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

(11) Publication number: **0 105 976**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **82201300.9**

(22) Date of filing: **15.10.82**

(51) Int. Cl.³: **B 63 B 21/00**, B 63 B 27/34

(43) Date of publication of application: **25.04.84**
Bulletin 84/17

(84) Designated Contracting States: **BE DE FR GB IT NL SE**

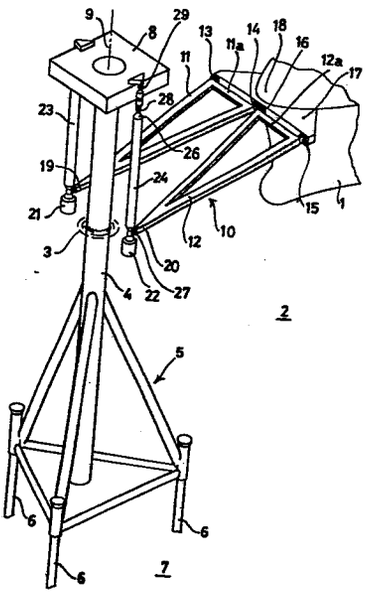
(71) Applicant: **Bluewater Terminal Systems N.V., Theaterstraat 17, Willemstad Curaçao Netherlands Antilles (NL)**

(72) Inventor: **Van Heijst, Willem Jan, 22 Route St. Barthelemy, CH-1700 Fribourg (CH)**

(74) Representative: **Timmers, Cornelis Herman Johannes et al, EXTERPATENT Willem Witsenplein 4, NL-2596 BK 's-Gravenhage (NL)**

(54) A single point mooring tower structure with rigid arm.

(57) The invention provides a permanent single point mooring structure in which the vessel (1) is moored to a single point mooring tower structure (4) via a rigid arm assembly (11, 12). The vessel (1) and rigid arm assembly (11, 12) are free to rotate about the vertical axis (9) of the tower structure (4). The rigid arm assembly (11, 12) is connected to the vessel by a hinge arrangement (13, 14, 15, 16) and to the turntable (8) of the tower structure by two tension members (23, 24). The rigid arm assembly (23, 24) is ballasted at the towerend (19, 20). These ballast weights (21, 22) provide a stable pendulum in combination with the tension members (23, 24). The weight of the rigid arm (11, 12) and its ballast (21, 22), and the loading on the tension members (23, 24) combine to produce a restoring force and moment which prevent the vessel (1) from moving away or from riding up to the tower structure (4), or jack-knifing of the assembly when the vessel (1) is affected by any combination of wind, waves and current.



EP 0 105 976 A1

0105976

A single point mooring tower structure with rigid arm.

The invention relates to a single point mooring structure for a vessel floating on the surface of a body of water and permanently to be moored to it. The single point mooring is a tower structure fixedly installed on the floor of the body of water, while the vessel is coupled to the tower by a rigid arm assembly which serves to hold the vessel away from the tower. This assembly is at one end pivotably hinged around a horizontal axis affixed to the bow of the vessel, and at the other end it is coupled to the tower structure in such a manner that the vessel is free to swing about the vertical axis of the structure by means of a turntable on top of the tower structure and two suspension members fixed to the rigid arm assembly. Normally, permanently moored vessels are fitted via a rigid arm to a buoy or a similar elastic point to allow for the independent motions of the vessel in the waves. It is, however, impossible to connect a vessel firmly to a tower structure by a rigid arm as this will result in extremely high forces.

It is the general objective of the present invention to provide a novel structure for anchoring a vessel on the

surface of a body of water to the floor of that body of water, which allows the maximum of freedom of motion between the tower structure and the vessel, and provides a sufficient restoring force and moment to restrict the horizontal displacement of the vessel and rigid arm in relation to the tower in all directions without any driving means and which will prevent collision between vessel and tower under any combination of wind, waves and current. This is achieved through the provision of a tower structure fixed to the floor of said body of water, the vessel to be connected to said tower by means of a rigid arm assembly which is connected at its vesselend in an "in principle" horizontally pivotable manner to the vessel, said tower structure having a turntable rotatable around a vertical axis and the rigid arm assembly being connected to said turntable by means of pivotable tension members which are attached to the tower-ends of the rigid arm assembly, the tension members being separated by a certain distance and the rigid arm assembly and/or the tension members being tensioned by means of ballast to provide an all-directional restoring force on the mooring system.

