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

SAUGANKER, VERBUNDMODULSEGMENT FÜR EINEN SAUGANKER UND VERFAHREN ZUR MONTAGE SOLCHER SEGMENTE

ANCRE D'ASPIRATION, SEGMENT DE MODULE COMPOSITE POUR UNE ANCRE D'ASPIRATION ET PROCÉDÉ D'ASSEMBLAGE DE TELS SEGMENTS

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Description

[0001] The present invention relates to a modular composite suction anchor for mooring purposes.

[0002] 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 caisson or suction caisson, hereinafter only caisson 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 caisson such that the pressure differences between the outside and the inside of the caisson drives the anchor into the sea bed. Similarly, the anchor may be released from the sea bed by pumping water into the caisson.

[0003] 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.

[0004] Suction anchors may form a part of unitary sub-sea 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.

[0005] 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.

[0006] 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.

[0007] 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.

[0008] Furthermore it is a purpose of the present invention to provide a suction anchor that is considerably lighter than a steel counterpart.

[0009] Weight saving that will allow for the use of a smaller vessel will result in considerable installation savings and increased availability of installation vessels.

[0010] 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 included. Fur-

thermore, the expected lifespan of the suction anchors is independent of corrosion.

[0011] The present invention defines a suction anchor for providing a foundation or mooring attachment on a soft sea bed. The suction anchor includes a caisson 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.

[0012] The seabed immersing height is the height of the suction anchor, or the inserted design depth of the anchor into the seabed.

[0013] 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 caisson module segments with an inner surface and an outer surface forming a part of the first outer surface. Each caisson module segment extends at least along said immersing height. Each caisson 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 caisson module segments are made of a composite material. A load attachment portion is secured to the closed top portion.

[0014] 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 caisson module segment respectively.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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 at least one structural anchor cavity whereby said at least one structural anchor is embedded in said at least one stiffening rib.

[0019] 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.

[0020] The composite caisson module segment may further include 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.

[0021] The contact surface portion may adjoin a contact surface portion of an adjacent caisson module segment in a center of a stiffening rib of the suction anchor.

[0022] The suction anchor may include six caisson module segments.

[0023] Furthermore, the invention concerns a composite caisson module segment for a suction anchor. The caisson 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.

[0024] 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 caisson module segment respectively.

[0025] 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.

[0026] Furthermore, the invention concerns a method for assembling a suction anchor of composite caisson module segments comprising the steps of providing a first composite caisson module segment with a substantially constant outer perimeter along a sea bed immersing height (h_i), said composite caisson 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 caisson module segment substantially similar to the first composite caisson module segment, joining the first contact surface portion on the first composite caisson module segment with the second contact surface portion of the second caisson module segment, and continue providing caisson module segments and joining first contact surface portions and second contact surface portions of adjoining caisson module segment until a complete caisson is formed.

[0027] 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 caisson module segment of the invention;

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

Fig. 6 is a cross section of a composite caisson 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 caisson modules of fig. 6;

Fig. 10 is a perspective view of a caisson 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 caisson 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.

[0028] 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 caisson. The modular composite portion is assembled of segmented caisson module segments 4, 5 joined in module joints 7. Fig. 1 shows plain caisson module segments 4 and fluid connection caisson module segments 5 with connection portions 6 for connection to a pump and for pumping water in or out of the caisson. The caisson 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 caisson. 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 caisson module segment 4, 5.

[0029] Fig. 2 shows the caisson from below, where the cylindrical shape is clearly visible. The open bottom of the caisson 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 caisson module segments 5. The plain caisson module segments 4 are similar to the fluid connection caisson 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 caisson when the anchor is loaded with some load. The suction anchor / caisson define an inner volume 24. The

caisson module segments define an inner surface 22.

[0030] Fig. 2 shows six caisson module segments assembled in module joints 8 forming the segment joints 7. Each caisson 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 caisson. In the shown embodiment with six caisson module segments, each caisson 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 caisson module segment 4, 5 form faces for ease of assembly, in that the rib portions of each caisson module may be joined with the neighbouring caisson module. The rib portions provide ample area for adhesive bonding / moulding of the caisson module segments and for assembly of the caisson. The rib portions 12 facilitate formation of sealed joints between the modules and improve rigidity of the assembled caisson. 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.

[0031] 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.

[0032] Fig. 3 is a top view of the anchor of the invention. The six assembled caisson module segments 4, 5, including the fluid connection caisson 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 caisson. The rounded transition 15 extends between the cylindrical portion and the flat end portion 10.

[0033] Fig. 4 and fig. 5 show a top view of a fluid connection caisson module segment 5 and a plain caisson module segment 4 respectively. The fluid connection caisson 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 caisson and the flat end portion 10. Each caisson 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 caisson module is intended to extend into the female assembly guide of the adjacent caisson module to ease correct assembly of the caisson. 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 caisson. Contact surface portions 23b, 23c are located on each side of the exposed outer surface portion 23p for assembly and contact with the contact surface 23b, 23c on an outer surface of an adjoining mod-

ule.

[0034] The flat end portion 10 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 caisson module segments reduces the stress on the joint interface between the modules.

[0035] Fig. 6 shows a cross section of a caisson 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 caisson module is shown with a 60° arch, but this angle will depend on the number of caisson module segments that form the caisson. 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 caisson module to ensure proper alignment between the neighboring modules during assembly.

[0036] 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 caisson 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 caisson.

[0037] 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 caisson module segments and hence the caisson is sandwiched between the attachment flange 3 and the bottom flange 9. Flange bolts 18 extend through the flat end portion of the caisson, the attachment flange 3 and the bottom flange 9. The segment ribs 12 extend toward the flat end portion of the caisson to reinforce the top portion.

[0038] Fig. 9 shows a cross section of an assembly of two caisson 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 section 12b, 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 caisson modules are shown with a 60° arch, but this angle will depend on the number of caisson module segments forming the caisson. 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.

[0039] Fig 10 is a perspective view of a caisson 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 caisson. The male assembly guide 14 and the female assembly guide 13 form inverted L-shaped assembly guides to ensure proper alignment of the caisson 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.

[0040] 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 caisson 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.

[0041] 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 caisson 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. ;

[0042] 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 caisson module segments 4 at the flat end portion 10. A centre opening may be permanently plugged.

[0043] Fig 13 is a side elevation view of a caisson module segment 4 of the invention for the embodiment shown in fig. 11 and fig. 12. The caisson module segment has the same features as the caisson 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 caisson 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 caisson. 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, and 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 caisson module segment. A structural anchor is placed in a structural anchor cavity 30 before two caisson module segments are joined, and the structural anchors become embedded in the ribs joining the caisson module segments.

[0044] Fig. 14 is a perspective view of a third embodiment of a suction anchor 1 according of the invention, installed in a seabed 42. The embodiment of fig. 14 corresponds in most ways with the embodiment shown in figs. 11-13, but an attachment 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 attachment element 35 at a location below the seabed 42. 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.

[0045] 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 caisson module segments 4 at the cylindrical side of the suction anchor 1 at the lower half of the

suction anchor 1. The seabed 42 is located at the upper half of the suction anchor 1, leaving the attachment element 35 below the seabed 42.

[0046] 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.

[0047] 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 30 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 at 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.

[0048] 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.

[0049] "Composite" is not meant to cover materials such as concrete or steel.

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 caisson module segments (4, 5) each with an inner surface (22) and an outer surface (23p, 23b, 23c), wherein each caisson module segment (4, 5) extends at least along said immersing height (h_i); wherein each caisson 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 caisson module segment;

wherein the caisson module segments (4, 5) are made of a composite material; and wherein the first contact surface portion (23b) is formed on a segment rib (12) and the second contact surface portion (23c) is formed on a segment rib (12) and the contact surface portions (23b, 23c) adjoins the contact surface portions of at least one adjoining caisson module segment in a module joint (8) at a center of a stiffening rib of the suction anchor.

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 2, 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).
4. 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) for a mooring line (36) in said at least one structural anchor cavity (30) whereby said at least one structural anchor (37) is embedded in said at least one stiffening rib (12).
5. The suction anchor of any of the preceding claims including six caisson module segments (4, 5).
6. A composite caisson module segment (4, 5) for a suction anchor with a substantially constant outer perimeter along a sea bed immersing height (h_i), said caisson 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); the first contact surface portion (23b) is formed on a segment rib (12); and the second contact surface portion (23c) is formed on a segment rib (12)
7. The composite caisson module segment of claim 6 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).
8. The composite caisson module segment of claim 6 or 7 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).

