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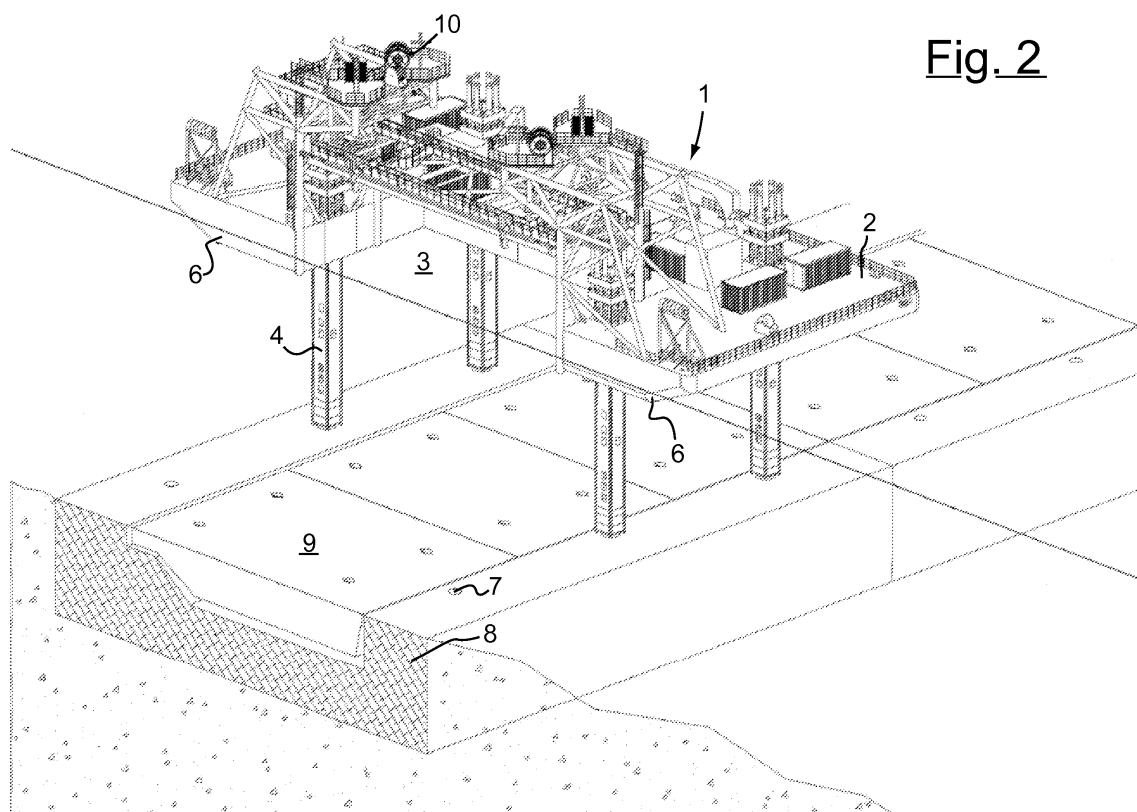
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(54) **Device for sitting on the seabed for self-raising sea vessels**

(57) Device for sitting on the seabed for sea vessels (1) equipped with self-raising support legs (4), wherein each leg comprises:
a vertical structural element capable of lowering and raising;
a device for absorbing collisions and for centering essentially consisting of:

i. a coaxial telescopic means (11) fixedly connected to said structural element through a hinged elastic means (13);
ii. a support foot comprising a semi-spherical joint (14) connected to the telescopic element; and
iii. a coaxial centering pin (15) fixedly connected to the support foot through a hinged elastic means.



Description

[0001] The present invention relates to a device for sitting on the seabed for self-raising sea vessels.

[0002] More specifically, the present invention relates to a moving, centering and resting device of the legs of a self-raising sea vessel and the rigid anchoring method of the legs of said sea vessel against a base plate positioned on a bed, preferably a seabed, under safety conditions.

[0003] As is known, the necessity of transporting and moving loads by lifting is extremely frequent in the maritime field, within a wide variety of application areas relating to the energy industry and civil, maritime and port constructions.

[0004] Various solutions are currently available for covering the different operative demands, in relation to the dimensions and weight of the end-products to be moved, the installation requirements and environmental reference scenarios.

