A drilling ship having twin hulls bridged by a deck operated as a drilling platform. The twin hulls have a deep-draft narrow beam configuration with a small waterplane area. Each hull extends outwardly fore and aft at the waterline and has appendages along the sides to provide icebreaking capability in all directions. Rolling and/or pitching motion is induced by pumping of air in and out of ballast tanks to induce the motion at or near the natural roll and pitch frequency of the vessel.

5 Claims, 3 Drawing Figures
1

TWIN-HULL SHIP FOR DRILLING IN ICE-COVERED WATERS

BACKGROUND OF THE INVENTION

This invention relates to offshore drilling vessels, and more particularly, is concerned with a drilling vessel for operation in ice-covered waters.

In copending application Ser. No. 183,466, filed Sept. 24, 1971, issued Nov. 26, 1974 as U.S. Pat. No. 3,850,125 and assigned to the same licensee as the present invention, there is described an icebreaking vessel of single hull construction which derives its improved icebreaking capabilities from a pneumatically induced pitching system that operates at or near the natural pitch frequency of the vessel. Pitching is induced by shifting the center of buoyancy of the vessel. While the vessel therein disclosed may be used as a drilling platform, as described in the application, the vessel is most effective as an icebreaker when moving through the water. When operating at a drilling location, the vessel must be maneuvered to point toward the direction of ice flow to be most effective.

The natural frequency for a single-hull vessel of the type described in the above-identified application has a pitch period in the order of 7 seconds. Since the induced pitching is at or near the natural pitch frequency of the vessel, the pneumatic system must function at the rate of approximately 8 cycles per minute. It is desirable to reduce this frequency in order to reduce the rate at which the inducing system must cycle. It is also desirable to reduce this frequency to improve the comfort of the crew who are exposed to this continuous pitching motion.

SUMMARY OF THE INVENTION

The present invention is directed to a vessel which provides improved operating characteristics, both in the transit mode and in the drilling mode, when operating in icy waters. The design of the vessel is such that it provides a high natural period in both roll and pitch, the pitch and roll frequencies being substantially equal. The cycle period is of the order of 30 seconds or higher, four times the pitch period of a shipshape vessel. The vessel design has the further advantage that it has icebreaking capability regardless of the direction of approach of the ice. Hence shift in the direction of ice flow during operation in the drilling mode, for example, does not necessitate any change in the mooring system to adjust the heading of the vessel. A further advantage of the present invention is that the vessel exhibits a high radius of gyration and a low water plane of inertia under normal load conditions. The vessel exhibits a much lower moment to trim than a conventional shipshape vessel, thus allowing much smaller exciting forces to start and maintain the induced pitching action.

In addition, the vessel design according to the present invention has the advantage that the vessel presents a very deep draft, permitting all propellers, thrusters, and mooring equipment to be located deep beneath the surface of the water and well below the ice, thus reducing the problem of damage to these functions by ice movement.

These and other advantages of the present invention are achieved by providing a vessel having a twin-hull construction in which the hulls are designed with a deep draft and low water plane area, and with a high radius of gyration. The moment to trim 1 inch is much lower than in conventional vessels. Each hull, with its deep draft, is designed to extend well below and clear of any surrounding ice. The propulsion system is at the bottom of each hull as are the mooring lines where they engage the vessel, thus keeping the mooring and propulsion functions below any surrounding ice. Chambers are provided at the bottom of each hull, fore and aft. Air pumped in these chambers controls the buoyancy and produces vertical movement of the vessel so as to induce pitching and/or rolling motion to the vessel.

Each hull is shaped at the bow and stern to provide a sharp angle of attack at the waterline for breaking the ice. Also, appendages running the length of both the inside and outside of each hull provide icebreaking action along the sides of the vessel. An icebreaking drill well extends into the water between the hulls to protect the drill pipe or riser extending from the vessel to the well.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the invention, reference should be made to the accompanying drawings, wherein:

FIG. 1 is a side elevational view of the vessel according to the present invention;

FIG. 2 is an end view of the vessel; and

FIG. 3 is a partial sectional view taken substantially on line 3—3 of FIG. 2.

DETAILED DESCRIPTION

The icebreaking vessel herein described is a modification of the drilling vessel described in copending application Ser. No. 183,466, filed Sept. 24, 1971, by the same inventors as the present invention.

