

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 0 916 006 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

29.10.2003 Bulletin 2003/44

(21) Application number: **96928044.5**

(22) Date of filing: **02.08.1996**

(51) Int Cl.7: **E02B 17/00**

(86) International application number:
PCT/US96/12639

(87) International publication number:
WO 98/005825 (12.02.1998 Gazette 1998/06)

(54) **TLP TENSION ADJUST SYSTEM**

SPANNUNGSREGELUNG FÜR EINE PLATTFORM MIT SPANNBEINEN

SYSTEME DE REGLAGE DE LA MISE EN TENSION D'UNE PLATE-FORME A JAMBES DE
TENSION

(84) Designated Contracting States:
FR GB NL

(43) Date of publication of application:
19.05.1999 Bulletin 1999/20

(73) Proprietor: **IMODCO, INC.**
Calabasas Hills, California 91301-5359 (US)

(72) Inventor: **POLLACK, Jack**
Calabasas Hills, CA 91301 (US)

(74) Representative: **Hackney, Nigel John et al**
Mewburn Ellis,
York House,
23 Kingsway
London WC2B 6HP (GB)

(56) References cited:

GB-A- 2 099 894	US-A- 4 060 995
US-A- 4 861 196	US-A- 4 913 238
US-A- 5 277 521	US-A- 5 439 321
US-A- 5 480 264	

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 916 006 B1

Description

BACKGROUND OF THE INVENTION:

[0001] One method for developing and producing hydrocarbons from deep water oil fields, is to provide a fixed platform. Such fixed platforms may have drilling equipment as well as hydrocarbon processing equipment (e.g. to separate stones, sand, etc. from hydrocarbons, separate gas from oil, and burn or reinject gas). However, in deep waters such fixed platforms are enormously expensive, with costs sometimes exceeding one billion dollars.

[0002] A lower cost approach for developing and producing from deep undersea oil fields, involves the use of a TLP (tension leg platform). A large platform floats at the sea surface and is anchored by a group of tendons that extend vertically to the seafloor. The tendons are under high tension, produced by the large buoyant platform, which results in very little drift of the platform. As wells are drilled and fluid-carrying risers are connected between the seafloor well and the platform, such risers must be placed in tension to prevent them from repeatedly scraping against one another or a tendon. Present platforms are massive, with presently installed TLP's having a net displacement of between 20,000 tons and 300,000 tons (40,000 kips to 600,000 kips, where kips stands for thousands of pounds, or 18,000 MT to 540,000 MT where MT stands for metric tons), with the tendons producing perhaps one-quarter of the platform displacement (e.g. 5,000 to 75,000 tons, or 4500 to 68000 MT). The net weight of the platform out of the water may be at least 65% to 80% of the rest of the displacement. Such large TLP's carry substantially the same type of equipment as a fixed platform, including hydrocarbon processing equipment and permanent quarters for a crew to service the various equipment. Such TLP systems may include perhaps twenty wells, and perhaps twenty corresponding fluid-carrying risers which must be tensioned.

[0003] The tension for fluid-carrying hydrocarbon-producing risers may be perhaps 100 tons (91 MT) each, which is much less than 1% of prior total platform displacement (at least 20,000 tons = 18,000 MT). A complement of 20 risers results in an additional downward force of perhaps 2,000 tons (1800 MT) on the platform of the TLP system, which is no more than 10% of the platform displacement. Such relatively small riser-caused load on a prior platform may be ignored, or may be taken by an initial slightly increased tendon load. Thus, when the risers are added, perhaps one at a time or in groups of a few, there is not much effect on the system, and the system need not be compensated as risers are added. However, such systems are still expensive (even though less than a fixed platform), and a system which was of much less cost than existing TLP systems, would be of considerable value.

[0004] US 4,913,238 shows a floating/tensioned pro-

duction system for use in deep-water drilling and production operations generally combining a relatively small tension leg platform with a semi-submersible platform. The semi-submersible platform is provided with a working deck supported above the water surface so that an air gap exists between the working deck and the water surface. The tension leg platform provides a heave-restrained production deck for near surface wellhead equipment. The production deck is supported above the drill site but beneath the water surface by buoyancy members and held in place by one or more letters.

SUMMARY OF THE INVENTION

[0005] In accordance with the present invention, a TLP (tension leg platform) system and method for operating such system are provided, according to claims 1 and 7. The platform may have a relatively small displacement such as 6,000 tons (5500 MT), and be anchored with correspondingly lightweight tendons which apply a load such as 1,200 tons (1100 MT). As a result, the load applied by a full complement (e.g. 20) of risers is significant, as it may amount to perhaps 2,000 tons (1800 MT), which is more than 20% and usually more than 30% of the total platform displacement. Each riser may apply a load such as 100 tons (91 MT), which is more than 1% of the total platform displacement. Applicant compensates for the load applied by each additional riser, by initially establishing the platform with flooded buoyancy chambers, and by adding buoyancy when each riser is attached, to compensate for the riser-added load. The platform may carry a drill/workover rig that can be moved to different locations. Buoyancy can be added to where the rig is moved and reduced from where the rig was moved, to avoid over and under tensioning of tendons and risers.

[0006] The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is an isometric view of a TLP (tension leg platform) of the present invention, showing one of the risers being installed, and also showing a maintenance boat.

FIG. 2 is an isometric view of the platform of the system of FIG. 1.

FIG. 3 is a partial section side view of the system of FIG. 1, showing how the buoyancy of the platform is changed.

