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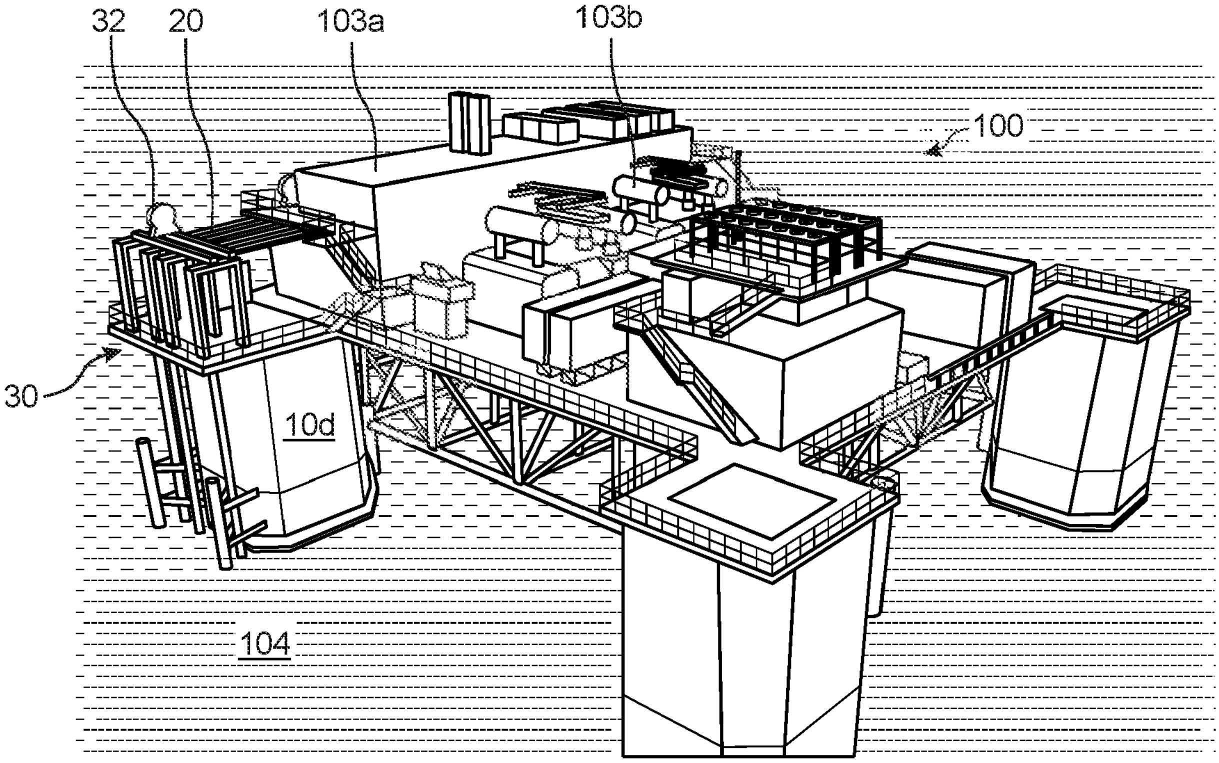