Since the tension members located at each side of the tower structure are pivotably connected to the turntable of the tower structure, the weight of the rigid arm assembly, including the ballast weights, provides a restoring force and a restoring moment when the vessel moves towards, away or out-of-line with the tower's central point. The restoring force is proportional to the weight of the rigid arm inclusive of its ballast weight, the sine of the angle of inclination from the vertical of the tension

members, and the length of the tension members. The value of the restoring moment is also proportional to the distance between the two tension members. The restoring moment can be altered by changing the length of the 'vertical' pivotable tension members, or by changing the weight of the rigid arm using ballast, depending on the demands imposed by the dimensions of the mooring arrangement, the expected weather and storm conditions, etc.

Preferably the rigid arm assembly consists of two triangular structures, each pivotally coupled with its basis to the vessel and with its apex to both a tension member and a ballast weight.

Additional improvements on the shear force levels in the rigid arm assembly can be obtained if the hinge axis of the two triangles forming the rigid arm assembly are slightly inclined towards each other, depending on the width of the vessel bow in relation to the diameter of the rigid structure.

The invention will be elucidated on the hand of the drawings.

Fig. 1 is a perspective view of a preferred embodiment of the mooring structure according to the invention;
Fig. 2 is a side view of part of said structure;
Fig. 3 is a plan view of part of said structure.

The figures show a vessel 1 floating upon a body of water 2, the surface of which is denoted by reference numeral 3. The vessel 1 is moored to a single point mooring structure comprising a tower structure 4 having a foundation

structure 5 anchored by means of one or more anchor piles 6 to the floor 7 of the water 2. The tower carries a turntable 8 which is free to rotate about its vertical axis 9. The mooring structure uses a rigid arm assembly 10 comprising two triangular structures 11, 12 each with their basis 11a, 12a respectively by means of hinges 13, 14 on the one hand and 15, 16 on the other hand connected to a supporting structure 17 carried by the bow 18 of the vessel 1. The axes of the hinges 11, 12 and 13, 14 are in principle horizontal.

The apexes 19, 20 of the structures 11, 12 respectively are connected to ballast weights 21, 22 and to tension members 23, 24 which are with their other ends 25, 26 connected to the turntable 8. These tension members can be chains but the figures show an embodiment in which they are tubular members and their interconnections comprise hinges of which only the hinges for tension member 14 are shown and denoted with reference numerals 27, 28, 29. Hinges 27 and 29 have horizontal, mutually parallel axes, the axe of hinge 27 is also horizontal but perpendicular to the other two.

The described arrangement allows for all movements of the vessel with respect to the tower structure and produces a restoring force and moment preventing the vessel from moving away or from riding up to the tower structure or from jack-knifing. The shearforce levels in the rigid arm assembly can be lowered by inclining the axes of the hinges 13, 14 on the one hand and 15, 16 on the other hand slightly towards each other, depending on the width of the vessel.

It is observed that the reference numerals in the claims are not intended to restrict the scope thereof, but are only denoted for clarification.

0105976

Claims:

1. Structure for mooring a vessel (1) floating on the surface of a body of water (2), comprising a tower structure (4) fixed to the floor (7) of said body of water (2), the vessel (1) to be connected to said tower (4) by means of a rigid arm assembly (11, 12) which is connected at its vesselend in an "in principle" horizontally pivotable manner (13, 14, 15, 16) to the vessel (1), said tower structure (4) having a turntable (8) rotatable around a vertical axis (9) and the rigid arm assembly (11, 12) being connected to said turntable (8) by means of pivotable tension members (23, 24) which are attached to the towerends (19, 20) of the rigid arm assembly (11, 12), the tension members (23, 24) being separated by a certain distance and the rigid arm assembly (11, 12) and/or the tension members (23, 24) being tensioned by means of ballast (21, 22) to provide an all-directional restoring force on the mooring system.

