SINGLE ANCHOR LEG SINGLE POINT MOORING SYSTEM

Inventors: John F. Flory, Morristown, N.J.; Colin N. T. Baptist, Tripoli, Libya; Russel C. Kuhn, Princeton; Frederick H. Stracke, Convent Station, both of N.J.

Assignee: Esso Research and Engineering Company

Filed: Sept. 9, 1969

Appl. No.: 856,445

U.S. Cl. 9/8; 8 P

Int. Cl. B63b 21/52

Field of Search 9/8, 8 P; 114/0.5, 0.5 T; 230; 61/46-46.5; 141/387-388; 137/236-236.05; 166/5

References Cited

UNITED STATES PATENTS


Primary Examiner—Milton Buchler
Assistant Examiner—Gregory W. O'Connor
Attorney—Manahan and Wright and Jay Simon

ABSTRACT

A single anchor leg single point mooring and cargo-handling system, primarily for tanker vessels, is provided which comprises a mooring buoy anchored to a mooring foundation by a single anchor leg, a portion of which is a rigid conduit utilized for cargo transfer, and a portion of which is a flexible connection, and providing means for permitting the buoy to rotate with respect to the mooring foundation.

11 Claims, 2 Drawing Figures
1 SINGLE ANCHOR LEG SINGLE POINT MOORING SYSTEM

FIELD OF THE INVENTION

This invention relates to a single point mooring system for seagoing ships, particularly tanker vessels, wherein fluid cargo handling facilities are integrated with the mooring system. More particularly, this invention relates to a mooring and cargo-handling facility wherein a mooring buoy is positioned by a single anchor leg, a portion of that anchor leg being simultaneously utilized as a fluid conduit for cargo handling, and wherein means are provided in the anchor leg to allow the buoy to rotate freely under the influence of the movement of the tanker.

PRIOR ART

With the advent of exceptionally large tanker ships of 200,000 to 300,000 d.w.t., and up to 500,000 d.w.t., loading and unloading of such ships has become increasingly complex. These ships have such deep drafts that natural harbors often cannot accommodate them and their size is such that mooring forces are quite high. Rather than create new harbors at an exceedingly high cost, it has been suggested to moor such ships in deep water and to transfer the fluid cargo through under-water pipelines to shore.

When a ship is moored to a single buoy in such a manner that it is free to swing around the buoy, the system is referred to as single point mooring. The ship is moored to the buoy by bow hawsers and the ship freely rotates 360° about the buoy, thus reducing the mooring forces. Provision must be made to transfer the fluid cargo between the ship and the underwater pipeline as the ship rotates. In order to avoid interference between the mooring system and the cargo-handling system, previous single point mooring designs have employed buoys moored by four or more anchor chains and have used expensive under-buoy cargo hoses. An integrated single point mooring and cargo-handling system has now been developed which is more economical than previous systems because the mooring and cargo-handling functions are combined in a single anchor leg. This single anchor leg system is described below.

SUMMARY OF THE INVENTION

In accordance with this invention, therefore, a single anchor leg single point mooring system, having integrated cargo-handling facilities, is provided wherein a mooring buoy located at or near the surface of the sea is anchored to a foundation fixed to the sea bottom. A single anchor leg of predetermined length connects the buoy and foundation and holds the buoy down against its natural buoyancy, i.e., the entire anchor leg is in tension, and a portion of the single anchor leg is simultaneously utilized as a fluid conduit. In order to accommodate the movement of the vessel, means are provided in the single anchor leg to permit the buoy to rotate freely about a vertical axis through the center of the foundation. Also, to eliminate excessive stresses on the anchor leg, antirotation flexible pivoting means are provided for connecting the single anchor leg to the foundation, thus assuring that the loads on the anchor leg will be axial.

DRAWING DESCRIPTION

The attached drawings will better illustrate this invention and several of the variously preferred embodiments it may take. In the drawings, identical numerals will refer to identical parts in the same or different drawings.

FIG. 1 shows the arrangement of a preferred integrated single anchor leg single point mooring and cargo-handling system.

FIG. 2 is a section at the upper end of the fluid conduit portion of the single anchor leg.

FIG. 3 is a side elevation of the connection between the fluid conduit portion of the single anchor leg and the upper connecting chain to the mooring buoy.