32
20
103a
103b
100
30
10d
104

FIG. 1

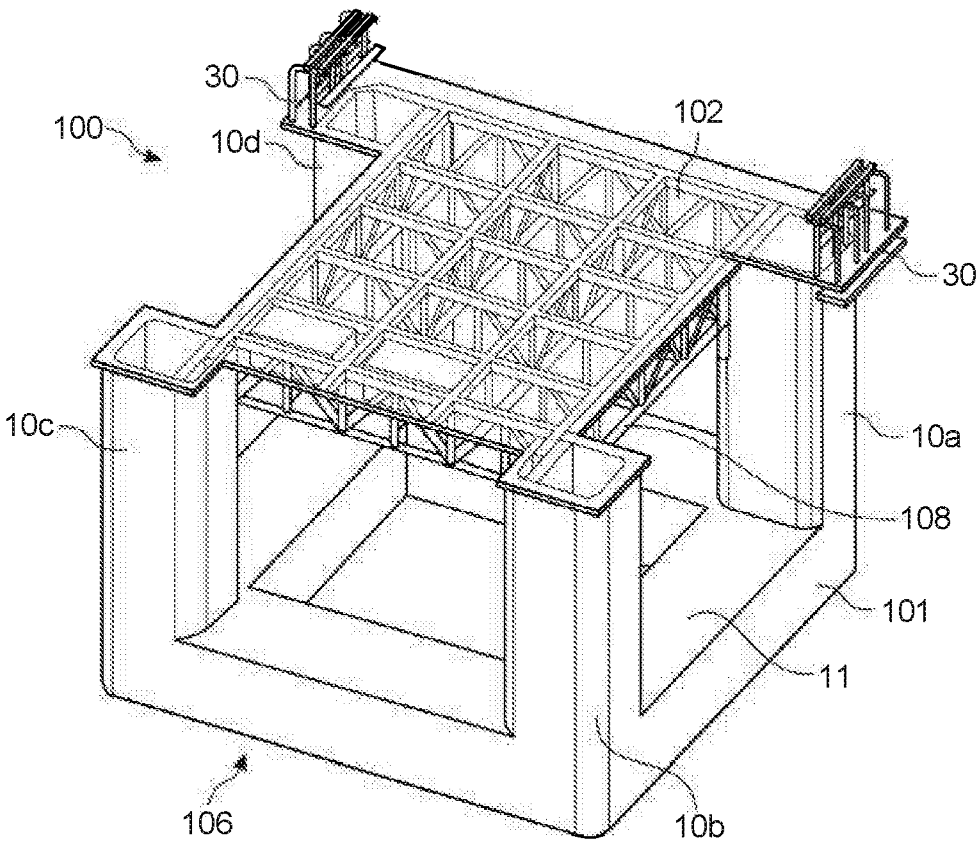
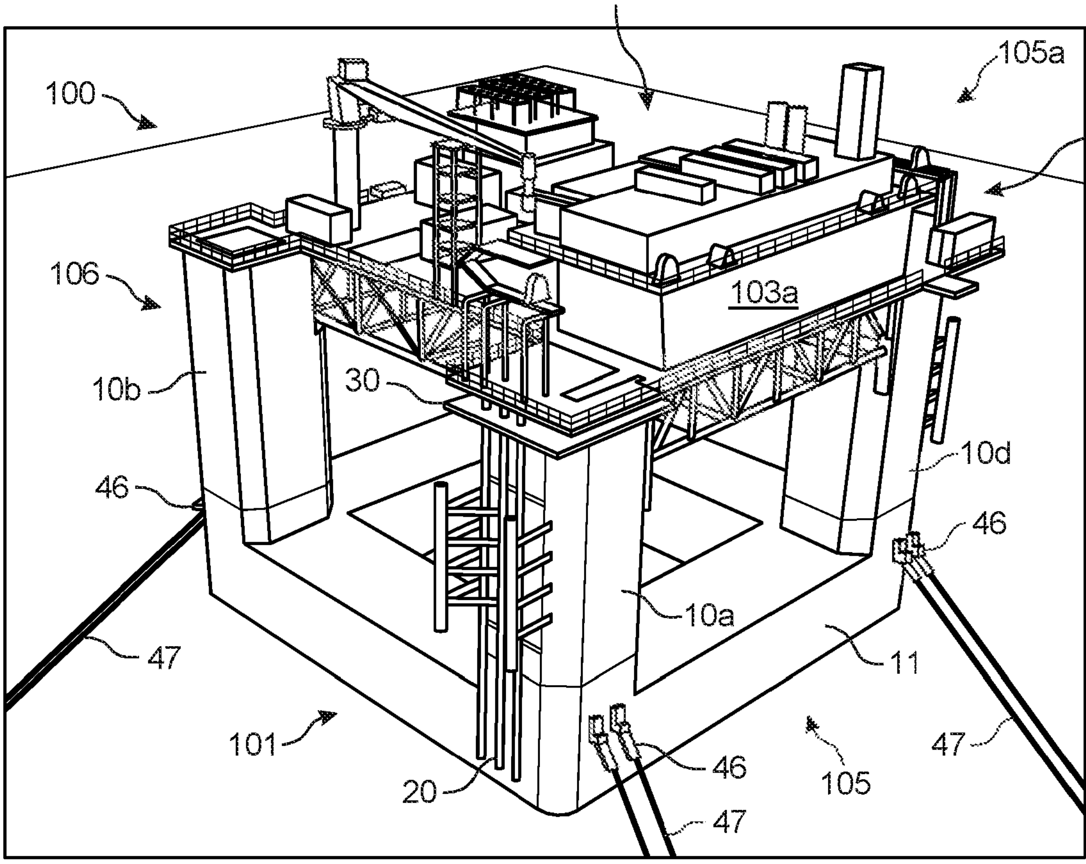
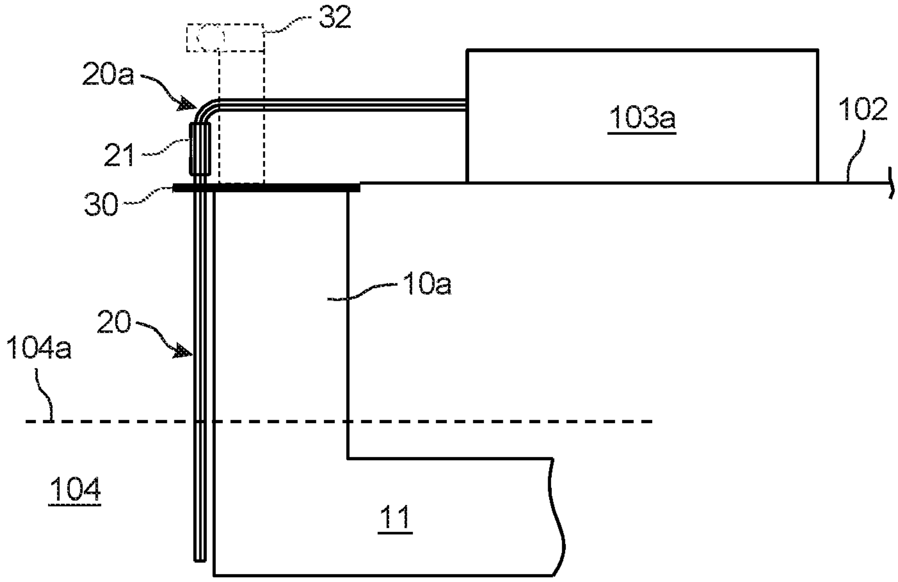

