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(71) Applicant: **Suction Pile Technology B.V.**
3447 GG Woerden (NL)

(72) Inventor: **Riemers, Mark**
3447 GG Woerden (NL)

(74) Representative: **Assendelft, Jacobus H.W.**
Keukenhofdreef 20
2161 AZ Lisse (NL)

(54) **Floating marine structure with suction piles and platform resting on a barge clamped between suction piles and platform.**

(57) A marine structure (1) floating in a body of water, said structure consisting of a platform (2) above the body of water and having at least three spaced upright supporting legs (3) extending downwards from the platform (2) towards the body of water, at the lower side of which a suction pile (4) is connected. According to an embodiment, the supporting leg (3) partly projects into the body of water while the suction piles (4) are completely submerged. A floater (5) extends through the space delimited by the supporting legs (3) and bears the platform (5).

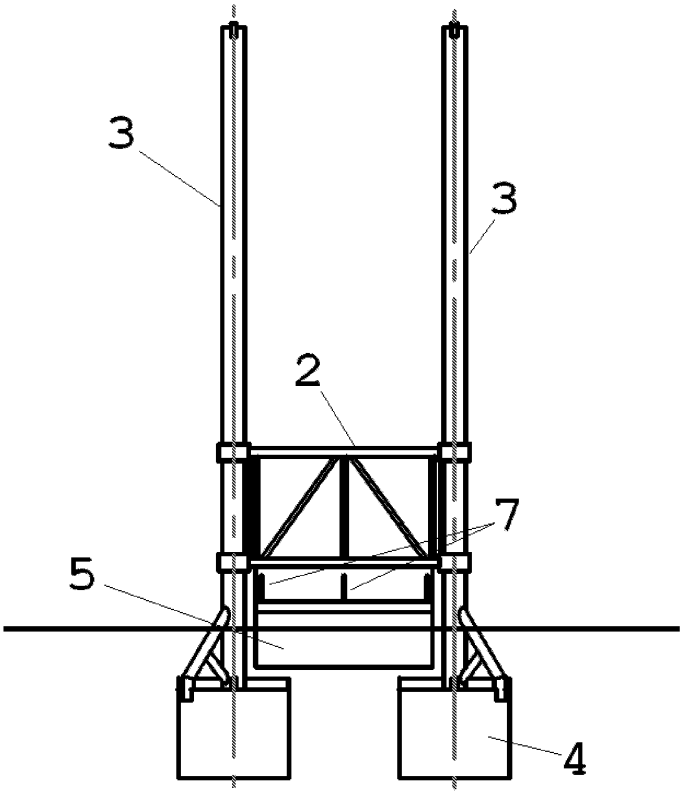

Fig. 2

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Description

[0001] The invention concerns a marine structure, a method of installing a marine structure and a suction pile. Particularly, the invention concerns application to a so called "marginal field" i.e. an offshore field for which the predicted economical exploitation is limited to less then 10 years.

[0002] Suction piles and their way of installing are a.o. known from GB-B-2300661 and EP-B-0011894, which disclosures are enclosed in here by reference. Briefly, a suction pile is a thin walled steel cylinder, closed at at least one longitudinal end, that is located on the subsea bottom with the opposite end and penetrates the subsea bottom with the aid of a suction created within the cylinder. The creation of the suction can be with the aid of a suction source, such as a pump, being on, or close to or at a distance (e.g. above the water surface, e.g. at a vessel) from the suction pile. The applied level of the suction can be e.g. at least substantially constant, smoothly increase or decrease or else pulsate, for which there are convenient means; for an e.g. pulsating level a possibly in the suction pile integrated pressure accumulator that is intermittently connected to the inner space of the cylinder. After use, the suction pile can easily be removed by creating an overpressure within the cylinder, e.g. by pumping in (sea) water.

[0003] A self installing platform applying suction piles which provide buoyancy is known from e.g. WO99/51821 (SIP1) or EP-A-1 101 872 (SIP2) of the present inventor.

[0004] In stead of installing a suction pile into the under water bottom by generating a fluid pressure difference between the inside and outside of the suction pile, it is also feasible that the suction pile at least partly penetrates the under water bottom by a weight resting on it, e.g. the platform and/or a ballast body.

