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Remarks:

Claim 16-20. is deemed to be abandoned due to non-payment of the claims fee (Rule 45(3) EPC).

(54) **GRAVITY ANCHOR DEVICE**

(57) A mooring system (10), a tethering system (12) and a method of deploying a mooring system is described. The tethering system (12) is operable to tether an array of modular gravity anchors (14) to a bed of a body of water (16). The tethering system comprises an elongate tether (18) locatable on, for example the seabed

(16). A plurality of stop members (22) is distributed along the tether (18) and attachable to the tether (18). The gravity anchors (14) are connectable to each of the stop members (22). The mooring system (10) includes the tethering system (12) and a plurality of gravity anchors (14) attached thereto.

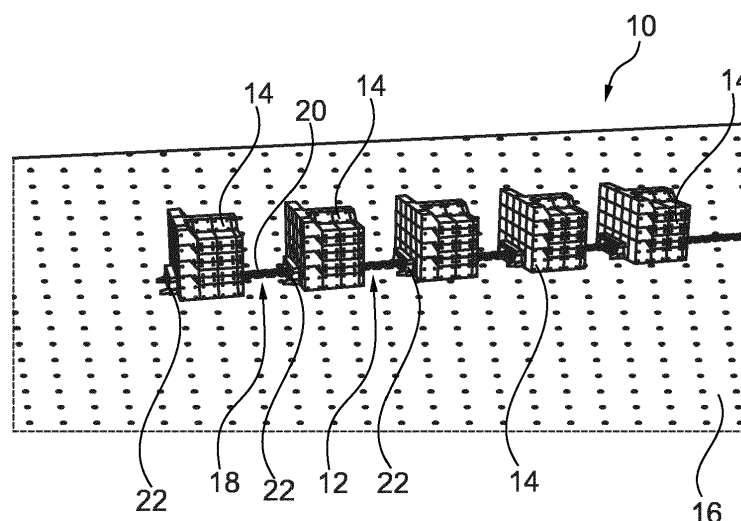


Fig. 1

Description

Field of the Invention

[0001] The present invention relates to a tethering system for use with an array of modular gravity anchors. In particular, but not exclusively, the invention relates to deployment of an array of gravity anchors on a seabed, where the array of gravity anchors work cohesively as a single anchor member.

Background to the Invention

[0002] An anchor is typically used to connect a vessel or underwater device, such as renewable energy devices to the bed of a body of water, for example the seabed. Gravity or deadweight anchors provide a holding force from the submerged weight of the anchor.

[0003] The holding force of the gravity anchor is proportional to its weight. Therefore, if the holding force required is greater the weight of the anchor must be proportionately greater. As the weight increases so does the dimensions of the anchor. It will be appreciated that the ability to transport and maneuver gravity anchors will be affected as the weight and dimensions increase. Large vessels are typically required to deploy large/heavy gravity anchors.

[0004] Gravity anchors are historically formed from a dense material such as cast iron, steel or lead. More recently, gravity anchors have been formed from concrete. The holding power of the anchor is defined by its weight underwater (accounting for buoyancy), although suction can increase this if it becomes buried. For instance, a solid concrete anchor of dimensions 10 m by 5 m by 3.6 m would have a weight in air of 550 Tonnes and a weight in water of 300 Tonnes. It will be appreciated that the holding force of a concrete anchor placed underwater is considerably lower than a correspondingly dimensioned iron, steel or lead anchor.

[0005] Large concrete anchors, formed in a conventional manner, are expensive to handle and install because heavy works vessel are typically required to transport the anchor to the seabed.

[0006] Concrete anchors are cheaper to manufacture than steel anchors, at less than a third of the cost, approximately, per unit holding force.

[0007] Anchorage systems with a capacity of, for example, 700 tonnes may be provided by single gravity anchors, subsea drilling or piling. Each of these activities involve using expensive heavy lift vessels.

[0008] It is desirable to provide an anchor system which involves reducing the cost of deployment and the cost of operational and maintenance (O&M) activities.

[0009] It is also desirable to provide an anchor system that does not require a heavy works vessel to deploy the anchor system, thereby reducing the O&M costs associated with conventional anchor systems.

[0010] It is desirable to provide improved means of in-

stalling a concrete gravity anchor on the bed of a body of water, for example the seabed.

[0011] It is further desirable to provide an anchoring system that reduces the cost associated with handling and/or installing a gravity anchor.

Summary of the Invention

[0012] A first aspect of the present invention provides a tethering system operable to tether an array of modular gravity anchors to a bed of a body of water, the tethering system comprising:

an elongate tether locatable on the bed of a body of water; and

a plurality of stop members distributable along the tether and fixedly attachable to the tether, wherein at least one gravity anchor is connectable to each of the stop members.

[0013] The arrangement of the elongate tether, stop members and modular gravity anchors is such that the interaction of the stop members with a corresponding modular gravity anchor combines the masses of each gravity anchor that are smaller and lighter than typical gravity anchors to act as a single cohesive mass on the bed of the body of water in which the system is deployed, for example the seabed.

