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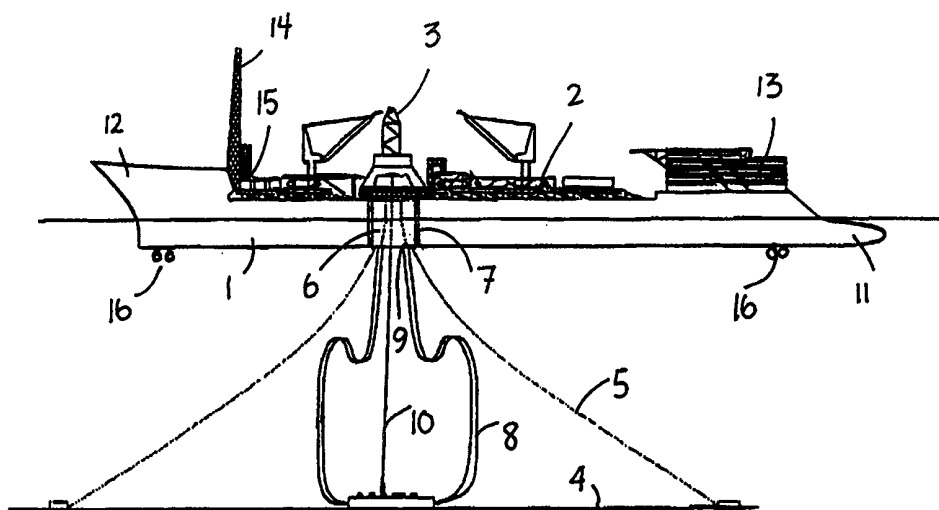
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(54) Title: SURFACE VESSEL



(57) Abstract

A vessel (1) for carrying out operations such as offshore drilling and production is designed having two bows (11 and 12). The ship has a vertical aperture or well (7) and supported therein a rotating part (6) which can be anchored to the seabed (4) by means of mooring lines (5), so that the rotating part (6) becomes a geostationary component. The well (7) and the rotating part (6) are located eccentrically relative to the centre of the vessel and furthest from the bow (11) which during normal operations will face into the wind and weather. If the weather conditions exceed a certain limit, the vessel (1) can be turned 180°, with the other bow (12) designed as a storm bow, facing into the wind and weather.

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SURFACE VESSEL

- The invention relates to a surface vessel for exploiting natural resources below the seabed, which vessel includes a geostationary moorable rotating part which is pivotally supported about a vertical axis in a vertical aperture or well in the vessel and dynamic positioning means for holding the vessel in a desired directional orientation, and which has equipment for establishing a rigid, heave-compensated string connection between the rotating part of the vessel and the seabed, in particular a drill string.
- Hydrocarbon recovery from floating structures (floaters) is well known today. Such floaters may be in the form of ships or semi-submersible units. The first known floaters were barges which were moored by a plurality of anchors to the seabed from where drilling operations were conducted. Gradually, as deeper waters were explored, equipment was developed making it possible to drill despite the motions of the vessel.
- In areas of the world with harsher climates, it is in practice virtually impossible to lie at anchor with a fixed directional orientation, because wind and current at times straight from the side produce forces which far exceed the capacity of the mooring, not to mention the problems due to the rolling of the vessel. On the basis of this, turret-based mooring and drilling on drill ships was introduced some time ago, thereby enabling the vessel to turn with the direction of the wind. This made it possible to use drill ships in areas where weather conditions were considerably more severe. However, it was found that drill ships with turrets (as they are known in offshore terminology) had their limitations, and as time went by problems were experienced in offering a regularity of the drilling operation which could match up to what had gradually been achieved on semi-submersible platforms. This was due primarily to the substantial motions of the ship in the sea. Nevertheless, in recent years ships equipped with turrets for mooring and risers have been put into service as platforms for offshore process plants, with great cost savings in comparison with semi-submersible platform solutions. This is due to the fact that riser solutions in connection with turrets have gradually become so good (flexible risers) that the motion of the vessel has not caused any particular problems. Furthermore, the majority of production ships are of such a size that they move relatively little (100000 tdw and over). When it comes to carrying out drilling operations from such ships as an additional function, this has been regarded as somewhat problematic, as for obvious reasons the drilling operations must be carried out on and/or through the turret. Even with today's relatively large vessels (L=200m to 300 m), these ships and the turret arrangements are constructed in such manner that at

some times of the year (e.g., in the North Sea) there will be too great a heave motion to allow such a ship-based solution to be used.