FIG. 4 is an enlarged view of a portion of FIG. 3, showing a hydrocarbon production tree thereof.

FIG. 5 is a sectional view of a tendon and of a riser

of the system of FIG. 1.

FIG. 6 is a side elevation view of an oil production complex which includes the system of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] FIG. 1 illustrates a TLP (tension leg platform) system 10 which includes a platform 12 that floats at the sea surface 14 and which is anchored largely by groups of tendons 16. The tendons extend substantially vertically from each of four corners 21 - 24 of the platform down to the seafloor 26. The tendons are connected to a template 30 that is anchored to the seafloor. The particular system includes twelve tendons arranged in groups of three at each of the corners of the platform and of the template. The template has wellhead couplings 32 arranged at the sides of the square template 30, to which risers such as 34 are connected. The system is initially setup as shown in FIG. 1, with only the tendons 16 extending down to the seafloor. Wells 31 may be drilled in the seafloor through the wellhead couplings 32, and risers such as riser 34 are then installed, which have lower ends 36 connected to the seafloor at the template 30, and upper ends 38 coupled to the platform. Both the platform and template are of substantially rectangular shape as seen in a plan view.

[0009] As shown in FIG. 3, the upper end 38 of the riser 34 extends through an aperture 40 in the lower portion 42 of the platform, through the water line or sea surface 14, and to an upper part 44 of the platform which lies above the sea surface. A hydrocarbon production tree 50 is mounted on the upper portion 44 of the platform to lie above the sea surface. As shown in applicant's FIG. 4, the tree 50 has various valves such as 52, 54 and pipe couplings, where well effluent can be removed for processing, and through which gas might be reinjected, control signals (in the form of fluid pulses) can be delivered to downhole equipment to operate a valve thereat, etc.

[0010] It is important that the risers 34 and tendons 16 be kept under a substantial tension, so they cannot whip about and strike one another. Tension in the risers is established by a rig 150 (FIG. 1). After a riser is tensioned, a stopper 56 (FIG. 4) thereafter maintains the tension. The tendons are tensioned by deballasting the TLP (by pumping air into water-filled chambers) when the TLP system is initially installed.

[0011] Applicant constructs the platform 12 (FIG. 1) so it is of relatively light weight and correspondingly small displacement, with the particular platform shown being designed for a working displacement of 6,000 tons (12,000 kips or thousands of pounds, or 5500 metric tons = 5500 MT). The term "working displacement" means the weight of water that is displaced by the platform in use. Applicant uses tendons 16 which are of relative low tension capacity, with their preferred tension under quiescent conditions being about 150 tons (140 MT) each. The result is that the total quiescent down-

ward force of the twelve tendons is about 1,800 tons (1600 MT). The riser tension is considerable as compared to platform displacement and tendon total tension, in that total riser tension (of twenty risers) is more than 20% of platform displacement, and more than 20% of total tendon tensions, so the tension in each riser is at least 1% of platform displacement and total tendon tension.

[0012] With each riser 34 being designed for a quiescent tension of 100 tons (91 MT), the total tension applied by all twenty risers would be about 2,000 tons (1800 MT), which is a very significant portion (about one-third) of the total downward force of 6,000 tons (5500 MT) on the platform 12. The total downward force of 6,000 tons on the platform may include a total weight of the platform in air, of 2,200 tons, plus 1,800 tons in tendon tension, plus 2,000 tons of riser tension (when all 20 risers are installed). Thus, the downward force that would be applied by all risers (of 2000 tons) is at least about equal to the downward force (of 1800 tons) applied by all of the tendons. The platform may have a width, length, and height, that are each about 30 meters, and is designed for installation in a deep sea (usually a plurality of hundreds of meters) that may have a depth on the order of 1,000 meters. Under severe storm conditions, the tendon tension may more than double to 300 tons or more per tendon.

[0013] Although the system shown in FIG. 1 can produce from up to twenty wells, it is common to drill and install only one or a few wells at a time, and to operate the system for an extended period before additional wells are added (if ever, depending on production rates achieved and other matters). As mentioned above, the additional downward load on the platform 12, that is added when each riser is installed, is substantial (over 1% of total platform displacement). If a group of risers are added, which each apply a load of 100 tons on the platform, this will result in a corresponding decrease in loading of the tendons and existing risers. When starting with no risers, the addition of a riser would result in under-tensioning (e.g. from 150 tons to 142 tons for one riser and to 100 tons for 6 risers) of the tendons so the tendons may repeatedly go slack and cause riser failure in a storm. It would be possible to retension the tendons whenever a group of risers were installed, but retensioning is time consuming and costly. Also, whenever a new group of risers were added, the old risers as well as all tendons would have to be retensioned, which would be very time consuming. It is noted that if one or a few risers were attached to only one of the four sides 81 - 84 (FIG. 2) of a platform, more tension would have to be added to the tendons on the same side of the platform as the risers. The wide variation in downward load on the platform, between a situation where only one or a few risers were connected as compared to a situation where all twenty risers were connected, also would result in some change in depth of submersion of the platform.

[0014] Because of the light weight of the tendons, it

is not practical to initially overtension them, so that when risers were added the tendon tensions would drop close to the ideal. That is because overtensioned tendons might fail. For example, in order for the twelve tendons to return to a quiescent tension of a total of 1,440 tons (1300 MT), or 120 tons (110 MT) each (only 20% below the ideal of 150 tons) after all twenty risers were installed, the tendons would have to be initially set at a tension of 287 tons each (a total of about 3,440 tons which is 91% over the ideal) and would be overtensioned in event of a storm. In a small prior art platform of 20,000 tons displacement, with an ideal tendon tension of 10,000 tons, the tendons could be initially tensioned at 11,000 tons (10% over ideal). When twenty risers (2,000 tons total tension) were added, the net tendon tension would fall to only 9,000 tons (10% below ideal). 90% of ideal tension does not substantially affect performance.