[0005] Therefor according to the invention it is proposed to make the marine structure self floating and self foundating or self installing by providing it with buoyancy and one or more suction piles. So the hoisting device and the plant for installing the foundation, e.g. hammering device, can be eliminated. Preferably the structure has buoyancy of its own, e.g. obtained by the with the structure integrated appliance that is designed to, once the structure is installed, ballast the structure. Buoyancy can also be obtained from the suction pile, which for that can be provided with a floater. Said own buoyancy is preferably such that it is substantially contributing to the required buoyancy to make the structure self floating. It is preferable, if the buoyancy can be at least substantially decreased for installation purposes. By e.g. filling the one or more floating bodies with ballast, like water. Therefor it is convenient, to provide the structure with means for adding and possibly removing of ballast, such as between the closed and open position switcheable shutter valves in a water supplying respectively water venting opening to a ballast tank.

[0006] Since the structure is self floating and is provided with one or more suction piles, removal after use is made easier. On the one hand in that by pressing out the suction pile, the anchoring of the structure to the underwater bottom can be removed. On the other hand in that the structure can independently rise to the water surface by the (possibly regained) buoyancy.

[0007] In this respect the marine structure typically will be rather large, e.g. a production platform with equipment. Due to its own weight, such marine structure is designed to be applied with a foundation of pile bodies to be pressed in the bottom. The marine structure preferably has, apart from the suction piles, no floating bodies, apart from parasitic floating bodies such as air filled spaces that are normally present, such as frame tubes. The marine structure according to the present invention will typically weigh not more than about 5, 000, 000 kilo, although structures with a much higher weight of e.g. 10,000,000 kilo or more are also feasible.

[0008] For the purpose of transporting to the final destination it is preferred that the marine structure is loaded onto a barge or other separate floating and/or sailing body with buoyancy of its own. "Barge" preferably means at least a vessel known as such with one or more floating spaces at least substantially hermetically delimited from the environment. Preferably the barge has no equipment of its own for propelling and/or directional control.

[0009] Preferably the marine structure is loaded onto the barge such that the suction piles penetrate the body of water into which the barge floats or are completely submerged while preferably the platform of the marine structure is at a distance above said body of water. More preferably, one or more of the following features are applied: the marine structure is loaded onto the barge in the upright orientation or the orientation equal to the operating position of the marine structure, which is typically the vertical orientation; the suction piles are completely below the water level of the body of water in which the barge floats and are preferably completely below the bottom level of the barge onto which the marine structure is loaded; the barge is present straight above at least a part of a suction pile and preferably at least a part of all suction piles; the barge with the marine structure loaded onto it is connected to a propulsion vessel, e.g. a towing boat, e.g. by virtue of a towing cable, and is preferably propulsed by said vessel; the barge with the marine structure loaded onto it advances through the body of water into which the barge floats, preferably with a speed between 4 and 6 nautical miles per hour; from each suction pile a supporting leg extends upward; the platform has a rectangular shape in top view; at each corner of the platform and possibly also at more locations along the side of the platform a supporting leg and/or suction pile is present; the platform is connected to the supporting legs by connection means that allow the platform to move along the supporting legs; the supporting legs have a length of at least 20 metres (e.g. 20 metre for a water depth of 5 metre and 100 metre for a water depth of 60 metre); each suction pile has a diameter of at least 5 metres and a

height of at least 5 metres and a wall thickness of at least 1 centimetre; the longitudinal axis of the suction pile and the relevant supporting leg are substantially in line; from the circumference, seen in top view, of each suction pile one or more mutually spaced straight frame members extend upward, inclined towards the relevant supporting leg and connected to it at a distance above the suction pile, to provide a bracing; said bracings are absent at the side of the supporting leg facing the barge; the vertical distance between the top of the suction pile and the barge measures 1 or 2 or 3 metre to a maximum; the barge is clamped or sandwiched between the platform and the top of the suction piles; the barge bears onto the top of the suction piles.

[0010] It is feasible that the barge has insufficient buoyancy of its own to keep the marine structure floating, considering the prevailing safety requirements. In such a case the one or more suction piles provide the additionally required buoyancy.

[0011] Thus a cost and time and energy and environmental saving is possible, and also the work is safer. Besides, additional dynamic stability is gained of the in the body of water floating and advancing assembly provided by the barge and the marine structure loaded onto it, compared to the embodiments disclosed in the state of the art, e.g. EP-A-1 101 872 (SIP2). Also the draft of the floating assembly is limited.

[0012] By providing that the barge is clamped or sandwiched between the platform and the top of the suction piles or bears onto the to of the suction piles (e.g. through the aid of spacers located between the bottom of the barge and the top of the suction piles), an extremely stable and reliable assembly is obtained.

[0013] To provide the additional buoyancy, the suction pile is preferably provided with compressed air or integral floating means, preferably present inside the suction pile. The floating means can at least substantially comprise a space in open communication with the surrounding water at its under side, such as the pressure space of the suction pile.