30
100
10d
102
30
10c
10a
108
101
11
106
10b

FIG. 2



103
105a
100
30
106
103a
10b
30
10d
46
46
10a
47
11
101
47
46
105
20
47

FIG. 3



32
20a
103a
102
21
30
10a
20
104a
104
11

FIG. 4

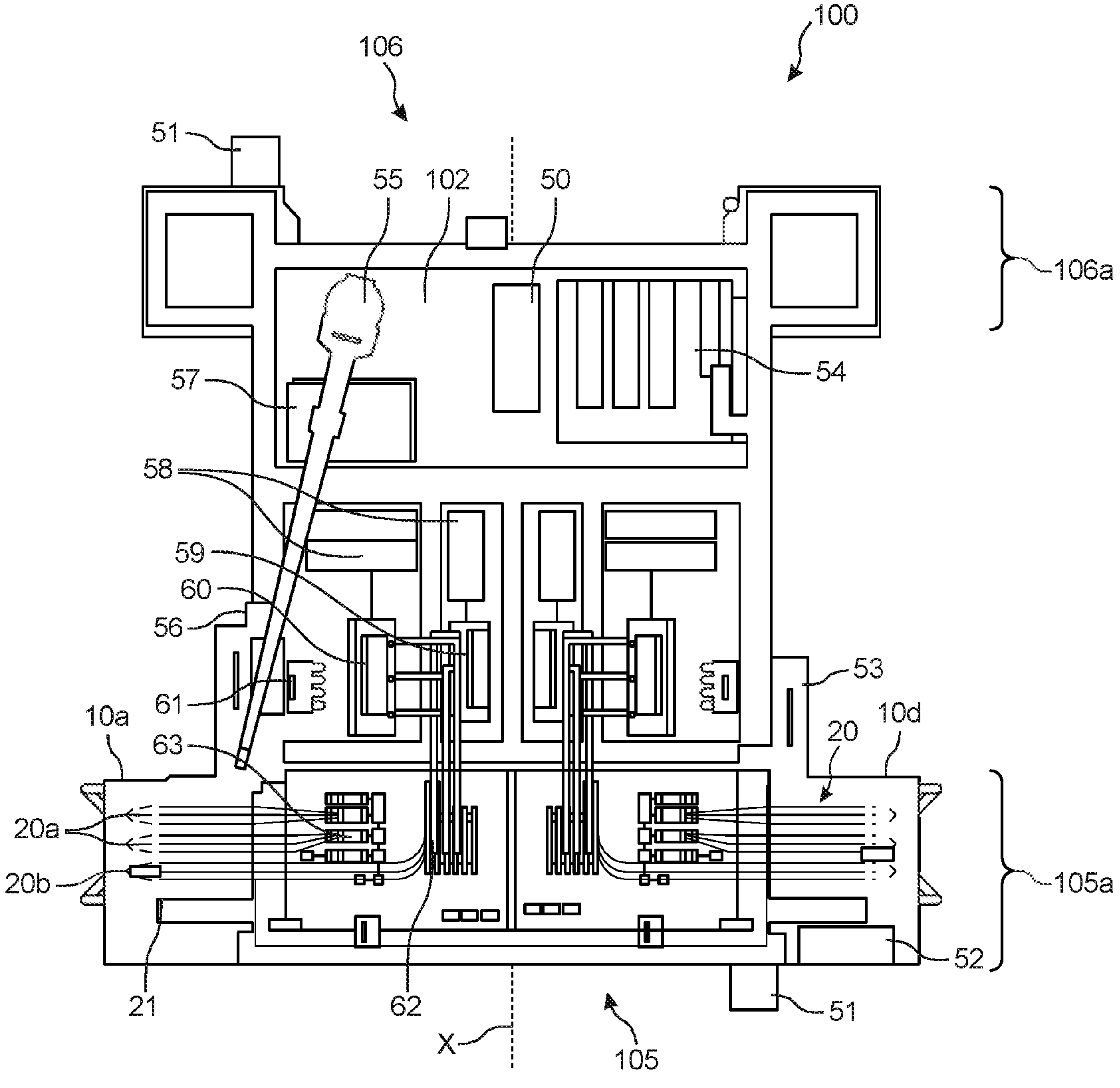

100
106
51
55
102
50
106a
57
54
58
59
60
56
53
61
10a
63
20
10d
20a
20b
105a
52
21
62
51
X
105