9. A method for assembling a suction anchor of composite caisson module segments of claim 6 comprising the steps of:

providing a first composite caisson module segment (4, 5) with a substantially constant outer perimeter along a sea bed immersing height (h_i), said composite caisson 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);

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

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

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

Patentansprüche

1. Sauganker mit einem Lastbefestigungsabschnitt, zum Bereitstellen eines Fundaments oder einer Verankerungsbefestigung in einem weichen Meeresgrund, einschließlich eines offenen Bodenabschnitts, eines geschlossenen Deckabschnitts, eines Seitenabschnitts, der eine erste äußere Oberfläche (23) mit einem im Wesentlichen konstanten Außenumfang entlang einer Meeresgrund-Einsinkhöhe (h_i) definiert, wobei der Sauganker ein Innenvolumen (24) und Mittel definiert, um zu ermöglichen, dass Wasser aus dem Innenvolumen (24) herausgepumpt wird, wobei der Sauganker folgendes aufweist:

mindestens zwei benachbarte Senkkastenmodulsegmente (4, 5) mit jeweils einer inneren Oberfläche (22) und einer äußeren Oberfläche (23p, 23b, 23c), wobei sich jedes Senkkastenmodulsegment (4, 5) mindestens entlang der Einsinkhöhe (h_i) erstreckt;

wobei jedes Senkkastenmodulsegment (4, 5) mindestens einen ersten und einen zweiten Kontaktflächenabschnitt (23b, 23c) aufweist, der auf der äußeren Oberfläche (23p, 23b, 23c) jeweils auf der Seite eines freiliegenden äußeren Oberflächenabschnitts (23p) liegt, der mit Kontaktflächen von mindestens einem benachbarten Senkkastenmodulsegment verbunden ist;

wobei die Senkkastenmodulsegmente (4, 5) aus einem Verbundmaterial hergestellt sind; und wobei der erste Kontaktflächenabschnitt (23b) auf einer Segmentrippe (12) ausgebildet ist und der zweite Kontaktflächenabschnitt (23c) auf einer Segmentrippe (12) ausgebildet ist und sich die Kontaktflächenabschnitte (23b, 23c) an die Kontaktflächenabschnitte von mindestens einem benachbarten Senkkastenmodulsegment in einer Modulfuge (8) in der Mitte einer Versteifungsrippe des Saugankers anfügen.

2. Sauganker nach Anspruch 1, wobei der erste Modul-Kontaktflächenabschnitt (23b) eine männliche Montage-Führung (14) aufweist und der zweite Modul-Kontaktflächenabschnitt (23c) eine weibliche Montage-Führung (13) aufweist.

3. Sauganker nach Anspruch 2, wobei der erste Kontaktflächenabschnitt (23b) als männliche Rippe (12b) mit einer männlichen Montage-Führung (14) ausgebildet ist und der zweite Kontaktflächenabschnitt (23c) als weibliche Rippe (12a) mit einer weiblichen Montage-Führung (13) ausgebildet ist.

4. Sauganker nach einem der vorangehenden Ansprüche, weiterhin aufweisend mindestens einen in mindestens einer Versteifungsrippe (12) ausgebildeten Strukturankerhohlraum (30), und einen Strukturanker (37) für eine Ankerleine (36) in dem mindestens einen Strukturankerhohlraum (30), wodurch der mindestens eine Strukturanker (37) in der mindestens einen Versteifungsrippe (12) eingebettet ist.

5. Sauganker nach einem der vorangehenden Ansprüche, der sechs Senkkastenmodulsegmente (4, 5) aufweist.

6. Senkkastenmodul-Verbundsegment (4, 5) für einen Sauganker mit einem im Wesentlichen konstanten Außenumfang entlang einer Meeresgrund-Einsinkhöhe (h_i), wobei das Senkkastenmodulsegment (4, 5) eine innere Oberfläche (22) und eine äußere Oberfläche (23b, 23c, 23p) einschließt, wobei die äußere Oberfläche einen ersten Kontaktflächenabschnitt (23b) auf einer ersten Seite eines freiliegenden Oberflächenabschnitts (23p) und einen zweiten Kontaktflächenabschnitt (23c) auf einer zweiten Seite des freiliegenden Oberflächenabschnitts (23p)

einschließt;

wobei der erste Kontaktflächenabschnitt (23b) auf einer Segmentrippe (12) ausgebildet ist und der zweite Kontaktflächenabschnitt (23c) auf einer Segmentrippe (12) ausgebildet ist.

7. Senkkastenmodul-Verbundsegment nach Anspruch 6, wobei der erste Kontaktflächenabschnitt (23b) als eine männliche Rippe (12b) mit einer männlichen Montage-Führung (14) ausgebildet ist und der zweite Kontaktflächenabschnitt (23c) als eine weibliche Rippe (12a) mit einer weiblichen Montage-Führung (13) ausgebildet ist. 10
8. Senkkastenmodul-Verbundsegment nach Anspruch 6 oder 7, weiterhin aufweisend einen Strukturkerzhohlraum (30), der in der äußeren Oberfläche des ersten Kontaktflächenabschnitts (23b) auf der ersten Seite des freiliegenden Oberflächenabschnitts (23p) und/oder des zweiten Kontaktflächenabschnitts (23c) auf der zweiten Seite des freiliegenden Oberflächenabschnitts (23p) ausgebildet ist. 20
9. Verfahren zur Montage eines Saugankers aus Senkkastenmodul-Verbundsegmenten nach Anspruch 6, die folgenden Schritte aufweisend: 25

Bereitstellen eines ersten Senkkastenmodul-Verbundsegments (4, 5) mit einem im Wesentlichen konstanten Außenumfang entlang einer Meeresgrund-Einsinkhöhe (h_i), wobei das Senkkastenmodul-Verbundsegment (4, 5) eine innere Oberfläche (22) und eine äußere Oberfläche (23b, 23c, 23p) einschließt, wobei die äußere Oberfläche einen ersten Kontaktflächenabschnitt (23b) auf einer ersten Seite eines freiliegenden Oberflächenabschnitts (23p) und einen zweiten Kontaktflächenabschnitt (23c) auf einer zweiten Seite des freiliegenden Oberflächenabschnitts (23p) einschließt; 30

Bereitstellen eines zweiten Senkkastenmodul-segments (4, 5), das im Wesentlichen dem ersten Senkkastenmodul-Verbundsegment (4, 5) ähnlich ist; 35

Verbinden des ersten Kontaktflächenabschnitts (23b) auf dem ersten Senkkastenmodul-Verbundsegment (4, 5) mit dem zweiten Kontaktflächenabschnitt (23c) des zweiten Senkkastenmodul-segments (4, 5); und 40

weiterhin Bereitstellen von Senkkastenmodul-segment (4, 5) und Verbinden von ersten Kontaktflächenabschnitten (23b) und zweiten Kontaktflächenabschnitten (23c) des benachbarten Senkkastenmodul-segments (4, 5), bis ein kompletter Senkkasten ausgebildet ist. 45

Revendications

1. Ancre d'aspiration avec une partie de fixation de charge, pour fournir une fondation ou une fixation d'amarrage dans un plancher océanique souple comprenant une partie inférieure ouverte, une partie supérieure fermée, une partie latérale définissant une première surface extérieure (23) avec un périmètre extérieur sensiblement constant le long d'une hauteur d'immersion de plancher océanique (h_i), ladite ancre d'aspiration définissant un volume intérieur (24) et des moyens pour permettre à de l'eau d'être pompée hors dudit volume intérieur (24), ladite ancre d'aspiration comprenant : 5

au moins deux segments de module de caisson adjacents (4, 5) ayant chacun une surface intérieure (22) et une surface extérieure (23p, 23b, 23c), dans laquelle chaque segment de module de caisson (4, 5) s'étend au moins le long de ladite hauteur d'immersion (h) ;

dans lequel chaque segment de module de caisson (4, 5) comprend au moins des première et seconde parties de surface de contact (23b, 23c) situées sur ladite surface extérieure (23p, 23b, 23c) de chaque côté d'une partie de surface extérieure exposée (23p), jointes avec des surfaces de contact d'au moins un segment de module de caisson adjacent ;

dans lequel les segments de module de caisson (4, 5) sont constitués d'un matériau composite ; et

dans lequel la première partie de surface de contact (23b) est formée sur une nervure de segment (12) et la seconde partie de surface de contact (23c) est formée sur une nervure de segment (12) et les parties de surface de contact d'au moins un segment de module de caisson adjacent dans un joint de module (8) au centre d'une nervure de renforcement de l'ancre d'aspiration. 50

2. Ancre d'aspiration selon la revendication 1, dans lequel la première partie de surface de contact de module (23b) comprend un guide d'assemblage mâle (14) et la seconde partie de surface de contact de module (23c) comporte un guide d'assemblage femelle (13). 45

3. Ancre d'aspiration selon la revendication 2, dans laquelle la première partie de surface de contact (23b) est formée sous la forme d'une nervure mâle (12b) avec un guide d'assemblage mâle (14) et la seconde partie de surface de contact (23c) est formée sous la forme d'une nervure femelle (12a) avec un guide d'assemblage femelle (13). 50

4. Ancre d'aspiration selon l'une quelconque des re- 55

vendications précédentes, comprenant en outre au moins une cavité d'ancre structurelle (30) formée dans au moins une nervure de raidissement (12), et une ancre structurelle (37) pour une ligne d'amar-
rage (36) dans ladite au moins une cavité d'ancre struc-
turelle (30), de sorte que ladite au moins une ancre
structurelle (37) est encastrée dans ladite au moins
une nervure de raidissement (12).

