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(54) Title: A SUCTION ANCHOR, A COMPOSITE MODULE SEGMENT FOR A SUCTION ANCHOR AND A METHOD FOR ASSEMBLING SUCH SEGMENTS

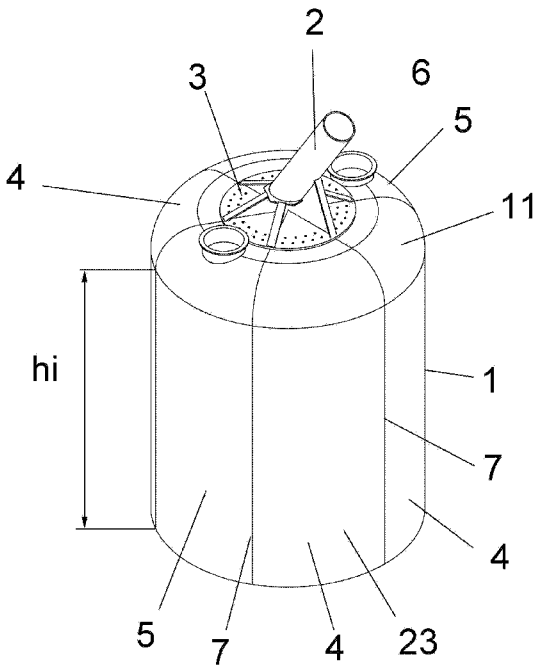

Fig. 1

(57) Abstract: The present invention relates to a composite suction anchor for providing a foundation or mooring attachment in a soft sea bed including an open bottom portion, a closed top portion, and a side portion defining a first outer surface (23) with a substantially constant outer perimeter. The anchor includes at least two adjoining canister module segments (4, 5) with an inner surface (22) and an outer surface (23p, 23b, 23c). Each canister module segment (4, 5) includes at least a first and a second contact surface portion (23b, 23c) located on said outer surface (23p, 23b, 23c) on each side of an exposed outer surface portion (23p), joint with contact surfaces of at least one adjoining module segment. A canister module segment and a method for joining such segments is also disclosed.

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A suction anchor, a composite module segment for a suction anchor and a method for assembling such segments

The present invention relates to a modular composite suction anchor for mooring purposes.

Suction caissons, suction anchors or suction moorings is well known technology used for mooring oil related installations, floating wind mills, subsea installations etc. to a soft sea bed. Suction anchors are convenient as they are removable, and provide reliable attachment points. A suction anchor includes a canister with an open end and a closed end, and some attachment arrangement at the closed end. During installation, suction anchors are lowered to the sea bed and water is pumped out of the canister such that the pressure differences between the outside and the inside of the canister drives the anchor into the sea bed. Similarly, the anchor may be released from the sea bed by pumping water into the canister.

Suction anchors are commonly made of large diameter steel tubing that is relatively heavy and cumbersome to install. Furthermore, solutions including steel tubing are difficult to provide in different sizes and must be transported in their full size.

Suction anchors may form a part of unitary subsea production equipment that is lowered onto the seabed from a vessel, and four suction anchors are typically used. The anchors are normally made of steel of sufficient gauge or thickness to allow for corrosion, and the thickness will depend on the anticipated lifespan of the installation. The anchors constitute a high percentage of the overall weight of the installation. The weight of the installation dictates the classification/allowable load of an installation vessel.

It is a purpose with the present invention to provide a suction anchor solution and a method of assembly that allows simple production of suction anchors with few limitations in size.

Furthermore, it is a purpose of the present invention to provide a modular suction anchor that is easy to transport, as the suction anchor can be transported in parts or can be filled with buoyant media and floated in place.

Furthermore, it is a purpose of the present invention to provide a suction anchor that is cost effective to manufacture in high numbers and in different sizes.

Furthermore it is a purpose of the present invention to provide a suction anchor that is considerably lighter than a steel counterpart.

Weight saving that will allow for the use of a smaller vessel will result in considerable installation savings and increased availability of installation vessels.

The use of composite suction anchors can reduce the weight of suction anchors typically to between one half and one third of the weight of comparable steel suction anchors and the potential for economic savings is considerable. Alternatively, the weight saving may result in more allowable weight for more useful components of an installation where the anchors are includes. Furthermore, the expected lifespan of the suction anchors is independent of corrosion.

The present invention defines a suction anchor for providing a foundation or mooring attachment on a soft sea bed. The suction anchor includes a canister with an open bottom portion, a closed top portion and a side portion defining a first outer surface with a substantially constant outer perimeter along a sea bed immersing height.

The seabed immersing height is the height of the suction anchor, or the inserted design depth of the anchor into the seabed.

The suction anchor defines an inner volume, and means are provided for allowing water to be pumped out of the inner volume. These means may include some sort of sealable opening, a valve that may be stabbed by a ROV or any other structure that allows water to be pumped into or out of the volume. The suction anchor

includes at least two adjoining canister module segments with an inner surface and an outer surface forming a part of the first outer surface. Each canister module segment extends at least along said immersing height. Each canister module segment furthermore includes a contact surface portion on the outer surface, joint with a contact surface portion on an outer surface of an adjoining module. The canister module segments are made of a composite material. A load attachment portion is secured to the closed top portion.

A first and a second contact surface portion may be located on said outer surface at each side of said outer surface portion of each canister module segment respectively.

The first module contact surface portion may include a male assembly guide, and the second module contact surface portion may include a female assembly guide.

The first contact surface portion may be formed as a rib and the second contact surface portion may be formed as a rib and the contact surface portion may then adjoin a contact surface portion of an adjacent element in a center a stiffening rib of the suction anchor.

The first contact surface portion may be formed as a male rib with a male assembly guide and the second contact surface portion may be formed as a female rib with a female assembly guide.

The suction anchor according may further include at least one structural anchor cavity formed into at least one stiffening rib, and a structural anchor in said least one structural anchor cavity whereby said at least one structural anchor is embedded in said at least one stiffening rib.

The first contact surface portion is formed as a male rib with a male assembly guide and the second contact surface portion is formed as a female rib with a female assembly guide.

The composite canister module segment may further includie a structural anchor cavity formed in said outer surface the first contact surface portion on the first side of the exposed surface portion and/or the second contact surface portion on the second side of the exposed surface portion.

The contact surface portion may adjoin a contact surface portion of an adjacent canister module segment in a center of a stiffening rib of the suction anchor.

The suction anchor may include six canister module segments.

Furthermore, the invention concerns a composite canister module segment for a suction anchor. The canister module segment includes a side portion defining an outer surface with a substantially constant outer perimeter along a sea bed immersing height, an inner surface and an outer surface, and a module contact surface portion on the outer surface.

A first and a second contact surface portion may be located on said outer surface at each side of said outer surface portion of each canister module segment respectively.

The first module contact surface portion may include a male assembly guide, and the second module contact surface portion may include a female assembly guide.

Furthermore, the invention concerns a method for assembling a suction anchor of composite canister module segments comprising the steps of providing a first composite canister module segment with a substantially constant outer perimeter along a sea bed immersing height (h_i), said composite canister module segment including an inner surface and an outer surface, wherein the outer surface includes a first contact surface portion on a first side of an exposed surface portion and a second contact surface portion on a second side of the exposed surface portion, providing a second canister module segment substantially similar to the first composite canister module segment, joining the first contact surface portion on the first composite canister module segment with the second contact surface portion

of the second canister module segment, and continue providing canister module segments and joining first contact surface portions and second contact surface portions of adjoining canister module segment until a complete canister is formed.

Short description of the enclosed drawings:

Fig. 1 shows a suction anchor according an embodiment of the invention;

Fig. 2 is a bottom view of the suction anchor of fig. 1;

Fig. 3 is a top view of the suction anchor of fig. 1;

Fig. 4 is a top view of a first composite canister module segment of the invention;

Fig. 5 is top view of a second composite canister module segment of the invention;

Fig. 6 is a cross section of a composite canister module segment of the invention;

Fig. 7 is a cross section of a suction anchor according the embodiment of the invention shown on fig. 1;

Fig. 8 shows a detail the cross section shown on fig. 7;

Fig. 9 shows a cross section of an assembly of two canister modules of fig. 6;

Fig 10 is a perspective view of a canister module of the invention.

Fig 11 is a perspective view of an alternative embodiment of a suction anchor of the invention;

Fig. 12 is a top view of the suction anchor of fig. 11;

Fig 13 is a side elevation view of a canister module segment of the invention for the embodiment shown in fig. 11 and fig. 12;

Fig. 14 is a perspective view of a third embodiment of a suction anchor according of the invention, installed in a seabed;

Fig. 15 is a cross section of a suction anchor according the embodiment of the invention shown on fig. 14;

Fig. 16 is a detail of the cross section of the suction anchor of fig. 15; and

Fig. 17 is structural anchor for the suction anchors shown of the figs. 11-16.

Detailed description of an embodiment of the invention with reference to the enclosed drawings:

Fig. 1 shows a suction caisson, suction anchor or suction mooring according to the invention, in the following referred to as anchor 1. The anchor 1 includes a metal load attachment portion 2, including an attachment flange 3, secured to a modular

composite portion or canister. The modular composite portion is assembled of segmented canister module segments 4, 5 joined in module joints 7. Fig. 1 shows plain canister module segments 4 and fluid connection canister module segments 5 with connection portions 6 for connection to a pump and for pumping water in or out of the canister. The canister has a cylindrical outer shape and curved transition portion 11 that forms a transition to a flat end portion 10. The curved transition portion 11 between the cylindrical outer shape and the flat end portion 10 ensures stress distribution in the composite canister. The flat end portion 10 provides an attachment area for the attachment flange 3. A side portion defines first outer surface 23 with a substantially constant outer perimeter along a sea bed immersing height h_i. The immersing height h_i represents the design penetration depth of the suction anchor into the seabed. A first outer surface 23, is a combination of external surfaces of each canister module segment 4, 5.

Fig. 2 shows the canister from below, where the cylindrical shape is clearly visible. The open bottom of the canister allows the anchor to be filled with soft sea bed when water is pumped out of at least one of the connection openings 6 in the two fluid connection canister module segments 5. The plain canister module segments 4 are similar to the fluid connection canister module segments 5 apart from the missing connection openings 6. The connection openings 6 may be sealed off when they not are connected to a pump unit to maintain a pressure difference between the inside and the outside of the canister when the anchor is loaded with some load. The suction anchor / canister define an inner volume 24. The canister module segments define an inner surface 22.

