(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 309 063 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.04.2011 Bulletin 2011/15

(51) Int Cl.:
E02D 27/42 *(2006.01)* ***E02D 13/04*** *(2006.01)*

(21) Application number: **10180777.4**

(22) Date of filing: **28.09.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

(30) Priority: **01.10.2009 NO 20093082**

(60) Divisional application:
11153383.2

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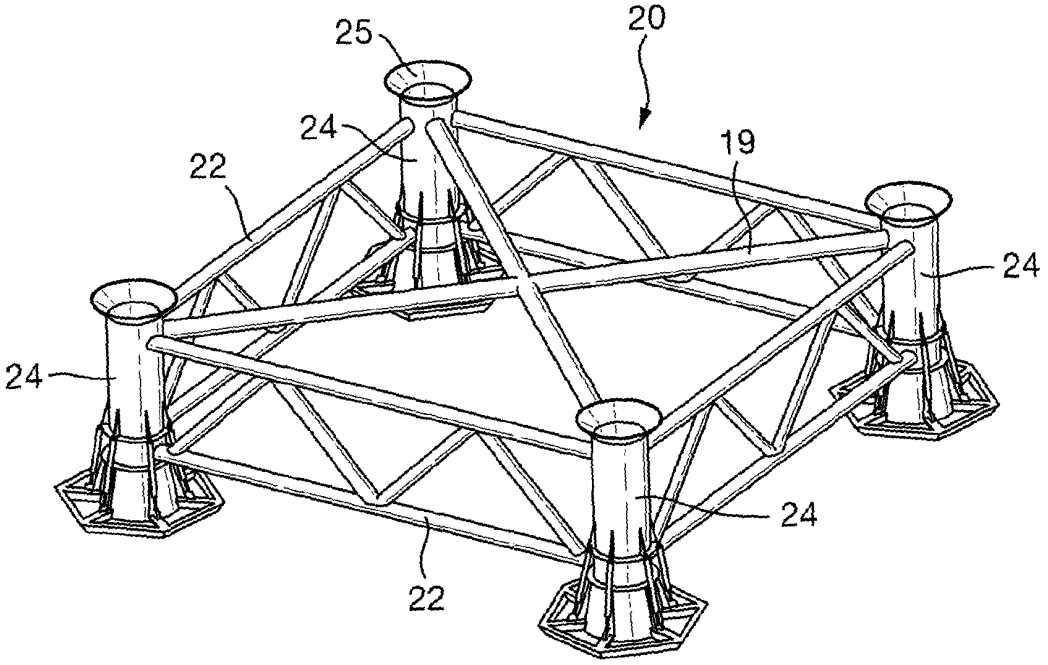
(54) Apparatus, system and method of extending piles into a seabed

(57) A guiding apparatus (20), system and method for piles (12) to be extended into a seabed, comprising a plurality of pile guiding elements (24) interconnected by connection elements (19, 22), each guiding element (24) having respective guiding means (27) and respective support elements (32) for supporting the apparatus on the seabed (B). The guiding means (27) is supported by the support element (32) via articulation means (23), each articulation means (23) having a first end (21) connected to the guiding means (27) and a second end (30) connected to the support element and being individually adjustable, whereby the articulation means (23) of each guiding element (24) are operable to ensure that the guiding apparatus (20) may brought into a level state on an inclined or uneven seabed.

Fig.2.



EP 2 309 063 A1

Description

Field of the invention

[0001] The invention concerns installation of piles. More specifically, the invention concerns an apparatus and a system for installation of piles, a method of installing the apparatus and a method of installing piles into the ground. The invention is of particular use for subsea applications and for installing piles into the seabed in connection with the erection offshore wind-energy power plants.

Background of the invention

[0002] The state of the art includes various structures, such as slender circular columns, for supporting wind powered plants for generating electricity. When installed at sea, such plants are commonly supported by a lower truss structure, also referred to as a "jacket", fixed to the seabed via piles or similar devices known in the art.

[0003] An example of a wind-powered plant for generating electricity is illustrated schematically in figure 1, where a truss structure 4, commonly referred to as a "jacket", is installed on a seabed B below a body of water W via foundation piles 12, in a manner well known in the art. The jacket 4 is in figure 1 shown as having main supports - or legs - 5a and diagonal struts 5b, and extends a distance above the water surface S.

[0004] The jacket 4 supports a circular column or tower 2, for example via a load transferring element 10, and the tower carries a wind turbine 6 having at least one turbine blade 6a. The action of the wind, both directly and via the rotation of the turbine, generates considerable torsion in the tower, as well as bending moments in the transition between the tower and the jacket. It is therefore of great importance that the jacket is properly and sufficiently supported on the seabed, and consequently that the piles 12 are set with the required precision and verticality.

[0005] It is known in the art to first install the piles in the seabed and the install the jacket on the pre-installed piles. Such pre-installation requires very high precision in order to for the jacket legs to fit precisely onto the piles. In order to ensuring that the piles are set in the correct position and inclination, it is known in the art to use various guide structures, operated either from a vessel or platform on the surface or via a subsea ROV. When the piles have been installed in the seabed, the structure (jacket) is placed on the piles, in a manner known in the art.

[0006] As an example, piles used for this purpose may have a length of 45m, a diameter of 1.5m and a weight in air of approximately 60 tonnes. Typically, the piles are extended 40m into the seabed. Jackets for use in wind farms are often placed in comparatively shallow waters (e.g. 15 - 25m), and subsea operations give poor or non-existent visibility in the water. This makes the use of ROVs and divers difficult.

[0007] It is therefore a need for a device and a method for ensuring accurate pre-installation of foundation piles, both in horizontal and vertical positions and orientations. It is also an object to provide an efficient and re-usable pile installation tool, whereby the installation time may be reduced.

Summary of the invention

[0008] It is thus according to the invention provided a guiding apparatus for piles to be extended into a seabed, comprising a plurality of pile guiding elements interconnected by connection elements, each guiding element having respective guiding means and respective support elements for supporting the apparatus on the seabed, characterised in that the guiding means is supported by the support element via articulation means, each articulation means having a first end connected to the guiding means and a second end connected to the support element and being individually adjustable, whereby the articulation means of each guiding element are operable to ensure that the guiding apparatus may brought into a level state on an inclined or uneven seabed.

[0009] The guiding means may comprise a tubular element having a first central axis and the support element may comprise a frusto-conical tubular element having a second central axis, and a portion of the guiding means is adjustably extendible inside the frusto-conical tubular element by said adjustment of the articulation means.

[0010] Preferably, the articulation means are individually and selectively adjustable, whereby the guiding means and the frusto-conical tubular element are movable with respect to one another, both in an axial direction where the first and second central axes coincide and in an articulated manner where the first and second central axes do not coincide. The extent of articulation is substantially determined by the conical angle of the frusto-conical tubular element.

[0011] In one embodiment, the articulation means are arranged with even spacing around the guiding element perimeter. In one embodiment, the articulation means comprise a hydraulic cylinder having a rod selectively adjustable between a retracted position and an extended position. Preferably, the articulation means of each guiding element are functionally interconnected, whereby each support element will adapt itself to the inclination of the seabed on which they are resting.

[0012] In one embodiment, the invention comprises a rectangular pile installation frame having four pile guiding elements rigidly interconnected by connection elements.

