(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 878 389 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.11.1998 Bulletin 1998/47

(51) Int. Cl.[6]: **B63B 21/50**

(21) Application number: **97201995.4**

(22) Date of filing: **01.07.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV RO SI

(30) Priority: **15.05.1997 EP 97201461**

(71) Applicant:
SINGLE BUOY MOORINGS INC.
CH-1723 Marly (CH)

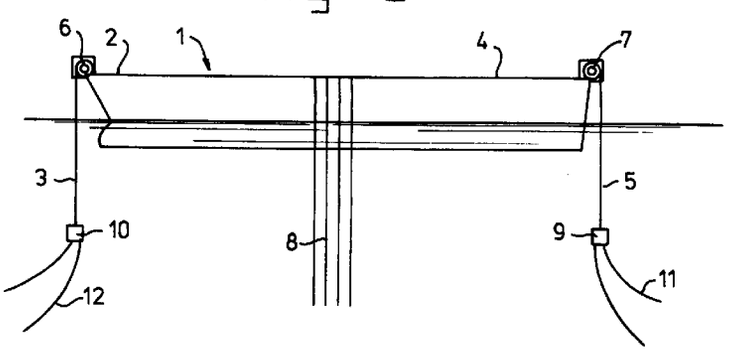
(72) Inventor: **Poldervaart, Leendert**
F-06 La Turbie (FR)

(74) Representative:
Jorritsma, Ruurd et al
Nederlandsch Octrooibureau
Scheveningseweg 82
P.O. Box 29720
2502 LS Den Haag (NL)

(54) Semi-weathervaning anchoring system

(57) The invention relates to a vessel (1) comprising at least two anchor lines (3,5) connected respectively at a substantially fixed position near the bow (2) and near the stern (4) of the vessel. At least one of the anchor lines comprises at least two branching anchor lines each connected with one end to the anchor line in a connection point (9,10) and connected with the other end (11,12) to the seabed. By means of this system, a stable anchoring arrangement is achieved in which the sides of the vessel are easily accessible by for instance a shuttle tanker. Furthermore the system according to the invention allows for a weathervaning action through relatively small angles, for instance between 0° and 90°. In another embodiment according to the present invention, at least one of the anchor lines is connected to a substantially fixed position pulling system such as a winch system for lengthening or shortening the anchor lines. For providing a weathervaning action through a range of about 0° and 90°, the anchor lines are maintained in a tensioned state by the winch system and are varied in length. In an embodiment the winch system varies the length of the anchor lines simultaneously. The anchor lines near the bow and the stern can be formed of a single anchor line which is connected to a single winch such that the anchor line which is payed out at the bow is taken in at the stern and vice versa.

Fig-4



EP 0 878 389 A1

Description

The invention relates to a vessel comprising at least two anchor lines connected respectively at a substantially fixed position near the bow and near the stern of the vessel.

From US-A-3,583,354 a bow-stern spread catenary mooring system is known in which the vessel is maintained in a fixed position by means of four anchor lines, two of which are connected to the bow of the vessel and two at the stern. By applying the correct tension to these anchor lines it is possible in normal weather to maintain the ship in a reasonably fixed position. According to US-A-3,583,354, during storm conditions the stern anchor lines are slackened, such that the vessel can weathervane around the bow through 90°.

From US-A-3,822,663, a weathervaning vessel is known, which is anchored to the seabed by means of four anchor lines. The vessel is provided with a track which encircles the hull of the vessel. A plurality of movable carriages are guided along the track, one anchor line being connected to each carriage. The carriages can be placed at specific points along the track, each carriage being equipped with a winch for accumulating or discharging a respective anchor line. By moving the position of the carriages along the track, and by selectively paying in or paying out the anchor lines, the vessel can weathervane about a substantially fixed position point located between the bow and the stern. The known anchoring construction however is relatively complex and the anchor line arrangement covers a relatively large part of the seabed. Hence the anchor lines may interfere with the operating area for the risers and leaves little room for the anchoring spread of a drilling/workover rig when such a rig is anchored next to, or in close proximity to the drilling vessel.

It is therefore an object of the present invention to provide for a vessel which can weathervane within a predetermined area, in a controlled manner, using a relatively simple anchoring system. It is a further object of the present invention to provide a vessel comprising such a weathervaning anchoring system having a reduced anchoring layout and leaving a relatively large seabed area for the risers and for the anchoring spread of adjacent vessels such as drilling/workover rigs or shuttle tankers.