Fig. 2 shows six canister module segments assembled in module joints 8 forming the segment joints 7. Each canister module segment 4, 5 is formed with a segment rib 12 at each side of a curved portion forming a part of the cylindrical outer shape of the canister. In the shown embodiment with six canister module segments, each canister defines a 60° arc shaped wall portion and segmented rib portions 12 at each side of the arc shaped wall portion. The rib portions 12 are extending in an inward radial direction in relation to the arc shaped wall portion. The rib portions 12 of each canister module segment 4, 5 form faces for ease of assembly, in that the

rib portions of each canister module may be joined with the neighbouring canister module. The rib portions provide ample area for adhesive bonding / moulding of the canister module segments and for assembly of the canister. The rib portions 12 facilitate formation of sealed joints between the modules and improve rigidity of the assembled canister. Furthermore, the rib portions 12 provide a considerable increase of seabed contact area and thus in holding friction, increasing the holding ability of the suction anchor.

Fig. 2 furthermore shows the bottom flange 9 that forms a base for bolts holding the attachment flange to the bottom flange and for stress distribution of the load from the attachment portion. The bottom flange includes radial notches to allow the ribs to extend through the bottom flange.

Fig. 3 is a top view of the anchor of the invention. The six assembled canister module segments 4, 5, including the fluid connection canister module segments 5 with connection openings 6, form a cylindrical outer face that is joined in segment joints 7. The attachment flange 3 with the load attachment portion 2 is secured to the flat end portion 10 of the canister. The rounded transition 15 extends between the cylindrical portion and the flat end portion 10.

Fig. 4 and fig. 5 show a top view of a fluid connection canister module segment 5 and a plain canister module segment 4 respectively. The fluid connection canister module segment 5 includes the sealable connection opening 6. A curved transition portion 11 is formed between the arch shaped portion forming a part of the cylindrical canister and the flat end portion 10. Each canister module segment 4, 5 include a male rib 12b with a male assembly guide 14 and a female rib 12b with a female assembly guide. The male assembly guide 14 of each canister module is intended to extend into the female assembly guide of the adjacent canister module to ease correct assembly of the canister. The outer surface of each module segment is divided into three separate outer surfaces 23p, 23b, 23c whereof a center surface / exposed surface portion 23p forms a part of the outer surface 23 of the canister. Contact surface portions 23b, 23c are located on each side of the ex-

posed outer surface portion 23p for assembly and contact with the contact surface 23b, 23c on an outer surface of an adjoining module.

The flat end portion10 forms a flange attachment portion 16 with flange bolt holes 19 for flange bolts extending through the bottom flange and the attachment flange. The flange attachment to all the canister module segments reduces the stress on the joint interface between the modules.

Fig. 6 shows a cross section of a canister module of the embodiment shown in the other figures, and clearly shows the arch shaped outer portion 21, the female segment rib 12a and the male segment rib 12b . The canister module is shown with a 60° arch, but this angle will depend on the number of canister module segments that form the canister. The inwards extending radial ribs 12a, 12b are formed with the male assembly guide 14 and the female assembly guide 13. The male assembly guide 14 is designed and dimensioned to extend into the female assembly guide of the neighboring canister module to ensure proper alignment between the neighboring modules during assembly.

Fig. 7 shows a cross section of an anchor of the invention with the attachment flange 3 with a load attachment portion 2 and a reinforcing gusset 17 therein between. The attachment flange 3 is fixed to the six canister module segments and the bottom flange 9. The segment ribs 12 are shown in dashed lines. The curved transition portion 11 between the cylindrical outer portion and the flat end portion 10, ensures stress distribution between the flange and the canister.

Fig. 8 shows a detail of the attachment flange 3 with the load attachment portion 2 and the bottom flange 9. The flat end portion of all the canister module segments and hence the canister is sandwiched between the attachment flange 3 and the bottom flange 9. Flange bolts 18 extend through the flat end portion of the canister, the attachment flange 3 and the bottom flange 9. The segment ribs 12 extend toward the flat end portion of the canister to reinforce the top portion.

Fig. 9 shows a cross section of an assembly of two canister modules of fig. 6 of the embodiment shown in the other figures. The arch shaped outer portions 21 form a smooth or even arc and a segment rib 12 is joined by a female rib section 12a and a male rib section12b, forming a double rib 12 with twice the wall thickness of the outer wall. This increased wall thickness also increases the rigidity of the assembly. Again, the canister modules are shown with a 60° arch, but this angle will depend on the number of canister module segments forming the canister. The male assembly guide 14 extends into the conforming female assembly guide 13 to ensure proper alignment between neighboring modules during assembly and contributes to increased stiffness and integrity of the joint. A U-shaped locking profile 25 straddles the two ribs 12 for additional stiffness, as a redundant sealing and to maintain the two ribs in an assembled position. An adhesive such as epoxy or polyester may be injected into the U-shaped locking profile 25 for added integrity and to form a seal. The U-shaped locking profile 25 may typically be made of a composite material or an extruded alloy.

Fig 10 is a perspective view of a canister module of the invention with the portion for attachment of an attachment flange. The female segment rib 12a and the male segment rib 12b are shown as tapered ribs with increasing width towards the top of the module. The curved transition portion 11 between the cylindrical outer portion, the flat end portion 10, and the tapered ribs ensure stress distribution between the flange and the canister. The male assembly guide 14 and the female assembly guide 13 form inverted L-shaped assembly guides to ensure proper alignment of the canister modules both a longitudinal and a radial direction. Again the rib size contributes to determine the total area of the anchor exposed to the seabed and hence to determine the total friction between the seabed and the anchor.

The shown embodiment includes a metal load attachment portion 2, including an attachment flange 3, secured to the suction anchor. The metal load attachment portion 2 could however be substituted with other attachment elements typically for attaching the suction anchor to subsea installations. Such attachment elements could for instance include a ring or cylindrical portion cast into the upper part of the

canister module segments for attachment to a conforming portion of a subsea installation. Alternatively, such a ring or cylindrical portion could be a part of a metal attachment flange structure corresponding to the one shown in for instance fig. 7, but where the attachment portion 2 and the gusset 17 are substituted with a part for attachment to a subsea installation. The attachment flange also contributes to stiffen and distribute stresses from the load of the element to be anchored to the suction anchor. A metal attachment structure may also improve resistance against wear and abrasion between the element to be anchored and the suction anchor itself.

Fig 11 is a perspective view of an alternative embodiment of a suction anchor of fig. 1 where the metal load attachment portion 2 of fig. 1 is substituted with structural anchor cavities 30 for (a structural anchor is shown on fig. 17). Reinforcement plates 31 surround openings for the structural anchor cavities 30. Each reinforcement plate 31 may be a metal plate embedded in the composite canister module segments 4 and includes an opening for a structural anchor. The remaining features of the suction anchor correspond to the features of the suction anchor of fig. 1 apart from the metal attachment flange shown on fig. 1. Contrary to the embodiment of fig 1, is the flat end portion 10 completely without perforations or openings for bolts and thus completely sealed and not relying on seals around bolts extending through the flat end portion 10. The structural anchor cavities 30 will not extend into the internal cavity of the anchor as will be seen on fig. 13.
;

Fig. 12 is a top view of the suction anchor of fig. 11, where the reinforcement plates 31 surrounding the openings for the structural anchor cavities 30 are more clearly shown. The reinforcement plates 31 bridges the module joints 7 between the canister module segments 4 at the flat end portion 10. A centre opening may be permanently plugged.

Fig 13 is a side elevation view of a canister module segment 4 of the invention for the embodiment shown in fig. 11 and fig. 12. The canister module segment has the same features as the canister module segment of fig. 10, apart from the top bolt holes and the connection openings 6 (shown in for instance fig. 2). Clearly the

embodiments shown in the figs. 11-17 may also include similar connection openings. Furthermore, the embodiment shows the structural anchor cavity 30 moulded or machined into the rib at the flat portion at the top of the of canister module segment 4. The structural anchor cavity 30 may be formed into one rib completely, or may be formed on mating faces of two adjoining ribs, such that a structural anchor is located for instance midway between two ribs. A male segment rib 12b is shown as tapered ribs with increasing width towards the top of the module. The curved transition portion between the cylindrical outer portion, the flat end portion, and the tapered ribs ensure stress distribution between the flange and the canister. Again the rib size contributes to determine the total area of the anchor exposed to the seabed and hence to determine the total friction between the seabed and the anchor. The location of the structural anchor cavity 30 there are no holes or openings between the inner and outer surfaces of the suction anchor, an thus that the likelihood of a leak is reduced. Furthermore, the location of the structural anchor cavity 30 ensures that forces from a structural anchor is transferred directly to the ribs of each canister module segment. A structural anchor is placed in a structural anchor cavity 30 before two canister module segments are joined, and the structural anchors become embedded in the ribs joining the canister module segments.

Fig. 14 is a perspective view of a third embodiment of a suction anchor 1 according of the invention, installed in a seabed 37. The embodiment of fig. 14 corresponds in most ways with the embodiment shown in figs. 11-13, but an anchoring element 35 with structural anchors is located in a module joint 7 in an internal rib, at the side on the cylindrical part of the suction anchor 1. A mooring line 36 is attached to the anchoring element 35 at a location below the seabed 37. The suction anchor 1 of the figs. 14-16 is intended for anchoring inclined mooring lines applying a sideways force component on the suction anchor 1.

Fig. 15 is a cross section of a suction anchor according the embodiment of the invention shown on fig. 14. The solution and features shown in fig. 15 corresponds in most ways solution and features shown in with fig 7, apart from the top flange in fig. 7 and the attachment element 35 of fig. 15. The attachment element 35 is

shown embedded between two ribs forming a rib 12 of two adjoining canister module segments 4 at the cylindrical side of the suction anchor 1 at the lower half of the suction anchor 1. The seabed 37 is located at the upper half of the suction anchor 1, leaving the attachment element 35 below the seabed 37.

Fig. 16 is a detail of the cross section of the suction anchor 1 of fig. 15, and shows the attachment element 35 integrated with two structural anchors 37 embedded in two structural anchor cavities 30. The mooring line 36 is attached to a mooring line attachment opening 38 in the attachment element 35.