[0013] It is also according to the invention provided a system for installation of piles to be extended into a seabed, comprising a guiding apparatus having a plurality of pile guiding elements interconnected by connection elements, each guiding element having respective guiding means and respective support elements for supporting the apparatus on the seabed, said system also com-

prising control- and power means for connection to the guiding apparatus, characterised in that the guiding apparatus further comprises position-sensing means and inclination-sensing means operably connected via control means to the guiding elements, whereby the guiding apparatuses' horizontal and vertical positions may be adjusted and the guiding apparatus may brought into a level state on the seabed.

[0014] Preferably, the guiding apparatus further comprises hydro-acoustic sensing means connected to a control unit, for sensing the movement and position of a pile being extended into the guiding element. In one embodiment, the guiding apparatus further comprises visual sensing means connected to a control unit, for sensing the movement and position of a pile being extended into the guiding element.

[0015] Each guiding apparatus preferably comprises guiding means having a longitudinal opening for monitoring the position of the pile inside the guiding apparatus.

[0016] The guiding apparatus preferably comprises a distance sensor for sensing the distance between a piling tool and an upper region of the guiding apparatus.

[0017] It is also according to the invention provided a method of installing the guiding apparatus according to the invention, characterized by the steps of:

a) deploying the guiding apparatus to the seabed below a body of water;
b) sensing the inclination of said guiding apparatus on the seabed, by means of inclination-sensing means;
c) selectively operating the individual articulation means on each guiding means until the guiding apparatus has reached a desired inclination with respect to the seabed.

[0018] It is also according to the invention provided a method of extending a pile into a seabed by means of the system according to the invention, characterized by the steps of:

a) deploying the guiding apparatus to the seabed below a body of water;
b) lowering the pile towards a guiding element while monitoring the distance between the pile and the guiding element;
c) extending the pile into the seabed while monitoring the length of the pile rising above guiding element, until the pile has reached the desired depth in the seabed.

[0019] In one embodiment, the pile vertical position is measured using hydro-acoustic sensing means. In one embodiment, the pile vertical position is measured using visual sensing means. In one embodiment, the distance between a piling tool and an upper region of the guiding apparatus is measured simultaneously with step c). With the invention, a large number of piles may be pre-installed in a precise and efficient manner.

Brief description of the drawings

[0020] These and other characteristics of the invention will be clear from the following description of a preferential embodiment, given as a non-restrictive example, with reference to the attached drawings wherein:

Figure 1 is a schematic illustration of a wind turbine installation, comprising a jacket structure connected to piles driven into a seabed.

Figure 2 is a perspective view of an embodiment of the installation frame according to the invention;

Figure 3 is an enlargement of a portion of figure 2, showing an embodiment of the guide funnel according to the invention;

Figure 4 is a perspective view of a lower portion of the guide funnel according to the invention;

Figures 5a - 5e are schematic illustrations of the adjustable support element in various positions and orientations with respect to a guiding element of the guide funnel;

Figure 6 is a top view of an embodiment of the installation frame according to the invention;

Figure 7 is a schematic illustration of a system for monitoring the levelling of an installation frame and the installation of piles;

Figures 8a and 8b are schematic illustrations of an installation procedure for a pile, using an installation frame;

Figure 9 is a schematic illustration of a distance-measuring apparatus;

Figure 10 is a perspective view of a detail on an embodiment of the guide funnel;

Figure 11 a perspective view of an embodiment of the installation frame according to the invention;

Figure 12 is a top view of an embodiment of the installation frame shown in figure 11, identifying monitoring devices;

Figures 13 and 14 are perspective views of embodiments of an instrumentation platform; and

Figure 15 is a schematic illustration of a system for monitoring the levelling of an installation frame and the installation of piles.

Detailed description of a preferential embodiment

[0021] An embodiment of the guiding apparatus according to the invention is illustrated in figure 2. A pile installation frame 20 comprises in this embodiment four guiding elements 24, spaced apart with equal distance to form a square structure, and interconnected by truss structures 22 and diagonal bracing 19. This installation frame thus serves as an installation template, ensuring that the four piles for a given jacket are installed with the required spacing. In a practical example, the installation frame may have a footprint of approximately 18x18m^2 and a vertical extension of about 7m. A typical weight (in air) is 150 tonnes.

[0022] Figure 3 is an enlargement of a portion of figure 2, showing one of the guiding elements 24. Each guiding element 24 comprises a pile receptacle 25 connected to a guide funnel 27, and an adjustable support element 32. The support element 32 is connected to the guide funnel 27 via a plurality of actuators 23, in the described embodiment hydraulic cylinders 23. This arrangement is shown in more detail in figure 4, illustrating the lower portion of the guiding element 24.

[0023] In the illustrated embodiment, six actuators 23 (only four shown) connect the support element 32 to the guide funnel 27. The actuators 23 thus provide an adjustable, articulated connection between the guide funnel and the support element. The support element 32 comprises a foot plate, or mud mat, 26 for placement on the seabed, and a frusto-conical (i.e. truncated cone) element 28.

[0024] Turning now to the sectional principle sketches in figures 5a - 5e, it can be seen (e.g. figure 5a) how the guide funnel 27 extends a distance into the frusto-conical element 28, having a cone angle α_C and being adjustably supported by the actuators 23. The actuators which in this embodiment are hydraulic cylinders, have a first end 21 connected to the guide funnel 27 and a second end 30 connected to the support element 32, preferably the mud mat 26.

[0025] Figure 5b and 5c illustrate various relative vertical positions between the support element 32 and the guide funnel 27, all actuators 23 having the same the degree of actuation and the guide funnel central axis C_{27} coinciding with the support element central axis C_{32}.

[0026] In figures 5d and 5e, the actuator 23 on the left-hand side is extended more than the actuator 23 on the left-hand side, whereby the support element and the guide funnel are pivoted (or deflected) with respect to one another, i.e. such that the central axes C_{27} and C_{32} are not coinciding. It will be appreciated that the cone angle α_C determines the maximum deflection between the central axes, i.e., in principle, $\alpha_M \sim 2\alpha_C$. In a practical application the maximum deflection may be somewhat greater, due to necessary tolerances between the frusto-conical element and the guide funnel. It is apparent from the figures, however, that the maximum deflection is limited by the abutment of the guide funnel against the inner wall of the frustro-conical element.

[0027] Therefore, the actuators serve as an articulated joint between the support element and the guide funnel By selectively varying the stroke of the individual actuators 23 on the individual guiding element 24, the support element 32 and the guide funnel 27 may be adjusted such that the support element is resting against the somewhat inclined seabed, while the guide funnel 27 extends substantially vertically. By adjusting the actuators on all of the guiding elements 24 in this fashion, the pile installation frame 20 may be adjusted to a substantially level state on the seabed, its guide funnels 27 thereby having a vertical orientation.

[0028] In a practical application, the guiding elements may accommodate a seabed inclination of 10° and the actuators may have maximum stroke of 1.5m. The actuators 23 may be hydraulic cylinders, interconnected via a subsea control unit 49 (see figure 7).

[0029] In one embodiment, the individual actuators 23 are selectively fluidly interconnected via fluid lines 52 and a remote control unit 49 (see figure 7). An operator may thus - based on measurements of the applicable seabed conditions, etc. - set a certain pressure in the fluid lines, common for all actuators on a given guiding element 24, whereby the respective support element 32 will be permitted to bear against the seabed surface S (having an inclination β with respect to the horizontal; see e.g. figure 5d), while ensuring that the guide funnel 27 is substantially vertical. This operation may be repeated for each guiding element, until the pile installation frame 20 has assumed a substantially level orientation. Thus, each support element will automatically adapt itself to the inclination β of the seabed on which it is resting. Then, the pressures in the hydraulic lines for each guiding element 24 may be equalized in order to ensuring that all four guiding elements bear against the seabed with the substantially same force.

