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(54) MOORING SYSTEM FOR TENSION LEG PLATFORMS

(57) The invention is directed to a reusable tension element for a tendon for tension leg platforms, said tension element comprising a lamella having an essentially rectangular cross-section with an aspect ratio that is defined as the ratio between the longest side and the shortest side of the rectangle of at least 10, preferably at least 15, wherein said lamella has thickness of at least 1 mm, and a length of at least 20 m, wherein said lamella comprises a material having an elastic modulus of more than 50 GPa. Further aspects of the invention are a tendon comprising said elements, a transportation system to transport said elements, and a tension leg platform that is tethered to a seabed with said tendons.

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Description

FIELD

[0001] The invention is in the field of mooring systems for tension leg platforms (TLPs). The invention is particularly directed to a tendon and reusable elements therefor for tethering deepwater TLPs.

BACKGROUND

[0002] Mooring systems keep TLPs in position by tethering the TLP under tension to the bottom of the body of water (sea or ocean) it is floating on. Mooring systems for these purposes require extremely high rigidity in order to guarantee stability on the floating platform. As such, those as developed in the 1970s rely on steel pipes or steel wire mooring lines due to their high stiffness. Examples of steel tubes that have been used extensively for TLPs in the past are described in US4297965A, US3648638A and US3780685A.

[0003] However, due to the extremely high stiffness of the tethers and their circular cross-section, the flexural stiffness is also high, leading to a large minimum bending radius, or no allowable bending at all as in the case of tubes. This in turn translates onto extremely long steel tubes that need to be transported on barges or wire ropes that have to be wound for transport and installation onto large diameter bobbins, up to 15 meters in diameter. Transportation and installation are difficult, expensive and cumbersome. These mooring systems require specialized transport and installation vessels which not only make them more expensive to install but also limit their scalability due to the limited availability of specialized vessels. As such, these systems can typically only be produced on a factory located next to a port facility due to the difficulties in transporting them. Moreover, the conventional steel-based systems have a limited lifetime in corrosive environments such as seawater which requires periodical inspection and replacement of the mooring tethers. Yet a further drawback of steel-based systems is their heavy weight.

[0004] A paper by Jackson et al. in Offshore Technology Conference (2005), OTC 17535 discloses a pultruded carbon fiber reinforced plastic (CFRP) rod for ultra-deepwater mooring line application such as mobile offshore drilling units (MODUs) and reviews other technologies such as polyester, aramide and HMPE as the main synthetic fibers for deepwater and ultra-deepwater applications. A drawback of such fiber ropes, however, is that due to their circular cross-section, fiber ropes also have the same limitations as steel wire in terms of high flexural stiffness and minimum bending radius which leads to very large bobbins. Also, for the same stiffness, synthetic ropes require a bigger diameter due to the lower elastic modulus of synthetic fibers compared to steel wire. This effect punishes synthetic ropes even further leading to even bigger rope coils.

[0005] A paper by Sparks et al. in Offshore Technology Conference (2003) OTC 15164 describes a rod tendon that is composed of a two-level hierarchy construction. The first level is composed of 19 rods (profiles) of 6 mm in diameter that are grouped together and clamped to a termination to form a sub-element having a circular cross-sectional shape. The second level is composed of 37 sub-elements to form a tendon, which also has a circular cross-sectional shape. Both the sub-elements and the tendon have to be assembled on site as even the 6 mm rods have a minimum winding diameter exceeding the road-transportable size when they reach longer lengths.

[0006] There is a desire to provide a mooring system that can readily be transported via the road, is compatible with the high stiffness requirements of tension leg platforms and can easily and economically be installed using commonly available Anchor Handling Tug Supply Vessels (ARTS). As such, quayside or offshore assembly can be obviated. Time on vessels or on the quayside is extremely expensive and any operation that can be avoided or sped up reduces the cost of installation significantly. As a reference, typical cost of an ARTS vessel is in the order of tens of thousands of euros per day.

SUMMARY

[0007] The present inventor realized that the high tensile stiffness requirements of tension leg platforms and the low flexural stiffness requirements for road-transport can be coincided by providing a modular system, wherein a tendon is constructed from tension elements and which tension elements each have an appropriate geometry such that they can readily be joined onsite without requiring specialized transportation methods and/or construction facilities. The inventor realized that the circular cross-sectional shape of conventional tendons and elements therefor, limit their transportability.

[0008] Accordingly, the present invention is directed to a tension element for a tendon for tension leg platforms, said tension element comprising a lamella having an essentially rectangular cross-section with an aspect ratio that is defined as the ratio between the longest side and the shortest side of the rectangle of at least 10, preferably at least 15, wherein said lamella has a thickness of at least 1 mm, a length of at least 20 meter, and comprises a material having an elastic modulus of more than 50 GPa, as determined according to the ISO 527 series of standards.

[0009] In a further aspect, the invention is directed to a transport system comprising a frame and a set of tension elements, which set is placed on said frame and which frame is preferably placed with the set of tension elements in a spatial envelope defined by the size of a standard 20-foot container or a 40-foot container.

[0010] In another aspect, the invention is directed to a high stiffness mooring system which can, after the service life of the platform it supports, be disassembled and rewound on site for reutilization in a different location.

[0011] In yet a further aspect, the invention is directed to a tendon for tension leg platforms comprising a plurality of said tension elements.