Fig. 17 is structural anchor 37 for the suction anchor shown in the figs. 11-16. The structural anchor 37 is formed as a “traditional” boat anchor with transverse portions 40 at a lower end of a center column 39 with a structure attachment portion 41. The structure attachment portion 41 will typically be adapted to a structure to be mounted on top of the suction anchor. Similarly with a traditional boat anchor, may the two transverse portions 40 be inclined or bent somewhat upwards in relation to the centre column 39. The structural anchors 37 an the attachment elements 35 are typically made of metal. The structural anchor cavity 30 is typically shaped as the structural anchor 37, and the shape of the structural anchor cavity 30 thus conforms to the shape of the structural anchor 37.

In this specification, the term “composite” is meant to cover fiber reinforced synthetic materials such as glass fibers in a polyester or epoxy matrix. Glass fibers are normally considered as the most cost effective solution, as the cost of carbon fibers or Kevlar fibers could be prohibitive.

“Composite” is not meant to cover materials such as concrete or steel.

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PATENT CLAIMS

1. A suction anchor with a load attachment portion, for providing a foundation or mooring attachment in a soft sea bed including an open bottom portion, a closed top portion, a side portion defining a first outer surface (23) with a substantially constant outer perimeter along a sea bed immersing height (h_i), said suction anchor defining an inner volume (24) and means for allowing water to be pumped out of said inner volume (24), said suction anchor comprising:
at least two adjoining canister module segments (4, 5) with an inner surface (22) and an outer surface (23p, 23b, 23c), wherein each canister module segment (4, 5) extends at least along said immersing height (h_i);
wherein each canister module segment (4, 5) includes at least a first and a second contact surface portion (23b, 23c) located on said outer surface (23p, 23b, 23c) on each side of an exposed outer surface portion (23p), joint with contact surfaces of at least one adjoining module segment; and
wherein the canister module segments (4, 5) are made of a composite material.

2. The suction anchor of claim 1, wherein the first module contact surface portion (23b) includes a male assembly guide (14), and the second module contact surface portion (23c) includes a female assembly guide (13).

3. The suction anchor of claim 1, wherein the first contact surface portion (23b) is formed as a rib and the second contact surface portion is formed as a rib and the contact surface portion adjoins a contact surface portion of an adjacent element in a center a stiffening rib (12) of the suction anchor.

4. The suction anchor of claim 3, wherein the first contact surface portion (23b) is formed as a male rib (12b) with a male assembly guide (14) and the second contact surface portion (23c) is formed as a female rib (12b) with a female assembly guide (13).

5. The suction anchor according to any of the preceding claims, further including at least one structural anchor cavity (30) formed into at least one stiffening rib (12), and a structural anchor (37) in said least one structural anchor cavity (30) whereby said at least one structural anchor (37) is embedded in said at least one stiffening rib (12).

6. The suction anchor of any of the preceding claims including six canister module segments (4, 5).

7. A composite canister module segment (4, 5) for a suction anchor with a substantially constant outer perimeter along a sea bed immersing height (h_i), said canister module segment (4, 5) including an inner surface (22) and an outer surface (23b, 23c, 23p), wherein the outer surface includes a first contact surface portion (23b) on a first side of an exposed surface portion (23p) and a second contact surface portion (23c) on a second side of the exposed surface portion (23p).

8. The composite canister module segment of claim 7 wherein the first contact surface portion (23b) is formed as a male rib (12b) with a male assembly guide (14) and the second contact surface portion (23c) is formed as a female rib (12b) with a female assembly guide (13).

9. The composite canister module segment of claim 7 or 8 further including a structural anchor cavity (30) formed in said outer surface the first contact surface portion (23b) on the first side of the exposed surface portion (23p) and/or the second contact surface portion (23c) on the second side of the exposed surface portion (23p).

10. A method for assembling a suction anchor of composite canister module segments of claim 4 comprising the steps of:
providing a first composite canister module segment (4, 5) with a substantially constant outer perimeter along a sea bed immersing height (h_i), said composite canister module segment (4, 5) including an inner surface (22) and an outer sur-

face (23b, 23c, 23p), wherein the outer surface includes a first contact surface portion (23b) on a first side of an exposed surface portion (23p) and a second contact surface portion (23c) on a second side of the exposed surface portion (23p);

providing a second canister module segment (4, 5) substantially similar to the first composite canister module segment (4, 5);

joining the first contact surface portion (23b) on the first composite canister module segment (4, 5) with the second contact surface portion (23c) of the second canister module segment (4, 5); and

continue providing canister module segment (4, 5) and joining first contact surface portions (23b) and second contact surface portions (23c) of adjoining canister module segment (4, 5) until a complete canister is formed.

AMENDED CLAIMS
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PATENT CLAIMS

1. A suction anchor with a load attachment portion, for providing a foundation or mooring attachment in a soft sea bed including an open bottom portion, a closed top portion, a side portion defining a first outer surface (23) with a substantially constant outer perimeter along a sea bed immersing height (h_i), said suction anchor defining an inner volume (24) and means for allowing water to be pumped out of said inner volume (24), said suction anchor comprising:
at least two adjoining canister module segments (4, 5) with an inner surface (22) and an outer surface (23p, 23b, 23c), wherein each canister module segment (4, 5) extends at least along said immersing height (h_i);
wherein each canister module segment (4, 5) includes at least a first and a second contact surface portion (23b, 23c) located on said outer surface (23p, 23b, 23c) on each side of an exposed outer surface portion (23p), joint with contact surfaces of at least one adjoining module segment; and
wherein the canister module segments (4, 5) are made of a composite material.

2. The suction anchor of claim 1, wherein the first module contact surface portion (23b) includes a male assembly guide (14), and the second module contact surface portion (23c) includes a female assembly guide (13).

3. The suction anchor of claim 1, wherein the first contact surface portion (23b) is formed as a rib and the second contact surface portion is formed as a rib and the contact surface portion adjoins a contact surface portion of an adjacent element in a center a stiffening rib (12) of the suction anchor.

4. The suction anchor of claim 3, wherein the first contact surface portion (23b) is formed as a male rib (12b) with a male assembly guide (14) and the second contact surface portion (23c) is formed as a female rib (12a) with a female assembly guide (13).

5. The suction anchor according to any of the preceding claims, further including at least one structural anchor cavity (30) formed into at least one stiffening rib (12), and a structural anchor (37) in said least one structural anchor cavity (30) whereby said at least one structural anchor (37) is embedded in said at least one stiffening rib (12).

6. The suction anchor of any of the preceding claims including six canister module segments (4, 5).

7. A composite canister module segment (4, 5) for a suction anchor with a substantially constant outer perimeter along a sea bed immersing height (h_i), said canister module segment (4, 5) including an inner surface (22) and an outer surface (23b, 23c, 23p), wherein the outer surface includes a first contact surface portion (23b) on a first side of an exposed surface portion (23p) and a second contact surface portion (23c) on a second side of the exposed surface portion (23p).

8. The composite canister module segment of claim 7 wherein the first contact surface portion (23b) is formed as a male rib (12b) with a male assembly guide (14) and the second contact surface portion (23c) is formed as a female rib (12a) with a female assembly guide (13).

9. The composite canister module segment of claim 7 or 8 further including a structural anchor cavity (30) formed in said outer surface the first contact surface portion (23b) on the first side of the exposed surface portion (23p) and/or the second contact surface portion (23c) on the second side of the exposed surface portion (23p).

10. A method for assembling a suction anchor of composite canister module segments of claim 7 comprising the steps of:
providing a first composite canister module segment (4, 5) with a substantially constant outer perimeter along a sea bed immersing height (h_i), said composite canister module segment (4, 5) including an inner surface (22) and an outer sur-

face (23b, 23c, 23p), wherein the outer surface includes a first contact surface portion (23b) on a first side of an exposed surface portion (23p) and a second contact surface portion (23c) on a second side of the exposed surface portion (23p);

providing a second canister module segment (4, 5) substantially similar to the first composite canister module segment (4, 5);

joining the first contact surface portion (23b) on the first composite canister module segment (4, 5) with the second contact surface portion (23c) of the second canister module segment (4, 5); and

continue providing canister module segment (4, 5) and joining first contact surface portions (23b) and second contact surface portions (23c) of adjoining canister module segment (4, 5) until a complete canister is formed.