FIG. 5

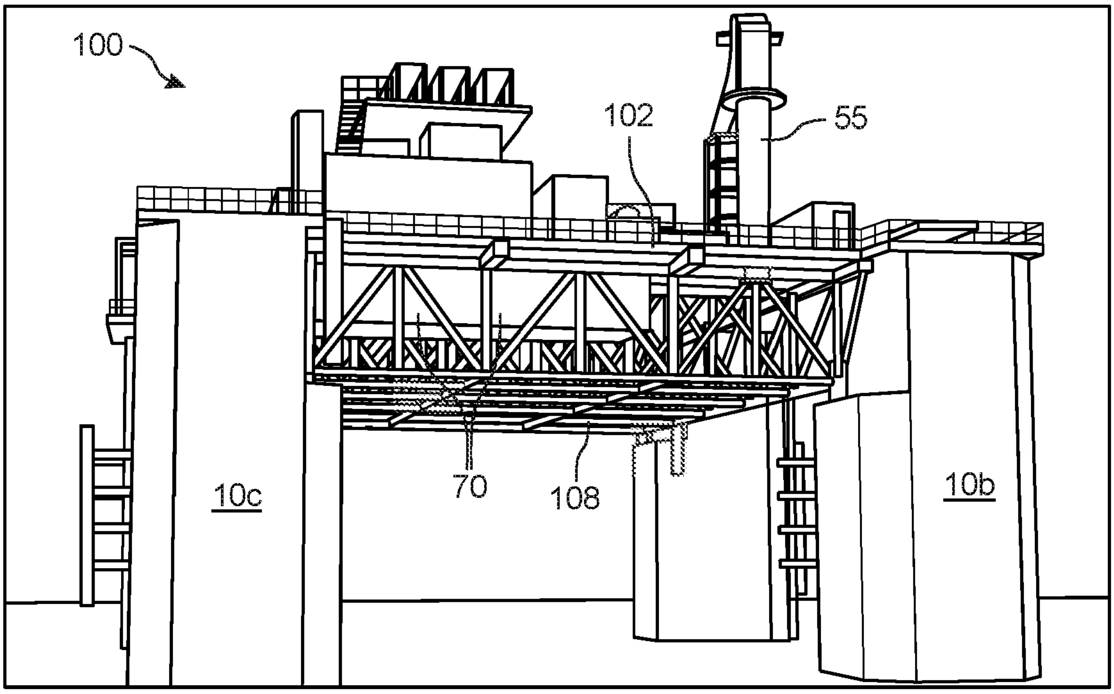


FIG. 6

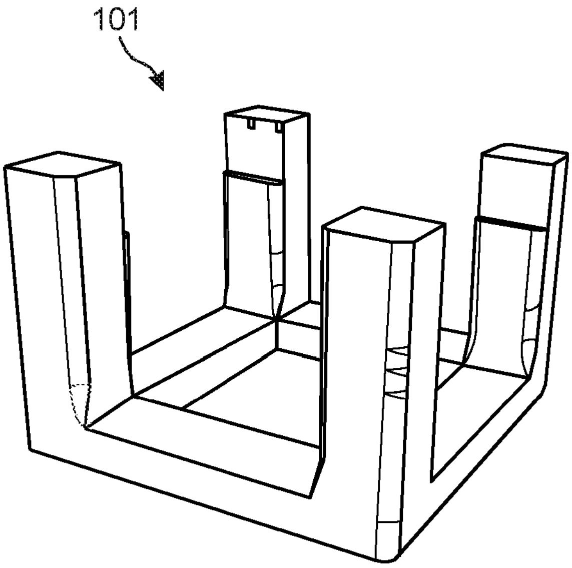


FIG. 7

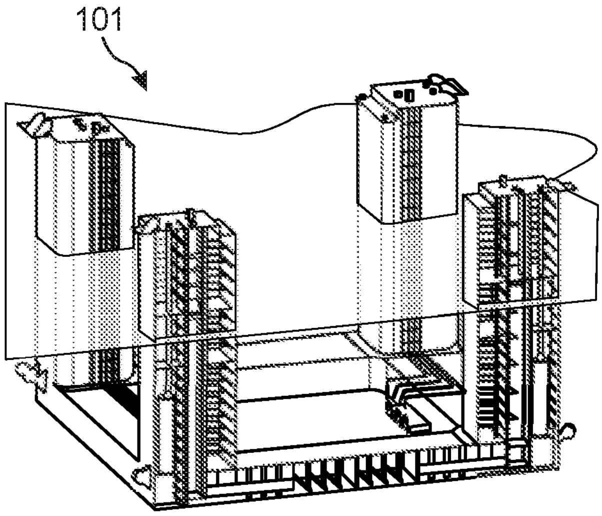


FIG. 8

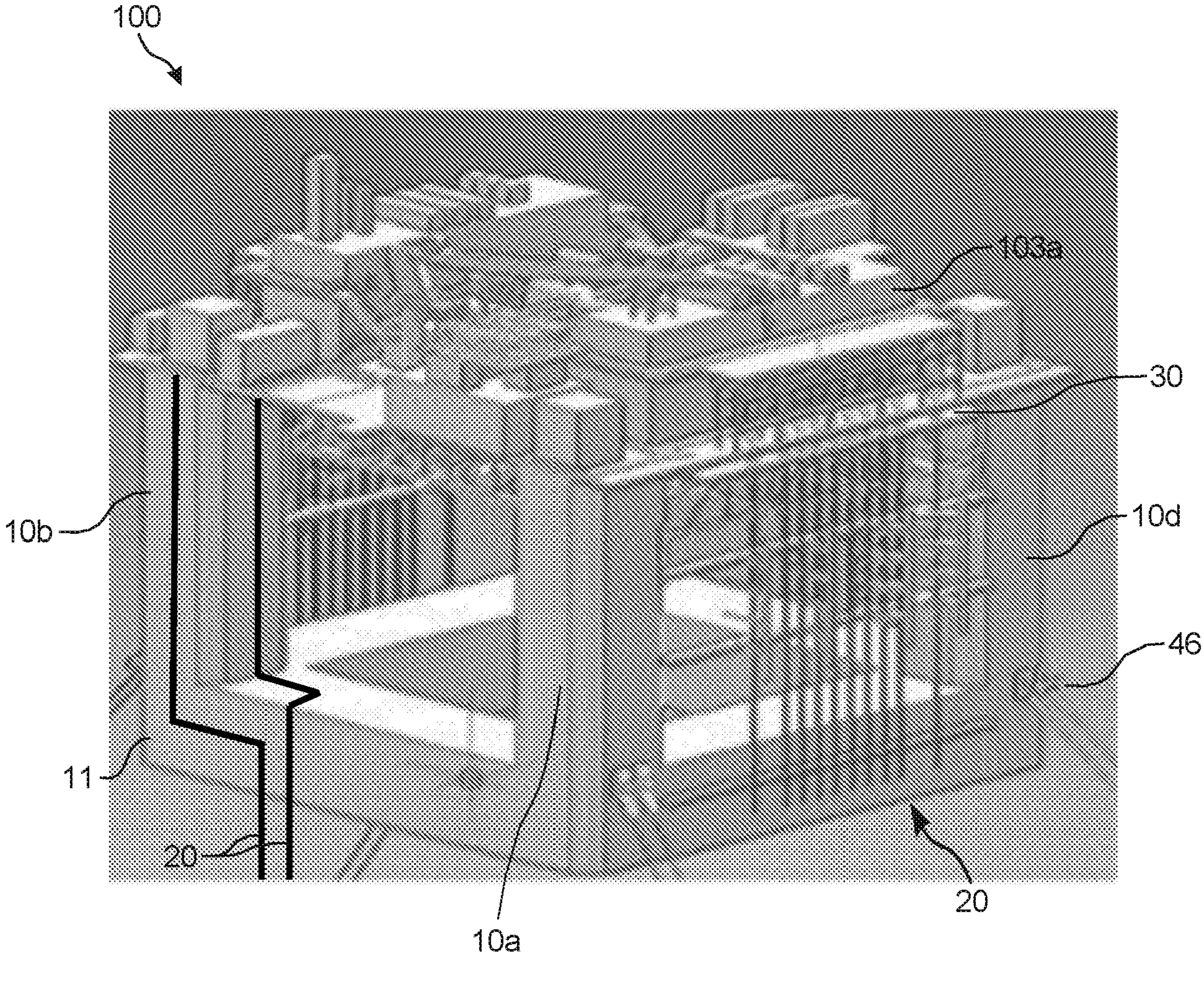


FIG. 9

FLOATING ELECTRICITY DISTRIBUTION

The present disclosure relates to distribution of electric energy offshore, and particularly to floating systems and related methods for electricity distribution at offshore locations.