[0012] In yet another aspect, the invention is directed to a TLP that is tethered to the seabed with one or more of the tendons.

DESCRIPTION OF THE DRAWINGS

[0013]

Figure 1 is an illustration of the tension element according to the invention.

Figure 2 is an illustration of a particular embodiment of the tension element, including a terminator at one end and through holes at the other end.

Figure 3A is an illustration of a tension element according to the invention in a wound configuration, Figure 3B shows a set of such elements and Figure 3C shows a frame comprising said set of elements in view of the size of a 20-feet container.

Figure 4 is an illustration of a tendon comprising a plurality of tension elements in accordance with the present invention.

Figure 5 is an illustration of a TLP that is tethered to a seabed with three tendons of the invention.

DETAILED DESCRIPTION

[0014] A first aspect of the invention is directed to a tension element for a tendon for tension leg platforms. Said tension element comprises a lamella having an essentially rectangular cross-section with an aspect ratio that is defined as the ratio between the longest side and the shortest side of the rectangle of at least 10, preferably at least 15, wherein said the lamella has a thickness of at least 1 mm, a length of at least 20 meter, and comprises a material having an elastic modulus of more than 50 GPa, as determined according to the ISO 527 series of standards.

[0015] As illustrated in Figure 1, the shape of the tension element (1) is preferably essentially cuboid, having an essentially rectangular shape in one plane and an essentially uniform thickness extending perpendicularly. The lamella (2) thus preferably possesses an essentially rectangular shape when viewed in plan, with two pairs of opposing sides that are substantially parallel to each other. The longer pair of sides defines the length (A) of the lamella, while the shorter pair defines its width (B). The thickness (C) is preferably essentially uniform across the entire lamella, ensuring consistency in its structural properties. It may be appreciated that the corners and longitudinal ends of the lamella may be sharp or slightly rounded.

[0016] The ratio of the longest side and the shortest side of the rectangular cross-section allows for the tension element to be flexible enough to be wound into an essentially circular bobbin having a diameter of less than 2.5 m, preferably less than 2.3 m such that the bobbin carrying the tension element can be placed into a 20-foot container, of which the internal dimensions are about 5.9m long, about 2.4m wide and about 2.4m high. The cross section of the lamella is herein regarded as the shape or profile when sliced through the lamella perpendicular to its length and in parallel to its width. In typical embodiments, the longest side and the shortest side of the rectangular cross-section thus respectively correspond to the width and the thickness of the lamella.

[0017] The material of the lamella is a high-stiffness material, meaning that its elastic modulus (or Young's modulus) is more than 50 GPa. Preferably, the material comprises metal and/or fiber composite, preferably steel, stainless steel, silicon nitride, silicon carbide, glass fiber composite, carbon fiber composite and/or ceramic fiber composite. Carbon fiber composites are most preferred, as such material can give the properties that are preferred of the invention. Carbon fiber composite material having an elastic modulus of more than 50 GPa are known to the skilled person. The elastic moduli referred herein are as determined according to the ISO 527 series of standards.

[0018] The lamella is preferably monolithic, meaning that is manufactured or formed from a single material or block without joints or separations. For instance, carbon fiber-based lamella can be produced from pultrusion processes. Monolithic lamellae have the advantage that they have a uniform structural integrity across its entire length and is free from seams, layers, or composite constructions typically associated with laminated or assembled parts. The monolithic nature can assist in that the lamella exhibits consistent mechanical properties throughout its structure, offering advantages in terms of overall strength, durability, and performance.

[0019] In typical embodiments, the material has an elastic modulus of more than 100 GPa, preferably more than 130 GPa, more preferably in the range of 130 GPa to 160 GPa, as determined according to the ISO 527 series of standards. Further, in typical embodiments, the material has compressive strength of more than 1 GPa, preferably more than 1.5 GPa, more preferably in the range of 1.5 GPa to 2 GPa, as determined according to the ISO 14126 standard. Such a high elastic modulus and compressive strength allow for the construction of a sufficiently rigid tendon, without needing an unrealistic number of tension elements.

[0020] To ensure that the lamella can be wound to a sufficiently small diameter, its thickness is generally in the range of 1 to 8 mm. The maximum thickness of a lamella (t) can be correlated to the minimum outer diameter of the lamella when wound, while taking into account the elastic modulus of its material in MPa, the compressive strength of its material in MPa, its length in meters, and a safety factor for the winding operation, in accordance with Formula (1),

$$t \leq \frac{-L + \sqrt{L^2 + \frac{8\pi^2 {P_r}^2 E^2 {S_f}^2}{\sigma^2}}}{\frac{4\pi E^2 {S_f}^2}{\sigma^2}}$$

(I)

where:

t is the thickness of the element in meters
E is the elastic modulus of the material in MPa
σ is the compressive strength of material MPa
S_f is the safety factor for the bending operation, preferably being
in the range of 105% to 120%
L is the length of the tendon in meters
P_r is the minimum outer diameter of the lamella when wound.

[0021] Formula (I) thus advantageously allows the calculation of the maximum thickness of the lamella for a given material and length of the lamella, while taking into account a safety factor (Sf) and the target outer diameter of the lamella when wound.

[0022] The tension element typically has a straight edge at both terminal ends (herein also referred to as end or ends), forming a linear boundary that is perpendicular to its longitudinal axis. However, it may be understood that the ends may be differently shaped, for instance having a curved edge.

