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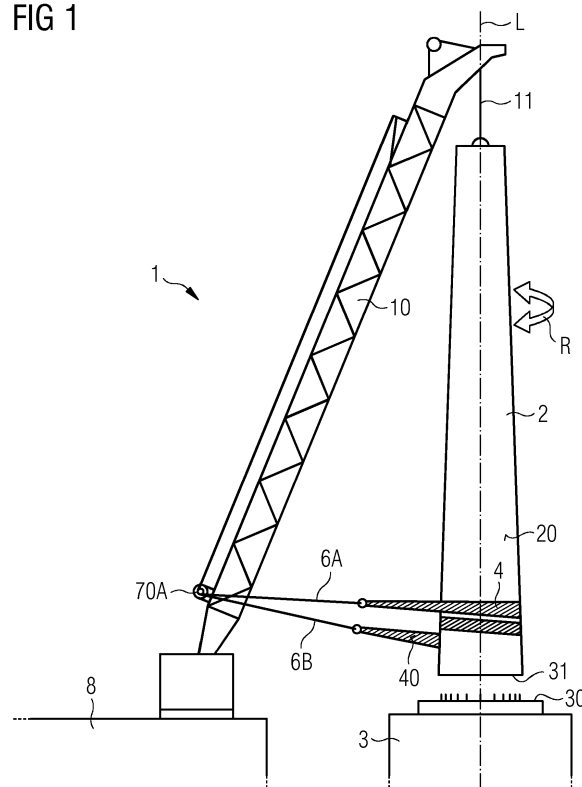
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(54) **Tower manoeuvring arrangement**

(57) The invention describes a tower manoeuvring arrangement (1) for bringing a tower assembly (2) into a mounting position relative to a tower mount (3), which apparatus comprises a lifting means (10, 11) for lifting the tower assembly (2) over the tower mount (3); a tag line coupling means (4, 5) realised to detachably couple a tag line arrangement (6A, 6B) to the tower assembly (2), which tag line coupling means (4, 5) comprises a

contact surface (40, 50) for application to an outer surface (20) of the tower assembly (2); and a winch arrangement (7) realised to deploy the tag lines (6A, 6B) to effect a controlled rotation of the tower assembly (2) about a longitudinal axis (L) of the tower assembly (2). The invention also describes a method of manoeuvring a tower assembly (2) into a mounting position relative to a tower mount (3).

FIG 1



Description

[0001] The invention describes a tower manoeuvring arrangement and a method of manoeuvring a tower assembly into a mounting position relative to a tower mount.

[0002] The size of wind turbines being constructed is increasing, and the number of wind turbines in use is also increasing. Particularly in the case of offshore wind parks, the construction and assembly of the wind turbines on site is a costly and hazardous undertaking. To erect a wind turbine tower at an offshore site, a complete tower or a set of tower sections may be transported in a horizontal position by ship to the offshore site and tower mount. The mount can be a foundation, jacket structure, monopile, etc., depending on factors such as water depth. The tower must then be raised into a vertical position and brought into place over its tower mount. This procedure usually involves a crane to hoist the tower into an upright position, and can be very hazardous for personnel since the lower region of the tower must be secured to prevent the tower from swinging sideways, but the base of the tower must also be aligned with the tower mount. A tower mount and wind turbine tower can be joined using some suitable connection means such as pin bolts and bushings which must be aligned before the tower can be lowered into place on the tower mount. However, it is time-consuming and difficult to achieve this alignment using known techniques. For example, a known approach requires that an arrangement of tag wires and a lifting frame is used. The tower is suspended from the lifting frame, and tag lines are connected to corners of the lifting frame. Winches are used to deploy the tag lines in order to effect a rotation of the tower. However, since a tower can have a height of 60 - 100 m or more, and a bottom diameter of 4.5 - 8.0 m or more, and since the tower/mount connectors are relatively small in comparison, it is very difficult to control the winches precisely enough to manoeuvre the very heavy tower into place so that the connectors are aligned. Safety measures must always be taken to ensure that personnel are not at risk at any time. The alignment procedure can therefore take a relatively long time, thus adding considerably to the overall cost of installing a wind turbine.

[0003] It is therefore an object of the invention to provide an improved way of aligning a tower to a tower mount.

[0004] This object is achieved by the tower manoeuvring arrangement of claim 1; and by the method of claim 12 of manoeuvring a tower assembly into a mounting position relative to a tower mount.

[0005] According to the invention, the tower manoeuvring arrangement - for bringing a tower assembly into a mounting position relative to a tower mount - comprises a lifting means for lifting the tower over the tower mount; a tag line coupling means realised to detachably couple a tag line arrangement to the tower assembly, which tag line coupling means comprises a contact surface for application to an outer surface of the tower assembly; and

a winch arrangement realised to deploy the tag lines to effect a controlled rotation of the tower assembly about a longitudinal axis.