[0030] The system for installing the pile installation frame 20 and for installing the piles, will now be described with reference to figures 6 to 10.

[0031] Figure 6 is a top view of the installation frame 20, showing some of the applicable instrumentation. Positioning data for the pile installation frame, e.g. in relation to an installation vessel, are provided by transponders 36, attached to the truss structure 22. The transponders may also be provided with inclinometers. A gyro 46, placed on an instrumentation platform 34, provides for high-accuracy measurement of heading and tilt data. Examples of applicable gyros are laser ring gyro and fibre-optic gyro.

[0032] For use during the pile installation, cameras 42 and lights 42a, pan-and-tilt cameras 42', a sonar 38, and echo sounders 40 are also fitted to the guide frame. The sonar may be a digital multi-frequency scanning sonar, having a 360° operations range. A convenient camera configuration may be two cameras in each corner of the frame, for example having pan-and-tilt capabilities for 360° monitoring. The lights may preferably be of the LED

type.

[0033] The instrumentation platform also comprises a valve assembly, termed a Remote Control Unit (RCU) 49, the connection of which is schematically illustrated in figure 7. The RCU 49 is connected via individual lines 52 to respective hydraulic actuators 23. As mentioned above, the actuators (hydraulic cylinders) 23 around each guiding element 24 are operated through two independent systems, and the system is fully operational with one faulty system for each guiding element. The RCU 49 is supplied from an umbilical 50 from a Hydraulic Power Unit (HPU) 54 on the topsides vessel 57 (see figure 8a), platform, or similar, and is operated by electrical signals routed through a Subsea Electronic Module (SEM) 48 on the installation frame. The aforementioned gyro 46, sonar 38, echo sounder 40 and cameras and light 42, 42', are also connected to the SEM 48. The topsides HPU 54 is included as an integral part of the overall control system, included in a operation container located at the installation vessel, also comprising known elements such as e.g. an umbilical reel 56. The umbilical 50 may be a conventional bundle of hydraulic hoses 55a, power cables and signal cables 47.

[0034] Figure 15 shows an alternative embodiment of the monitoring and control system, where hydraulic lines 55a (dotted lines) connects the topsides oil reservoir 55 and HPU 54a with the subsea installation frame. Power and signal lines 47 (solid lines) are via a connection plate 47a connected to matrices 70, which in turn are connected to the actuators via valve pack 69 and lines 52, as described above. Figure 15 also identifies accelerometer 71, pan-and-tilt camera 42', as well as cameras 42, 42a, d, and gyro 46, sonar 38 and distance measuring units 62.

[0035] An alternative embodiment of the instrumentation platform 34 is illustrated in figures 11 - 14. One instrumentation platform is positioned substantially in the centre of the installation frame, and one instrumentation platform is placed on or in the vicinity of each guiding element 24 (see figure 11), i.e. for monitoring the setting of each respective pile. Each instrumentation platform 24 is in this embodiment provided with - in addition to the aforementioned instruments - multiplexer 68, a distance-measuring unit 62 (described below) and cameras 42 and lights 42a, as well as a vertical measurement camera 42b underneath the platform 34.

[0036] With the system described above, an operator is able to:

- Verify that the installation frame is placed on the correct position with correct heading on the seabed;
- Monitor and verify horizontal leveling of the frame on the seabed;
- Assist in guiding the piles into the frame funnels by monitoring the location of the pile during stabbing; and
- Monitor and verify vertical position of the piles.

[0037] Using the apparatus and system described above, the typical operation sequence is thus:

1. Placing the installation frame 20 on the seabed in the correct position and orientation;
2. Adjusting the installation frame to horizontal alignment (level) through individual leveling of each guiding element 24 (i.e. each corner of the frame) and verifying horizontal position;
3. Guiding the piles 12 into the respective pile receptacle 25 on each guiding element 24;
4. Driving the foundation piles 12 using a hydraulic hammer 64 (optionally supplemented by a follower on top of the pile);
5. Observing the pile driving towards target penetration, by either visual or hydro-acoustic means;
6. Measuring the vertical position of each pile top, by either visual or hydro-acoustic means;
7. Guiding soil removal tool into the piles, and,
8. When the piles are cleaned to specified depth, retrieving the installation frame 20 to the surface.

[0038] Figures 8a and 8b are schematic representations of the installation of a pile 12 into the seabed, using the apparatus and system described above. In figure 8a, the pile 12 is lowered by a crane 58 on a surface vessel 57, while the approaching pile and its distance from the guiding element 24 is being monitored bye means of the sonar 38 or the echo sounder 40. A platform, e.g. a jack-up platform or similar topsides structure, may be used instead of the floating vessel 57. It is also possible to monitor the introduction of the pile into the guiding funnel 27 by visual means, such as the cameras 42, 42' (not shown in figure 8a). Using these hydro-acoustic or visual means, the operator can monitor the length of pile remaining (see figure 8b) and thus determine the penetration depth. The central sonar will observe the hammer 64 as this approaches the height for target penetration. This will give indication to when observations from other systems should be started.

[0039] Figures 9 and 10 illustrate further means for controlling the pile installation, more specifically the vertical position of the top of the pile.

[0040] In figure 9, a distance sensor 62 is mounted on the guide funnel 27, and through an opening 63 in the pile receptacle 25 being able to measure the distance to a defined point on the hammer 64 or follower, e.g. up to the flange 65 on the hammer (see also figures 12 and 14).

[0041] In figure 10, visual confirmation via the cameras

42, 42' is possible by a slot 67 in the guide funnel 27, combined with markings on the pile top or pile follower (indicated by horizontal stripes in the slot 67 in figure 10).

Claims

1. A guiding apparatus (20) for piles (12) to be extended into a seabed, comprising a plurality of pile guiding elements (24) interconnected by connection elements (19, 22), each guiding element (24) having respective guiding means (27) and respective support elements (32) for supporting the apparatus on the seabed (B), **characterised in that**
the guiding means (27) is supported by the support element (32) via articulation means (23), each articulation means (23) having a first end (21) connected to the guiding means (27) and a second end (30) connected to the support element and being individually adjustable,
whereby the articulation means (23) of each guiding element (24) are operable to ensure that the guiding apparatus (20) may brought into a level state on an inclined or uneven seabed.

2. The guiding apparatus of claim 1, wherein the guiding means (27) comprises a tubular element having a first central axis (C_{27}) and the support element (32) comprises a frusto-conical tubular element (28) having a second central axis (C_{32}), and a portion of the guiding means (27) is adjustably extendible inside the frusto-conical tubular element (28) by said adjustment of the articulation means (23).

3. The guiding apparatus of claim 2, wherein the articulation means (23) are individually and selectively adjustable, whereby the guiding means (27) and the frusto-conical tubular element (28) are movable with respect to one another, both in an axial direction where the first (C_{27}) and second (C_{32}) central axes coincide and in an articulated manner where the first (C_{27}) and second (C_{32}) central axes do not coincide.

4. The guiding apparatus of claim 2 or claim 3, wherein the extent of articulation is substantially determined by the conical angle (α_C) of the frusto-conical tubular element (28).

5. The guiding apparatus of any one of claims 1 - 4, wherein the articulation means (23) are arranged with even spacing around the guiding element (24) perimeter.

