United States Patent [19]

Dean, III

[11] **3,774,562**

[45] **Nov. 27, 1973**

[54] **360° ROTARY ANCHORING SYSTEM WITH DIFFERENTIAL DRIVE CAPABILITY**

[75] Inventor: **James T. Dean, III,** Long Beach, Calif.

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

[22] Filed: **June 12, 1972**

[21] Appl. No.: **261,911**

[52] **U.S. Cl.** ..... **114/0.5 D,** 9/8 P, 308/231, 61/46.5

[51] **Int. Cl.**..... **B63b 35/00**

[58] **Field of Search**..... 114/.5 D, .5 F, .5 T, 114/.5 R, 144 B, 206, 230; 9/8 P; 175/7; 308/231; 212/70; 108/103; 312/125

[56] **References Cited**

UNITED STATES PATENTS

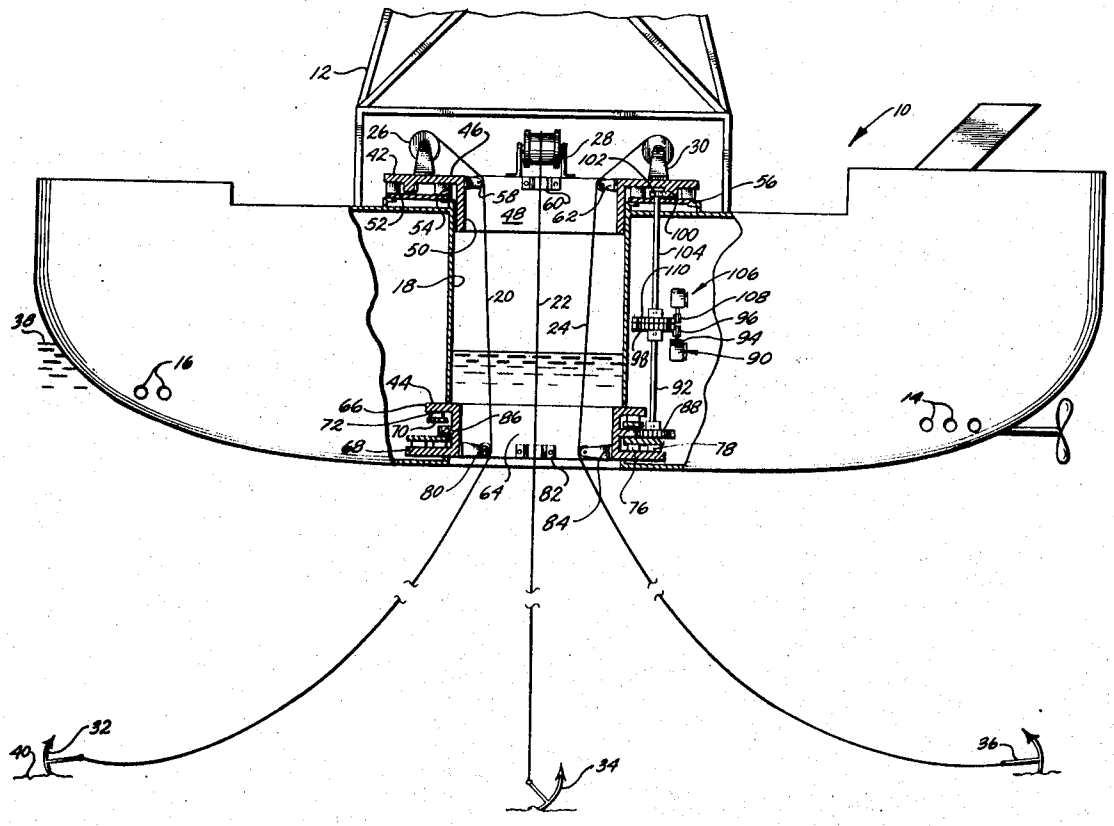
3,191,201	6/1965	Richardson et al.	114/.5 D
3,602,302	8/1971	Kluth	114/.5 T
3,590,407	7/1971	Bratianu	114/.5 T
3,525,312	8/1970	Beck et al.	114/.5 T

Primary Examiner—George E. A. Halvosa
Assistant Examiner—Edward R. Kazenske
Attorney—Robert L. Parker et al.