[0014] The invention is further illustrated by way of a non-limiting, presently preferred embodiment providing the best way of carrying out the invention and shown in the drawings.

Fig. 1 shows a side view of a marine structure prior to installation;
Fig. 2 shows a front view of the structure of fig. 1;
Fig. 3 shows a view according to fig. 1, after installation;
Fig. 4 shows a top view of the structure of fig. 1;
Fig. 5 shows a top view of the structure of fig. 3;
Fig. 6 shows a top view of a suction pile;
Fig. 7 shows a side view of the suction pile of fig. 6; and
Fig. 8 shows a side view of the suction pile of fig. 6 from another angle.

[0015] Fig. 1-5 show a marine structure 1 consisting of a platform 2, rectangular in top view, each corner of which having a supporting leg 3 at the lower side of which a suction pile 4 is connected. The supporting legs 3 are mutually connected by braces 10, however braces 10 are not always required. Each supporting leg 3 is connected to the suction pile 4 such that the longitudinal axis of both are in line.

[0016] In this example the suction piles 4 are at such low level beneath the water level 6, that the space between the supporting legs 3 is completely available to a barge 5, providing a floating transport means. The buoyancy provided by the barge can therewith be optimised. This is also beneficial for the stability during transport across the water 6.

[0017] The barge 5 partly covers each suction pile 4 and is present at a small distance straight above part of each suction pile 4.

[0018] During transport over water, the supporting legs 3 are retracted such that they maximally extend above the water level 6. The marine structure is at least partly supported by the barge 5 and the platform 2 is preferably close to the water surface 6. Therefor, the platform 2 preferably rests directly onto the barge 5, possibly through supports 7. The barge provides all required buoyancy, or the barge and the suction piles 4 together provide the required buoyancy.

[0019] During installation, the supporting legs 3 and the platform 2 are mutually shifted in longitudinal direction of the supporting legs 3, such that the lower side of the supporting legs 3 move away from the platform 2. One can proceed in at least the two following manners:

1. While the structure 1 still rests onto the barge 5 floating in the water, one lowers the suction piles 4 onto the under water bottom 8 together with the supporting legs 3. After the suction piles 4 have penetrated the under water bottom 8, preferably to their final depth, the platform 2 is lifted from the barge 5 and to its operating position while the barge 5 is removed by sailing it from below the platform 2. Lifting of the platform 2 is carried out by lifting means operating between the supporting legs 3 and the platform 2. During lifting, the platform 2 shifts along the stationary supporting legs 3.
2. One lifts the structure 1 from the barge 5, preferably by increasing the buoyancy of the suction piles 4, whereafter one disengages the barge 5 from the structure 1 and removes it by sailing it away from below the platform. Subsequently one lowers the suction piles 4 together with the lower side of the supporting legs 3 onto the under water bottom 8, while one shifts the platform 2 along the supporting legs 3 to remain at least substantially at the same level above the water surface. After the suction piles 4 are penetrated into the under water bottom 8, preferably to their final depth, the platform 2 is lifted to its final level, shifting along the supporting legs 3.

[0020] To be able to mutually shift the supporting legs 3 and the platform 2, convenient means can be present, such as strands and strand jacks or cables 9 and driven winches which are connected to the platform 2 and the supporting legs 3.

[0021] Fig. 6-8 show that the supporting leg 3 is concentric or coaxially with the suction pile 4. From the radial circumference of the suction pile two straight braces extend upward, inclined towards the leg 3.

[0022] The invention is not limited to the above described and in the drawings illustrated embodiments. E.g. the marine structure can have less than four, e.g. two or three, or more than four, e.g. five or six, suction piles 4. The number of supporting legs 3 is preferably equal to the number of suction piles 4, but this is not absolutely necessary. E.g. three suction piles are at the corners of a structure 1 that is triangular in top view. It is not required that the suction piles and supporting legs are at the corners of the structure 1. The platform 2 can be constructed and/or shaped differently. The suction pile can be eccentrically connected to the relevant supporting leg 3, e.g. the supporting leg 3 is connected to the suction pile 4 at or near the circumferential edge of the suction pile 4 in which case it is feasible that the barge is present above the almost complete suction pile 4.

