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HOISTING SYSTEM FOR INSTALLING A WIND TURBINE

57

A hoisting system for the installation of a wind turbine, wherein the wind turbine comprises a tower, the hoisting system comprising a column, a boom and a winch, wherein the column is arranged for creating a load bearing connection to a part of the tower of the wind turbine using one or more fixation points successively located along a longitudinal direction of the tower, and wherein the column is arranged to move the hoisting system essentially in vertical direction along said part of the tower when the load bearing connection is created.

HOISTING SYSTEM FOR INSTALLING A WIND TURBINE

Field of the invention

The present invention relates to a hoisting system for the installation of a wind turbine, to a wind turbine comprising measures to facilitate the use of said hoisting system, a segment of a wind turbine, a method for installing a wind turbine, a method for fixing a hoisting system to a wind turbine, a method for removing a hoisting system from a wind turbine and to a method for adapting an existing wind turbine.

10 Background of the invention

The costs of labor and maintenance increase only gradually with increasing turbine size, and therefore to minimize costs, wind turbines are getting bigger and bigger. With increasing size and height the installation costs of the turbines are not rising gradually but at least linearly with turbine size. The largest industrial cranes available are required to install the largest land based wind turbines. Those heavy modular crane units are expensive, often require strengthening of the roads and special transportation permits. In addition to these disadvantages said cranes need a lot of space which is not always available and when such a crane is needed for the next turbine in a wind farm it may occur that the crane cannot move thereto for example because the terrain is complex or the roads are too small. Then the crane has to be decommissioned, transported in parts and commissioned again which is an inefficient time consuming operation.

There is a need to be able to install a wind turbine more efficiently and in particular without the need of a large general purpose crane.

25 WO2014/082176A1 discloses a rail that is attached to the tower and a lifting platform that can move up and down over said rail. This system has a drawback that the rail is required over the full length of the tower, which adds weight and increases the tower stiffness in one direction so that the tower eigen frequencies in that direction become higher than those in the perpendicular direction reducing the design freedom for modern variable rotor speed wind turbines where resonance between the tower eigen frequencies should be avoided in the full range of rotor frequencies and blade passage frequencies. Another drawback is that the lifting platform is attached to the rail over a vertical distance of about the length of one tower segment or less. This relatively short distance leads to large forces on the wind turbine tower when heavy parts like the nacelle are lifted. Furthermore, since the lifting platform moves over the entire rail

length, the rail needs to be strong and heavy over the entire length and becomes expensive and economically inefficient.

Alternative lifting platforms are disclosed in US4311434, US6357549, US6614125 and US6522025, with similar disadvantages.

5 US8069634 discloses a first crane, which can be a large industrial crane or a crane of a ginpole type, which is moveably attached to a partially constructed structural tower of a wind turbine. The first crane is applied to hoist and install a structural tower in several parts and, once the tower is completed, to lift a second lifting system, which is installed on top of the tower and serves to hoist the nacelle and the rotor. Besides to the
10 disadvantage of requiring two lifting systems, the application is time consuming: the first crane is to hoist the second lifting system to the top and this second lifting system is to be installed and made operational. Then the first crane is to be positioned away to avoid interfering with the second lifting system. After that the nacelle and rotor can be hoisted and when this is finished all steps need to be repeated in reversed order. A further
15 disadvantage is that the disclosed ginpole is not resistant to sideward wind loading: the tall crane has one or two slender beamlike joints to the tower which cannot take the sideward wind load so that the entire crane could spin around the vertical axis. A further disadvantage of the disclosed ginpole moving system is that the system employs one or more standoff brackets for fixation of a jump rack slidably to the wind turbine tower. The
20 ginpole is also connected slidably to the jump rack. Moving the ginpole is a stepwise procedure wherein each step consists of installing successive standoff brackets to wind turbine tower, shifting the jump rack so that it overlaps with the successive standoff brackets and subsequently sliding the ginpole over the jump rack. This cumbersome procedure.

25 A similar ginpole solution with similar disadvantages is disclosed in DE-G9414643.8, which operation is time consuming and not cost-effective.

It should be noted that the erection of a wind turbine requires a period of calm weather and in particular low wind speeds. If the hoisting takes much time the probability of completing the job in the low wind period is reduced which further decreases
30 efficiency.

US2015/0048043A1 discloses another comparable lifting system, wherein, after completion of the tower, a crane is installed on the tower top to hoist the nacelle and rotor. This system has the disadvantages that it applies a winch at the tower bottom which acts as a counter weight, resulting in the downward forces on the tower top to be
35 about double, and much long cables are required. Furthermore this system cannot lift tower segments, so that a large conventional crane is required.

An alternative method to install a wind turbine is by designing the nacelle of the wind turbine in such a way that it comprises a hole which encloses a non-tapered tower as disclosed e.g. in US756216, DE2823525B1, DE2735298A1 and US6408575. Although the so-called Growian, a wind turbine of 100m in height, was made using this method, it turned out to be not efficient for large wind turbines: the large turbines require tapered towers to deal efficiently with the high bending moments. Therefore non-tapered towers have phased out for wind turbines with an axis height of above about 80 meters.

Known wind turbine towers are typically of the tapered structural type or of the tapered tubular type and sometimes the lower side of the tower is structural and the upper side tubular. Structural towers are known to be transported in parts and assembled at the site. The appearance of tubular towers is generally better publicly accepted. Tubular towers protect the equipment inside the turbines such as the inverter, transformer and controller against the outdoor climate. Therefore, a solution for efficient installation of wind turbines is more relevant for tubular towers than for structural towers.

It should be noted that tubular towers are defined as towers of which horizontal cross sections are closed curves, which can be circular, polygonal, or of any other closed shape.

In DE19741988A1 and DE19647515A1 alternative lifting systems are disclosed, wherein the lifting systems can climb tubular towers by fixing itself by a system that surrounds the tower. Those systems easily damage the tower since large holding forces are needed to obtain sufficient friction on the tower wall to avoid the systems from gliding downward. Furthermore, these systems are most suitable for non-tapered towers which have phased out and these systems are not designed for carrying heavy parts of large modern wind turbines since the vertical length on which the bending moments are fed into the tower is less than the length of one tower segment or less than two tower top diameters which leads to unacceptable high forces on the tower wall.

Since wind speed increases with height, and the average hub height of wind turbines increases with the successive wind turbine generations, the hoisting is getting increasingly hindered by high wind speeds. In particular this is relevant to the hoisting of the entire rotor i.e. the hub and the blades in a single hoist: the large aerodynamically shaped blades are sensitive to gusts. The lifting devices of the above prior art are typically designed for single hoist lifting of the rotor and are not suitable for single blade hoisting and in particular not for the single blade hoisting in an about horizontal position.

Summary of the invention

The aim of the invention is to overcome the above mentioned disadvantages of existing solutions.

Hereto, according to an aspect of the invention a hoisting system is proposed for
 5 the installation of a wind turbine comprising a column, a boom and a winch wherein said column comprises measures to achieve a load bearing connection to the tower of the wind turbine and wherein said column comprises measures to move the hoisting system up and down along the tower. The tower comprises one or more fixation points and the column is arranged for creating the load bearing connection to a part of the tower using
 10 the one or more fixation points, and wherein the column is arranged to move the hoisting system essentially in vertical direction along said part of the tower when connected to the part of the tower.

Such a system can install successive tower segments while moving upwardly along the installed tower segments. After the tower is completed it can install the
 15 nacelle, generator, hub and the rotor blades.

Advantageously, the hoisting system of the present invention can be used instead of conventional large industrial cranes for installing wind turbines, enabling wind turbines to be built at lower costs and without requiring strengthening of roads and special transportation permits. Furthermore, the area of the building site of a wind
 20 turbine can be reduced from up to 3000m² when using conventional cranes to about 200m² when using the hoisting system of the present invention.

The column of the hoisting system typically comprises a rail which guides the hoisting system in essentially vertical direction along fixation points which are fixed to the tower. A beneficial maximum length of said rail is 60m, while a beneficial minimum
 25 length is 10m, preferably 20m, more preferably 34m. The relatively long rail allows the hoisting of heavy parts such as the lower tower segments or the nacelle without applying high sideward forces to the tower since force equals bending moment divided by arm.

The hoisting system is efficient since it allows simple and fast movement of the system up and down along the fixation points on the tower.

30 In an embodiment the hoisting system comprises a rail of which a section can be put in a first position wherein the rail section can be placed over a fixation point on the wind turbine tower and in a second position wherein it encloses the fixation point in such a way that the rail can only move up and down along the tower.

In an embodiment the column of the hoisting system comprises measures to
 35 move the hoisting system up and down along the tower. Such measures can comprise a climbing actuator and or a connection actuator which both can be of the type of a

hydraulic cylinder or an electromechanical linear actuator. Those actuators can have a fixed part and a moving part. The fixed part of each actuator can be fixed at one end to the column possible in a hinged manner. In one embodiment according to the invention the other end of the fixed part of the climbing actuator is connected to the end of the moving part of the connection actuator so that the connection actuator can move the climbing actuator in a direction from nearby the column to further away from the column. The end of the moving part of the climbing actuator is the connection end, which comprises measures for connecting to a fixation point. A climbing system includes a climbing actuator which can move the hoisting system up and down and the connection end of the climbing actuators can be controlled by the connection actuator from a free position to a position wherein the connection end is connected to a fixation point.

In an embodiment a climbing system comprises a double set of climbing and connection actuators, which has the advantages of distributing the loads and therefore reducing the costs of the system and introducing redundancy so that the climbing system still can be operated when combination of climbing and connection actuator is failing. In case of such a failure the hoisting system at least still can be moved downward to the ground thanks to the redundancy.

In an embodiment the hoisting system comprises a first and a second climbing system, wherein the distance between the center of the connection of the first climbing actuator to the column and the center of the connection of the second climbing system to the column is about 5.7m and at least 1.8m in length direction of the column. The advantage of having two climbing systems is that each climbing actuators can have about half the length compared to a single climbing system which provides better stability and lower costs. The two climbing systems are repeatedly used to move the hoisting system in essentially vertical direction along the tower. For example first the first climbing system is fixed to a fixation point and pulls the hoisting upward over about 50% of the distance between fixation points, then the second climbing system connects to another fixation point, then the first climbing system disconnects and subsequently the second climbing system pulls the hoisting system further upwardly so that it can be fixed to the next fixation point. It will be clear that also three, four, five etc. climbing actuators can be used which each can move the hoisting over respectively about one third, one fourth, one fifth etc. of the distance between fixation points, which distance is usually between 6m and 26m, preferably between 10 and 18m, for example about 11.5m.

In an embodiment the hoisting system comprises a chain moving around over driven cogwheels which are fixed to the column. By fixing the chain to a fixation point it can move the hoisting system up and down. Another option to move the hoisting system

is to fix a cable at one side to a fixation point and at another side to a winch which is mounted to the column.

In an embodiment the hoisting system comprises a coupling which can fix the hoisting system rigidly to a fixation point in such a manner that it can transfer vertical
 5 forces of the hoisting system to the fixation point in particular at least 30% of those vertical forces and more in particular at least 90% of those vertical forces. The height position of a coupling in the column is within the lower 65% of the length of the rail and preferably between 35% and 65% of the rail length.

In an embodiment the coupling between the column and the fixation point is such
 10 that during hoisting operation it allows for at least 0.25 degrees and preferably at least 0.5 degrees and more preferably at least 1 degrees for example 2 degrees rotational freedom about an imaginary horizontal axis between the parts joint by the coupling. This freedom avoids that large bending moments are exerted on the fixation points and therefore reduces costs.

A beneficial embodiment of the hoisting system comprises a boom which reaches at least 15m from the rail and preferably at least 25m from the rail. According to one embodiment of the hoisting system the maximum length of the boom is 60m. A further beneficial hoisting system is that wherein the boom is fixed to the column via a yaw bearing and in particular wherein the rotation axis of said yaw bearing is inclined to
 20 the length direction of the rail by more than 0.5 degrees, preferably by more than 1 degree, more preferably by less than 5 degrees. In a further beneficial embodiment of the hoisting system the boom is fixed with a tilt hinge to the yaw bearing or the boom comprises a tilt hinge, wherein the tilt hinge can be adjusted over at least 20 degrees and preferably over less than 200 degrees. The tilt motion can be driven by a hydraulic or electro mechanic actuator.
 25

In an embodiment the column is extended to more than 15m and preferably more than 25m above the rail and comprises a yaw bearing whereon an about horizontal boom is attached which comprises a hoisting point which can move along the boom.

In an embodiment the boom comprises a winch which drives the hoisting cable and in particular the boom comprises multiple winches which each have a separate hoisting cable leading to the hoisting point so that each winch carries part of the total load.

In an embodiment the hoisting system comprises a boom which is bended or
 35 inflected so that a line piece from the center of the tilt hinge to the hoisting point reaches

a distance to the boom of at least 1.5m and preferably of at least 2.5m and more preferably of about 4m.

The hoisting system can be powered with an electric cable from the ground. In an embodiment the hoisting system comprises a power supply based on a chemical
5 reaction such as a diesel generator, a fuel cell or a battery, wherein said power supply is installed in the hoisting system so that a long cable to the ground is avoided. This saves the costs and weight of the cable and avoids the problem of motion of the cables by the wind which reduces the weather window for hoisting operations and reduces the reliability of the system. In an embodiment the power supply is connected directly or
10 indirectly via an electric motor to the hydraulic pump. In another embodiment the hoisting system comprises a second hydraulic pump, which e.g. can be driven by an electric cable from the ground as backup.

While a conventional heavy crane requires several dozens of trucks, e.g. 50 trucks, for transportation, the hoisting system according to the invention can be
15 transported by less than 5, e.g. just 2 standard trucks, which gives advantage in cost and space requirements at the site.

A further advantage is that the hoisting system can be installed in several hours while the erection of a heavy crane takes several days.

An even further advantage is that the hoisting system can move up and down
20 along the wind turbine tower relatively fast compared to the lifting systems found in the prior art.

According to a further aspect of the invention a wind turbine is proposed comprising a tower, a nacelle, a generator, a hub and at least a blade wherein the tower comprises fixation points for the fixation and guiding of a hoisting system and in
25 particular of the hoisting system according to the invention.

In an embodiment the wind turbine comprises fixation points at a relative spacing of more than 10m and less than 30m.

In an embodiment the tower of the wind turbine comprises tubular overlapping segments which are bolted together on the overlap and wherein a fixation point is
30 installed on the overlap so that less stiffening of the tower near the fixation points is required since the double layered overlapping parts have more stiffness by themselves.

In an embodiment a fixation point comprises a stiffening structure which is fixed to the tower and which extends from the center of the fixation point by at least 50 cm and preferably by at least 100 cm. Such a stiffening structure can be installed at the
35 outer side or at the inner side or at both sides of the tower. In particular for the first or second tower segment of a segmented tower the stiffening structure may comprise a

structural beam from the fixation point to the tower foundation or a structural beam in about horizontal direction to the tower wall at a position which is more than 10 degrees and preferably more than 30 degrees away from the fixation point when rotating around the tower axis along the tower wall.

- 5 In an embodiment the wind turbine the fixation points are aligned in the longitudinal direction of the tower with a maximum deviation. If there are N fixation points which are numbered 1 to N in upward direction for fixation point M for $M = 1$ to $N-2$, then the line between the centers of fixation points M and $M+1$ reaches a distance to the center of a successive fixation point of maximally 5 cm, in preferably of maximally 10
10 cm and more preferably of maximally 20 cm.

In an embodiment the wind turbine comprises a tower with a load carrying wall and in particular one wherein the wall is load carrying over a tower length a wind turbine according to the invention comprises a non-structural tower with a load carrying wall over its full length.

- 15 In an embodiment the wind turbine comprises a tower of which a horizontal cross section of the outer side is shaped circular or polygonal.

In an embodiment the wind turbine comprises a tubular tower which comprises vertical segments, which segments are made of bended or folded steel plates which extend over the vertical length of said segment.

