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STABILIZED FLOATING DRILLING PLATFORM

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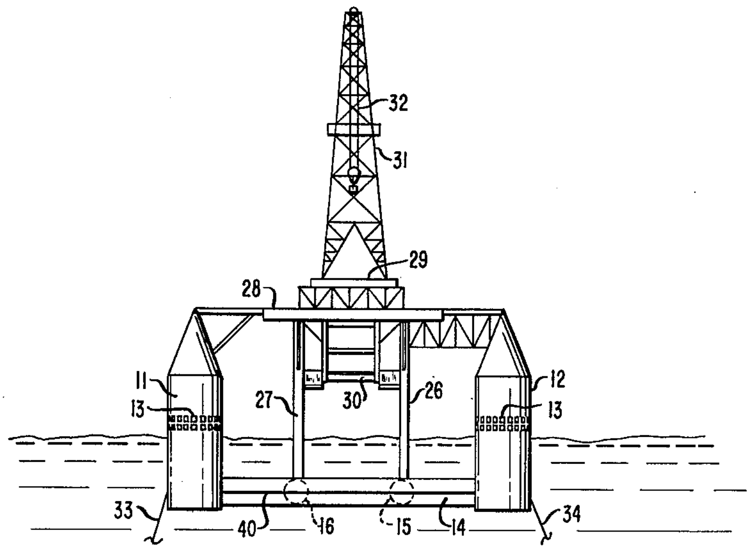

FIG. 1

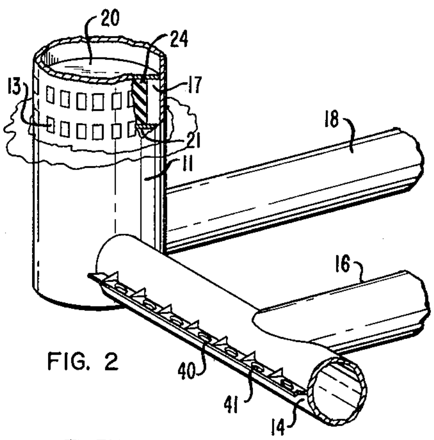

FIG. 2

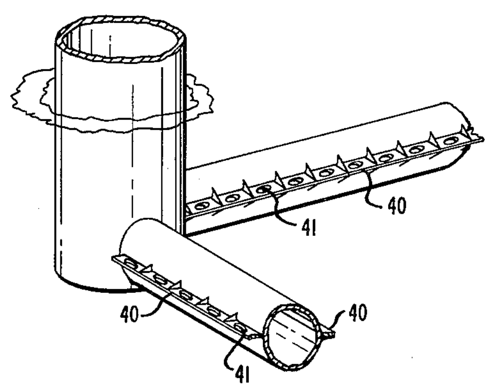

FIG. 4

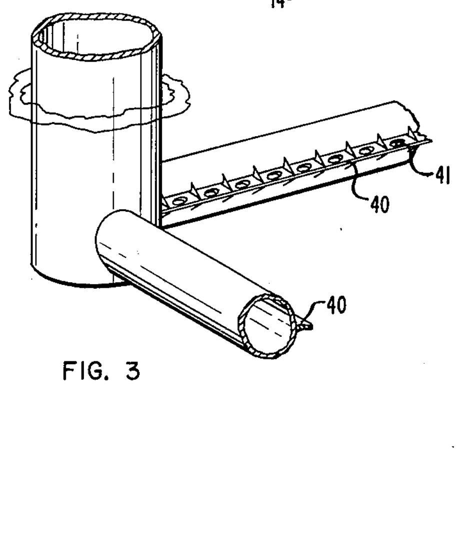

FIG. 3

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STABILIZED FLOATING DRILLING PLATFORM

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This invention relates to apparatus for use in drilling offshore wells and pertains more particularly to a floating drilling platform which may be anchored in deep water and from which an underwater well may be drilled and/or produced.