In the offshore industry it is normally accepted that a ship's hull with a normal turret location (in front of $L_{pp}/2$) will provide little regularity with a geostationary turret as a drilling platform. The main reason for this is the heave motion. Satisfactory regularity means that it must be possible to compensate heave of up to 25 m to be able to be in communication with the seabed in storm conditions. The known turret location in the forward half of the ship is due to it being desirable to obtain a stable or assisted (active propeller system) weather cock effect. The main reason why the ship's hull with the aforementioned normal turret location provides little regularity as a drilling platform is the extreme motions in the turret, primarily generated by the ship's heave motion combined with pitch motion. Great distance from the pitch axis (the axis is in proximity to midship) to the turret location is a major reason for the overall motion. On a number of ships this distance is as much as 70 to 80 m, and this means that in some cases the turret may move 50% more than the wave height. An optimal position of the turret with regard to motions is the midship area. Moving further astern will lead to a cancellation of motion in the heave/pitch interplay which results in smaller motions than amidships. A complex interplay is involved here, where factors such as the ship's length, the bow design, the position of the centre of gravity etc. play a part.

One of the objects of the invention is to achieve greater regularity for operations requiring a rigid string connection, heave compensated in the longitudinal direction, between the turret and the seabed, in particular drilling operations.

This is achieved by designing the vessel so that it can be operated in two operational modes. In the case of an oil drilling vessel, this means that the vessel can be provided with a drilling mode in which the vessel is oriented "back-to-front", with the turret astern of $L_{pp}/2$. This will give a gain in heave response, resulting in greater regularity. Owing to the turret location, the ship will be directionally unstable, but the directional orientation is maintained with the aid of a dynamic positioning system. If the weather conditions exceed a given limit, the drilling operation can be temporarily interrupted and the ship switched to a stormy weather mode where the turret will be in front of $L_{pp}/2$, thereby obtaining greater directional stability.

Thus, according to the invention there is proposed a surface vessel for exploiting natural resources under the seabed, which vessel includes a geostationary moorable rotating part

which is pivotally supported about a vertical axis in a vertical aperture or well in the vessel, and dynamic positioning means for holding the vessel in a desired directional orientation, and which has equipment for establishing a rigid, heave compensated string connection between the vessel's rotating part and the seabed, in particular a drill string, which surface vessel is characterised in that the vessel has a bow structure at both ends, and that the well and rotating part are positioned eccentrically relative to the longitudinal centre of the vessel.

This makes it possible to operate the vessel in two modes, i.e., an operational mode with smaller heave in the turret and a second mode which gives an improvement in directional orientation. In this second mode seabed operations are interrupted temporarily, and, if necessary, the string connection is broken if the heave motion exceeds the telescopic capacity of the heave compensator.

Based on the ship size that is used today as production ships (100000 dwt and over), the invention initially provides a basis for drilling which far outclasses the drill ships that have been used earlier. Pure drill ships of this size have not been of interest earlier, since the costs of a large hull and the turret arrangement would go far towards giving excessively high costs. However, the invention makes possible the use of such large production ships also as combined production and drill ships.

It is especially advantageous if the surface vessel according to the invention is designed to have a fair weather mode and a storm mode. This is achieved in that the bow closest to the well or turret is designed as a storm bow.

It is particularly advantageous if the living quarters on the vessel are located in the bow area which is furthest from the well/rotating part. Such location of the living quarters is favourable for several reasons. In the so-called drilling mode or fair weather mode, the living quarters will be well in front of (upwind of) the turret or the drilling. If, as a result of an accident, there is burning oil on the sea surface, it will be relatively easy to turn the vessel in such direction as to ensure that life boats which are launched do not drift straight into the burning oil on the sea surface.

In extreme weather, the vessel will be switched to the storm mode or extreme weather mode. The said location of the living quarters will then be optimal with respect to comfort and the possibility of launching life boats in storm conditions.