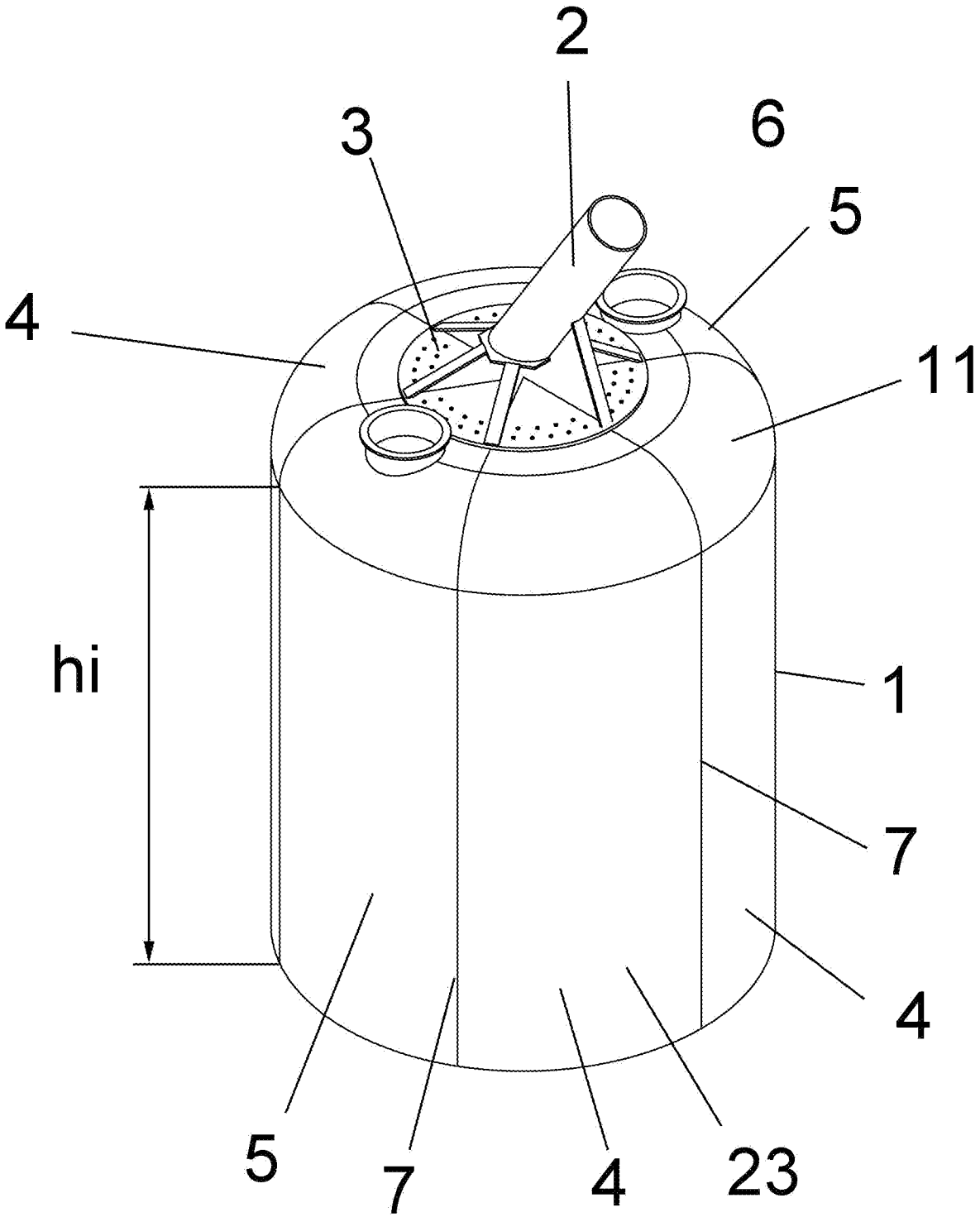

Fig. 1

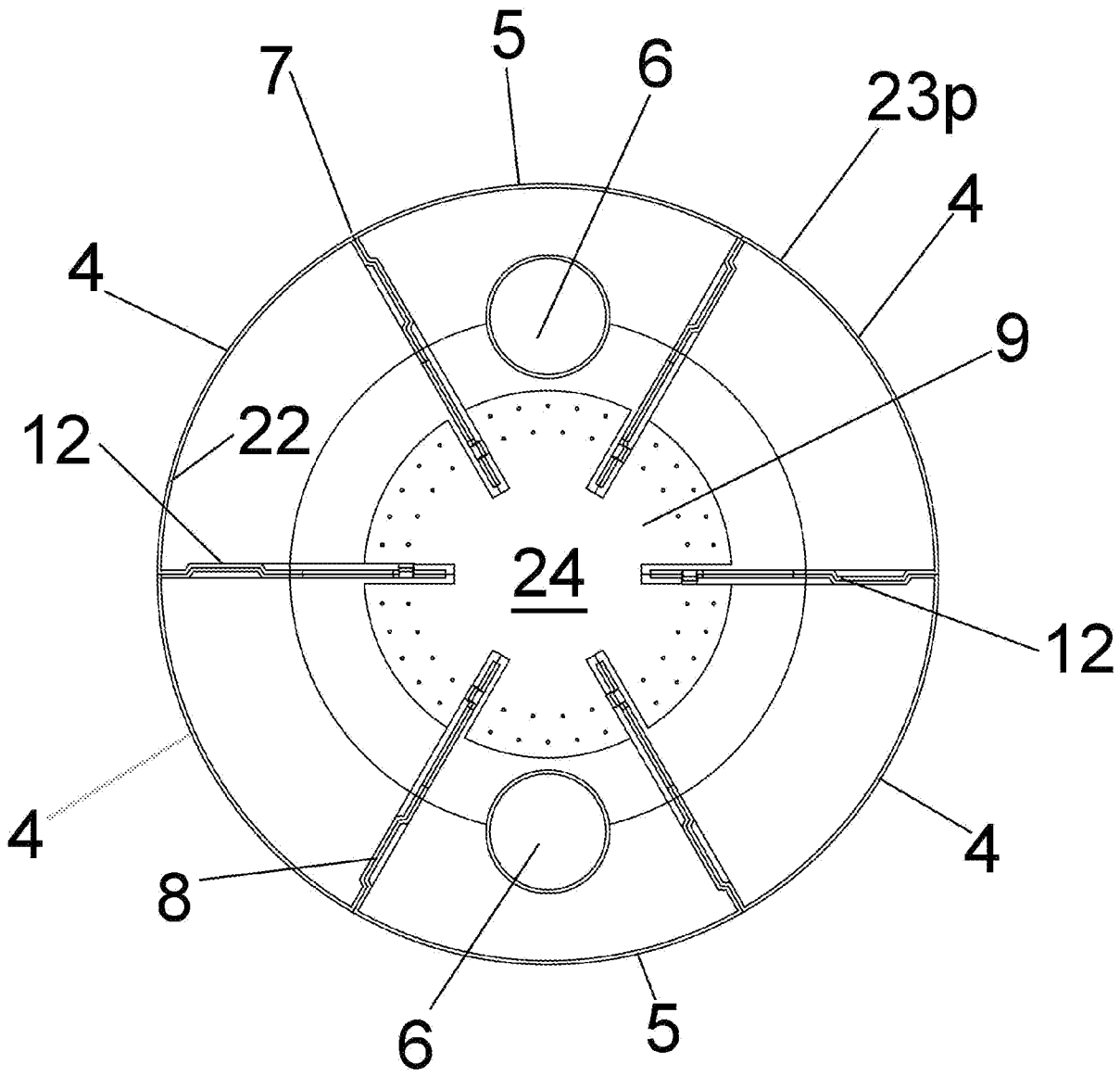

Fig. 2

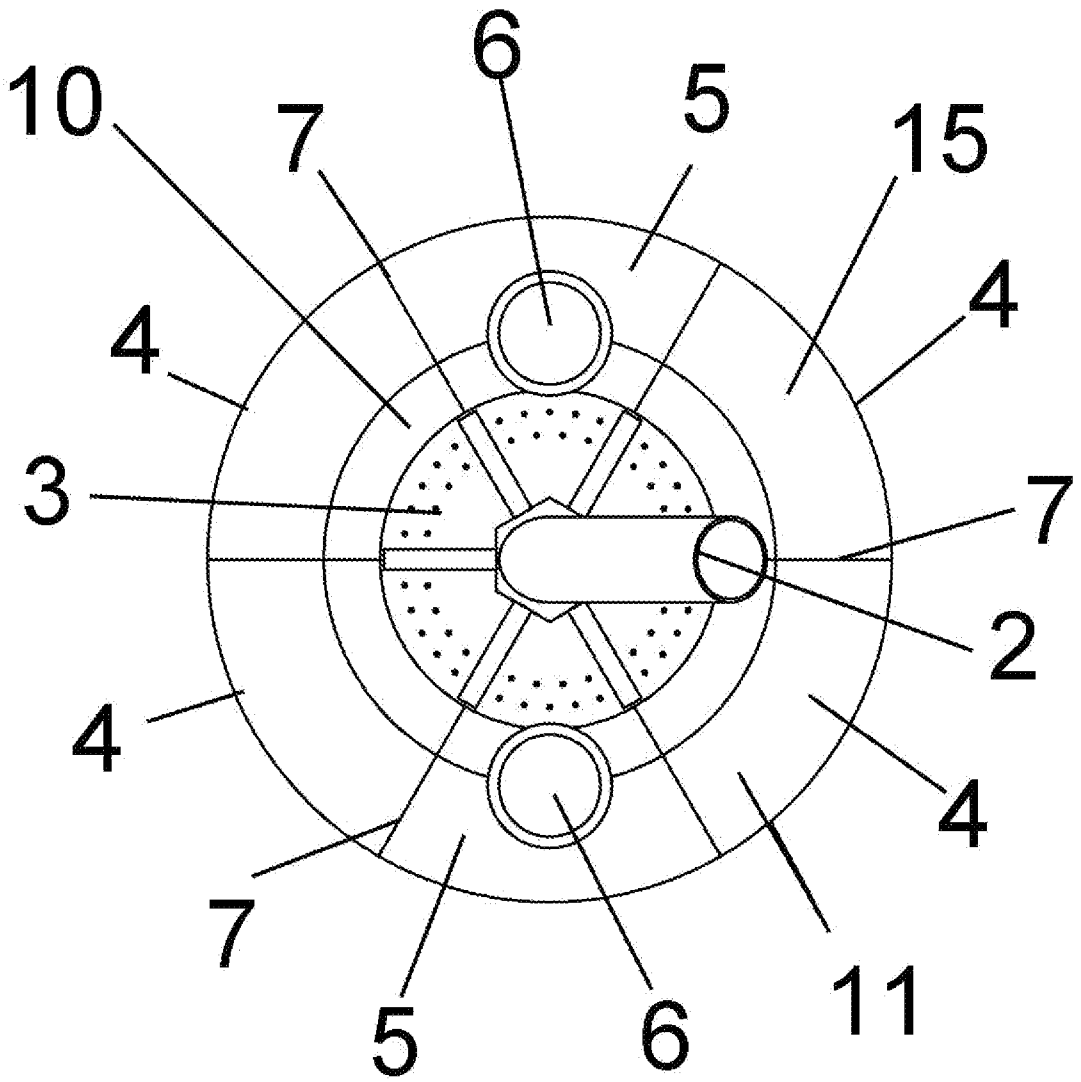

Fig. 3

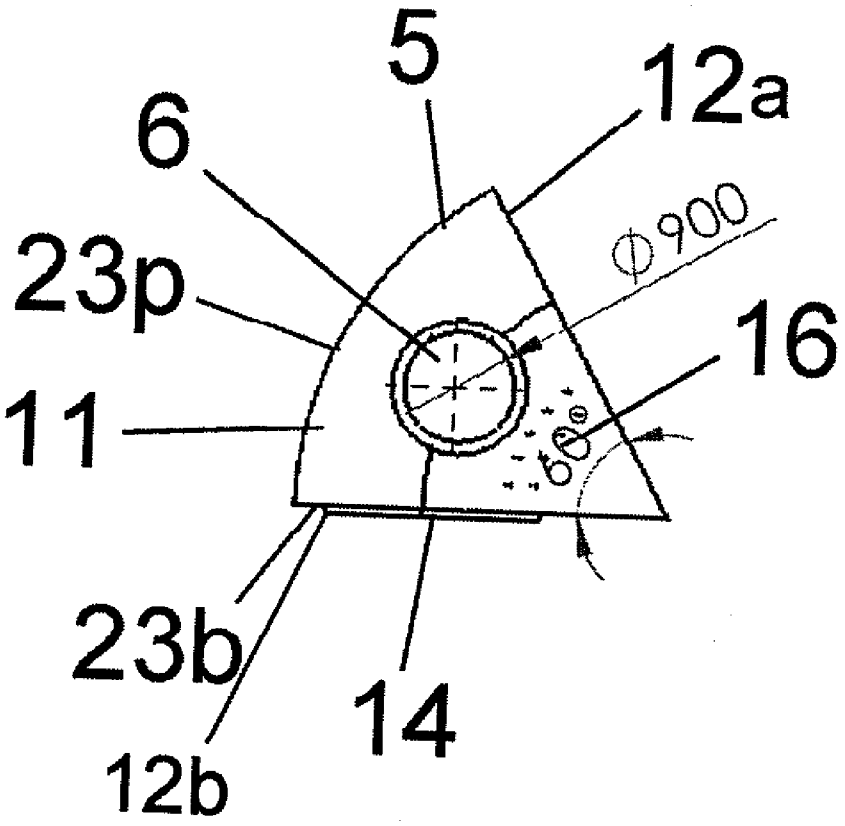

Fig. 4

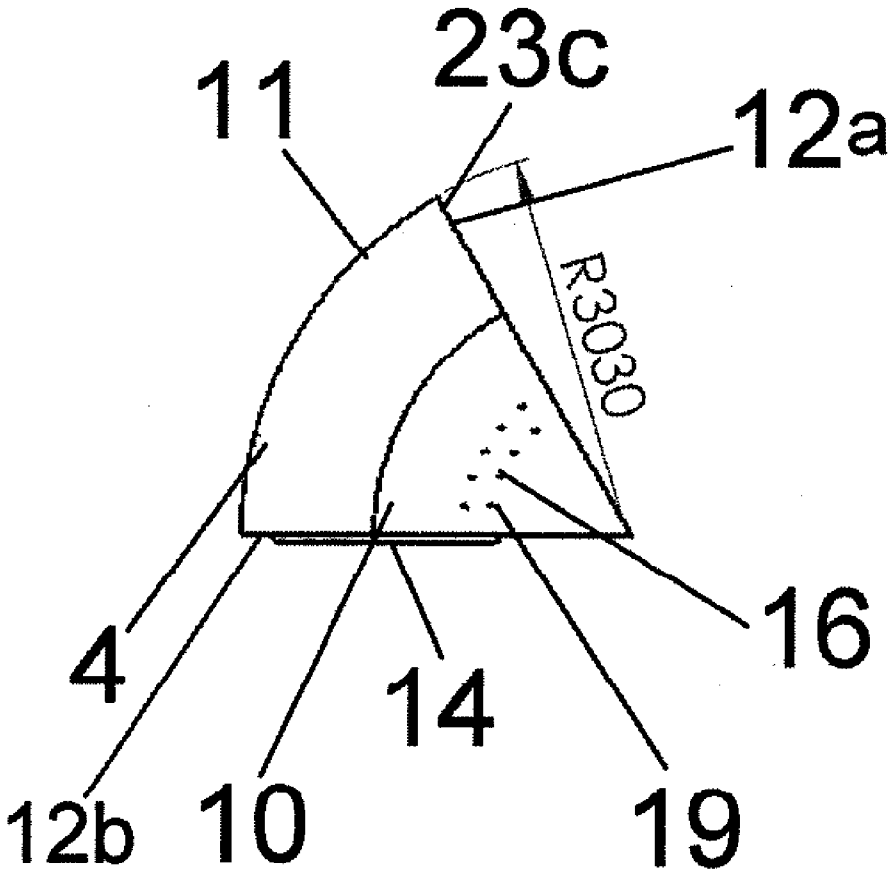

Fig. 5

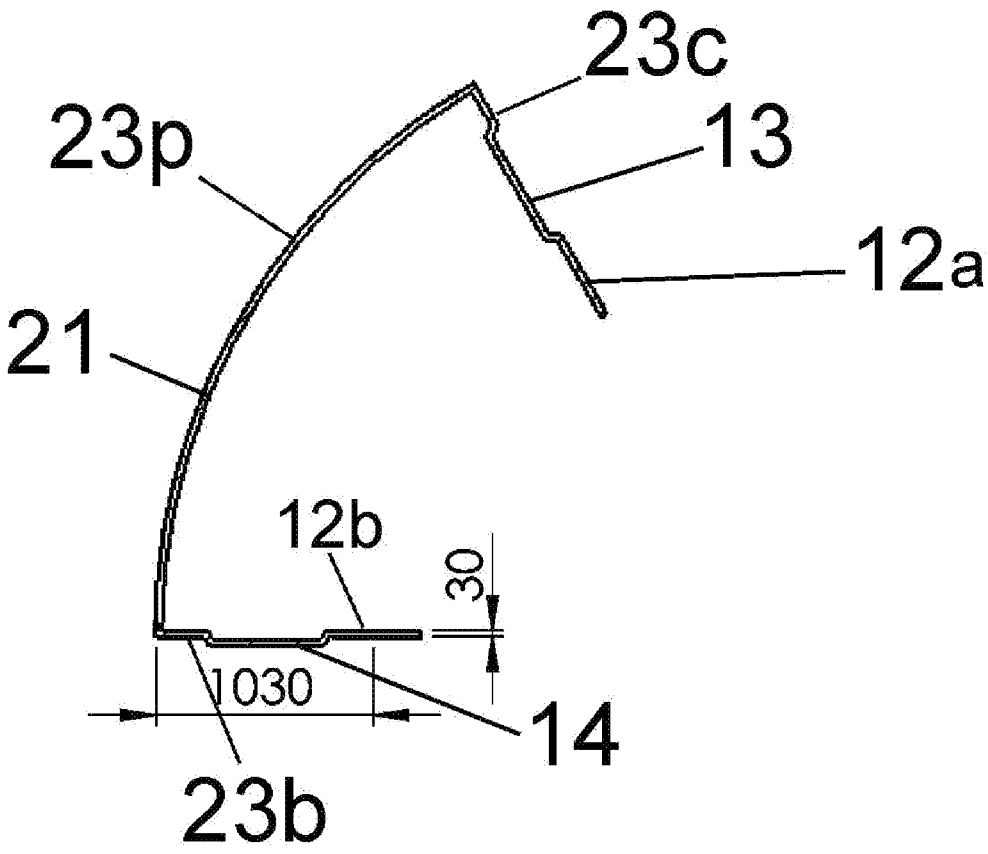

Fig. 6

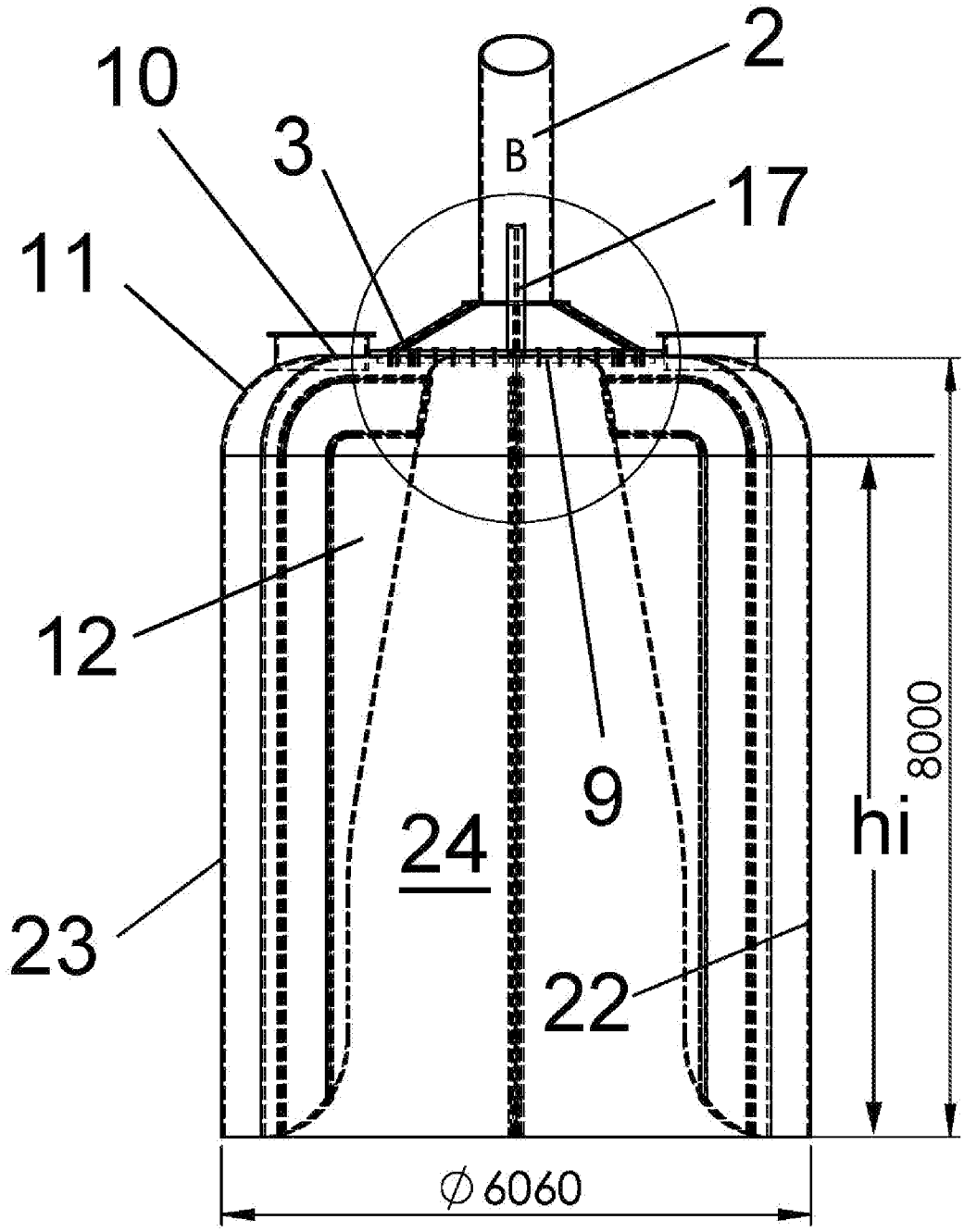

Fig. 7

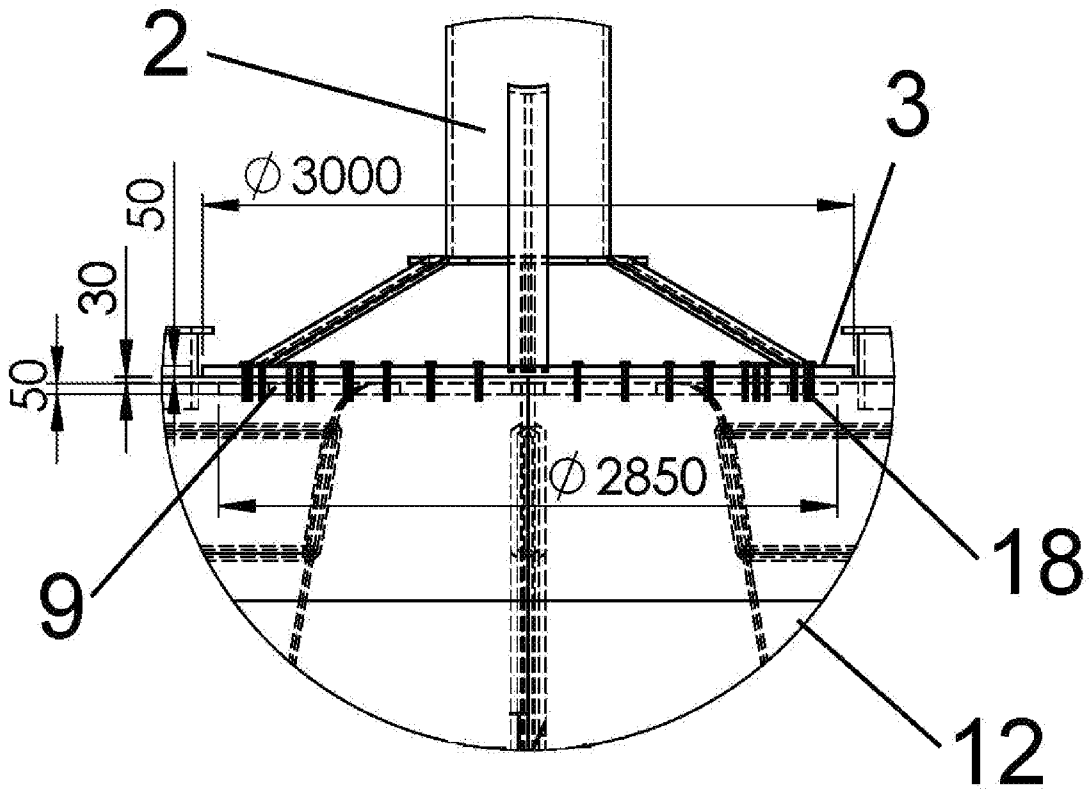

Fig. 8

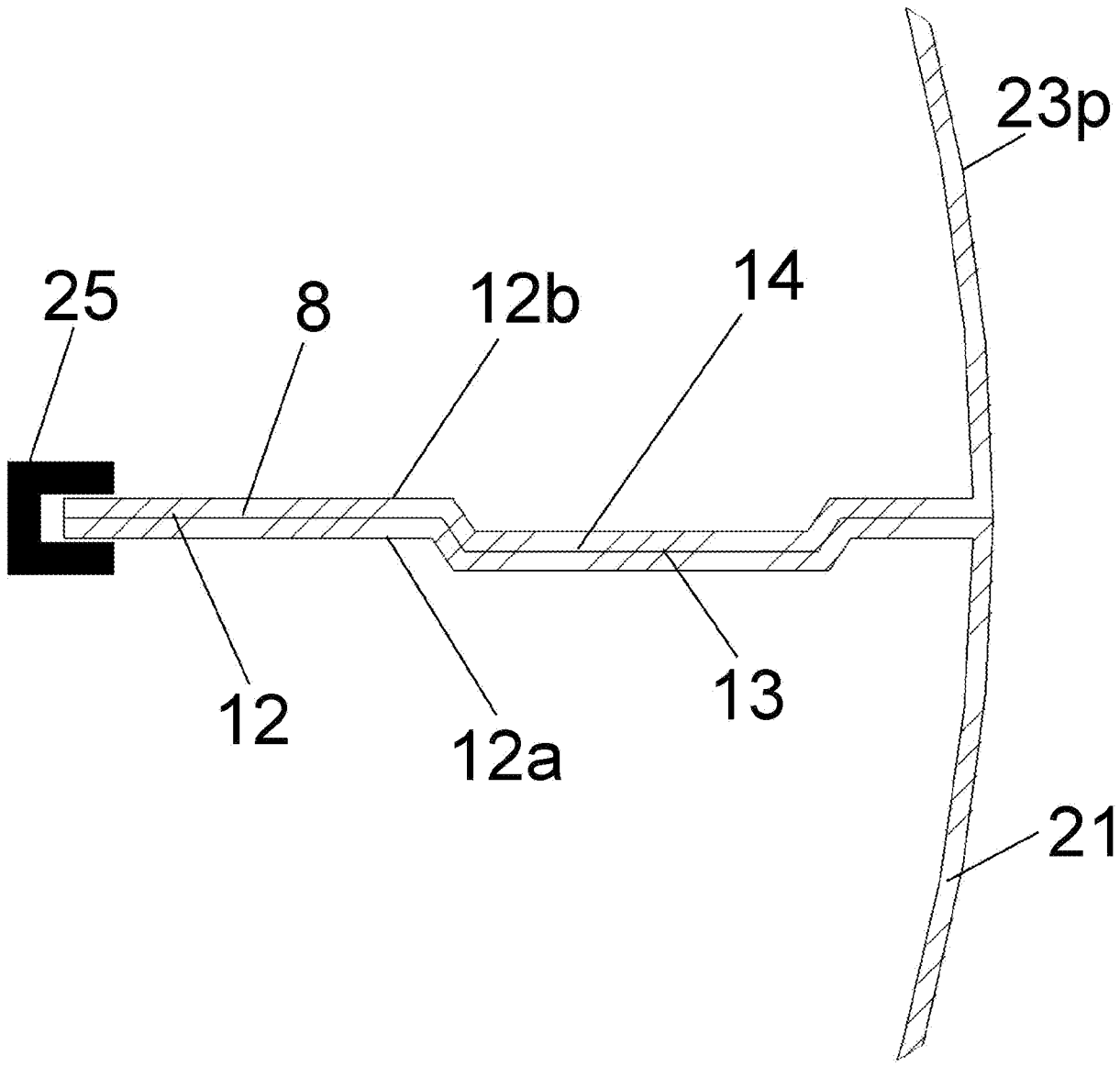

Fig. 9