BACKGROUND

Generation and/or use of electric energy offshore is of growing importance in many parts of the world. For example, electrification of offshore petroleum industry or aquaculture installations requires distribution of large amounts of electric power, and the rapidly growing investments into offshore renewable energy generation, such as offshore wind or solar, also require offshore distribution networks to be established.

Such offshore electricity distribution can be costly to establish and technically challenging. Some components, such as cables, are usually arranged at the sea floor, however not all components are suitable for subsea arrangement. For example, many types of electrical switchgear or transformers may not be suitable for subsea arrangement, or such placement may involve increased costs. Further, regular access to the components may be required, for example for inspection and maintenance.

It is known to place offshore electricity distribution components on fixed or floating platforms. Subsea / sea floor cables may in such cases be routed to and from the platform, for example such that a voltage step-up can be done before electric energy is further distributed, e.g. to a shore-based grid via an export cable if the platform is used in conjunction with an offshore renewable energy plant. Such platforms can add significant cost to a project, and can be technically challenging, as various requirements in relation to for example mooring, accessibility, and costs need to be managed. Fixed platforms are only suitable for shallow waters, whereas floating units are otherwise required.

There is a need for further improved technology to enable cost-efficient, safe and reliable distribution of electric energy offshore. The present disclosure has the objective to provide such improvements, or at least to provide useful alternatives to existing technology.

SUMMARY

According to the invention, there is provided a floatable electricity distribution platform comprising: a semisubmersible hull having a plurality of columns supported by a pontoon structure; a deck supported by the columns; cables arranged from the sea to the deck; and electric equipment arranged on the deck. The electric equipment comprises a switchgear housing and the cables are arranged from the sea to the switchgear housing. The switchgear housing is arranged adjacent a front of the platform and the platform comprises transformers electrically connected to the switchgear, and the transformers are arranged between the switchgear housing and a back of the platform. The switchgear housing comprises pairs of switchgear and the transformers comprise pairs of transformers, the pairs of switchgear and pairs of transformers being arranged mirrored about a longitudinal axis of the platform.

The detailed description below and appended claims outline further embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other characteristics will become clear from the following description of illustrative, non-restrictive examples, with reference to the attached drawings, in which:

Fig. 1 is a perspective view of a floatable electricity distribution platform in one example.

Fig. 2 illustrates parts of a floatable electricity distribution platform.

Fig. 3 is a perspective view of a floatable electricity distribution platform in one example.

Fig. 4 illustrates parts of a floatable electricity distribution platform.

Fig. 5 is a top view of a floatable electricity distribution platform in one example.

Fig. 6 illustrates parts of a floatable electricity distribution platform.

Figs 7 and 8 illustrate a hull for a floatable electricity distribution platform.

Fig. 9 illustrates a floatable electricity distribution platform in one example.

DETAILED DESCRIPTION

Figs 1-5 illustrate floatable electricity distribution platforms 100 according to some examples. The platform 100 comprises a semisubmersible hull 101, best seen in Figs 2 and 3, having a plurality of columns 10a-d supported by pontoons 11. In these examples, the hull 101 has four columns, which may be a suitable configuration for any aspect and example described herein, however in some examples less than four or more than four columns may be used. For example, the hull 101 may have three columns or five columns. The columns 10a-d and pontoons 11 may, for example, be of circular, squared or another polygonal shape in their longitudinal cross-sections. The hull 101 can float on the columns 10a-d and on the pontoons 11. The pontoons 11 can be arranged between all columns 10a-d, or between two or more columns 10a-d. In the shown example, the pontoon structure 11 forms a continuous ring pontoon. Alternatively, the pontoon structure 11 may comprise several individual pontoon members, such as two pontoon members, and where each pontoon member interconnects two columns 10a-d. For example, the hull 101 shown in Fig. 2 may alternatively have one pontoon member between columns 10a and 10b, and a separate pontoon member between columns 10c and 10d.

A deck 102 is supported on the columns 10a-d, such that the hull 101 carries the deck 102. A cut-in or shoulder may for example be provided in each columns 10a-d, on which the deck 102 can rest, or the deck 102 can rest on and against a top surface of the columns 10a-d. Other ways of supporting the deck 102 onto the columns 10a-d may also be possible, for example dedicated hang-off points on the columns 10a-d. The deck 102 can extend horizontally both inwards towards the center and outwards exceeding the side of one or more column(s) 10a-d. The deck

102 may be flush with the outer perimeter of the hull 101 at one or more sides. In the shown example, the deck 102 is flush with the outer perimeter of the hull 101 at the front 105 (see Fig. 3) of the platform 100.

In the illustrated examples, the deck 102 is carried by a truss structure 108 fixed to the columns 10a-d. In any of the examples described herein, the truss structure 108 may be a so-called “wet truss” which is designed for interaction with the sea at rough sea states. This provides advantages of lower build height, reduced centre of gravity and hence reduced hull weight.

Best seen in Fig. 3, cables 20 are arranged extending from the sea 104 to the deck 102. In this example, the cables 20 extend along one or more of the columns 10a-d. The cables 20 may, for example, be one or more inter-array cable(s) or one or more export cable(s), which can transport electric energy to and/or from the platform 100. The cables 20 may be, or include, cables/pipes for auxiliary purposes (sea water, etc.). The cables 20 extend on or directly adjacent the column 10a-d, and may also be attached to dedicated points along the pontoon 11, the column 10a-d, and/or the deck 102.