5. Ancre d'aspiration selon l'une quelconque des re-
vendications précédentes comprenant six segments
de module de caisson (4, 5).
6. Segment de module de caisson composite (4, 5)
pour une ancre d'aspiration avec un périmètre exté-
rieur sensiblement constant le long d'une hauteur
d'immersion de plancher océanique (h), ledit seg-
ment de module de caisson (4, 5) comprenant une
surface intérieure (22) et une surface extérieure
(23b, 23c, 23p), dans lequel la surface extérieure
comprend une première partie de surface de contact
(23b) sur un premier côté d'une partie de surface
exposée (23p) et une seconde partie de surface de
contact (23c) sur un second côté de la partie de sur-
face exposée (23p) ;
la première partie de surface de contact (23b) est
formée sur une nervure de segment (12) ; et
la seconde partie de surface de contact (23c) est
formée sur une nervure de segment (12).
7. Segment de module de caisson composite selon la
revendication 6 dans lequel la première partie de
surface de contact (23b) est formée sous la forme
d'une nervure mâle (12b) avec un guide d'assem-
blage mâle (14) et la seconde partie de surface de
contact (23c) est formée sous la forme d'une femelle
nervure (12a) avec un guide d'assemblage femelle
(13).
8. Segment de module de caisson composite selon la
revendication 6 ou 7, comprenant en outre une cavité
d'ancre structurelle (30) formée dans ladite surface
extérieure, la première partie de surface de contact
(23b) sur le premier côté de la partie de surface ex-
posée (23p) et/ou la seconde partie de surface de
contact (23c) sur le second côté de la partie de sur-
face exposée (23p).
9. Procédé d'assemblage d'une ancre d'aspiration
constituée de segments de module de caisson com-
posites selon la revendication 6, comprenant les éta-
pes consistant à :

Fournir un premier segment de module de cais-
son composite (4, 5) avec un périmètre extérieur
sensiblement constant le long d'une hauteur
d'immersion de plancher océanique (h), ledit
segment de module de caisson composite (4,

5) comprenant une surface intérieure (22) et une
surface extérieure (23b, 23c, 23p), dans lequel
la surface extérieure comprend une première
partie de surface de contact (23b) sur un premier
côté d'une partie de surface exposée (23p) et
une seconde partie de surface de contact (23c)
sur un second côté de la partie de surface ex-
posée (23p) ;
fournir un second segment de module de cais-
son (4, 5) sensiblement similaire au premier seg-
ment de module de caisson composite (4, 5) ;
joindre la première partie de surface de contact
(23b) sur le premier segment de module de cais-
son composite (4, 5) avec la seconde partie de
surface de contact (23c) du second segment de
module de caisson (4, 5) ; et
continuer à fournir un segment de module de
caisson (4, 5) et à joindre les premières parties
de surface de contact (23b) et les secondes par-
ties de surface de contact (23c) du segment de
module de caisson adjacent (4, 5) jusqu'à former
un caisson complet.