[0014] For example a typical mooring system requiring two 700 tonnes (wet weight) anchors is deployed to the sea bed using a heavy load vessel. Such large masses typically cannot be deployed with a small multi-cat vessel, which typically has a winch capacity of less than 100 tonnes. Accordingly, a system according to embodiments of the present invention combines multiple smaller masses to provide a large mass on the seabed. Therefore, the system is suitable for deployment using vessels smaller than those conventionally used to deploy an equivalent single large mass whilst having the ability to provide the required anchorage due to the cohesive affect provided by the tethering system. As such a tethering system according to the embodiments described can be deployed at less cost than conventional methods and has the added benefit of reducing the risks associated with a single lift operation of large masses.

[0015] The tether may comprise a chain comprising a series of connected links wherein the stop members are fixedly attached to the tether relative to one or more links of the chain.

[0016] The stop members may comprise a surface against which the gravity anchor locates when on the bed of a body of water. Alternatively, the stop members may comprise a receiving member against which or upon which the gravity anchor is connectable when it is lowered towards the stop member. In the embodiment where the gravity anchor is connectable upon the receiving member, the receiving member may protrude from a surface of the stop member and may be configured to be receiv-

able in a correspondingly shaped cavity provided at a surface of the gravity anchor.

[0017] The stop member may comprise a frame structure comprising at least two plate members spaced apart by structural supports, wherein the structural supports act to engage with the tether to fixedly attach the stop member to the tether. The structural supports may comprise two rods or pins each secured to each plate and spaced sufficiently to receive a section of the tether therebetween and to prevent relative movement of tether and the stop member.

[0018] In an alternative embodiment the tether may comprise a series of longitudinal substantially rigid members, each longitudinal member being connected by a hinge mechanism to an adjacent longitudinal member, wherein each stop member is fixedly attached relative to a longitudinal member and hinge mechanism and is configured to receive a gravity anchor.

[0019] The stop members may comprise a receiving member upon which the gravity anchor is receivable when it is lowered towards the stop member. The receiving member may protrude from a surface of the stop member and may be configured to be receivable in a correspondingly shaped cavity provided at a surface of the gravity anchor.

[0020] A second aspect of the present invention provides a mooring system comprising a tethering system according to the first aspect and a plurality of gravity anchors, wherein at least one gravity anchor is connectable to each stop member.

[0021] A mooring system of the second aspect provides a single cohesive system of multiple relatively small masses to emulate a conventional large mass system, wherein applying a load to the tether results in the tether and the stop members acting together to transfer mooring loads to the anchors.

[0022] The at least one gravity anchor may comprise a pre-cast concrete block configured for connection to the tethering system. Alternatively, the at least one gravity anchor may comprise cast iron, steel or lead.

[0023] Connection of the gravity anchor to the tethering system may be by locating a gravity anchor adjacent to a face of the stop member. Alternatively, connection of the gravity anchor to the tethering system may be by being received upon a receiving member protruding from each stop member.

[0024] The at least one gravity anchor may comprise a modular construction, wherein a plurality of modular elements can be combined to form a gravity anchor connectable to each stop member.

[0025] Each modular element may comprise a self aligning geometrical configuration comprising complementary mating surfaces such that a plurality of modular elements are stackable relative to the stop member.

[0026] This configuration effectively reduces the weight of each gravity anchor being located on the bed of a body of water. Multiple modular elements can be transported to the deployment location and each modular

element can be deployed individually to the bed of the body of water in engagement firstly with the tether and the stop member and subsequently with a modular element already deployed.

[0027] The first modular element may comprise a void area on its underside from front to back or side to side, wherein the void area straddles the tether when in use.

[0028] Each modular element may comprise a void area from front to back or side to side on its underside and a correspondingly shaped raised area on its upper surface such that in assembling the gravity anchor each modular element is aligned by engagement of the raised area within the void area.

[0029] A further aspect of the present invention provides a method of deployment of a mooring system according to a second aspect of the present invention comprising the steps:

locating a tethering system comprising an elongate tether and stop elements distributed along the length of the tether on a bed of a body of water;
lowering at least one gravity anchor per stop element towards the bed of the body of water;
locating each of the gravity anchors relative to a stop element;
pulling the tether thereby transferring the tether load to the gravity anchors via engagement of the stop elements and the gravity anchors thereby combining masses of each gravity anchor and providing a cohesive singular mass on the bed of the body of water.

[0030] The step of lowering at least one gravity anchor per stop element may comprise lowering a plurality of modular elements per stop element, firstly locating a first modular element relative to the tether and each stop element and subsequently repeating lowering a further modular element into engagement with a previously installed modular element to connect a gravity anchor structure with each stop element.

Description of the Drawings

[0031] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a mooring system according to an embodiment of the present invention;

Figure 2 is a schematic representation of an assembly of an elongate chain tether and a plurality of stop members according to an embodiment of the present invention;

Figure 3 is a schematic representation of a stop member attached to the tether as illustrated in figure 2;

Figure 4 is a schematic representation of the stop member of Figure 3 showing engagement of the stop member and the chain tether;

Figure 5 is a schematic representation of a tether system according to an embodiment of the present invention; and

Figure 6 is a schematic representation of a modular gravity anchor system as used with the tethering system of figures 2, 3 and 4.