Thereto the vessel according to the present invention is characterised in that at least one anchor line comprises a first line section extending to a connection point located below keel level of the vessel and at least two branching anchor lines, each connected with one end to the anchor line in the connection point and connected with the other end to the sea-bed. With the above anchoring arrangement the vessel according to the present invention can be easily accessed along its sides. Thereby other vessels can easily approach and moor aside the vessel according to the present invention, and sufficient space is available for location of for instance flexible risers.

By providing at least one anchor line with two branching anchor lines, a very stable multiple point mooring system (at least a three point system) is provided which will leave enough play for the vessel to weathervane through angles less than 90° in both directions. Preferably both the bow and the stern anchor lines each comprise at least two branching anchor lines.

In one embodiment, the anchor lines extend substantially vertically downward. Hereby access of the vessel is further increased.

As used herein, the term "substantially vertical" shall mean a position from the first anchor line section being inclined from the vertical position by no more than 45 degrees.

In another embodiment, a buoyancy member is connected near the branching anchor lines. In this way, the stiffness of the anchor arrangement can be adjusted for varying the weathervaning action.

The term "anchor line" as used herein comprises anchor cables, ropes, chains or combinations thereof.

In one embodiment, at least one anchor line extends through a generally vertical shaft extending through the hull of the vessel from deck level to keel level. In this way the anchor lines are located below the vessel, and the bow and stern are easily accessible as well.

Preferably a counterweight is connected to at least one of the anchor lines, such that the tension in the vertically extending part can be adjusted and the stiffness of the anchor line system can be varied for adjustment of the weathervaning action.

Another embodiment of a vessel according to the present invention comprises at least two anchor lines connected respectively at a substantially fixed position near the bow and near the stern of the vessel, at least one of the anchor lines being connected to a substantially fixed-position pulling device for lengthening or shortening of the anchor line, and is characterised in that the pulling device can vary the length of the at least one anchor line such that both anchor lines are maintained in a tensioned state, and the vessel can weathervane around the bow anchor line or the stern anchor line.

The invention is based on the insight that during normal operating conditions, a vessel will be subjected to wind and wave directions which are more or less constant for larger time periods. During these substantially constant conditions, the vessel only needs to weathervane through a relatively small angle such as between 0° and 90°. For these conditions, by properly tensioning and slackening at least one of the anchor lines at the bow and stern of the vessel, an efficient and controlled weathervaning action can be achieved, without the need of a complex system of displaceable winches.

In one embodiment the pulling device, such as for instance a winch system, according to the invention var-

ies the length of the anchor lines simultaneously. Variation of the anchor lines can take place under the control of a mean position sensor which actuates the winch system on the basis of the mean position of the vessel, the wind or wave directions, etc. The change in one of the above environmental characteristics will change the control signal and hence the stiffness of the anchor line system.

Preferably each anchor line is connected to the pulling device via a sheave located generally at the centre line of the vessel. By the placement of the sheaves on the centre line of the vessel, a symmetric weathervaning action to both sides is achieved.

According to an embodiment of the vessel according to the present invention the anchor lines are connected to a single pulling device or winch. By operation of this single pulling device, bow and stern anchor lines can be simultaneously slackened or tightened to obtain a proper weathervaning position of the vessel. In one embodiment, a single anchor line passes from the bow, via the pulling device to the stern of the vessel, such that the length of the anchor line that is for instance taken in at the bow corresponds with the length of anchor line payed out at the stern.

By passing the anchor lines through a vertical shaft or hawser pipe extending from deck level to keel level, the sides of the vessel are easily accessible, and a shuttle tanker can be moored alongside the vessel according to the present invention without interference with the anchor lines.

By connecting at least one of the anchor lines below sea level to a counterweight, which in turn is connected to the seabed, the vertical arm of the weathervaning system can be adjusted and thereby the stiffness of the weathervaning system can be varied. Preferably the vessel according to the invention is connected to a subsea hydrocarbon structure via at least one riser. The riser is connected to the side of the vessel near midship where dynamic movements are minimum thereby increasing the longevity of these risers. The riser may pass through the vessel via the moonpool. As the movements of the vessel are limited to rotations of approximately 90 degrees, the risers also do not require complicated swivels at their attachment points as the riser itself can twist this angle.