[0023] Both terminal ends of the tension element are typically equipped with a terminator that allows joining multiple elements in an essentially parallel manner to form the tendon. The terminators at either end may be of the same or different type. If both ends of the tension elements have the same shape, the terminators are typically of the same type. Accordingly, the tension element generally comprises a first terminator at one end of the lamella and second terminator of the other end of the lamella, which first and second terminators may be the same or different. In typical embodiments, the first and/or second terminator is of the major part made of a metal, preferably stainless steel.

[0024] The terminators can be connected to the lamella with common fixation means such as mechanical fasteners (*e.g.* bolts and nuts, washers, rivets, pins, clips and clamps, studs and the like), adhesives and bonding agents (*e.g.* epoxy resins and/or hot melt adhesives) and welding and soldering. It may be understood that a combination of fixations means can be used.

[0025] In an embodiment, the tension element is provided with one or more through holes at an end, preferably at both ends of the lamella which allow the attachment of the terminator or terminators. As such, the terminator can comprise a sleeve section in which an end of the lamella can be embedded, and in which the lamella can be fixated through its through hole, for instance using a bolt and nut.

[0026] In another embodiment, the end of the tension element can be sandwiched between two separable parts of the terminator that clamp the end of the tension element. In a variation of this embodiment, one part of the terminator may be shared with an adjacent tension element when a plurality of tension elements is joined to form a tendon. In other words, the ends of lamellae and terminators parts are alternatingly arranged.

[0027] The terminator may comprise a through hole allowing its fixation to a mooring line connector.

[0028] In Figure 2, an embodiment of a tension element (1) comprising the lamella (2) with a terminator (4) at one terminal end of the lamella is illustrated. At the other end of the lamella, the terminator is not yet installed onto the lamella to display the through holes (3).

[0029] As illustrated in Figure 3A, the tension element (1) can be wound onto a bobbin (7), which is a spool, spindle or cylinder, with or without any flanges. By winding up the tension elements, which can also be referred to as coiling, rolling, spooling, reeling, bending into a coil, and the like, the tension element can be brought to transportable dimensions. By maintaining a sufficiently small thickness of the tension elements, the final outer diameter of the wound tension element onto the bobbin can be kept sufficiently small (see formula (I)) for it to be road-transportable, for instance in an intermodal container such as a 20- or 40-feet container. Intermodal containers, also referred to as ISO containers (ISO standard 668:2020), are of 20-feet or 40-feet (6.10 or 12.19 m, respectively) long, 8 feet (2.44 m) wide, and 8 feet 6 inches (2.59 m) or 9 feet 6 inches (2.90 m) high. Accordingly, the tension elements, when wound to a wound configuration, preferably has an outer diameter of for instance 2.5m or less such that it fits into an intermodal container.

[0030] A further aspect of the present invention is directed to a transport system that allows transportation of the tension elements in an intermodal container. As illustrated for a particular embodiment in Figure 3B, the transport system comprises a frame (8) and a set of tension elements (1) that are wound up on a bobbin (7). The frame (8) can carry a plurality of tension elements (1) and preferably facilitates the unwinding of the wound tension element on site to facilitate the construction of the tendon. The frame (8) can be placed in a 20-foot container or a 40-foot container (9) for transport, and taken out of the container at the TLP site, where the tension elements can be unwound and joined together to form the tendon. In another embodiment, the frame can be constructed to the shape and size of a standard 20-foot or 40-foot container allowing for a weight reduction in the transport of the mooring system. To this end, the tension elements preferably comprise the terminators when wound, such that the elements can be readily joined together using a mooring line connector to form the tendon.

[0031] The frame thus allows for the whole mooring system to be shipped together in shipping trucks or vessels. Once on site, the individual elements for a single tendon can all be connected to a single mooring line connector and unwound from the frame directly onto the sea for installation. Once the whole tendon has been unwound, the second mooring line connector can be attached, and the tendon is connected to either the anchor or buoy ahead of the connection to the platform. Advantageously, the unwinding of the elements, construction of the whole tendon and connecting the tendon to the platform can all be done in a single operation. The frame can then be reused for a new mooring system.

[0032] Figure 3C illustrates the unwinding of several tension elements. Figure 3C shows a top view on the unwinding and thus shows only one set of parallel tension elements, but it may be understood that by placing four bobbins as shown in the figure, stacks of four tension elements can be unwound in a single operation, and when two of such stacks are unwound, a bundle of 8 tension elements can be unwound in a single operation. This bundle can be joint at the terminators (4) with two mooring line connectors (5) at either end to form the tendon (6). Thus, the tendon that is illustrated in Figure 4, comprising a total of 12 tension elements, can be formed by unwinding two stacks of tension elements from 6 bobbins comprising the tension elements.

[0033] Once connected, the mooring line connector transfers the load to the terminators of the tension elements for each tendon. The high stiffness tension elements allow for a direct load transfer without any construction effect as those found in steel wire ropes or synthetic ropes. This allows for maximum stiffness and elastic response of the mooring system.

[0034] Also, the usage of the preferred monolithic tension elements minimizes the hysteretic effects associated with the usage of assemblies where friction have an effect such as wire ropes or synthetic wire ropes.