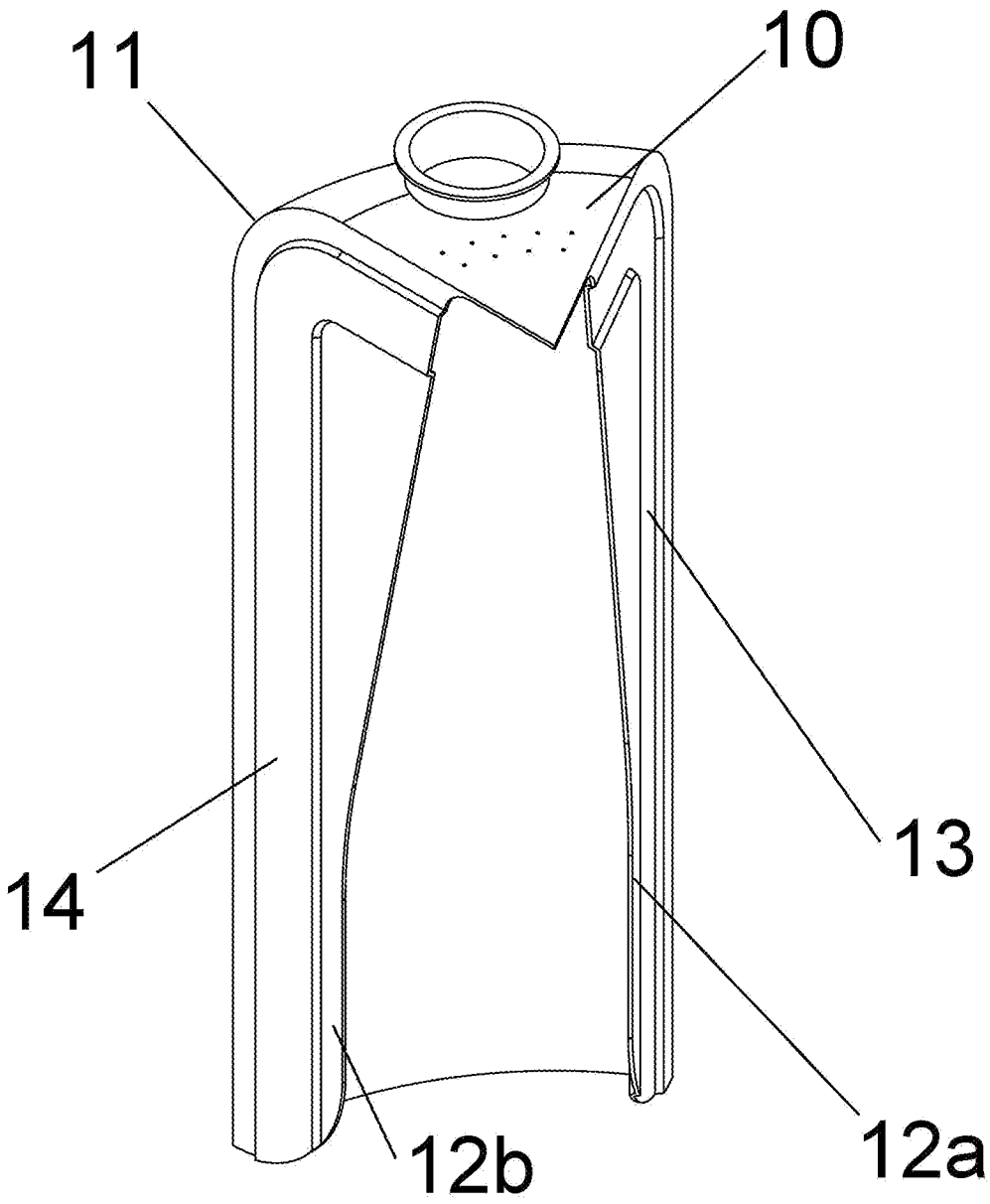

Fig. 10

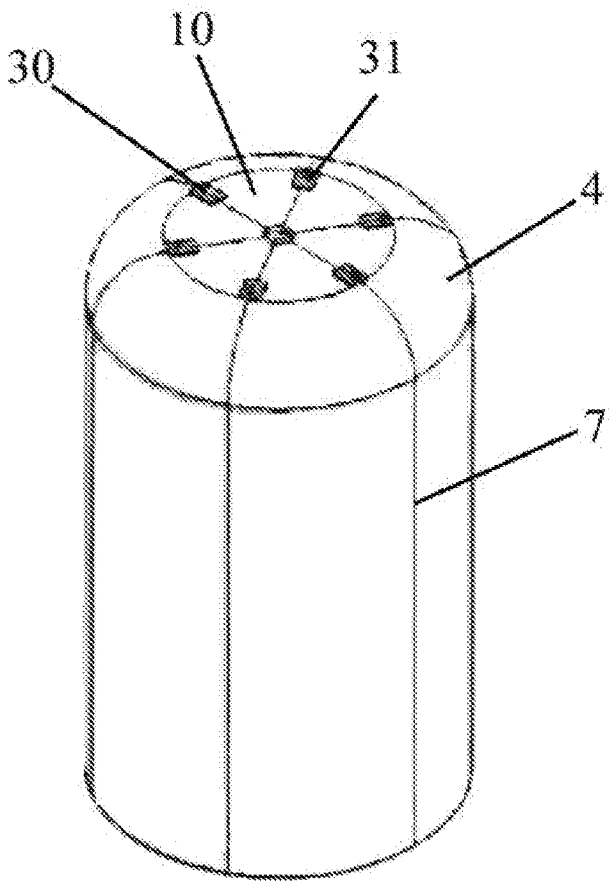

Fig. 11

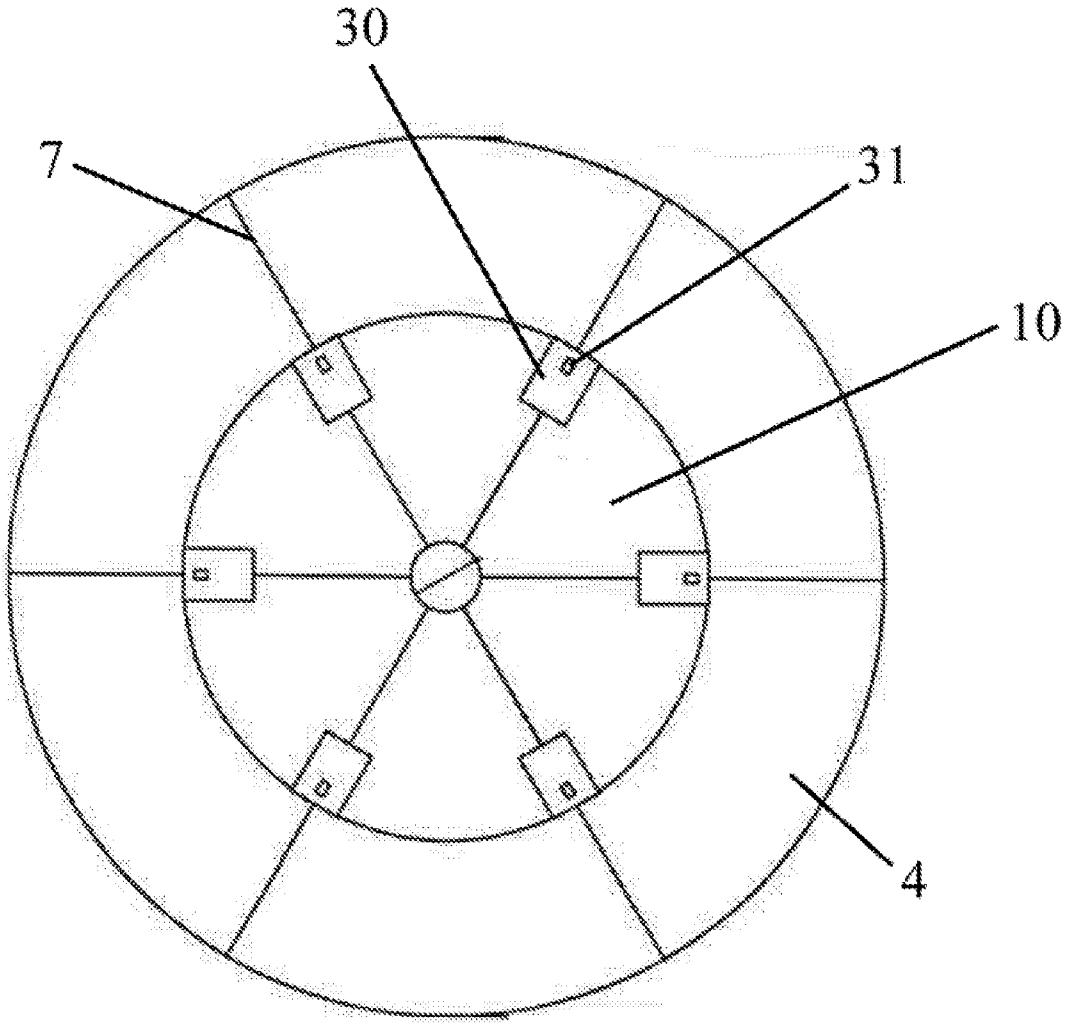

Fig. 12

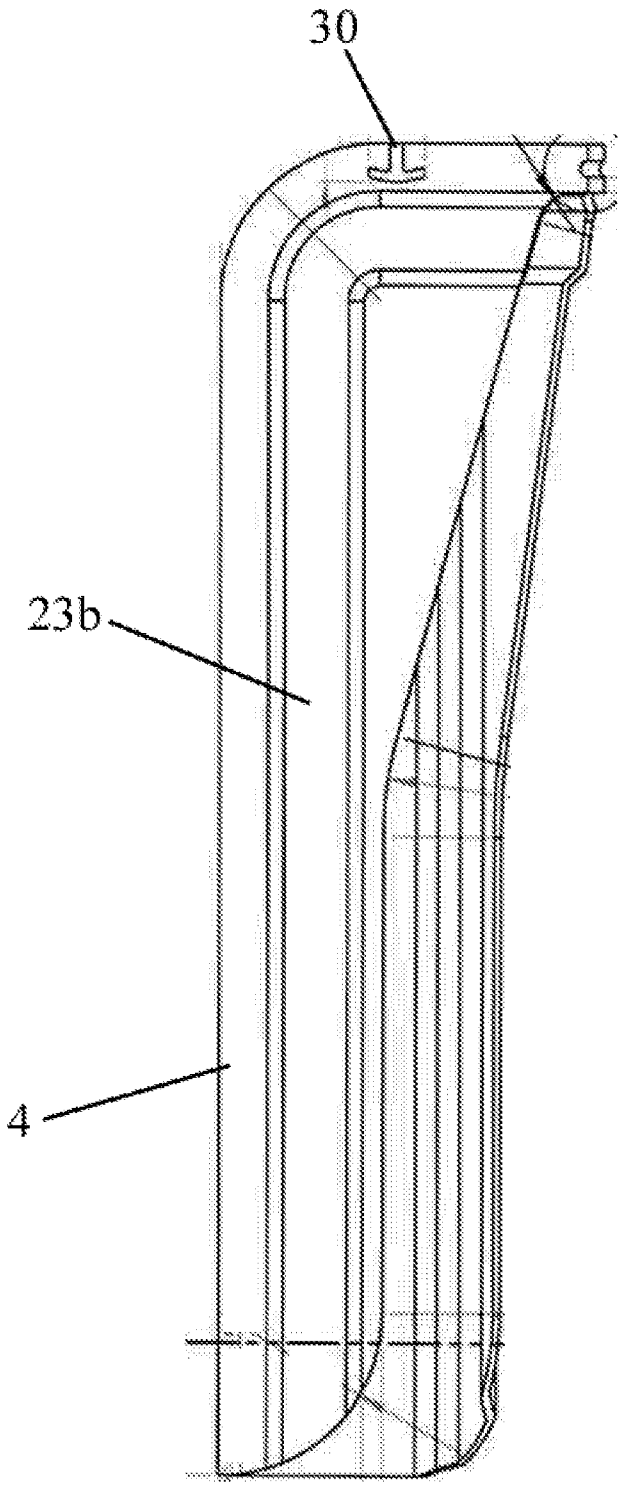

Fig. 13

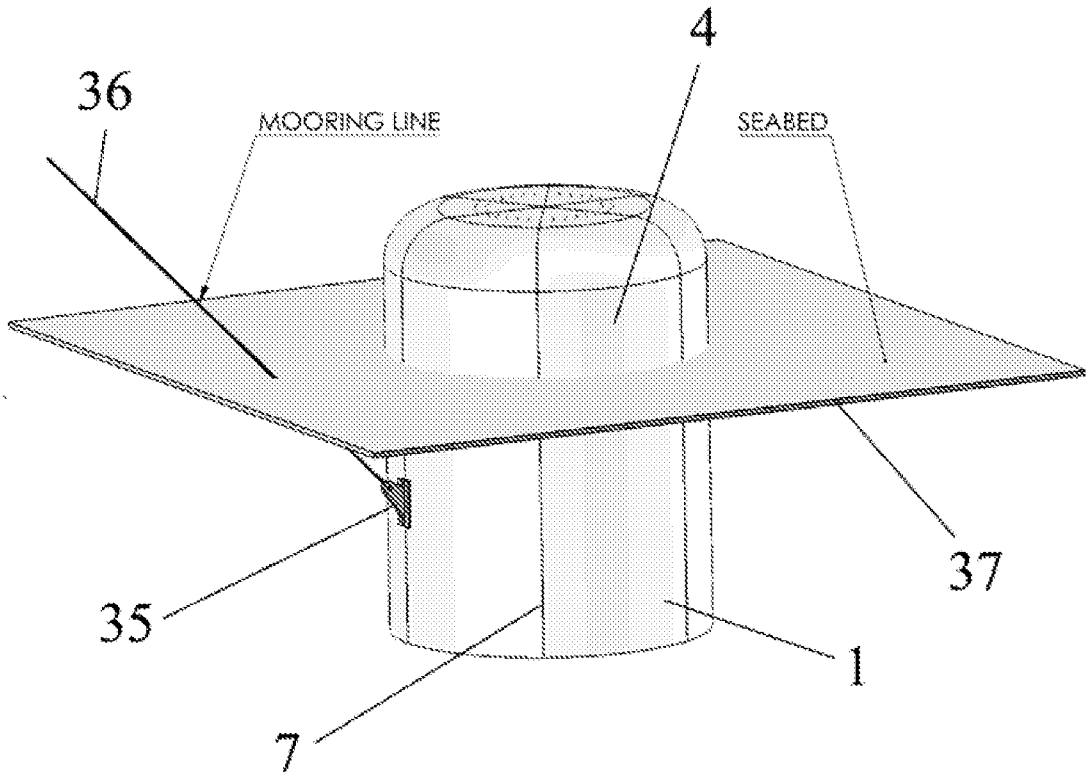

Fig. 14

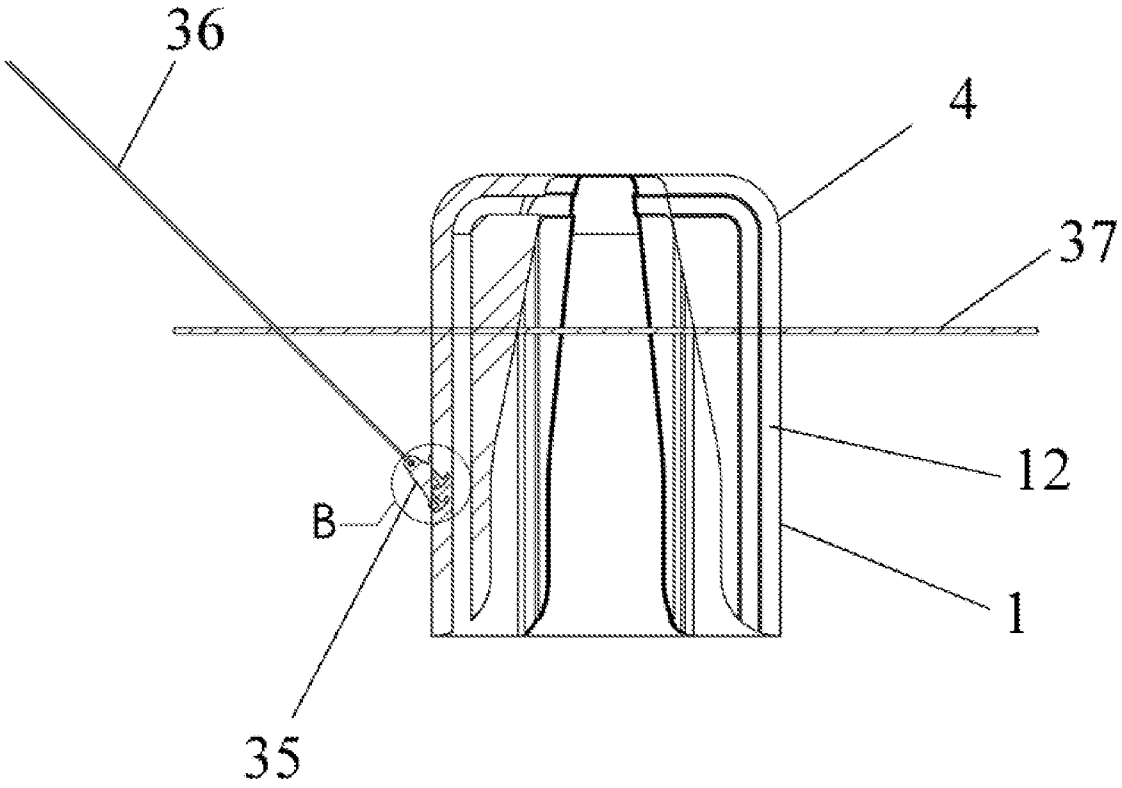

Fig. 15

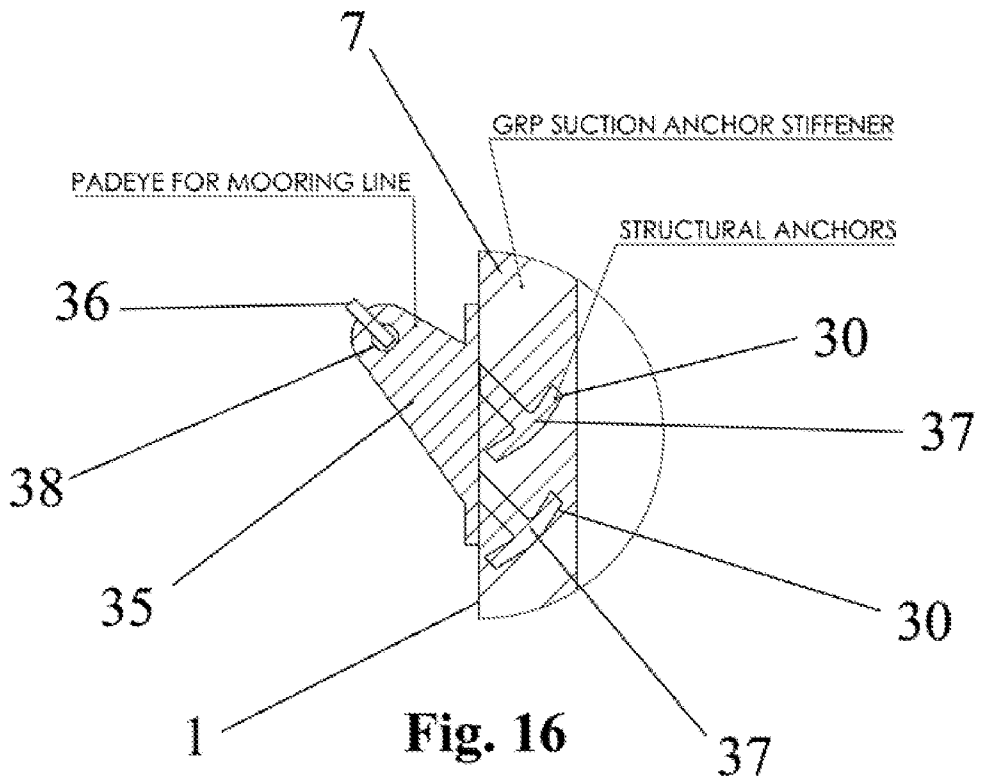
7
GRP SUCTION ANCHOR STIFFENER
PADEYE FOR MOORING LINE
STRUCTURAL ANCHORS
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Fig. 16