Some embodiments of a vessel according to the present invention will be explained in detail, by way of example, with reference to the accompanying drawings. In the drawings:

Figure 1a shows a schematic side view of a vessel according to the present invention wherein the anchor lines are connected to the bow and the stern,

Figure 1b shows an anchoring arrangement according to figure 1 comprising buoyancy means,

Figure 2 shows a schematic side view in which the front most anchor line is connected to a pulling device, both front and rear anchor lines extending through a vertical shaft in the vessel,

Figure 3 shows a schematic side view of a vessel wherein the anchor lines at the bow and at the stern are mutually connected to a cable, the bow anchor line being connected to a winch,

Figure 4 shows a schematic side view of an embodiment of a vessel according to the present invention wherein each anchor line is connected to a separate winch,

Figure 5 shows a schematic side view of an embodiment wherein the anchor lines are connected to a single winch,

Figure 6 shows an embodiment wherein the anchor lines are passed through vertical shafts in the vessel,

Figures 7 and 8 show a schematic plan view of the vessel according to the present invention in different weathervaning positions, and

Figure 9 shows a schematic perspective view of the embodiment using a single winch and a single anchor line as shown in figure 8.

Figure 1a shows a vessel 1 which at its bow 2 and at its stern 4 is connected to anchor lines 3 and 5. The anchor lines 3 and 5 comprise a generally vertically extending section and two branching sections 11,11', 12,12' attached to the vertical parts.

In the embodiment of figure 1b, submerged buoys 13,14 are attached to the stern and bow anchor lines. By positioning of the buoys 13,14, the stiffness of the anchoring system can be varied.

In the embodiment shown in figure 2, the bow anchor line 3 is connected to a fixed position winch 6. Both stern and bow anchor lines are connected to counter weights 9 and 10. Each anchor line extends through a vertical shaft 19,20 extending from deck level to keel level. The vessel will weathervane around the anchor line which is stiffest. If both anchor lines have the same stiffness and the winch 6 pays out bow anchor line 3, the vessel will weathervane around the stern anchor line 5 because this anchor line is relatively stiffer than anchor line 3. In reverse, if winch 6 takes in bow anchor line 3, then the vessel will be weathervaning around anchor line 3 because this anchor line will be stiffer than the stern anchor line 5.

In the embodiment shown in figure 3, the bow anchor line and stern anchor line are mutually connected by a cable 13. By adjusting the length of the bow anchor line 3 by operation of the winch 6, the stern counter weights 9 will be lifted or lowered and the stiffness of the system will be varied for adjustment of the weathervaning action thereof.

Figure 4 shows a vessel 1 with at its bow 2 and its stern 4 respective winches 6,7. To each winch 6,7 an anchor line 3,5 is connected. The anchor lines 3,5 may be comprised of ropes, chains or cables. Each anchor line 3,5 in the present embodiment is connected to a

counterweight 9,10 which counterweight in turn is connected to the seabed by means of chains or cables 11,12. The stiffness of the weathervaning system according to the present invention may be adjusted by changing the weight of the counterweight 9 and 10 or by changing the length of the vertical arm (vertical part of the anchor line 3,5). The use of the counterweights 9 and 10 however is optional, and instead thereof buoys could be used as in figure 1b.

Risers 8 are connected near midship of the vessel 1, which risers are connected to a subsea oil or gas structure which is not shown in the drawings.

Figure 5 shows an embodiment wherein the anchor lines 3,5 are connected to a fixed position sheave 16,17 at the stern and bow of the vessel 1. The anchor lines are connected to a single winch 15 on the vessel 1.

In the embodiment of figure 6, each anchor line 3,5 is passed through a vertical shaft 19,20 extending from deck level to keel level through the hull of the vessel 1. In this way, the anchor lines 3,5 stay clear from the sides of the vessel and do not interfere with other vessels which need to moor alongside the vessel 1 according to the present invention.

As can be seen in figure 7, the sheaves 15 and 16 and the winch 15 are all located on the longitudinal centre line of the vessel 1. In this way, a symmetric construction is obtained and weathervaning to both sides of the centre line of the vessel can take place around the bow anchor line 3 or the stern anchor line 5. As can be seen from figure 4, in this embodiment each anchor line 3,5 is connected to the seabed by means of three chains or cables 11,11',11" and 12,12',12" which extend from the counterweights 9,10 to the seabed.

Figure 8 shows a situation in which the anchor line 3 at the bow is payed out and the anchor line at the stern is taken in, such that the vessel 1 will weathervane around the stern anchor line 5 in the direction of the arrow as indicated. In this construction it is possible to use a single anchor line for the bow and stern anchor lines 3,5, such that the anchor line which is payed out at the bow corresponds to the length of anchor line which is taken in at the stern, as shown in figure 6.

Claims

1. Vessel comprising at least two anchor lines (3,5) connected respectively at a substantially fixed position near the bow (2) and near the stern (4) of the vessel, characterized in that, at least one anchor line comprises a first line section extending to a connection point located below keel level of the vessel and at least two branching anchor lines, each connected with one end to the anchor line in the connection point and connected with the other end to the sea-bed.