In an attempt to locate new oil fields, an increasing amount of well drilling has been conducted at offshore locations, such for example, as off the coasts of Louisiana, Texas and California. Well drilling operations are being carried out further and further from shore and in increasingly deeper water. At present, however, substantially all offshore well drilling is being conducted from a platform having legs affixed to the ocean floor, as by piling, or from mobile drilling platforms or barges having legs which may be extended downwardly through the water and in contact with the ocean floor in order to fixedly support the barge thereon. To date, using either of the two above-described platforms, well drilling operations have been limited to water depths of about 125 feet. Most deep water drilling that has been conducted to date has taken place from a converted ship in which a drilling well has been provided. Since ships are prone to roll fairly easily, deep water drilling operations carried out from ships can only take place when wind and wave forces are fairly small.

It is therefore an object of the present invention to provide a moored floating drilling platform for use in carrying out drilling operations in waters that are too deep to have bottom supporting legs extending down through the water to the ocean floor and to drill wells during sea conditions not possible with converted boats or too severe for converted ships.

A further object of the present invention is to provide a floating drilling platform of the semi-submersible type (one relying on freeboard for stability, but having much of its mass underwater) from which drilling operations may be carried out economically and safely in deep waters.

Another object of the present invention is to provide a floating drilling platform which is designed with a natural period of movement different from the wave periods so that resonance is avoided.

Still another object of the present invention is to provide a floating drilling platform designed to have a natural period of roll larger than that of the wave periods to be encountered.

A further object of the present invention is to provide a floating vessel having a hull of a design which minimizes or dampens heave, pitch and roll when the vessel is anchored or otherwise positioned at a selected position with the hull submerged to a predetermined depth.

A further object of the present invention is to provide a floating drilling platform having a discontinuous natural period of roll, so that when the platform or vessel rolls more than, say 3 degrees, which occurs only in extremely high waves, means are provided for changing the natural period of roll, thus destroying any resonance effect between the waves and the platform.

It is also an object of the present invention to provide a hull of unique design for the floating platform so that the amplitude of the angular motion (pitch or roll) of the platform is substantially reduced when the platform is anchored at a selected operating draft depth.

A further object of the present invention is to provide

a floating drilling platform having a hull designed with sufficient buoyancy to support the load and sufficient reserve buoyancy to resist overturning, while at the same time the hull has sufficient area in the water plane zone to resist large changes in draft of the platform with changes in deck loads.

Still another object of the present invention is to provide a floating platform provided with means for reducing the oscillation of the platform when it is anchored at a selected location.

Still another object of the present invention is to provide a floating drilling platform with a hull of a design which is virtually independent of direction of wave approach whereby motions at 90° for head or beam seas would be the same.

These and other objects of this invention will be understood from the following description taken with reference to the drawing, wherein:

FIGURE 1 is a diagrammatic view showing the outboard profile of the floating platform of the present invention; and

FIGURES 2, 3 and 4 are fragmental isometric views of portions of the hull of the vessel of FIGURE 1 illustrating means for reducing the heave, pitch and roll of the vessel at its anchored position.

Referring to FIGURE 1 of the drawing, the hull of the floating drilling or production platform may comprise three or more vertically-extending support or stabilizing columns **11** and **12** which are interconnected in a close geometric configuration by cross-bracing hull members **14**, **15** and **16** which extend laterally between the stabilizing columns near the lower ends thereof and may form a grid-type buoyant hull inside the corner columns. The cross-bracing hull members **14**, **15** and **16** are preferably hollow, fluidtight members divided into a plurality of buoyancy tanks by means of watertight bulkheads.

The four corner support or stabilizing columns **11** and **12** (only two being shown for ease of illustration) are preferably in the form of cylindrical tanks, as illustrated, which may be selectively flooded in order to lower the entire drilling platform in the water, thus stabilizing it by lowering its center of gravity. The stabilizing columns **11** and **12** may be of the same diameter throughout their height, say for example 25 feet in diameter. However, the upper portions of the stabilizing columns **11** and **12** are in some cases preferably provided with a series of open ports **13** a short distance above the water line when the floating platform is in its semi-submerged position or operating depth as illustrated in FIGURE 1. The diameter of the stabilizing columns **11** and **12** is large in order to reduce the amount of immersion which takes place when abnormally high hook loads are imposed on the floating platform through the fall lines and derrick. As shown in FIGURE 2, the ports **13** in the outer surface of the hull or columns **11** are in communication with a readily floodable and drainable annular chamber **17** within the hull which may be divided for reinforcing purposes into a series of smaller chambers by vertical plates (not shown). The top and bottom of the annular chamber **17** is formed by horizontal column-divider plates **20** and **21**. The central portion between plates **20** and **21** may be filled with plastic material **24** to keep water out.