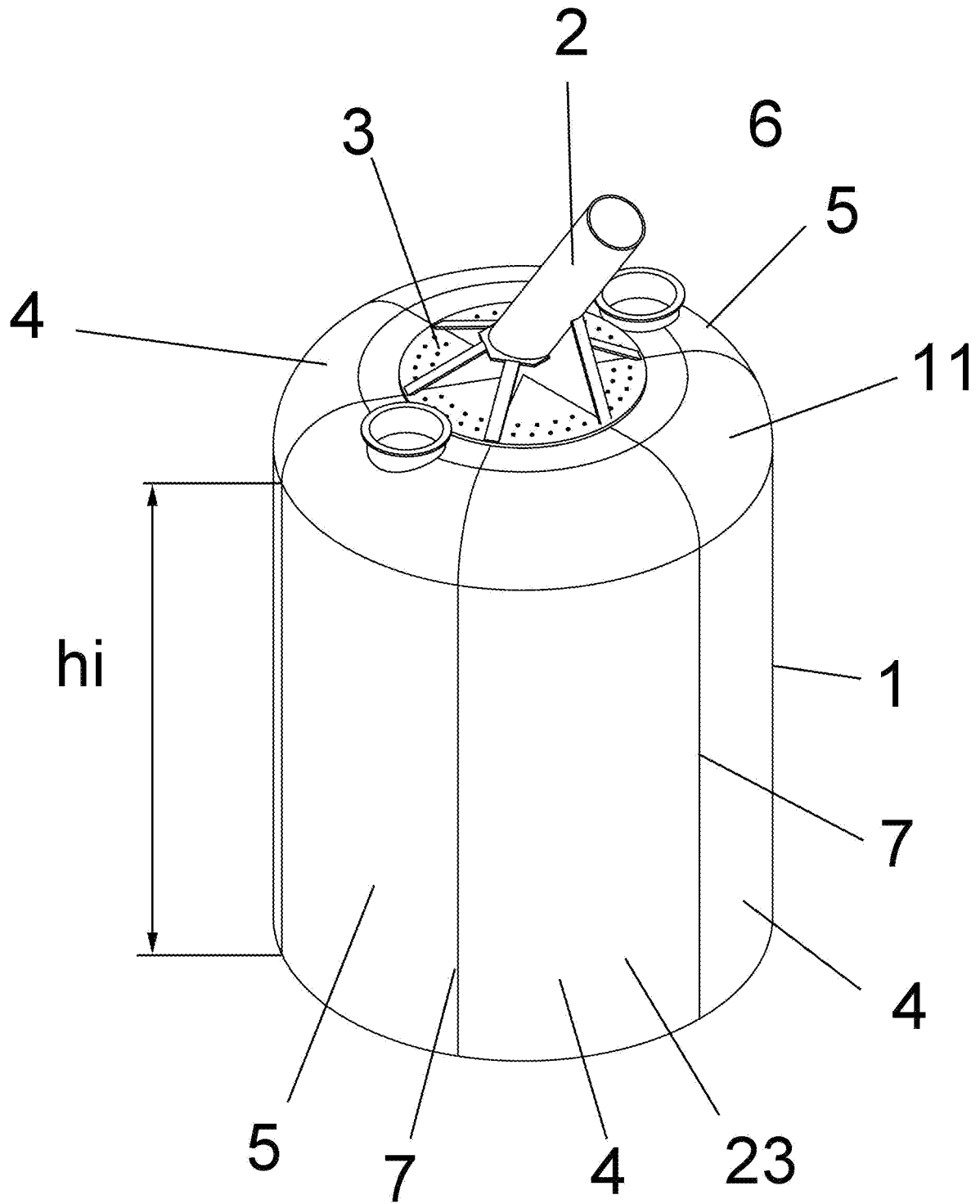


Fig. 1

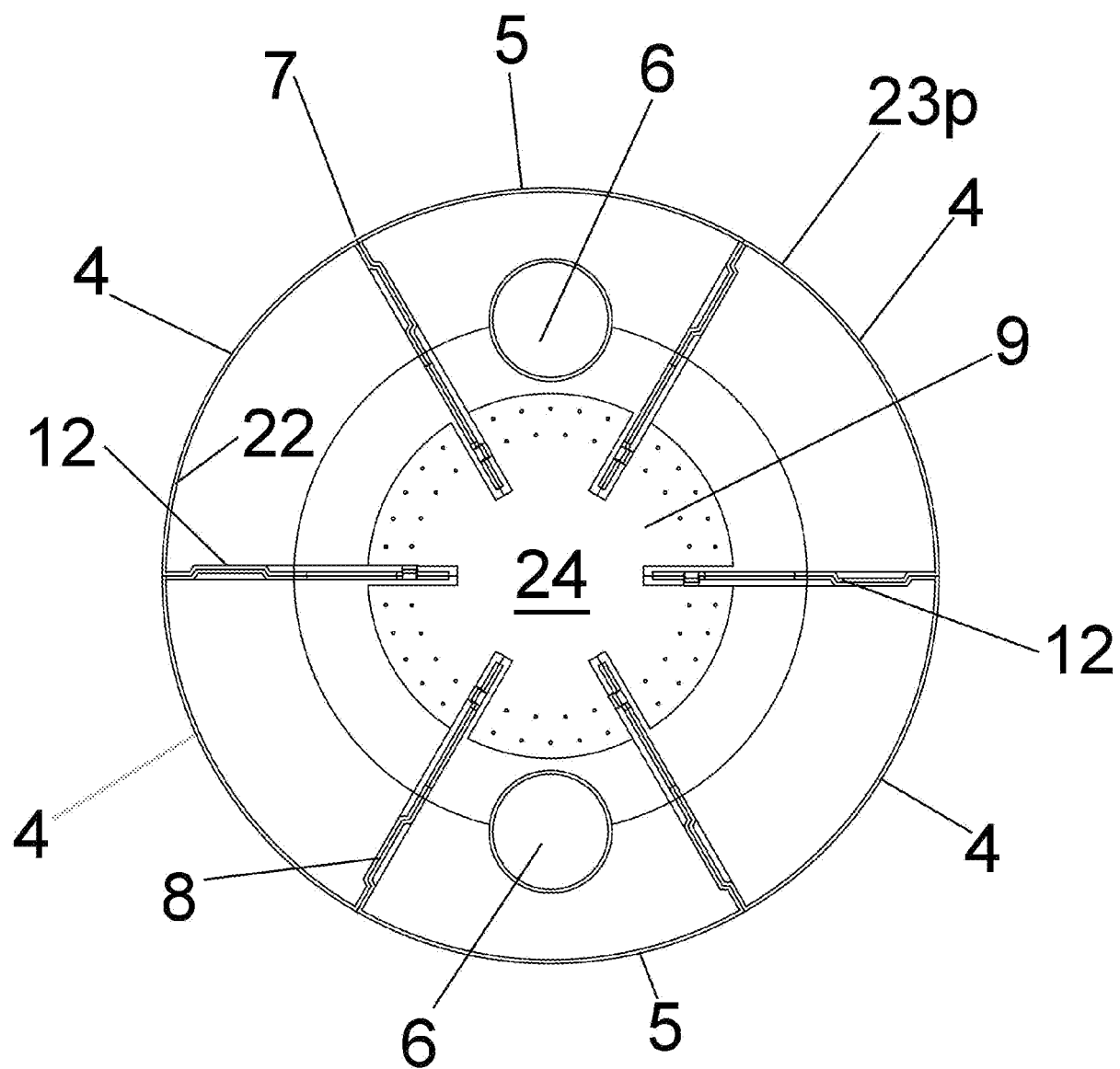


Fig. 2

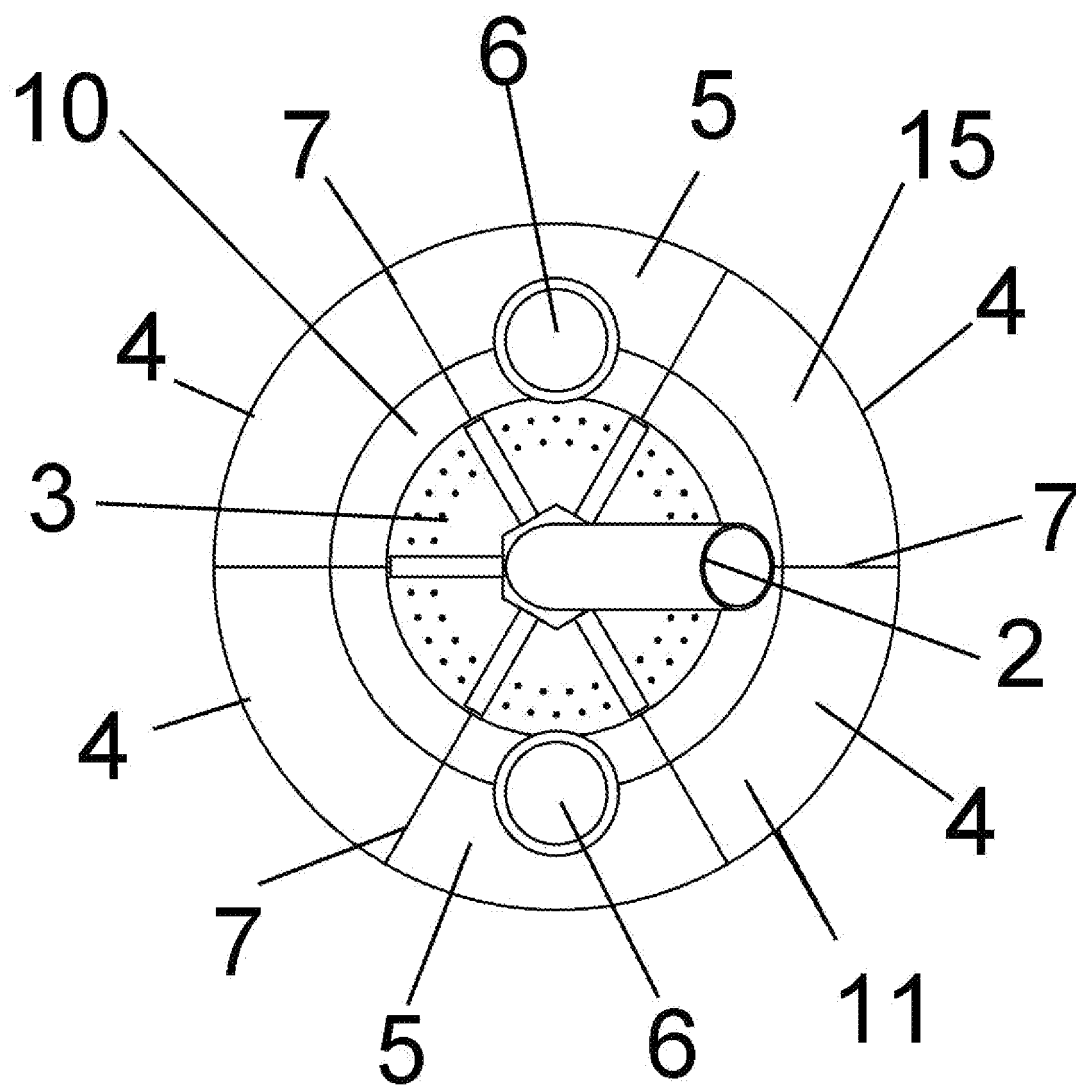


Fig. 3