2. Vessel according to claim 1, characterised in that, the anchor lines extend from their fixed position substantially vertically downward.

3. Vessel according to claim 1, characterised in that, a buoyancy means is connected to at least one anchor line at or near the connection point.

4. Vessel according to claim 2, characterized in that, at least one anchor line extends through a generally vertical shaft extending through the hull from deck level to keel level of the vessel.

5. Vessel according to claim 1,2 or 4, characterized in that, at least one anchor line is at or near the connection point connected to a ballast weight.

6. Vessel according to claim 1,2,3,4 or 5 characterized in that, both anchor lines are connected to respective branching anchor lines.

7. Vessel according to any of the previous claims, characterized in that, at least one of the anchor lines is connected to a pulling device for lengthening or shortening the anchor line, wherein the pulling device can vary the length of the at least one anchor line such that both anchor lines are maintained in tensioned state and the vessel can weathervane around the bow anchor line (3) or the stern anchor line (5).

8. Vessel (1) comprising at least two anchor lines (3,5) connected respectively at a substantially fixed position near the bow (2) and near the stern (4) of the vessel, at least one of the anchor lines (3,5) being connected to a substantially fixed-position pulling device (6,7,15) for lengthening or shortening of the anchor line, characterised in that, the pulling device (6,7,15) can vary the length of the at least one anchor line (3,5) such that both anchor lines are maintained in a tensioned state, and the vessel can weathervane around the bow anchor line (3) or the stern anchor line (5) by paying in or out at least one of the anchor lines.

9. Vessel according to claim 8, characterized in that, the pulling device is a winch system (6,7,15).

10. Vessel according to claim 8 or 9, characterized in that, each anchor line is connected to a pulling device.

11. Vessel (1) according to claim 8,9 or 10, characterised in that, the pulling device (6,7,15) varies the length of the anchor lines (3,5) simultaneously.

12. Vessel (1) according to claim 8,9,10 or 11, characterised in that, each anchor line (3,5) is connected to the pulling device (15) via a sheave (16,17) located generally at the centre line of the vessel (1).

13. Vessel (1) according to any of claims 8 to 12, characterised in that, the anchor lines (3,5) are connected to a single pulling device (15).

14. Vessel (1) according to claim 13, characterised in that, an anchor line extends from the bow (2) via the pulling device (15) to the stern.

15. Vessel (1) according to any of claims 8 to 14, characterised in that, the anchor lines pass (3,5) from the pulling device (15), through the hull of the vessel to a respective anchoring point.

16. Vessel (1) according to claim 15, characterised in that, the vessel is at least near its bow (2) or stern (4) provided with a generally vertical shaft (19,20) extending through the hull, at least one anchor line extending through the shaft (19,20).

17. Vessel (1) according to claim 16, characterised in that, the vessel comprises a shaft (19,20) near the bow (2) and near the stern (4).

18. Vessel (1) according to any of the claims 8 to 17, characterised in that, at least one of the anchor lines is connected below sea level to a counter weight (9,10), which in turn is connected to the seabed via at least one anchor line.

19. Vessel (1) according to any of claims 8 to 17, characterised in that, a buoyancy member is connected to at least one of the anchor lines.

20. Vessel (1) according to any of the previous claims, characterised in that, the vessel is connected to a subsea hydrocarbon structure via at least one riser (8).

21. Vessel according to any of the previous claims, characterised in that, the vessel does not comprise a turret structure.