6. The guiding apparatus of any one of claims 1 - 5, wherein the articulation means (23) comprise a hydraulic cylinder having a rod selectively adjustable between a retracted position and an extended position.

7. The guiding apparatus of any one of claims 1 - 6, wherein the articulation means (23) of each guiding element (24) are functionally interconnected, whereby each support element will adapt itself to the inclination of the seabed on which they are resting.

8. The guiding apparatus of any one of claims 1 - 7, comprising a rectangular pile installation frame having four pile guiding elements (24) rigidly interconnected by connection elements (19, 22).

9. A system for installation of piles (12) to be extended into a seabed (B), comprising a guiding apparatus (20) having a plurality of pile guiding elements (24) interconnected by connection elements (19, 22), each guiding element (24) having respective guiding means (27) and respective support elements (32) for supporting the apparatus on the seabed (B), said system also comprising control- and power means (54, 56) for connection to the guiding apparatus (20), **characterised in that** the guiding apparatus (20) further comprises position-sensing means (36) and inclination-sensing means (46) operably connected via control means (49) to the guiding elements (24), whereby the guiding elements' (24) horizontal and vertical positions may be adjusted and the guiding apparatus (20) may brought into a level state on the seabed.

10. The system of claim 9, wherein the guiding apparatus (20) further comprises hydro-acoustic sensing means (38; 40) connected to a control unit (48), for sensing the movement and position of a pile (12) being extended into the guiding element (24).

11. The system of claim 9 or claim 10, wherein the guiding apparatus (20) further comprises visual sensing means (42; 42') connected to a control unit (48), for sensing the movement and position of a pile (12) being extended into the guiding element (24).

12. The system of any one of claims 9 - 11, wherein each guiding element (24) comprises guiding means (27) having a longitudinal opening (67) for monitoring the position of the pile (12) inside the guiding elements (24).

13. The system of any one of claims 9 - 12, wherein the guiding element (24) comprises a distance sensor (62) for sensing the distance between a piling tool (64) and an upper region (25) of the guiding element (24).

14. The system of any one of claims 9 - 13, wherein the guiding apparatus (20) comprises the guiding apparatus according to claims 1 - 7.

15. A method of installing the guiding apparatus accord-

ing to claims 1 - 8, **characterized by** the steps of:

a) deploying the guiding apparatus (20) to the seabed (B) below a body of water (W);
b) sensing the inclination of said guiding apparatus on the seabed, by means of inclination-sensing means (46);
c) selectively operating the individual articulation means (23) on each guiding means (27) until the guiding apparatus (20) has reached a desired inclination with respect to the seabed.

16. A method of extending a pile (12) into a seabed (B) by means of the system of claims 9 - 14, **characterized by** the steps of:

a) deploying the guiding apparatus (20) to the seabed (B) below a body of water (W);
b) lowering the pile (12) towards a guiding element (24) while monitoring the distance between the pile and the guiding element;
c) extending the pile into the seabed while monitoring the length of the pile rising above guiding element (24), until the pile has reached the desired depth in the seabed.

17. The method of claim 16, wherein the pile vertical position is measured using hydro-acoustic sensing means (38, 40).

18. The method of claim 16 or claim 17, wherein the pile vertical position is measured using visual sensing means (42, 42').

19. The method of any one of claims 16 - 18, wherein the distance between a piling tool (64) and an upper region (25) of the guiding element (24) is measured simultaneously with step c).

20. The method of any one of claims 16 - 19, wherein the method of claim 14 is executed after step a) and before step b).

Fig.1.

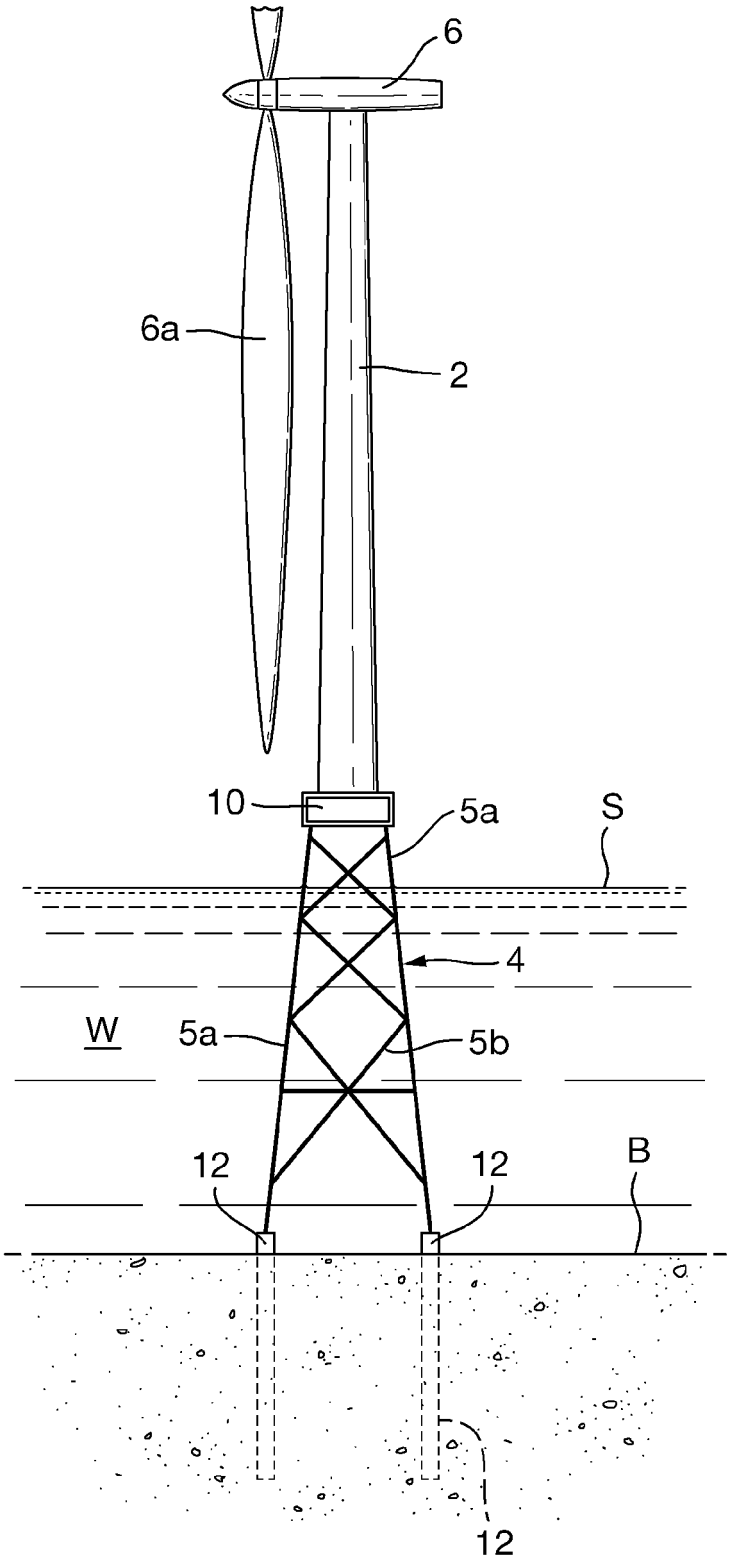


Fig.2.