[0006] An advantage of the tower manoeuvring arrangement according to the invention is that, with relatively little effort, a precise alignment of the tower assembly with the tower mount can be achieved. The tower can be rotated about the longitudinal axis - for example the vertical axis of the tower - by any amount, for example by a few degrees or by a fraction of a degree, thereby allowing the very precise alignment with the tower mount without any manual intervention by ground personnel. Furthermore, since the tag lines are coupled to the tower surface using only a contact surface, there is no need to secure any fasteners to the surface of the tower. Essentially, the tag line coupling means does not require the use of any fasteners such as a threaded connector, a bolted or screwed-in connector, a hook connector, etc. The contact surface that is applied to the tower outer surface can effect a satisfactory connection on the basis of friction and/or negative pressure, etc., as will be explained below. Once the tower is in place on the tower mount, the tag line coupling means can simply and quickly be removed.

[0007] According to the invention, the method of manoeuvring a tower assembly into a mounting position relative to a tower mount comprises the steps of lifting the tower assembly over the tower mount; applying a contact surface of a tag line coupling means to an outer surface of the tower assembly to detachably couple a tag line arrangement to the tower assembly; and actuating a winch arrangement to deploy one or more tag lines of the tag line arrangement to effect a controlled displacement of the tower assembly relative to the tower mount.

[0008] An advantage of the method according to the invention is that it allows the tower to be manoeuvred in a very precise and controlled manner, since the contact surface connection between tag line coupling means and tower surface has little or no degree of freedom, as will be explained below. Furthermore, the tower is held securely at all times throughout the manoeuvring procedure and can be rotated about the longitudinal axis by means of the winches, the tag line arrangement and the tag line coupling means.

[0009] Particularly advantageous embodiments and features of the invention are given by the dependent claims, as revealed in the following description. Features of different claim categories may be combined as appropriate to give further embodiments not described herein.

[0010] In the following, it may be assumed that the tower assembly is a wind turbine tower, for example of steel or concrete. The tower assembly may be a complete tower or a tower section. It follows that a tower mount may be a foundation for the tower, for example an offshore platform, tripod, etc. Equally, the tower mount can be a previously placed "lower" tower section onto which a "higher" tower section is to be mounted. In the following, but without restricting the invention in any way, it may be

assumed that the tower mount and tower are to be joined using some suitable connection means such as pin bolts and bushings which must be aligned before connecting the tower to the tower mount.

[0011] In a preferred embodiment of the invention, the lifting means comprises a hoist connecting means for connecting an upper part of the tower to a crane. This can comprise a bearing wire, which can be connected in some suitable way to the top of the tower so that the tower can be lifted by the crane. For example, a free swivel connection can be used, so that the tower can freely rotate about its longitudinal axis when the winch drive unit of the tower manoeuvring arrangement according to the invention is actuated. Alternatively, such a bearing wire can be connected to a lifting yoke which in turn is connected to the top of the tower. Such a lifting yoke can also be connected or mounted to allow a free rotation of the tower about its longitudinal axis when the winch drive unit is actuated.

[0012] To actuate the tag lines, in a preferred embodiment of the invention the winch arrangement comprises a first winch realised to deploy a first tag line, a second winch realised to deploy a second tag line, and a controller for controlling the winches. The winches can be controlled so that one winch deploys the same amount of tag line that is drawn in by the other winch, so that the tension in the tag lines is maintained at an essentially constant level. This control technique may be used, for example, when the tower is positioned over the tower mount, but the corresponding fasteners are not correctly aligned, and a rotation about the tower longitudinal axis is required. Alternatively or in addition, a "mooring" approach may be used, in which one winch holds its position, and the other winch either pays out or retracts its tag line. This control technique may be used, for example, when the tower is not yet correctly positioned over the tower mount, and a lateral displacement is necessary between the tower and the tower mount.

[0013] As indicated above, the tag line coupling means of the tower manoeuvring arrangement according to the invention does not require the use of any fasteners that must first be mounted to the tower and later removed again, with the inherent risk of damage to the tower surface. Instead, the contact surface of the tag line coupling means that is applied to the tower outer surface can effect a satisfactory connection on the basis of friction and/or negative pressure. In a preferred embodiment of the invention, the tag line coupling means is characterized by a high degree of friction between its contact surface and the outer surface of the tower. This can be achieved in any suitable manner. In a particularly preferred embodiment of the invention, the tag line coupling means comprises a sling, and the contact surface of the sling is realised to extend about a circumference of the tower. The sling can comprise a flexible band or strip of a suitable material such as a webbing sling or a standard nylon lifting sling to which a suitable anti-slip material such as rubber or silicon may be applied. The surface properties

of the material are preferably chosen so that the sling does not slip across the surface of the tower, but instead adheres to the tower outer surface on account of the friction between it and the tower surface.

[0014] Preferably, the sling comprises a tag line connector for connecting to a tag line. When the sling is realised as a long band of material, the sling preferably comprises a first tag line connector at one end for connecting to a first tag line, and a second tag line connector at its other end for connecting to a second tag line.

[0015] To apply the contact surface of the sling to the outer surface of the tower, the sling is simply wrapped around the tower. Preferably, the ends of the sling have already been connected to the tag lines which can be held sufficiently taut to prevent the sling from slipping downwards before the manoeuvring process commences.

