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[54] **MOORING APPARATUS FOR ICE-BREAKING DRILL SHIP**

[75] Inventors: **Russell B. Thornburg**, Palos Verdes Peninsula; **Klemme M. Jones**, Escondido, both of Calif.

[73] Assignee: **Global Marine Inc.**, Los Angeles, Calif.

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(Under Rule 47)

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[52] **U.S. Cl.** ..... **114/40**; 114/0.5 D; 114/179; 114/230

[51] **Int. Cl.**.. **B63b 35/10**; B63b 35/44; B63b 21/14

[58] **Field of Search** ..... 114/0.5 D, 40, 41, 42, 114/230, 179–181

[56] **References Cited**

UNITED STATES PATENTS

2,391,290	12/1945	Berger	114/181
2,808,229	10/1957	Bauer et al.	114/0.5 D
2,995,103	8/1961	Waas et al.	114/40
3,191,201	6/1965	Richardson et al.	114/144 B
3,739,736	6/1973	Carreau et al.	114/0.5 D

Primary Examiner—Trygve M. Blix
Assistant Examiner—Sherman D. Basinger
Attorney, Agent, or Firm—Christie, Parker & Hale

[57] **ABSTRACT**

There is described a mooring system for an ice-breaking drill ship in which the vessel is positioned for drilling in ice-covered waters. Positioning is controlled by multiple mooring lines going to anchors on the sea floor. The mooring lines are controlled by winches on the vessel and are directed through hawse pipes and fairleads positioned below the waterline and the bottom of ice so as to be free of ice movements.