The provision of floodable open chambers **17** (FIGURE 2) in each of the support columns **11** and **12** also provides the floating platform with a discontinuous natural period of roll. When the floating platform experiences angular motion more than a predetermined amount, say past 3°, which occurs only in extremely high waves, the corner stabilizing column diameter suddenly changes from 25 feet to 20 feet if the chamber **17** is

2.5 feet wide and the natural period of the angular motion increases while the amplitude of motion is substantially reduced. Therefore, if the floating platform were subjected to large swells or hurricane waves of an undesirable period so that a resonance oscillation build-up occurs, the sudden increase in the natural period of roll or pitch to a higher value for angles above 3° would destroy any further resonant affects. Since the natural period of angular motion of the floating platform is a function of the water plane area of the hull or stabilizing columns, a radical change in the natural period of angular motion of the platform takes place when a wave comes along to dip one supporting column below the surface of the water so that the range of reduced diameter on one or more of the chambers 17 in the columns become flooded. Since the period of the platform and that of the waves are then different, resonant oscillation is destroyed and the amplitude of pitch and roll motion of the vessel immediately decreases.

The stabilizing columns 11 and 12 may serve as the primary ballast tanks with the tanks being filled substantially to the water level 25 when the platform is positioned as shown in FIGURE 1. Since the water level inside the stabilizing columns is nearly the same as that outside, a leak caused by a work boat rupturing the wall of the column would not be serious. Since the buoyancy tanks in the lower hull members 14, 15, 16 and 18 are deeply submerged and support the weight of the platform there is little likelihood of their being damaged. Damage to the stabilizing columns would not affect the intact buoyancy tanks so the platform would neither sink nor heel. This feature provides a safer floating platform than can be achieved by converting ships. The space in the columns 11 and 12 above the plate 20 form emergency buoyancy tanks.

When the floating drilling platform of the present invention is in its semi-submerged state, as illustrated in FIGURE 1, the section of the large diameter portion of the stabilizing columns 11 and 12 above the water line provides reserve buoyancy to absorb heavy hook loads, increase the stability of the vessel, and afford a sharp change in the natural period of roll and pitch as previously discussed. These tanks are further designed to have the correct size for the ballast water required to bring the platform down to the predetermined drilling draft, the size being such that the ballast water inside the tanks will be at or near the water level outside the tank. The ports 13 in the wall of the column by which the annular chamber 17 are flooded may be positioned from 2 to 8 feet above the water level 25 as desired.

Extending upwardly from the horizontal buoyancy tanks 14, 15, and 16, as shown in FIGURE 1, are a plurality of vertical support legs 26 and 27 for supporting with or without the aid of the stabilizing columns, any suitable type of operational platform thereon. The buoyant force in tanks 14, 15, 16 and 18 is designed to equal the weight of the equipment and structure of the support legs 26 and 27 and the operational platform. When floating horizontally no vertical force is transmitted between stabilizing columns 11 and buoyancy tank 14 for example. Thus, stabilizing column 11 only exerts a vertical force when the platform rolls or lists. In this way, a safer platform is achieved. The particular platform illustrated is a multi-deck platform having an operating deck 29 and a main deck 28 as well as a partial or spider deck 30 suspended between the legs 26 and 27 and which is preferably movable horizontally toward and away from the center hole of the well extending down through the decks and hull. A derrick 31 is positioned over the center of the hull structure on the operating deck 29. Suitable hoist means 32 and cable reeling means may be provided. If desired the operation platform may be entirely supported on the stabilizing columns. As shown in FIGURE 1, the vessel is provided with a pair of mooring lines 33 and 34 running from each of the stabilizing columns 11 and 12 as well as using anchor lines (not shown) on the other side. If desired other suitable vessel-positioning means may be employed instead of anchor lines.