[0016] The sling can be made to extend at least half-way about the tower outer circumference in a lower tower region. Then, when one or more of the winches are actuated, the tag lines are deployed and the resulting change in length of the tag lines results in a displacement of the sling and a corresponding rotation of the tower, since the friction between sling contact surface and tower surface means that the tower must rotate when the sling is displaced. However, in a particularly preferred embodiment of the invention, the sling is dimensioned such that the contact surface of the sling exceeds the circumference of the tower by at least 150%, i.e. the portion of the sling in contact with the tower is at least one and a half times as long as the circumference of the tower. In a setup in which the tag lines run essentially parallel, this length ensures that the sling can be wrapped about the tower at least one and a half times, so that the contact area of the sling is applied to the tower surface about the entire circumference of the tower.

[0017] In another preferred embodiment of the invention, the tag line coupling means is characterized by a negative pressure connection between its contact surface and the outer surface of the tower. For example, in a preferred embodiment of the invention, the tag line coupling means comprises a suction element realised to attach to the outer surface of the tower. A suction element can be a device such as a suction cup, a suction disc, etc., with a flexible body that can be deformed to expel air from the interior of the suction element, but which strives to retain its shape. For example, the suction element can be pressed onto the tower surface to expel air from the interior of the suction element. When the suction element is released (i.e. pressure is no longer applied to it), its flexible body attempts to resume its shape, so that a negative pressure is created in the interior, and the atmospheric pressure is greater on the exterior. This pressure difference ensures that the suction element cannot release from the tower surface of its own accord. In a preferred embodiment of the invention, the suction element comprises a means of expelling air from between its contact surface and the tower surface, for ex-

ample a manually actuated lever for "pumping" the suction element, e.g. for repeatedly pushing the flexible body of the suction element inwards in order to expel air from its interior.

[0018] Preferably, such a suction element comprises a tag line connector for connecting to a tag line. For example, the suction element can comprise an eyelet formed to accommodate the tag line or a connector such as a carabiner that can be connected to the tag line.

[0019] To apply a contact surface of the suction element to the outer surface of the tower, the flexible body of the suction element is preferably pressed onto the outer surface of the tower until sufficient air has been expelled from between the suction element and the tower surface. This ensures that a sufficient negative pressure can be created. This step can be carried out prior to or after connecting the tag lines to the suction element.

[0020] The quality of the negative pressure connection may depend to a large extent on the porosity of the surface to which the suction element is attached. For example, an underpressure or vacuum may be maintained for a relatively long time if the tower outer surface is smooth and non-porous. That might already be the case when the tower is a steel tower, since construction steel is an essentially non-porous material. Alternatively, in a preferred embodiment of the invention, the method also comprises the step of providing a non-porous surface region to which the suction element can be pressed. For example, a plain concrete tower outer surface may be sealed and/or painted in the region in which a suction element is to be attached. For example, a band or strip, extending about the tower circumference and having a suitable width, may be coated or treated with an appropriate substance to reduce or eliminate any porosity of the tower material in that region. The suction elements will then adhere reliably to the tower surface when attached in that region.

[0021] Other objects and features of the present invention will become apparent from the following detailed descriptions considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for the purposes of illustration and not as a definition of the limits of the invention.

Fig. 1 shows a first embodiment of a tower manoeuvring arrangement according to the invention;

Fig. 2 shows a cross-section through a tower being aligned using the tower manoeuvring arrangement of Fig. 1, in a first position;

Fig. 3 shows the tower of Fig. 2 in a second position after alignment using the tower manoeuvring arrangement of Fig. 1;

Fig. 4 shows a second embodiment of a tower manoeuvring arrangement according to the invention;

Fig. 5 shows a cross-section through a suction element of the tower manoeuvring arrangement of Fig. 4;

Fig. 6 shows a third embodiment of a tower manoeuvring arrangement according to the invention.

Fig. 7 shows a fourth embodiment of a tower manoeuvring arrangement according to the invention.

[0022] In the diagrams, like numbers refer to like objects throughout. Objects in the diagrams are not necessarily drawn to scale.

[0023] Fig. 1 shows a first embodiment of a tower manoeuvring arrangement 1 according to the invention. Here, a crane 10 is used to hoist or lift a tower assembly 2 over a mount 3, for example an offshore monopile 3. The crane 10 can be part of an installation vessel 8. The tower 2 is suspended from a bearing wire 11 that allows a rotation R of the tower 2 about its longitudinal axis L.

[0024] It is necessary to correctly align the tower 2 with the mount 3, so that a lower mating portion 30 (for example a circular arrangement of mounting bolts) can be aligned with an upper mating portion 31 (for example a circular arrangement of bushings on a lower flange of the tower). In this embodiment, the tower manoeuvring arrangement 1 comprises a sling 4 wrapped at least one and half times about the tower in a lower tower region. The sling 4 has a high-friction inner surface 40 that lies against the tower outer surface 20. Each end of the sling 4 is connected to a tag line 6A, 6B. The tag lines 6A, 6B are deployed by winches 70A, 70B. Here, only a first winch 70A can be seen in the diagram and the other winch 70B may be assumed to be behind the first winch 70A.

[0025] A "sideways" or lateral displacement of the tower can be effected by deploying both tag lines 6A, 6B by the same amount and in the same direction. This step can be done to achieve an initial alignment of the longitudinal axis L of the tower 2 with a central axis of the mount 3.