[0023] It is possible to assemble the marine structure from separate sub assemblies in the harbour or offshore, e.g. at the operating site. E.g. a first sub assembly comprises the suction piles 4 and possibly the lower part of the legs 3 and their mutual connecting braces 10. A second sub assembly comprises the platform 2 and the supporting legs 3 or upper part of it. The first sub frame is lowered onto the water bottom such that the suction piles thereof penetrate the bottom. Then the second sub assembly is located above the first sub assembly and the first and second sub assemblies are coupled, during which operations the second sub assembly is supported by the barge 5. Then the supporting legs 3 are lifted by shifting them along the platform 2, taking the suction piles 4 with them. Now the condition shown in fig. 1-3 is obtained such that the complete marine structure is now supported by the barge 5 and can be towed to the final location.

[0024] Alternatively, in a different production variant, the suction piles 4 and lower part of the supporting legs 3 can be installed offshore at the final location after which the platform 2, supported onto the barge 5, and top section of the legs 3, connected to the platform 2, move in between the pre installed lower part of the legs 3. Then the top section of the legs 3 are lowered onto the pre installed lower part of the legs 3 and connected with them. Then the platform 2 is lifted (while shifting along the legs 3) to the top level and the barge 5 is removed from below the platform 2 and from between the legs 3.

[0025] In another production variant, the platform is constructed with clamps, the number of which equals the number of supporting legs. First the platform is located on a barge floating in the water. Then an upright supporting leg mounted to a suction pile is mated with a corresponding clamp and the clamp is closed. After all clamps are loaded with a relevant supporting leg mounted to a relevant suction pile, the condition shown in fig. 1-3 is obtained and the marine structure is ready to be towed to its final location.

[0026] In again another production variant, the supporting legs are pivotably mounted, such that they can pivot from a substantially vertical position to a substantially horizontal position. In the latter position, the suction piles at their lower ends can completely extend above the water while the platform rests on a barge, such that in this position the stability during towing is assured. At the final location, the supporting legs are pivoted to their upright position such that the suction piles can be lowered to penetrate the water bottom.

Claims

1. A marine structure (1) floating in a body of water (6), said structure consisting of a platform (2) above the body of water and having at least three spaced upright supporting legs (3) extending downwards from the platform (2) towards the body of water, at the lower side of which a suction pile (4) is connected, which marine structure is loaded onto a separate floating body or floater (5).

2. A marine structure according to claim 1, wherein the suction piles (4) are below and the platform (2) is above the floater (5) and wherein the floater (5) is clamped between the platform (2) and the suction piles (4).

3. A marine structure according to claim 1 or 2, wherein the floater (5) extends through the space delimited by the supporting legs (3).

4. A marine structure according to any of claims 1-3, wherein said floater (5) has two opposite longitudinal sides and wherein the suction piles are on both longitudinal sides of the floater.

5. A marine structure according to any of claims 1-4, wherein the suction piles (4) are completely below the surface of the body of water and the supporting legs (3) penetrate the surface of the body of water such that they extend partly above and partly into the water.

6. A marine structure according to any of claims 1-5, wherein the floater (5) at least partly covers one or each suction pile (4); or the floater (5) and one or each suction pile (4) at least partly overlap.

7. A marine structure according to any of claims 1-6, wherein the floater (5) and the suction piles (3) com-

monly provide the required buoyancy of the marine structure to keep it independently floating in a body of water.

8. A marine structure according to any of claims 1-8 wherein the floater is sandwiched between the platform (2) and the suction piles (4).

9. A marine structure according to any of claims 1-8, wherein the supporting legs (3) are mounted to the platform (2) by mounting means such that the supporting legs (3) can slide relative to the platform (2) in longitudinal direction of the supporting legs (3), such that the lower side of the supporting legs (3) can be moved away from the platform (2).