[0035] A further aspect of the present invention is directed to a tendon for tension leg platforms comprising a plurality of tension elements. Figure 4 shows an illustration of a tendon in accordance with the invention. In a typical embodiment, the plurality of tension elements (1) is joined together at both ends of each the lamellae of said tension elements, preferably using the terminators (4) of the tension elements. The terminators may be connected to mooring line connectors (5), which allow the tendon to be anchored to the TLP and the bottom of the body of water on which the TLP is floating. Like the terminators, these mooring line connectors may be of the same or of a different type. Generally, they are of the same type, in particular if both terminal ends of the tendon are the same. According, the tendon preferably further comprises a first mooring line connector at one end of the tension elements and a second mooring line connector at the other end of the tension elements. The mooring line connectors are also typically made for a major part of a metal, preferably steel or stainless steel, accounting for corrosion effects.

[0036] In the tendon, the lamellae of the tension elements are preferably oriented in the same direction and more preferably at least part of the tension elements are arranged in a stacked configuration, wherein each lamella is positioned one above the other along a common axis. The lamellae may be spaced apart from one another by predetermined gaps, allowing for separation between adjacent lamellae. The spacing between the lamellae is preferably essentially uniform, but variations, in particular when in use may be possible. Additionally, or alternatively, at least part of the tension elements is arranged in coplanar and parallel configuration, wherein each lamella is positioned in a common plane and oriented parallel to one other. Similarly, the lamellae may be spaced apart from each other by predetermined spacing, such that adjacent lamellae maintain parallel alignment while allowing for separation. The spacing between the lamellae is typically essentially uniform.

[0037] It may thus be understood that more than one of the tension elements can be combined to form the tendon. Depending on the mechanical requirements of the tendon, the dimensions and/or the material, as well as the number of tension elements in each tendon can be appropriately selected. Thus, the nature of the system means that a higher or lower stiffness can be achieved easily by only adding or removing elements from the tendon with no additional assembly required. The tendon in accordance with the present invention is thus a modular system, as it comprises distinct, interchangeable tension element that can be independently replaced, or combined. This modular design allows for flexibility, scalability, customization, and facile maintenance. For example, if one or more of the tension elements are damaged during use, e.g. by fishing nets or steel wire ropes from pelagic fishing vessels or bottom trawlers, and the tendon requires repair, the damaged elements can be replaced *in situ* without requiring the full replacement of the tendon.

[0038] In a typical embodiment, the tendon comprises 4 to 20 tension elements, such as about 12 tension elements as schematically illustrated in Figure 4.

[0039] A further aspect of the present invention is directed to a TLP, preferably a deepwater TLP such a one illustrated in Figure 5, comprising a floating platform and one or more tendons. Examples of TLPs wherein the tendon can suitably be used include offshore wind turbines, oil and gas platforms and power substations. The TLP is tethered to the bottom of the body of water (*e.g.* a seabed) with one or more, typically three or more tendons under tension, allowing the TLP to remain stable in water depths where fixed foundations are impractical. TLPs typically require a tendon having a length of at least 50 meters and typical mooring depths are in the range of 50 to 1500 meters. The tendon, and the tension elements forming the tendon according to the present invention may have such long lengths.

[0040] Advantageously, the tendon can be easily disassembled, repacked, transported and reused for another platform, *i.a.* because of its modular design with the terminators and the mooring line connectors. Thus, for instance, the mooring system can be reused after the platform reaches the end of its lifetime on the moored site. Due to the long potential lifetime of composites when compared to that of materials conventionally used in the construction of TLPs, a mooring system or its tension elements can be reused multiple times. Accordingly, another aspect of the present invention is directed to the reuse of the tendon. The modular concept of the system allows the tension elements to be reversibly disconnected from the mooring line connector and rewound as individual tension elements onto a bobbin, to be placed on the transport frames and reused on a different site or platform. The system allows for same depths to be serviced with the system as is. Lower depths can be accommodated by re-placing the terminators at shorter lengths along the tension elements. Higher depths can be accommodated by additional tendons installed in series.

[0041] As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. The term "and/or" includes any and all combinations of one or more of the associated listed items. It will be understood that the terms "comprises" and/or "comprising" specify the presence of stated features but do not preclude the presence or addition of one or more other features.

[0042] For the purpose of clarity and a concise description features are described herein as part of the same or separate embodiments, however, it will be appreciated that the scope of the invention may include embodiments having combinations of all or some of the features described.

Claims

1. A tension element for use in a tendon for tethering tension leg platforms, said tension element comprising a lamella having an essentially rectangular cross-section with an aspect ratio that is defined as the ratio between the longest side and the shortest side of the rectangle of at least 10, preferably at least 15, wherein said lamella has a thickness of at least 1 mm, and a length of at least 20 m, wherein said lamella comprises a material having an elastic modulus of more than 50 GPa, as determined according to the ISO 527 series of standards.

2. The tension element according to claim 1, wherein the material comprises metal and/or fiber composite, preferably steel, stainless steel, silicon nitride, silicon carbide, glass fiber composite, carbon fiber composite and/or ceramic fiber composite, more preferably carbon fiber composite.

3. The tension element according to any one of the previous claims, wherein the material has an elastic modulus of more than 100 GPa, preferably more than 130 GPa, more preferably in the range of 130 GPa to 160 GPa, as determined according to the ISO 527 series of standards.