[0026] A rotation of the tower 2 relative to the mount 3 can then be effected by actuating the winches 70A, 70B independently of each other. For example, by only paying out one tag line 6A, one end of the sling 4 (the end connected to the other tag line 6B) is fixed in place, and the other end of the sling is free to move, so that the tower can turn slightly about its vertical axis L. Alternatively, the winches 70A, 70B can be actuated at the same time but at different rates.

[0027] The diagram shows the sling 4 arranged at a lower level of the tower 2. However, the sling 4 could equally well be deployed at an upper level of the tower, or even to a tower lifting arrangement. For example, the tower 2 can be raised by connecting the bearing wire 11 to a suitable interface element such as a flange gripper realised to grip an upper flange at the top of the tower 2. In such an embodiment, the sling 4 could be arranged about the flange gripper, and the tag lines 6A, 6B could be arranged at a suitably high level. Here also, a controlled and precise rotation R of the tower 2 can be achieved in a simple and effective manner by controlling the winches 70A, 70B and the tag lines 6A, 6B according to the desired degree of rotation R.

[0028] The alignment procedure is shown more clearly in Figs. 2 and 3, which indicate a cross-section through

the tower 2, and show a sling 4 wrapped "one and a half turns" about the tower 2, and with both ends connected to tag lines 6A, 6B by means of connectors 41, for example swivel connectors 41 or carabiner connectors 41. Fig. 2 shows an initial position in which the longitudinal axis L of the tower 2 is aligned with a vertical axis L of the mount. However, a tower reference point T must be brought into alignment with a corresponding point of the mount. To this end, as shown in Fig. 3, the winches 70A, 70B are actuated to effect the desired rotation R, and Fig. 3 shows the tower in a second position after alignment. The tower 2 has been rotated slightly about its axis L so that the reference point T has been brought to the desired position, so that the tower 2 can be fixed to the mount. The rotation R was made possible by the friction contact between the sling inner surface 40 and the tower outer surface 20. Once the tower 2 is aligned with the mount 3, the sling 4 can be detached from the tag lines 6A, 6B simply and quickly.

[0029] Fig. 4 shows a second embodiment of a tower manoeuvring arrangement 1 according to the invention. In this embodiment, the tower manoeuvring arrangement 1 comprises a suction cup 5 mounted to the outer surface 20 of the tower 2. The suction cup 5 has been pressed to the tower surface 20 to effect a negative pressure connection. The diagram shows one suction cup 5, and a second suction cup 5 (not shown) is placed on the other side of the tower 2, essentially diametrically opposed to the first suction cup 5. Each suction cup 5 is connected to a tag line 6A, 6B. In this embodiment also, the tag lines 6A, 6B are deployed by winches 70A, 70B to effect a rotation R of the tower 2 so that an upper mating portion 31 of the tower 2 can be aligned with a lower mating portion 30 of the mount 3. This diagram also shows an alternative hoisting arrangement, in which the upper part of the tower 2 is connected by means of a lifting yoke 12 to a bearing wire 11. Of course, instead of a lifting yoke, a standard lifting bracket could be used.

[0030] Fig. 5 shows a cross-section through the suction cup 5 of the tower manoeuvring arrangement of Fig. 4. The suction cup 5 comprises a flexible body with a smooth inner surface 50, and was initially pressed to the outer surface 20 of the tower 2 to expel air from between the suction cup 5 and the tower surface 20. Once released, the flexible body of the suction cup 5 resumes its initial form, so that the pressure P_N in the interior of the suction cup 5 is lower than the atmospheric pressure P_A acting on the suction cup 5 from outside. The negative pressure difference ensures that the suction cup 5 is effectively "pressed" onto the surface of the tower 2 until it is deliberately removed. For example, once the tower 2 has been aligned with the mount and the mating portions have been joined, an edge of the suction cup 5 can be lifted slightly to equalize the pressure, allowing the suction cup 5 to be removed. The quality of the surface contact between suction cup 5 and tower outer surface 20 can be improved by having previously applied a coating to that region of the tower surface to obtain a non-

porous surface region 200.

[0031] Fig. 6 shows a tower manoeuvring arrangement in which a combination of sling 4 and suction cup 5 is used. Here, the sling 4 is not wrapped about the tower 2 but only completes a "half-turn" about the tower 2. A suction cup 5 can be attached to the tower outer surface 20 at the level of the sling 4, and the sling 4 can be "fixed" relative to the tower 2 by fitting it over a fitting pin 52 of the suction cup 5. The ends of the sling 4 can be connected to the tag lines 6A, 6B, and a rotation R of the tower 2 can be effected in the manner described above, namely by actuating winches to deploy one or both of the tag lines 6A, 6B until the desired alignment of tower and mount is achieved. In this embodiment, a friction contact between sling 4 and tower outer surface 20 is not strictly necessary, since the negative pressure connection fixes the suction cup 5 to the tower outer surface 20, and the fitting element 52 fixes the sling 4 relative to the suction cup 5. These measures can be sufficient to ensure that the sling 4 does not slip relative to the tower.

[0032] Although the present invention has been disclosed in the form of preferred embodiments and variations thereon, it will be understood that numerous additional modifications and variations could be made thereto without departing from the scope of the invention.