Description of an Embodiment

[0032] Figure 1 illustrates a mooring system 10 comprising a tethering system 12 and a plurality of gravity anchors 14 as located on the bed 16 of a body of water, for example a seabed 16.

[0033] In the illustrated example the tethering system 12 comprises a chain 18 made up of a system of links 20 and a plurality of structural stop members 22 distributed along the chain 18. Each structural stop member 22 is configured to engage with a link 20 of the chain 18 such that relative movement of the chain 18 and the stop member 22 is prevented (this is illustrated further in figures 3 and 4). The arrangement resembles a train, with the structural stop members 22 and anchors 14 resembling carriages.

[0034] A gravity anchor 14 is located at each stop member 22. In the illustrated example each anchor 14 comprises a void on the underside (not visible in figure 1). The void straddles the chain 18 such that the chain 18 effectively runs freely beneath the anchors 14. In the illustrated example the arrangement is such that pulling on the chain 18 pulls the stop members 22 into contact with a corresponding gravity anchor 14 whereby the pulling force is transferred from the chain 18 to the gravity anchor 14. As such the arrangement combines multiple small masses to act as a single cohesive mass on the seabed 16.

[0035] The mooring system 12 provides a modular gravity anchor train that facilitates deployment of large mooring forces using multi-cat type vessels that typically have limited lifting capacity, for example less than 100 tonnes.

[0036] A mooring system 12 as illustrated in figure 1 can be installed in stages by a multi-cat class vessel. Therefore, significant cost savings can be made on installation activities. Conventional deployment of a mooring system requiring large mooring forces uses large vessels or multiple vessels. As such a system according to embodiments of the present invention represents saving in respect of hire and mobilization costs. This means that down time and delays become fewer and therefore less expensive.

[0037] Figure 2 illustrates the arrangement of the tethering system 12 including the chain 18 and a plurality of structural stop members 22. Figures 3 and 4 illustrate

the arrangement of the stop members 22 relative to the chain 18 and the chain links 20.

[0038] In the illustrated example, the stop member 22 comprises a structural steel framework including two structural members 24, shown as tubular members, for example steel hollow section. The structural members 24 are spaced apart to accommodate the chain 18 passing between them. Two high strength steel rods or pins 26 are located between the structural members 24 such that a link 20 is received between the rods 26 to prevent relative movement of the chain 18 and the stop member 22.

[0039] The arrangement of the rods 26 is such that a vertically orientated chain link 21 is located between the rods 26 and the spacing is such that the adjacent horizontally orientated chain links 20 are too wide to pass through the gap between the rods 26. Therefore, movement of the stop member 22 and chain 18 relative to each other is limited to the length of the chain link 21 located between the rods 26.

[0040] In the illustrated example the stop member 22 includes a stabilizing element 28 extending from one face such that the support member 22 is stably located on the sea bed 16 and a clean face 30 against which the gravity anchor 14 is engaged when a load is applied to the tethering system 12 via the chain 18.

[0041] Lifting rings 30 may be included at the upper face of the stop member 22 as illustrated. The lifting rings 30 are used to lift the rods 26 into place when assembling the stop members 22. The stop members 22 are generally assembled on shore.

[0042] The tethering system 12 is deployed onto the seabed as an assembly of tether 18 and stop members 22 with the anchors 14 being deployed after the tethering system 12 is located on the seabed.

[0043] Figure 4 illustrates a cross-section through the centre of the stop member 22 as illustrated in figure 3. Figure 4 illustrates the arrangement of the rods 26 relative to the links 20 of the chain 18 and highlights how the spacing of the rods 26 is wide enough to accommodate a vertically orientated chain link 20 between them and narrow enough to stop adjacent horizontally orientated links 20 passing between the rods 26 when a load is applied to the tether 12. Therefore, relative movement of the chain 18 and the stop member 22 is limited.

[0044] The engagement of the chain 18 and the stop member 22 is such that when a load is applied to the chain 18 the stop members 22 are pulled into contact with the associated gravity anchor 14 and the load is transferred from the tethering system 12 to the anchors 14 to provide an effective mooring system 10.

[0045] Figure 5 illustrates a further example of a tethering system 120 that can be used with the individual anchor elements as illustrated in figure 1. In the illustrated example the tethering system 120 includes a plurality of longitudinal substantially rigid members, for example steel bars or rods 180, that are connected end to end with a hinge mechanism 182. The hinge mechanism 182

is operable to join the longitudinal members 180, whilst maintaining some flexibility to facilitate installation and movement within the system when located on the seabed 16.

[0046] Stop members 220 are provided at the junction of adjacent longitudinal members 180. In this example the stop members 220 each comprise a receiving member 222 against which the gravity anchors 14 (not illustrated in figure 5) are located when they are lowered to the seabed 16. In the illustrated example the receiving member is a vertically orientated bar or pole upon which or against which the anchors 14 can be secured.