[57] **ABSTRACT**

A mooring system for a vessel has two independently drivable positioning bases in the form of rings. An upper of these rings carries the mooring chain winches and is disposed at the upper end of a moonpool in the vessel. The lower of the rings is at the bottom of the moonpool and carries fairleads for the anchor chains. Small positional changes of, say, one or two degrees required in the heading of a moored ship are accommodated by rotation of the vessel with respect to the bottom ring. Larger heading changes require the use of the ship's positioning system in conjunction with the upper and lower positioning rings which are then synchronized together.

8 Claims, 4 Drawing Figures



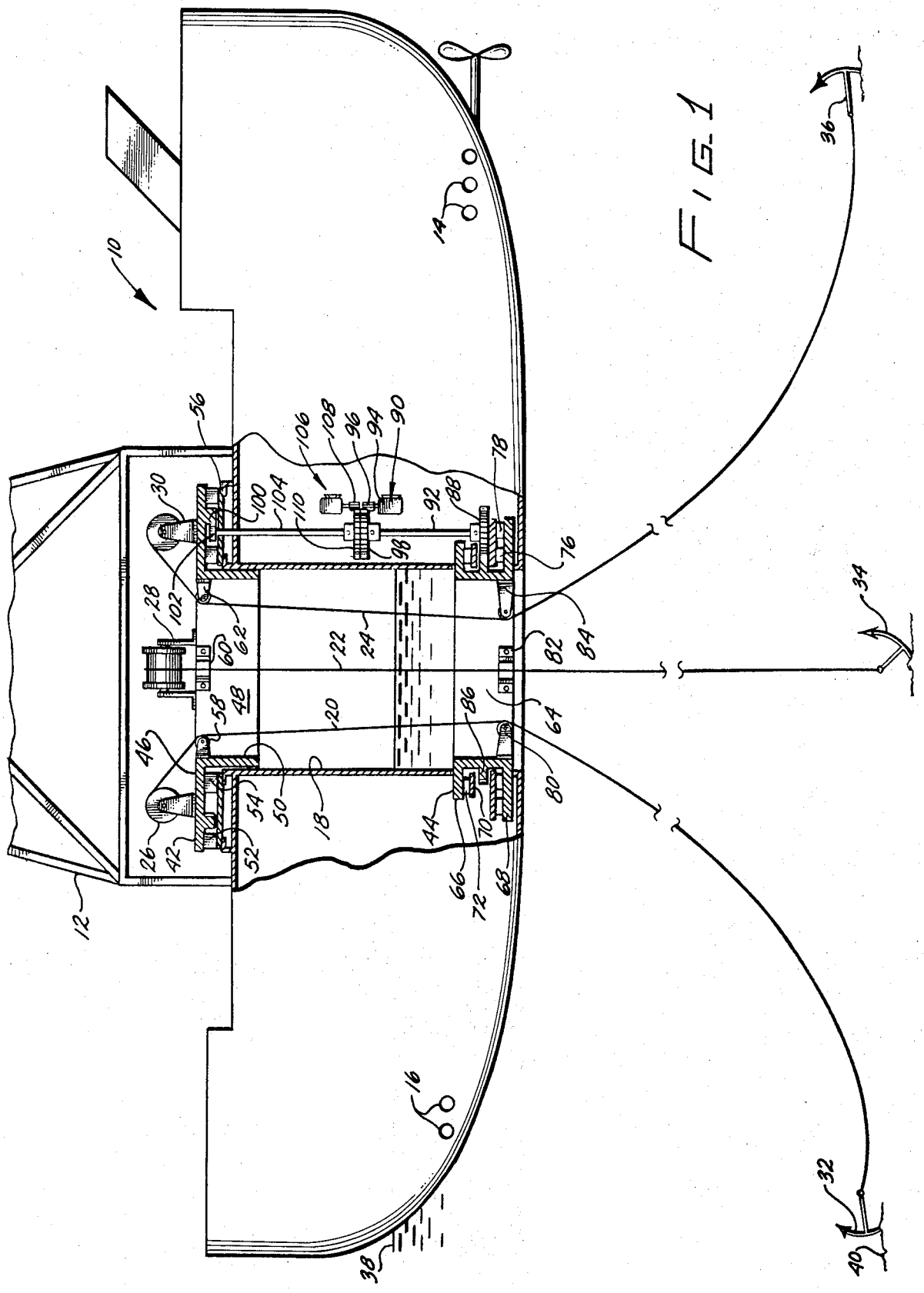

10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
76
78
80
82
84
86
88
90
92
94
96
98
100
102
104
106
108
110