[0033] For the sake of clarity, it is to be understood that the use of "a" or "an" throughout this application does not exclude a plurality, and "comprising" does not exclude other steps or elements.

Claims

1. A tower manoeuvring arrangement (1) for bringing a tower assembly (2) into a mounting position relative to a tower mount (3), which apparatus comprises
 - a lifting means (10, 11) for lifting the tower assembly (2) over the tower mount (3);
 - a tag line coupling means (4, 5) realised to detachably couple a tag line arrangement (6A, 6B) to the tower assembly (2), which tag line coupling means (4, 5) comprises a contact surface (40, 50) for application to an outer surface (20) of the tower assembly (2); and
 - a winch arrangement (7) realised to deploy the tag lines (6A, 6B) to effect a controlled rotation of the tower assembly (2) about a longitudinal axis (L) of the tower assembly (2).
2. An apparatus according to claim 1, wherein the tag line coupling means (4) is **characterized by** a high degree of friction between its contact surface (40) and the outer surface (20) of the tower assembly (2).
3. An apparatus according to claim 1 or claim 2, wherein the tag line coupling means (4) comprises a sling (4), and wherein the contact surface (40) of the sling

(4) is realised to extend about a circumference of the tower assembly (20).

4. An apparatus according to claim 3, wherein the sling (4) is dimensioned such that the contact surface (40) of the sling (4) exceeds the circumference of the tower assembly (20) by a ratio of at least 1.5 to 1. 5
5. An apparatus according to claim 3 or claim 4, comprising a tag line connector (41, 51) for connecting a tag line coupling means (4, 5) to a tag line (6A, 6B). 10
6. An apparatus according to claim 5, comprising a first tag line connector (41) for connecting to a first tag line (6A) and a second tag line connector (41) for connecting to a second tag line (6B). 15
7. An apparatus according to any of the preceding claims, wherein the tag line coupling means (5) is **characterized by** a negative pressure connection between its contact surface (50) and the outer surface (20) of the tower assembly (2). 20
8. An apparatus according to claim 7, wherein the tag line coupling means (5) comprises a suction element (5) realised to attach to the outer surface (20) of the tower assembly (2). 25
9. An apparatus according to claim 8, wherein a suction element (5) comprises a tag line connector (51) for connecting to a tag line (6A, 6B). 30
10. An apparatus according to any of the preceding claims, wherein the winch arrangement (7) comprises a first winch (70A) realised to deploy a first tag line (6A); a second winch (70B) realised to deploy a second tag line (6B); and a controller (71) for controlling the winches (70A, 70B). 35
11. An apparatus according to any of the preceding claims, wherein the lifting means (10, 11, 12) comprises a hoist connecting means (11) for connecting an upper part of the tower assembly (2) to a crane (10). 40
12. A method of manoeuvring a tower assembly (2) into a mounting position relative to a tower mount (3), which method comprises the steps of 45
 - lifting the tower assembly (2) over the tower mount (3); 50
 - applying a contact surface (40, 50) of a tag line coupling means (4, 5) to an outer surface (20) of the tower assembly (2) to detachably couple a tag line arrangement (6A, 6B) to the tower assembly (2); and 55
 - actuating a winch arrangement (7) to deploy tag lines (6A, 6B) of the tag line arrangement

(6A, 6B) to effect a controlled rotation of the tower assembly (2) about a longitudinal axis (L) of the tower assembly (2).

13. A method according to claim 12, wherein the step of applying a contact surface (40) of the tag line coupling means (4) to an outer surface (20) of the tower assembly (2) comprises wrapping a sling (4) about the outer surface (20) of the tower assembly (2).
14. A method according to 12 or claim 13, wherein the step of applying a contact surface (50) of the tag line coupling means (5) to an outer surface (10) of the tower assembly (2) comprises pressing a suction element (5) to the outer surface (20) of the tower assembly (2).
15. A method according to claim 14, comprising the step of providing a non-porous surface region (200) on the outer surface (20) of the tower assembly (2), onto which the suction element (5) can be pressed.