[0047] Figure 6 illustrates an example of modular elements 50 used to create each gravity anchor 14 as used with the tethering system 12, 120 as illustrated in figures 1 to 5. Each modular element 50 includes a self aligning geometry such that the complete anchor structure is stable when located on the seabed and that movement of each modular element 50 relative to an underlying modular element is restricted. The gravity anchor 14 as illustrated in figure 1 is formed from a tower of the modular elements 50. In the illustrated example (figure 1) four modular elements are used to form each gravity anchor 14.

[0048] As illustrated in figure 6 an anchor 14 is formed by building a tower of modular elements 50. An exploded assembly of two modular elements 50 is illustrated in figure 6 such that the interaction of the modular elements 50 is evident.

[0049] Each modular element 50 includes a void 52 in the underside. The void 52 runs along the width, from the front 54 to the back 56, of the modular element 50. The top/upper surface 58 of each modular element includes a raised portion 60. In the illustrated example the cross sectional shape of the void 52 and the raised portion 60 is a trapezoid. It will be appreciated that the shape and size of the void 52 and the raised portion 60 correspond and are shaped such that each modular element 50 is aligned relative to a previously installed/underlying modular element 50.

[0050] In the illustrated example, the first modular element, which is first to be located on the seabed includes a flat base from front to back and includes the void area 52 described above. The void area 52 in the first modular element 50 is provided to straddle the tether 12, 120 when situated on the seabed 16.

[0051] At the back of the each subsequent modular element 50 a beveled void 62 is included on the underside and a beveled step 64 is included on the upper surface to correspond in shape and size with the beveled void 62.

[0052] The gravity anchor 14 is assembled by locating a first modular element 50 on the seabed such that the void 52 straddles the tether 12 located on the seabed 16. A subsequent modular element 50 is lowered onto the first modular element 50 such that the beveled void 62 and the trapezoidal void 53 on the subsequent modular element mate with the corresponding beveled step 64 and trapezoidal raised section 60 respectively on the first

modular element 50. The assembly process is repeated with subsequent modular elements 50 being installed until the gravity anchors 14 are representative of the required total effective mass.

[0053] The self-aligning geometry of the modular elements 50 reduces the required positional accuracy compared with, for example a basket-type frame. The mooring system 10 as illustrated is assembled more easily than a basket frame arrangement because the assembly process is more open because there is no confined structure surrounding the blocks. As such a wider approach angle can be adopted and the geometry of each modular element 50 assists in aligning the modular element when being lowered towards the seabed.

[0054] The self-aligning geometry of the modular elements simplifies deployment operations, reducing the required positional accuracy. The known system using basket-type frames is less easily handled by multi-cat vessels, if at all, and requires a clear, flat landing zone on the sea-bed. Moreover, a greater degree of accuracy is required when placing concrete blocks in the basket frame.

[0055] In the illustrated example each modular element 50 is made from a cast concrete block. However, it will be appreciated that other materials may also be suitable, for example cast iron, steel or lead.

[0056] It will be appreciated that the modular arrangement of the mooring system according to the described embodiments provides improvements in how a gravity anchor system is deployed onto the seabed. The mooring system according to the described embodiments can be deployed using a multi-cat class vessel.

[0057] Such vessels are more readily available for use than larger working vessels and the cost to use such vessels is generally an order of magnitude less expensive than the larger vessels. Whilst the present embodiment involves multiple lifting operations it will be appreciated that the smaller masses can be lifted, manoeuvred and located on the seabed more easily than a single large load. As such the present invention provides portability in a mooring system and substantial cost savings in cost of operational and maintenance costs.

[0058] In deployment of any gravity anchor system local sea-bed conditions can be problematic, for example the size and location of boulders etc may interfere with successful placement of a gravity anchor. A mooring system according to the described embodiments is considered adaptable to such seabed conditions by distributing the stop members along the tether with knowledge of the seabed surface undulations. As such the modular elements/anchors can be selectively placed to reduce the problems associated with an uneven seabed. As such interference with the tethering system can be controlled and therefore unexpected loadings or unstable deployment, presenting the risk of anchors toppling, can be monitored and controlled.

[0059] It will be appreciated that installation of the modular mooring system may take more time than installation

of an equivalent large anchor. However, as discussed above the cost of equipment involved in deploying the large anchor is an order of magnitude more expensive than a smaller vessel, which is suited to installing multiple smaller blocks. For the modular system described above the vessel day rate is vastly cheaper than that for the single lift system therefore even though multiple passes/lifts are required for the modular system it is still more cost effective to do so.

[0060] Whilst specific embodiments of the present invention have been described above, it will be appreciated that departures from the described embodiments may still fall within the scope of the present invention.

Claims

1. A tethering system operable to tether an array of modular gravity anchors to a bed of a body of water, the tethering system comprising:

an elongate tether locatable on the bed of a body of water; and
a plurality of stop members distributable along the tether and fixedly attachable to the tether, wherein at least one gravity anchor is attachable to each of the stop members.

2. A tethering system as claimed in claim 1, wherein the tether comprises a chain comprising a series of connected links and wherein the stop members are fixedly attached to the tether relative to one or more links of the chain.