FIG. 1

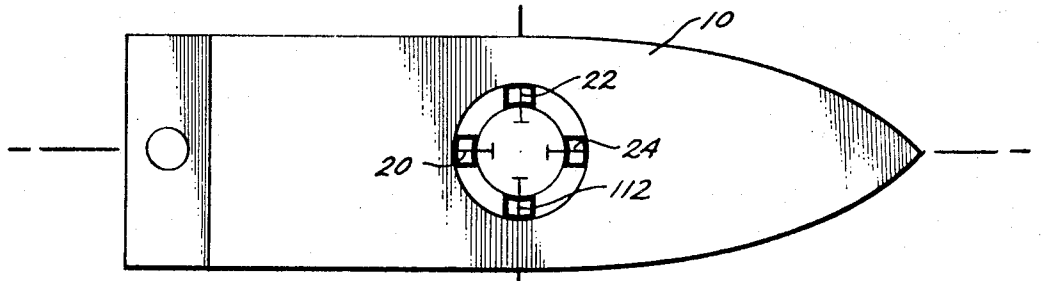


FIG. 2

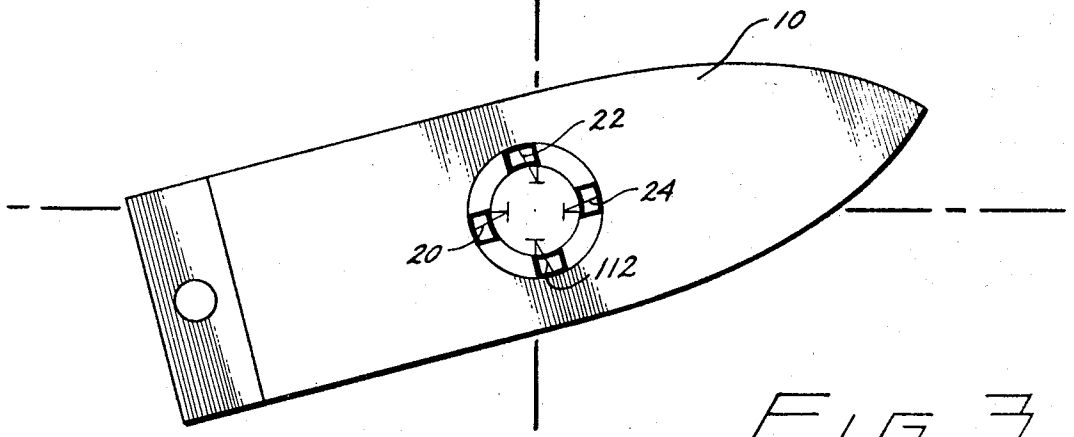


FIG. 3

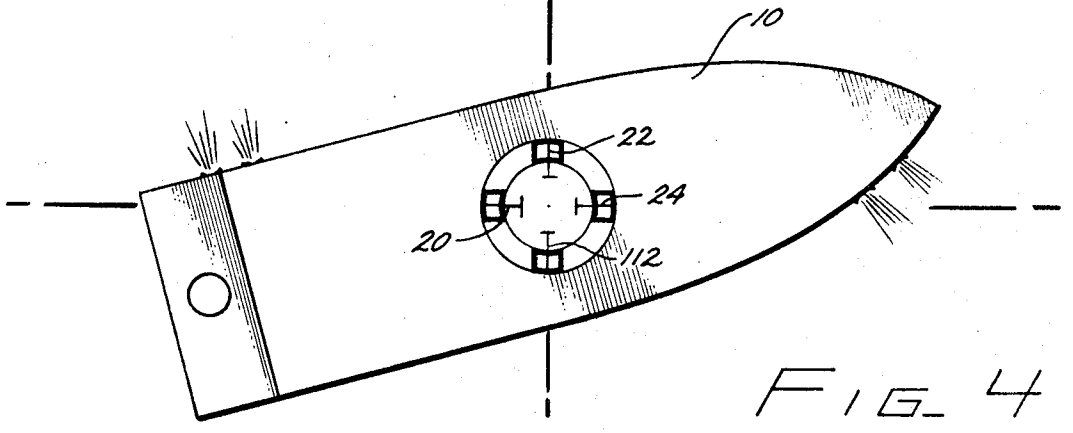


FIG. 4

360° ROTARY ANCHORING SYSTEM WITH DIFFERENTIAL DRIVE CAPABILITY

BACKGROUND OF THE INVENTION

The present invention relates to mooring systems in general and, more in particular, to a mooring system for a vessel which must maintain a station for a reasonable period of time.

It is the practice for moored vessels, such as offshore drilling vessels, to moor the vessel through a plurality of anchors disposed radially about the vessel.

In many applications it is important to keep a very accurate station. The importance of keeping an accurate station with respect to the ocean's floor is obvious when consideration is given to offshore drilling and the requirement there that the drill string, for example, should be relatively stationary against ocean-caused shear forces at all times.

To accommodate changes in environmental factors such as sea state, currents, winds and the like, a vessel is headed in a direction to provide least resistance to environmental forces. The change in heading which is often required in a vessel is difficult to accomplish with the multiple anchor mooring system described briefly above because anchor chains must be taken in and paid out to accommodate the change in vessel heading.