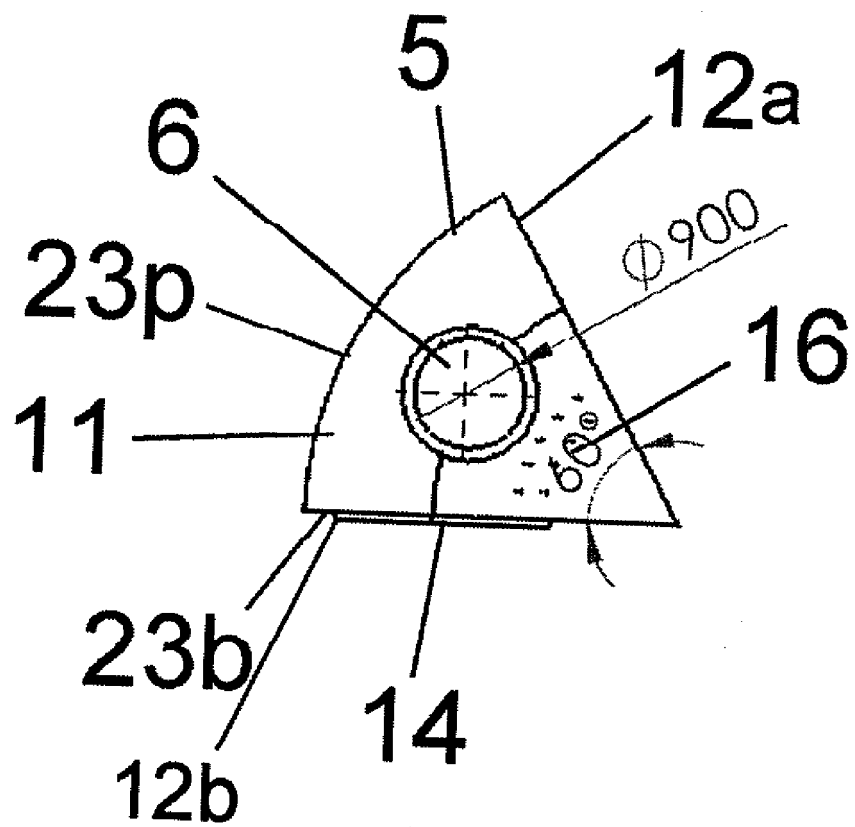


Fig. 4

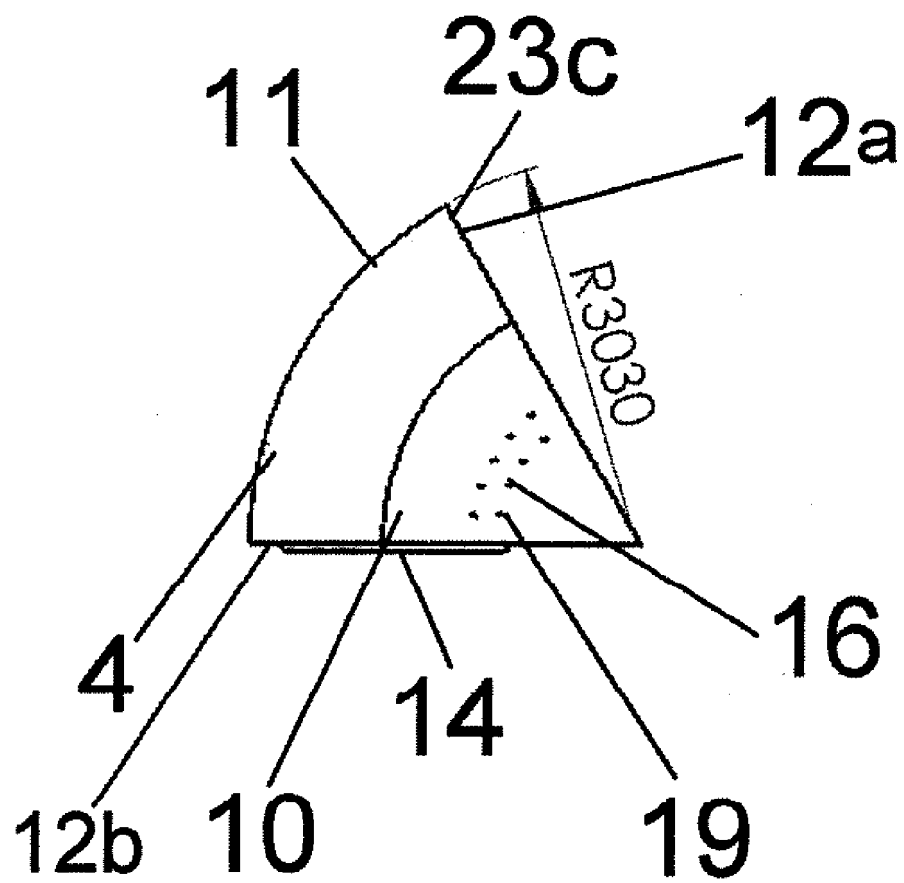


Fig. 5

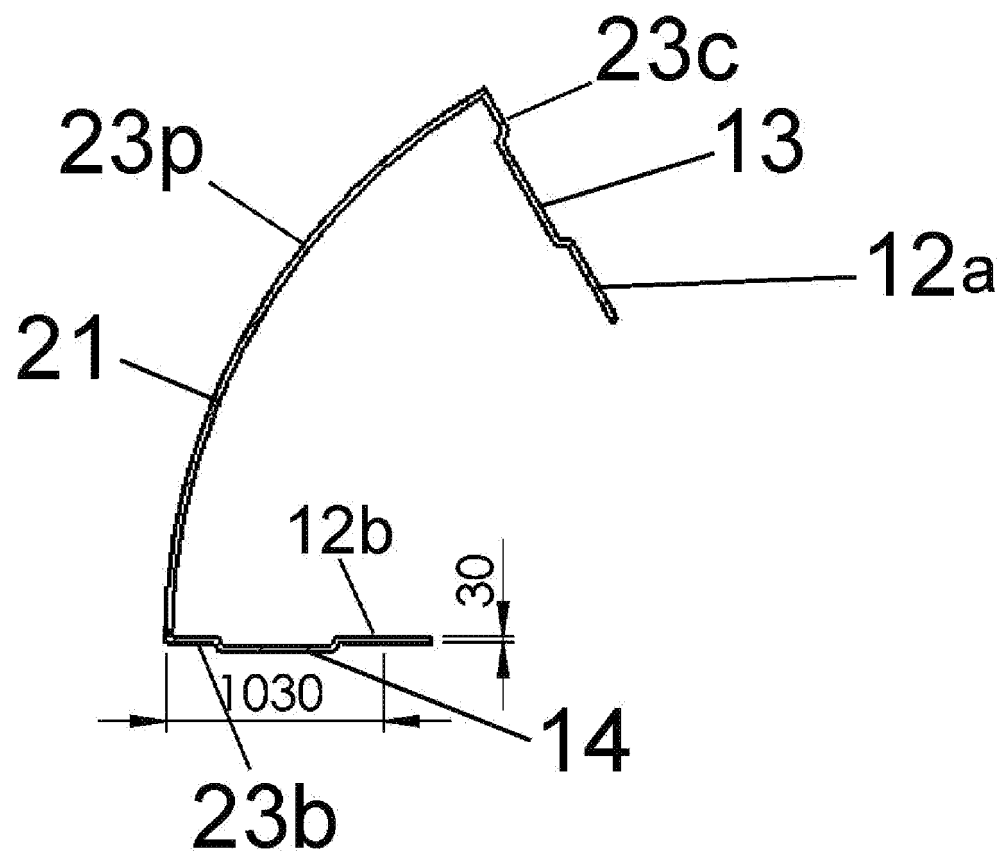


Fig. 6

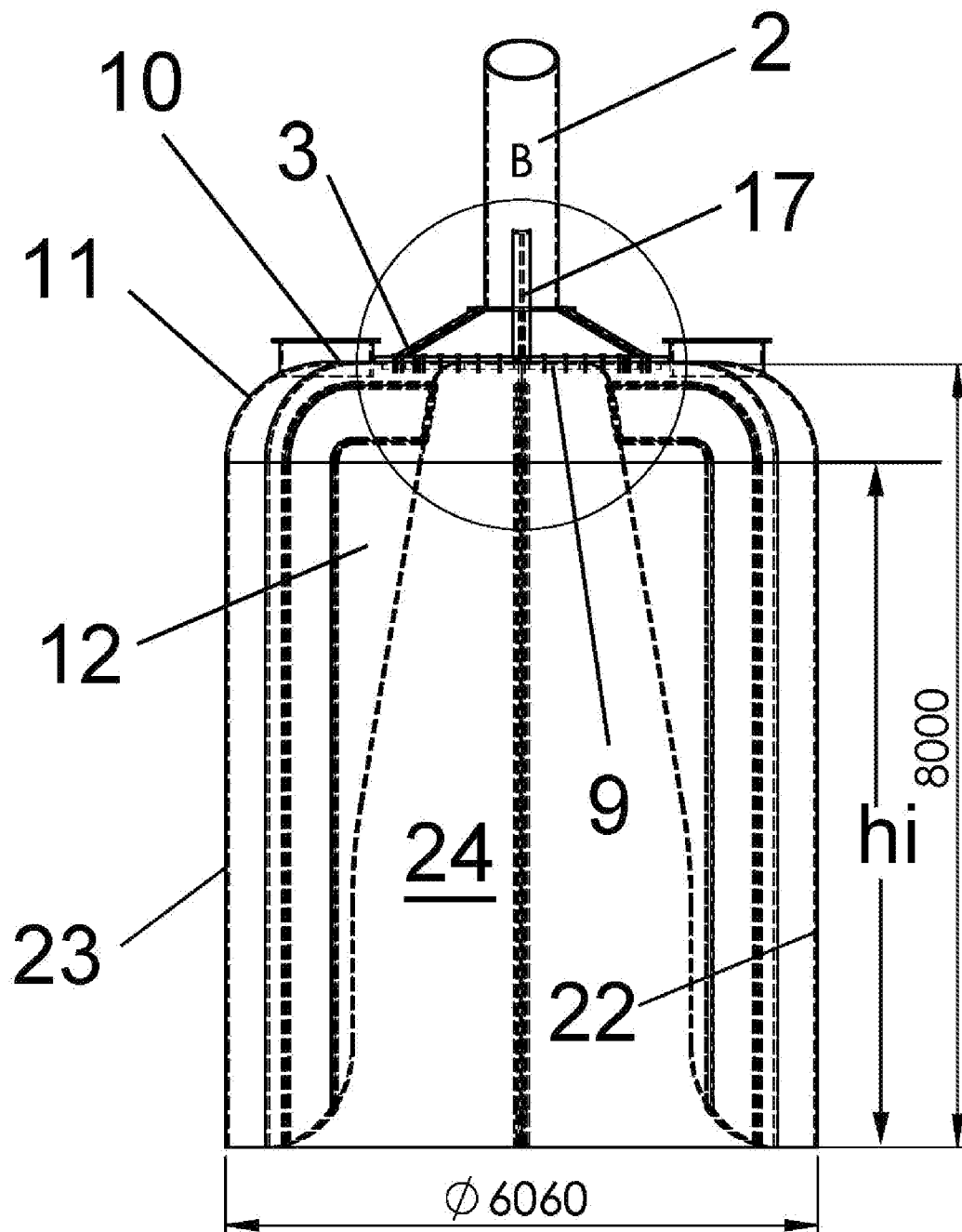