4 Claims, 3 Drawing Figures

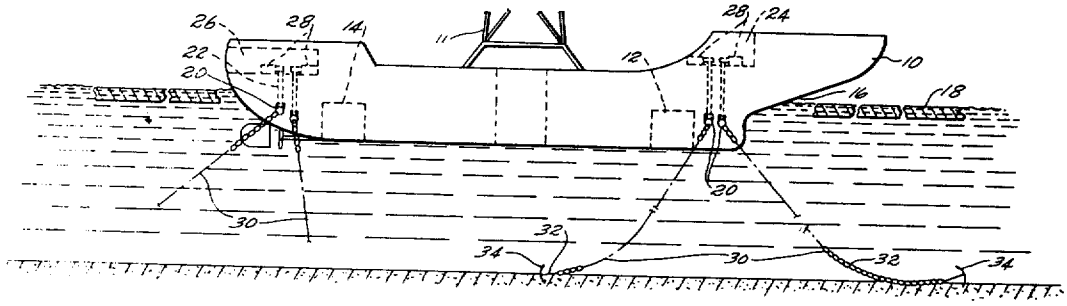


Fig. 1

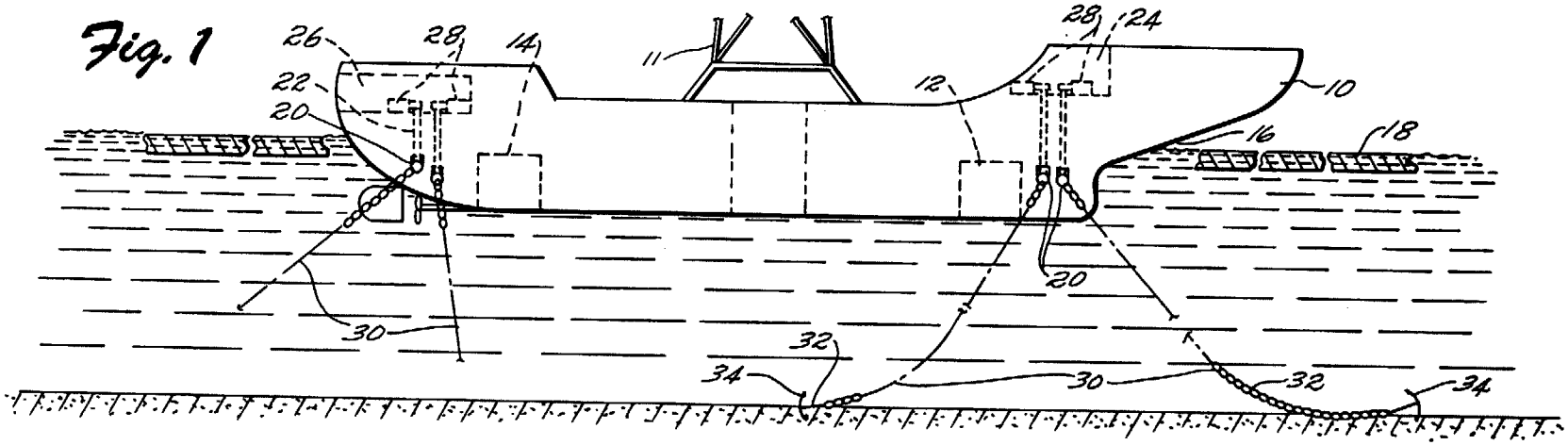


Fig. 2

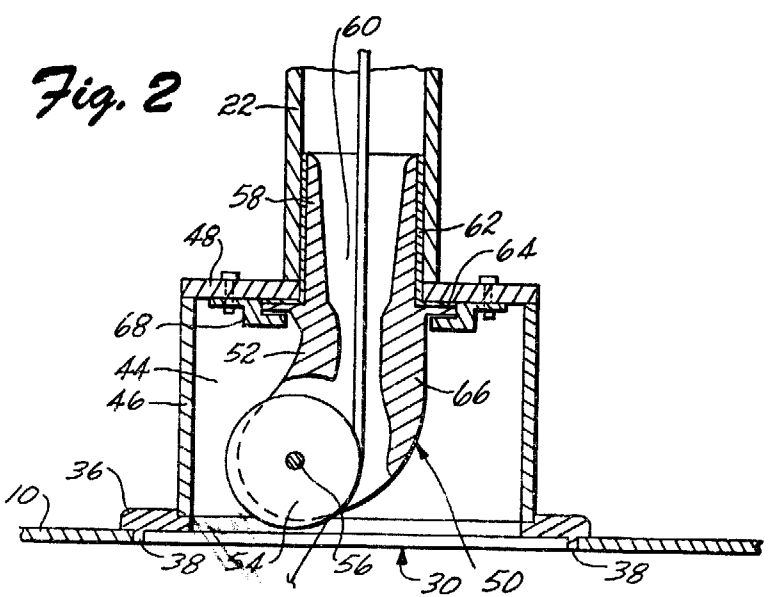
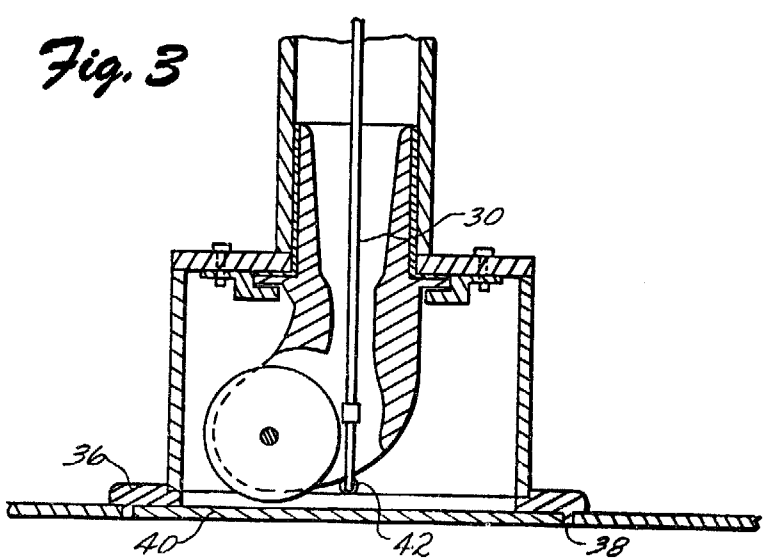


Fig. 3



MOORING APPRATUS FOR ICE-BREAKING DRILL SHIP

BACKGROUND OF THE INVENTION

With the increasing offshore oil potential in the arctic areas of northern Canada, for example, there has developed a need for a vessel which can operate as a drilling platform and which, at the same time, can maneuver in ice. This ship must not only have the ability to move through an ice sheet to reach the drilling location, but must be capable of keeping the ship on location throughout the drilling operation. During the arctic winter, all channels and inlets are ice-covered. The ice cover consists of either solid sheets of ice or broad fields of heavy flows. The ice cover is constantly in motion due to the action of wind and tides. The general movement of the ice in the arctic flows in a clockwise direction under the influence of the prevailing winds and currents. On a short-time basis, the ice movements do not follow any regular pattern but are controlled by local wind stresses, ocean currents and coastal geography. During breakup and freeze-up the polar ice pack is continually moving in and out from the shoreline. Young ice forms in the water vacated by the pack and then is ground into pieces and piles on the shore when the pack returns. The ice as it continues to form makes fast to the bottom. This pattern of movement of ice in the arctic region has heretofore frequently forced interruptions or even cessation of drilling operations where ordinary drill ships are used, sometimes with little forewarning.