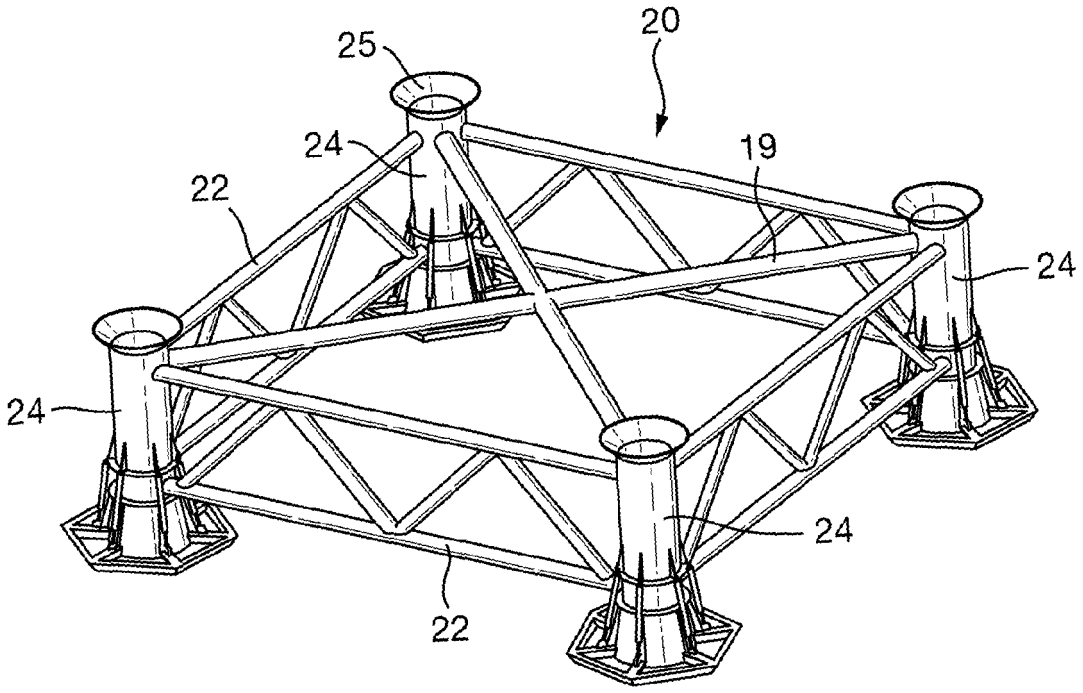


Fig.3.

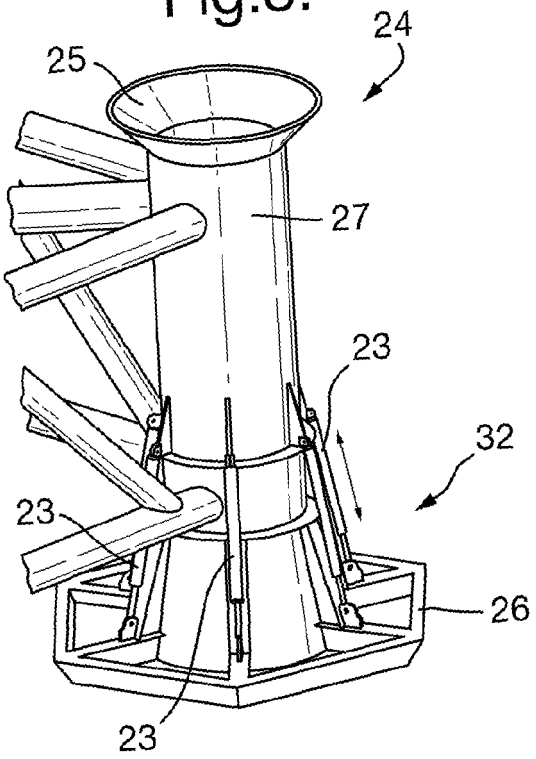


Fig.4.

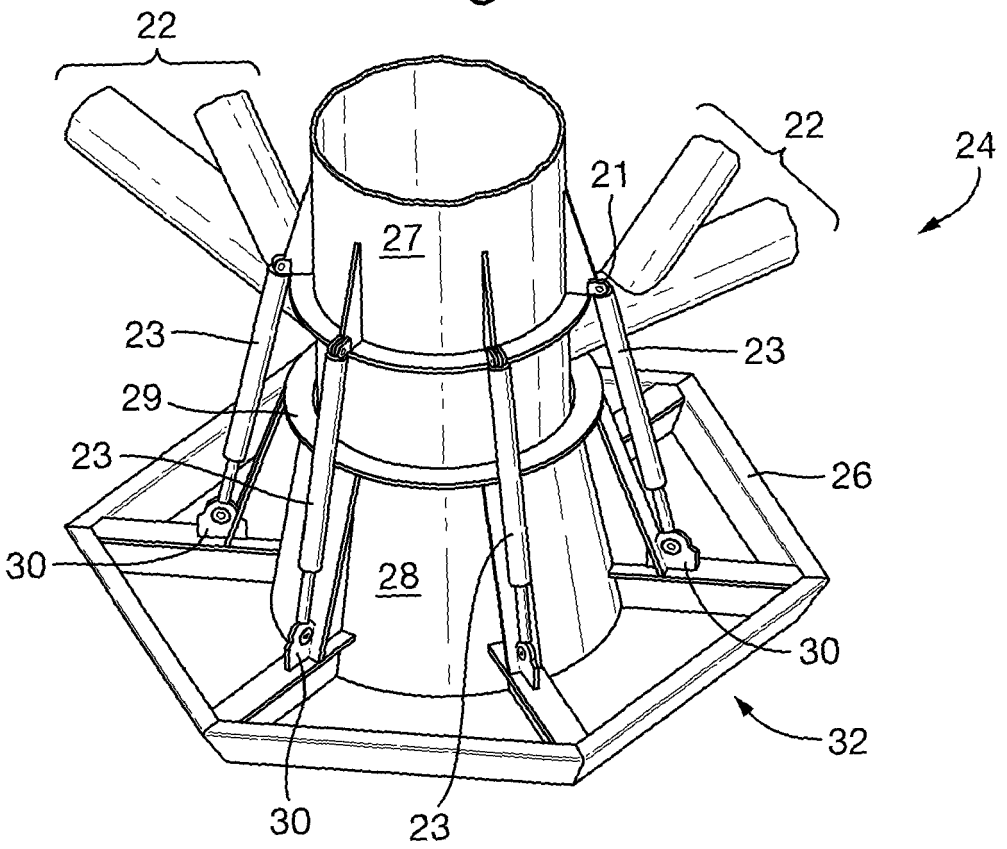

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Fig.5a.

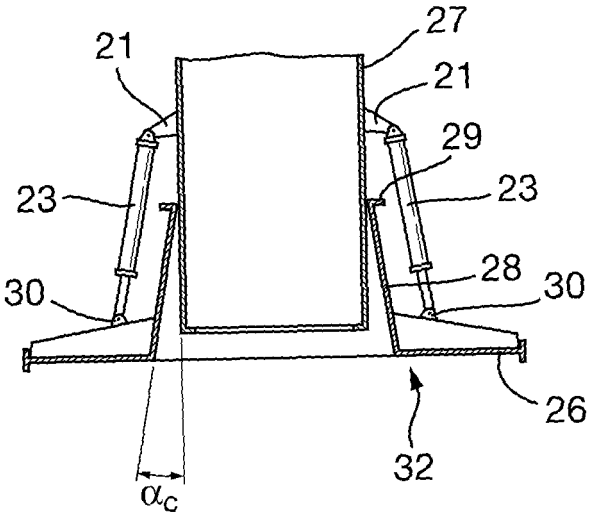
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Fig.5b.