Fig. 7

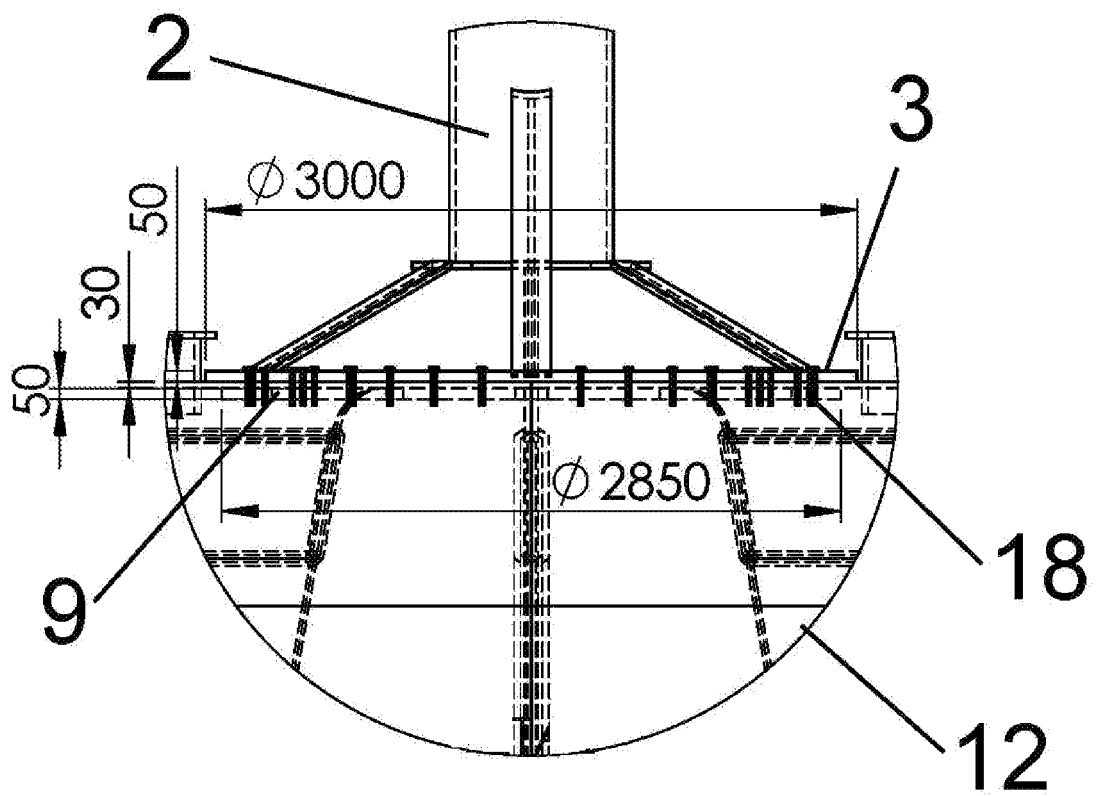


Fig. 8

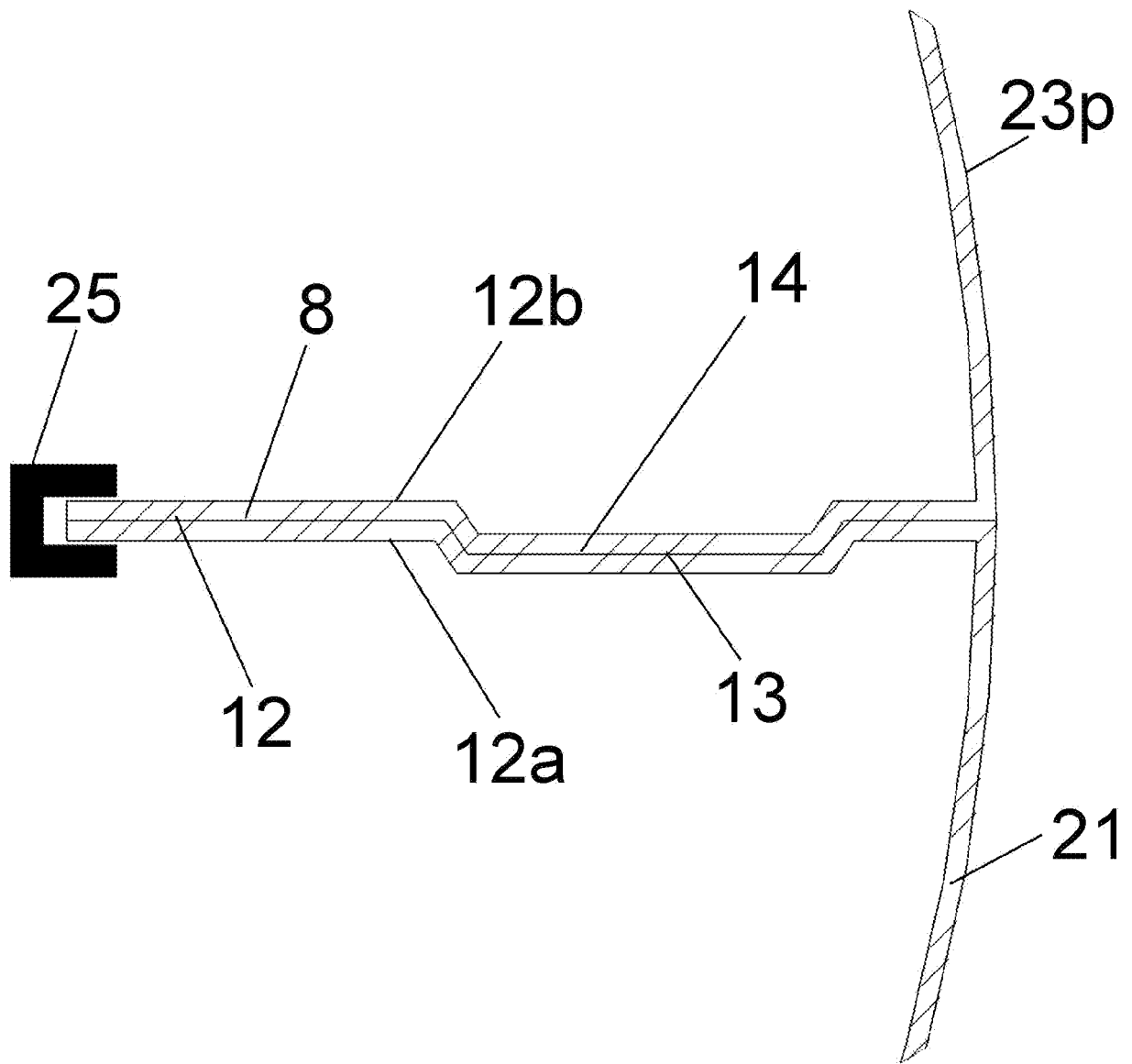


Fig. 9

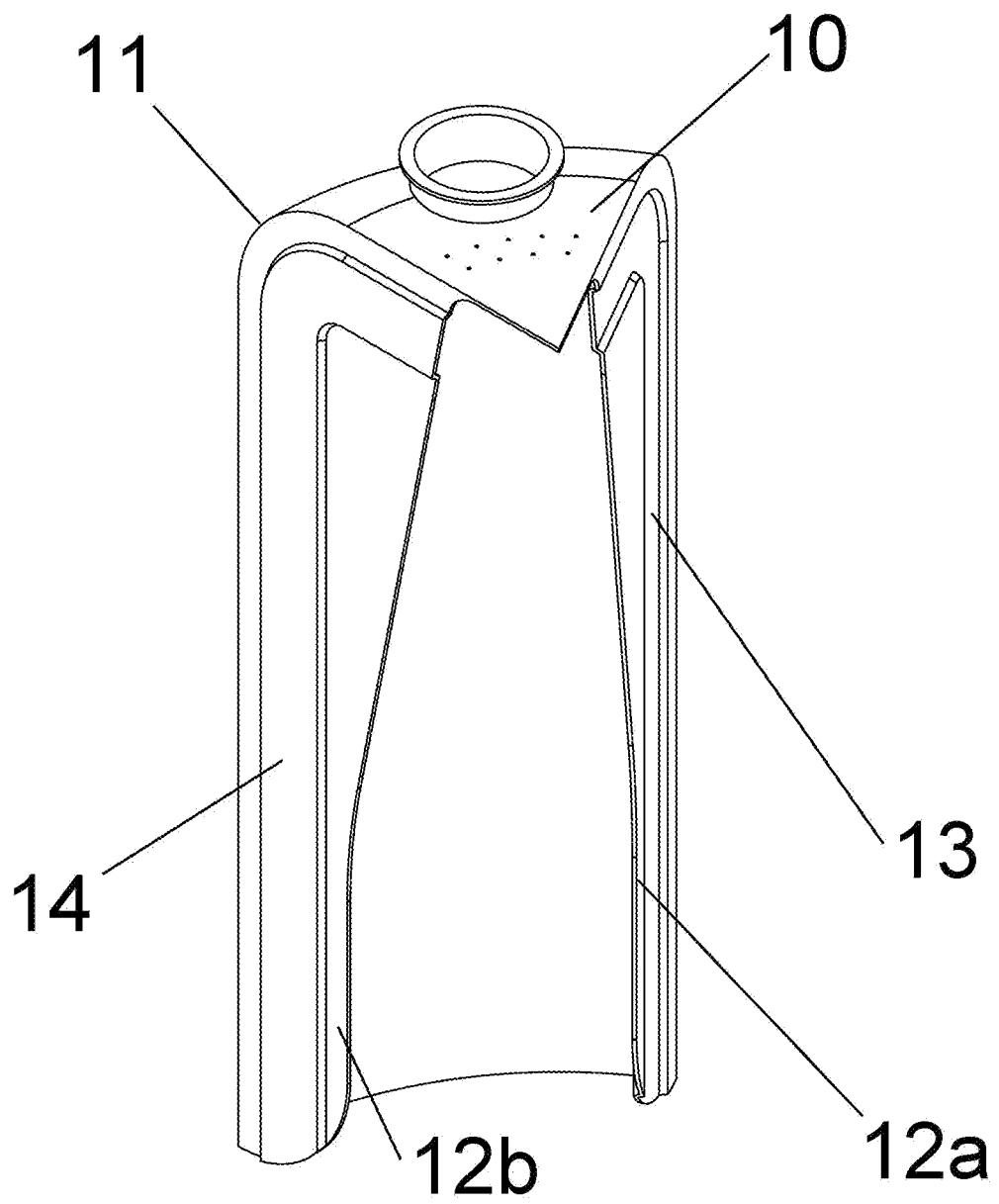


Fig. 10