[0015] In accordance with an aspect of the invention, applicant changes the buoyancy of the platform 12 whenever a group of risers are added. As shown in FIG. 3, the TLP is provided with multiple buoyancy chambers such as 90, 92, and 94, which may be initially flooded with water, so that an imaginary water line 96 on the platform lies at sea level 14 when all tendons are attached and properly tensioned, but no riser has been installed. When a group of risers (which includes one or more risers) is installed and tensioned, and the platform tends to move down in the water (and the tendon tension tends to decrease) applicant adds buoyancy to the platform. (It is noted that the buoyancy can be added before or even during riser tensioning.) An air pump 100 pumps air (or other gas such as nitrogen) through a valve and pipe 102 to one of the compartments or buoyancy chambers 94. The compressed air at 103 in the chamber, causes water 104 in the chamber to be expelled through a vertical pipe 106 into the sea. Thus, all chamber connections are above water level, even for chambers that lie completely underwater, which assures that a chamber will not be flooded if a valve malfunctions. The water level in the chamber is recorded by a calibrated pressure gauge 108. Air is pumped until the weight of expelled water approximately equals the tension load (e.g. 100 tons = 91 MT) added to the platform by the properly tensioned riser. As a result of the buoyancy adjustment, the level of platform submersion will remain constant and the tension in the tendons will remain constant. Thus, no retensioning of the tendons is required and the platform remains at a constant desired level of submersion which will keep the trees 50 above water (for easy servicing) while maintaining only a moderate profile for low wave response.

[0016] The pump 100 is preferably brought to the platform on a relatively small boat by a crew that is not quartered on the platform (although a temporary emergency shelter can be provided). The boat also can bring the rig to the platform. By avoiding permanent quarters (beds, cooking and entertainment facilities, etc.), the platform

can be made relatively small and cheap.

[0017] Since one or a few risers may be added to only one side of the platform, applicant prefers to add buoyancy to only that side of the platform to maintain a more constant tendon tension. Accordingly, applicant may add buoyancy to a pair of chambers 94, 110 which lie at opposite ends of the same side 82 of the platform. The platform includes numerous chamber spaced about the axis 109 of the platform, including a plurality of completely underwater chambers stacked one on another. This facilitates compensation for riser tension that avoids tilt of the platform.

[0018] FIG. 2 shows that the particular platform 12 has six apertures such as 40A - 40F at each side such as 82. A maximum of five is used, with the sixth used if one of the others cannot be used. The platform has three apertures such as 116A - 116C at each corner such as 22, where tendons will lie.

[0019] FIG. 5 is a sectional view of one tendon 16 and of one riser 34. A common tendon size has an outside diameter D of about 33 cm (13 inches) while a common riser size has an outside diameter of about 26 cm (9 5/8 inch). One or several fluid-carrying pipes such as 112, 114 may lie within the riser 34 to actually carry fluid. The rest of the inside of the riser normally contains air or nitrogen, as does the inside of the tendon 16, to provide buoyancy that counteracts the weight of the steel. Although prior risers might be of the same diameter as riser 34, prior tendons used in TLP systems were typically of greater diameter than risers 16 and/or more of them were used.

[0020] In FIG. 3, the riser 34 bends about the bottom of the tree for up to 0.8° of platform deviation from its quiescent position. Between 0.8° and 5° of deviation, an upper crossload bearing 111 presses against the walls of aperture 40, and riser bending occurs immediately below bearing 111. Between 5° and maximum deviation (perhaps 8° in a severe storm), riser bending occurs at a lower crossload bearing 113. The tendons each bend about a joint 115 that is also at the bottom of the platform, so the tendons and risers remain parallel for large platform drift.

[0021] The tendon 16 of FIG. 5 of diameter D of 13 inches (33cm) has a cross-sectional area of steel of 17.3 inches² (112cm²), while the riser 34 of 9 5/8 inch (24.4cm) diameter has a cross-sectional area of steel of 11.45 inches² (74cm²). It is desirable to maintain the steel in each tendon and riser at the same unit tension stress level, of about 19,200 psi (132 MPa). For a sea depth of 1,000 meters, such equal stress (per unit cross-sectional area) results in an elongation of 2.2 feet (0.67 meter) for each. Applicant prefers to maintain the strain (elongation) and therefore the stress per unit area, of the tendons and risers within 20% of each other, and more preferably within about 10% of each other in the quiescent position of the platform, so the strain is about equal under severe storm conditions and the mooring load is shared by tendons and risers.

[0022] As shown in FIG. 2, the platform 12 includes four vertically extending corner columns 116, 117, 118 and 119 lying at the corners of an imaginary rectangle (which is preferably substantially a square). Four horizontal beams 121, 122, 123 and 124 each connect the lower ends 125 of a different pair of columns. Each of the columns and beams 116-119 and 121-124 has an average width W of a plurality of feet (e.g. 7 meters), with the particular columns and beams shown having an average width of over one meter, and all form at least one chamber which can hold water or air to change the ballast condition of the platform. A beam structure 126 comprising multiple steel beams (none forms a hollow water-filled chamber), connects the upper ends 127 of the columns. Each column such as column 116 shown in FIG. 3 has a plurality of vertically spaced chambers with a horizontal separating wall 128. The separating wall is part of the column structure. The use of a plurality of vertically-spaced columns avoids large platform tilt if one of the chambers develops a leak.