- 20 In an embodiment the wind turbine comprises a tower which comprises multiple vertical segments of a length between 10m and 22m and preferably between 10m and 16m.

- The tower can be of the tubular type and can be made of pre tensioned concrete or of wood or of steel. Alternatively, the tower can be a structural tower, or in other
25 words a lattice tower made of steel or wood. The tower can be partly of the tubular and partly of the lattice type. The lower part of the tower can be a tripod with three tubular legs, a jacket or a floating structure, in particular in offshore sites.

In an embodiment the wind turbine comprises a tower which is tapered over at least 50% of the tower length and preferably over at least 80% of the tower length.

- 30 In an embodiment the hoisting system comprises a straight rail which can be guided over at least two fixation points during climbing and therefore the fixation points are typically aligned following a straight line in the longitudinal direction of the tower of the wind turbine. Due to spatial and dimensional tolerances in the fixation points in the rail, some curvature is allowed between the fixation points.

The rail of the hoisting system may not be straight has and can have a constant curvature instead. In such a case the hoisting system can climb towers with a constant curvature in the tower wall in vertical direction.

5 The rail of hoisting system can be connected to just one single fixation point in a part of the track. Then the hoisting system is typically also connected via the climbing system to a second fixation point. The advantage of such a hoisting system is that it can move along towers which change of taper level, e.g. from cylindrical to tapered.

10 In an embodiment the wind turbine comprises a tower of which the fixation points including the stiffening thereof cover together less than 10% and preferably less than 20% of the tower length in any side view of the tower.

In an embodiment the tower center is installed at a horizontal distance to the center of a dike of less than 100m, preferably less than 50m and more preferably less than 20m.

15 In an embodiment two hoisting systems are applied to the same wind turbine. The two hoisting systems can be installed below each other on the same track of fixation points or can be installed at different angles in a cylindrical coordinate system around the tower axis. The tower could comprise two tracks of fixation points at different angles from the bottom to the top or a single track at a first angle and just one or more fixation points at a second angle. In the latter case a first hoisting system can climb all the way
20 up to the tower top along the single track of fixation points at said first angle and can install the second crane to the one or more fixation points at that second angle. The difference between said angles in said cylindrical coordinate system comprises at least 20 degrees, preferably at least 45 degrees and more preferably at least 60 degrees, for example 90 degrees.

25 Using two hoisting systems has several advantages. First the hoisting systems together can hoist heavier parts and therefore are suitable for the installation of larger wind turbines. Second the hoisting of parts by two cranes is less sensitive to the wind thus more stable so that the operational weather interval increases. Third the loads exerted by two hoisting systems to the tower are more distributed compared to the situation of a single heavier hoisting system. The distribution of loads reduces the costs
30 of the hoisting systems and of the fixation points. Fourth the hoisting systems can be used more efficiently because the same system is used for installing mid size and large size wind turbines and when a wind farm is installed, each single hoisting system can be used to erect wind turbine towers while only for the hoisting of the nacelle, generator,
35 hub and rotor the hoisting systems are applied together.

In an embodiment of the wind turbine comprises an offshore turbine, of which the part that passes the sea level can comprise a fixation point, e.g. wherein the transition piece comprises the fixation point for a hoisting system.

The term offshore turbine also refers to turbines installed in lakes or rivers.

5 In an embodiment an offshore turbine comprises a fixation point below the water line.

In an embodiment the hoisting system is pre-installed on a tower segment and said hoisting system and tower segment are in a single hoist installed on a lower already installed tower part.

10 In the embodiments concerning an offshore turbine the hoisting system can be used to complete the installation of the entire offshore wind turbine by lifting parts from a vessel and installing them. Said vessel does not need to be an expensive jack-up vessel and therefore reduces the installation costs much. Optionally the hoisting system remains on the turbine after commissioning to serve as maintenance tool or for the
15 decommissioning of the turbine later.

In an embodiment the wind turbine has a axis height of more than 80m, preferably more than 130m and more preferably more than 180m, wherein the maximum axis height according to an embodiment is 500m.

In an embodiment the wind turbine has a design rpm, of which the ratio between
20 the design rotor speed at 12m/s wind speed and at 6m/s wind speed is above 1.3, preferably above 1.5 and more preferably above 1.8, and less than 3. Such turbines with variable rotor speed have a range of excitation frequencies wherein the tower should not reveal resonance. In such cases, advantageously the attachment of fixation points hardly influences tower eigen frequencies and does not cause the tower to have
25 different eigen frequencies for excitations in the plane of the tower axis and the fixation points compared to those in the plane perpendicular thereto and parallel to the tower axis.

According to an aspect of the invention a combination of a wind turbine according to the invention with a hoisting system according to the invention is proposed.

30 In an embodiment the rail of the hoisting system during hoisting work is fixed permanently in a rigid non-slidable manner to the column of the hoisting system while said rail is rigidly or slidably fixed to the fixation points on the tower of the wind turbine.

In an embodiment the rail of the hoisting system is at least connected to two or three fixation point during hoisting work.

In an embodiment the highest fixation point where the hoisting system is fixed to the tower during the hoisting of tower parts corresponds to the overlapping part of the highest two installed tower segments.

5 According to an aspect of the invention a method is proposed for installing a wind turbine according to the invention, the method comprising building at least a part of a tower of the wind turbine by placing one or more tower segments using the hoisting system of the invention.

In an embodiment the lower one to three tower segments can be installed with a conventional method.

10 In an embodiment, subsequently the installation of the rail of the hoisting system to the fixation points of the one or more installed tower segments can be performed.

In an embodiment wherein the hoisting system is attached to the first two installed tower segments, the hoisting system hoists and installs the third segment without a fixation point installed and then installs the fixation point to the third segment.
15 An advantage of this method is that when the third segment is lowered, the additional constraint is avoided and its fixation point should simultaneously fit into the rail of the hoisting system.

In an embodiment the hoisting of one to three higher tower segments in parts or in single hoists and the installation of said higher segments can be performed.

20 The repetition of unlocking, moving and relocking the hoisting system in a higher position and the hoisting and installation of one or two higher tower segments results in the tower being fully assembled.

In an embodiment the hoisting system can be unlocked, moved and relocked in the highest available position and the hoisting of the nacelle, generator, hub and the rotor blades can be performed in one or more combined hoists or in a single hoist.
25

In case of single blade hoisting the hoisting system can be used to turn the hub in a convenient position for installation a next blade by hoisting an installed blade to a lower or higher position.

According to an aspect of the invention the hoisting system can be unlocked and moved downwardly by repetitively locking and moving the hoisting system back to the tower bottom. At the bottom the hoisting system can be removed from the tower.
30

In the case that the hoisting system installs also (part of) the first tower segment, a temporal separate support can be required or the section of the first segment with a fixation point can be installed first by a conventional crane after which the hoisting system can be installed.
35

In an embodiment the horizontal distance between the hoisting point of the boom and the highest applied fixation point is less than the diameter of a hoisted tower segment.

5 Brief description of the drawings

The following drawings show exemplary embodiments of the invention:

Fig. 1: a wind turbine and a hoisting system;

Fig. 2: tower segments of a wind turbine;

Fig. 3: tower segments of a wind turbine;

10 Fig. 4: tower segments of a wind turbine;

Fig. 5: tower segments of a wind turbine;

Fig. 6: a wind turbine under construction and a hoisting system;

Fig. 7: a wind turbine under construction with two hoisting systems;

Fig. 8: installation of a hoisting system for an offshore wind turbine;

15 Fig. 9: installation of a hoisting system for an offshore wind turbine;

Fig. 10: a fixation point on a wind turbine tower;

Fig. 11: cross section of the fixation point in Fig. 10;

Fig. 12: a column of a hoisting system with three climbing systems;

Fig. 13: a column of a hoisting system with a single climbing system;

20 Fig. 14: a cross section of a fixation system;

Fig. 15: a cross section of a fixation and a climbing system; and

Fig. 16: a wind turbine and a hoisting system.

The drawings are to be understood not to be drawn to scale.

25 Detailed description of the invention

Fig. 1 shows an exemplary combination 1 of a wind turbine and a hoisting system. The wind turbine comprises tower segments 2 which overlap in areas 8 and each have a fixation point 7, a nacelle 3, a generator 4, a hub 5 and several blades 6. The hoisting system comprises a column 10, a yawing platform 11 which carries via a tilt hinge 12 the boom 14. The boom can tilt by activation of the hydraulic cylinder 13. The
30 hoisting cable 18 is lead via pulleys 16 and 17 to the winch 15. The hoisting system is fixed to a rail 9 which is, depending on its position, slidably attached to fixation points 7, 19 and 20, so that it can move up and down along the tower. Before hoisting is started any of the locking systems 21, 22, 23, 24 locks the rail to a fixation point.

Advantageously, the hoisting system can be releasably fixed to one side of the tower without the need for a contra weight or means for creating a contra force at another side of the tower.

Fig. 2 shows the first three tower segments 30, 31 and 32 of an exemplary wind turbine. Segment 32 is elevated for illustrative reasons. Segment 30 comprises the
 5 fixation points 34 and 36 with respectively stiffening structures 33 and 35. Segments 31 and 32 comprise fixation points 39 and 40 with stiffening structures 38. Fixation points 36 and 40 comprise a hole 37 which is used for locking the hoisting system to the installed tower segments. The supporting beams 44 are fixed to stiffener 35 and to
 10 fixation means 45 which are fixed to the tower foundation 46. The dashed lines 41, 42 and 43 illustrate positions of the connection between the tower segments which e.g. can be bolted together. In this example the stiffeners 33, 35 and 38 are also bolted to the tower segments.

According to an installation method according to the invention a general purpose
 15 crane installs the first tower segment 30. Then the hoisting system is installed to the fixation points 34 and 36 of this first tower segment 30. The hoisting system uses locking system 22 to lock itself to hole 37 of fixation point 36. Then it hoists tower segment 31 on top of segment 30 and during this hoist the fixation point 39 is placed in the rail 9. The segments are bolted together and the hoisting system hoists segment 32 similarly
 20 on top of segment 31 and subsequently hoists the fourth segment. Then the hoisting system unlocks, moves upwardly and locks with locking system 23 to fixation point 37 of segment 32 so that it can hoist segment 5. This continues until the entire tower is installed. The hoisting system subsequently hoists and installs the nacelle, generator, hub and the blades, where several combined hoisting operations can be beneficial e.g.
 25 the nacelle and generator or the entire rotor comprising the hub and the blades or even the combination of the nacelle, the generator and the rotor in a single hoist.

Fig. 3 illustrates another embodiment of the first two tower segments 55 and 56 where segment 55 has two fixation points 34 and 62. Fixation point 62 is installed on stiffener 58 which is placed via plate 59 (shown by a dashed line) to the tower wall. Plate
 30 59 has the same thickness as the wall of tower segment 56, so that this segment fits precisely between segment 57 and stiffener 58. The dashed lines 57 and 58 illustrate the positions for a bolted connections. In practice the bolts can be placed in multiple lines per connections which is not shown for illustrative reasons. Fixation point 62 is supported by beams 60 which are fixed to supports 61 on the inner side of the tower.
 35 The embodiment of Fig. 2 can also be combined with supporting beams on the inner

side of the tower and that of Fig. 3 can be combined with supporting beams on the outside of the tower. In the embodiment of Fig. 3 the locking system 22 is optional.

Fig. 4 illustrates another embodiment of the first tower segments 70, 71 and 32 of a wind turbine. In this case segment 32 and the higher segments which are not shown have a standard length 78 which can be transported easily e.g. a length between 10m and 16m such as e.g. 12m. The tower segments overlap over a distance 76 which is e.g. 0.5m, so that the tower height increases 11.5m per standard segment. For the hoisting system it is beneficial when the fixation points always have the same vertical spacing 79, e.g. one fixation point per 11.5m. By increasing the length 75 of the first tower segment 70 it can comprise two fixation points at a spacing of 11.5m and still sufficient length is left for the overlap 76 with tower segment 71. This enables to attach the hoisting system to segment 70 and subsequently to hoist segment 71 and 32, without the need of the special structure with plates 58 and 59 in Fig. 3. A consequence is that segment 75 requires a longer transport length. Segment 71 has a shorter length 77 and does not carry a fixation point. Fixation point 74 has a stiffening structure 73 on the outer side of the tower and a stiffening structure 80 on the inner side of the tower.

Fig. 5 illustrates another embodiment of the first tower segments. In this embodiment the first tower segment 85, which also could be an integrated part of the tower foundation 46, comprises the first fixation point 90 with stiffener 91 at a distance 94 from the foundation. The second segment 86 comprises a fixation point 92 with stiffener 93 and similar to Fig. 4 an internal stiffener 79. This embodiment has the advantage that the first, second and third segments can have equal or shorter lengths, respectively 88, 89 and 77, compared to the length 78 of the fourth segment 32, which can be the maximum transport length of all segments.

Fig. 6 shows an exemplary hoisting system and exemplary first tower segments in more detail compared to Fig. 1. The column of the hoisting system comprises a hydraulic cylinder 95 with piston 96 and an actuator in a state 97 so that it can pass a fixation point 99 and in a state 98 wherein it connects to fixation point 99. The hoisting system can move up after the actuator is in state 98 and is locked to fixation point 99 on tower segment 103 and the hydraulic cylinder 95 is actuated until the weight of the crane is carried by the hydraulic cylinder. Then the locking systems 21, 23 and 24 are unlocked, where it should be noted that although Fig. 6 illustrates three locking systems, any number of locking systems larger than zero is possible. Then the hydraulic cylinder 95 is further activated so that piston 96 is pulled into cylinder 95 so that the hoisting system moves upwardly. The upward movement continues until any locking system

reaches a fixation point whereon it can be locked and the weight of the hoisting system can be transferred from the hydraulic cylinder 95 to the locking system.

It should be clear that also two cylinders are possible: each at one side of the column or even multiple cylinders e.g. cylinders which push the hoisting system
5 upwardly instead of pulling it upwardly.

Fig. 6 also shows that due to the inflection of the boom, the boom reaches a distance 102 to the line segment 101 between the center of the tilt hinge and the hoisting point.

Fig. 6 further illustrates another tower segment 105 which still has to be hoisted.
10 The segment comprises a fixation point 107 with edge 106 which serves to capture actuator 98. Fig. 7 shows an exemplary wind turbine tower under construction with two exemplary hoisting systems on opposite sides of the tower. In fig. 7 only the bottom tower segment 2 with overlapping part 8, fixation point 7 and additional fixation point 120 is shown with reference numbers for illustrative reasons. The higher tower segments are
15 similar to the bottom tower segment. The hoisting system shown on the left hand side of the tower with rail 9, column 10, yaw bearing 11, tilt hinge 12, tilting actuator 13, boom 14 and hoisting cable 18 is similar to the second hoisting system shown on the right hand side. The hoisting systems together can advantageously be used for the hoisting of heavy parts such as e.g. the nacelle 122. Another advantage of two hoisting systems
20 is that the hoisting of some parts, like the blade or the rotor, is less sensitive to wind gusts and more stable when using two cables, i.e. one cable from each hoisting system.

Most tower segments in the embodiment of Fig. 7 have two fixation points 7 and 120, i.e. one fixation point for each hoisting system. The two fixation points 7 and 120 may be positioned at any angle difference of at least 20 degrees in a cylindrical
25 coordinate system around a tower center axis. In Fig. 7 the two fixation points 7 and 120 are located on opposite sides of the tower segment, i.e. at an angle difference of 180 degrees. In an alternative embodiment a first hoisting system is installed to the tower and climbs upwardly and subsequently installs a second hoisting system immediately at an elevated location suitable to hoist heavy parts. In the latter alternative embodiment
30 the second hoisting system cannot climb or can only climb over a limited range so that not all tower segments need a second fixation point 120. The second hoisting system may be similar to the first hoisting system or may have a different layout. For example it may not comprise a climbing system or have a different boom.