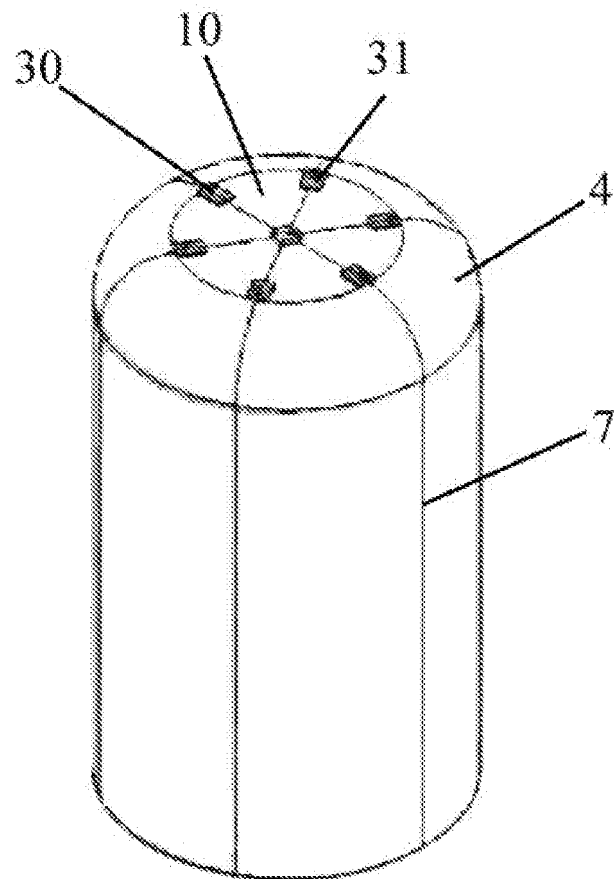


Fig. 11

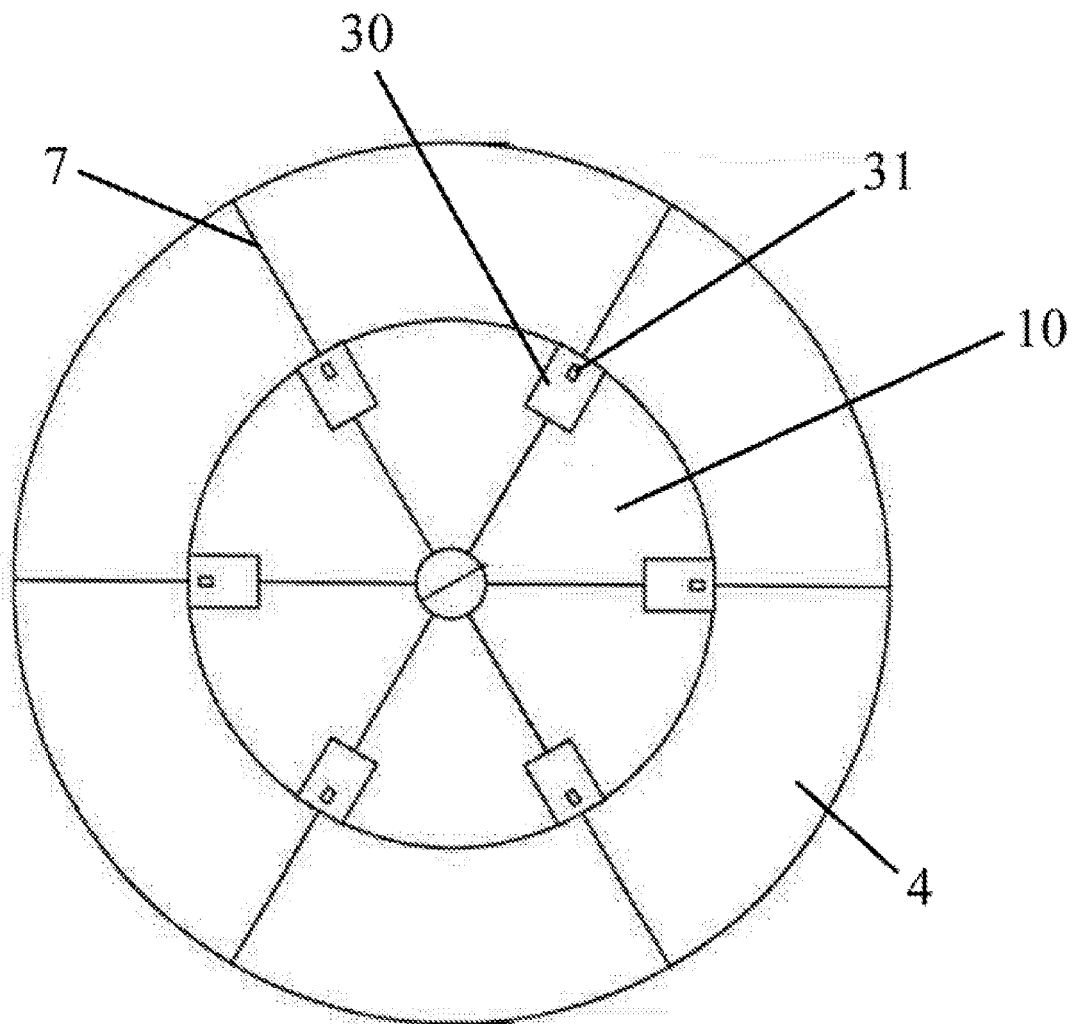


Fig. 12

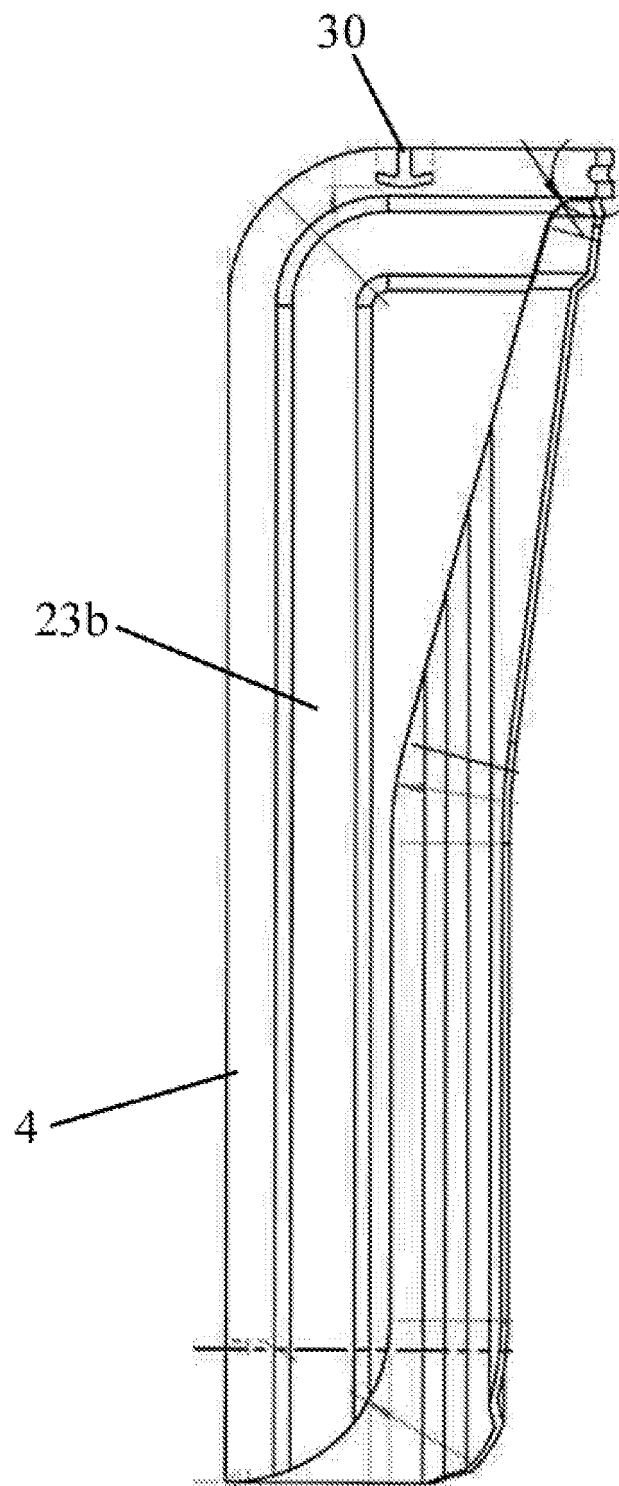


Fig. 13

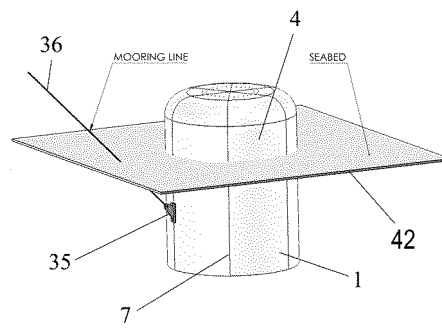


