkhead panel, the interface device comprising: a damper pad that supports the compressive loads transmitted from the blade root wall to the bulkhead panel through the tab support; and an axial reinforcement that connects the tab support to the bulkhead panel, wherein the axial reinforcement supports the tensile loads

transmitted from the blade root wall to the bulkhead panel through the tab support, said tensile loads being substantially supported by the axial reinforcement before the damper pad reaches its yield strength.

Description

Title of Invention: A BULKHEAD FOR AN AEROGENERATOR BLADE ROOT

Technical Field

- [1] This invention relates to aerogenerator blades and more particularly to a blade root bulkhead.

Background Art

- [2] Wind power is frequently produced by large generators comprising a vertical structure (*e.g.* tower) on top of which is placed at least one horizontal axis wind turbine that includes one, two, three or multiple rotor blades. Wind power generators, or simply 'aerogenerators', are designed to exploit wind energy existing at a particular location and therefore vary in height, control system, number of blades, blade orientation, shape and materials.
- [3] Currently, blades of 20 to 40 meters in length for an aerogenerator with rated power of about 0.5MW to 1.5MW are very common, but there is an increasing attention spent on even larger aerogenerator blades, which nowadays are reaching 80 meters high with 3.0MW rated power. Nevertheless, both medium-sized blades and larger blades still have many design and manufacturing problems.
- [4] In general, an aerogenerator blade has an airfoil profile with a root region, a tip region, a leading edge, a trailing edge, a pressure side (intrados shell) and a suction side (extrados shell).
- [5] During operation of the aerogenerator, the blades are subject to various aerodynamic strains. The tip is usually considered to be the most fragile part of blade; however, as the root of the blade transmits the main loads of the blade to the hub, the root region is also subject to considerable stresses due to blade bending, twisting and buckling, among other factors.

Disclosure of Invention

Technical Problem

- [6] One particular technical problem regarding the blade root region is that there is a need to isolate the internal part of blade for personnel security issues during maintenance and for avoiding debris falling inside the blade. This isolation is provided using some configuration of bulkhead. It is known in the prior art that using a rigid connection between the blade shell and the bulkhead may almost inevitably cause damage to either the blade shell or to the bulkhead. Hence, other configurations are suggested by the prior art, such as using composite material brackets, steel rods, rubber supports and angled flanges, which in some cases are combined with additional

sealants around the bulkhead for hermetically closing the internal part of the blade. These configurations are still subject to failure due to the fatigue caused by the stresses and they do not provide an effective solution for hermetically closing the internal part of the blade.

Technical Solution

- [7] To overcome the drawbacks and problems described above and other disadvantages not mentioned herein, in accordance with the purposes of the invention, as described herein, one basic aspect of the present invention is directed to a bulkhead panel disposed within the blade, the blade having a wall with an internal surface; a means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall; a bracket for attaching the bulkhead panel to the blade root wall, the bracket being characterized by comprising: a tab support with a first and a second portion; an interface device; wherein the first portion of the tab support is configured to be secured to the internal surface of the blade root wall and the second portion of the tab support is configured to be secured to the interface device, and wherein the interface device provides the connection between the tab support and the bulkhead panel, the interface device comprising: a damper pad that supports the compressive loads transmitted from the blade root wall to the bulkhead panel through the tab support; and an axial reinforcement that connects the tab support to the bulkhead panel, wherein the axial reinforcement supports the tensile loads transmitted from the blade root wall to the bulkhead panel through the tab support, said tensile loads being substantially supported by the axial reinforcement before the damper pad reaches its yield strength.

- [8] In another aspect of the invention, the means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall includes an elastomeric tubular profile, the profile having in one side projecting flaps that engage along the bulkhead panel perimeter, and whose opposite side is attached to the blade root wall internal surface.