Fig-1a

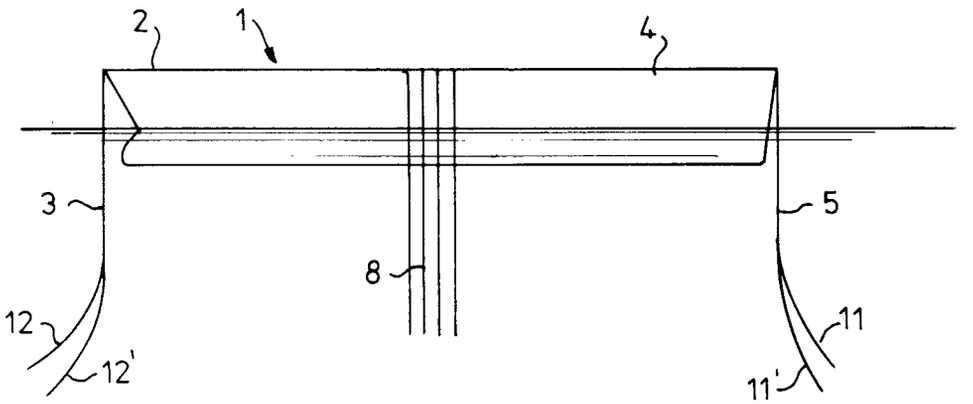


Fig-1b

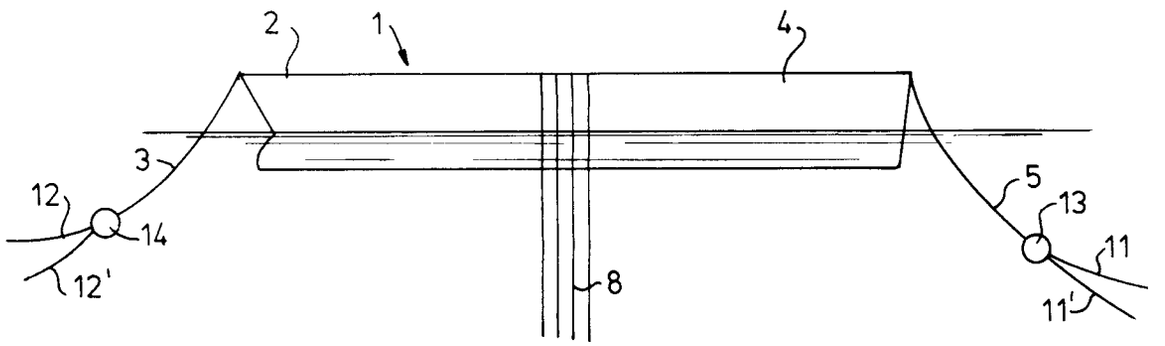


Fig-2

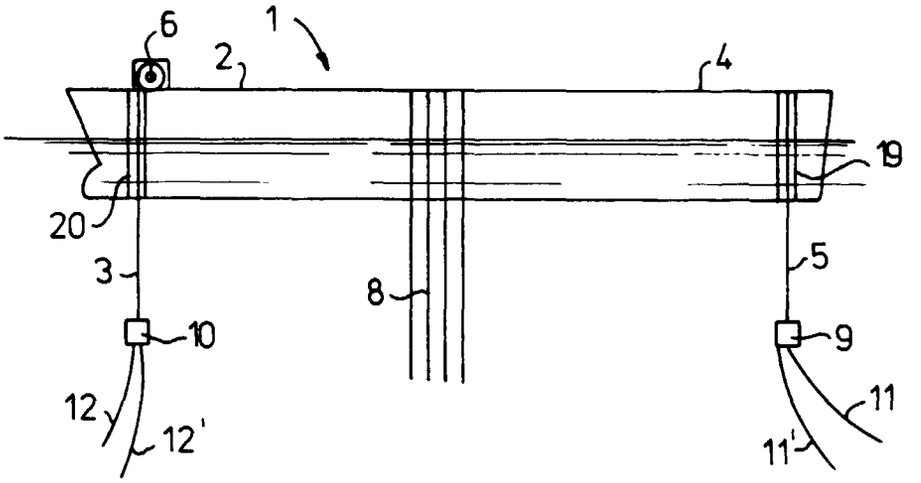


Fig-3