Fig. 7 further illustrates two positions 123 and 124 where the boom 14 may have
35 joints and position 125 where the column 10 may have a joint. At those joints the hoisting system may be folded or taken apart to facilitate transportation.

Fig. 8 shows an exemplary offshore wind turbine under construction. A vessel 130 with crane 131 uses a cable 132 to hoist a segment 135 of the tower of the offshore wind turbine. The segment 135 is for example a transition piece where to an exemplary hoisting system with boom 136, rail 137, column 138 and fixation points 139 is attached.

5 The hoisting system has, similar to the above exemplary embodiments, a tilt hinge 140 with actuator 141, but also may have a second tilt hinge 142 with a second tilt actuator 143 which are arranged so that the boom can fold to the column where the tip of the boom is connected at location 144 to the column to obtain a better structural stability. A relatively low cost vessel can be used to install the tower segment with the hoisting

10 system in a single hoist on the foundation 133 of the offshore wind turbine.

In the example of Fig. 8 the foundation 133 is a monopile support structure which passes the sea level 134. Once the hoisting system is installed, it can pick up the subsequent tower segments and the other parts of the wind turbine from the same or another vessel and build the offshore wind turbine. The hoisting system can

15 subsequently be removed or it stays on the turbine for maintenance work or for the replacement of parts of the wind turbine or for decommissioning of the turbine. An advantage of using the hoisting system on an offshore wind turbine is that the installation of parts of the turbine is cheaper than the conventional method wherein said parts are installed by a jack-up vessel. The hoisting system is even more convenient

20 since it is attached to the tower under construction and therefore follows its movements.

Fig. 9 shows an alternative exemplary combination of an offshore wind turbine and a hoisting system. In this embodiment the hoisting system is hoisted with cable 157 from pontoon 150. Before the hoisting system is elevated, it may be placed on foot 151 which is arranged to stabilize the hoisting system for motion of the pontoon by waves.

25 Foot 151 is e.g. placed on hydraulic cylinders 152 for stabilization and to lower the support completely below deck level, so that the other side of the hoisting system supported by wheel 156 can pass over it. While cable 157 hoists the system upwardly the cable 155 is released by winch 154 on support 153. This continues until the hoisting system is almost parallel to the tower. At a certain moment wheel 156 comes free from

30 the deck and cable 155 is further released until wheel 156 reaches the wind turbine tower. After that the system is connected to the fixation points and performs the further completion of the offshore wind turbine by installing the remaining parts. Cable 157 can be pulled upwardly by a separate winch but also by the winch installed in the boom of the hoisting system, for example by guiding the hoisting cable from point 144 via the

35 column 138 to the hook 158.

Fig. 10 shows an exemplary fixation point 160 in more detail. With protuberance 161 the fixation point can be installed with bolts 162 to the upper tower segment 169, so that this element can be hoisted together with the fixation points and installed on top of segment 168 where it is further fixed with bolts 163 in the overlap range 170. The
 5 element 164 is arranged to fit into the rail of the hoisting system and hole 165 serves for locking to the rail. Ribs 166 may be used to distribute the loads over a large part of the tower. Note also that only some of the bolts of the fixation points are drawn and those for the further connection of the upper and lower segments in the overlap zone 170 outside of the fixation point are not drawn. Element 167 is arranged to connect to the
 10 hoisting system and to carry the majority of the vertical loads during hoisting operations. It is installed close to the tower wall so that the vertical forces have a small arm and therefore exert a relatively small bending moment to the fixation point.

Fig. 11 shows cross section I-I of the fixation point in Fig. 10. From this side also stiffening plate 171 is visible.

15 Fig. 12 shows a combination of an exemplary wind turbine tower with a column of an exemplary hoisting system. The tower comprises segments 180, 181, 182, 183 of which the upper three have respectively fixation points 184, 185, 186 and hooks 187, 188, 189. Of the hoisting system only the column 190, the rail 191, a closed rail door 193, an opened rail door 194, fixation systems 192 and three hydraulic climbing systems
 20 are shown. For illustrative reasons the hoisting system is shown in a position wherein it can connect to the rail by moving the system towards the tower. The upper rail door 194 is open so that the fixation point 186 can move into the rail. The lower door 193 is shown in closed position for illustrative reasons, but will be open to connect to fixation point 186. When the fixation points 185 and 186 have entered the rail, the hoisting system can
 25 move downwardly so that also fixation point 184 enters the rail. Subsequently the doors 193 and 194 are closed and the system can be locked by one or more fixation systems 192.

In the exemplary embodiment of Fig. 6 the hoisting system included a climbing system with a hydraulic cylinder 95 with piston 96 and an actuator in states 97 and 98
 30 for connecting to fixation point 99. The exemplary hoisting system of Fig. 12 includes an alternative climbing system that uses hooks next to the fixation points for climbing the tower.

In the embodiment of Fig. 12 the column is provided with three hydraulic climbing systems. The lower hydraulic climbing system comprises main cylinder 196 which is
 35 rotatably fixed with one end 195 to the column. The other end is guided through rail 198 by actuator 197. In Fig. 12 the piston 199 is fully extended and has a spherical end 200

which fits into any of the hooks, e.g. hook 188. When the column is unlocked from the fixation points and the lowest hydraulic climbing system is hooked on, it can pull the hoisting system upwardly over about one third of the distance between the successive fixation points. Then the mid hydraulic climbing system can extend its piston, connect it to hook 189 and pull the hoisting system further upwardly, after the lowest hydraulic climbing system is disconnected. The last step is performed by the highest hydraulic climbing system with hydraulic cylinder 202 which is connected at point 201 to the column and at the other end guided through rail 204 by control actuator 203. This highest hydraulic climbing system completes the stroke to the position where a fixation system can lock again to a fixation point. In Fig. 12 the parts of the mid hydraulic climbing system are not numbered but correspond to those of the highest hydraulic climbing system.

A hoisting system with three climbing systems instead of one climbing system, wherein with each climb one third of the distance between successive fixation points is covered, has an advantage that shorter and therefore more stable and cheaper hydraulic cylinders can be used. The invention is not limited to three hydraulic climbing systems, and any number of climbing systems can be used in principle, including just one hydraulic climbing system.

Fig. 13 shows an alternative embodiment of a column 210 of the hoisting system. In this embodiment the length of the column extends over less than two times the distance between successive fixation points. An advantage of such a shorter system is that it is lighter and smaller, and therefore cheaper. Furthermore, since its rail can be slidably fixed by only a single fixation point during part of the climbing of the system, the system can move along towers of which the taper changes in longitudinal direction. In Fig. 13 the lowest tower segment 217 is cylindrical, while segments 182 and 183 are tapered.

In an embodiment of the hoisting system the column is arranged such that an operator has access to it. The column may have a door, one or more platforms and stairs inside so that an operator can carry out repairs and maintenance. From the inside of the column there may be inspection hatches, for example for the inspection of the fixation systems and/or climbing systems.

In an embodiment the hoisting system may have a single fixation system, for example the system of Fig. 12 only in the middle of the column and the system of Fig. 13 only at the upper end of the column.

In another embodiment of the hoisting system it may have no fixation system at all: For example the system of Fig. 12 may be executed without any of the fixation

systems 192 and use the climbing systems for both climbing and fixation. The climbing systems are repeatedly activated so that always at least one climbing system connects the column to the tower. Advantages of such an embodiment are lower cost and more simplicity.

5 Figs. 6, 12 and 13 show climbing systems on one side of the column. Alternative embodiments may have climbing systems on both sides of the column.

The exemplary hoisting system of Fig. 13 includes a single climbing system with a relatively long cylinder 211 fixed in a hinged manner at end 212 and guided at the other end through rail 213 by controlling actuator 214. Piston 215 is locked into hook
10 189 with its spherical end 216. During climbing the column 210 is pulled up by the climbing system until the rail 191 is released from fixation point 184 after which the column is slidably fixed by fixation point 185 and further fixed via the piston of the climbing system to fixation point 186. In this part of the upward stroke the column can change slightly of tilt angle so that its rail is aligned to the successive fixation point.

15 Fig. 13 also shows an exemplary optional power system 218 which e.g. comprises a generator for electric and hydraulic power which are arranged such that the hoisting system can operate stand alone. The power system is fixed with joint 219 and the power and control lines between the column and the power system are led via joint 220. The hoisting system can comprise a backup hydraulic pump which can be driven
20 by electric power fed via an electric cable from the ground.

Fig. 14 shows a cross section of an exemplary fixation system. On the left hand side part of two tower segments 168 and 169 are shown with a fixation point 230. On the right hand side part of the column 210 with the yaw platform 221 of a hoisting system are shown. Hydraulic cylinder 222 controls piston 223 with a hook 224 into the element
25 226 of the fixation point. The end 225 of the hook and element 226 together form a cylindrical hinge with the hinge axis approximately normal to the drawing plane and thus are arranged such that the column of the crane has some tilt freedom. The hook and thus also the column of the crane also has some rotational freedom of movement around the approximately horizontal axis of the piston 223. Those freedoms around the
30 about horizontal axes avoid that large bending moments are exerted to the fixation point. During a fixation process, the column is lifted slightly first so that piston 223 can be extended. Then the column is lowered until hook 224 connects with element 226, and after that hydraulic cylinder 227 drives piston 228 in the hole 229 so that the column cannot move up or down anymore. The rail has a outside guiding strip 231 and an inside
35 strip 232 with an mutual distance 233.

In an embodiment the thickness of plate 234 of the fixation point located inside the rail is e.g. 15 cm, preferably 10 cm less and for example 5 cm less and at least 1 mm more than the mutual distance 233. An advantage of having a play of for example 5 cm is that the column has a tilt freedom of about 0.25 degree which allows the taper of the tower to change by about this amount over each section. Towers of changing taper have an structural advantage and can thus be installed with an hoisting system according to the invention.

The center of a fixation point may be defined by the center of plate 234.

The pistons 223 and 228 in Fig. 14 are directly driven by the hydraulic fluid. In an alternative embodiment any of those pistons may be guided pins which are driven by separate hydraulic cylinders. An advantage of such an embodiment is that the guided pins may be better suitable for sideward loading.

In a further embodiment of the hoisting system it may not have doors in the rail. For example the hoisting systems of Fig. 12 or Fig. 13 may be made without doors 193 and 194. They still can be installed on the rail aided by some play of the fixation points in the rail. In the case of Fig. 13 first fixation point 184 is slide in the rail by moving the hoisting system downwardly and subsequently by moving the system upwardly again, the rail slides over fixation point 185. The hoisting system in Fig. 12 may be installed in a similar manner.

Fig. 15 shows an exemplary wind turbine tower on the left hand side and an exemplary column of a hoisting system on the right hand side. For illustrative reasons the mid part of the column was not drawn. The column comprises a wagon 242 which comprises a hydraulic cylindre 245 with piston 246 which fits in the hole in plate 234 of the fixation point 230. A spindle 241 which is driven by a hydraulic motor 240 and is further positioned by bearing 244 slides through wagon 242 and drives it parallel to the rail through the back side of the rail. When wagon 242 is locked to a fixation point and hook 224 is unlocked, the hydraulic motor will move the hoisting system up and down by rotating the spindle. Advantages of climbing by a wagon connected to a spindle is that it saves the climbing system with the hydraulic cylindres, that locking to a fixation point with piston 246 is simpler than connecting to the hooks 187, 188, 189 and that the wagon is a relatively stable option.

Fig. 16 shows an exemplary wind turbine 250 with nacelle 252, hub 253 and blades 254 where to a hoisting system 255 is attached. The wind turbine can be any one of the wind turbines of the above embodiments. The hoisting system can be any one of the hoisting systems of the above embodiments.

The above description focuses at the installation of wind turbines using a hoisting system. The invention is not limited to the installation of wind turbines and may additionally or alternatively be used for maintenance or decommissioning of wind turbines using the hoisting system.

5 The fixation point can be used for rigidly fixing or slidably fixing the hoisting system to the tower of the wind turbine and/or as support for the climbing system of which the latter is also a form of fixation and guiding of the hoisting system. Thus, where reference is made to a fixation point, it is to be understood that the fixation point can serve either or both as fixation and guiding of the hoisting system. Of course those
10 functions can be split over multiple points for example wherein at least one point has a fixation function only or wherein at least one point has a guiding function only.

 The hoisting system may be controlled via a computer that only allows for operation within the operational limits of the system. The system may be controlled by remote and fixed controllers, e.g. from the ground, in the crane and in the turbine under
15 construction. A crane operator may be assisted by camera's.

 It is to be understood that in the present application, the term "comprising" does not exclude other elements or steps. Also, each of the terms "a" and "an" does not exclude a plurality. Any reference sign(s) in the claims shall not be construed as limiting the scope of the claims.

CONCLUSIES

1. Een hijssysteem (255) voor de installatie van een windturbine (250), waarbij de windturbine een tower, het hijssysteem omvattende een kolom (10, 138, 190, 210),
5 een giek (14, 136) en een lier (15) omvat, waarbij de kolom is ingericht om een dragende verbinding te creëren met een deel van de toren gebruikmakend van een of meer bevestigingspunten (7, 19, 20, 34, 36, 49, 40, 62, 74, 90, 92, 99, 107, 139, 160, 184, 185, 186, 230) die zich opeenvolgend bevinden langs een lengterichting van de toren, en waarbij de kolom is ingericht om het hijssysteem te verplaatsen in hoofdzaak
10 in verticale richting langs genoemd deel van de toren als de dragende verbinding is gecreëerd.

2. Het hijssysteem volgens conclusie 1, waarbij de dragende verbinding tussen de kolom en het bevestigingspunt zodanig is dat zij tijdens hijsbedrijf .25 graden
15 rotatievrijheid toelaat om een denkbeeldige horizontale as tussen delen die verbonden zijn door de dragende verbinding, bij voorkeur tenminste 0.5 graden rotatievrijheid, bij grotere voorkeur tenminste 1 graad rotatievrijheid.

3. Het hijssysteem volgens conclusies 1 of 2, waarbij de kolom is ingericht om
20 een dragende verbinding te creëren verder gebruikmakend van een rail (9, 137, 191, 198, 204, 213) die het mogelijk maakt om het hijssysteem te geleiden langs de dragende verbinding gebruikmakend van de een of meer bevestigingspunten.

4. Het hijssysteem volgens conclusie 3, waarbij de giek reikt tot een afstand
25 van de rail van tenminste 15m en bij voorkeur tenminste 25m.

5. Het hijssysteem volgens conclusie 4, waarbij de giek is verbonden aan de kolom via tenminste een van de volgende:

een kruilager, waarbij bij voorkeur de hoek tussen de as van het kruilager en de
30 lengterichting van de rail tenminste 0.5 graden en bij grotere voorkeur ongeveer 0.75 graden is; en

een tiltscharnier, bij voorkeur omvattende een hydraulische cilinder of een elektro
mechanische actuator voor het draaien van de giek ten opzichte van de kolom rondom
het tiltscharnier over een tilthoekverandering van tenminste 20 graden.

6. Het hijssysteem volgens een der voorgaande conclusies, waarbij de giek een kabellier omvat om de hijskabel mee te bedienen.

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7. Het hijssysteem volgens een der voorgaande conclusies, waarbij de giek is geknikt of gebogen zodanig dat tussen de giek en een denkbeeldig lijnstuk van het hijspunt van giek tot het centrum van een tiltscharnier een afstand is verkregen van tenminste 1.5m, bij voorkeur tenminste 2.5m, en bij grotere voorkeur van ongeveer 4m.

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8. Het hijssysteem volgens een der conclusies 3-7, waarbij de toren omvat de een of meer bevestigingspunten en waarbij de rail is verbonden aan de kolom, waarbij de rail bij voorkeur een minimale lengte heeft van 10m, bij grotere voorkeur heeft de rail een minimale lengte van 20m, en bij nog grotere voorkeur heeft de rail een minimale lengte van 34m.