Advantageous Effects

- [9] The present invention has several advantages over the prior art. For instance, in the prior art, the bonded connections, the flanged rims, the angled brackets, the rubber supports or the steel rods are the sole interfaces used for supporting the stresses from the blade root wall movement. Therefore, as the blade is in almost constant movement and subject to variable wind speed forces, said interface components are subject to tensile loads and compressive loads, as well as torsion and shear stresses, resulting in long-term exposure to a critical operational condition. Conversely, the present invention provides a better stress and strain relief distributing the main compressive loads over a damper pad and the main tensile loads over an axial reinforcement. Thus,

the axial reinforcement avoids the damper pad from reaching its yield strength, protecting the damper pad from fatigue and creep. In addition to having a better stress and strain behaviour regarding the axial loads, the combination of the tab support with the interface device also has the advantage of supporting torsion and shear stresses. This allows more flexibility in defining the method of hermetically sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall. In yet another aspect of the invention, an advantageous effect is obtained by using a tubular profile with projecting flaps, which at the same time is used for sealing and providing additional stress relief for the movement of the bulkhead panel in its diameter axis.

Description of Drawings

- [10] The accompanying drawings are not necessarily drawn on scale. In the drawings, some identical or nearly identical components that are illustrated in various figures may be represented by a corresponding numeral. For purposes of clarity, not every component may be labelled in every drawing.
- [11] Fig. 1 illustrates one exemplary aerogenerator blade.
- [12] Fig. 2 illustrates an aerogenerator blade root with one exemplary bulkhead according to an embodiment of the present invention.
- [13] Fig. 3 illustrates a partial view of an aerogenerator blade root with one exemplary bulkhead according an embodiment of the present invention.
- [14] Fig. 4 illustrates a partial view of an aerogenerator blade with one exemplary bulkhead according an embodiment of the present invention.

Mode for Invention

- [15] This invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of 'including', 'comprising', 'having', 'containing' or 'involving', and variations thereof herein, is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.
- [16] Fig. 1 illustrates one exemplary aerogenerator blade (1). An aerogenerator blade (1) commonly has an airfoil profile with a root region (2), a tip region (3), a leading edge (4) and a trailing edge (5). The blade root end (6) usually includes a ring for providing reinforcement to the blade root wall (7) and a plurality of studs (8) or other types of fasteners for connecting the blade to the aerogenerator hub. The blade wall includes an internal surface (9) and an external surface (10).

- [17] Figs. 2, 3 and 4 illustrates an aerogenerator blade (1) with an exemplary bulkhead (11) according an embodiment of the present invention.
- [18] The bulkhead (11) comprises a bulkhead panel (12) disposed within the aerogenerator blade (1), the aerogenerator blade (1) having a blade wall with an internal surface (9); a means for sealing (13) the perimeter between the bulkhead panel (12) and the internal surface (9) of the blade root wall (7); and a bracket (14) for attaching the bulkhead panel (12) to the blade root wall (7).
- [19] The bracket (14) comprises a tab support (15) with a first and a second portion; an interface device (16); wherein the first portion of the tab support (15) is configured to be secured to the internal surface (9) of the blade root wall (7), and the second portion the tab support (15) is configured to be secured to the interface device (16), and wherein the interface device (16) provides the connection between the tab support (15) and the bulkhead panel (12). The interface device (16) comprises a damper pad (17) that supports the compressive loads transmitted from the blade root wall (7) to the bulkhead panel (12) through the tab support (15); and an axial reinforcement (18) that connects the tab support (15) to the bulkhead panel (12), wherein the axial reinforcement (18) supports the tensile loads transmitted from the blade root wall (7) to the bulkhead panel (12) through the tab support (15), said tensile loads being substantially supported by the axial reinforcement (18) before the damper pad (17) reaches its yield strength.
- [20] The axial reinforcement (18) may include one or more of the following: chain links, a tension bar, a flexible rod or other equivalent devices for supporting the tensile loads transmitted from the blade root wall (7) to the bulkhead panel (12) through the tab support (15). In the embodiment shown in Fig.4, two chain links are used as axial reinforcement (18).
- [21] The interface device (16) in the bulkhead (11) may comprises fasteners elements (19), such as bolts, nuts and washers, providing the connection between the tab support (15) and the bulkhead panel (12). The interface device (16) may further comprise stress relief plates (25) that distribute the forces throughout the damper pad (17), avoiding damage due to friction.
- [22] The damper pad (17) may comprise an elastomeric material. For instance, the elastomeric material may include a thermosetting polyurethane elastomer, because besides having very good compression and tensile properties, these properties are maintained even with variations of temperature, which is a common issue in aerogenerator blades that may be subject to severe climate variations. For instance, a typical medium-sized or larger aerogenerator blade may adopt a thermosetting polyurethane elastomer with a maximum compression strength between the range of about 136 to 204 MPa, preferentially about 170 MPa; a maximum yield strength

between the range of about 122 to 182 MPa, preferentially about 152 MPa; with an operational working temperature range from about 213.15 K to about 363.15 K.