It is especially advantageous if the bow which is furthest from the well/rotating part is designed as a submersed bulbous bow. When the vessel is in operation, a special bow design of this type will give a reduced pitch motion.

- 5 It is particularly advantageous if the vessel has azimuth thrusters in both bow areas.

It is particularly advantageous if the part of the vessel's hull that is closest to the well/rotating part is full, whilst the other hull part of the vessel is lean. In this way, the location of the centre of gravity can be affected favourably with a view to the
10 heave/pitch interplay, where, as mentioned, the centre of gravity plays a part. In the fair weather mode, there will be a lean "foreship" and a full "stern". "Full" and "lean" are terms that are well known to naval architects. The purpose of a full and a lean hull portion is, as mentioned above, to ensure that the displacement buoyancy centre is in the part of the hull where the well is located.

15

It is especially advantageous if the surface vessel according to the invention has a second through-going aperture or well in the vessel. This well can then be used as a service well, i.e., that service operations can be carried out on the seabed through the well, for example, in connection with positioning or parking safety valves, wellhead
20 Christmas trees etc., without there being any need to clear the turret or moonpool of equipment for drilling (e.g., several hundred metres of riser), which takes place through the rotating part. A service well of this kind will also be favourable in connection with any work or operations in connection with the production which is to take place parallel with the drilling through cable risers which run from the seabed up to the vessel via the
25 rotating part. The use of the service well may be hindered to a certain extent by mooring lines and/or flexible risers, as the ship must maintain the same direction whilst the operation takes place.

The invention will now be explained in more detail with reference to the drawings,
30 wherein:

Fig. 1 is a schematic sectional elevation of a surface vessel according to the invention;
Fig. 2 shows a second possible surface vessel according to the invention, in schematic sectional elevation;

35 Fig. 3 shows a vessel as in Fig. 2; and

Fig. 4 is a plan view of a vessel as in Fig. 2.

Fig. 1 shows a vessel 1 which carries a process plant 2 and a drilling package 3. The vessel 1 is anchored to the seabed 4 by mooring lines 5. The mooring arrangement is attached to a turret 6 which is located in the vessel 1, in a vertical aperture or well 7. The drilling package 3 is placed on the turret 6 or straddling it. Flexible risers 8 pass
5 from the seabed 4 up to the vessel 1. Through these flexible risers oil and gas can be passed from the seabed to the vessel through the turret 6 and a system not shown in any detail which transfers the oil and/or gas from the turret 6 to the vessel's 1 deck. Such transfer systems may include swivels or so-called drag chains and involve what in the eyes of the skilled artisan is prior art.

10

In the centre of the turret 6 there is an opening 9, a so-called moonpool, through which drilling operations can be carried out with drilling package 3. A drill string with surrounding risers is indicated by means of the reference numeral 10.

15 The vessel 1 has a bow structure 11 at one end and a bow structure 12 at the other end. The turret is located closer to the bow 12 than to the bow 11. In Fig. 1 the bow 12 is designed as a storm bow, i.e., a bow which is proportioned for extreme storm conditions (usually 100 year storm conditions). The bow 11 is designed as a submerged bow which gives reduced pitch motions. The vessel 1 has living quarters 13 in proximity to
20 the bow 11. The process plant 2 has a flare tower 14 at a good distance from the living quarters. The main power plant 15 (for process) is also located close to the bow 12.

The turret 6, including mooring lines 5, drilling package 3 and the risers 8, is to be understood as geostationary in normal operation. The drilling package may also be
25 supported by the ship's deck and only operate through the turret. The vessel 1 is equipped with automatic propeller systems 16 which in combination with the mooring arrangement, i.e., the mooring lines 5, will be capable of holding the vessel 1 into the wind and weather.

30 The vessel 1 can be operated in two modes.

1. Operation, with the bow 11 facing into the wind and weather. This is a mode with reduced vessel motions in the vessel's turret area - the turret 6 is located astern of the vessel's centre. Typically, drilling, well maintenance or, for example, installation of
35 equipment on the seabed 4, can be carried out in this mode.