15

9. Het hijssysteem volgens een der conclusies 3-8, waarbij een eerste sectie van de rail voorzieningen omvat die ingericht zijn om de rail te openen om de rail op een bevestigingspunt te plaatsen, waarbij de voorzieningen verder ingericht zijn om de rail te sluiten resulterende in een verschuifbare verbinding met het bevestigingspunt voor het toelaten van beweging van het hijssysteem ten opzichte van de toren in hoofdzaak in een richting parallel aan de rail.

20

10. Het hijssysteem volgens een der voorgaande conclusies, waarbij de kolom ingericht is om het hijssysteem te bewegen hoofdzakelijk in verticale richting langs de toren, bij voorkeur gebruikmakend van een continue (rondgaande) ketting of een klimactuator of een wagon.

25

11. Het hijssysteem volgens conclusie 10, waarbij de klimactuator een bevestigingsactuator omvat, waarbij de bevestigingsactuator ingericht is om een kant van de klimactuator te bewegen in een richting van of naar de kolom.

30

12. Het hijssysteem volgens conclusie 10 or 11, waarbij de kolom een eerste klimsysteem en een tweede klimsysteem omvat, waarbij elk klimsysteem aan een uiteinde is ingericht om een verbinding te maken met een bevestigingspunt en aan het andere uiteinde verbonden is met de kolom, waarbij elk klimsysteem ingericht is voor

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het bewegen van het hijssysteem langs de toren in een hoofdzakelijk verticale oriëntatie, waarbij bij voorkeur de afstand tussen het eerste klimsysteem en het tweede klimsysteem gemeten tussen hun vaste uiteindes tenminste 1.8m is in de lengterichting van de kolom.

5

13. Het hijssysteem volgens een der voorgaande conclusies, waarbij de dragende verbinding een dragende koppeling omvat voor het vastmaken van het hijssysteem aan een bevestigingspunt, bij voorkeur zodanig dat gedurende hijsbedrijf de dragende koppeling tenminste 90% van de verticale kracht overdraagt op de toren via een enkel bevestigingspunt dat is gepositioneerd in de bovenste 65% van de lengte van de rail, bij grotere voorkeur in de bovenste 35% van de lengte van de rail, bijvoorbeeld in de bovenste 10% van de lengte van de rail.

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14. Het hijssysteem volgens een der voorgaande conclusies, verder omvattende een energievoorziening gebaseerd op een chemische reactie zoals een diesel generator, een brandstofcell of een accu.

15

15. Het hijssysteem volgens een der voorgaande conclusies, ingericht voor hijsen en installatie van het torentopsegment en een of meer van een gondel, een generator, een naaf en bladen, of delen daarvan, van de windturbine.

20

16. Een windturbine omvattende een toren, een gondel, een generator, een naaf en tenminste een blad, waarbij de toren een of meer bevestigingspunten omvat die opeenvolgend gesitueerd zijn langs een lengterichting van de toren voor het losmaakbaar bevestigen en geleiden van een hijssysteem volgens een der conclusies 1-15.

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17. De windturbine volgens conclusie 16, waarbij de toren bevestigingspunten omvat op een onderlinge afstand van meer dan 10m, bij voorkeur op een onderlinge afstand van minder dan 30m, bij grotere voorkeur op een onderlinge afstand van minder dan 15m.

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18. De windturbine volgens conclusie 16 or 17, waarbij de toren een veelheid van gestapelde segmenten omvat, waarbij tenminste een bevestigingspunt zich bevindt op de overlap van twee naburige torensegmenten.

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19. De windturbine volgens een der conclusies 16-18, waarbij tenminste een bevestigingspunt versterkt is aan de buitenzijde van de toren over een afstand van het centrum van het bevestigingspunt tot tenminste 50 cm weg van het centrum van het bevestigingspunt, bij voorkeur tot tenminste 100 cm weg van het centrum van het bevestigingspunt.

20. De windturbine volgens een der conclusies 16-19, waarbij de binnenzijde van de toren versterkt is bij het bevestigingspunt.

21. De windturbine volgens een der conclusies 16-20, waarbij de centra van drie opeenvolgende bevestigingspunten op een rij liggen in de lengterichting van de toren met een maximale afwijking van 20 cm in een radiale richting van de toren, bij voorkeur met een maximale afwijking van 10 cm in de radiale richting van de toren, bij grotere voorkeur met een maximale afwijking van 5 cm in de radiale richting van de toren.

22. De windturbine volgens een der conclusies 16-21, waarbij de toren een dragende wand omvat over 50% van de toren lengte, bij voorkeur over 80% van de torenlengte.

23. De windturbine volgens een der conclusies 16-22, waarbij een doorsnede van de dragende wand in een richting loodrecht op de lengterichting van de toren de vorm heeft van een cirkel of een veelhoek.

24. De windturbine volgens een der conclusies 16-23, waarbij de toren de vorm heeft van een buis en opgebouwd is uit een veelheid van verticale segmenten, waarbij elk segment is samengesteld uit gekromde of gezette platen die zich uitstrekken over de lengte van een segment.

25. De windturbine volgens een der conclusies 18-24, waarbij een of meer van de segmenten een lengte heeft tussen 10m en 16m.

26. De windturbine volgens een der conclusies 16-25, waarbij de toren taps is over 50% van de torenlengte, bij voorkeur over 80% van de torenlengte.

27. De windturbine volgens een der conclusies 16-26, waarbij de som van de hoogtes van alle bevestigingspunten minder is dan 20% van de torenlengte, bij voorkeur minder dan 10% van de torenlengte.

5 28. De windturbine volgens een der conclusies 16-27, waarbij de windturbine geïnstalleerd is op een afstand van het midden van een dijk van minder dan 100m, bij voorkeur minder dan 50m, bij grotere voorkeur minder dan 20m.

10 29. De windturbine volgens een der conclusies 16-28, omvattende een of meer verdere bevestigingspunten (107) die zich opeenvolgend bevinden langs een verticale richting van de toren en op een hoekverschil van tenminste 20 graden van de een of meer bevestigingspunten in een cilindrisch coördinaten stelsel rondom de toren, voor het losmaakbaar verbinden van een tweede hijssysteem conform het hijssysteem van een der conclusies 1-15.

15

30. De windturbine volgens een der conclusies 16-29, waarbij de windturbine een offshore windturbine is.

20 31. De windturbine volgens conclusie 30, omvattende een constructie die het zeeniveau passeert, waarbij de constructie een transitiedeel betreft dat tenminste een of meer bevestigingspunten omvat voor het losmaakbaar verbinden en geleiden van het hijssysteem.

25 32. De windturbine volgens een der conclusies 16-31, waarbij de windturbine een ashoogte heeft en de ashoogte meer is dan 80m, bij voorkeur meer dan 130m, bij grotere voorkeur meer dan 180m.

30 33. De windturbine volgens een der conclusies 16-32, waarbij de windturbine een ontwerptoerental heeft, waarbij de verhouding tussen het ontwerptoerental bij 12 m/s windsnelheid en bij 6m/s minder is dan 3 en meer dan 1.3, bij voorkeur meer dan 1.5 en bij grotere voorkeur meer dan 1.8.

35 34. De windturbine volgens een der conclusies 16-33, waarbij het hijssysteem losmaakbaar verbonden is aan de buitenzijde van in hoofdzaak een zijde van de toren daarbij een combinatie (1) vormende van de windturbine en het hijssysteem.

35. De windturbine volgens conclusie 34, waarbij het hijssysteem een kolom en een rail omvat, waarbij de kolom bevestigd is aan de rail en de rail ingericht is voor het geleiden van het hijssysteem langs de toren, waarbij de rail star of verschuifbaar verbonden is met tenminste een van de bevestigingspunten.

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36. De windturbine volgens conclusie 35, waarbij de rail verschuifbaar en/of star is verbonden met tenminste twee bevestigingspunten.

37. De windturbine volgens conclusie 35 of 36, waarbij een hoogste bevestigingspunt gemeten vanaf het grondniveau dat gebruikt wordt voor het losmaakbaar bevestigen van het hijssysteem aan de toren voor hijswerkzaamheden van torendelen tijdens het oprichten van de windturbine, zich bevindt op de intersectie van de twee hoogste reeds geïnstalleerde torensegmenten.

38. De windturbine volgens een der conclusies 34-37, waarbij het hijssysteem losmaakbaar verbonden is aan de toren zonder contragewicht of maatregelen voor het creëren van een contrakracht ongeveer aan de tegenovergestelde zijde van het hijspunt ten opzichte van het tiltscharnier.

39. Een torensegment, niet zijnde het torentopsegment, van een windturbine volgens een der conclusies 16-38, waarbij het segment een bevestigingspunt omvat voor het losmaakbaar bevestigen van een hijssysteem volgens een der conclusies 1-15 als het segment is geïnstalleerd als deel van de windturbine.

40. Een methode voor het installeren van een windturbine volgens een der conclusies 16-39, de methode omvattende het opbouwen van tenminste een deel van de toren van de windturbine door het plaatsen van een of meer torensegmenten gebruikmakend van het hijssysteem volgens een der conclusies 1-15.

41. De methode volgens conclusie 40, verder omvattende het opbouwen van een of meer onderste torensegmenten die zich dichtbij het grondniveau bevinden gebruikmakend van een conventionele bouwmethode, geen betrekking hebbend op het hijssysteem.

42. De methode volgens conclusie 40 of 41, omvattende:

het hijsen van een of meer delen van opeenvolgende torensegmenten gebruikmakend van het hijssysteem en het installeren van de segmenten om een deel van de toren te vormen; en

5 het opwaarts geleiden van het hijssysteem langs de bevestigingspunten en star en verschuifbaar verbinden van de rail aan de een of meer verbindingspunten van de opeenvolgende toren segmenten.

43. De methode volgens conclusie 42, verder omvattende, als het laatste segment is geïnstalleerd, de stap van het star verbinden van de rail aan tenminste een bevestigingspunt en het hijsen en installeren van een of meer van een gondel, een generator, een naaf en bladen, of delen daarvan, van de windturbine.

44. De methode volgens conclusie 43, waarbij, in het geval van het een voor een hijsen van de bladen, de methode omvat de stappen van het roteren van de naaf door het geïnstalleerde blad omhoog of omlaag te hijsen gebruikmakend van het hijssysteem, om het mogelijk te maken om de naaf in een gunstige positie te plaatsen voor het hijsen en installeren van een ander blad.

45. De methode volgens een der conclusies 40-44, waarbij tijdens het hijsen van een der vier laagste torensegmenten als geheel, een horizontale afstand tussen het hijspunt van een giek van het hijssysteem en het centrum van een bovenste bevestigingspunt tussen het hijssysteem en de toren altijd minder is dan de diameter van het torensegment.

25 46. De methode volgens een der conclusies 40-45, verder omvattende het hijsen en installeren van een tweede hijssysteem volgens conclusie 29, waarbij het hijsen en installeren gebruik maakt van het hijssysteem.

30 47. Een methode voor het losmaakbaar bevestigen van een hijssysteem volgens een der conclusies 1-15 aan een windturbine of in aanbouw zijnde windturbine volgens een der conclusies 16-38, het hijssysteem omvattende een kolom en een rail, waarbij de kolom is bevestigd aan de rail, de windturbine omvattende een toren omvattende twee of meer torensegmenten en een of meer bevestigingspunten, de methode omvattende de stap van het star bevestigen van de rail aan het bevestigingspunt of de bevestigingspunten.

48. De methode volgens conclusie 47, waarbij de windturbine een offshore windturbine is, de methode verder omvat het hijsen van het hijssysteem terwijl het bevestigd is aan een of meer torensegmenten van een vaartuig (130) op de fundatie (133) van de windturbine.

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49. De methode volgens conclusie 47, waarbij de windturbine een offshore windturbine is, de methode verder omvat het hijsen van het hijssysteem van een ponton (150) naar het bevestigingspunt of de bevestigingspunten van een geïnstalleerd deel van de windturbine gebruikmakend van een kabel (157) die verbonden is aan het geïnstalleerde deel van de windturbine.

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50. Een methode voor het verwijderen van een hijssysteem volgens een der conclusies 1-15 van een windturbine of een in aanbouw zijnde windturbine volgens een der conclusies 16-38, het hijssysteem omvattende een kolom en een rail, waarbij de kolom bevestigd is aan de rail, de windturbine omvattende een toren omvattende twee of meer segmenten en een of meer bevestigingspunten, de methode omvattende de stappen van het losmaken van vaste verbindingen van de rail aan bevestigingspunten, het omlaag bewegen van het hijssysteem gebruikmakend van verschuifbare verbindingen van de rail met bevestigingspunten, en het hijssysteem losmaken van de windturbine.

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51. Een methode voor het aanpassen van een bestaande windturbine, omvattende het aanbrengen van een of meer bevestigingspunten aan een toren van de bestaande windturbine om het daarbij mogelijk te maken een hijssysteem volgens een der conclusies 1-15 losmaakbaar te verbinden aan de een of meer bevestigingspunten van de bestaande windturbine.