Referring to the drawings in detail, the numeral 10 indicates generally an icebreaking drilling vessel which includes a pair of vertical hulls 12 and 14 connected at their upper end by a bridging structure forming a platform 16. The platform 16 provides a main deck 18 and a lower deck 20. The vertical hulls 12 and 14 are secured to the platform 16, the assembly of the vertical hulls 12 and 14 on the bridging platform 16 being structurally reinforced and joined together in a unitary rigid structure by means of suitable tubular reinforcing members 22 extending between the hulls 12 and 14 above the waterline. Additional vertical and diagonal bracing members 24 provide added rigidity to the platform 16. The hulls 12 and 14 are also joined below the waterline by a pair of horizontal cross members 26.

Mounted on the top deck 18 is a drilling derrick 28 and related equipment necessary to carry on sub-sea drilling operations. A riser or drill pipe (not shown) extending from the drilling rig 28 down to a well being drilled passes through a casing 30 which passes through the platform 16 and extends downwardly a distance below the waterline. The casing 30 is surrounded by an icebreaking protective shroud indicated generally at 32. The shroud is no wider than the diameter of the casing 30 but extends fore and aft a substantial distance. The shroud is tapered at either end, terminating in edges 34 and 36 which extends at a sharp angle at the waterline to act as an icebreaking and ice-deflecting element. Lateral bracing of the casing 30 and shroud 32 is provided by tubular members 38 extending between the sides of the shroud and one of the tubular cross-bracing members 22. These cross-bracing members are
secured to the shroud at a point well above the water-line so as to be clear of any chunks of ice which might be encountered.

Considering the construction of the vertical hulls 12 and 14, the keel portion of each hull is in the form of a cylindrical torped-shaped portion 40 having a semi-spherical bow 42 and a conically tapered stern 44 terminating in a propeller 46 surrounded by a suitable protective shroud 48. Each hull further includes a pair of substantially parallel flat sides 50 and 52 extending between the bottom of the platform 16 and the top of the torped-shaped portion 40. The spacing between the sides 50 and 52 is preferably less than the diameter of the torped-shaped portion 40. The sides 50 and 52 terminate fore and aft in converging surfaces 54 and 56 which join in a vertically extending edge or prow 58. The edge 58 extends vertically from the top of the torped-shaped hull portion 40 to a point sufficiently below the waterline to be below the water-ice interface. From this point, the prow angles outwardly at a sharp angle to the horizontal, as indicated at 60 to form an icebreaking prow at both the bow and stern edges of the hull. The hulls 12 and 14 are constructed in conventional manner by providing a plurality of vertical bulkheads 62 to which are welded or otherwise secured steel plates forming the sides, bow, and stern sections of the hulls.

To achieve icebreaking capability where ice is approaching from the starboard or port sides of the vessel, each hull is provided with a pair of icebreaking appendages 64 and 66 which extend longitudinally along the respective sides 50 and 52 of each hull and centered approximately along the waterline. The appendages are formed so as to form a triangle with the side walls 50 and 52 and are tapered at either end. The void spaces within the icebreaking appendages 64 and 66 are left open to the sea by suitable openings so that the addition of the appendages has negligible effect on the buoyancy characteristics of the vessel.

The icebreaking capabilities of the vessel are enhanced by incorporating a roll and pitch inducing system of the type described in detail in the above-identified pending application Ser. No. 183,466. To this end, fore and aft chambers 70 and 72 are provided in each of the hulls 12 and 14 that are opened to the sea. Flooding of each of these chambers is controlled by an air duct 74 and 76 respectively, which extend to the upper deck 18. Each of the air ducts is connected either to atmosphere or to a blower 78 through an air diverting mechanism 80 which permits air to be either forced under pressure from the blower down the duct into the associated chamber, or permits the air to be forced out of the chamber back into the atmosphere under the pressure exerted by the water. Thus the level of water within the chambers can be rapidly raised or lowered to change the buoyancy effect of the chamber on the vessel. Thus by exhausting the air from the aft chamber while forcing air into the forward chambers, the bow of the vessel can be lifted and the stern lowered. By reversing this action a pitching motion of the vessel can be induced in the manner described in detail in the above-identified application. Similarly by controlling the chambers on the port side and on the starboard side, a rolling action can be induced. Also any combination of a rolling and pitching motion can be induced.

After the vessel moves into location over a drilling site it may be moored by an arrangement of preferably eight mooring lines. These mooring lines, two of which are indicated in FIG. 1 at 82, extend outwardly from the vessel below the water level to chains 84 and anchors 86. The lines 82 enter the vessel through the torped-shaped portion 40 of the two hulls through fairleads 88. The fairleads are connected to hause pipes 90 which extend up to the lower deck 20. The line 82 after passing through the hause pipe 90 is attached to a mooring winch 92. With eight mooring lines, there are two hause pipes both fore and aft of each of the hulls, as seen in the sectional view of FIG. 3. The subsurface fairleads 88 which guide the mooring lines 82 out of the hause pipes are preferably constructed in the manner taught in more detail in co-pending application Ser. No. 183,466,Filed Sept. 24, 1971, and assigned to the same assignee as the present invention.