Fig. 14

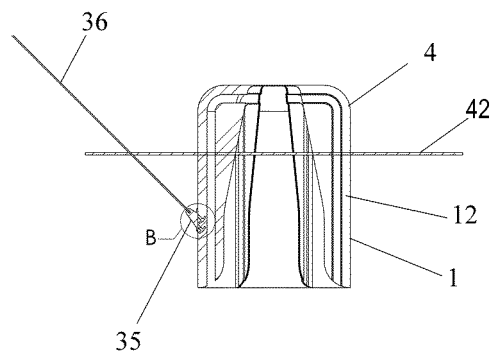
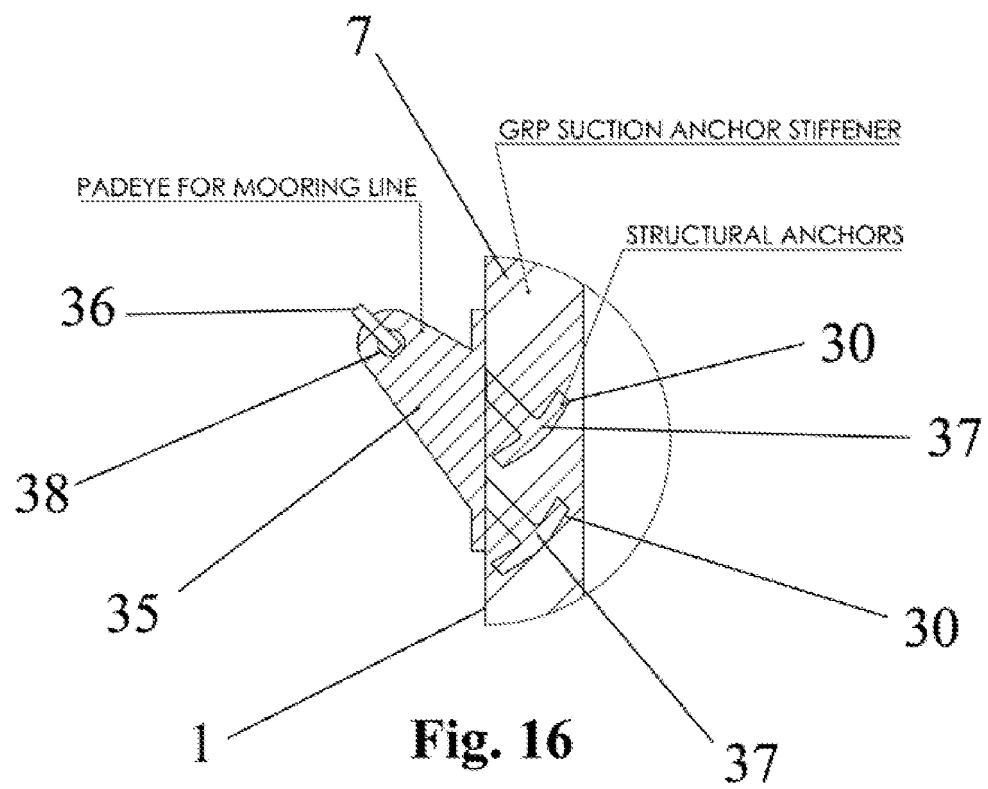


Fig. 15



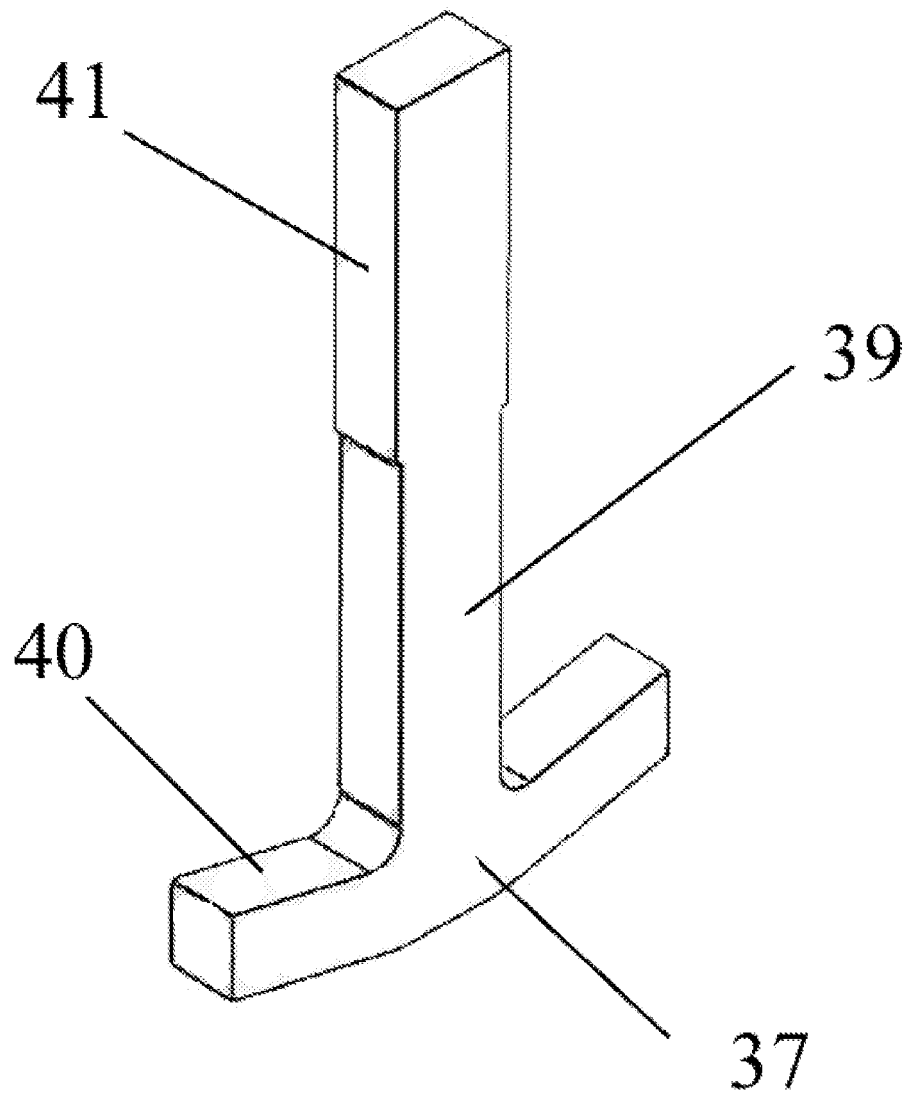


Fig.17