- [23] The tab support (15) may have an angled plate configuration. The angled plate configuration may further include a secondary angled portion configured to offset the tab support (15) from the internal surface (9) of the blade root wall (7) or from the bulkhead panel (12).
- [24] The tab support (15) may be secured to the blade root wall (7) with an adhesive component (20) or other materials that provide a secure fastening to the blade root wall.
- [25] The tab support (15) may be made of at least one laminated material, such as wood, fabric, metals or other appropriate materials.
- [26] The means for sealing (13) the perimeter between the bulkhead panel (12) and the internal surface (9) of the blade root wall (7) may include at least one sealant adhesive component (21). The means for sealing (13) includes an elastomeric tubular profile (22), the elastomeric tubular profile (22) having in one side projecting flaps (23) that engage along the bulkhead panel (12) perimeter, and whose opposite side is attached to the internal surface (9) of the blade root wall (7). The elastomeric tubular profile (22) provides additional stress relief for the movement of the bulkhead panel (12) in its diameter axis.
- [27] The bulkhead (11) for an aerogenerator blade root may comprise a flange rim providing reinforced support for the bulkhead panel (12).
- [28] The bulkhead (11) may include other additional features, such an opening (24) for allowing the access to the internal side of the blade and additional structural members in the bulkhead panel (12), such as beams, for providing additional structural reinforcement for the bulkhead panel (12).
- [29] While the invention has been disclosed by this specification, including its accompanying drawings and examples, various equivalents, modifications and improvements will be apparent to the person skilled in the art. Such equivalents, modifications and improvements are also intended to be encompassed by the following claims.

Claims

- [Claim 1] **01.** A bulkhead for an aerogenerator blade root, wherein the bulkhead comprises:
- a) a bulkhead panel disposed within the blade, the blade having a wall with an internal surface;
 - b) a means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall;
 - c) a bracket for attaching the bulkhead panel to the blade root wall, the bracket being characterized by comprising:
 - c1) a tab support with a first and a second portion;
 - c2) an interface device;
 - c3) wherein the first portion of the tab support is configured to be secured to the internal surface of the blade root wall and the second portion of the tab support is configured to be secured to the interface device, and
- wherein the interface device provides the connection between the tab support and the bulkhead panel, the interface device comprising:
- a damper pad that supports the compressive loads transmitted from the blade root wall to the bulkhead panel through the tab support; and
 - an axial reinforcement that connects the tab support to the bulkhead panel, wherein the axial reinforcement supports the tensile loads transmitted from the blade root wall to the bulkhead panel through the tab support, said tensile loads being substantially supported by the axial reinforcement before the damper pad reaches its yield strength.
- [Claim 2] **02.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the axial reinforcement includes at least one chain link.
- [Claim 3] **03.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the axial reinforcement includes at least one tension bar.
- [Claim 4] **04.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the axial reinforcement includes at least one flexible rod.
- [Claim 5] **05.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the interface device further comprises fasteners elements providing the connection between the tab support and the bulkhead panel.
- [Claim 6] **06.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the interface device further comprises at least one stress relief plate.