2. Structure according to claim 1, characterized in that the rigid arm assembly consists of two triangular structures (11, 12), each pivotally coupled with its basis (11a, 12a) to the vessel and with its apex (19, 20) to both a tension member and a ballast weight.

3. Structure according to claim 2, characterized in that the hinge axis of the two triangles (11a, 12a) forming the rigid arm assembly are slightly inclined towards each other, depending on the width of the vessel bow in relation to the diameter of the rigid structure.

0105976

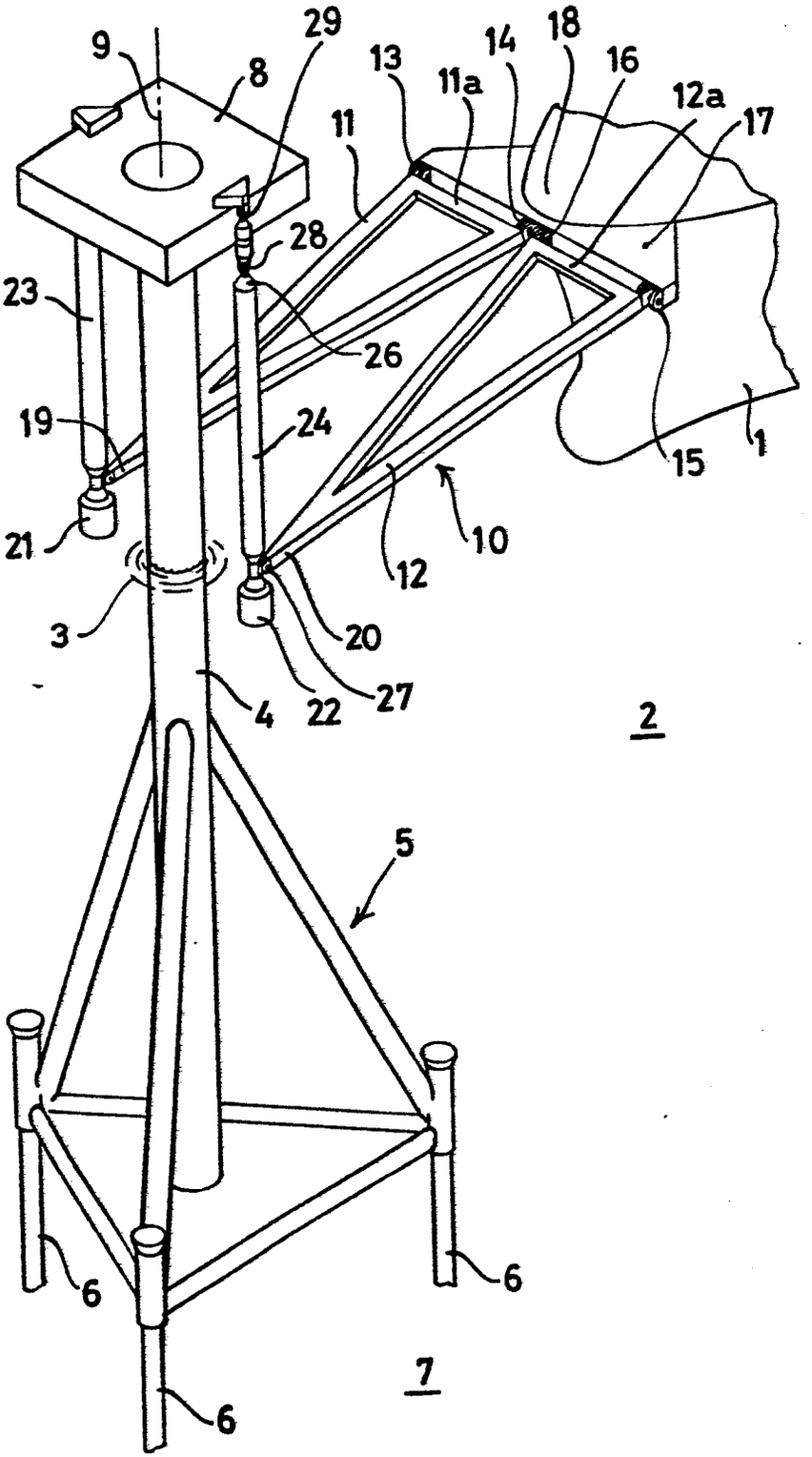


Fig. 1.