4. The tension element according to any one of the previous claims, wherein the material has a compressive strength of more than 1 GPa, preferably more than 1.5 GPa, more preferably in the range of 1.5 GPa to 2 GPa, as determined according to the ISO 14126 standard.

5. The tension element according to any one of the previous claims, having a length of at least 50 m, more preferably in the range of 50 to 500 m and/or a width in the range of 0.1 m to 2 m.

6. The tension element according to any one of the previous claims, having a thickness in the range of 1 to 8 mm, preferably 1 to 6 mm.

7. The tension element according to any one of the previous claims, comprising one or more through holes at one end of the lamella and/or one or more through holes at the other end of the lamella.

8. The tension element according to any one of the previous claims, comprising a first terminator at one end of the lamella and second terminator of the other end of the lamella.

9. A tendon for deepwater tension leg platforms comprising a plurality of tension elements in accordance with any one of the previous claims.

10. The tendon in accordance with claim 9, wherein the plurality of tension elements is joined together at both ends of each the lamellae of said tension elements.

11. The tendon in accordance with any one of claims 9-10, further comprising a first mooring line connector at one end of the tension elements and a second mooring line connector at the other end of the tension elements.

12. The tendon in accordance with any one of claims 9-11, the lamellae of the tension elements are oriented in the same direction and wherein preferably at least part of the tension elements are arranged in a stacked configuration and/or at least part of the tension elements are arranged in coplanar and parallel configuration.

13. A tension leg platform such as an offshore wind turbine, comprising a floating platform and one or more tendons according to any one of claims 9-12

attached to the floating platform.

14. The tension element according to any one of claims 1-8, which is wound onto a bobbin to a wound configuration with an outer diameter of less than 2.9 m, preferably less than 2.5 m.

15. A transport system comprising a frame and a set of tension elements in accordance with claim 14, which set is placed on said frame and said frame preferably fits into a 20-foot container or a 40-foot container.

16. Method for reusing the tension element or the tendon according to any one of claims 1-12 that is attached to a tension leg platform (TLP), said method comprising reversibly disconnecting the tension element from the TLP, for instance from the mooring line connector, and winding the tension element onto a bobbin, placing the wound tension element on a transport frames, and transporting the wound tension element to a different site or platform for further use, optionally followed by unwinding the tension element and constructing a new tendon with the unwound tension element.