[0023] FIG. 6 shows an oil production complex 130 which includes the system 10 of FIG. 1. Oil passing up through the risers 34 and into the trees on the platform 12, is gathered and passed through pipes lying within a conduit 132 that extends to a large vessel 134. The large vessel 134 may be a tanker with large oil-storing capacity, and which also has hydrocarbon processing equipment 136, permanent (nonemergency crew quarters where personnel stay for many days under normal operating conditions), offloading equipment for transferring oil to other tankers, life boats, etc. If the platform has any hydrocarbon processing equipment, it is minimal in that the mass of processing equipment on the vessel is at last 5 times as great. The vessel supports a turret 140 that can remain stationary (not rotate much, but only drift) while the vessel weathervanes around it, and the vessel is moored by catenary anchor chains 142. The anchor chains allow the vessel to drift only a moderate amount such as 300 meters. The platform 12 lies in water having a depth of 1,000 meters and the space between the vessel 134 and platform is at least 500 meters. It is noted that the fluid conduit 132 includes two sections, With a buoy 144 connecting them.

[0024] Systems for anchoring large vessels such as 134 while allowing them to drift, are of only moderate cost. Applicant's TLP system 10 is of relatively small size, so it is also of moderate cost. Servicing of the platform 12 is done by relatively small boats 146 carried by crew members stationed on the vessel 134. Such crew members may carry air pumps and various equipment for maintaining parts of the system 10, and also serve to operate a tender assisted workover rig 150 which can carry out well completion, workover and re-drilling. The rig 150 can be shifted around the TLP on skids, which is well known to the industry. Fig. 2 shows the drilling rig shifted away from the center (axis 109 in Fig. 3) of the platform to lie over one of the apertures (40A-40F). For some systems, it is possible to remove the rig when a

storm approaches. By minimizing equipment on the fixed platform 12, where the cost for the platform and anchoring equipment is relatively high, and placing such equipment on the weathervaning vessel 134 where the cost of supporting such equipment is relatively small (especially because it is already large enough to store oil), applicant minimizes the cost of the entire complex 130. Of course, in some installations, the conduit 134 can extend to shore and the crew is quartered on shore.

[0025] The rig 150 has considerable weight (e.g. 400 tons = 360 MT, which is at least 5% of tendon and riser tension). As a result, when the rig is moved from a first location on the platform to a primarily horizontally spaced second location, such movement could overtension tendons and risers whose upper ends lie near the first location and undertension tendons and risers at the second location. Applicant compensates for the change in center of gravity (and center of buoyancy) caused by such movement by reducing buoyancy at the previous rig location (by admitting water into buoyancy chambers near the previous rig location) and/or by adding buoyancy at the new rig location (by removing water from buoyancy chambers near the new rig location). This is because tension elements (tendons and any already-installed risers) are spaced about the platform axis 152, and such compensation minimizes changes in tension of such tension elements due to such rig movement.

[0026] Thus, applicant provides a relatively low cost-TLP system. This is accomplished by using a relatively small platform and relatively light duty tendons that hold it in place, together with moderately large risers (requiring moderately large tension) which may be connected singly or in small groups, with the system designed to operate for indefinite periods and even in storms, between riser additions. The platform is provided with buoyancy adjusting means in the form of chambers which are initially flooded but which can be partially or completely filled with gas instead of water to increase platform buoyancy. Such ability to increase platform buoyancy in steps, allows applicant to easily adjust for the additional tension produced by the addition of each riser. This allows for the use of a relatively light weight platform and relatively light weight tendons, which greatly reduces the cost of the system. The light weight platform preferably has only minimal equipment, including a tree for each riser, possibly a mount for holding a derrick, and minimal couplings and piping.

Claims

1. A tension leg platform system which includes a platform (12) that floats at the sea surface and that has a vertical axis (109), a plurality of tendons (16) extending down from said platform to the seafloor (26) and anchored thereto, and a drilling rig (150) that lies on said platform said platform having means (50, 56) for attaching up to a predetermined maxi-

mum number of risers, and including a plurality of risers (34) each extending down from said platform to the seafloor and anchored thereto, with said tendons and risers each being held under tension which produces downward forces on said platform that are countered by displacement of said platform, **characterized in that:**

said drilling rig has a weight of at least 5% of the tension of said tendons and risers and can be shifted horizontally about said platform; said platform has a small enough buoyancy and said tendons have enough tension, that the combined downward force that would be applied by said tendons and said predetermined number of risers to said platform is at least 20% of the working displacement of said platform; and said platform has a plurality of adjustable buoyancy chambers (90, 92, 94) spaced about said vertical axis and apparatus (100, 106) for controlling the buoyancy of said chambers to maintain approximately constant tendon tension in all of said tendons when said drilling rig is shifted.

2. The system described in claim 1 wherein:

said platform has a horizontal width and a horizontal length, said drilling rig is horizontally moveable away from a position over said axis, and said buoyancy chambers are adjustable for said movement of said rig to avoid changes in tendon tension.

3. The system described in claim 1 including:

said platform includes four vertical corner columns (116, 117, 118, 119) having upper (127) and lower (125) end portions, a structure (126) that connects said upper end portions together with said drilling rig moveably mounted on said structure, and four horizontal beams (121, 122, 123, 124) connecting together said lower end portions of said columns, with each of said columns and each of said beams having at least a portion of one of said buoyancy chambers.