FIG. 4 shows the arrangement of an alternative single anchor leg single point mooring system integrated with cargo-handling facilities.

FIG. 5 is a section at the bottom of the rigid fluid conduit portion of the single anchor leg.

Referring now to FIG. 1, numeral 10 indicates a rigid fluid conduit, i.e., a pipe, capable of supporting the mooring load of a vessel. The pipe 10 is connected through a flexible pivoting means 16, e.g., a universal joint, to a mooring foundation 12, which is rigidly fixed to the sea bottom. It should be noted that the joint 16 prevents rotation of pipe 10 relative to foundation 12, while permitting pipe 10 to pivot freely from the joint under the influence of current, tides, mooring loads, etc. A submerged pipeline 18 transports the cargo fluid to the foundation 12 and into foundation hoses 20 which transmit the cargo fluid from the submerged pipeline 18 to swivel joints 21 at the base of the pipe 10. A buoyancy chamber 22 is mounted on the pipe 10 near its upper end to aid in supporting the pipe.

A fluid swivel assembly 24, consisting of a center load-carrying shaft 23, surrounded by a rotatably mounted housing 19, is mounted on the top of pipe 10. (This fluid swivel assembly is more fully described in copending application Ser. No. 856,259 filed Sept. 9, 1969, to be assigned to the same assignee as that of the present application.) Anchor chain swivel 34 is connected to an eye 35 at the top of the shaft 23 and anchor chain 32 is connected to the anchor chain swivel 34. The mooring buoy 28 is firmly attached to the other end of the anchor chain 32. Of course, anchor chain swivel 34 could be located either at the base of mooring buoy 28 or at the top of the fluid swivel assembly 24.

Pivotedly mounted on housing 19 of the fluid swivel assembly 24 at pivot point 25 (FIGS. 2-4) are restraint means comprising a chain spreader arm 26 which extends outwardly from the fluid swivel assembly 24. Generally, the ends of the chain spreader arm 26 will be located at or within the perimeter of the mooring buoy 28 and connected to mooring buoy 28 by means of flexible chains or cables 30 of predetermined length so as to remain slack while anchor chain 32 is tensioned by the mooring load. The effect of the spreader arm and connecting chains (of which there are at least two) is to permit the housing 19 of the fluid swivel assembly 24 to rotate in unison with the mooring buoy. Thus, when a ship is moored to mooring buoy 28, by affixing a line from the ship to hook 29 mounted on the buoy, the ship can rotate freely around the buoy, the buoy also rotating to follow the motion of the ship. The rotational motion of the buoy is then transmitted through the chains 30 and spreader arm 26 to housing 19 of fluid swivel assembly 24.

Now, fluid cargo flowing to the ship will pass upwardly through pipe 10 into fluid swivel assembly 24 and into a pipe yoke 36 connected to fluid swivel assembly 24 by means of two fluid swivel joints 37. The pipe yoke 36 is connected to a flexible fluid conduit 38, e.g., rubber hose, for transporting cargo between the ship and the mooring system. Of course, if desired, a pipe yoke need not be employed and separate conduit means from the ship may be connected directly to swivel joints 37. Additionally, floating loading hose between the ship and the buoy can be employed when separate hoses are used to transfer cargo between the swivel and the buoy.

A highly advantageous feature of the invention shown in FIG. 1 is that the fluid conduit means connecting the fluid swivel assembly and the ship is connected to the fluid swivel assembly at some point between the sea surface and the sea bottom. Previous proposals have positioned the fluid conduit and swivels either at the surface, where they are subject to ship damage and wave forces, or at the sea bottom, where they are subject to abrasion. This factor is particularly important in the case of flexible conduit means, e.g., rubber or reinforced rubber, which is relatively expensive.

Turning now to FIG. 4, a variation of the single anchor leg single point mooring system is shown. At the upper end of the single anchor leg, pipe yoke 36 has been replaced by conduit means 40 which connect the fluid swivel assembly 24 to piping 41 located in or on the mooring buoy 28. A fluid conduit
means 43 is connected through swivel joint 42 to piping 41 for transporting the fluid cargo to or from the ship, the conduit 43 normally floating on the surface of the sea.