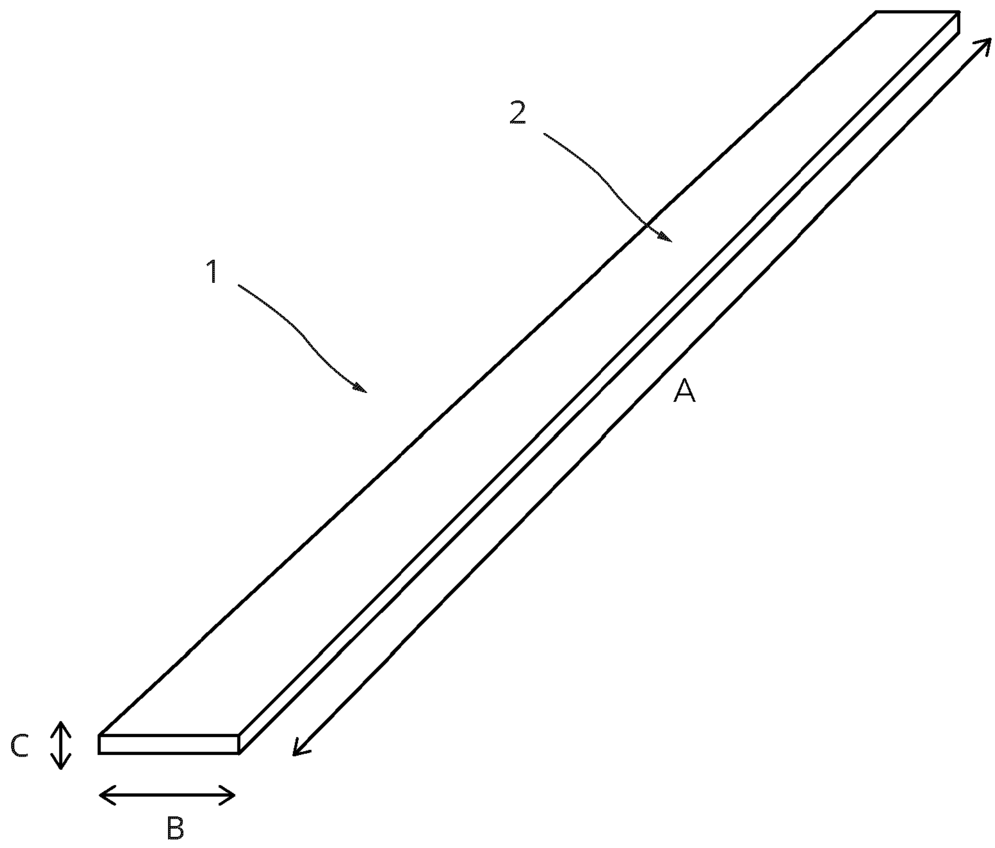


Fig. 1

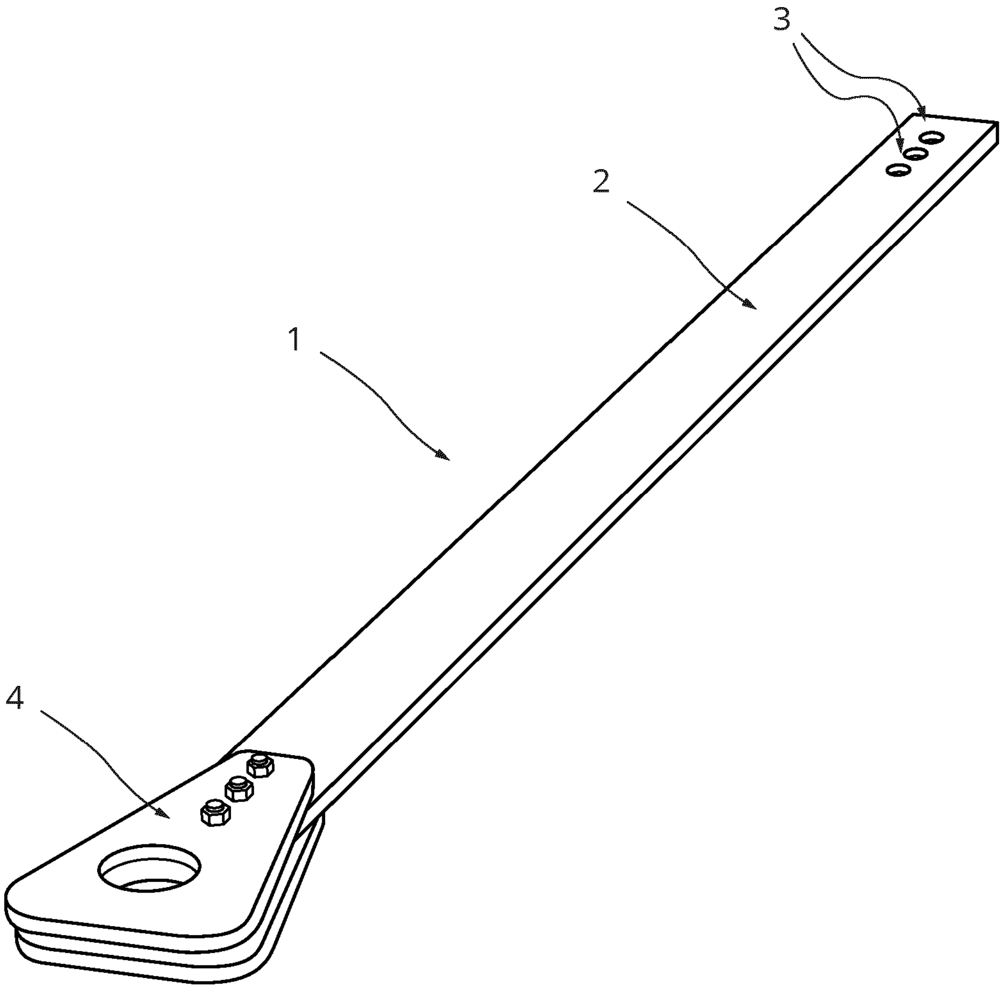


Fig. 2

Fig. 3A