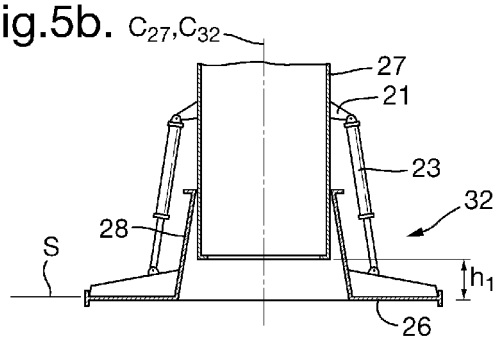


Fig.5c.

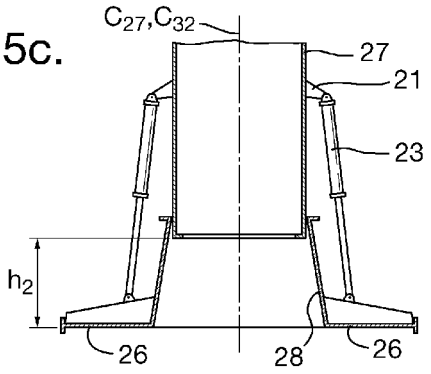


Fig.5d.

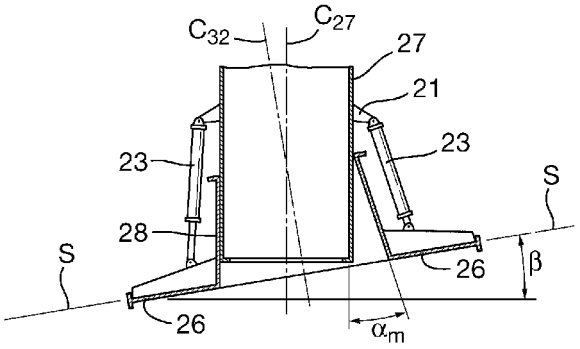


Fig.5e.

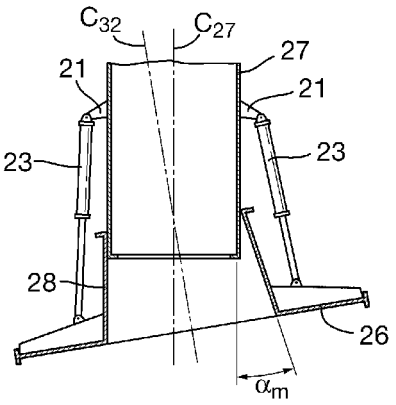
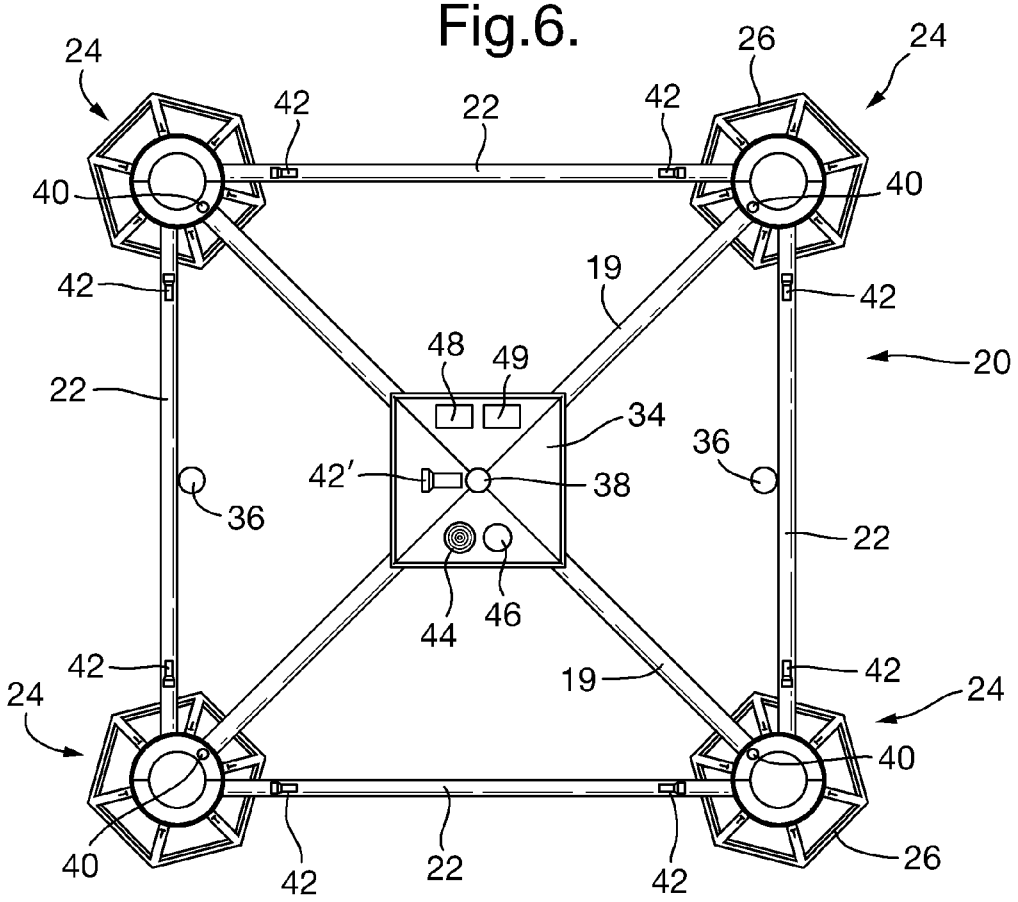


Fig.6.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42'
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Fig.7.

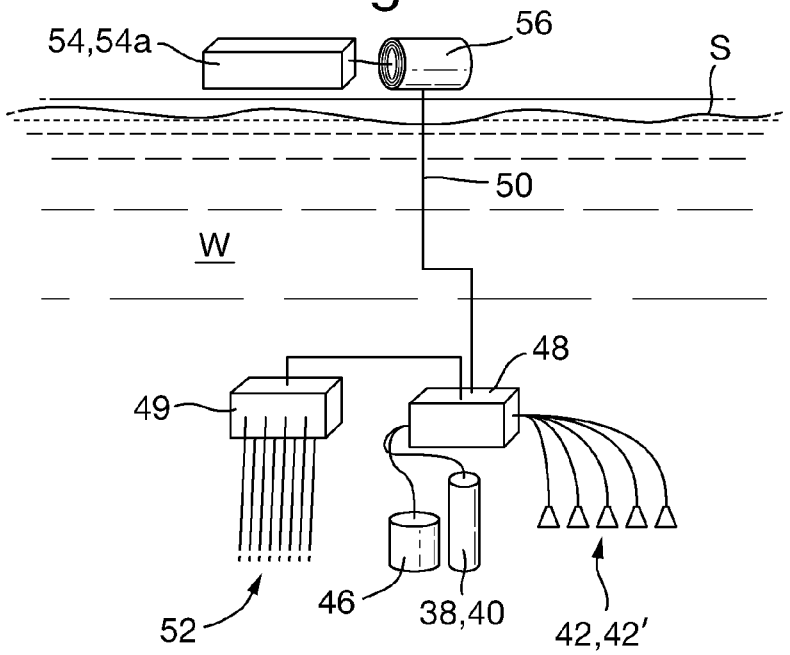

54,54a
56
S
50
W
48
49
52
46
38,40
42,42'

Fig.8a.