- [Claim 7] **07.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the damper pad comprises an elastomeric material.
- [Claim 8] **08.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the damper pad comprises a thermosetting polyurethane elastomer material.
- [Claim 9] **09.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the tab support has an angled plate configuration.
- [Claim 10] **10.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the tab support has an angled plate configuration further including at least one secondary angled portion configured to offset the tab support from the blade root wall internal surface or from the bulkhead panel.
- [Claim 11] **11.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the tab support is secured to the blade wall with an adhesive component.
- [Claim 12] **12.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the tab support is made of at least one laminated material.
- [Claim 13] **13.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall includes at least one sealant adhesive component.
- [Claim 14] **14.** A bulkhead for an aerogenerator blade root according to claim 01, wherein the means for sealing the perimeter between the bulkhead panel and the internal surface of the blade root wall includes an elastomeric tubular profile, the elastomeric tubular profile having in one side projecting flaps that engage along the bulkhead panel perimeter, and whose opposite side is attached to the blade root wall internal surface.
- [Claim 15] **15.** A bulkhead for an aerogenerator blade root according to claim 01, further comprising a flange rim providing reinforced support for the bulkhead panel.

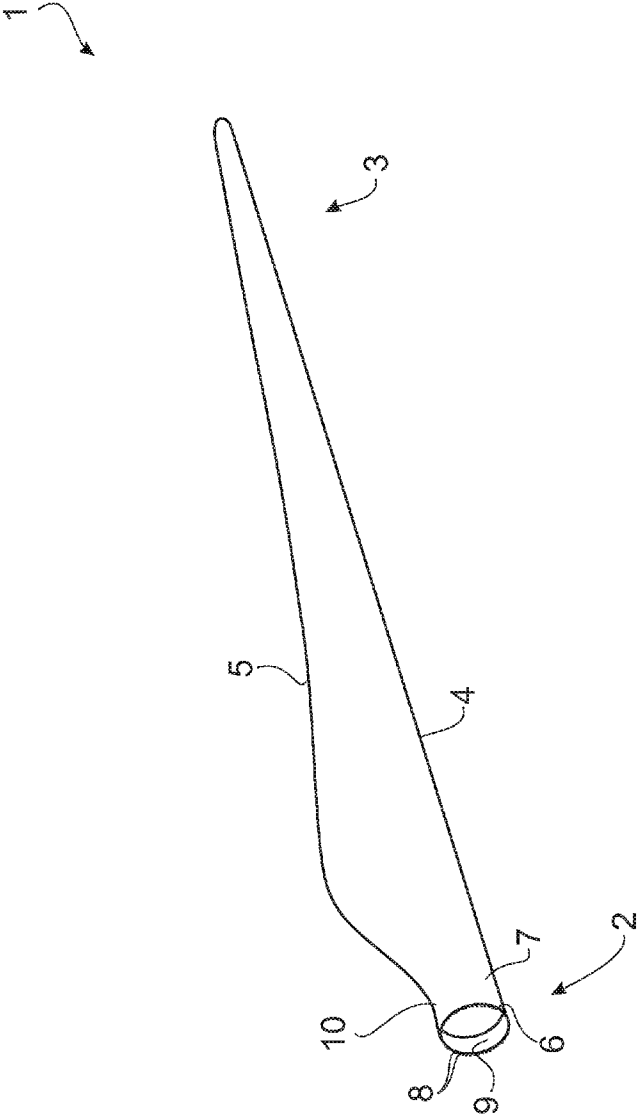


FIG. 1

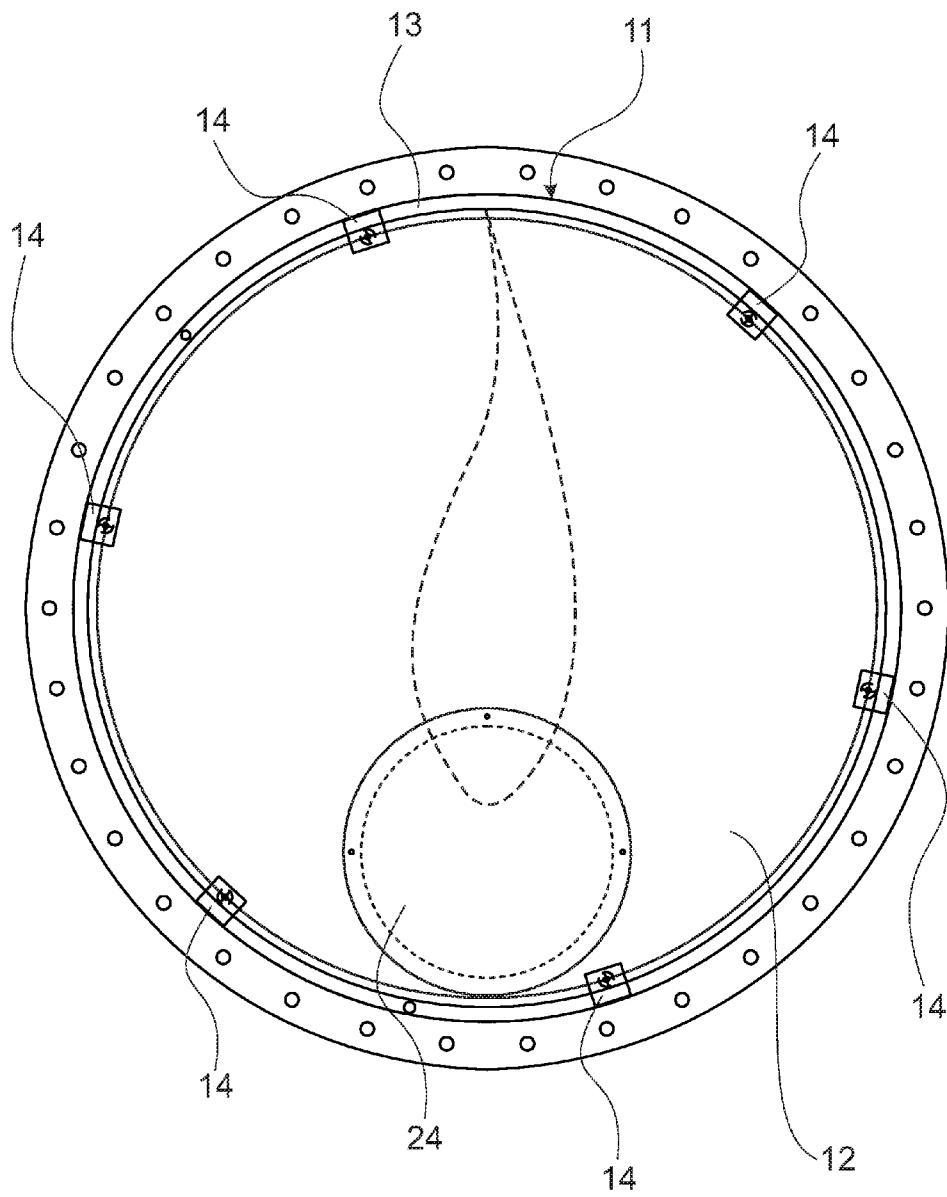


FIG. 2

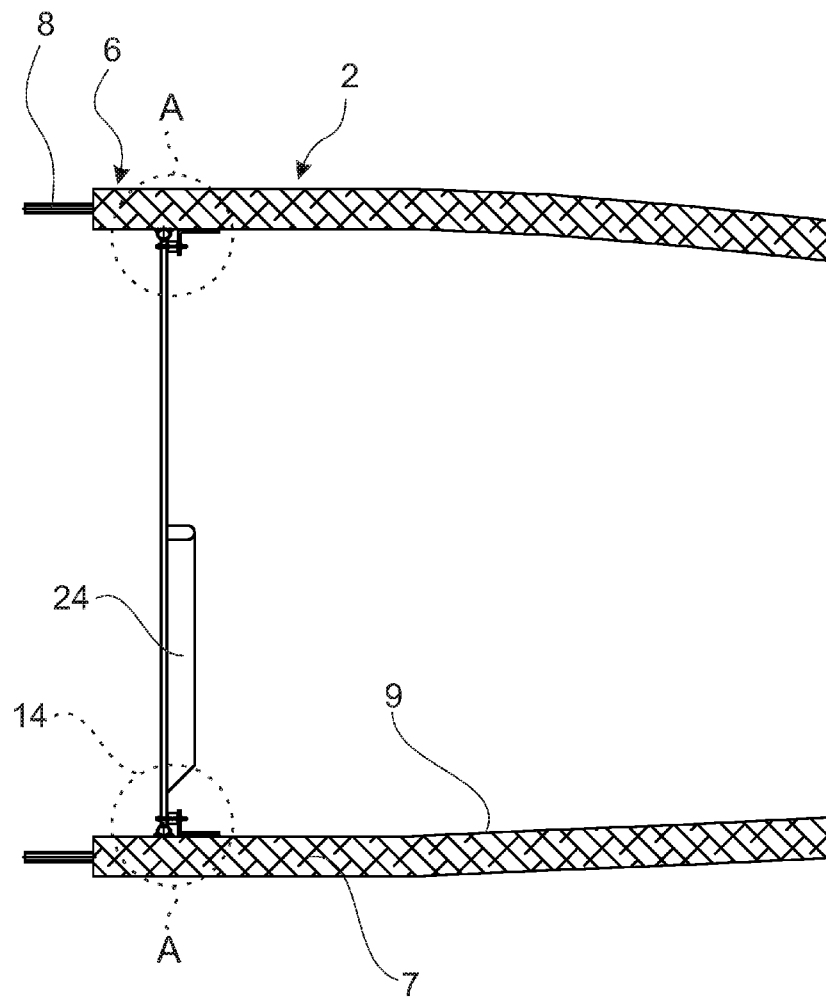


FIG. 3

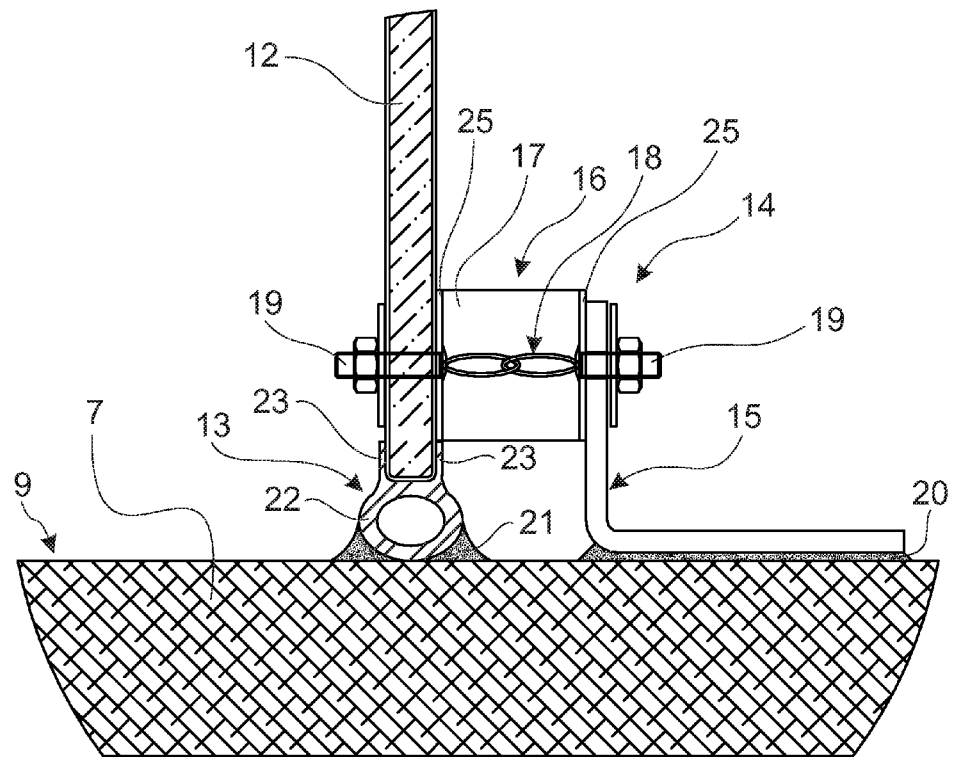


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2010/052261

A. CLASSIFICATION OF SUBJECT MATTER

INV. F03D1/06

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	WO 2009/056643 A2 (AIRBUS GMBH [DE]; STEPHAN ANDREAS [DE] AIRBUS OPERATIONS GMBH [DE]; ST) 7 May 2009 (2009-05-07) page 11, lines 6-10; figure 1 page 11, line 21 - page 12, line 14; figures 2-3 page 17, line 6 - page 18, line 26; figures 4-5 ----- -/--	1-5,9, 11,13-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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