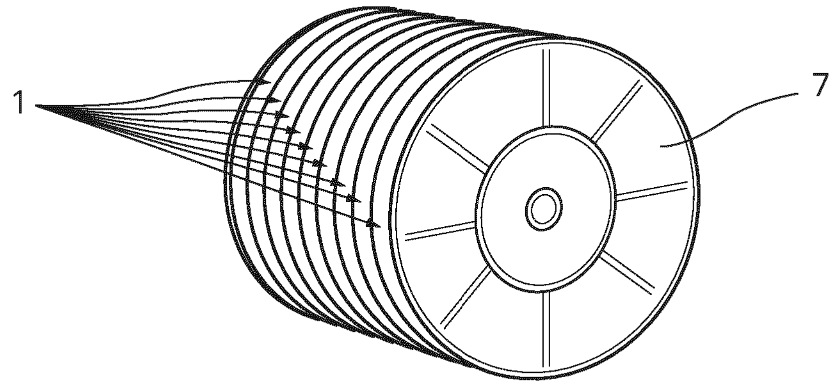


Fig. 3B

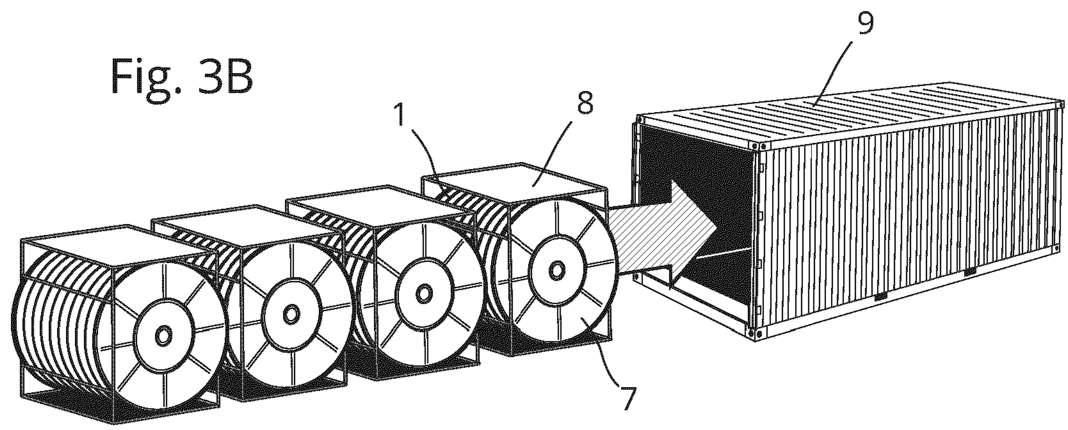
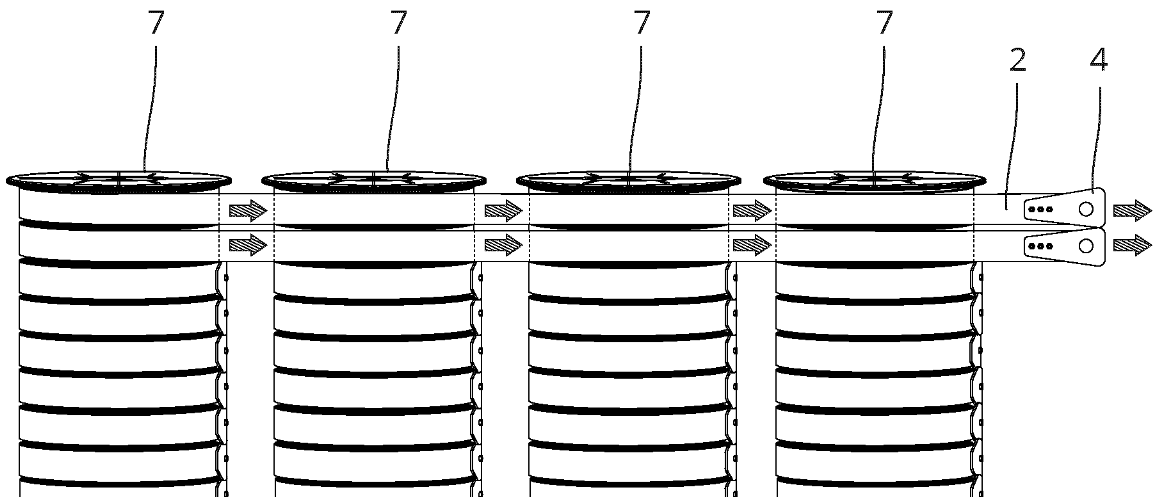