4. The system described in claim 3 wherein:

a plurality of said beams has a least one aperture (40, 40A-40F), with said drilling rig being shiftable to move it over any one of said apertures.

5. The system described in claim 3 wherein:

said columns and said beams each have at

least portions of adjustable-buoyancy chambers (90, 92, 94), whose buoyancy can be adjusted to compensate for changes in the tensions of said tendons resulting from shifting of said drilling rig.

6. A method for operating a tension leg platform (10) that has an axis (109), a drilling rig (150) that is horizontally shiftable on said platform, a plurality of adjustable buoyancy chambers spaced about said axis, and a plurality of tendons and at least one riser all extending vertically from said platform to the sea bed and anchored to the sea bed, comprising:

shifting said drilling rig horizontally on said platform, and adjusting the buoyancy of said chambers to maintain a substantially constant tension in said tendons and said at least one riser.

7. The method described in claim 6, wherein:

said platform has a plurality of apertures (40A-40F) horizontally spaced from said axis, said drilling rig is moveable to lie over a selected one of said apertures, and said step of adjusting includes adding water to at least one of said buoyancy chambers to reduce its buoyancy and blowing out water to add buoyancy to another of said buoyancy chambers.

Patentansprüche

1. Trossenverspanntes Bohrplattformsystem, das eine Plattform (12), die auf der Meeresoberfläche schwimmt und eine vertikale Achse (109) aufweist, eine Vielzahl von Vorspanngliedern (16), die sich von der Plattform zum Meeresboden (26) hinunter erstrecken und dort verankert sind, sowie einen Bohrturm (150) umfasst, der auf der Plattform liegt, wobei die Plattform Mittel (50, 56) aufweist, um bis zu einer maximalen Anzahl von Steigleitungen (34) zu befestigen, und eine Vielzahl von Steigleitungen (34) beinhaltet, die sich jeweils von der Plattform zum Meeresboden hinunter erstrecken und dort verankert sind, wobei die Vorspannglieder und die Steigleitungen jeweils unter Spannung gehalten werden, wodurch abwärts gerichtete Kräfte auf die Plattform erzeugt werden, denen durch eine Verlagerung der Plattform entgegenwirkt wird, **dadurch gekennzeichnet, dass**

der Bohrturm ein Gewicht aufweist, das zumindest 5 % der Spannung der Vorspannglieder und der Steigleitungen ausmacht, und horizontal um die Plattform verschoben werden kann,

der Auftrieb der Plattform klein genug ist und

die Vorspannglieder ausreichend Spannung aufweisen, damit die kombinierte abwärts gerichtete Kraft, die von den Vorspanngliedern und der vorbestimmten Anzahl von Steigleitungen auf die Plattform ausgeübt wird, zumindest 20 % der Arbeitsverlagerung der Plattform ausmacht; und

die Plattform eine Vielzahl einstellbarer Auftriebskammern (90, 92, 94) aufweist, die um die vertikale Achse und die Vorrichtung (100, 106) beabstandet sind, um den Auftrieb der Kammern so zu steuern, dass eine annähernd konstante Vorspannglied-Spannung in allen Vorspanngliedern beibehalten wird, wenn der Bohrturm verschoben wird.

2. System nach Anspruch 1, worin:

die Plattform eine horizontale Breite und eine horizontale Länge aufweist, wobei der Bohrturm horizontal von einer Position über der Achse weg bewegt werden kann und die Auftriebskammern für die Bewegung des Turms eingestellt werden können, um Veränderungen der Vorspannglied-Spannung zu vermeiden.

3. System nach Anspruch 1, worin:

die Plattform vier vertikale Ecksäulen (116, 117, 118, 119) mit oberen (127) und unteren (125) Endabschnitten, eine Struktur (126), die die oberen Endabschnitte miteinander verbindet, wobei der Bohrturm beweglich auf der Struktur montiert ist, sowie vier horizontale Träger (121, 122, 123, 124) umfasst, die die unteren Endabschnitte der Säulen miteinander verbinden, wobei jede der Säulen und jeder der Träger zumindest einen Abschnitt einer der Auftriebskammern aufweisen.

4. System nach Anspruch 3, worin:

eine Vielzahl der Träger zumindest eine Öffnung (40, 40A-40F) aufweist, wobei der Bohrturm so verschiebbar ist, dass er sich über eine beliebige der Öffnungen bewegt.

5. System nach Anspruch 3, worin:

die Säulen und die Träger jeweils zumindest Abschnitte von Kammern (90, 92, 94) mit einstellbarem Auftrieb aufweisen, deren Auftrieb eingestellt werden kann, um Veränderungen der Spannungen der Vorspannglieder zu kompensieren, die aus der Verschiebung des Bohrturms resultieren.

6. Verfahren zum Betreiben einer trossenverspannten Bohrplattform (10), die eine Achse (109), einen Bohrturm (150), der horizontal auf der Plattform verschoben werden kann, eine Vielzahl einstellbarer Auftriebskammern, die um die Achse beabstandet sind, sowie eine Vielzahl von Vorspanngliedern und zumindest eine Steigleitung aufweist, die sich alle vertikal von der Plattform zum Meeresboden erstrecken und im Meeresboden verankert sind, umfassend:

das horizontale Verschieben des Bohrturms auf der Plattform und das Einstellen des Auftriebs der Kammern, um eine im Wesentlichen konstante Spannung in den Vorspanngliedern und der zumindest einen Steigleitung beizubehalten.