3. A tethering system as claimed in claim 1, wherein the tether comprises a series of longitudinal substantially rigid members, each longitudinal member being connected by a hinge mechanism to an adjacent longitudinal member, wherein each stop member is fixedly attached relative to a longitudinal member and hinge mechanism and is configured to receive a gravity anchor.

4. A tethering system as claimed in any of claims 1 to 3, wherein the stop members comprise a surface against which the gravity anchor locates when on the bed of a body of water.

5. A tethering system as claimed in any of claims 1 to 3, wherein the stop members comprise a receiving member upon which the gravity anchor is receivable when it is lowered towards the stop member.

6. A tethering system as claimed in claim 5, wherein the receiving member protrudes from a surface of the stop member and is configured to be receivable in a correspondingly shaped cavity provided at a surface of the gravity anchor.

7. A tethering system as claimed in any preceding claim, wherein the stop member comprises a frame structure comprising at least two structural members spaced apart by structural supports, wherein the structural supports act to engage with the tether to fixedly attach the stop member to the tether.

8. A tethering system as claimed in claim 7, wherein the structural supports comprise two rods or pins each secured to each plate and spaced apart to receive a section of the tether therebetween and being operable to restrict relative movement of tether and the stop member.

9. A mooring system comprising:

a tethering system according to any of the preceding claims; and
a plurality of gravity anchors, wherein at least one gravity anchor is connectable to each stop member.

10. A mooring system as claimed in claim 9, wherein connection of the gravity anchor includes locating a gravity anchor adjacent to a face of the stop member.

11. A mooring system as claimed in claim 9, wherein connection of the gravity anchor includes locating the gravity anchor to be received upon a receiving member protruding from each stop member.

12. A mooring system as claimed in any of claims 9 to 11, wherein the at least one gravity anchor comprises a modular construction, wherein a plurality of modular elements can be combined to form a gravity anchor connectable to each stop member.

13. A mooring system as claimed in claim 12, wherein each modular element comprises a self aligning geometrical configuration comprising complementary mating surfaces such that a plurality of modular elements are stackable relative to the stop member.

14. A mooring system as claimed in claim 12 or 13, wherein a first modular element comprise a void area on its underside from front to back or side to side, wherein the void area straddles the tether when in use.

15. A mooring system as claimed in any of claims 12 to 14, wherein each modular element comprises a void area from front to back or side to side on its underside and a correspondingly shaped raised area on its upper surface such that in assembling the gravity anchor each modular element is aligned by engagement of the raised area on a subsequent modular element within the void area on a previous modular element.

16. A mooring system as claimed in any of claim 9 to 15,
wherein the at least one gravity anchor comprises a
pre-cast concrete block configured for connection to
the tethering system. 5
17. A method of deployment of a mooring system ac-
cording to any of claims 9 to 16 comprising the steps:
- locating a tethering system according to any of
 claims 1 to 8 on a bed of a body of water; 10
 lowering at least one gravity anchor per stop el-
 ement towards the bed of the body of water;
 locating each of the gravity anchors relative to
 a stop element; and
 pulling the tether thereby transferring the tether 15
 load to the gravity anchors via engagement of
 the stop elements and the gravity anchors there-
 by combining masses of each gravity anchor
 and providing a cohesive singular mass on the 20
 bed of the body of water.
18. A method of deployment of a mooring system as
claimed in claim 17, wherein the step of lowering at
least one gravity anchor per stop element comprises
lowering a plurality of modular elements per stop el- 25
ement, including firstly locating a plurality of first
modular elements relative to the tether and each stop
element and subsequently repeating lowering a plu-
rality of further modular elements into engagement 30
with the first installed modular element to provide a
gravity anchor structure at each stop element and
repeating the step of lowering a plurality of modular
elements into engagement with previously installed
modular elements until the required anchorage is 35
achieved.
19. A tethering system as described herein and with ref-
erence to the drawings.
20. A mooring system as described herein and with ref- 40
erence to the drawings.