2. Extreme operation, with the bow 12 facing into the wind and weather. This mode is selected when mode 1 is not desirable, and, e.g., ordinary production is in progress, but no drilling, or when an excess of the weather condition for mode 1 is highly probable. The operations, such as drilling, are then terminated and the vessel 1 is
5 put into mode 2 to ride out the storm. A total failure of power for the propeller system may also cause the vessel 1 to pass from mode 1 to mode 2 as a result of the natural directional stability the vessel has in mode 2, where the turret 6 will be located in front of the centre of the vessel.

10 The dynamic positioning means 16 are proportioned to hold the bow 11 into the wind until a specified state of the sea, whereafter the choice can be made in a controlled manner to turn the ship 180° so that the bow 12 comes into the wind. With the storm bow 12 facing into the wind and weather, the vessel will be designed for extreme storm conditions (100 year storm conditions).

15 Fig. 2 shows a vessel 17 with a bow structure at each end. One of the bows 18 is designed as a storm bow, whilst the other bow 19 is designed as a normal bulbous bow. A rotating part 21, geostationary with the aid of mooring lines 20, is pivotally supported in a well 22 in the vessel 17. A heave compensated string 23 runs down into the sea
20 through the rotating part 21. Between the rotating part 21 and the seabed, not shown in Fig. 2, there run flexible risers 24.

In addition to the well 22, the ship 17 has an extra service well 25 through which it is possible to pass a string 26 up and down, and for example, carry out work or operations
25 on the non-illustrated seabed.

Living quarters 25 are located in the area close to the bow 19. The ship 17 has positioning/driving means 28 in the form of azimuth thrusters.

30 The vessel 17 operates in the same modes of operation as the vessel 1 in Fig. 1, with the bow 19 facing into the wind and weather in operational mode 1 (fine weather mode), with the well/rotating part 22, 21 located astern of the centre of the vessel. The storm bow 18 is brought into the wind and weather according to need, in the same way as the bow 12 in the embodiment in Fig. 1.

35

In Fig. 2 the drilling package, process plant etc. are not shown.

It will be appreciated that the invention provides a vessel which is operable with a high degree of regularity for drilling operations, which vessel can at the same time be used for production and storage and also service operations (through the well 25). It is not shown, but a person versed in the art will understand that the hull of the vessel can be designed to have a lean "foreship" and full "stern". The terms "foreship" and "stern" refer here to the ship's directional position in mode 1, with the well/turret placed astern of the centre of the vessel. The invention makes possible an optimal drilling/production ship which will have a regularity that is fully comparable with today's semi-submersible drilling platforms.

10

A turret located astern (mode 1) will relieve the stresses in the midship. A midship bending moment is generally a problem when there are large openings for a turret. The location of the living quarters on production ships is the subject of much discussion. Some people prefer a location at the back (downwind), others prefer a position in front (upwind). The disadvantage of a rear position is that any explosion and subsequent fire in a downwind position is disastrous with regard to safety. On the other hand, it is a preferable location with a view to launching the lifeboats (drift away from the vessel). The forward location is better as regards safety, but will be dangerously close to turret drilling, and could present major problems as regards launching the lifeboats. In addition, it may be mentioned that the forward location is not very comfortable in bad weather. The proposed vessel according to the application has living quarters in the bow in mode 1 - operation, i.e., upwind at some distance from the turret/drilling, i.e., a good starting point for safety. If it is required to launch lifeboats, it will be relatively easy to let the ship turn in a direction so that the lifeboats do not drift straight into possible burning oil on the sea surface. In extreme weather the vessel will be switched to mode 2 - extreme. The location of the living quarters according to the invention will then be optimal as regards comfort and the possibility of launching lifeboats in storm conditions.

Fig. 3 shows a favourable distribution of various types of units and packages on a ship according to the invention, of the type shown in Fig. 2.

The vessel 17 has a bow 18 designed as a storm bow, whilst its other bow 19 is designed as a normal bulbous bow. As in Fig. 2, a geostationary rotating part 21 is pivotally supported in a well 22 in the vessel 17, and an extra service well 25 is provided close to the well 22.

As in Fig. 2, living quarters 27 are arranged at the area close to the bow 19. Then, in the direction towards the bow 18, there follows a power plant 29, a drilling package 30, a process plant 31 and a flare tower 32.

- 5 The service well 25 helps considerably to increase the possible applications of the vessel. Fig. 4 is a plan view of the vessel 17 in Fig. 2, with the same reference numerals.