Fig. 9 illustrates another example, wherein the cables 20 extend from the sea to the deck 102 between the columns 10a-d. Fig. 9 also shows two cables 20 which are attached to the pontoon 11 and routed along the pontoon side/top towards the side of a column 10b, and further routed to the top of the column 10b and to the deck 102.

In any of the examples and embodiments described herein, the cables 20 may be arranged in guide tubes, with supports, protection members, or the like. Such items may be fixed to the hull 101 and/or to the cables 20 themselves. The cables 20 may for example be provided with bend stiffeners in the splash zone, i.e. where the cables 20 enter the sea 104.

Electric equipment 103 is arranged on the deck 102. The electric equipment 103 may comprise switchgear 103a, transformers 103b and further components such as shunt reactors and auxiliary equipment. The electric equipment 103 may for example be configured to receive electric power from an offshore wind turbine farm through inter-array cables, and process the electric power and transport it to a remote location (such as a shore-based grid) via an export cable. The equipment 103 may be stick-built on the deck 102, be located on a container, a building or a module, all with either 1 or more levels. The platform 100 may also contain batteries for storage of energy arranged on the deck 102.

The deck 102 can advantageously extend above at least one of the columns 10a-d. As can be seen particularly clearly in Fig. 2, the deck 102 may comprise a flush deck surface arranged above at least one of the columns 10a-d and above a space between the columns 10a-d. The deck 102 may alternatively be arranged entirely between the columns (or the vertical extension thereof), i.e. in the central region of the platform 100 (as seen in a horizontal plane), such that the deck 102 does not span any of the columns 10a-d. This configuration may be sufficient if deck space requirements can be met with the area available in the central part of the hull 101, between the columns 10a-d.

The deck 102 may extend outside the horizontal perimeter of the semisubmersible hull 101. Particularly, the deck 102 may extends outside the horizontal perimeter of the semisubmersible hull 101 at one or more of the columns 10a-d. The outer perimeter of the deck 102 may end inside the horizontal perimeter of the semisubmersible hull 101 between some or all the columns 10a-d, for example as in Fig. 2, where the deck 102 ends inside the horizontal perimeter of the semisubmersible hull 101 between columns 10a and 10b, between columns 10b and 10c, and between columns 10c and 10d.

In the illustrated examples, the deck 102 comprises a cable platform 30 extending outside the horizontal perimeter of the at least one column 10a-d, and the cables 20 are arranged from the sea 104 to the deck 102 via the cable platform 30. A separate cable platform 30 may not be necessary if the deck 102 has the required outward extension, or the cable platform 30 may be integral with the deck 102 in such a case.

In any of the examples and embodiments described herein, the cable platform 30 may advantageously extend outside the horizontal perimeter of the semisubmersible hull 101, e.g. outside the perimeter ("footprint") of the pontoon structure 11.

Advantageously, the switchgear housing 103a is arranged adjacent the cable platform 30 on the deck 102. The switchgear housing 103a may, for example, be a gas insulated switchgear (GIS) module. This arrangement is illustrated in Figs 3 and 4. The cables 20 are in this example arranged from the sea 104 through the sea surface 104a running vertically along column 10a, and further to the switchgear housing 103a on the deck 102.

The cables 20 may advantageously run horizontally into the switchgear housing 103a. By arranging the switchgear 103a adjacent the cable platform 30, the cables 20 can be arranged with only one 90 degree bend 20a (see Fig. 4) between the sea 104 and the switchgear housing 103a. The 90 degree bend 20a may be a bend in a vertical plane, and the cables 20 may be arranged without having any bend(s) in a horizontal plane on the platform 100 before being connected to the switchgear 103a.

In some examples, the platform 100 may have two cable platforms 30 arranged in conjunction with respective, different columns 10a,d. As in the examples described above, the cable platforms 30 may extend at least partly outside the horizontal perimeter of the columns 10a,d, such as to form a “balcony” onto which the cables 20 are led from the sea 104.

As shown in Fig. 3, the two cable platforms 30 can be arranged at a front part 105a of the platform 100 and in conjunction with the two frontmost columns 10a,d. The switchgear housing 103a is arranged between the two cable platforms 30. Advantageously, this allows the cables 20 from both platforms 30 to extend into the switchgear 103a with only one 90 degree bend at the cables 20, and with the cable lengths being relatively short. The two cable platforms 30 may have different purposes, for example one may be dedicated to inter array cables for providing electric energy to the platform 100 while the other is dedicated to one or more export cable(s) to distribute electric energy (e.g. having a higher, stepped-up, voltage) from the platform 100 to a remote location, such as a land-based grid. Alternatively, each of the two cable platforms 30 and associated equipment may have several types of cable and several functions associated with it, for example wherein both inter-array cables and export cable(s) are provided at each cable platform 30.

In another example, inter-array cables may be arranged at one location, such as columns 10a,d as illustrated in Fig. 3, whereas the export cable(s) is (are) arranged at another location, for example at a side or at column 10b and/or 10c.

Illustrated in Fig. 4, the cable(s) 20 may comprise a spliced section 21 and the cable(s) 20 may be arranged such that spliced section 21 is arranged vertically in a section of the cables 20 which is vertically aligned with and in vertical extension of the section of the cables 20 arranged along the column 10a-d. The spliced section 21 is preferably arranged above the cable platform 30.

This arrangement can provide advantages during the construction and/or installation of the platform 100. For example, during installation, sea floor cables may be provided and pulled in to the platform 100 for connection, subsequent to the platform 100 having been moored in place offshore. The platform 100 may comprise a cable hoist 32, such as a winch, for this purpose. The cable hoist 32 can be permanently or temporarily installed on the platform 100, and may advantageously be arranged above the cable platform 30. By means of the cable hoist 32, the cables 20 (or a cable part) can be pulled in from the sea 104 and up to the deck 102. It may then be spliced into connection with an existing part of the cable(s) 20 which extend further into the switchgear 103a. By providing a vertically arranged spliced section 21, it will not be necessary to pull a cable from the sea 104 into (or through) a bend on the platform 100, and less deck space is required. The part of the cable(s) 20 pulled in from the sea 104 may merely be pulled in vertically so that an end thereof reaches the area where the spliced section 21 will be located, and fixed to the platform 100. Further, this arrangement allows all cable bends, such as the 90 degree bend 20a, to be pre-installed on the platform 100, for example in the yard or at shoreside. This simplifies installation operations offshore, for example reducing the time required for pull-in and hook-up of cables 20.