FIG 1

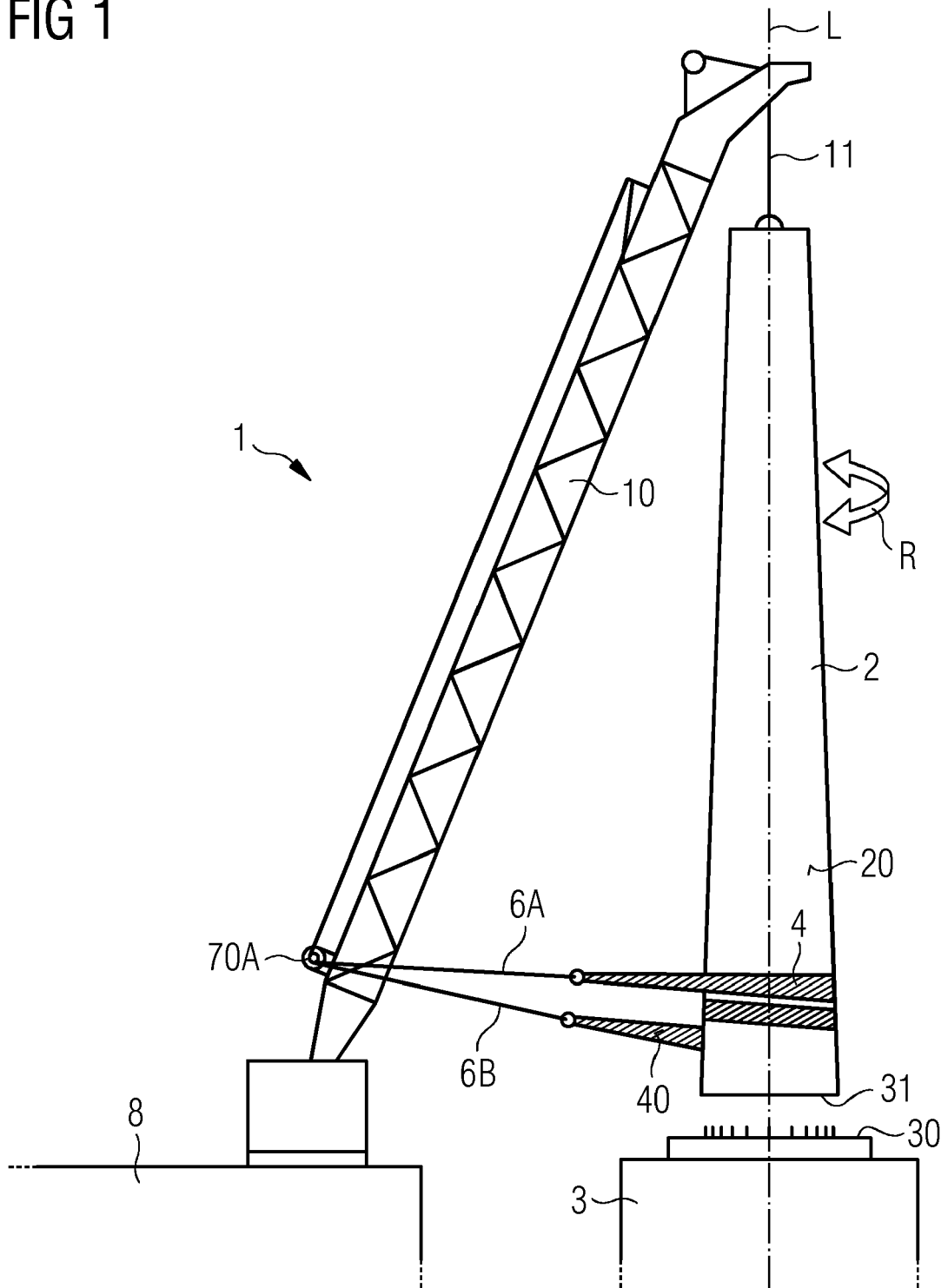


FIG 2

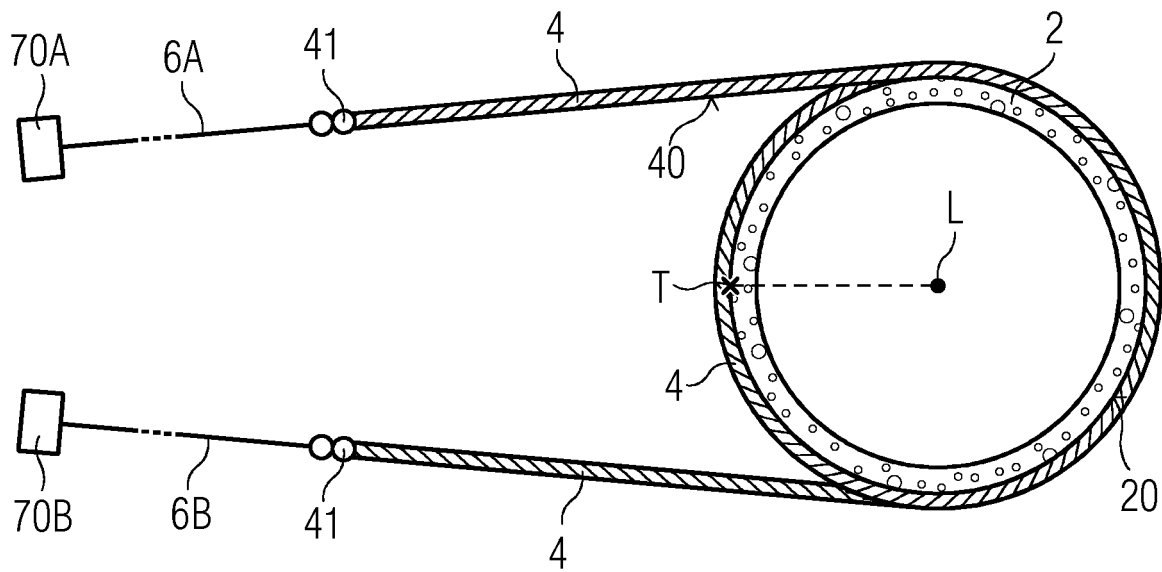


FIG 3

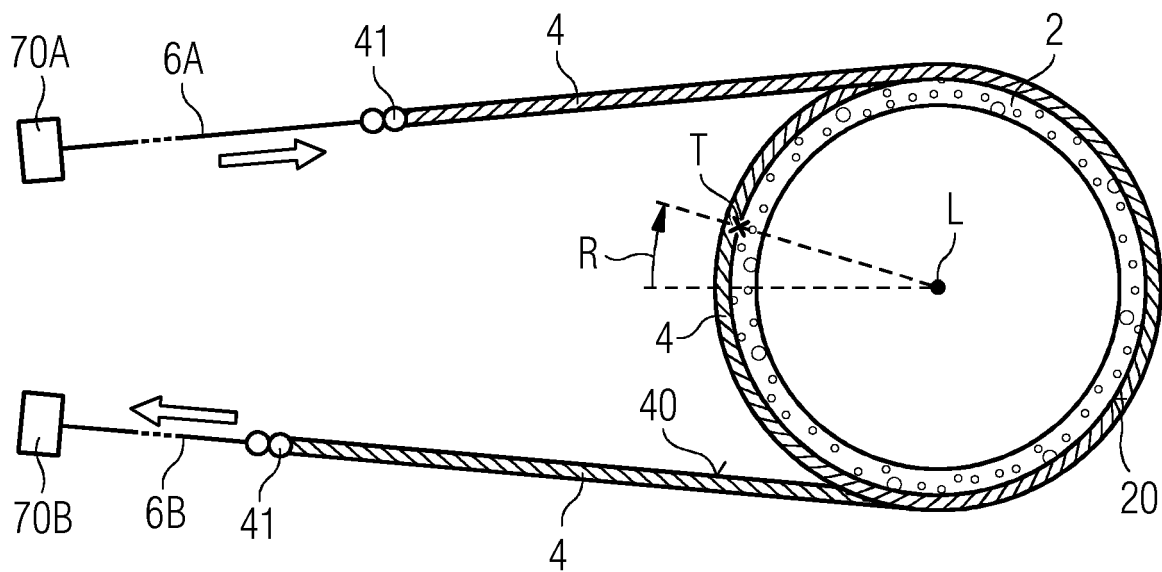


FIG 4

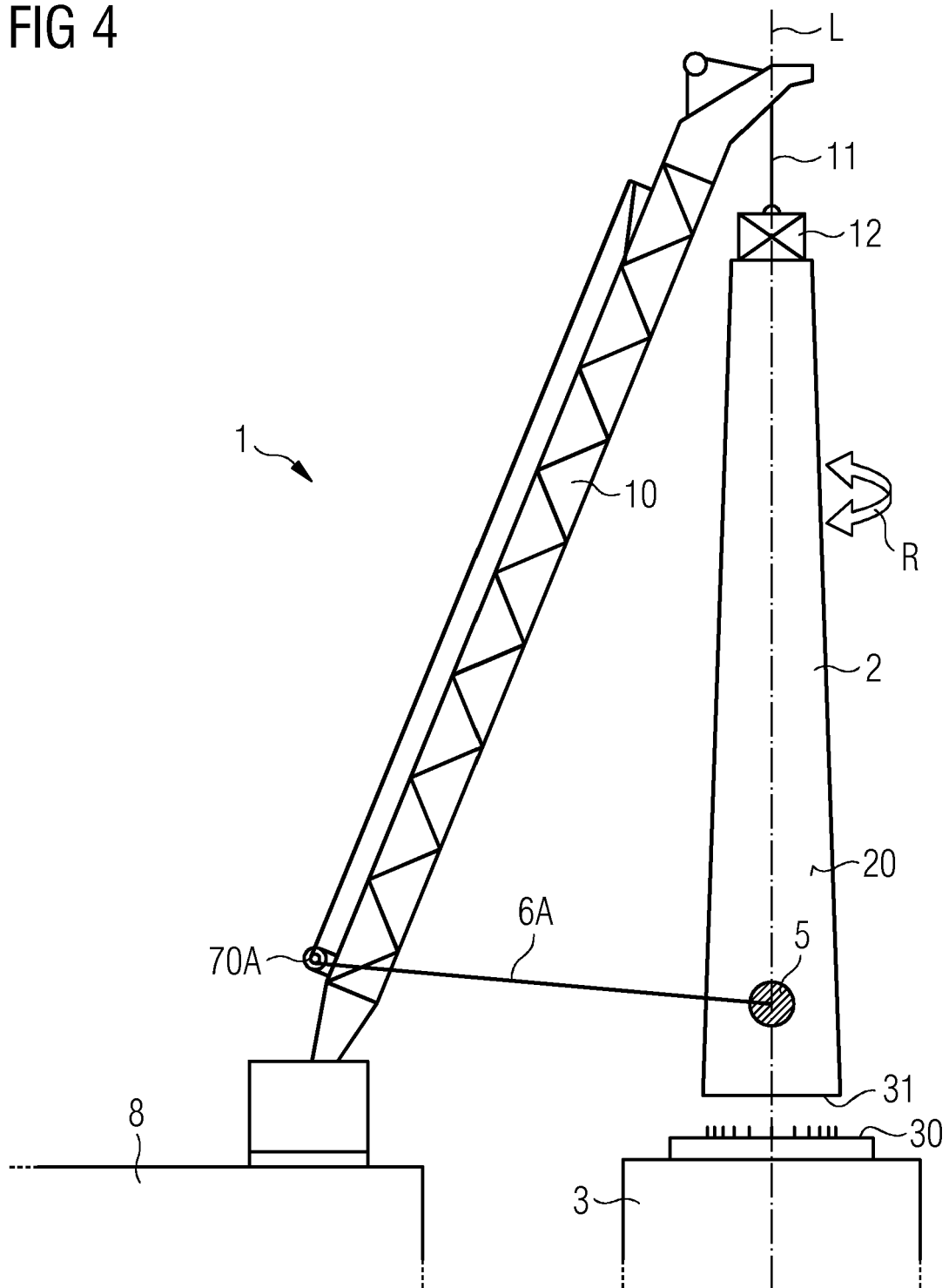


FIG 5

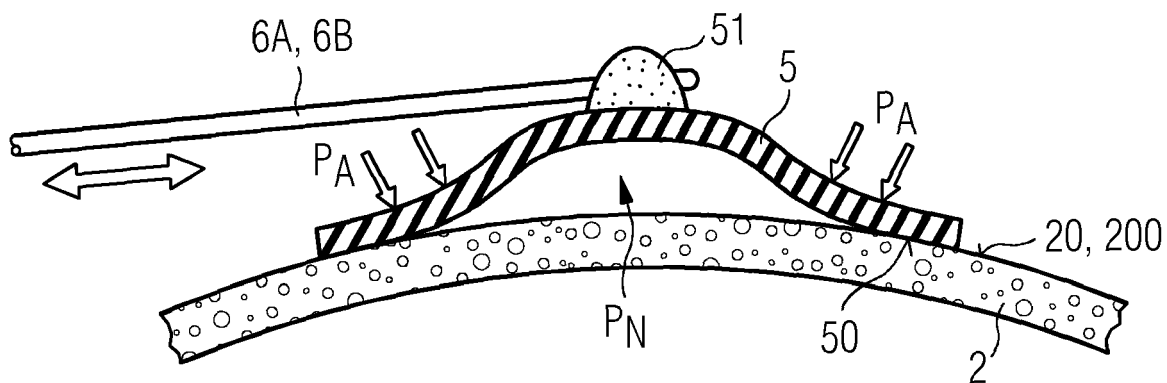
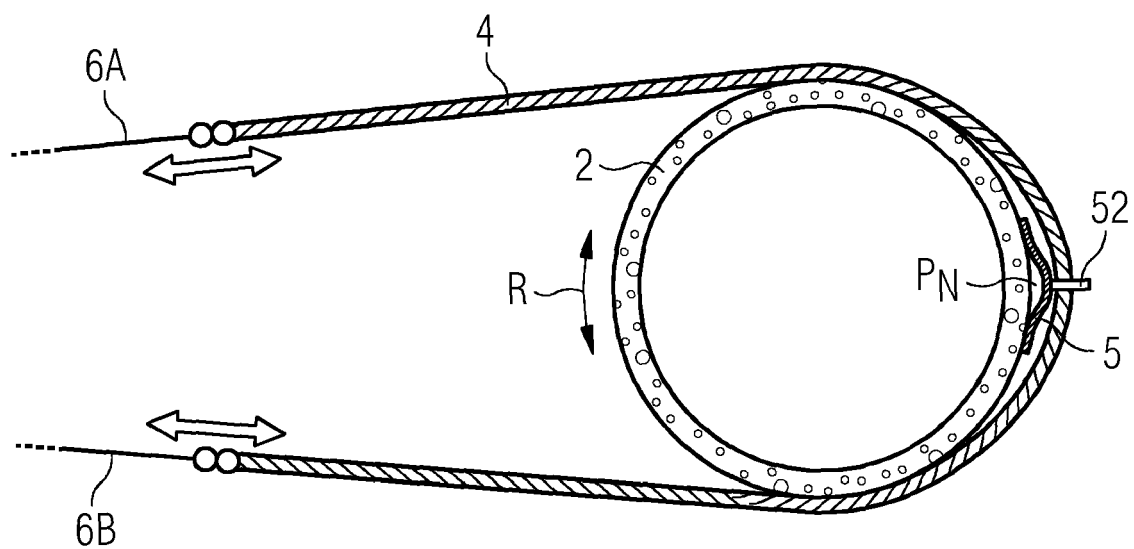


FIG 6





EUROPEAN SEARCH REPORT

Application Number
EP 13 18 9319

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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	EP 2 364 949 A1 (VESTAS WIND SYS AS [DK]) 14 September 2011 (2011-09-14) * the whole document *	1-15	INV. B66C13/08 B66C23/18
A	WO 2013/091632 A1 (VESTAS WIND SYS AS [DK]; FRIIS JESPER FYHN [DK]) 27 June 2013 (2013-06-27) * the whole document *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 February 2014	Examiner Faymann, L
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 2364949	A1	14-09-2011	EP 2364949 A1	14-09-2011
			US 2011221215 A1	15-09-2011

WO 2013091632	A1	27-06-2013	NONE	

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