SUMMARY OF THE INVENTION

The present invention is best used in a drilling ship having an ice-breaking capability and provides an improved mooring system which permits the drilling to continue even in the presence of movement of surrounding ice. This is accomplished by using as a drilling vessel an ice-breaker ship which may, and preferably does, utilize a pneumatically-induced pitching system (PIPS) for breaking the ice, although the invention, in its broader aspect, is not dependent upon a drilling vessel or any particular style of ice-breaking system or mechanism. The vessel is moored at location by a unique mooring system in which a plurality of mooring lines extend out to anchor chains and anchors strategically positioned on the ocean floor. Positioning of the ship over a submerged location is accomplished by adjusting the length and tension on the mooring lines by means of wire-drum winches located in heated compartments within the hull of the ship. The cables extend through the ship in hawse pipes to swiveling fairleads located substantially below the waterline to keep the mooring lines free of icing or fouling. The fairleads are recessed in the hull and can be covered by removable plates when the ship is under way to provide unrestricted movement of the hull through the water.

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 an outboard profile of the drilling vessel incorporating the features of the present invention;

FIG. 2 is a detailed sectional view of the hawse pipe and fairlead construction according to the present invention; and

FIg. 3 is a sectional view similar to FIG. 2 but showing the fairland cover in place.

DETAILED DESCRIPTION

Referring to the drawings which illustrate the presently preferred embodiment of the invention, the numeral **10** indicates generally the hull of an ice-breaking drill ship having a drilling derrick **11** mounted amidships. The hull of the ship is designed to have an ice-breaking capability through a pneumatically induced pitching system, such as described in copending application Ser. No. 183,466, filed Sept. 24, 1971, and assigned to the same assignee as the present invention. To this end, the ship is provided with fore and aft tanks **12** and **14** which are opened to the sea. Pneumatic pumps (not shown) are operated to pump air alternately into the two tanks to apply buoyancy to the bow and then to the stern to induce a fore and aft pitching motion to the ship. This pitching action, in combination with the specially shaped bow **16,** produces an ice-breaking action on the ice cover beneath the bow, indicated at **18,** as the ship is moved through the water, or as ice moves toward the moored ship.

Located on either side of the hull **10** and in both fore and aft positions are pairs of hawesholes **20,** there being eight such holes in total. While eight hawesholes are shown by way of example, the number may vary depending on the size of the vessel and other design considerations. These hawseholes are located well below the waterline of the ship, for example, at least **10** feet below the waterline. Each hawsehole communicates through a hawse pipe **22** to fore and aft morring winch rooms **24** and **26.** These rooms are located well above the waterline in a heated and protected environment. Each room is fitted with four wire-drum winches, as indicated at **28.** When the ship is at location over the wellhead, each winch controls the tension and length of an associated mooring line **30** which passes from the winch through the hawse pipe **22** and hawse opening **20** into the ocean beneath the ice. Each mooring line in turn is connected to a length of anchor chain **32,** terminating in an anchor **34** which rests on the ocean floor.

Referring to FIG. **2,** there is shown in detail the construction where the hawse pipe terminates at the hawsehole in the side of the ship. Each hawsehole **20** in the hull **10** is formed by a steel ring **36** which preferably has a circular flange **38** that abuts a circular opening cut in the outer plates of the hull **10.** As seen in FIG. **3,** the ring **36** with its circular flange **38** provides a seat for receiving a removable cover plate **40.** This cover plate is used when the ship is underway to close off the hawsehole and thereby reduce drag and provide protection. The cover **40** may be held in place by an eye **42** attached to the inside of the cover at the center and to which the end of the mooring line **30** is secured. In this manner the mooring line **30** can be used to pull the cover plate into position and to hold it there using the associated winch **28.**

Referring again to FIG. **2,** behind the opening **20** a cylindrical chamber **44** is provided, formed by a cylindrical section **46** which is welded to the ring **36** at one end and to an annular plate **48** at the other end. The hawse pipe **22** in turn terminates and is secured to the annular plate **48.** The chamber **44** and hawse pipe **22** form a watertight passage for the mooring line, water entering this passage being excluded from the rest of the hull interior.

A fairlead, indicated generally at **50**, is provided for guiding the mooring line out of the hawse pipe opening **20**. The fairlead includes a steel body **52** which is bifurcated at one end to receive a sheave **54**. The sheave **54** is journaled on a shaft **56** extending between the bifurcated portions of the body **52**. The body **52** has a cylindrical end portion **58** which is arranged to extend into the hawse pipe **22**. A central opening **60** through the body **52** provides a passageway and guide for the mooring line **30** through the fairlead, permitting the mooring line to pass from the hawse pipe **22** over the sheave **54** and out to the anchor point.