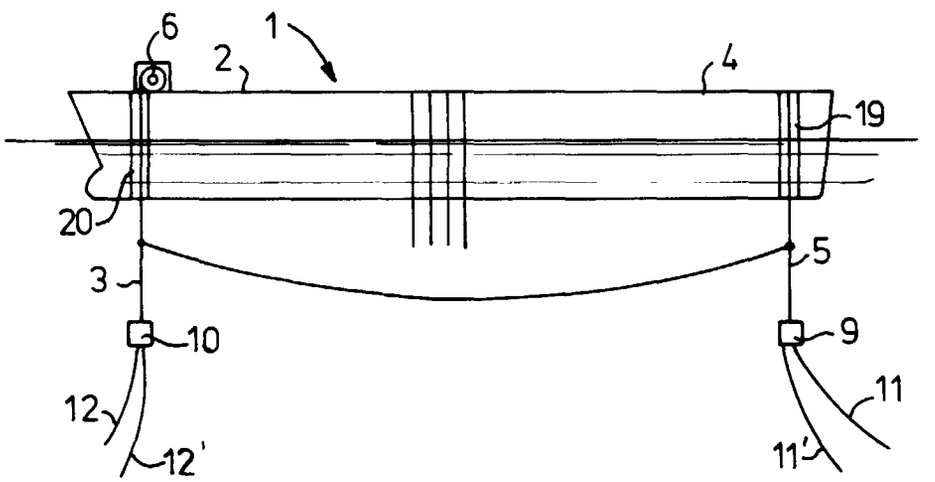


Fig-4

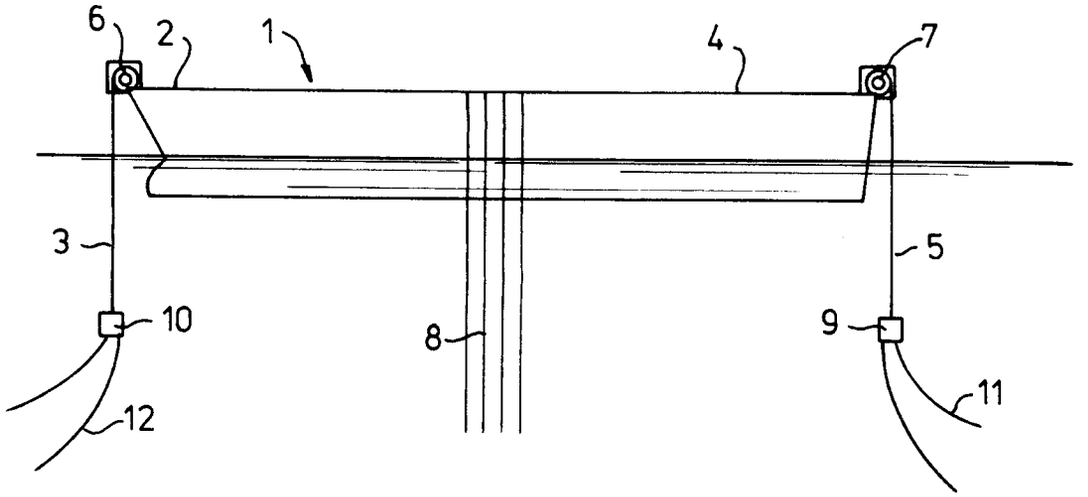


Fig-5

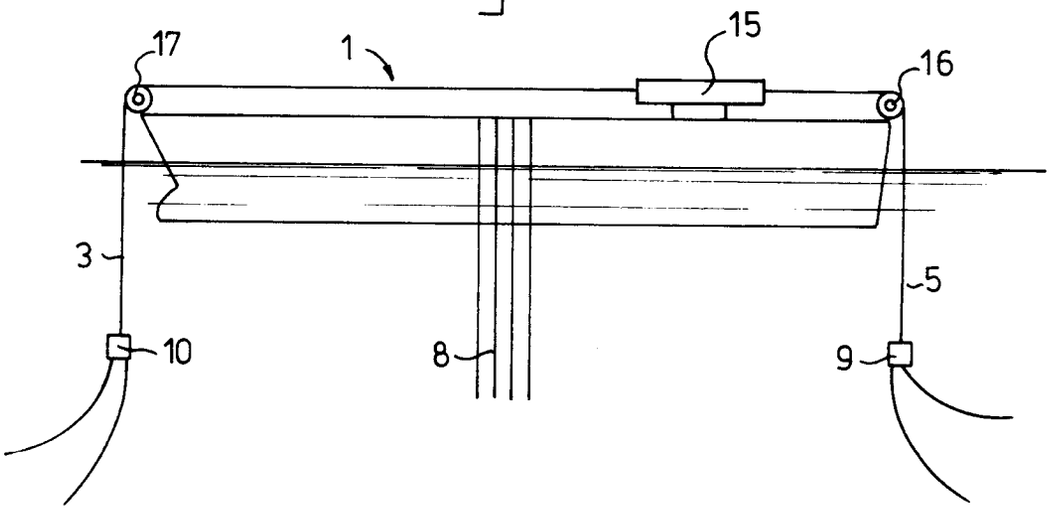


Fig-6