The vessel is designed to provide a high natural period in both roll and pitch, for example, of the order of 30 seconds or higher, as compared with the natural period of a conventional vessel of about 7 seconds. This is accomplished by designing the vessel with a high radius of gyration and relatively small waterplane area. The hulls at full load draft have a beam width which is quite small compared to the length of the hulls and draft at full load waterline. This enables the pitch and roll inducing system to operate at a much lower frequency, i.e., approximately one-fourth the frequency as required in a conventional icebreaking vessel. This lower frequency also means that the living conditions aboard the vessel are much more tolerable to the crew.

Because both the bow and stern of both hulls as well as the adding of the icebreaking appendages along the sides of the hulls insures that regardless of the quadrant from which an ice flow approaches the vessel, pitching or rolling motion of the vessel is capable of breaking up the ice at the edge of the ice flow as it moves into the vessel. Therefore a shift in the direction of ice movement does not necessitate a change in the heading of the moored vessel during drilling operation. A further advantage of the present invention is that the vessel design with its high radius of gyration and low waterplane area provides that the moment required to trim or heel the vessel by one inch is much lower than in a conventional icebreaking ship-shape vessel. This means that the forces required to excite the rolling and pitching movement of the vessel is substantially reduced. Ballast tanks can easily be arranged to provide good draft, heel, and trim control. This provides greater stability control for relocating heavy weights on the vessel during drilling operations. Because propellers are located deep under water as are the mooring lines, there is practically no likelihood of damage from ice particles and other objects floating on the surface of the water. Likewise fuel oil can be stored in tanks deep under the water in the torped-shaped hull sections reducing the chance of rupture and oil spillage by ice damage. The very narrow hull beam at the waterline permits bow and stern of each hull to be designed with a very sharp angular edge, giving the ship greatly reduced icebreaking resistance as the vessel oscillates.

To better appreciate the overall design of the vessel, typical dimensions for a vessel having a loaded displacement of 18,000 to 20,000 long tons are:
Beam width of the vertical hulls 20 ft.
Draft of the vertical hulls 70 ft.
Length of the vertical hulls 275 ft.
Overall length of the torpedo-shaped sections at the base of the hulls 350 ft.
Distance between center lines of the vertical hulls 170 ft.

The vessel according to the design of the present invention may be operated in the transit mode either in open water or where danger of floating ice exists. It permits operation of the vessel on location in the drilling mode, not only in normal open waters, but in open waters where moving ice sheets may occur.

What is claimed is:

1. An icebreaking vessel for providing a mobile drilling platform capable of operating in arctic waters, comprising: a pair of spaced parallel hulls, deck means interconnecting the hulls above the waterplane when the vessel is floating, the vessel having a high radius of gyration and a small waterplane area, each hull having a very narrow beam in relation to the length and draft, the bow and stern of each hull having a wedge-shaped portion forming an icebreaking edge extending at a substantial angle from the vertical from a point substantially below to a point substantially above the waterline, icebreaking sponsons extending along the sides of each of the hulls at the waterline from the bow to stern, each sponson having a lower surface extending below the waterline and projecting outwardly and upwardly from the side of the hull at an acute angle so as to ride up on and depress the ice along the full extent of the sides of the hulls with rolling motion of the vessel.

2. Apparatus of claim 1 wherein the vessel has a high natural period in both roll and pitch of the order of thirty seconds or more, each hull including chambers opening downwardly through the bottom of the hull adjacent the bow and the stern, and means pumping air alternately into and out of each chamber at a frequency to induce pitching or rolling at or near the said natural period of the vessel.

3. Apparatus of claim 2 wherein the lower portion of the hull has a wider beam than the upper portion and is positioned sufficiently below the waterline so as to extend below any surface ice.

4. Apparatus of claim 2 further including a plurality of mooring lines extending from winches in the vessel through openings in the lower hull portions.

5. Apparatus of claim 2 further including a drilling rig mounted on the top of the deck means, the deck means having an opening to the water below the drilling rig, a protective shroud extending around said opening from the deck means to below the waterline, the shroud being elongated and terminating in a wedge-shaped edge fore and aft, the edges extending at an acute angle to the waterline.

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