25

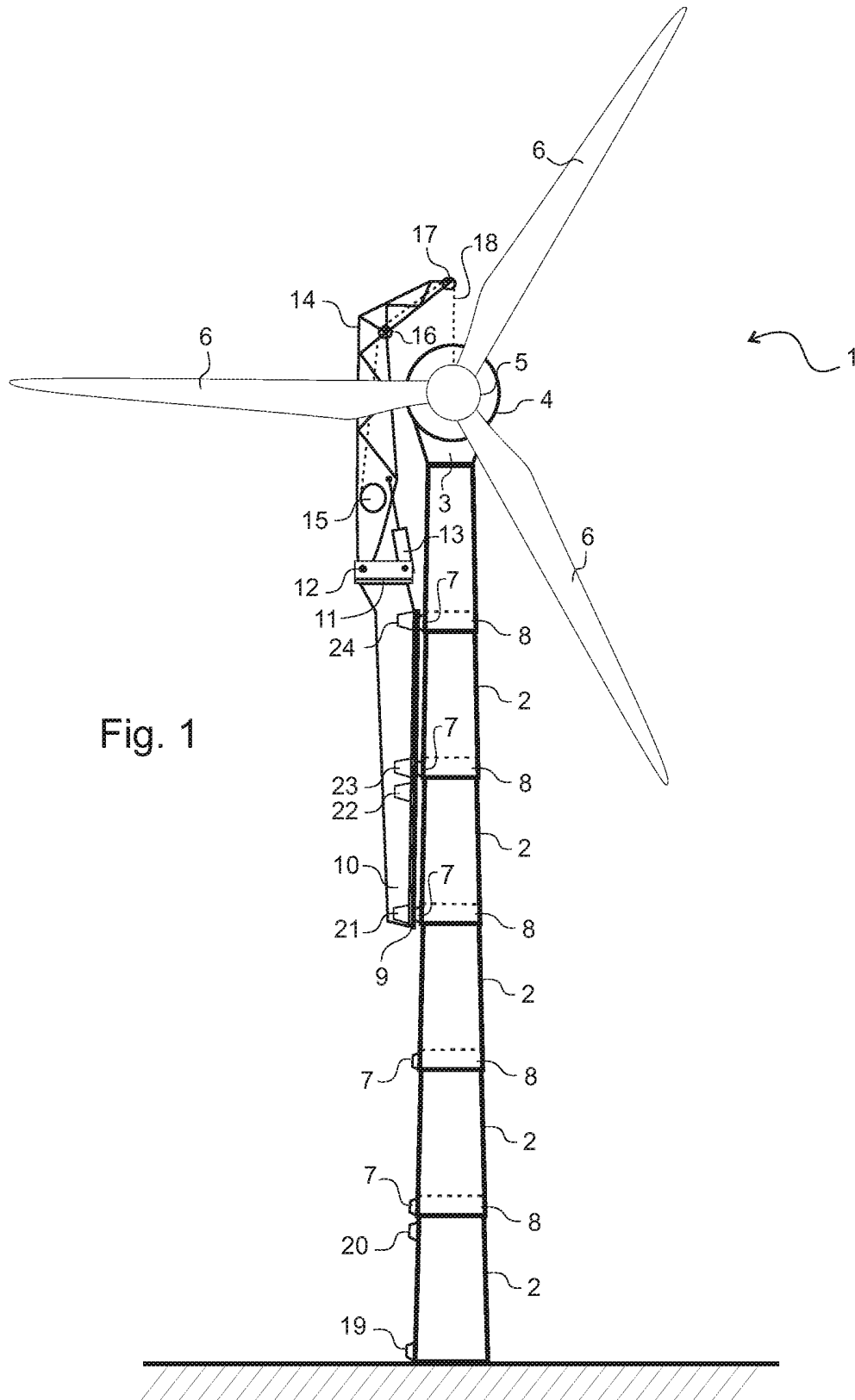


Fig. 1

Fig. 2

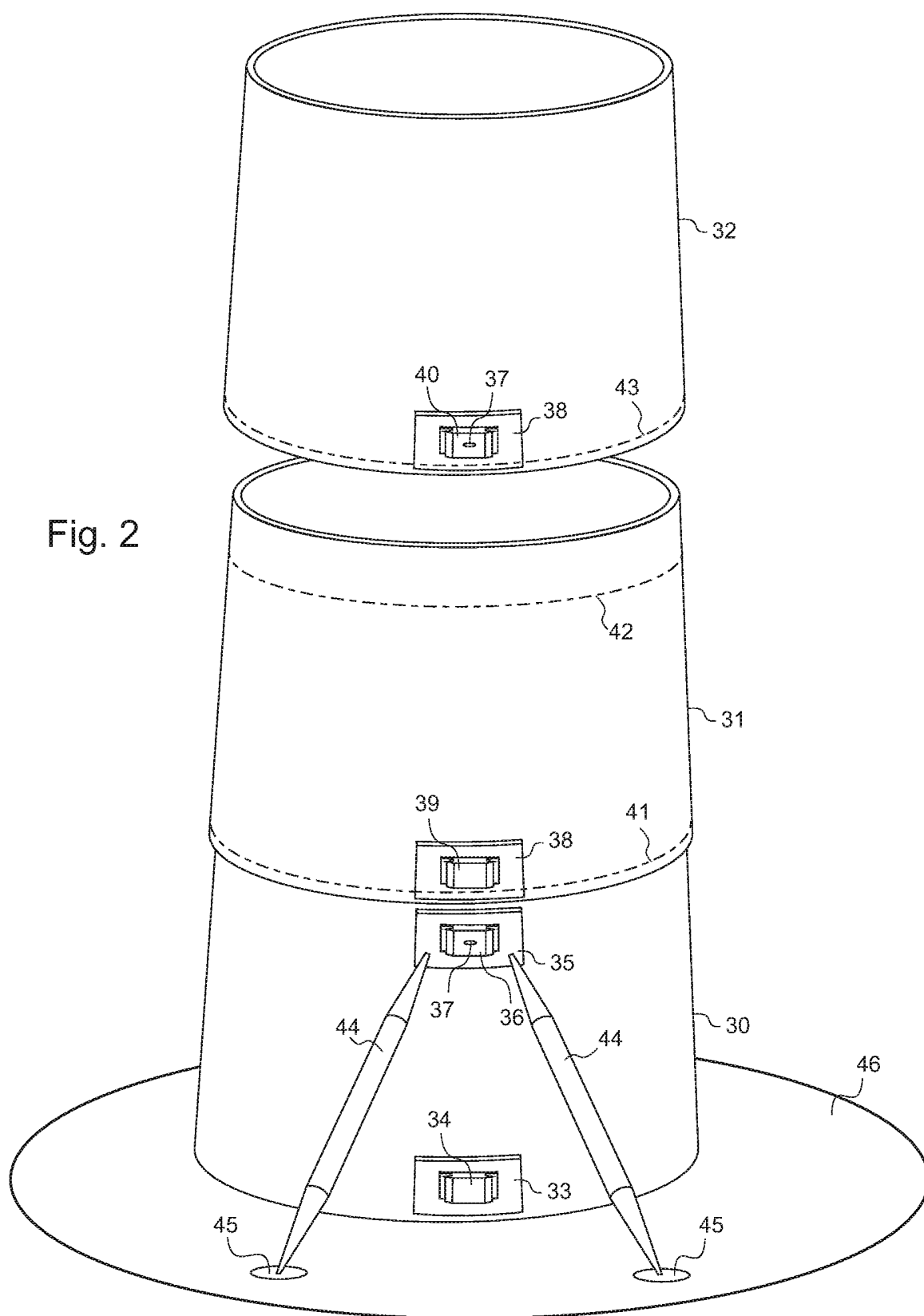
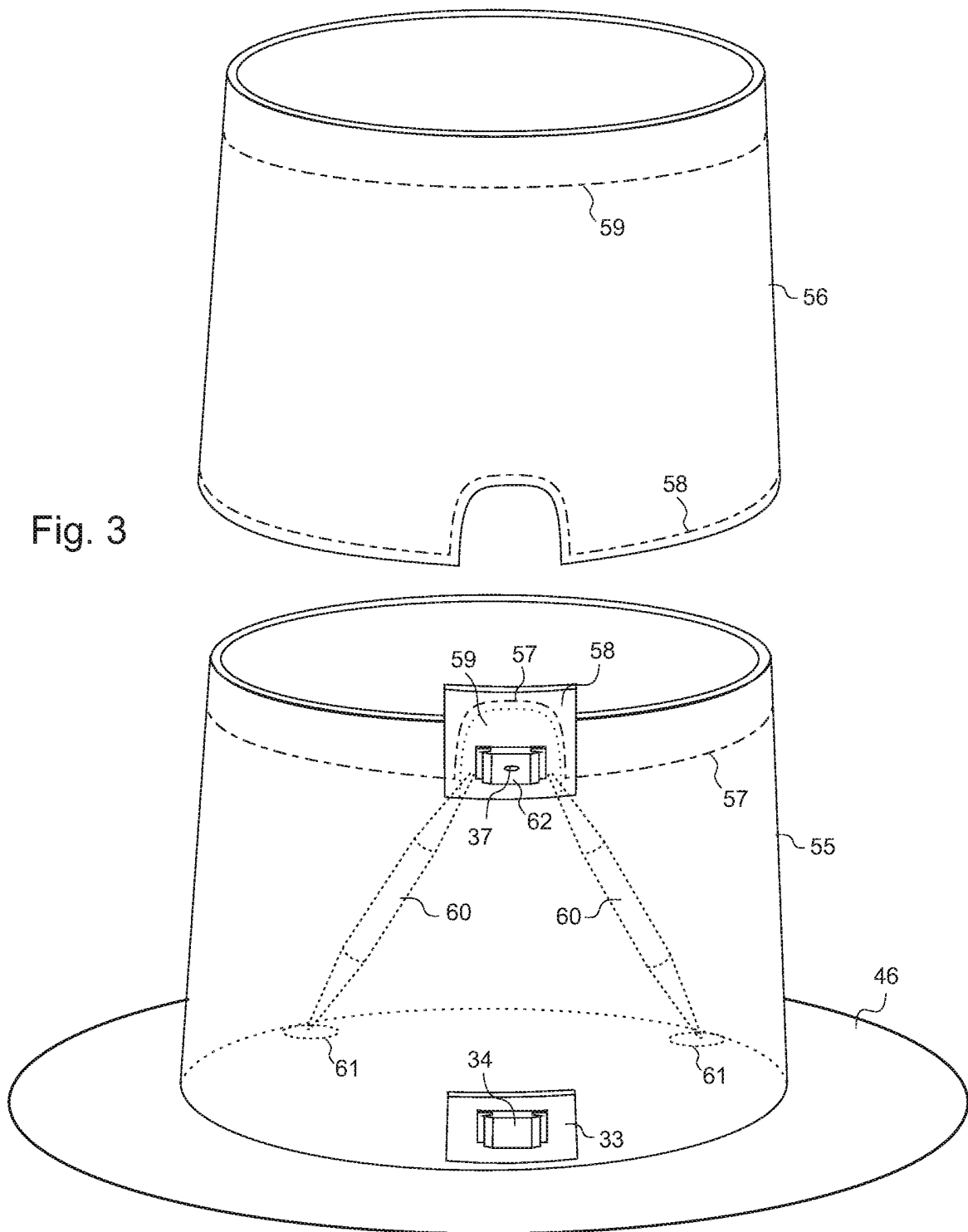
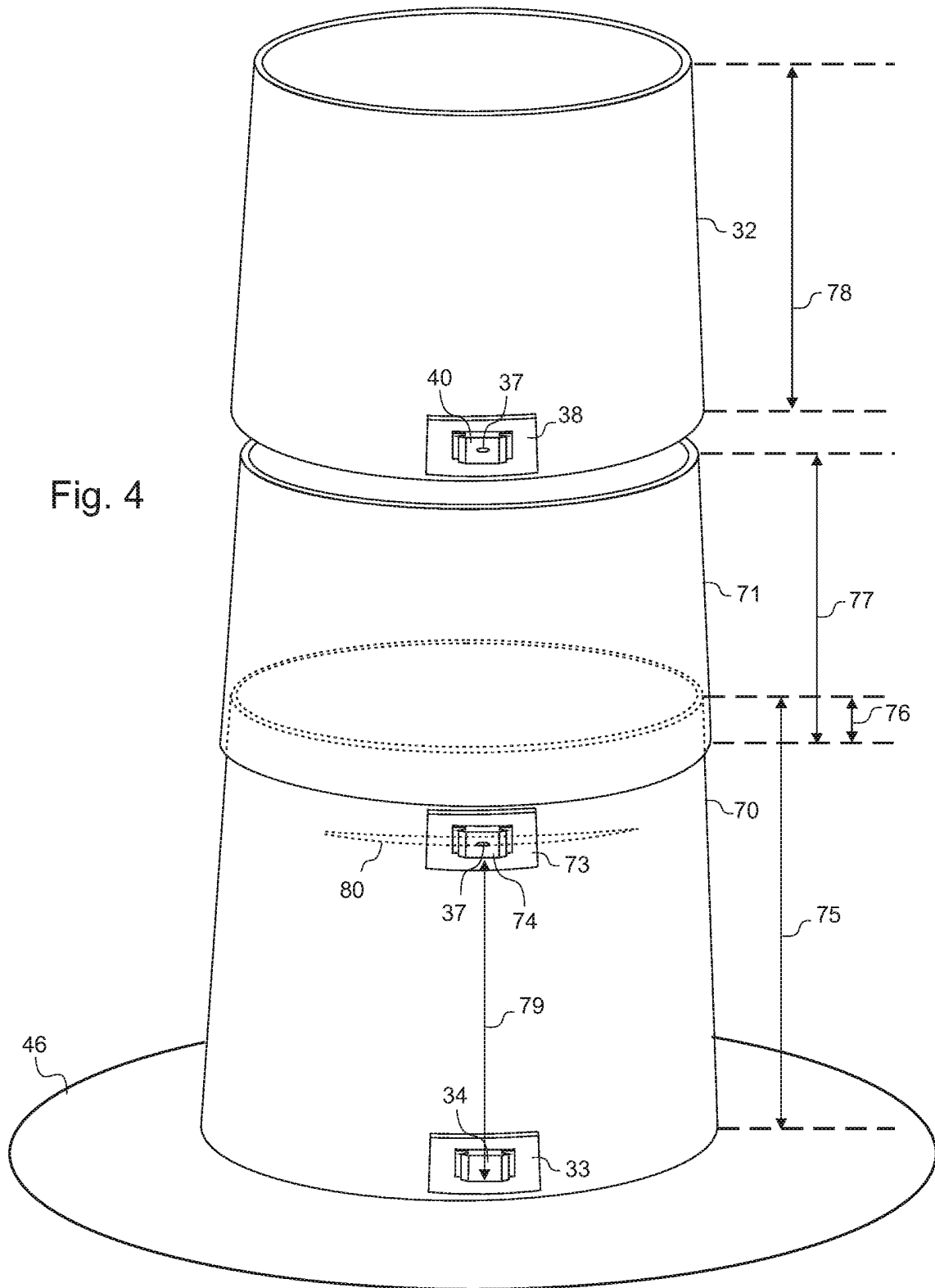