The anchor lines 20 are arranged so that a large sector 33 is kept free, where desired
10 operations can be carried out through the service well.

P a t e n t c l a i m s

1.

A surface vessel for exploiting natural resources beneath the seabed, which vessel (1; 5 17) has a bow structure at both ends and includes a geostationary moorable rotating part (6; 21) which is pivotally supported about a vertical axis in a vertical aperture or well (7; 22) in the vessel (1) located eccentrically relative to the longitudinal centre of the vessel, and also dynamic positioning means (16; 28) for holding vessel (1; 17) in a desired directional orientation, and which has equipment (3) for establishing a rigid, 10 heave-compensated string connection (10; 23) between the vessel's rotating part (6; 21) and the seabed (4), in particular a drill string, characterised in that the bow (12; 18) closest to the well/rotating part (7,6;22,21) is designed as a storm bow, i.e., a bow which is proportioned for extreme storm conditions (usually 100 year storm conditions), and that the vessel (1; 17) has azimuth thrusters (16; 28) in both bow areas.

15

2.

A surface vessel according to claim 1, characterised in that the part of the hull of the vessel which is closest to the well (7; 22) is full, whilst the other hull part of the vessel is lean.

20

3.

A surface vessel according to claim 1 or 2, characterised in that living quarters (13; 27) are located in the bow area (11; 19) furthest from the well/rotating part (7,6;22,21).

25 4.

A surface vessel according to claims 1 to 3, characterised in that the bow (11) that is furthest from the well/rotating part (7,6) is designed as a submerged bulbous bow with a substantial amount of displacement before or in the immediate vicinity of the start of the water line.

30

5.

A surface vessel according to claims 1 to 4, characterised by a second through-going well (25) in the vessel (17).