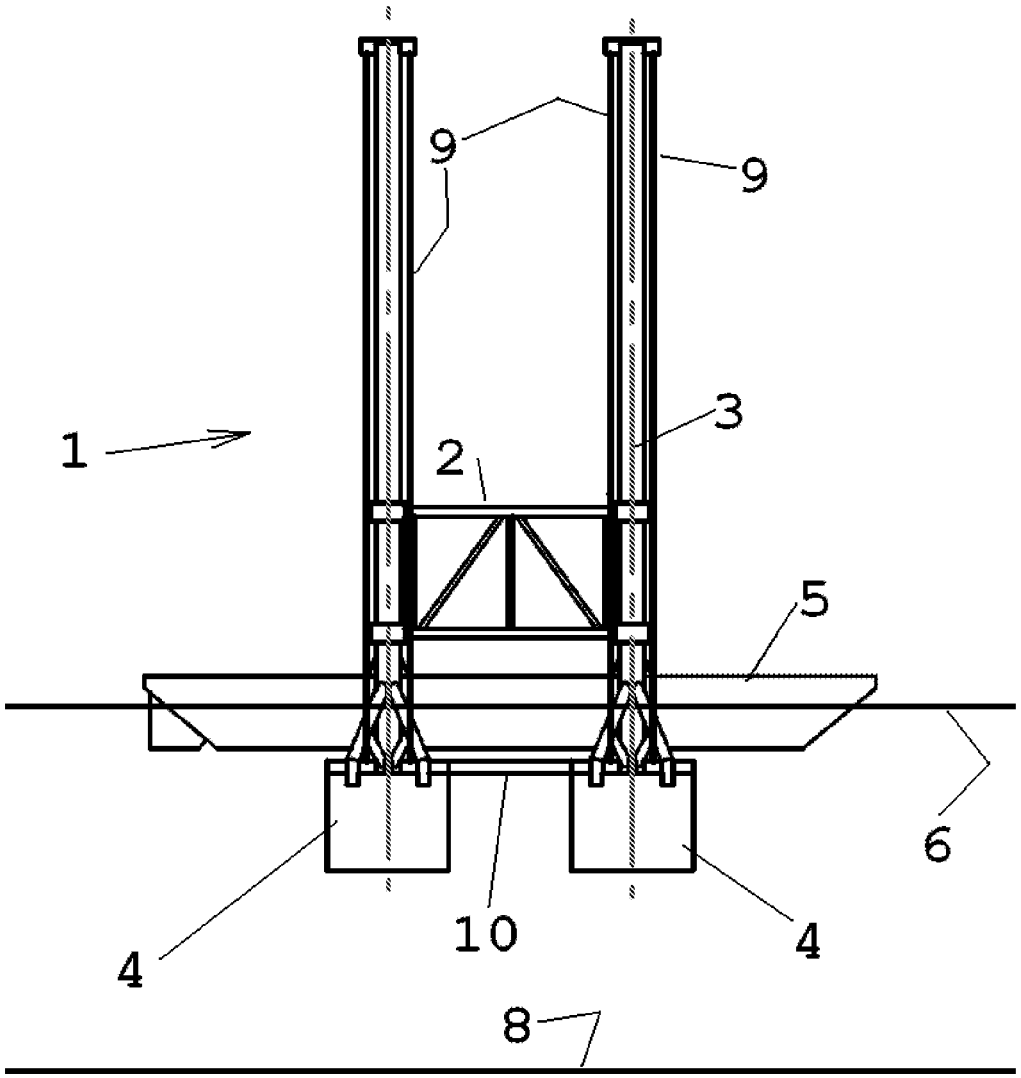

Fig. 1

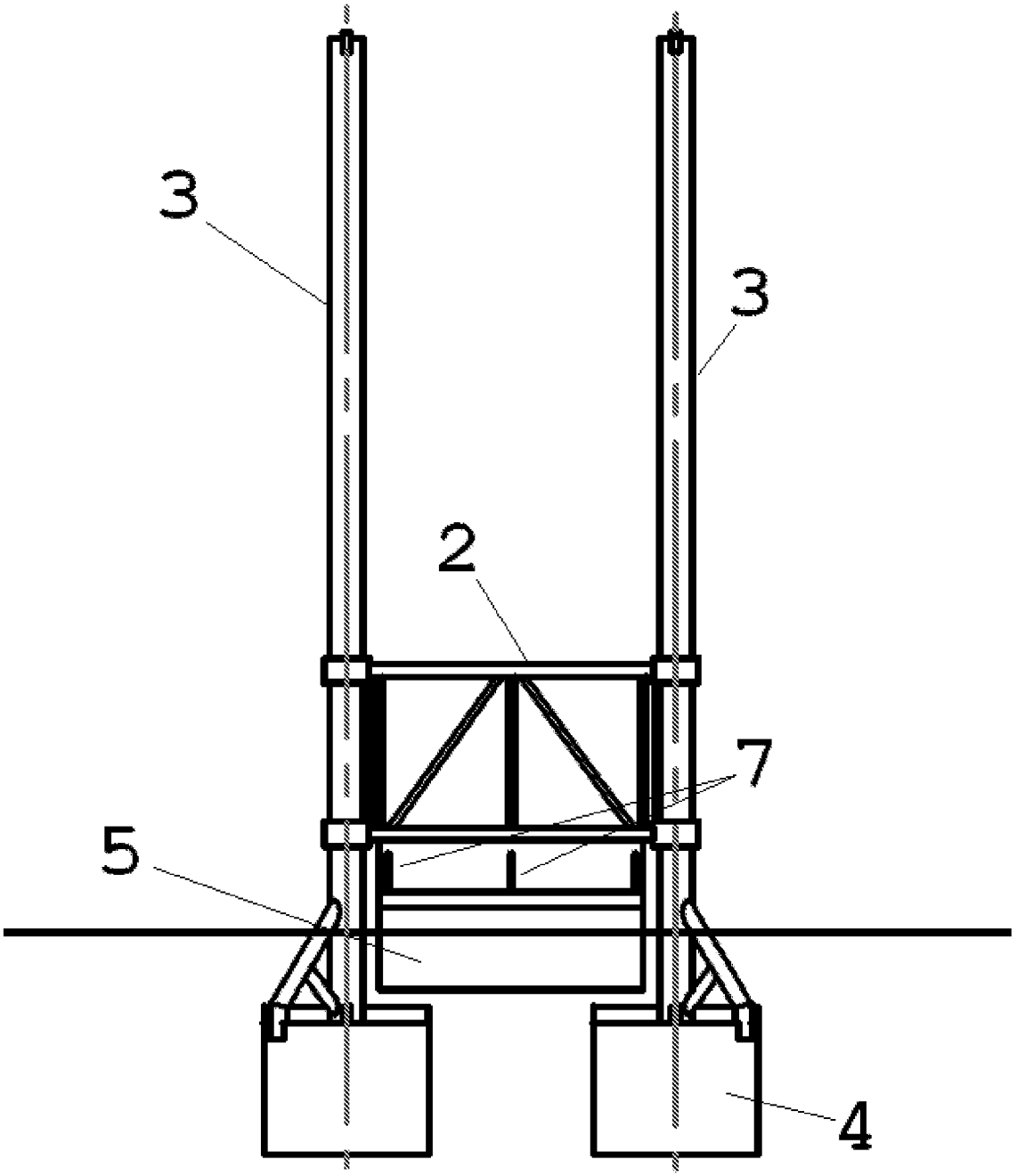

Fig. 2

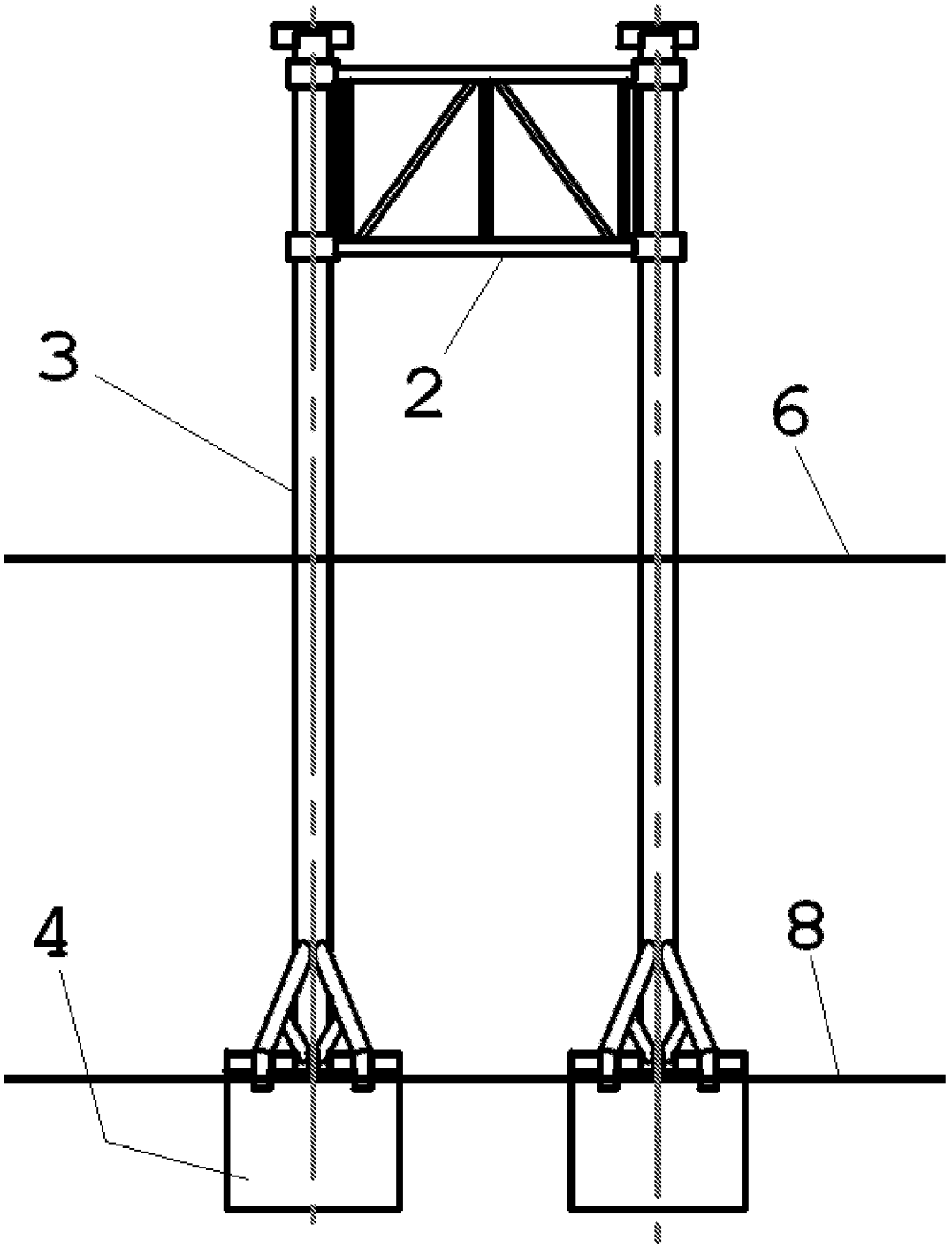

Fig. 3