0105976

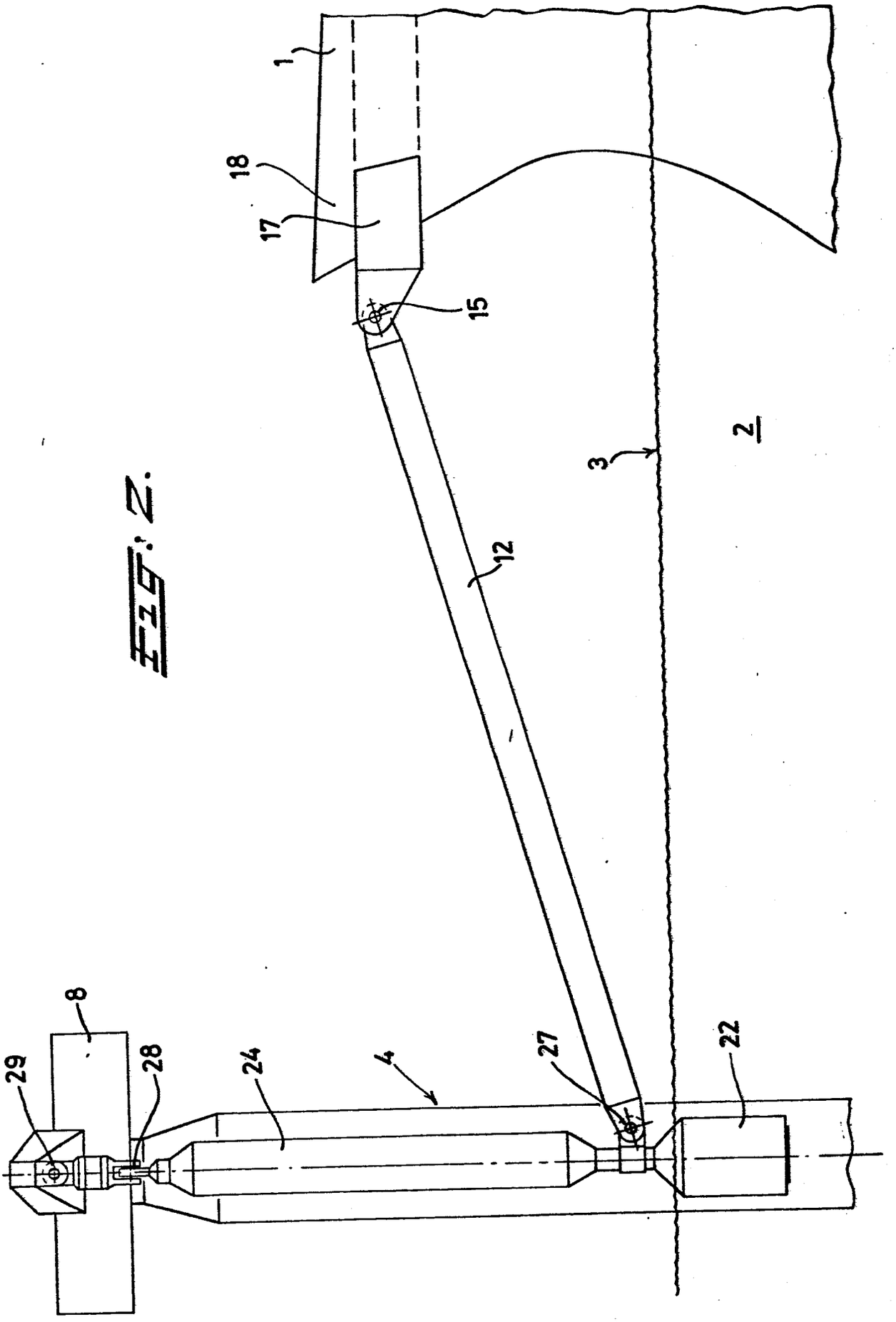


FIG. 2.