Fig. 3





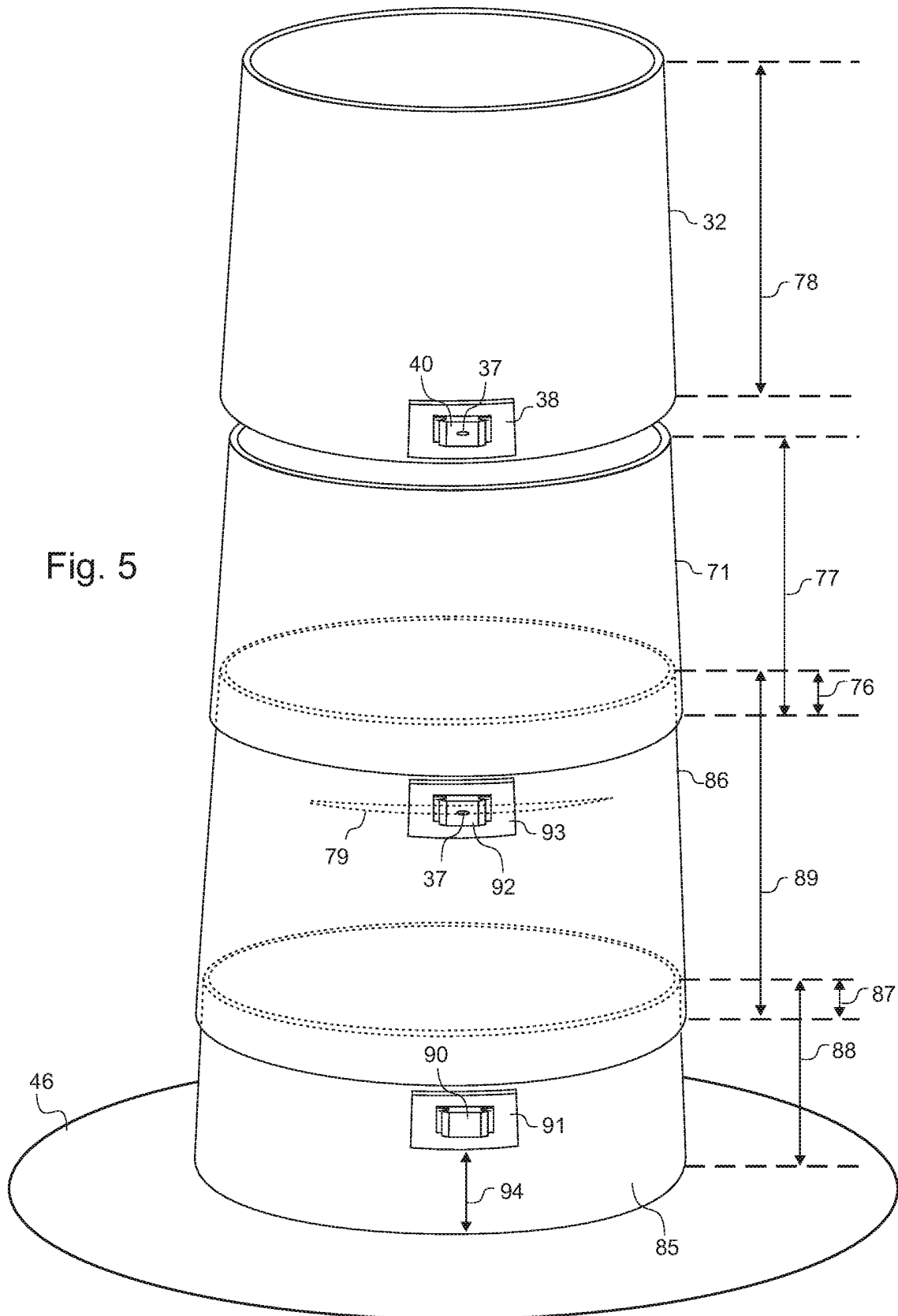


Fig. 6

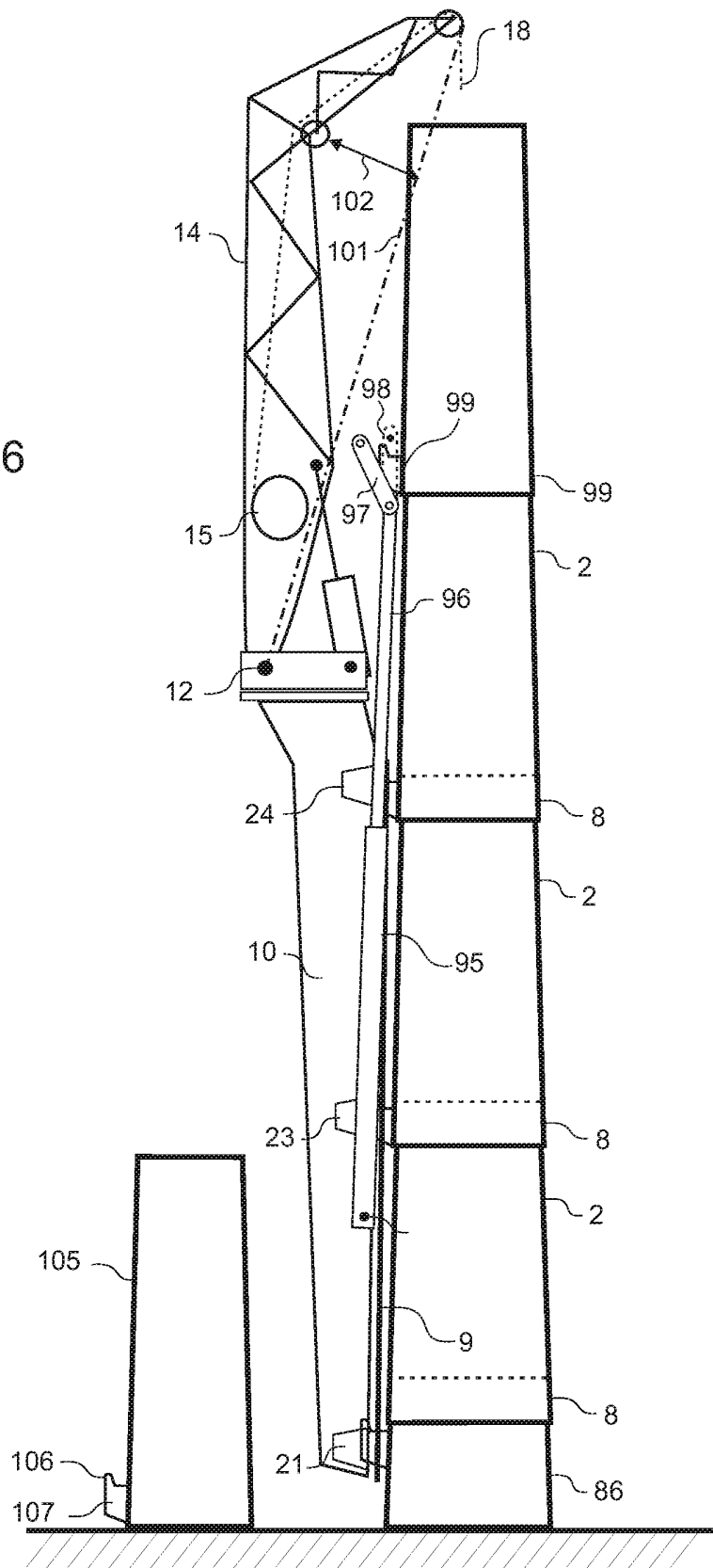


Fig. 7

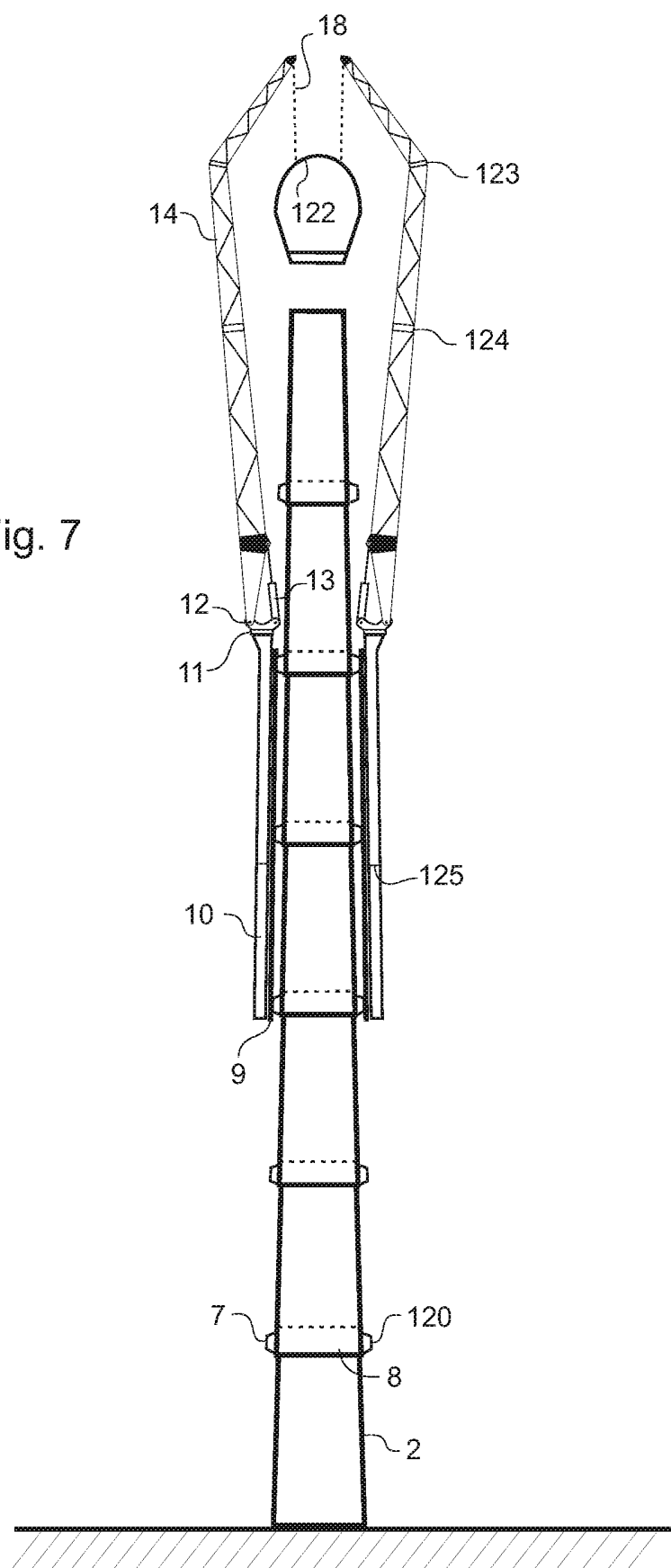


Fig. 8

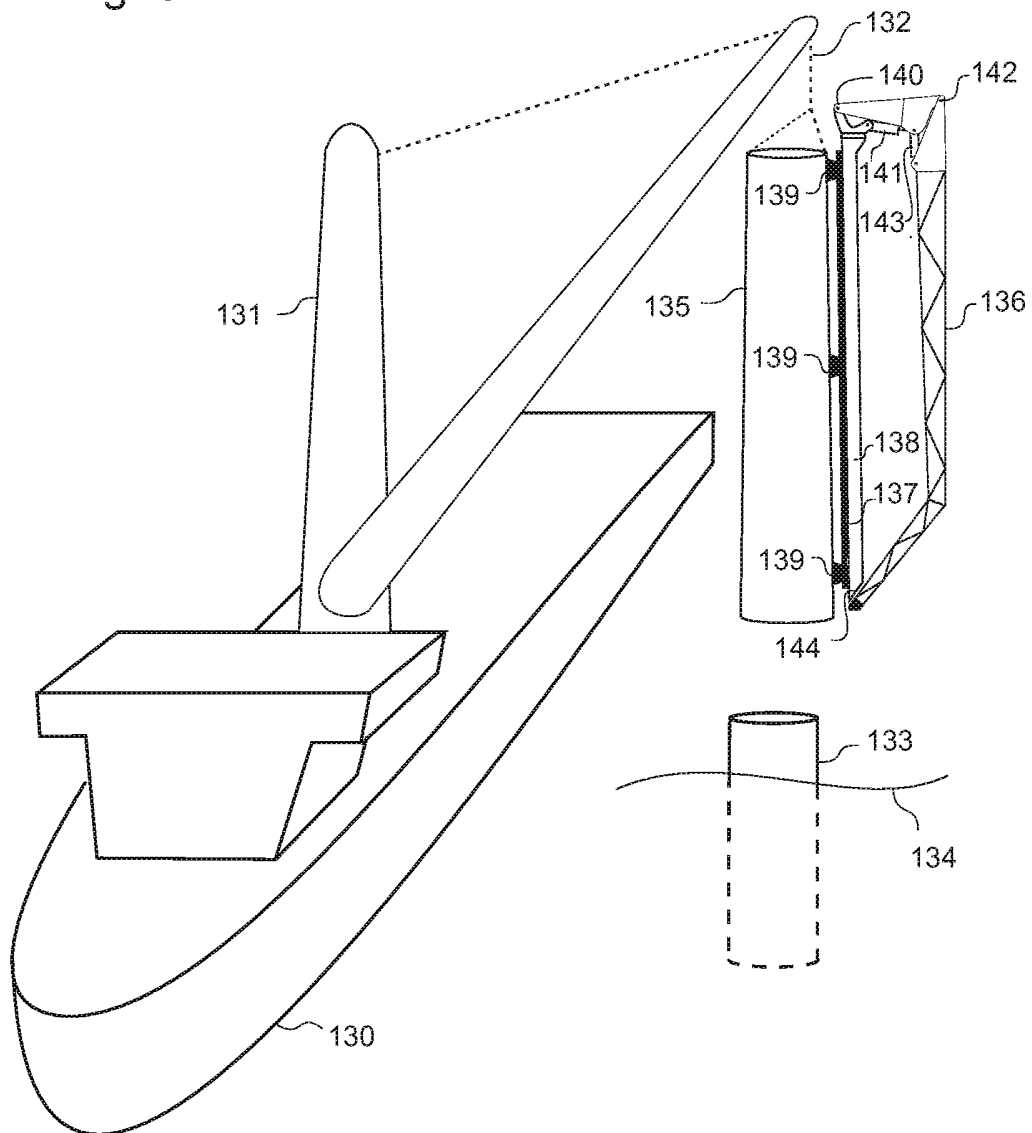


Fig. 9

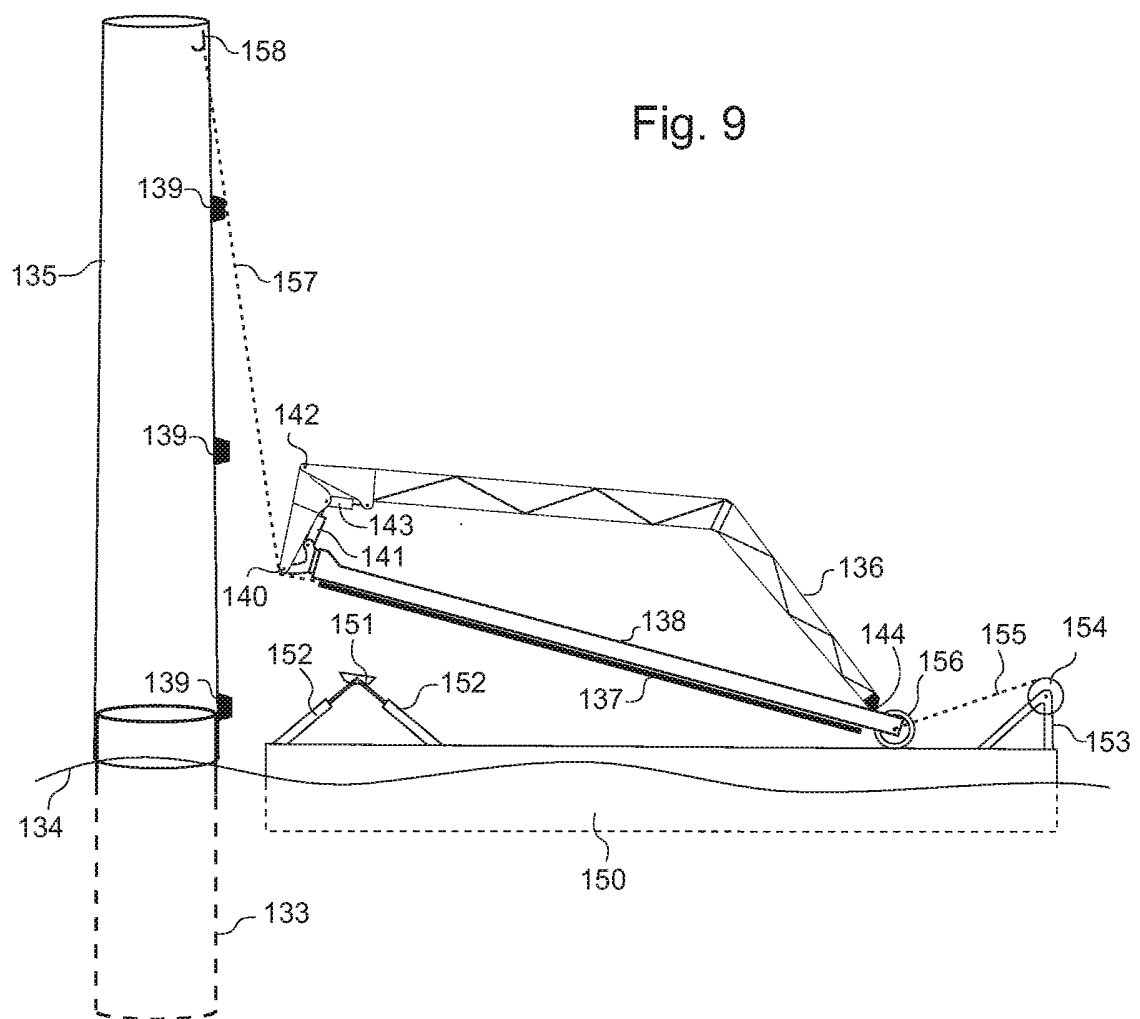


Fig. 10

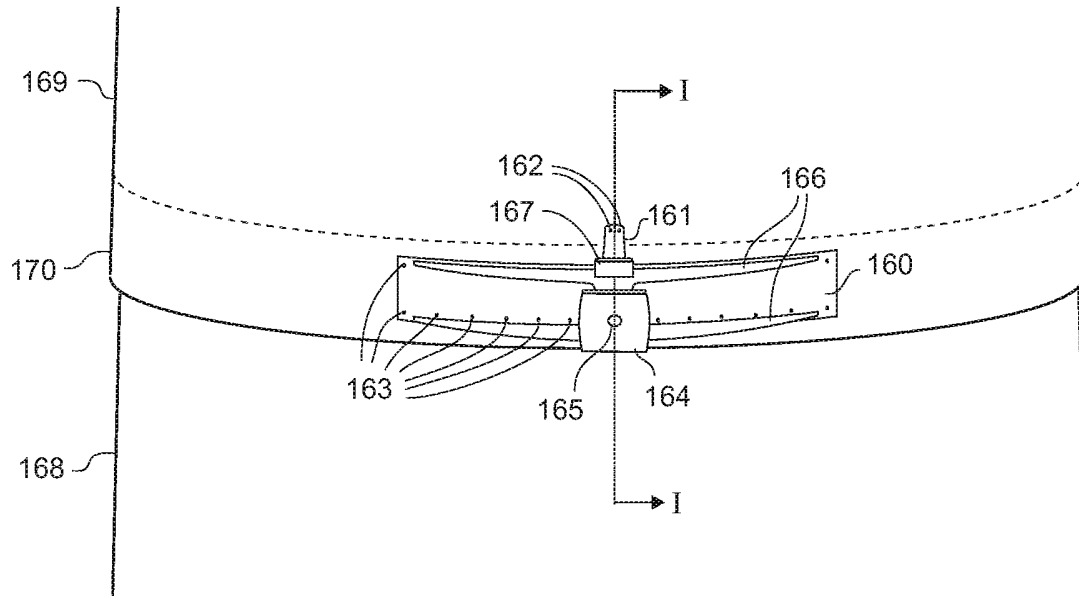


Fig. 11