Alternatively to the cables 20 being arranged along a column 10a-d, the cables 20 may extend from the sea 104 and to the deck 102 between columns 10a-d, as for example illustrated in Fig. 9. If the deck 102 is not flush with the outer perimeter of the hull 101, or if desirable for other reasons, a cable platform 30 can be arranged on the deck 102 or a cantilever extension of the deck 102 can be arranged similarly as the cable platform 30.

The cables 20 may also be distributed so that some cables 20 extend from the sea 104 to the deck 102 via one or more columns 10a-d, and some cables 20 extend from the sea 104 to the deck 102 at different locations on the platform 100, e.g. at a side, as illustrated in Fig. 9.

As illustrated in Fig. 3, the platform 100 may comprise a plurality mooring connectors 46 configured for having mooring lines 47 connected thereto. The platform 100 may, for example, have four or more mooring connectors 46 and mooring lines 47. Various types of mooring connectors can be used, for example a fairlead connector or a fairlead chain stopper. In one example, a fairlead chain stopper with an installation chain extending up to deck level and accessible from the deck 102 can be used. The hull 101 may have mooring brackets, for attachment to either an end of a mooring socket or a fairlead chain stopper.

In the shown example, the platform 100 has eight mooring lines 47, arranged in pairs of two. The mooring connectors 46 are arranged on a column 10a,d along which cables 20 are also arranged, and the at least one mooring connector 46 is arranged on a side of the column 10a,d which is different from a side of the column 10a,d along which the cables 20 are arranged. Each mooring connector 46 may be arranged on a side which is adjacent the side of the column 10a,d along which the cables 20 are arranged.

Particularly, the platform 100 can comprise four or more mooring connectors 46, with at least two of the mooring connectors 46 arranged at a front 105 and at least two of the mooring connectors 46 arranged at a back 106 of the platform 100, while the cables 20 are arranged at a side of the platform 100, such as a lateral side which is not the front 105 or the back 106. Such an arrangement can simplify installation of the platform 100 (for example, for mooring hook-up) and/or the installation of cables 20 to the platform 100, and can reduce the risk of the mooring system and cable system interfering with each other.

Alternatively, the mooring connectors 46 may be arranged symmetrically about the longitudinal and transverse axes of the platform 100 in the horizontal plane, for example with eight mooring lines arranged with two mooring connectors arranged near each corner of the hull 101. For example, the mooring connectors 46 may be arranged at or below each outward-facing side of a column 10a-d.

The front 105 can be configured to be positioned against a predominant wind direction. For example, in a wind energy park, the layout of the park and the arrangement of individual turbines will usually be done in view of a predominant wind direction at the site. The platform 100 may advantageously be arranged such that the front 105 is arranged against this predominant wind direction, for improved dynamic behaviour and/or safety.

Advantageously, the cables 20 are arranged along a column 10a,d having one side which forms part of the front 105, and the cables 20 are arranged at a side of the column 10a,d which does not form part of the front 105, for example on a side of the column 10a,d which is adjacent to the side forming part of the front 105. Optionally, as illustrated in Fig. 3, the cables 20 are arranged along two columns 10a,d, each having one side which forms part of the front 105, and the cables 20 are arranged at a side of the columns 10a,d which does not form part of the front 105.

Fig. 5 illustrates a top view of a platform 100 in one example. Fig. 5 illustrates various equipment and installations which may be arranged on the deck 102, hereunder:

- diesel generator set(s) 50,
- walk-to-work landing platforms 51,
- storage/shelter containers 52,
- personnel access 53,
- auxiliaries room(s) 54,
- pedestal crane 55,
- boom rest 56 for the crane 55,
- storage space 57,
- coolers 58,
- shunt reactors 59,
- main transformers 60,
- auxiliary transformers 61,
- high-voltage gas isolated switchgear (GIS) 62, and
- low-voltage gas isolated switchgear (GIS) 63.

In the example shown in Fig. 5, the cables 20 comprise a plurality of input cables 20a, for example inter-array cables from a plurality of wind power generators, and output cables 20b, for example an export cable to a shore-based grid. Electric power provided to the input cables 20a is directed via the low-voltage GIS 63 to the transformer 60, and then exported at a higher voltage through the output cables 20b and via the high-voltage GIS 62.

Advantageously, the switchgear housing 103a, comprising the high-voltage and low-voltage GIS 62,63 can be arranged adjacent the front 105, i.e. in the front part 105a. The transformers 103b, comprising the main transformer 60 and associated equipment, such as the shunt 59, are arranged between the switchgear housing 103a and the back 106. This provides an advantageous layout in view of the cabling as well as the weight distribution on the platform 100. Further, this arrangement may be beneficial for the transformers 103b and the shunt 59, which may be motion sensitive equipment. Arranging such components between the front part 105a and the back part 106a may reduce their exposure resulting from platform motion in the sea.

In one example, as illustrated in Fig. 5, the platform 100 may comprise cables 20 arranged at opposite sides (e.g. at opposite columns 10a,10d) and pairs of switchgear 62,63 and pairs of transformers 60 arranged mirrored about a longitudinal axis x of the platform 100. The pairs of switchgear 62,63 and transformers 60 may be independent of each other and serve the set of cables 20 provided at the respective side or column 10a or 10d.