Because of the difficulties in changing the vessel heading with multiple anchor mooring systems, it has been proposed to employ a mooring swivel which extends completely through the ship from the deck through to the keel. The mooring chains extend through the swivel. When a heading change is required, the vessel is effectively rotated about the mooring swivel to a desired heading, the swivel being stationary with respect to the mooring anchors. While this solution to the station-keeping problem is attractive, it has drawbacks. Initially, the mooring swivel is tremendously heavy and therefore the friction loads between the swivel and the ship are very high, requiring a great deal of power to effect rotation of the ship about the mooring swivel. In addition, load takeup from the loads of mooring is distributed fairly well throughout the length of the swivel, which is not always desirable in that thrust loads in the horizontal are best taken by a vessel close to its keel. This is because in the keel zone of a vessel there is a great deal of the vessel's structure to take the horizontal thrust loads and loads there least affect the stability of the vessel.

Thus there is a need for a station-keeping mooring system which is capable of operation without undue consumption of power, with the facility to take mooring loads in the vicinity of the keel, and which is responsive to the station-keeping requirements of a vessel.

SUMMARY OF THE INVENTION

The present invention provides a mooring system which is characterized in the use of two independently drivable positioning bases on a ship. One of these bases provides the attachment point of the anchor chains to the vessel, while the other provides means such as fairleads for the anchor chains for transferring load between the mooring system and the vessel.