7. Verfahren nach Anspruch 6, worin:

die Plattform eine Vielzahl von Öffnungen (40A-40F) aufweist, die horizontal von der Achse beabstandet sind, wobei der Bohrturm so bewegt werden kann, dass er über einer ausgewählten der Öffnungen liegt, und der Schritt des Einstellens das Einfüllen von Wasser in zumindest eine der Auftriebskammern, um ihren Auftrieb zu verringern, sowie das Ausblasen von Wasser umfasst, um den Auftrieb einer anderen der Auftriebskammern zu erhöhen.

Revendications

1. Système d'une plate-forme à jambes de tension qui comporte une plate-forme (12) qui flotte sur la surface de la mer et qui présente un axe vertical (109), plusieurs éléments de précontrainte (16) s'étendant de ladite plate-forme au fond de la mer (26) et ancrés dans celui-ci, et une installation de forage (150) qui repose sur ladite plate-forme, ladite plate-forme comportant des moyens (50,56) pour la fixation à un nombre maximal prédéterminé de colonnes montantes, et comportant plusieurs colonnes montantes (34) chacune s'étendant de ladite plate-forme au fond de la mer et étant ancrée à celui-ci, lesdits éléments de précontrainte et colonnes montantes étant chacun maintenu sous tension, ce qui produit des forces descendantes sur ladite plate-forme qui sont contrées par le déplacement de ladite plate-forme, **caractérisé en ce que:**

ladite installation de forage a un poids d'au moins 5% de la tension desdits éléments de précontrainte et colonnes montantes et peut être déplacée horizontalement autour de ladite plate-forme;

ladite plate-forme a une flottabilité suffisam-

ment petite, et lesdits éléments de précontrainte ont suffisamment de tension pour que la force descendante combinée qui serait appliquée par lesdits éléments de précontrainte et ledit nombre prédéterminé de colonnes montantes à ladite plate-forme représente au moins 20% du déplacement de travail de ladite plate-forme; et

ladite plate-forme comporte plusieurs chambres de flottabilité ajustable (90,92,94) espacées autour dudit axe vertical et l'appareil (100,106) pour commander la flottabilité desdites chambres afin de maintenir une tension approximativement constante dans tous les éléments de précontrainte précités lorsque ladite installation de forage est déplacée.

2. Système selon la revendication 1, où ladite plate-forme présente une largeur horizontale et une longueur horizontale, ladite installation de forage est déplaçable horizontalement au loin d'une position sur ledit axe, et lesdites chambres de flottabilité sont ajustables en vue dudit déplacement de ladite installation de forage pour éviter des changements de tension dans les éléments de précontrainte.

3. Système selon la revendication 1, incluant:

ladite plate-forme comporte quatre colonnes de coin verticales (116,117,118,119) présentant des portions d'extrémité supérieures (127) et inférieures (125), une structure (126) qui relie lesdites portions d'extrémité supérieures ensemble avec ladite installation de forage montée d'une manière mobile sur ladite structure, et quatre poutres horizontales (121,122,123,124) reliant ensemble lesdites portions d'extrémité inférieures desdites colonnes, chacune desdites colonnes et chacune desdites poutres présentant au moins une portion d'une desdites chambres de flottabilité.

4. Système selon la revendication 3, dans lequel:

une pluralité desdites poutres présente au moins une ouverture (40,40A-40F), ladite installation de forage étant déplaçable pour l'amener sur l'une quelconque desdites ouvertures.

5. Système selon la revendication 3, dans lequel lesdites colonnes et lesdites poutres ont chacune au moins des portions des chambres à flottabilité ajustable (90, 92, 94), dont la flottabilité peut être ajustée pour compenser des changements dans les tensions desdits éléments de précontrainte résultant du déplacement de ladite installation de forage.