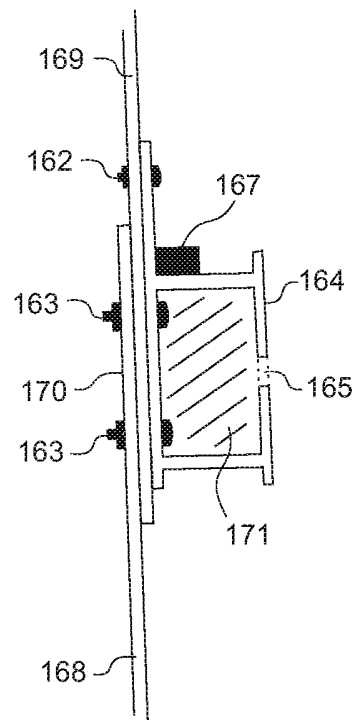


Fig. 12

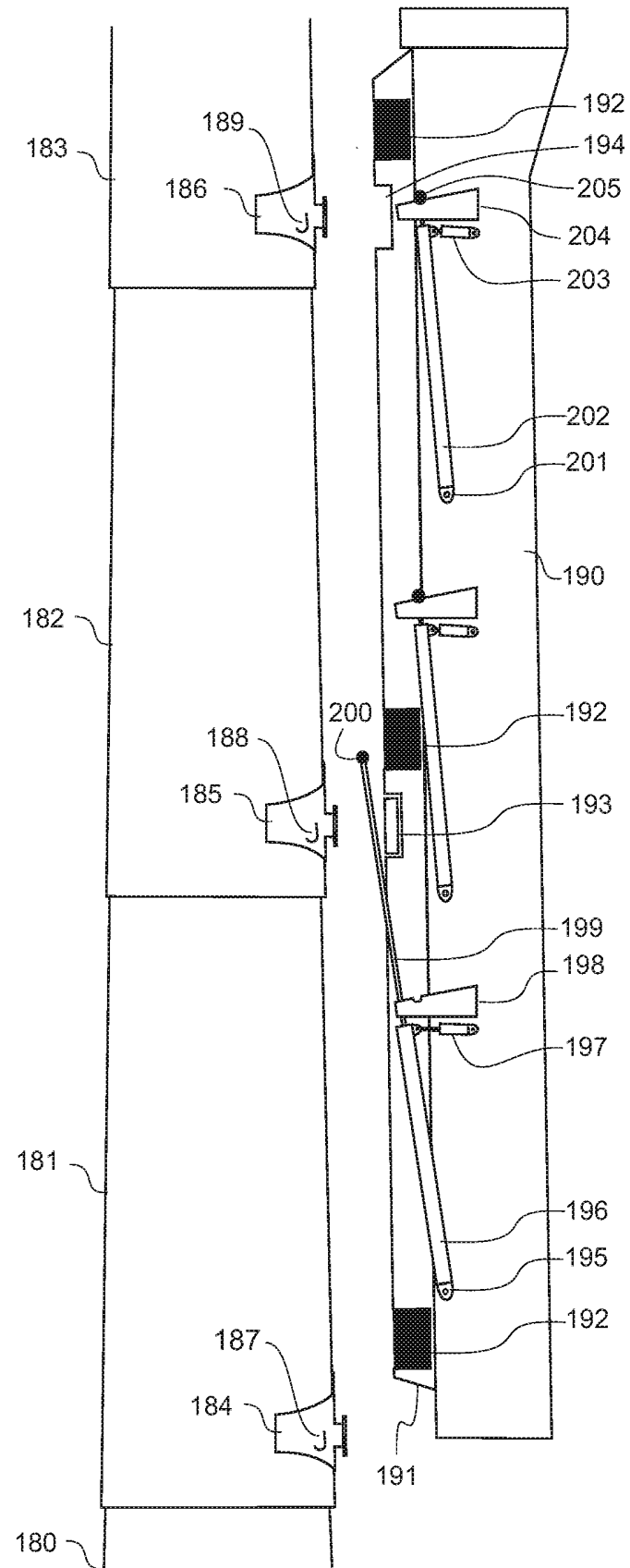


Fig. 13

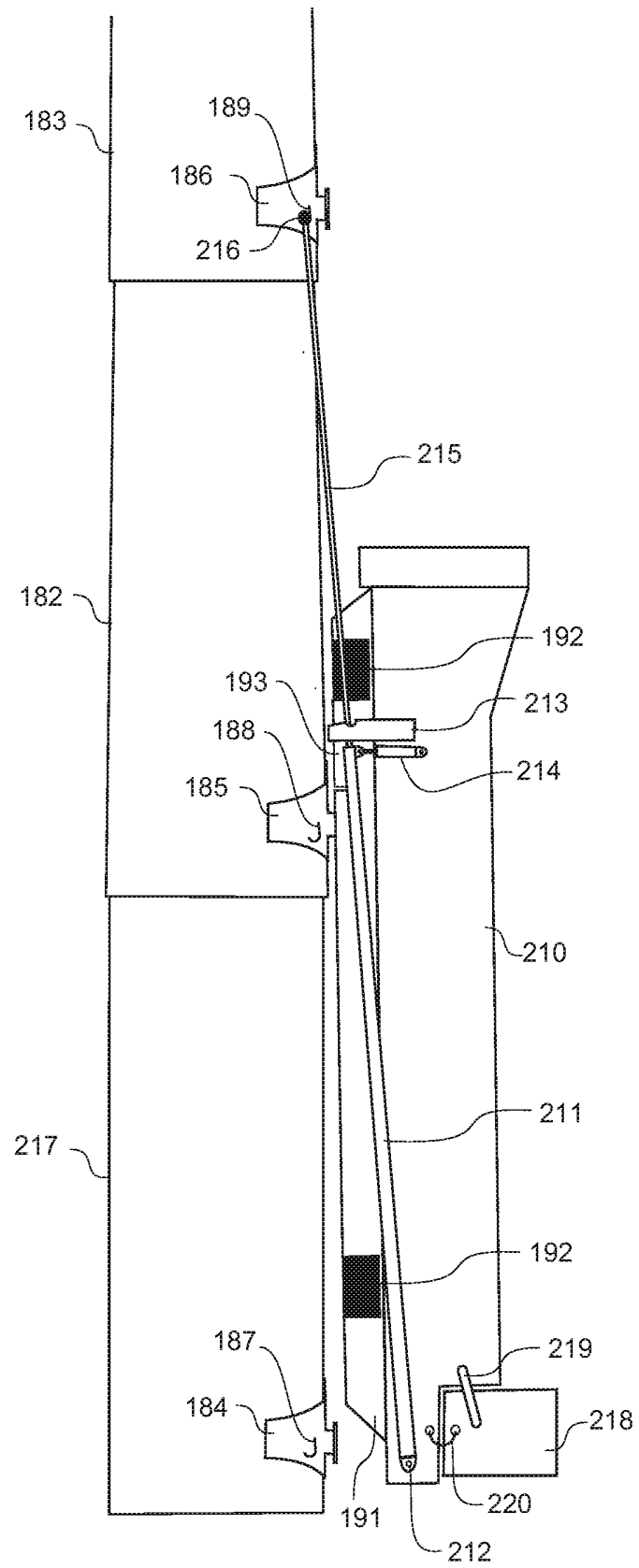


Fig. 14

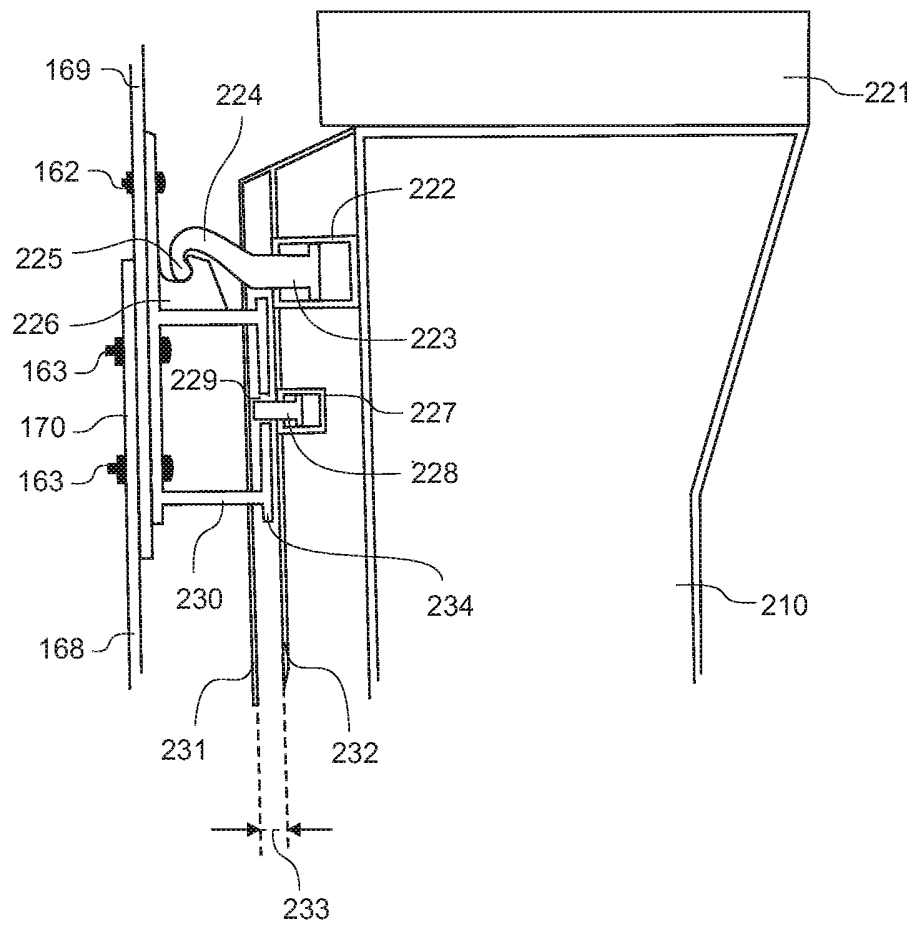


Fig. 15

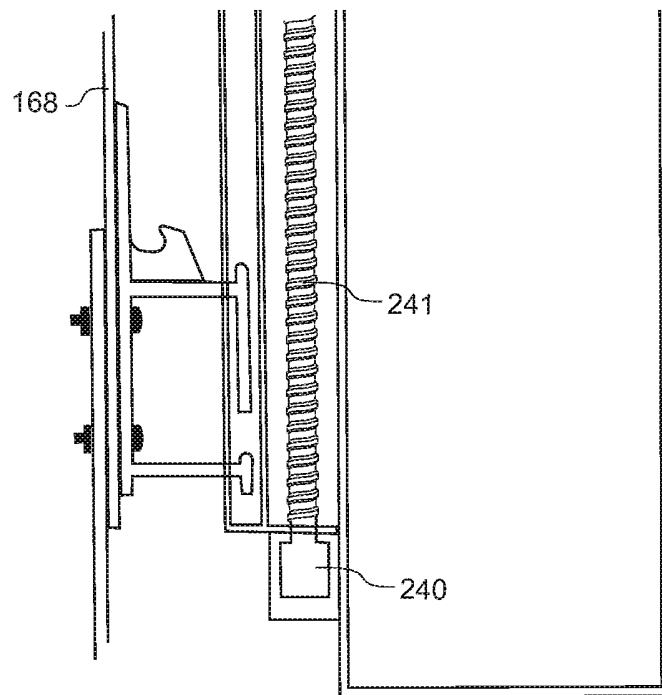
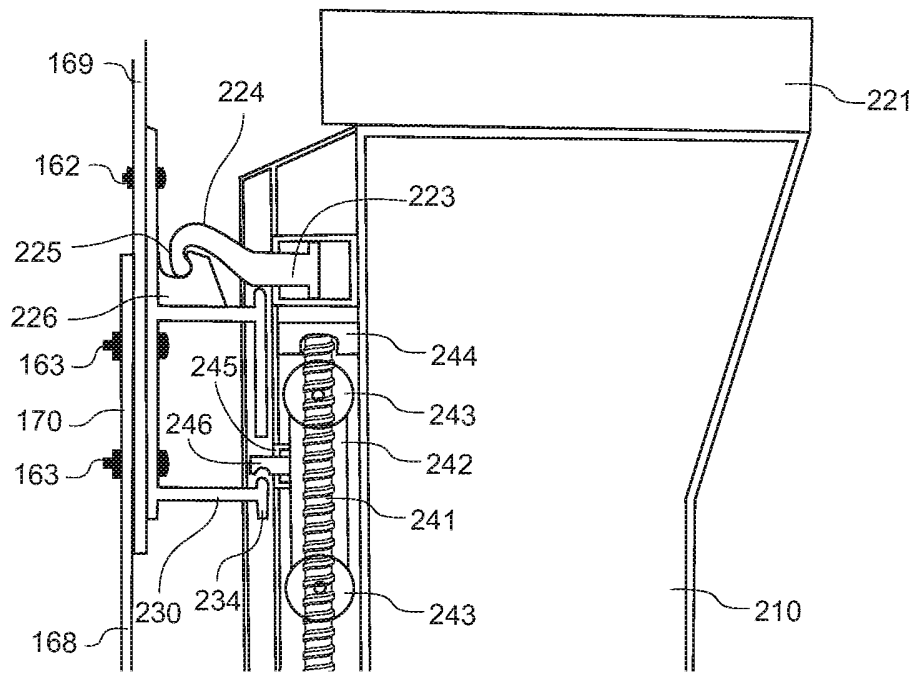
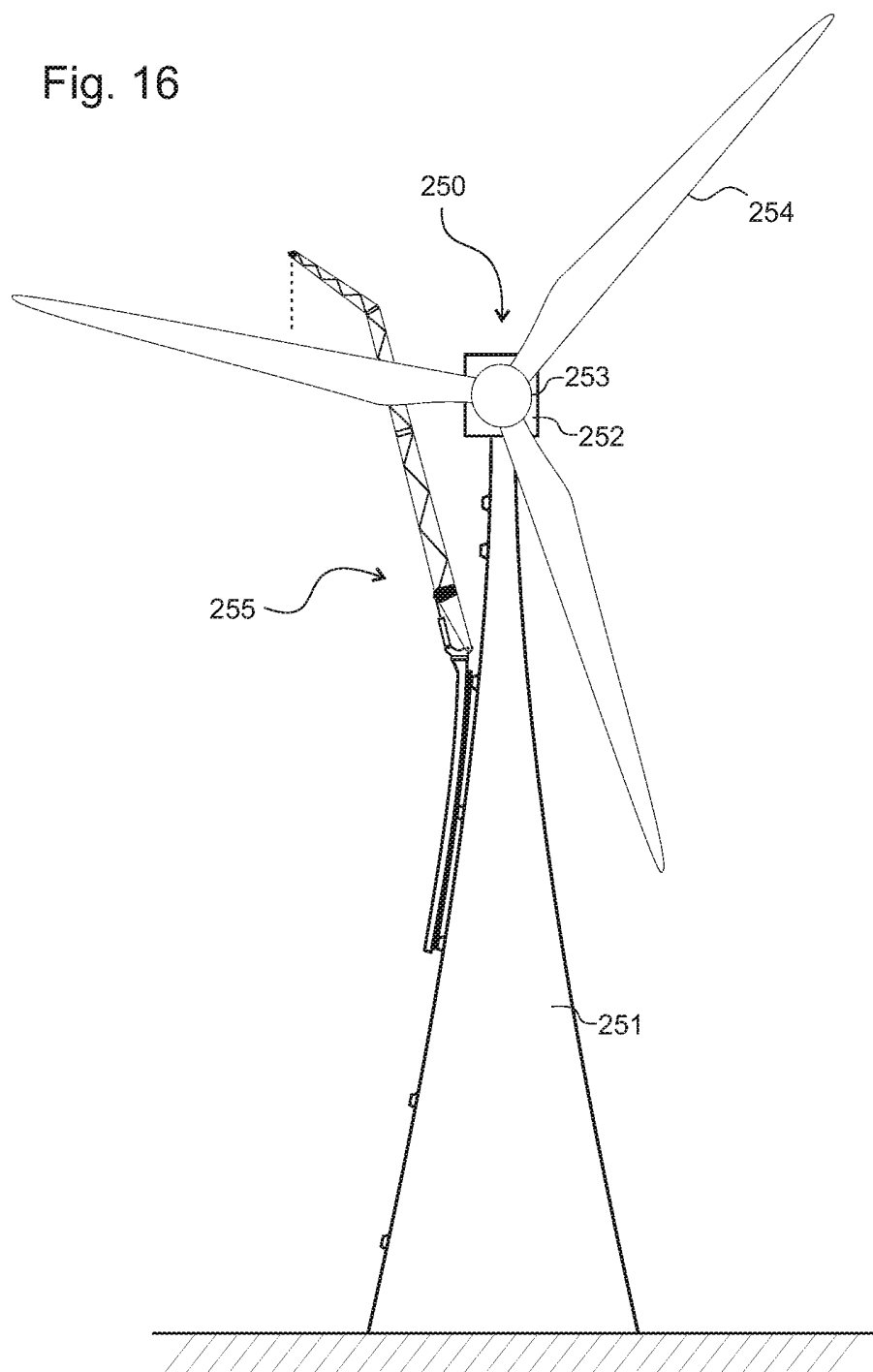