Fig. 3C



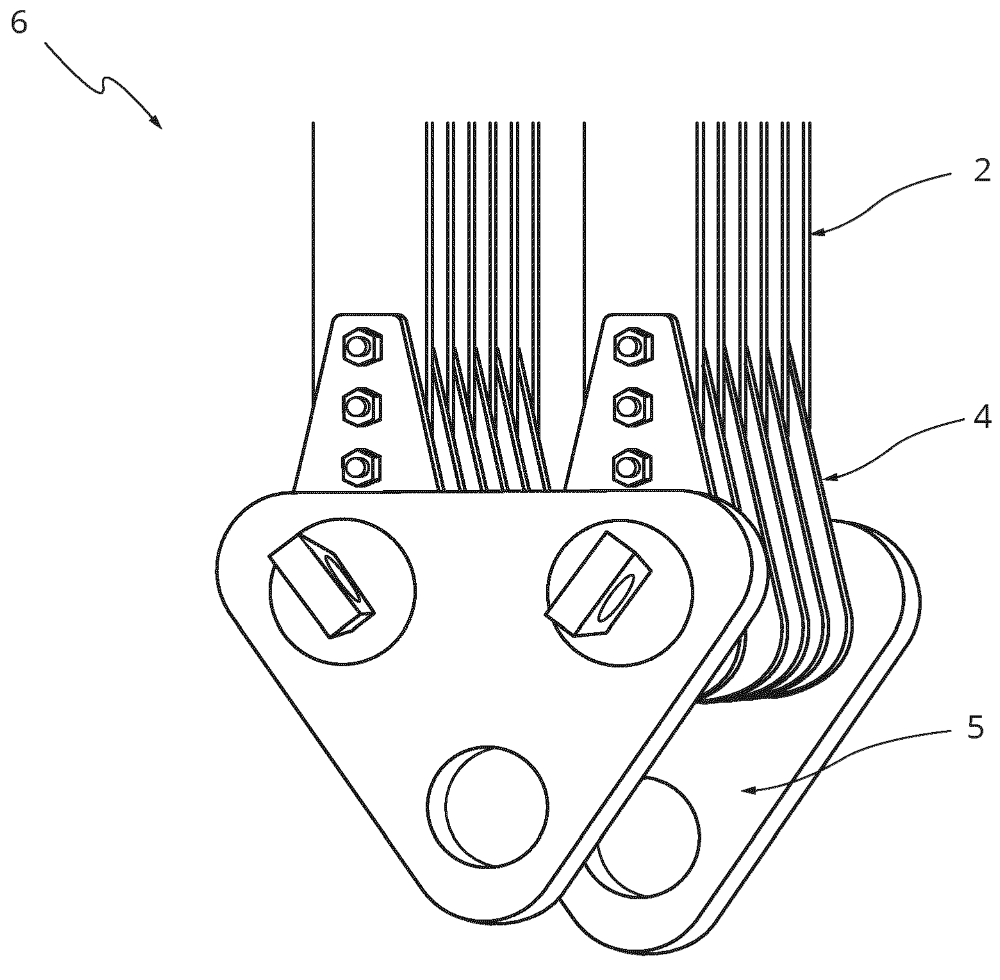


Fig. 4

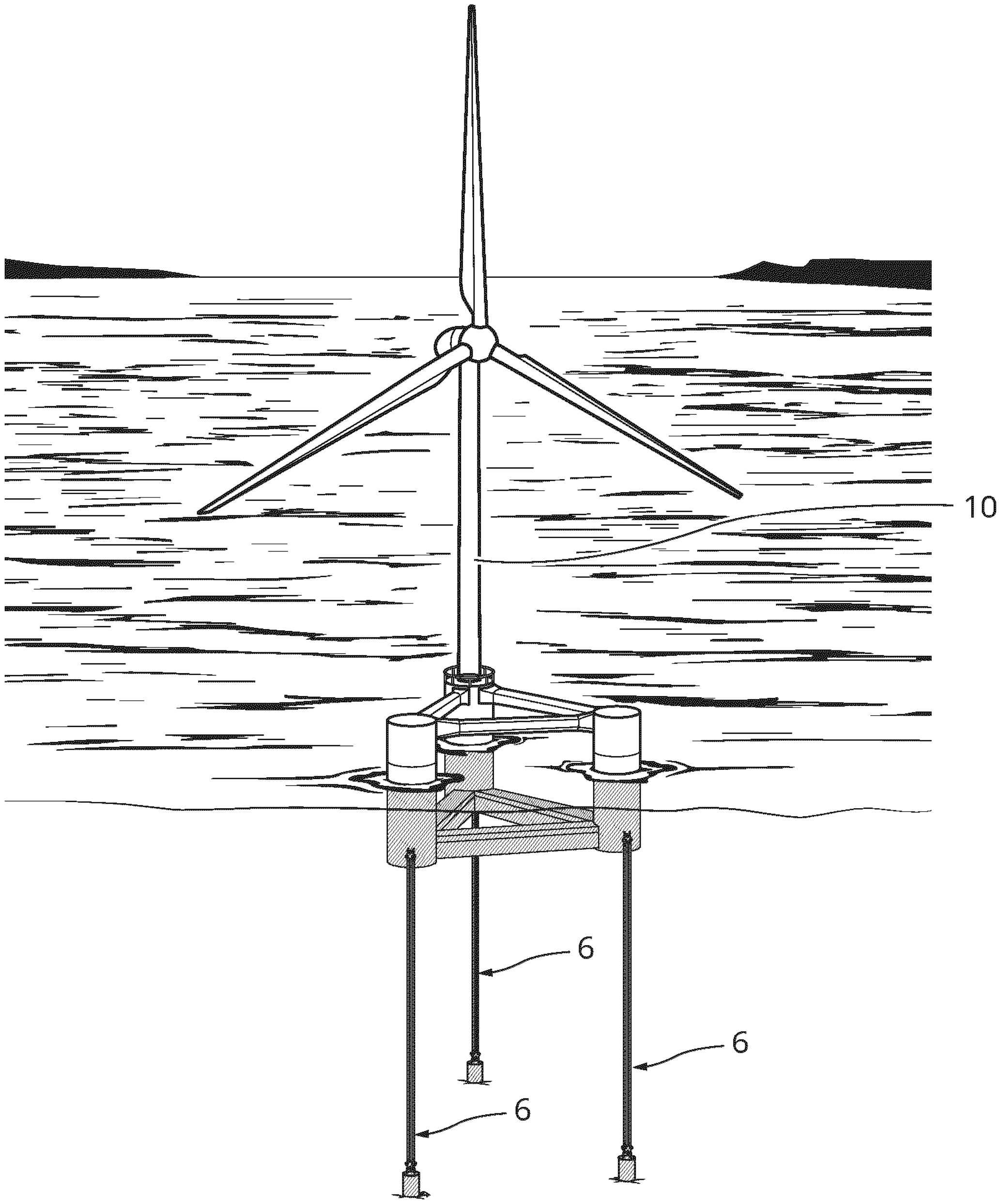


Fig. 5

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 1776

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	US 5 269 129 A (LUNDY BRIAN T [US]) 14 December 1993 (1993-12-14) * column 1, lines 7-13 * * column 1, line 64 - column 2, line 6 * * column 3, lines 36-50 * * claim 1 * * figures * -----	1-16	INV. B63B21/20 B63B21/50
A	WO 2022/050935 A1 (MODEC INC [US]) 10 March 2022 (2022-03-10) * abstract * * figures * -----	1-13	
A	GB 2 549 080 A (SLLP 134 LTD [GB]) 11 October 2017 (2017-10-11) * abstract * * figures * -----	1-13	
A	GB 2 363 617 A (FREYSSINET INTERNAT [FR]; GTM CONSTRUCTION [FR]) 2 January 2002 (2002-01-02) * page 2, line 19 - page 3, line 10 * * page 5, lines 8-19 * * page 6, lines 11-16 * * figure 3 * -----	1,14-16	TECHNICAL FIELDS SEARCHED (IPC) B63B
A	US 7 168 889 B2 (CONOCOPHILLIPS CO [US]) 30 January 2007 (2007-01-30) * abstract * * figures * -----	1,14-16	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	17 May 2025	Gardel, Antony

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
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