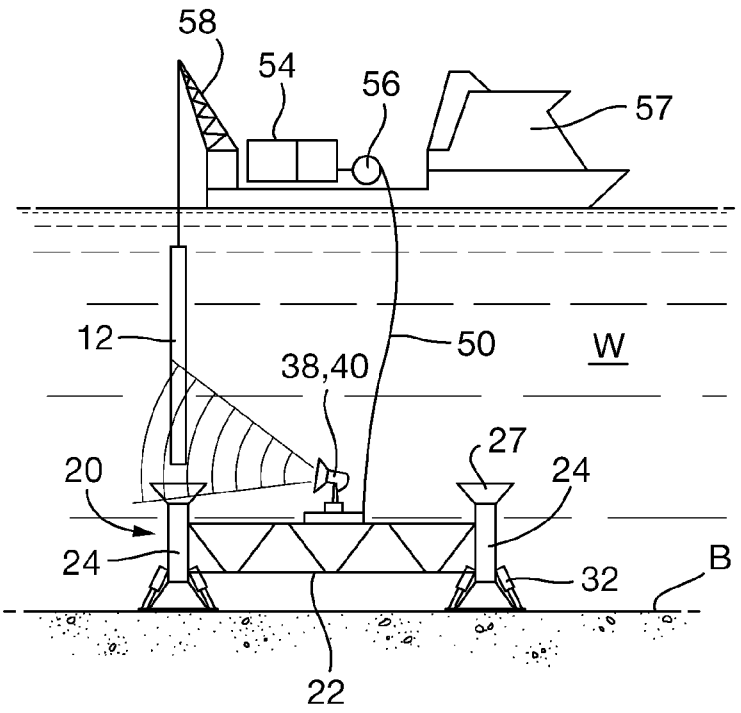
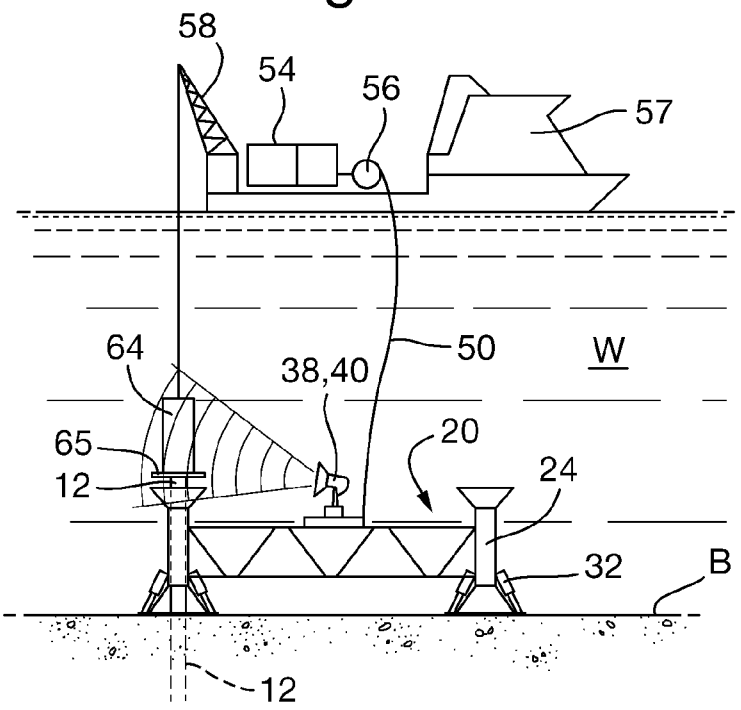

58
54
56
57
12
50
W
38,40
27
20
24
24
32
B
22

Fig.8b.


58
54
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64
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W
38,40
65
20
12
24
32
B
12

Fig.9.

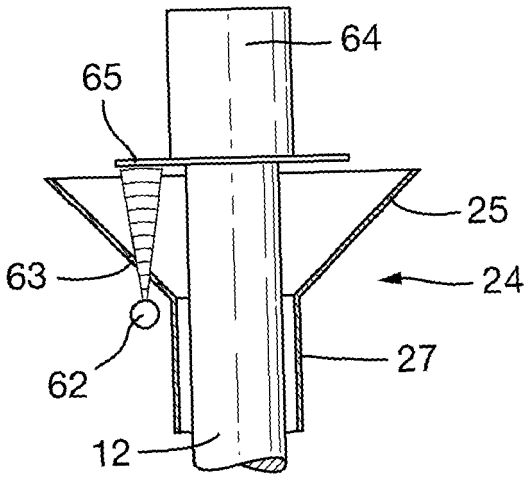


Fig.10.

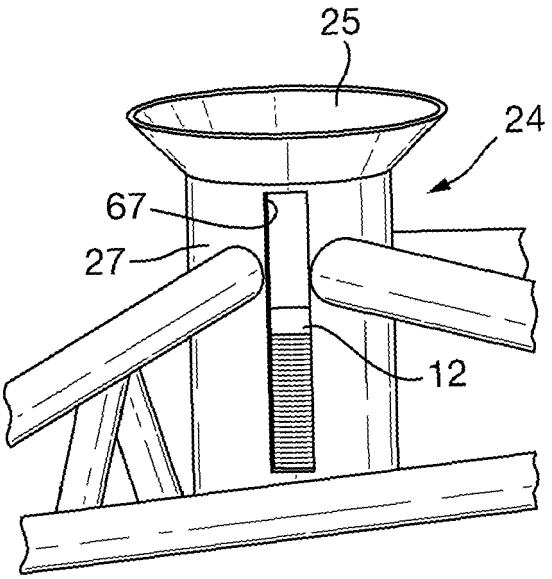


Fig.11.

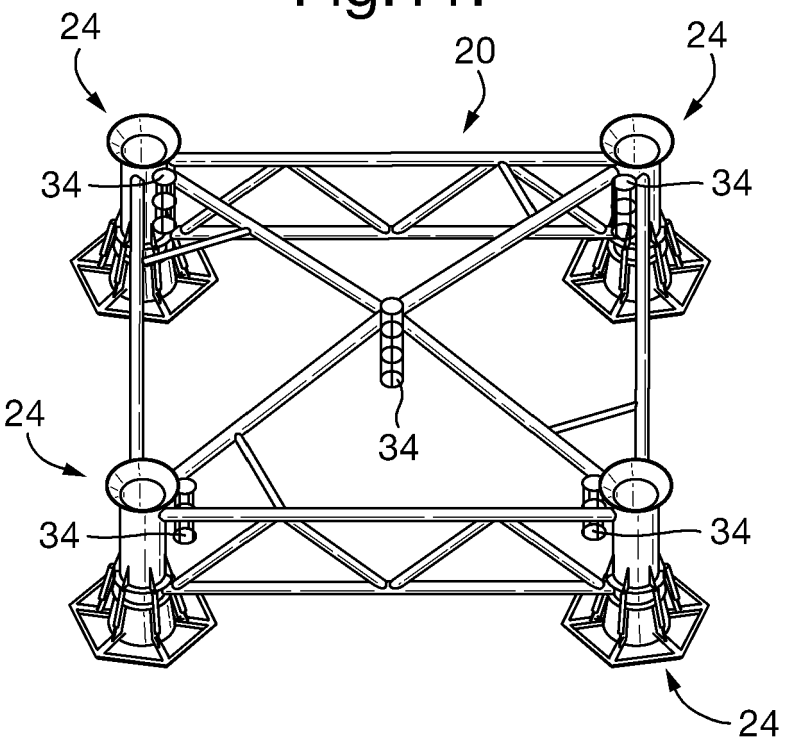


Fig.12.