[0005] A solution currently adopted for lifting, transporting and installing voluminous and heavy offshore end-products consists of a self-propelled pontoon on which moving means are positioned (lifting/lowering) of the end-product. These means are preferably positioned symmetrically on the emerging surface of the hull of the pontoon. The latter also comprises a series of constraining means to the seabed consisting of a plurality of moveable legs in a vertical direction, peripherically arranged, which are lowered and rest against the seabed to stabilize the pontoon and lift it above sea level in order to actuate the positioning phases of the end-product transported, without being substantially influenced by weather-sea conditions.

[0006] An example of a self-propelled pontoon suitable for moving large-dimensional steel bulkhead is that which will be used for the MOSE project which has been proposed for regulating the tide flows in the lagoon of the city of Venice. This is a modular C-shaped pontoon whose side concavity allows the bulkhead - removed from onshore shipyards and brought in correspondence with the inlet mouths of the lagoon (Malamocco, Chioggia, Lido San Nicolò and Lido-Treporti) where they will be installed to form four barriers, hinged on base plates, each of which consisting of about 20 bulkhead - to be lifted, housed for transportation and lowered.

[0007] The pontoon has at least four retractable legs, symmetric with respect to the hull, which are lowered until they rest on the bottom of the lagoon to allow the hull to be raised above sea level at the moment in which the bulkhead must be lowered into the water and installed.

[0008] More specifically, when the pontoon, which is transporting the bulkhead, arrives in position, it lowers the four legs to rest on a concrete base already situated on the bed of the lagoon, lifts the hull and then lowers the bulkhead. This operation has various difficulties due to the fact that in the positioning phase of the pontoon

and lowering of the legs, the hull is subjected to the weather-sea conditions which, among other things, also cause rolling, pitching and yawing movements which limit, or even prevent, the positioning and constraining operations to the seabed, to be correctly effected. Due to these movements of the hull, in fact, there is the risk that the retractable legs can collide strongly against the concrete base, becoming damaged, or preventing an accurate positioning of the legs themselves.

[0009] Whereas the yawing can be regulated by a precise management of the self-propelling means, nothing can be done for the rolling and pitching.

[0010] The Applicant has found a device for sitting on the seabed for self-raising sea vessels which allows the vessel to be constrained to the bed with precision and without collision also in the presence of weather-sea conditions which can cause a strong rolling and pitching of the hull of the vessel.

[0011] An object of the present invention therefore relates to a device for sitting on the seabed for sea vessels equipped with self-raising support legs, in which each leg comprises:

a. a vertical structural element capable of lowering and raising;

b. a device for absorbing collisions and for centering arranged at the support end of said structural element, **characterized in that** said device for absorbing collisions and for centering essentially consists of:

i. a coaxial telescopic means fixedly connected to said structural element through a hinged elastic means;

ii. a support foot comprising a semi-spherical joint connected to the unconnected end of said telescopic element, the flat part of said support foot facing the seabed; and

iii. a coaxial centering pin fixedly connected to the support foot through a hinged elastic means, suitable for centering housings arranged on the seabed.

[0012] According to the present invention, the structural element (a) forms the holding part of the leg of the sea vessel and consists of a reticular structure or a hollow cylindrical structure or in the form of a parallelepiped with a square or rectangular structure. It can be made of stainless steel or corrosion-resistant metal alloy and can be lowered or lifted by means of rack systems or with hydraulic systems of "jacking" type.

[0013] The shock-absorption and centering device is characterized by the presence of elastic means which respectively connect the telescopic means and the centering pin to the structural element and support foot respectively. Said elastic means are produced by means of jacks or oil-dynamic pistons connected to accumulators or by means of mechanical springs or rubber ele-

ments for guaranteeing malleability.

[0014] The telescopic means and centering pin, described in more detail hereunder with reference to the enclosed Figures, are both coaxial with the structural element and essentially consist of structures made of steel or metal alloy.

[0015] A further object of the present invention consists of a method for resting a self-raising sea vessel on a base, positioned on a seabed, said sea vessel being equipped with a plurality of self-raising support legs, and for lifting said sea vessel above the water level by means of said self-raising support legs, which comprises:

- A. providing a plurality of recesses on the base plate, suitable for receiving corresponding means for absorbing collisions and for centering associated with said self-raising support legs;
- B. positioning the sea vessel so that the vertical axis of each leg substantially coincides with each recess;
- C. lowering the support legs up to a predetermined distance from the base plate;
- D. once the predetermined distance has been reached, stopping the descent of the legs and starting the descent of said means for absorbing collisions and for centering, inside each leg, until contact is made with the base plate;
- E. centering the recess located in the base plate with a centering pin associated with said means for absorbing collisions and for centering;
- F. once the recess is centered, lowering the legs until contact is made with the base plate and lifting the hull of the sea vessel above the water level.