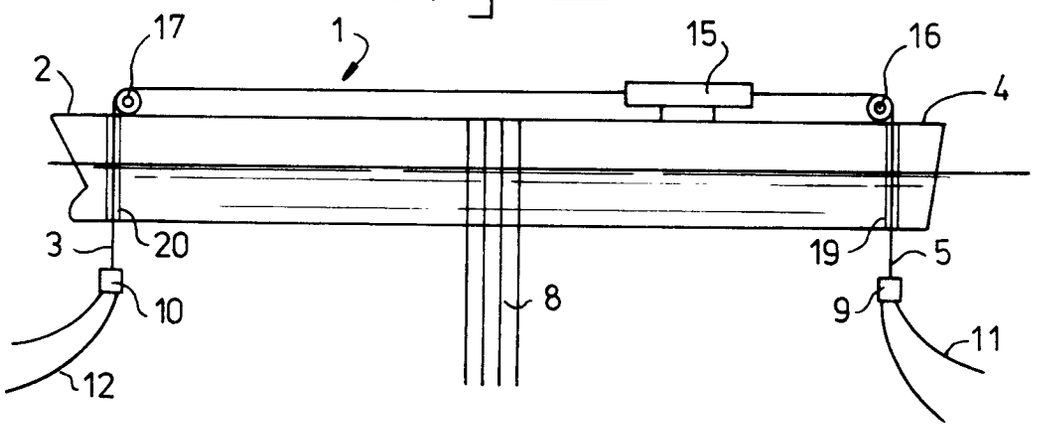


Fig-7

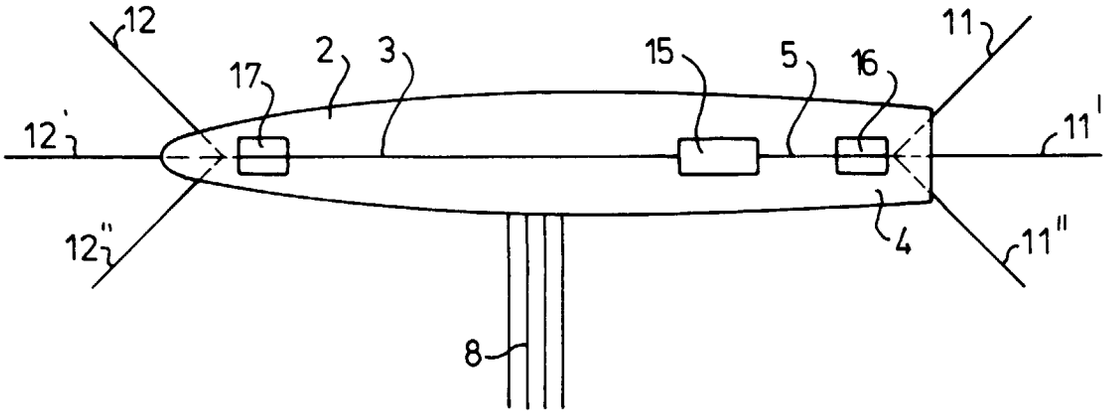


Fig-8

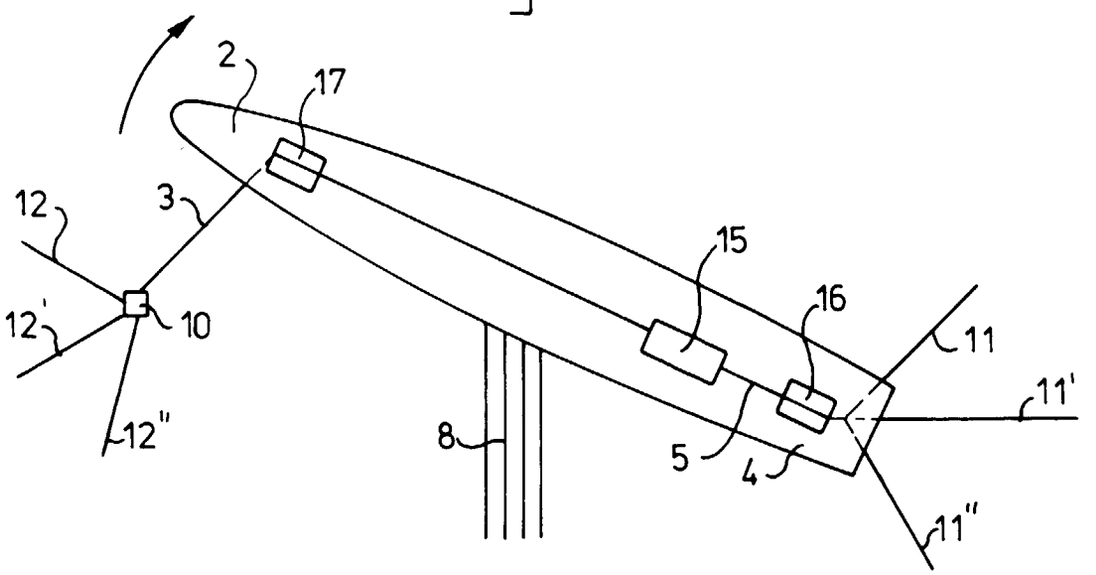
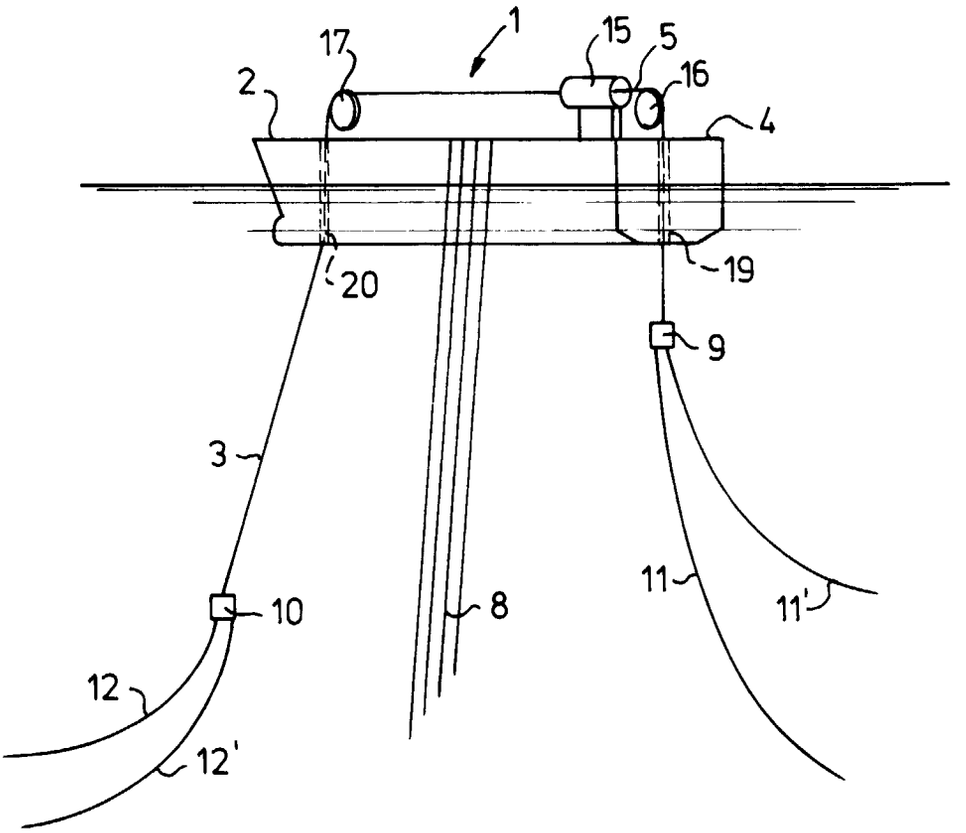