Preferably, one of the bases is disposed proximate the bottom of a moonpool of a vessel and provides the mounting for the fairleads. The second base is disposed proximate the top of the moonpool and mounts the means for securing the vessel's anchors, such as winches for the various anchor chains. Anchor chains from the winches extend over respective fairleads to their anchors. Means are provided, such as separate, two-directional D-C motors, to drive each of the bases with respect to the ship. Means are also provided to drive the bases synchronously with respect to one another and with respect to the ship, as through a transmission operable to couple the drive trains of both bases together. Means are also preferably provided to position the vessel when it is necessary for large changes in heading. These latter means may be prior art thrusters disposed in the vessel's bow and stern.

After a vessel has been moored, assume that a slight change in heading, say, 1 or 2°, is required to accommodate an environmental change of, say, current direction. In this instance the lower base becomes the drive base for the vessel and the upper base is coupled to the vessel to change position with it. The drive for the lower base effectively rotates the vessel the 1 or 2° about the lower base to the desired heading. Obviously, the lower base does not rotate with respect to the ocean's floor.

For larger changes in heading of, say, 15°, both the upper and lower bases are rotated together to provide a rotation base for the vessel. In addition, such normal positioning means as bow and stern thrusters are employed. The reason for the difference in approach between small and large heading changes is that anchor chain orientation with respect to each of the bases would become unsatisfactory in large heading corrections if only one of the bases were rotated.

The present invention provides a ready means for station keeping of a moored vessel. Side thrust loads from the vessel's mooring chains are substantially completely transferred from the lower rotation base to the vessel in the vicinity of its keel. This means that no substantial additional structure in the ship is required to accommodate the loads. The power required to rotate the ship with respect to the rotation bases is substantially less than that required in the previously suggested concept of providing a sleeve or swivel throughout the entire depth of the ship because the friction loads are substantially reduced. Moreover, there is little additional structure needed on deck side to accommodate the weight of the upper rotation base, at least when compared to the structure required when the deck must support the entire weight of a mooring swivel which extends completely through the vessel.

These and other features, aspects and advantages of the present invention will become more apparent from the following description, appended claims and drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a schematic depiction of a vessel moored to the sea floor employing the mooring system of the present invention;

FIG. 2 is a schematic depiction looking down on a vessel as moored prior to heading change to accommodate changes in environmental factors;

FIG. 3 illustrates the mooring system of the present invention as it would appear in slight heading changes, the heading change illustrated being exaggerated for purposes of illustration; and

FIG. 4 illustrates a change of heading to accommodate environmental factors which requires the use of

the vessel's positioning system other than that provided by the rotation bases alone.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention provides a mooring system characterized in the use of two independently drivable rotation bases mounted on a vessel, one over the other, around the moonpool of the vessel. The rotation bases may be coupled together so that a vessel can rotate around them, or only one may be used to drive the vessel a few degrees for a heading correction. The present invention requires the use of additional heading correction means when the heading of a vessel is to be changed by a considerable amount, say, 15°.

As will become more apparent as this description proceeds, when the heading of a vessel is changed by its rotation about one or both of the rotation bases, the rotation base around which the vessel rotates is fixed relative to the sea floor because it is moored through the anchor chains and anchors to the sea floor.

With reference to FIG. **1**, the mooring system of the present invention is illustrated generally schematically. The Figure illustrates a ship or vessel **10**. The vessel is of a standard design for use in offshore drilling. It has a derrick **12**. It also has positioning means for positioning itself while moored to a desired heading. The means illustrated includes port stern thrusters **14** and port bow thrusters **16**. Starboard stern and bow thrusters are also provided. Because the particulars of the thrusters are well known in this art, their detailed description will not be presented here. Vessel **10** has a moonpool **18** through which apparatus attendant with the drilling of a well extends to the sea floor below the derrick.