[0016] According to the method of the present invention, the sea vessel is a self-raising sea vessel, for example a barge or pontoon i.e. a sea hull provided with a keel such as that described in US patent 7,131,388, which must rest on the seabed to effect lowering and/or lifting operations of heavy bodies, without being influenced by the weather-sea conditions and particularly by waves. For this purpose, the sea vessel has legs which, when resting on the sea bottom, directly or on a pre-arranged base plate, push on this and raise the hull or keel above the sea level.

[0017] The method, object of the present invention allows these resting and lifting operations to be effected without there being any risk of the support legs colliding heavily against the seabed or base plate during their descent towards the bottom, thus being damaged and losing their positioning. As the self-raising legs are integral with the hull of the sea vessel, in fact, in the case of unfavourable weather-sea conditions, the lowering phase of the legs themselves takes place with an oscillating movement which depends on the movement of the hull. The contact between legs and seabed/base plate is therefore dampened if the support and centering device of the present invention is combined with the legs of the sea vessel.

[0018] The device and resting and anchoring method of the sea vessel object of the present invention can be better understood by referring to the schemes of the enclosed drawings, which represent illustrative and non-limiting embodiments of the invention. In particular,

Figure 1 represents a sea vessel of the pontoon type equipped with legs for self-raising in the navigation phase, with the legs raised;

Figure 2 represents the sea vessel of Figure 1 resting on the seabed and raised with respect to the water level;

Figure 3 illustrates a detail of the resting system, in a vertical section, in the operational phase; and

Figure 4 represents a detail of the support foot.

[0019] With reference to the Figures, the sea vessel (1) is the pontoon (2) prepared for the laying of bulkhead gates for the MOSE project and consists of a plurality of modular means assembled and arranged in C-form, so that the cavity (3) allows the metallic bulkhead gates to be housed, during their transferal, and lowered or recovered, in the case of their installation or removal for maintenance.

[0020] The pontoon has vertical legs (4) moveable in a descending/ascending direction which, in the navigation phase, are lifted as illustrated in Figure 1. The legs are positioned along the perimeter of the hull and symmetrically, to guarantee the equilibrium and balancing of the hull when it is in a resting condition on the seabed or on the base plate and in complete emersion (Figure 2). Once it has reached the site, the pontoon is stabilized, by lowering one or more sonar references to the seabed, then, by managing the propulsion means (6), it is positioned so that the projection of the legs onto the seabed substantially coincides with the corresponding centering recesses (7) of the legs, arranged on the concrete base (8), prepared for housing and supporting the bulkhead gates (9), in the drawing already in an operative position.

[0021] At this point, the legs (4) are lowered towards the recesses by means of a specific system (Jack-in System) (10). The legs of the pontoon can only be moved in a vertical direction, downwards or upwards, remaining constrained to the pontoon with respect to the other movements. This means that, in the case of a rough sea and consequently strong pitching and rolling of the hull of the pontoon, the legs (4) are subjected to an oscillating movement (in various oscillation planes) substantially centered on the corresponding recess.

[0022] In order to prevent these oscillations from causing collision against the base plate, which could damage it and jeopardize the stability of the pontoon, or lose the precise position requested, once they arrive in correspondence with the surface of the base plate, for example at a distance of 100 to 150 cm, the descent of the legs is stopped and the resting system, object of the present invention, is initiated.

[0023] The resting system comprises the telescopic el-

ement (11), constrained to the leg (4) by means of an elastic system (12), for example a hydraulic piston with an accumulator or a gas spring, fixed internally to the leg by means of cardan joints (13), the support foot (18) comprising the semi-spherical joint (14) and the centering pin (15) constrained by means of a spring (16) to the semi-spherical joint. The resting of the support foot on the surface of the base plate can be further achieved with a support disk (17) connected to the semi-spherical joint by means of a negligible mass connection elastic element, produced, for example, with rubber elements in order to have limited impact forces.