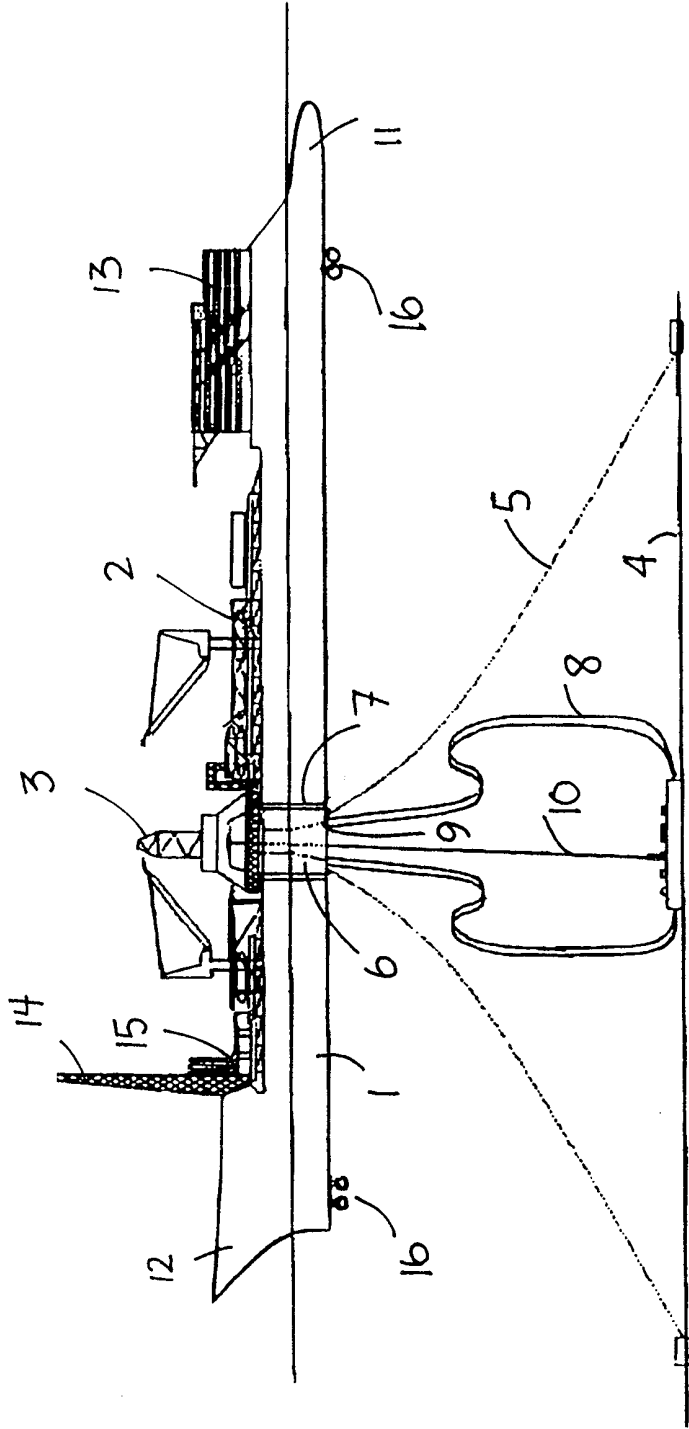


FIG. 1

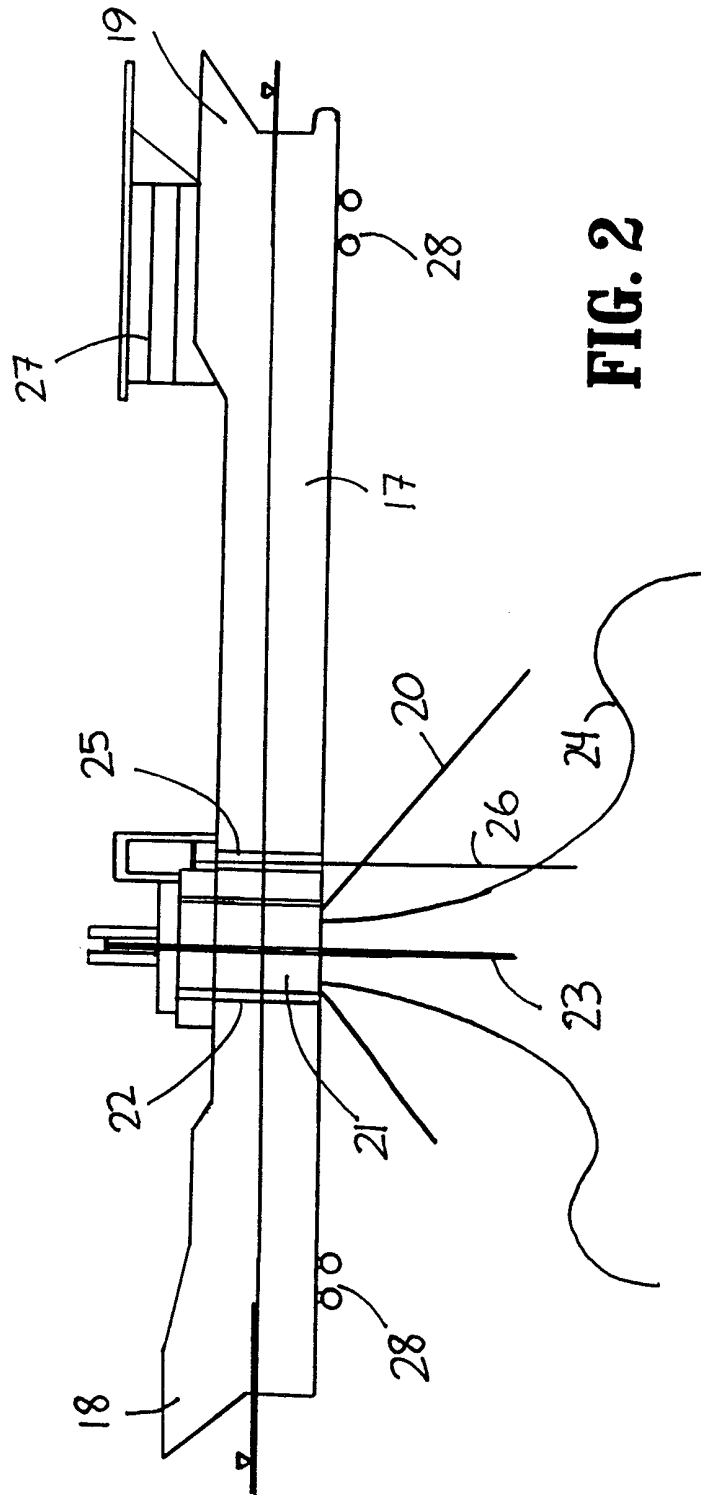


FIG. 2

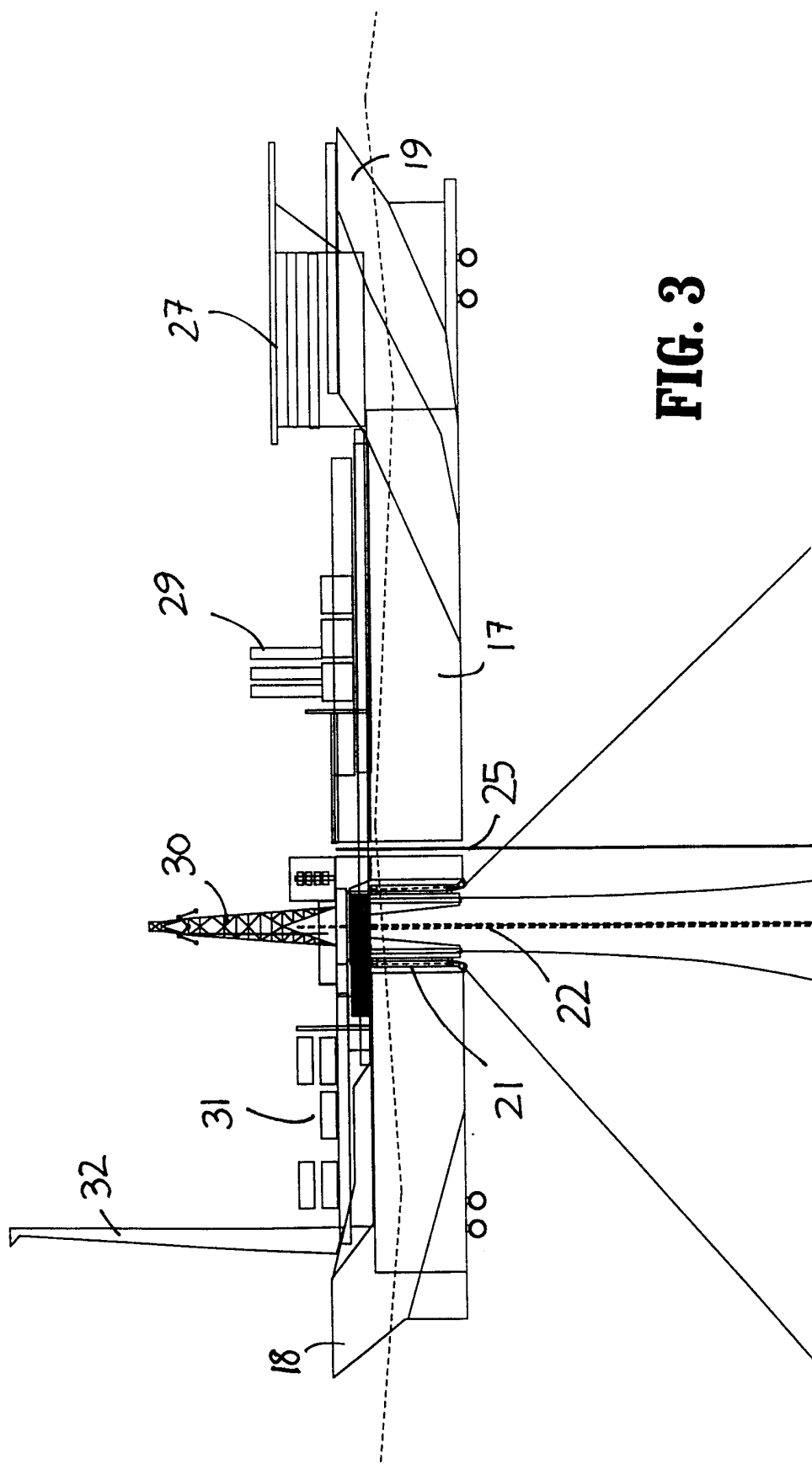


FIG. 3

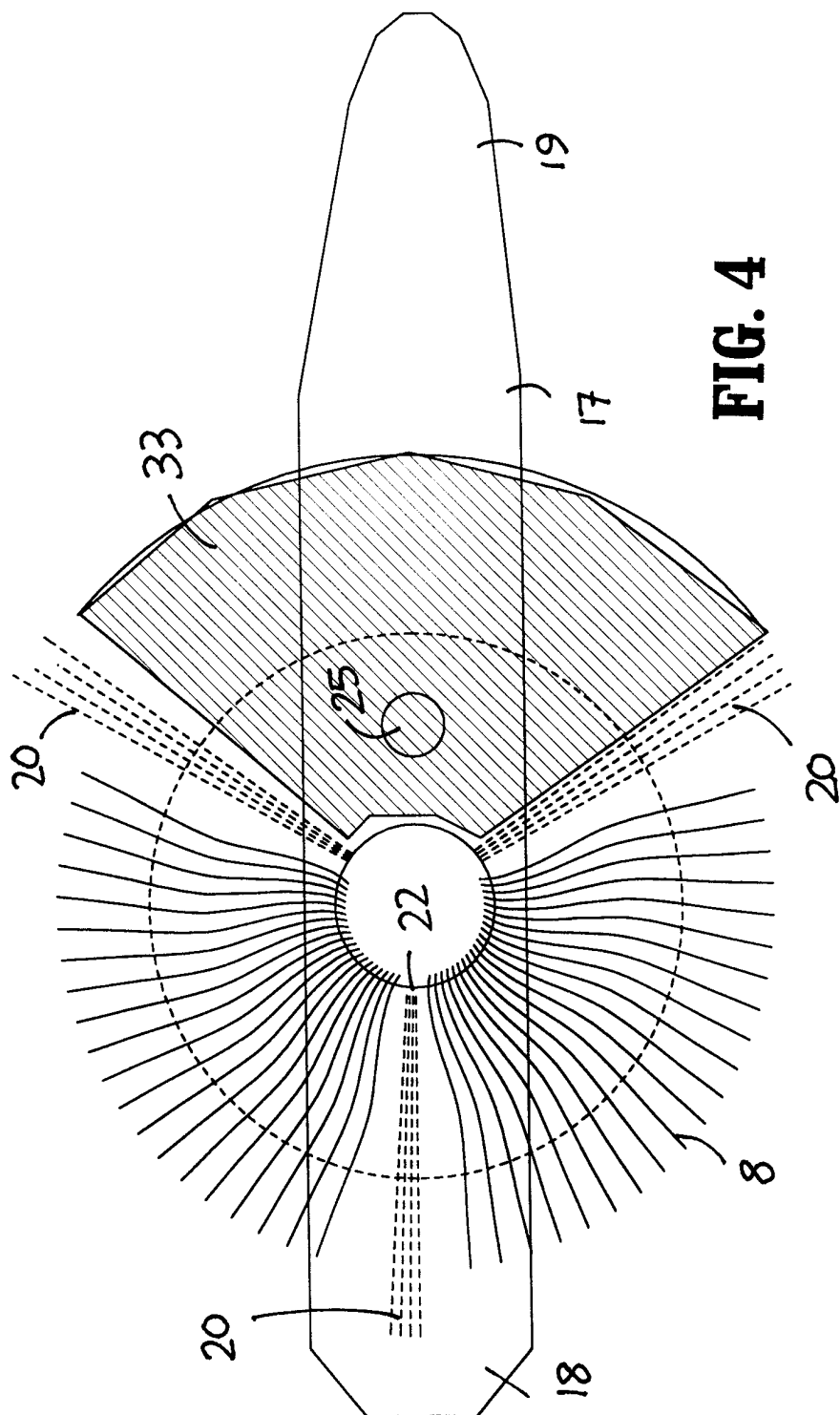


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 98/00069

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B63B 21/50, B63B 22/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4509448 A (PEASE ET AL.), 9 April 1985 (09.04.85) --	1-5
A	US 4519728 A (OSHIMA ET AL.), 28 May 1985 (28.05.85) --	1-5
A	US 4604961 A (ORTLOFF ET AL.), 12 August 1986 (12.08.86) --	1-5
A	EP 0656293 A1 (IMODCO, INC.), 7 June 1995 (07.06.95), figure 2 -- -----	1-5

☐

Further documents are listed in the continuation of Box C.

☒

See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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