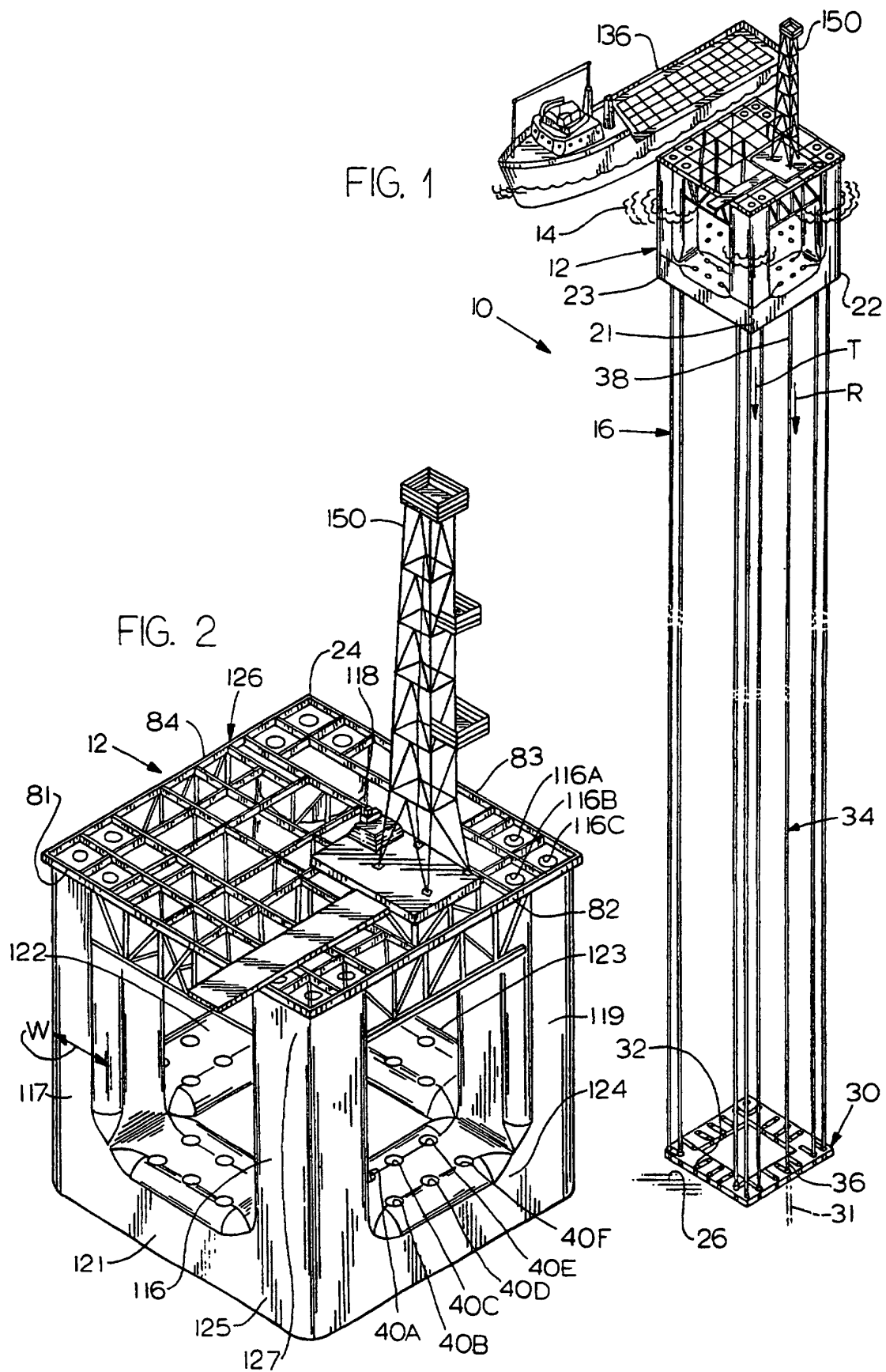
6. Procédé pour faire fonctionner une plate-forme à

jambes de tension (10) qui possède un axe (109), une installation de forage (150) qui est déplaçable horizontalement sur ladite plate-forme, plusieurs chambres à flottabilité ajustable espacées autour dudit axe, et plusieurs éléments de précontrainte et au moins une colonne montante, tous s'étendant verticalement de ladite plate-forme au fond de la mer et étant ancrés dans le fond de la mer, comprenant:

le déplacement de ladite installation de forage horizontalement sur ladite plate-forme, et le réglage de la flottabilité desdites chambres afin de maintenir une tension sensiblement constante dans lesdits éléments de précontrainte et ladite au moins une colonne montante.

7. Procédé selon la revendication 6, dans lequel:

ladite plate-forme présente plusieurs ouvertures (40A-40F) espacées horizontalement dudit axe, ladite installation de forage est déplaçable pour reposer sur une ouverture sélectionnée parmi lesdites ouvertures, et ladite étape de réglage comprend l'addition d'eau à au moins une desdites chambres à flottabilité pour réduire sa flottabilité et pour expulser de l'eau pour ajouter de la flottabilité à une autre desdites chambres à flottabilité.