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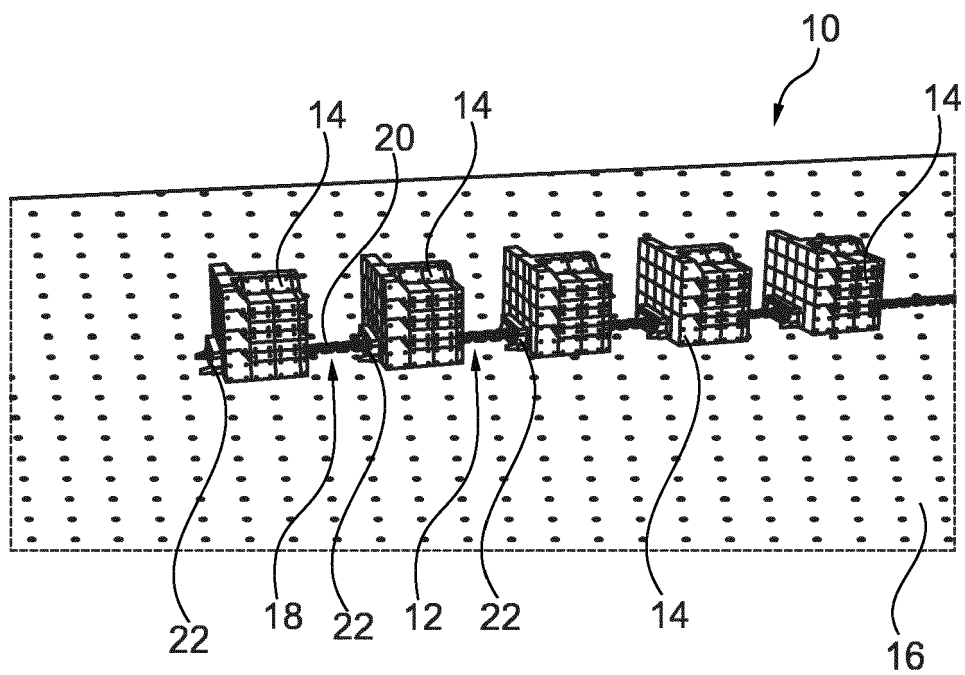