The fairlead is made rotatable about the longitudinal axis of the hawse pipe **22**. To this end a bushing having a cylindrical portion **62** between the interior of the hawse pipe and the end portion **58** acts as a bearing to provide free rotation of the fairlead within the hawse pipe. The bushing also includes a flange portion **64** which forms a thrust bearing for a flange portion **66** of the fairlead body **52**. The fairlead body is retained in position by a collar **68** which is secured to the annular plate **48** and has an inner lip which extends over the flange portion **66** of the fairlead body **52** to retain the fairlead in the end of the hawse pipe.

With the above-described arrangement, the heading of the ship can be controlled by the eight (per the illustrated example) wire-drum winches **28** to maintain the ship in position over the wellhead. Furthermore, the ship can be rotated about this location so as to adjust the heading of the ship to keep the bow pointed against the direction of flow of the surrounding ice. The penumatically induced pitching action of the ship then can act to break up the ice as it flows toward the bow of the ship.

The control of the position and heading of a drill ship by means of multiple mooring lines is known. See for example the article "Mooring Techniques in the Open Sea" by John R. Graham, Marine Technology, Volume 2, No. 2, Apr. 1965, Page 132. However, the use of mooring lines for positioning an ice-breaking drill ship has not heretofore been accomplished and specifically, the arrangement by which the mooring lines pass out of the vessel through hawseholes located below the ice is important in being able to achieve this capability.

The invention has been described above in the context of its presently preferred embodiment, namely an arctic drillship equipped with a pneumatically-induced pitching system to enable the veseel to stay stationary in the presence of moving ice. The underwater mooring line lead-out provided by this invention can be used on any vessel, if desired, but is of particular utility where a vessel (such as a tanker, supply ship, or an oil or gas processing vessel, for example, not necessarily a drill ship) is to be moored in the presence of moving flow or sheet ice. The invention makes it possible to keep the moored vessel aligned with the direction of ice movement while preventing contact of the ice with the mooring lines. In the context of ice sheets, the present mooring arrangement is believed to be unique; conventional mooring systems cannot be used at all with sheet ice and can be used only with considerable hazard in the presence of flow ice. Also, the present mooring arrangement is better suited to use with an induced motion ice-breaking mechanism than is a conventional mooring arrangement. For these reasons, the foregoing description of the presently preferred embodiment of the invention should not be regarded as limiting the scope of this invention.

What is claimed is:

1. An ice-breaking drill ship for operation in ice-covered waters, including operation while moored over a fixed submerged location in the presence of ice movable laterally relative to the submerged location, comprising, in combination,

a. a ship-form hull,

b. means in the hull operable for inducing pitching motions of the hull effective at the bow, including during periods when the hull is moored, for breaking any surrounding ice below the bow, and

c. means for mooring the hull to a plurality of submerged anchor points disposed about a desired fixed submerged location and for adjusting the heading of the hull while so moored into the direction of movement of ice over the submerged location including

i. a plurality of winches mounted to the hull adjacent the bow and stern thereof,

ii. hawseholes in the hull in association with the winches for passage of mooring lines therethrough from the winches to the exterior of the hull, the hawseholes opening through the hull substantially below the waterline of the hull, and

iii. a rotatable fairlead mounted in the hull at the opening of each hawsehole for rotation about substantially the axis of the hawsehole for guiding a mooring line into the hawsehole from the exterior of the hull from any direction, whereby the heading of the ship, while moored and during operation of the pitch inducing means, may be changed by controlled selective operation of the winches to take in and pay out mooring lines extending from the winches via the hawseholes to submerged anchor points disposed about the desired fixed location.

2. Apparatus of claim **1** further comprising means defining a recessed chamber surrounding the opening of each hawsehole and open to the water, the fairlead being mounted inside the chamber.

3. Apparatus of claim **2** further including a removable plate for covering the opening of each of the chambers to the water when the ship is underway.

4. An ice-breaking drill ship for operation in ice-covered waters comprising means in the ship inducing a pitching motion of the bow of the ship for breaking any surrounding ice beneath the bow, and means for positioning the ship for drilling and for heading the bow of the ship against the flow of the ice including a plurality of winches mounted in the ship, anchor means including mooring lines extending from the winches through hawse holes in the hull of the ship to anchor points spaced from the ship, the hawseholes opening through the hull of the ship substantially below the waterline of the ship, a rotating fairlead mounted in the ship at the opening of each hawsehole for rotation about the axis of the hawsehole so as to guide the mooring line into the hawsehole from the water from any direction, a recessed chamber in the ship surrounding the opening of each hawsehole and open to the water and in which the fairlead for the hawsehole is mounted, and a removable plate for covering the opening of each chamber to the water when the ship is underway.

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