Fig - 9



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1995

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB 2 061 850 A (K.A. OVRETVEIT) 20 May 1981 * claims 1,8,13,14; figures 4-8 * * page 5, line 18 - line 74 * * page 6, line 31 - line 45 *	1,3,6,7	B63B21/50
Y		2,4,19, 21	
A		8-10	

Y	PATENT ABSTRACTS OF JAPAN vol. 10, no. 205 (M-500), 19 July 1986 & JP 61 049008 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD), 10 March 1986, * abstract; figures 2,5,7,11,12 *	2,4	
A		1,5,8, 15-18	

X	US 3 886 882 A (R.B. THORNBURG ET AL.) 3 June 1975 * claim 1; figure 1 * * column 1, line 47 - line 54 * * column 2, line 24 - line 43 * * column 3, line 25 - column 4, line 2 *	8-10, 15-17,20	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B63B
Y		11,13, 18,19,21	
A		1,4,7,12	

Y	DE 35 35 091 A (THYSSEN NORDSEEWERKE GMBH) 16 April 1987 * figure 8 * * column 5, line 55 - column 6, line 20 *	11,13	
A		8-10	

	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 October 1997	Häusler, F.U.

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

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1995

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 5, no. 65 (M-066), 30 April 1981 & JP 56 017782 A (PENTA OCEAN CONSTR CO LTD), 19 February 1981, * abstract; figures 1,6-8 *	18	
A		1,4,8, 15-17	
T	WO 97 23380 A (PERTRÓLEO BRASILEIRO S.A. - PETROBRAS) 3 July 1997 * the whole document *	1,7,8	
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 17 (M-109), 30 January 1982 & JP 56 135386 A (HITACHI ZOSEN CORP) * abstract *	8,10,13, 14	
A	GB 2 087 819 A (BLOHM & VOSS A.G.) 3 June 1982 * the whole document *	1,4	
A	FR 2 385 584 A (SOCIETE NATIONALE ELF AQUITAINE (PRODUCTION)) 27 October 1978 * figure 1 *	7-10,12	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US 3 138 135 A (R.M. LANGER) 23 June 1964		
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 411 (M-869), 11 September 1989 & JP 01 148688 A (SUMITOMO ELECTRIC IND LTD), 12 June 1989, * abstract *		
A	US 3 620 181 A (B.R. NACZKOWSKI) 16 November 1971		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 October 1997	Häusler, F.U.

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

EPO FORM 1503 03.82 (P04C01)