Fig. 1

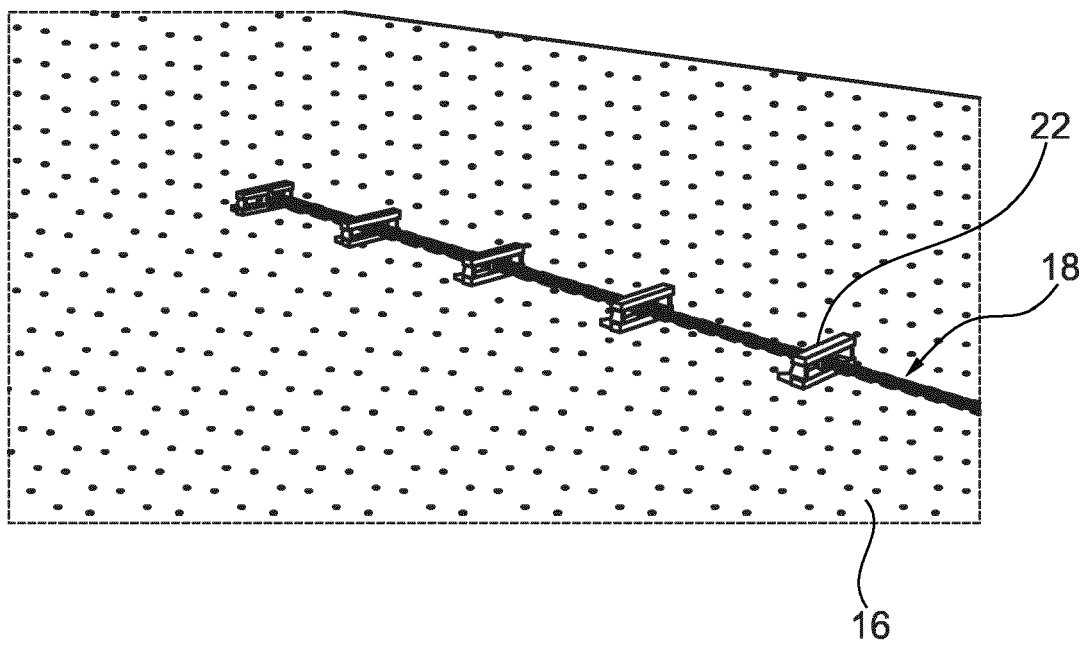


Fig. 2

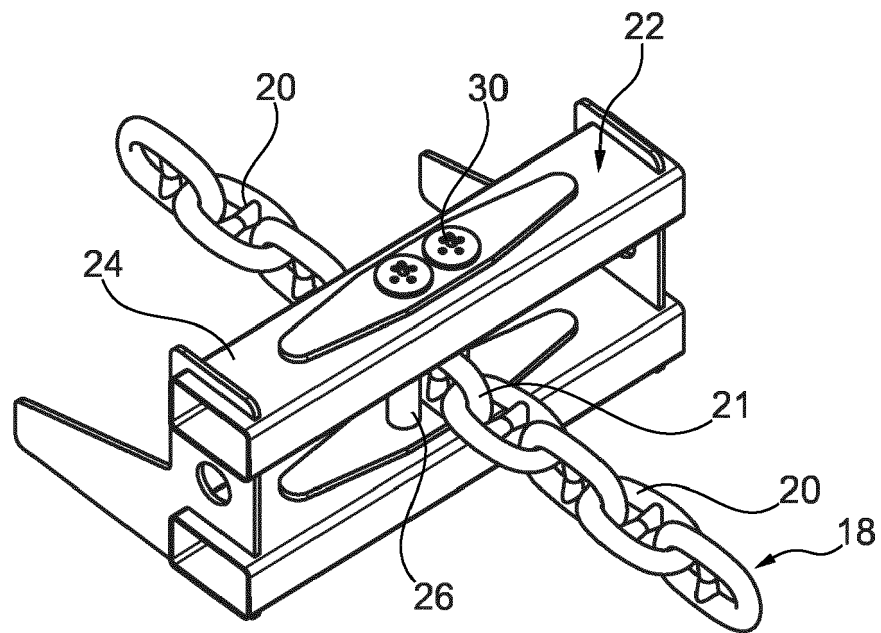


Fig. 3

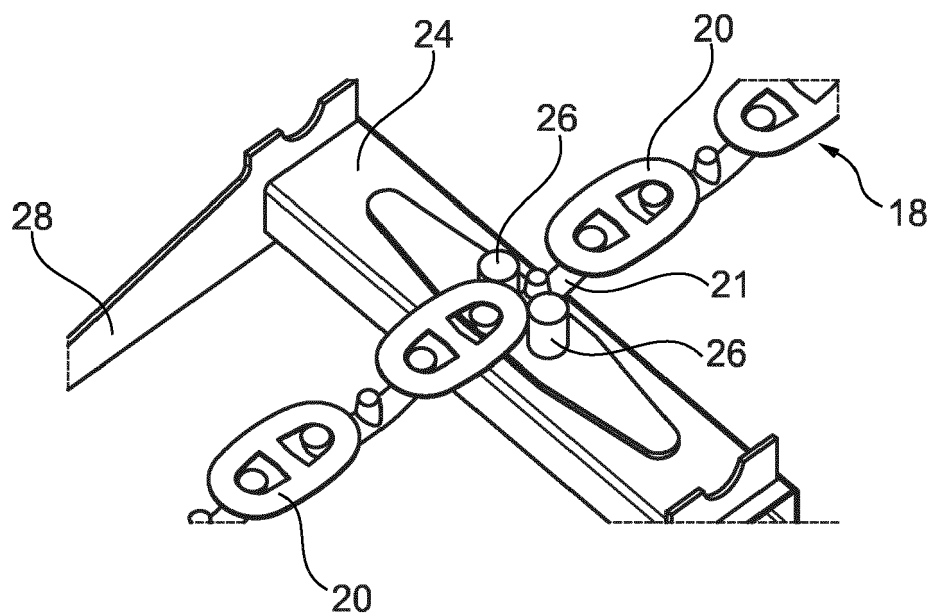


Fig. 4

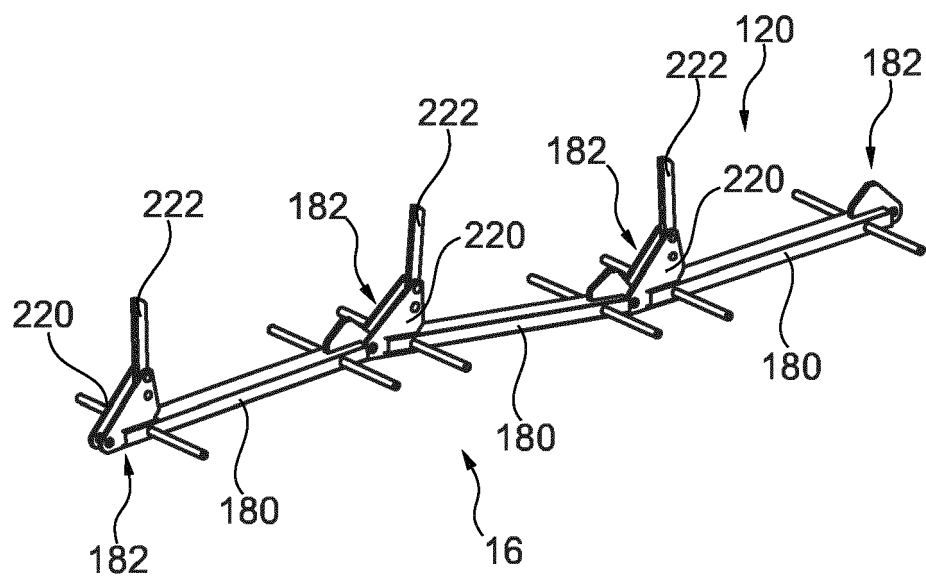


Fig. 5

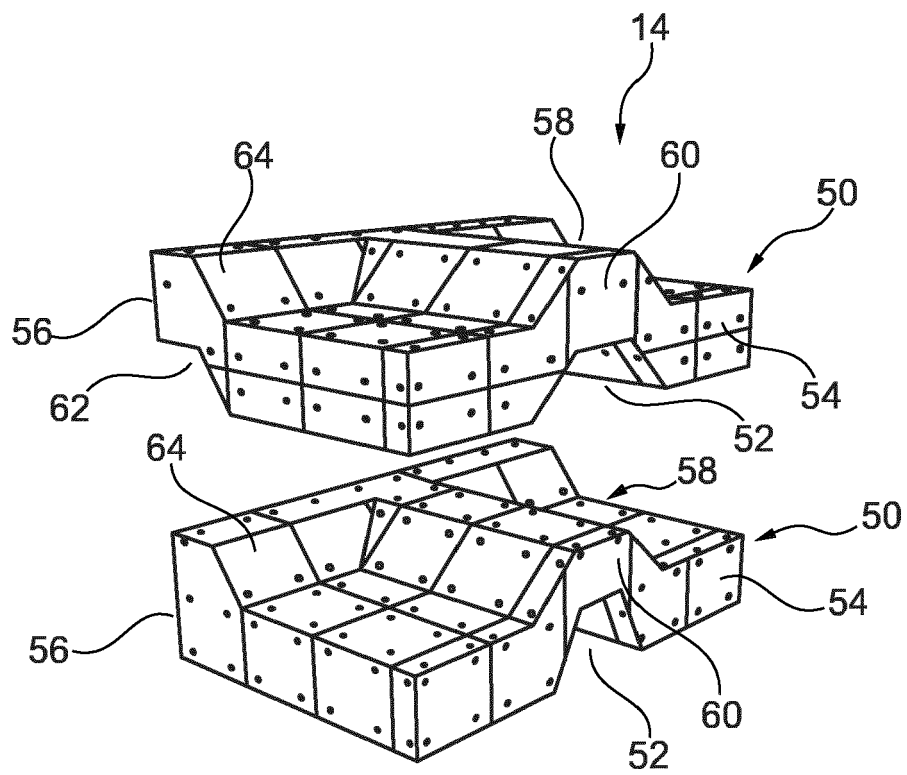


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 16 16 8315

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 81/02413 A1 (BRUPAT LTD [GB]; BRUCE P [GB]) 3 September 1981 (1981-09-03)	1,3-7, 9-11,16, 17,19,20	INV. B63B21/20 B63B21/29 B63B21/50 B63B21/22
Y	* page 3 - page 6; figures * -----	12-14,18	
X	GB 2 132 149 A (BLOHM VOSS AG [DE]) 4 July 1984 (1984-07-04) * the whole document * -----	1-6, 9-11,16, 17,19,20	
X	DE 31 44 728 A1 (BLOHM VOSS AG [DE]) 19 May 1983 (1983-05-19) * page 5 - page 8; figures * -----	1-11,16, 17,19,20	
X	DE 27 05 177 A1 (SOEDERBERG GUNNAR) 18 August 1977 (1977-08-18) * the whole document * -----	1,4-7, 9-11,16, 17,19,20	
Y	WO 2014/081317 A1 (RISER SUPPORT SYSTEMS [NO]) 30 May 2014 (2014-05-30) * page 2 - page 6; figures * -----	12-14,18	TECHNICAL FIELDS SEARCHED (IPC)
A	JP H11 59565 A (ISHIKAWAJIMA HARIMA HEAVY IND) 2 March 1999 (1999-03-02) * abstract; figures * -----	2	B63B E04B
A	WO 97/02978 A1 (KARMOY WINCH AS [NO]; HYSTAD SERINA & HF [NO]) 30 January 1997 (1997-01-30) * abstract; figures * -----	8	
A	FR 2 572 745 A1 (HONVAULT MAXIME [FR]) 9 May 1986 (1986-05-09) * abstract; figures * -----	15,18	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		22 March 2017	Popescu, Alexandru
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			