A plurality of anchor chains **20, 22** and **24** extend from respective winches **26, 28** and **30** to anchors **32, 34** and **36,** respectively. More anchor chains, anchors and winch combinations can be employed, and usually are, than those illustrated in FIG. **1**. The water level is indicated by reference numeral **38**. The sea floor is indicated by reference numeral **40**.

The mooring system includes an upper rotation base **42** and a lower rotation base **44**. The rotation bases may be coupled together for the ship's rotation with respect to them, or they can be driven independently of one another for the ship's rotation with respect to only one of them.

The upper rotation base includes an annular, ring-like winch mounting platform **46** having a central opening **48** for the passage of oil drilling apparatus and the anchor chains. Winches **26, 28** and **30** are mounted on the platform. A right cylindrical guide **50** depends vertically from platform **46** into the moonpool. This guide transmits relatively modest thrust forces to the vessel, the remaining of the lateral loads being transmitted through lower rotation base **44**.

Upper rotation base **42** is supported above the deck of a vessel through a plurality of rollers shown in two concentric circles of different diameters of rollers **52** and **54**. These rollers bear on a track **56** and may be caged in any manner well known in the art. Track **56** is fixed to the vessel. The purpose of the rollers of course is to provide low friction losses during rotation of the upper base with respect to the ship and to transmit vertical compression loads to the hull of the ship. Fairleads **58, 60** and **62** are provided to keep anchor chains **20, 22** and **24** away from the rotation base proper. If desired, guide **50** can be dispensed with in favor of thrust plates associated with thrust rollers in place of the rollers illustrated, this being well within the province of the art.

Lower rotational base **44** is an annular, ring-like member having a generally cylindrical and vertically extending inner wall **64** extending a limited distance along the vertical axis of the moonpool at the bottom of the moonpool. A load transmitting flange **66** depends radially away from wall **64** into the hull of the ship. A second and lower load transmitting flange **68** depends radially in the same direction into the hull of the ship. A ring-like track **70** and rollers **72** are provided to carry the load transmitted by the upper flange to the ship's hull. This load is no more than the weight of the lower base. A similar arrangement is provided for transmitting vertical forces acting upwardly from the bottom rotation base to the ship's hull. Thus a track **74** and concentrically disposed roller sets **76** and **78** are provided. Roller set **76** has a diameter smaller than the diameter of roller set **78.** Roller sets **76** and **78** are provided to reduce friction. For each of the anchor chains a fairlead is provided to prevent the anchor chain from engaging the rotation base proper. Thus fairleads **80, 82** and **84** are illustrated in FIG. **1** for anchor chains **20, 22** and **24.**

A ring gear **86** secured to rotation base **44** provides for its selective rotation. A gear **88** engages the ring gear from a lower rotation base drive **90.** A drive shaft **92** is provided for lower gear **88.** A lower rotation base drive motor **94** drives shaft **92** through a gear **96** and a gear **98.** A similar arrangement is provided for the upper rotation base. Thus a ring gear **100** is affixed to the upper rotation base proper and is driven by a gear **102.** Gear **102,** in turn, is driven through a drive shaft **104.** An upper rotation base drive **106** drives drive shaft **104** through a gear **108** and a gear **110.** The motors for the upper and lower rotation bases may be operated independently at variable speeds and can be reversed. If desired, a single motor can be provided with transmission means for coupling and uncoupling the bases together. Again the means for accomplishing the coupling and uncoupling of the bases together for common drive is well within the province of the art, and, accordingly, a more detailed description of the drive will not be presented. Gears **98** and **110** are shown, however, adjacent to one another to symbolize the fact that they can be coupled together for common rotation of both the upper and lower rotation bases.

The operation of the present invention will be described with reference to all the Figures.