[0024] The telescopic element is lowered until it touches the base plate. The possible collision is absorbed by the damping system (12). Contemporaneously, the flat surface (17) of the foot rests on the surface of the base plate (8), thanks to the semi-spherical joint.

[0025] Under the thrust of the oscillating movement of the legs, the flat surface of the foot slides on the base plate around the recess until the centering pin (15) enters the recess (7). The pin itself guides the oscillating movement towards the vertex of the recess allowing the foot to be put into position. In order to favour the centering of the pin (15) in the recess (7) and therefore stop the oscillating movement of the legs, the recess and tip of the pin have a V-shaped vertical section, to guarantee a seat for the pin towards the centre of the recess.

[0026] Once the foot has been centered, the resting system is progressively tightened to activate the lifting phase of the pontoon. The legs (4) are re-lowered, which, after touching the surface of the base plate, allow the thrust to be applied for lifting the hull of the pontoon above the sea level.

Claims

1. Device for sitting on the seabed for sea vessels equipped with self-raising legs, wherein each leg comprises:

- a. a vertical structural element capable of lowering and raising;
- b. a device for absorbing collisions and for centering arranged at the support end of said structural element, **characterized in that** said device for absorbing collisions and for centering essentially consists of:

- i. a coaxial telescopic means fixedly connected to said structural element through a hinged elastic means;
- ii. a support foot comprising a semi-spherical joint connected to the unconnected end of said telescopic element, the flat part of said support foot facing the seabed; and
- iii. a coaxial centering pin fixedly connected to the support foot through a hinged elastic

means, suitable for centering housings arranged on the seabed.

2. Stand device according to claim 1, wherein the flat part of said support foot comprises a support disc elastically connected to the semi-spherical joint.

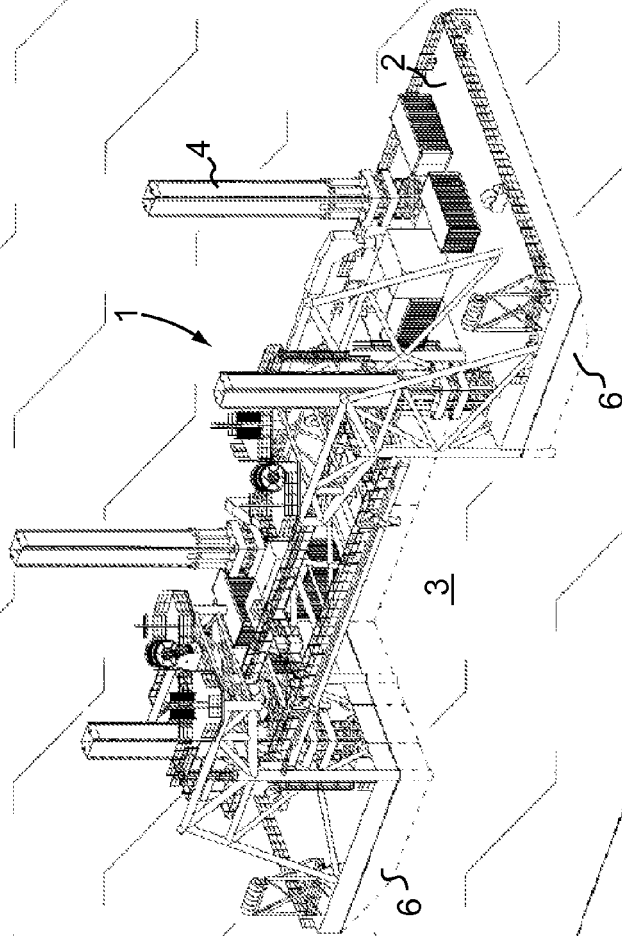
3. Method for anchoring a sea vessel equipped with a plurality of self-raising support legs on a base plate, arranged on the seabed, and for raising said sea vessel above the water level through said self-raising support legs, which comprises:

- A. providing a plurality of recesses on the base plate, suitable for receiving corresponding means for absorbing collisions and for centering associated with said self-raising support legs;
- B. positioning the sea vessel so that the vertical axis of each leg substantially coincides with each recess;
- C. lowering the support legs up to a predetermined distance from the base plate;
- D. once the predetermined distance has been reached, stopping the descent of the legs and starting the descent of said means for absorbing collisions and for centering, inside each leg, until contact is made with the base plate;
- E. centering the recess located in the base plate with a centering pin associated with said means for absorbing collisions and for centering;
- F. once the recess is centered, lowering the legs until contact is made with the base plate and lifting the hull of the sea vessel above the water level.