Such arrangements may be beneficial for redundancy, the manufacturing and/or the maintenance of the platform 100. For example, it may be beneficial to lift off transformers or other equipment from the middle part of the floater, i.e. between the front part 105a and the back part 106a. This may facilitate easier replacement of equipment offshore.

In one example, illustrated in Fig. 6, the platform 100 may comprise drain tanks 70 arranged fully or partly below the deck 102, and arranged in the truss structure 108. This can save space on the deck 102 and/or on the platform 100.

In some examples, cables between components arranged on the deck 102 can be routed below the deck 102, e.g. in the truss structure 108. This can provide more efficient layout of components on the deck 102 and save space.

Also shown in Fig. 6, the crane 55 may extend through the deck 102 and be fixed to or into the truss structure 108. This can provide a solid foundation for the crane 55.

Figs 7 and 8 illustrate examples of a hull 101 for the platform 100. The hull 101 may be provided with no sea chests or through-hull connections, such that hull penetrations below the waterline are eliminated. All ballast water can be pumped in or out through external column top manifolds or connections only. This ensures that there is no possibility for inadvertent flooding of hull for example during abandonment due to hurricanes or other extreme weather events.

The four independent hull quadrants may have no bulkhead penetrations between them, and thereby no possibility for ballast water communication across hull quadrants. In one example, there may be no machinery spaces in the hull 101, whereby no internal hull access is required during normal operations. The compartments in the hull 101 may be ballast tanks or dry void spaces. Pumps may be accessed externally from the column top(s), and there may optionally be no permanent utilities (e.g., air, electric power, storage/transfer systems) located in the hull 101.

Equipment and modules arranged on the deck 102 may be protected by weather cladding, as required.

The hull 101 can, for example, be made of steel or concrete.

The platform 100 may be movable and re-usable at different locations. For example, a platform 100 according to examples described herein may serve as an electricity distribution platform at one location for a given number of years, then be re-located to serve at a different location. Optionally, this may involve maintenance, retrofits or redesigns of the onboard equipment. Advantageously, the design of the platform 100, particularly with respect to the flat top deck 102, eases such maintenance, retrofits or redesigns, for examine in the event that the new use has different requirements compared with the previous one.

The platform 100 may further comprise living quarters or rooms/shelter for personnel, if/as required.

In some examples, the cables 20 may be routed inside the pontoon structure 11, i.e. up from the sea 104 centrally within the hull 101 and not on the outside of the hull 101. In some examples, the cables 20 may be routed through, and inside, one or more of the columns 10a-d from the sea to the deck 102, e.g. by providing the columns 10a-d with vertical, through-going passages for this purpose.

According to examples described herein, advantages in terms of cable layout, structural properties and operational properties can be obtained, for example reduced cable lengths, less demanding installation of electrical cables, the possibility for increased pre-manufacturing at shore, improved maintenance efficiency, etc. Positioning of equipment may allow better segregation of zones onboard, for example to meet relevant safety standards.

The skilled reader will understand that the term “floatable platform” as used herein refers to a platform which is capable of floating in water (as opposed to resting on a sea floor). The floatable platform may nevertheless, in some circumstances and temporarily, be supported on a foundation, such as under construction or maintenance (e.g. in a dock).

The invention is not limited by the embodiments described above; reference should be had to the appended claims.

CLAIMS

1. A floatable electricity distribution platform (100) comprising:

   a semisubmersible hull (101) having a plurality of columns (10a-d) supported by a pontoon structure (11);

   a deck (102) supported by the columns (10a-d);

   cables (20) arranged from the sea (104) to the deck (102); and

   electric equipment (103) arranged on the deck (102), the electric equipment (103) comprising a switchgear housing (103a) and the cables (20) are arranged from the sea (104) to the switchgear housing (103a),

   wherein the switchgear housing (103a) is arranged adjacent a front (105) of the platform (100) and comprises pairs of switchgear (62,63), the platform (100) comprises transformers (103b) electrically connected to the switchgear (103a), the transformers (103b) being arranged between the switchgear housing (103a) and a back (106) of the platform (100), and wherein the transformers (103b) comprise pairs of transformers (60), the pairs of switchgear (62,63) and pairs of transformers (60) being arranged mirrored about a longitudinal axis (x) of the platform (100).

2. The floatable electricity distribution platform (100) of claim 1, wherein the cables (20) are arranged from the sea (104) to the deck (102) along one or more of the columns (10a-d).

3. The floatable electricity distribution platform (100) of any preceding claim, wherein the deck (102) comprises a flush deck surface arranged above at least one of the columns (10a-d) and above a space between the columns (10a-d).

4. The floatable electricity distribution platform (100) of any preceding claim, wherein the deck (102) extends outside the horizontal perimeter of the semisubmersible hull (101).

5. The floatable electricity distribution platform (100) of any preceding claim, wherein the deck (102) comprises a cable platform (30), and the cables (20) are routed from the sea (104) to the deck (102) via the cable platform (30).

6. The floatable electricity distribution platform (100) of claim 5, wherein the cable platform (30) extends outside the horizontal perimeter of the semisubmersible hull (101).

7. The floatable electricity distribution platform (100) of claim 6, wherein the cable platform (30) is arranged above or extending outwardly from at least one column (10a-d).

8. The floatable electricity distribution platform (100) of any preceding claim, wherein the cables (20) extend horizontally into the switchgear housing (103a).

9. The floatable electricity distribution platform (100) of claim 8, wherein the cables (20) are arranged with exactly one 90 degree bend (20a) between the sea (104) and the switchgear housing (103a).

10. The floatable electricity distribution platform (100) of any preceding claim, wherein the switchgear (62,63) and transformers (60) are independent of each other and are electrically connected to different cables (20).

11. The floatable electricity distribution platform (100) of any preceding claim, wherein the cables (20) comprise a spliced section (21) and the spliced section (21) is arranged in a vertically arranged section of the cables (20).