In FIG. **2**, ship **10** is shown at an initial heading, say, due east. Suppose it is desirable to change the heading of the ship, say, 1 or 2° to the north. To accomplish this, upper drive **106** is disconnected from lower drive **90.** The lower drive is then operated to act on ring gear **86** of lower rotation base **44.** The rotation base is fixed in position rotationally because of the forces on it of anchor chains **20, 22** and **24,** and a fourth anchor chain **112.** The reaction force to the torque applied on ring gear **86** through drive **90** rotates the vessel in the desired direction to the new heading, a few degrees from the former east heading towards north. The upper drive is not operated during this minor heading correction and thus only the friction loads associated with the lower rotation base must be overcome by base drive **90.** The new heading is shown in FIG. **3.** In the Figure, the

lower base's fairleads have not moved from the FIG. 2 position.

If a larger heading change is desired, it is preferred that the rotation base drives of the present invention be used in conjunction with the ship's bow and stern thrusters. This is illustrated schematically in FIG. 4. A course correction from due east to, say, northeast, is required to bring the ship into the wind. The starboard bow thrusters and port stern thrusters are operated to rotate the ship about both rotation bases. Simultaneously, the upper and lower rotation base drives are operated to at least overcome any friction between these bases and the ship proper. When the final heading is reached, both bases again will be in the same position that they were in when the ship had a heading of due east.

The present invention has been described with reference to a certain preferred embodiment. The spirit and scope of the appended claims should not, however, necessarily be limited to the foregoing description.

What is claimed is:

1. An improved mooring system for drilling vessels and the like comprising:

a. a vessel having anchor chains;

b. a moonpool in the vessel;

c. a lower rotation base in the moonpool and coupled to the vessel for rotation with respect thereto;

d. an upper rotation base in the moonpool and coupled to the vessel for rotation with respect thereto;

e. drive means for the upper and lower rotation bases operable to drive the lower rotation base independently of the upper rotation base and to drive the two together; and

f. means for transmitting lateral thrust loads from the anchor chains to the lower rotation base.

2. The improved mooring system claimed in claim **1** wherein the means for transmitting lateral thrust loads to the lower rotation base includes a fairlead for each of the anchor chains.

3. The improved mooring system claimed in claim **2** wherein the upper and the lower rotation bases are rotationally coupled to the vessel through respective sets of roller means.

4. The mooring system claimed in claim **3** wherein the upper rotation base includes a generally ring-like member horizontally disposed with respect to the vessel to transmit vertical downward forces applied to the upper rotational base through the roller means of the upper rotation base to the vessel.

5. In a drilling vessel or the like, an improved mooring system comprising:

a. a moonpool;

b. a lower rotation base disposed in the moonpool and coupled to the vessel for rotation with respect thereto;

c. an upper rotation base disposed above the lower rotation base in the moonpool and coupled to the vessel for rotation with respect thereto;

d. a plurality of mooring winches disposed on the upper rotation base;

e. an anchor chain operably coupled to each of the mooring winches, the anchor chain being extendable through the moonpool and the upper and lower rotation bases;

f. means for transmitting lateral thrust loads from the anchor chains to the lower rotation base;

g. drive means for the lower rotation base and the upper rotation base operable to drive the lower rotation base independently of the upper rotation base to rotate a ship about the lower rotation base while the upper rotation base rotates with the ship; and

h. independent ship heading positioning means for changing the heading of a ship when a change in the heading is of a relatively large magnitude.

6. The mooring system claimed in claim **5** wherein the means for transmitting lateral thrust loads to the lower rotation base includes a plurality of fairleads attached to the lower rotation base with one of the fairleads being associated with each one of the anchor chains to transmit lateral thrust loads therefrom to the lower rotation base and to the vessel.

7. The mooring system claimed in claim **5** wherein the upper and the lower rotation bases are rotationally coupled to the vessel through respective sets of roller means.

8. The mooring system claimed in claim **7** wherein the upper rotation base includes a generally ring-like member horizontally disposed with respect to the vessel to transmit vertical downward forces applied to the upper rotational base through the roller means of the upper rotation base to the vessel.

* * * * *