4. Method according to claim 3, wherein each means for absorbing collisions and for centering is part of the stand device according to claims 1 or 2.

5. Self-raising sea vessel equipped with the stand device according to claim 1 or 2.

Fig. 1



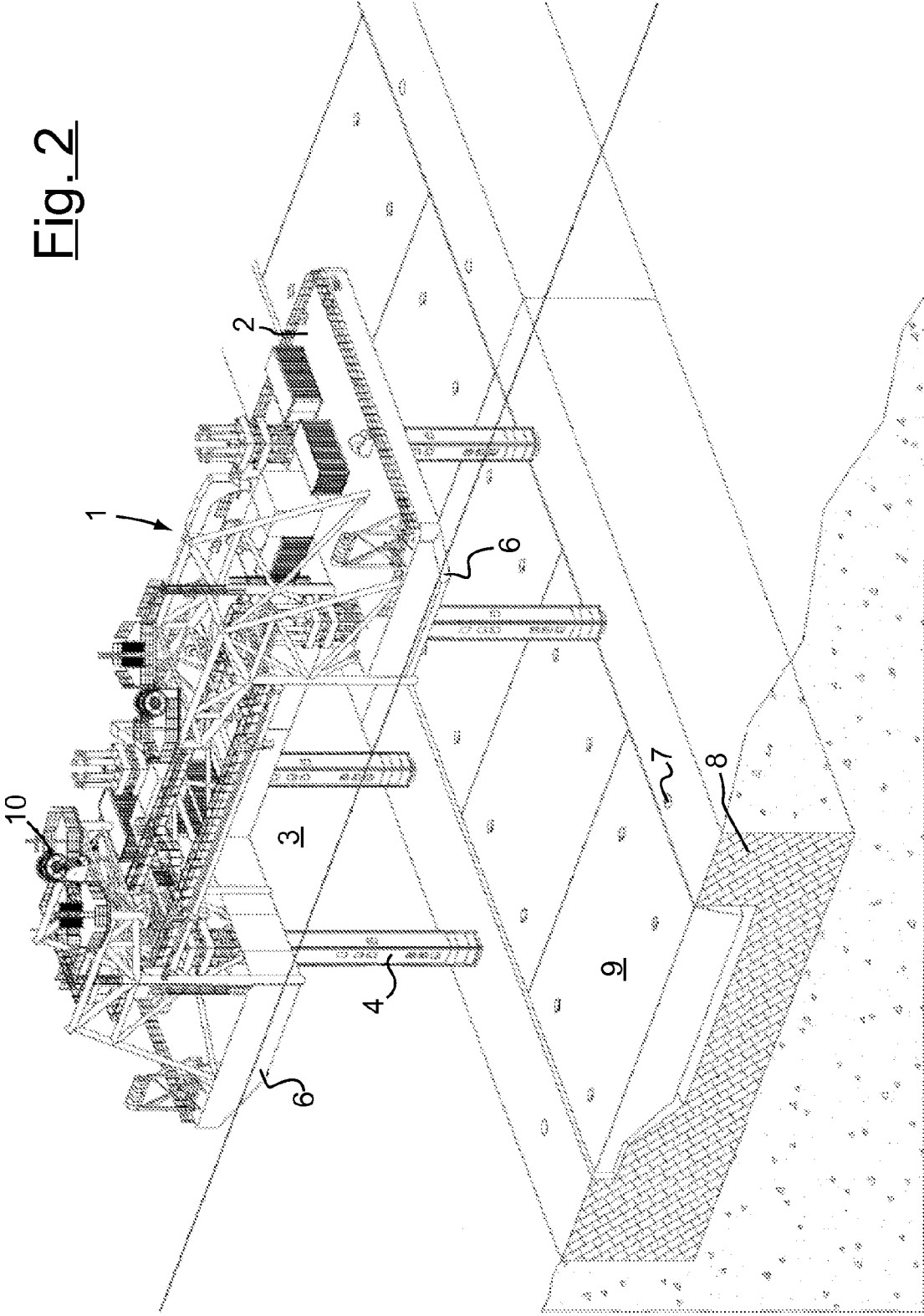
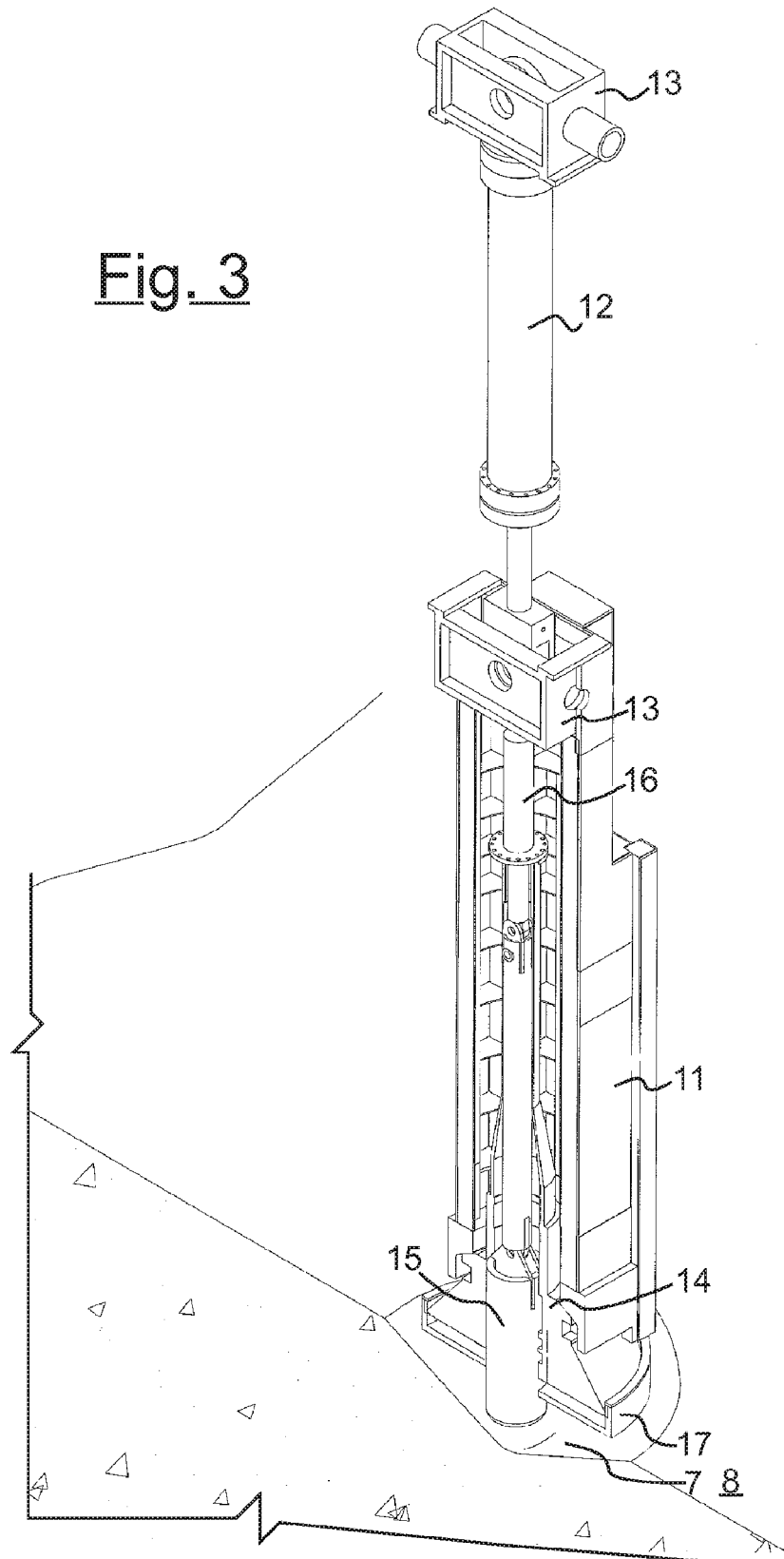
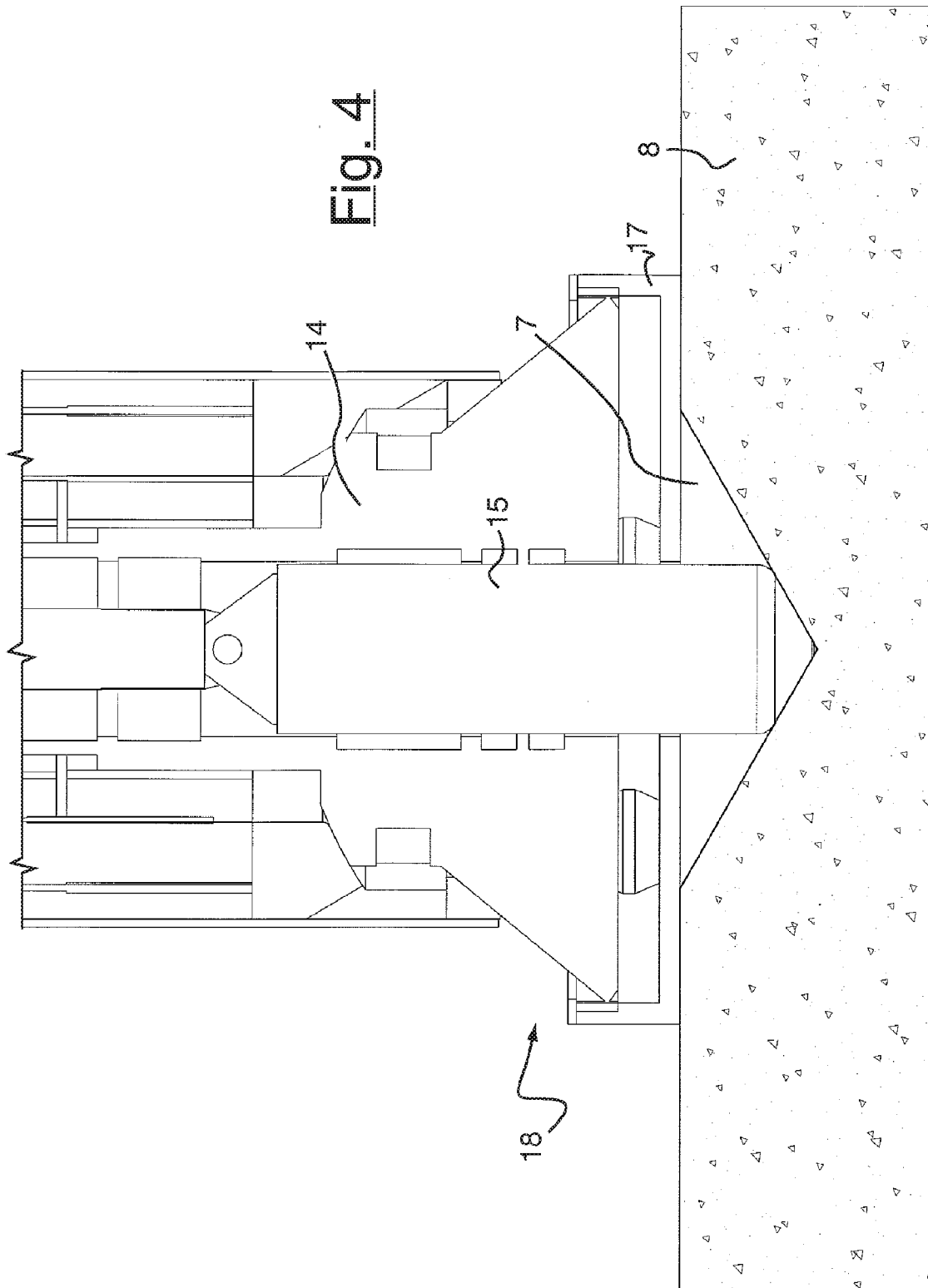


Fig. 3







EUROPEAN SEARCH REPORT

Application Number
EP 10 15 5620

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 4 195 950 A (GOLDMAN JEROME L [US]) 1 April 1980 (1980-04-01) * column 3, line 16 - column 6, line 9; figures 1,3,5,6 *	1,2,5	INV. E02B17/02
A	US 3 138 932 A (KOF AHL DAVID C ET AL) 30 June 1964 (1964-06-30) * column 1, line 65 - column 3, line 30; figures 1-4 *	3,4	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 July 2010	Examiner Zuurveld, Gerben
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 15 5620

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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02-07-2010

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REFERENCES CITED IN THE DESCRIPTION

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