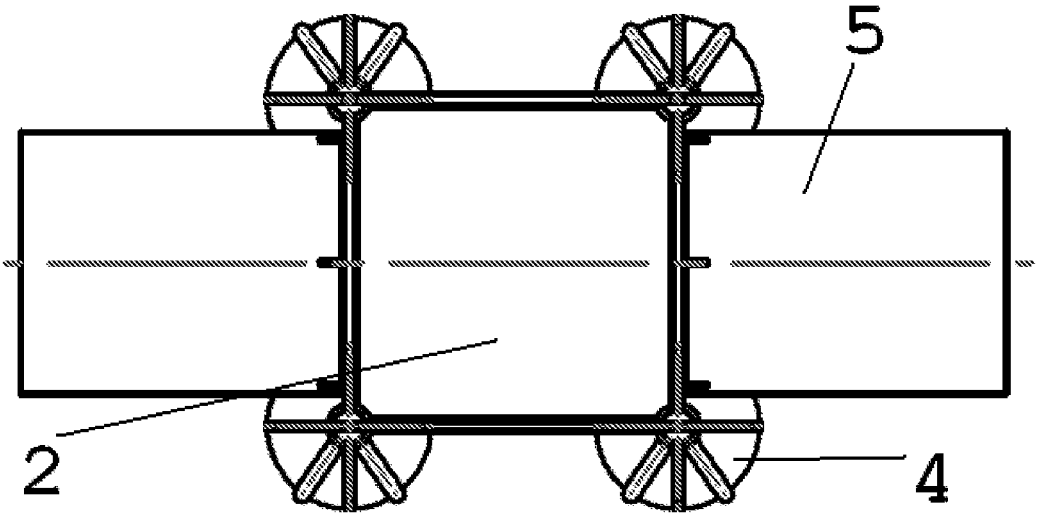

Fig. 4

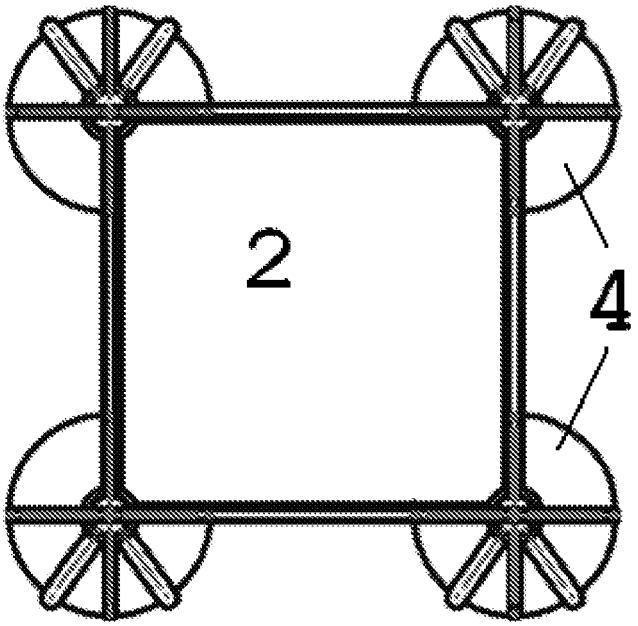

Fig. 5

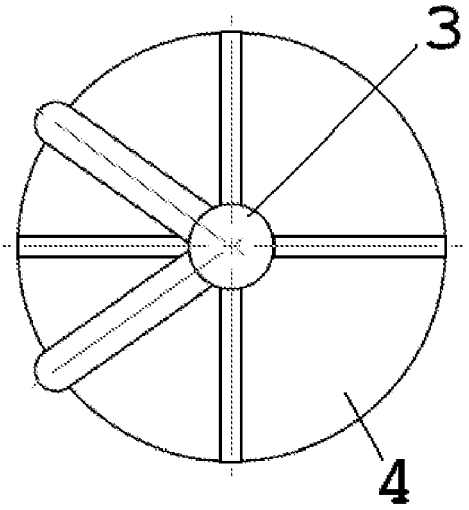

Fig. 6