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

EP 16 16 8315

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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22-03-2017

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30

35

40

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50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8102413 A1	03-09-1981	AU 547262 B2	10-10-1985
		EP 0045762 A1	17-02-1982
		IE 50734 B1	25-06-1986
		NO 813521 A	19-10-1981
		WO 8102413 A1	03-09-1981

GB 2132149 A	04-07-1984	FR 2538338 A1	29-06-1984
		GB 2132149 A	04-07-1984
		NL 8304408 A	16-07-1984
		NO 834702 A	25-06-1984
		US 4563972 A	14-01-1986

DE 3144728 A1	19-05-1983	NONE	

DE 2705177 A1	18-08-1977	DE 2705177 A1	18-08-1977
		DE 7703662 U1	06-07-1978
		DK 27077 A	12-08-1977
		GB 1527218 A	04-10-1978
		NO 770413 A	12-08-1977
		SE 411032 B	26-11-1979
		US 4090463 A	23-05-1978

WO 2014081317 A1	30-05-2014	AU 2013348479 A1	04-06-2015
		GB 2523497 A	26-08-2015
		NO 337954 B1	18-07-2016
		WO 2014081317 A1	30-05-2014

JP H1159565 A	02-03-1999	NONE	

WO 9702978 A1	30-01-1997	AT 207434 T	15-11-2001
		AU 701331 B2	28-01-1999
		BR 9609508 A	15-06-1999
		CA 2226844 A1	30-01-1997
		CN 1196020 A	14-10-1998
		DE 69616326 D1	29-11-2001
		DE 69616326 T2	25-07-2002
		DK 0836570 T3	11-02-2002
		EP 0836570 A1	22-04-1998
		ES 2168125 T3	01-06-2002
		NO 952771 A	13-01-1997
		RU 2145932 C1	27-02-2000
		US 6019057 A	01-02-2000
		WO 9702978 A1	30-01-1997

FR 2572745 A1	09-05-1986	NONE	

EPO FORM P0459

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