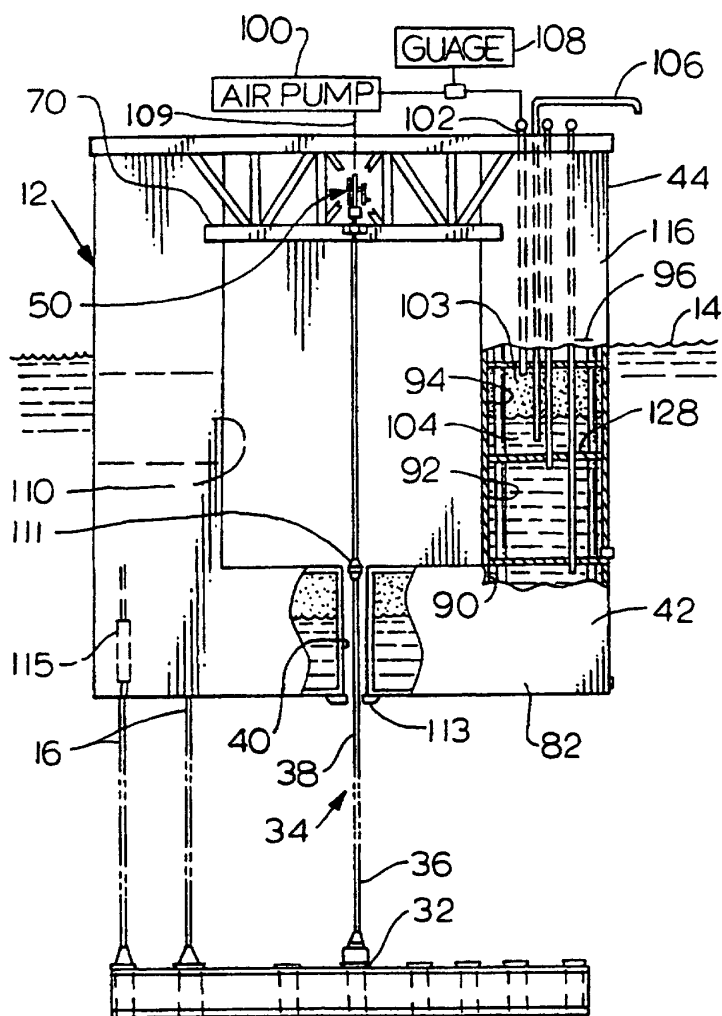


FIG. 3

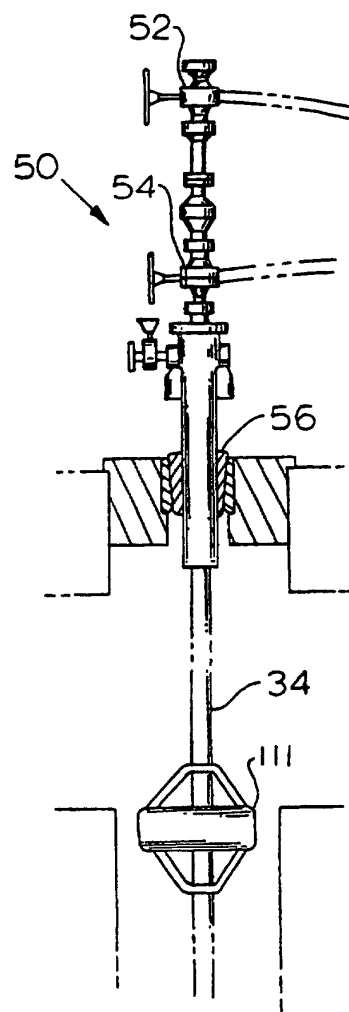


FIG. 4

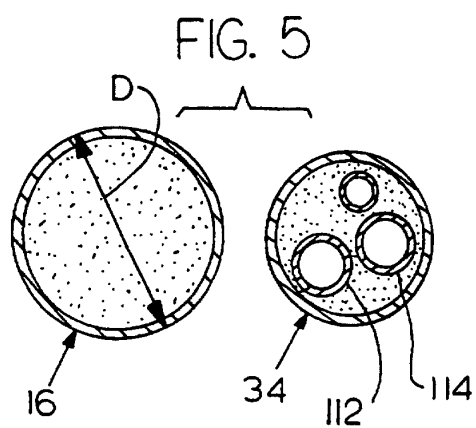


FIG. 5

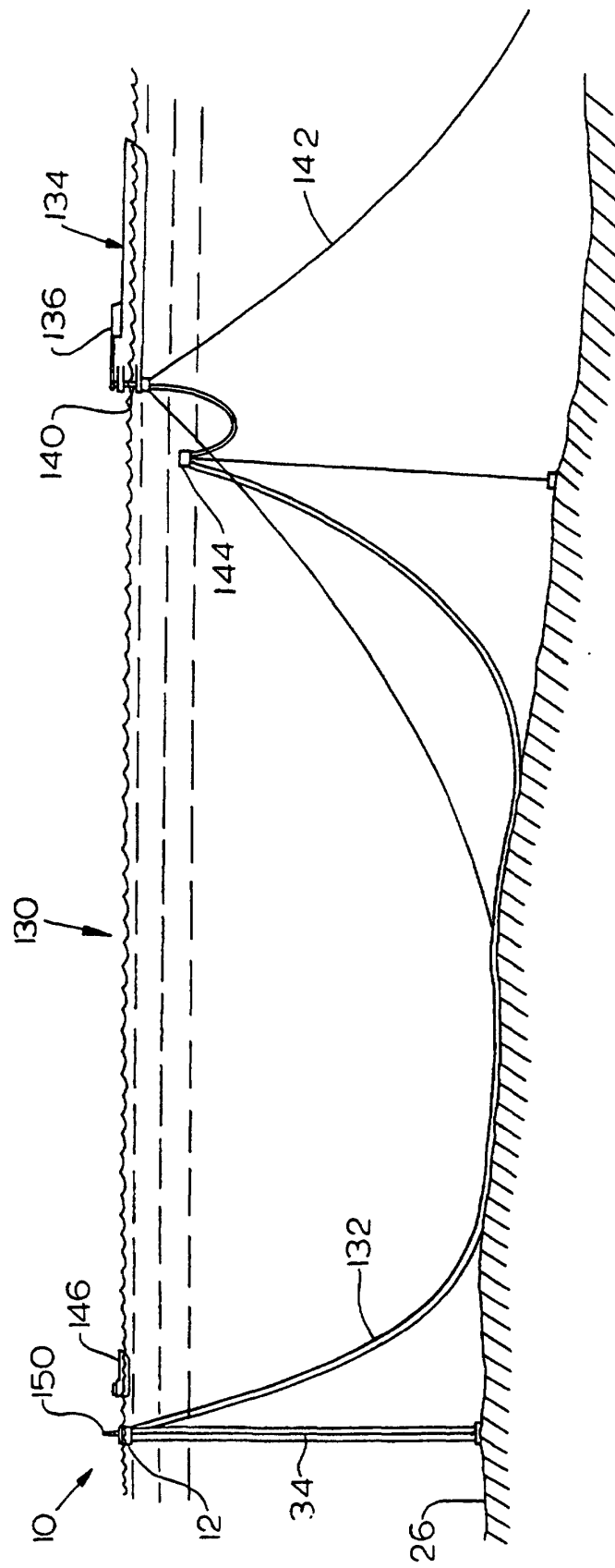


FIG. 6