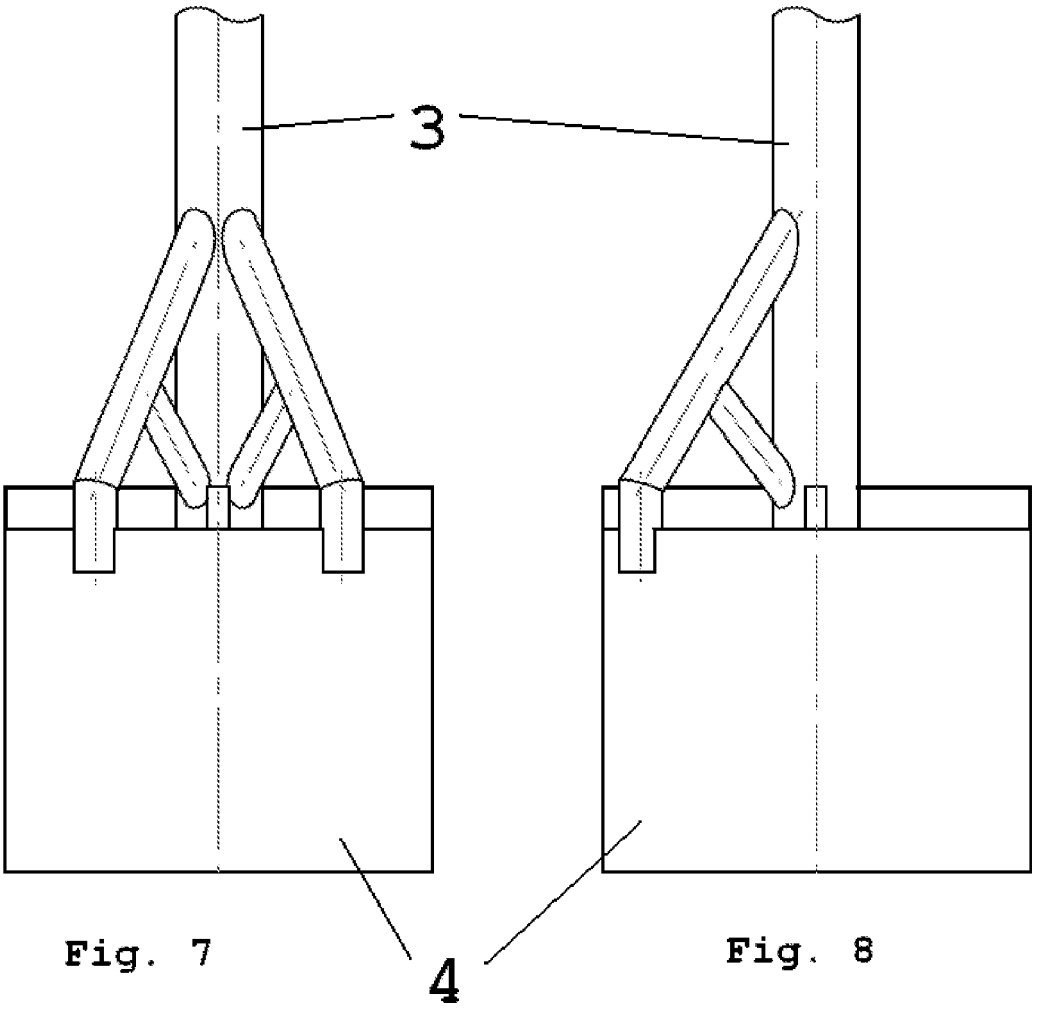

Fig. 7

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
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E02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	11 May 2010	Geisenhofer, Michael

CATEGORY OF CITED DOCUMENTS

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