Fig. 16



ABSTRACT

A hoisting system for the installation of a wind turbine, wherein the wind turbine comprises a tower, the hoisting system comprising a column, a boom and a winch, wherein the column is arranged for creating a load bearing connection to a part of the tower of the wind turbine using one or more fixation points successively located along a longitudinal direction of the tower, and wherein the column is arranged to move the hoisting system essentially in vertical direction along said part of the tower when the load bearing connection is created.

(+Fig. 6)

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE 31621.0002.NLNO								
Nederlands aanvraag nr. 2016927	Indieningsdatum 09-06-2016								
	Ingeroepen voorrangsdatum								
Aanvrager (Naam) Lagerwey Wind B.V.									
Datum van het verzoek voor een onderzoek van internationaal type 17-09-2016	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. SN67340								
I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven) Volgens de internationale classificatie (IPC) B66C23/20;B66C23/32;B66C23/18;F03D01/00									
II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK Onderzochte minimumdocumentatie									
Classificatiesysteem	Classificatiesymbolen								
IPC	B66C;F03D;E04H								
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen									
<table border="0" style="width: 100%;"> <tr> <td style="width: 5%;">III.</td> <td style="width: 5%;">☐</td> <td style="width: 60%;">GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES</td> <td style="width: 30%; text-align: right;">(opmerkingen op aanvullingsblad)</td> </tr> <tr> <td>IV.</td> <td>☐</td> <td>GEBREK AAN EENHEID VAN UITVINDING</td> <td style="text-align: right;">(opmerkingen op aanvullingsblad)</td> </tr> </table>		III.	☐	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES	(opmerkingen op aanvullingsblad)	IV.	☐	GEBREK AAN EENHEID VAN UITVINDING	(opmerkingen op aanvullingsblad)
III.	☐	GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES	(opmerkingen op aanvullingsblad)						
IV.	☐	GEBREK AAN EENHEID VAN UITVINDING	(opmerkingen op aanvullingsblad)						

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2016927

A. CLASSIFICATIE VAN HET ONDERWERP

INV. B66C23/20 B66C23/32 B66C23/18 F03D1/00
ADD.

Volgens de internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)

B66C F03D E04H

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	WO 2014/082176 A1 (MARMEN INC [CA]) 5 juni 2014 (2014-06-05)	1,3-7, 10-16, 28, 30-34, 38-41,45
Y	* alinea [0078] - alinea [0079] *	17-27
A	* alinea [0089] - alinea [0090] *	47,50
	* alinea [0080] - alinea [0087] *	
	* figuren *	
X	JP S51 62222 U (-----) 17 mei 1976 (1976-05-17)	1,6,10, 13
A	* figuren *	4,5,47, 50
	----- -/-	

☒ Verdere documenten worden vermeld in het vervolg van vak C.

☒ Leden van dezelfde octroofamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvraag vermeld

"E" eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octroofamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid

21 oktober 2016

Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type

Naam en adres van de instantie

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

De bevoegde ambtenaar

Guthmuller, Jacques

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar
de stand van de techniek
NL 2016927

C.(Vervolg). VAN BELANG GEACHTTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X,D	US 2016/010623 A1 (ZUTECK MICHAEL [US]) 14 januari 2016 (2016-01-14) in de aanvraag genoemd	51
Y A	* figuren 2-6 * * alinea [0029] - alinea [0031] * * alinea [0044] * * alinea [0046] *	17-27 1,16,40, 47,50
X	JP S63 189391 A (KAWASAKI HEAVY IND LTD; KAWAJU KOJI KK) 4 augustus 1988 (1988-08-04)	1
A	* figuren 1, 4 *	47,50
A	JP 2003 184730 A (TOMOE GIKEN KK) 3 juli 2003 (2003-07-03) * figuren *	1,16,40, 47,50
A	US 2 720 694 A (HINES CLARENCE W) 18 oktober 1955 (1955-10-18) * figuren *	1,40,47, 50,51
A	JP S56 155193 A (ISHIKAWAJIMA HARIMA HEAVY IND; ICHIKAWA YOSHIO) 1 december 1981 (1981-12-01) * de figuren 3 tot 5 samen met de detail-figuren 10 en 11 *	1,10
A	JP S59 158794 A (TOMOEGUMI GIKEN KK) 8 september 1984 (1984-09-08) * de figuren 1, 2 en 3 samen met de detail-figuren 4-6 *	1,10
A	US 2009/019816 A1 (LOCKWOOD PHIL [CA] ET AL) 22 januari 2009 (2009-01-22) * figuren *	18,23, 25,26
A	WO 2009/097858 A1 (IB ANDRESEN IND AS [DK]; KRYGER ARNE [DK]; RYHOLL LARS [DK]) 13 augustus 2009 (2009-08-13) * samenvatting * * figuren 1-4 *	23-26
A	CN 101 375 011 A (VESTAS WIND SYS AS [DK]) 25 februari 2009 (2009-02-25) * figuren 1-5 *	23-26

**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2016927

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 2014082176	A1	05-06-2014	CA 2892651 A1 05-06-2014
			EP 2925942 A1 07-10-2015
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			WO 2014082176 A1 05-06-2014
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			JP S5435489 Y2 27-10-1979
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JP S63189391	A	04-08-1988	JP 2515531 B2 10-07-1996
			JP S63189391 A 04-08-1988
JP 2003184730	A	03-07-2003	JP 3950333 B2 01-08-2007
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			EP 1851401 A1 07-11-2007
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**ONDERZOEKSRAPPORT BETREFFENDE HET
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar
de stand van de techniek

NL 2016927

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie

WRITTEN OPINION

File No. SN67340	Filing date (<i>day/month/year</i>) 09.06.2016	Priority date (<i>day/month/year</i>)	Application No. NL2016927
International Patent Classification (IPC) INV. B66C23/20 B66C23/32 B66C23/18 F03D1/00			
Applicant Lagerwey Wind B.V.			

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

	Examiner Guthmuller, Jacques
--	-------------------------------------

WRITTEN OPINION

Application number

NL2016927

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the application as filed.
 - ☐ filed together with the application in electronic form.
 - ☐ furnished subsequently for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes: Claims	2, 4, 5, 7-9, 11, 12, 14, 17-33, 35-37, 41-51
	No: Claims	1, 3, 6, 10, 13, 15, 16, 34, 38-40
Inventive step	Yes: Claims	2, 8, 9, 29, 35-37, 42-44, 46-50
	No: Claims	1, 3-7, 10-28, 30-34, 38-41, 45, 51
Industrial applicability	Yes: Claims	1-51
	No: Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION

Application number
NL2016927

Box No. VII Certain defects in the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 WO 2014/082176 A1 (MARMEN INC [CA]); (2014-06-05) cited in the application

D2 JP S51 62222 U (-----) 17 mei 1976 (1976-05-17)

D3 US 2016/010623 A1 (ZUTECK MICHAEL [US]); (2016-01-14)

D4 JP S63 189391 A (KAWASAKI HEAVY IND LTD; KAWAJU KOJI KK); (1988-08-04)

CONCERNING THE CLAIMS 1-15:

2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

2.1 **D1** discloses: Een hijssysteem (see the relevant passages cited in the search report) voor de installatie van een windturbine, waarbij de windturbine een ~~tower~~ toren (22) [= second entity] omvat, het hijssysteem omvattende een kolom (72; see figure 3; see also the paragraphs [0078] & [0079]), een giek (see the boom 82 & the gantry 84; see also the paragraphs [0089] & [0090]) en een lier (see the winch on the figures 3 & 4) omvat, waarbij de kolom (72) is ingericht om een dragende verbinding te creëren (using the pawls; see also the figures 2-7 and the paragraphs [0083]-[0086]) met een deel (the slotted tracks) van de toren (22) gebruikmakend van een of meer bevestigingspunten (apertures 104) [= second entity] die zich opeenvolgend bevinden langs een lengterichting van de toren (22), en waarbij de kolom (72) is ingericht om het hijssysteem te verplaatsen (using the actuator(s); see for example the paragraphs [0080], [0082], [0084]) in hoofdzaak in verticale richting langs genoemd deel (slotted tracks) van de toren (22) als de dragende verbinding is gecreëerd.

2.2 **D2** (see the figures) also discloses a "hijssysteem" according to independent apparatus claim 1.

- 3 Concerning again independent claim 1: It is to be noted that **D4** (see the figures 1 and 4) also discloses the features of claim 1, excepted that: "de kolom is ingericht om een dragende verbinding te creëren gebruikmakend van een of meer bevestigingspunten". Nevertheless, D4 strongly hints at the solution proposed in claim 1.
- 4 Dependent claims 3, 6, 10, 13 and 15 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty.
- 4.1 **D1** (see again the relevant passages cited in the search report) also discloses the additional technical features of said claims 3, 6, 10, 13 and 15.
- 4.2 **D2** (see again the figures) also discloses the additional technical features of said claims 6, 10, 13.
- 5 Dependent claims 4, 5, 7, 11, 12 and 14 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step.
- In the claims 4, 5, 7, 11, 12 and 14 slight constructional changes in the "hijssysteem" of respectively claim 3, claim 4, claim 1, claim 10, claim 10 and claim 1 are defined which come within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen. Consequently, the subject-matter of said claims 4, 5, 7, 11, 12 and 14 also lacks an inventive step.
- 6 The combination of the features of the dependent claims 2, 8 and 9 is neither known from, nor rendered obvious by, the available prior art.

CONCERNING THE CLAIMS 16-39:

- 7 The present application does not meet the criteria of patentability, because the subject-matter of claim 16 is not new.
- D1** discloses: Een windturbine omvattende een toren (22), een gondel, een generator, een naaf en tenminste een blad (see also the figures 1, 11-16), waarbij de toren (22) een of meer bevestigingspunten (apertures 104) omvat

die opeenvolgend gesitueerd zijn langs een lengterichting van de toren (22) voor het losmaakbaar bevestigen en geleiden van een hijssysteem volgens een der conclusies 1-15 (see again the passages mentioned under point 2.1).

- 8 Dependent claims 34, 38 and 39 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty.

D1 (see again the relevant passages cited in the search report) also discloses the additional technical features of said claims 34, 38 and 39.

- 9 Dependent claims 17-28 and 30-33 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of inventive step.

- 9.1 The obvious combination of the documents **D1** and **D3** (see the figures 2 to 6, the paragraphs [0029]-[0031], [0044] & [0046]) discloses or at least very strongly suggest a "windturbine" having the additional technical features of the dependent claims 17 throughout 27. (*Even in the case where said combination D1 & D3 would not disclose all the features of one or several claim(s) taken among said claims 17-27, the respective undisclosed details would correspond to slight constructional changes which come within the scope of the customary practice followed by persons skilled in the art.*)

- 9.2 Concerning claim 28: Said claim does not define further the "windturbine" in terms of technical features (*this constitutes a minor clarity issue*), but rather where it should be placed. Placing said "windturbine" as defined in claim 28 is simply a matter of choice of the user. No inventive effort is involved.

- 9.3 Concerning claim 30: Said claim defines that the "windturbine" should be an "offshore windturbine". This is a slight constructional change which comes within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen. Consequently, the subject-matter of claim 30 also lacks an inventive step.

- 9.4 In claim 31 a slight constructional change in the "windturbine" of claim 30 is defined which comes within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen. Consequently, the subject-matter of claim 31 also lacks an inventive step.

- 9.5 In the claims 32 and 33 slight constructional changes in the "windturbine" of claim 16 are respectively defined which come within the scope of the customary practice followed by persons skilled in the art, especially as the advantages thus achieved can readily be foreseen. Consequently, the subject-matter of said claims 32 and 33 also lacks an inventive step.
- 10 The combination of the features of the dependent claims 29 and 35 to 37 is neither known from, nor rendered obvious by, the available prior art.

CONCERNING THE CLAIMS 40-46:

- 11 The present application does not meet the criteria of patentability, because the subject-matter of claim 40 is not new.
- D1** (see again the relevant passages cited in the search report) does obviously also disclose all the steps and features defined in said independent method claim 40.
- 12 Dependent claims 41 and 45 do not contain any elements and/or features which, in combination with the elements/features of claim 40 to which they refer, meet the requirements of inventive step.
- In the claims 41 and 45 slight changes in the method formulated in claim 40 are respectively defined which are strongly suggested in **D1**, and which would anyway come within the scope of the customary practice followed by persons skilled in the art.
- 13 The steps/elements suggested in the dependent claims 42 to 44 and 46 are neither known from, nor rendered obvious by, the available prior art.

CONCERNING THE CLAIMS 47-49 & 50:

- 14 Neither the steps/elements suggested in the method claims 47 to 49, nor the steps/elements suggested in the method claim 50 are known from, or rendered obvious by, the available prior art.

Indeed, none of the available documents discloses that:

*"...het hijssysteem omvattende een kolom **en** een rail, ... de methode omvattende de stap van het star bevestigen van de rail aan het bevestigingspunt of de bevestigingspunten."*

"...het hijssysteem omvattende een kolom en een rail, ... de methode omvattende de stappen van het losmaken van vaste verbindingen van de rail aan bevestigingspunten"

[The rail is part of the "hijssysteem", the "bevestigingspunten" are on the "windturbine".]

CONCERNING CLAIM 51:

- 14.1 **D3** (see the figures 2 to 6, the paragraphs [0029]-[0031], [0044] & [0046]) discloses a "windturbine" equipped with "bevestigingspunten" (8A) used in conjunction with a type of crane different from the one claimed in claim 1. D3 does not formally disclose adapting an existing wind mill. Nevertheless, the man skilled in the art - knowing D3 - would certainly consider adapting existing wind mills in order to be able to adequately support the "hijssysteem" defined in anyone of the claims 1 to 15. Therefore, the subject-matter of method claim 51 is not inventive.

Re Item VII

Certain defects in the application

- 15 The independent claims, especially the apparatus claims 1 and 16 are not drafted in the two-part form.