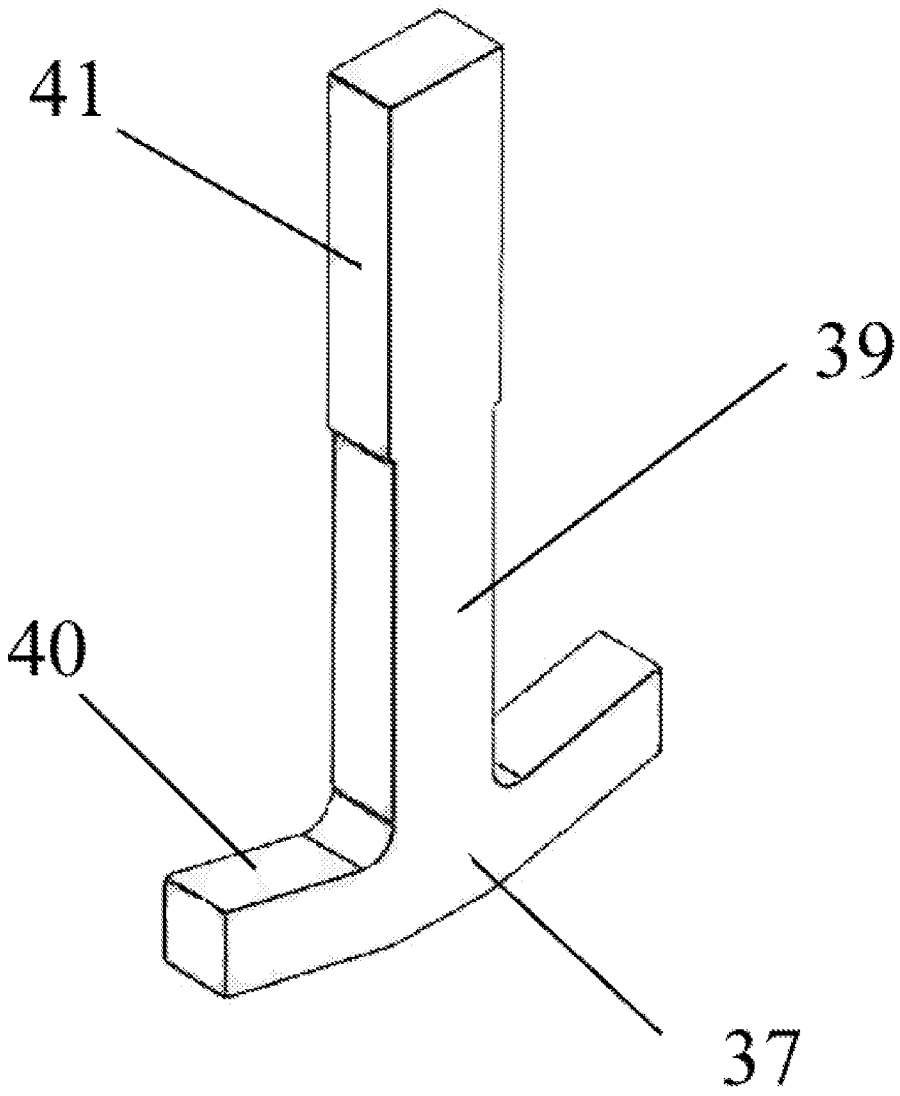

Fig.17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO2014/050064

A. CLASSIFICATION OF SUBJECT MATTER
IPC: B63B 21/27 (2006.01), B63B 21/50 (2006.01), E02D 7/28 (2006.01), E02D 27/52 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: B63B, E02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI: Classes as above.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI, FULL-TEXT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 1999/57009 A1 (SUCTION PILE TECHNOLOGY B V) 1999.11.11 whole document	1-10
A	NO 20092869 A (COMPOCEAN AS) 2011.02.21 whole document	1-10
A	WO 2001/71105 A1 (SCHAKENDA, B.) 2001.09.27 whole document	1-10
A	CN 101255701 A (TIANJIN CITY NEPTUNE OFFSHORE) 2008.09.03 whole document	1-10
A	NL 1037967C (MERCON HOLDING B V) 2011.11.22 whole document	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24/07/2014	25/07/2014
Name and mailing address of the ISA Nordic Patent Institute Helgeshøj Allé 81 DK - 2630 Taastrup, Denmark. Facsimile No. + 45 43 50 80 08	Authorized officer Øystein Skalland Telephone No. +47 22 38 75 25

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO2014/050064

Patent document cited in search report / Publication date	Patent family member(s) / Publication date
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NL 1037967C C 2011.11.22	NONE