In the event that the vessel as constructed has natural response periods of heave, pitch and roll which are significantly greater than the periods of the waves which could be encountered in the body of water in which the vessel was to be used, the vessel may be further modified in order to prevent resonant amplification and decrease large amplitude motions. This can be accomplished, with or without the use of the damping ports 13, by providing substantially laterally-extending damping keels 40 which consist of steel plate sections fitted to either the outboard, inboard or both sides of the horizontal lower hull members 14, 15, 16 and 18, as shown in FIGURE 2, 3 and 4. These keels 40 act to increase damping of the platform by increasing the viscous drag and increasing the virtual mass of the submerged portion of the platform. The increased drag produces motion damping while the increase in virtual mass increases the response periods of the platform and thereby lessens the likelihood of resonant amplification. Although the keels are illustrated as extending the full length of the hull members, it is to be understood that several short sections of keel may be employed on each hull member. The area of the keels may vary from 1 to 25% or more of the area of the hull depending upon the amount of damping that is desired.

Preferably, the laterally-extending damping keels are provided with venting holes 41 to increase their effectiveness. The effect of the holes 41 is to increase the drag of the keels as they move up and down in the water due to the creation of vortices produced by fluid accelerating through the holes, as well as to increase the natural response periods of the vessel due to virtual mass increase resulting from eddy and vortices creation. Studies made on one platform indicated that the area of the damping holes 41 gives good performance when it is between 3 and 12% of the area of the plate or damping keel. Damping keels with venting holes whose area are between 5½ and 7½% of the keel plate area are 22% more effective in reducing of oscillatory motion (pitch, roll or heave) than keels without venting holes.

Damping keels without holes are 300% more effective in reducing the duration of oscillatory motion than when the platform is not provided with keels. The optimum vented keels are 400% more effective than a platform section without keels. Damping keels reduce the maximum amplitude of oscillatory motion to one third the amplitude of a oscillation without keels. Additionally, damping keels increase the amount of entrained fluid associated with oscillatory motion in a fluid and thereby increase the natural periods of oscillation. The energy discipation rate produced by the optimum vented keels on a platform is from 7 to 35% (an average of 19%) greater than the energy discipation rate for non-vented keels and is 80% greater than the rate for an oscillation platform with no keels. Motion amplitude and duration of oscillation are appreciably less with damping keels on the platform than without any keels at all.

Either damping keels 40 or damping ports 16 are quite effective in reducing angular motion near the synchronous period of a vessel at its operating draft. Additionally, damping keels consistently reduce the heave motion of a vessel to a considerable extent under certain wave conditions, i.e., waves of certain periods. Tests on one platform indicate that the platform without keels oscillates three times as long as when keels are employed with no holes and four times as long when using keels with a hole area in the range of 7½%. The damping ports 13 reduce the maximum pitch or roll angle of a vessel. The flow of sea water in and out of the venting ports 13 and into the angular chamber 17 of each column also increases energy discipation and contributes to motion damping.

I claim as my invention:

1. A semi-submersible floating platform for carrying out operations at offshore locations such as drilling a well, said platform comprising

a buoyant hull,

an operating platform carried by said buoyant hull at a level above any wave action at the time the platform is positioned at its operating location and depth, and

keel means fixedly secured to the outer surface of the buoyant hull of said vessel at a point below the normal operating water line thereof, said keel means being rigid and extending substantially laterally from said hull, said keel means comprising plate means having perforations therethrough, said perforations having an area equal to from about 2% to about 15% of the area of the keel means.

2. The apparatus of claim 1 wherein said keel means are secured to at least two opposite sides of the hull of said platform.

3. The apparatus of claim 1 wherein said keel means are secured to the hull and extend around the periphery thereof.

4. The apparatus of claim 1 wherein said buoyant hull comprises a plurality of buoyant members partially in spaced relationship one to another and connected together in a geometric configuration.

5. The apparatus of claim 4 wherein said keel means are secured to said spaced buoyant members at a location inboard of the periphery of said platform.

6. The apparatus of claim 4 wherein said keel means extend laterally from each of said buoyant members on both sides of each member.

7. The apparatus of claim 1 wherein the hull of the platform comprises a plurality of vertically-extending columns with cross bracing members arranged in a geometric configuration, a plurality of said columns having floodable chamber means formed therein in open communication with the space outside said columns, said chamber means being positioned in each column at a level adjacent and above the surface of the water in which the platform is positioned.

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