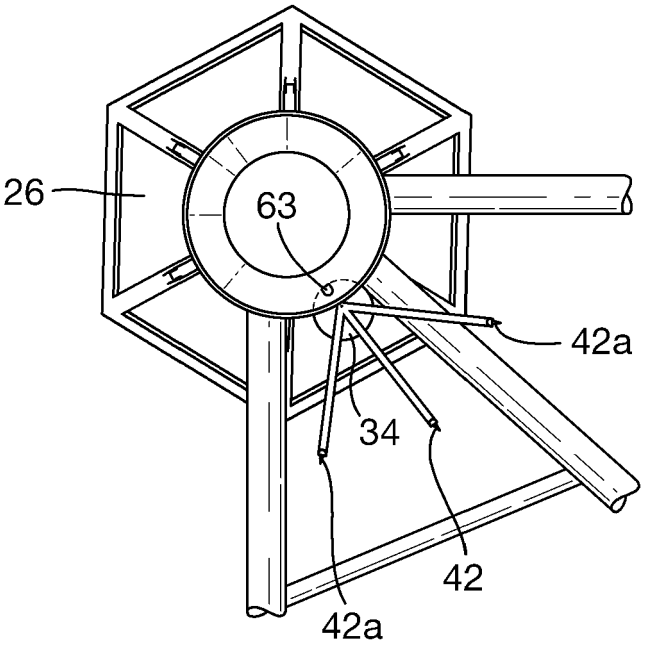


Fig.13.

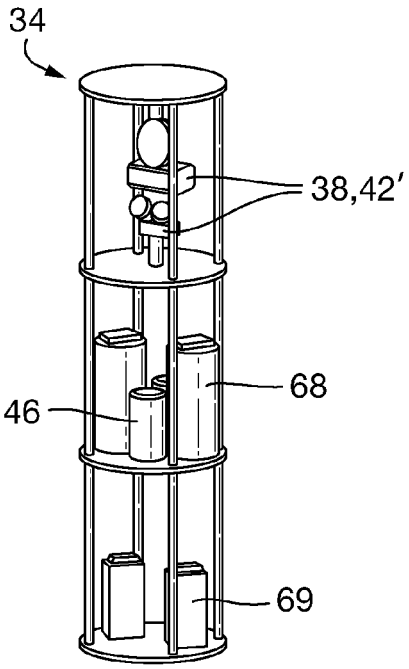


Fig.14.

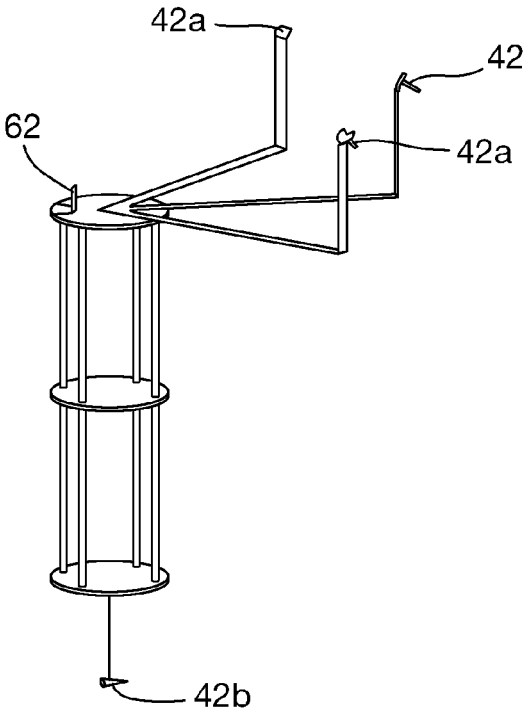
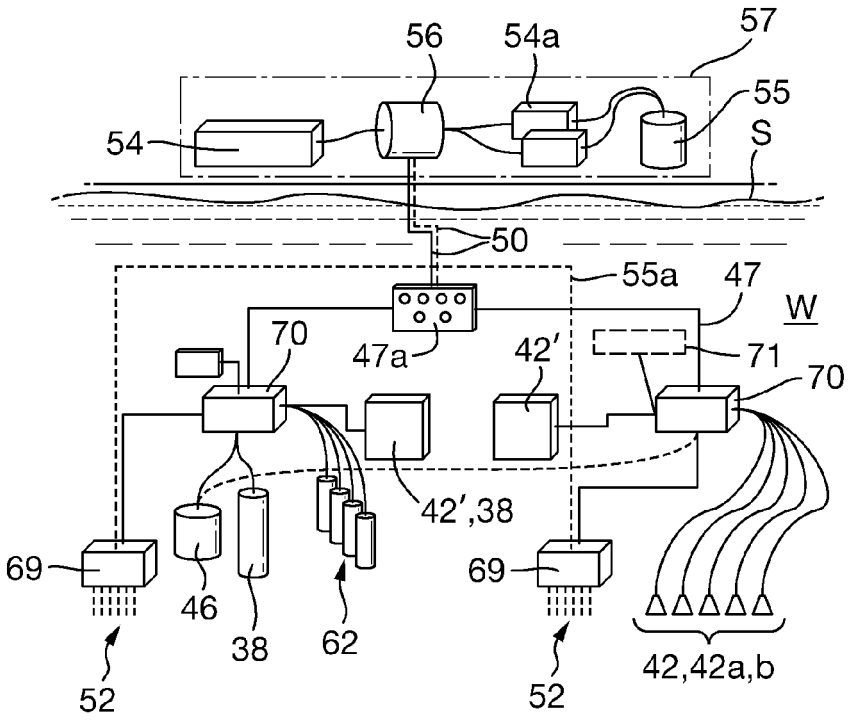


Fig.15.



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PARTIAL EUROPEAN SEARCH REPORT

under Rule 62a and/or 63 of the European Patent Convention. This report shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 10 18 0777

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	NL 1 029 056 C1 (BREEJEN PIETER DEN [NL]) 3 October 2005 (2005-10-03) * the whole document *	1-8, 15-20	INV. E02D27/42 E02D13/04
X,P	GB 2 460 172 A (MARINE CURRENT TURBINES LTD [GB]) 25 November 2009 (2009-11-25)	1,5-7, 15,16, 18,20	
Y,P	* page 6, line 19 - page 13, line 14; figures 1,3,4 *	8	
X,P	GB 2 467 842 A (MARINE CURRENT TURBINES LTD [GB]) 18 August 2010 (2010-08-18)	1,5-7, 15,16, 18,20	
Y,P	* page 6, line 11 - page 12, line 23; figures 1,3,4 *	8	
Y	GB 2 054 710 A (CJB BEARL & WRIGHT LTD) 18 February 1981 (1981-02-18) * figure 2 *	8	

TECHNICAL FIELDS SEARCHED (IPC)

E02D

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
Munich	11 February 2011	Geiger, Harald

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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INCOMPLETE SEARCH
SHEET C

Application Number
EP 10 18 0777

Claim(s) completely searchable:
1-8, 15-20

Claim(s) not searched:
9-14

Reason for the limitation of the search:

Within the time limit set out in Rule 62a (1) first sentence, the applicant did not indicate on which independent claim of the product category the search should be based. Therefore, only the first independent product claim with its depending claims 2-8 has been searched.

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11-02-2011

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