0105976

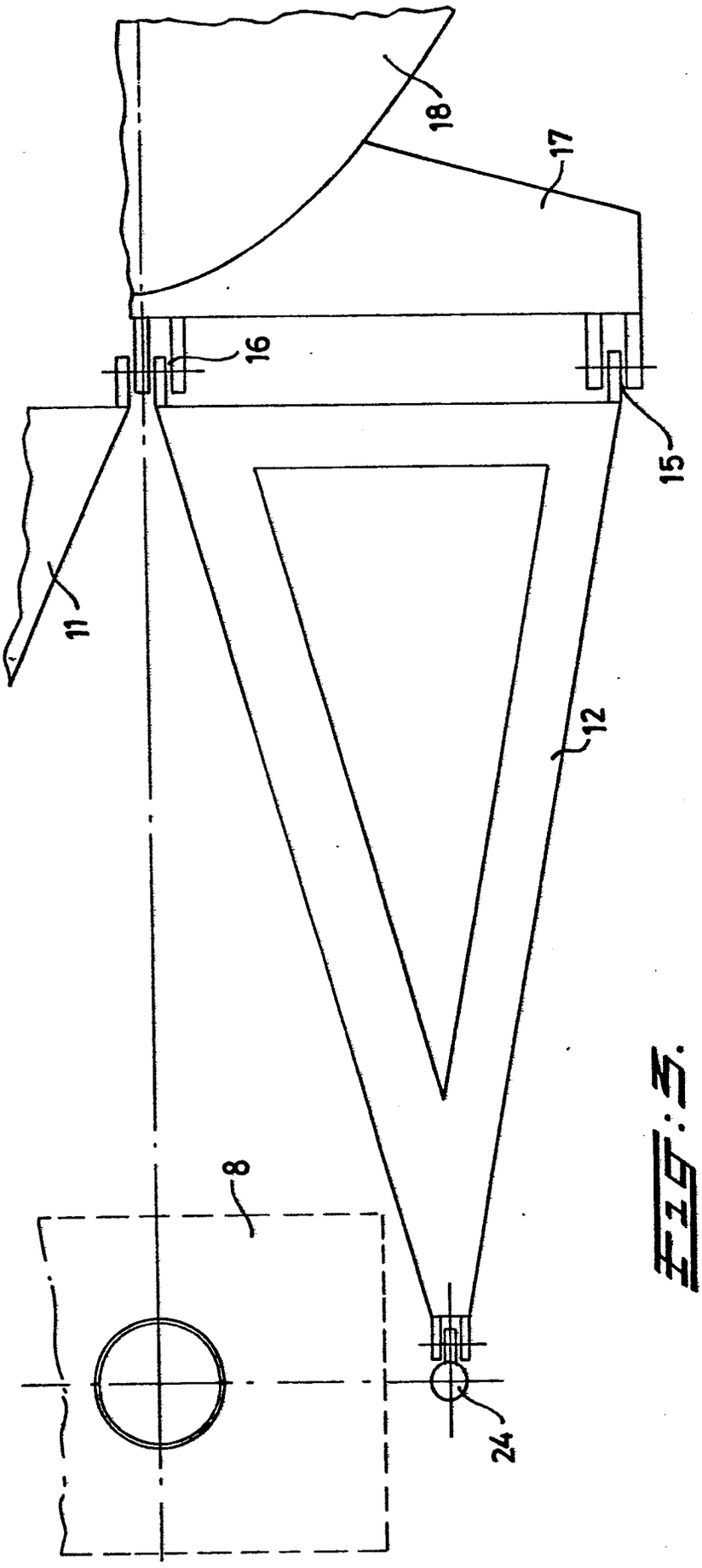


FIG. 3.

European Patent Office

EUROPEAN SEARCH REPORT

0105976
Application number

EP 82 20 1300

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. ³)
X	FR-A-2 420 475 (E.M.H.) * Page 3, line 17 - page 4, line 29; figures 1,2 *	1	B 63 B 21/00 B 63 B 27/34
A	NL-A-8 202 335 (SINGLE BUOY MOORINGS INC.)		
A	NL-A-8 202 334 (SINGLE BUOY MOORINGS INC.)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

B 63 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-06-1983	DE SCHEPPER H.P.H.

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