Still referring to FIG. 4, another embodiment of the invention is shown wherein the lower end of the single anchor leg 5 shows an alternate method of connecting pipe 10 to mooring foundation 12. In this instance, instead of a joint permitting angular movement and resisting rotational motion of pipe 10, a tensioned anchor chain 50 connects pipe 10 to mooring foundation 12. Fluid conduit means 20 from conduit means 18 to 10 are connected through swivel joints 37 to pipe 10. A chain spreader arm 26 extends outwardly from pivot points 25 on pipe 10. The outer ends of spreader arm 26 are connected to mooring foundation 12 by means of flexible chains or cables 30 of predetermined length so as to remain slack while anchor chain 50 is tensioned by the mooring load. This arrangement serves the same purpose as the connection 16 shown in FIG. 1, i.e., permitting angular movement of pipe 10 with respect to mooring foundation 12 but resisting relative rotational movement of pipe with respect to mooring foundation 12 by virtue of the tension in chains 30.

Having now described the invention, of which various modifications and variations will be obvious to those skilled in the art, the following claims will point out that which is believed to be the invention herein.

What is claimed is:

1. A single point mooring and cargo-handling system for tanker vessels which comprises, in combination:
   a. a mooring foundation anchored to the sea bottom;
   b. a mooring buoy capable of carrying a mooring load located at or near the surface of the sea including means for mooring the vessel directly thereto;
   c. an anchor leg means for interconnecting said mooring buoy and said foundation in coxial relation and capable of carrying a mooring load, said anchor leg means including a nonrotating rigid fluid conduit flexibly connected to said foundation and means for flexibly interconnecting said rigid fluid conduit and said buoy such that said buoy is held under tension, and means in operable communication with said rigid fluid conduit for transferring cargo to and from said rigid fluid conduit.

2. The system of claim 1 wherein said anchor leg means comprises a lower portion said rigid fluid conduit flexibly connected to said foundation and as an upper portion said means for flexibly interconnecting said rigid fluid conduit to said buoy, said upper portion comprising means for allowing said buoy to rotate with respect to said lower portion.

3. The system of claim 2 wherein said lower portion comprises swivel means and said upper portion comprises means for preventing said lower portion from rotating about a vertical axis with respect to said foundation.

4. The system of claim 2 wherein said flexible restraint means comprises a universal joint for permitting free pivotal movement of said rigid fluid conduit relative to said foundation.

5. A single point mooring and cargo-handling system for tanker vessels which comprises, in combination:
   a. a mooring foundation anchored to the sea bottom;
   b. a mooring buoy located at or near the surface of the sea including means adapted for mooring the vessel directly thereto;
   c. an anchor leg means for interconnecting said buoy and said foundation about a common main axis and capable of carrying a mooring load, said anchor leg means comprising:
      i. said lower portion including a nonrotating rigid fluid conduit flexibly connected to said foundation and a shaft rigidly attached to the top of said rigid fluid conduit,
      ii. said upper portion including flexible means for connecting said lower portion to said buoy, means for allowing said buoy to rotate with respect to said lower portion and swivel means surrounding said shaft and rigidly mounted thereon and having first conduit means communicating with said rigid fluid conduit, said shaft extending through said swivel means and secured to said flexible means; and
      d. means in operable communication with said rigid fluid conduit for transferring cargo to and from said rigid fluid conduit.

7. The system of claim 6 wherein said rigid fluid conduit is connected to said foundation by flexible restraint means for preventing said lower portion from rotating about a vertical axis with respect to said foundation, said flexible restraint means comprising at least one spreader arm pivotally mounted to said rigid fluid conduit, and extending outwardly therefrom, and flexible tension means connecting said foundation with the outer ends of said spreader arm.

8. The system of claim 6 wherein said first conduit means communicates with second conduit means for transferring cargo to and from the moored vessel.

9. The system of claim 6 wherein said first conduit means communicates with flexible conduit means for transferring cargo to and from said buoy, and second conduit means are provided for transferring the cargo between said buoy and the moored vessel.

10. A single point mooring and cargo-handling system for tanker vessels which comprises, in combination:

   a. a mooring foundation anchored to the sea bottom;
   b. a mooring buoy located at or near the surface of the sea including means adapted for mooring the vessel directly thereto;
   c. anchor leg means for interconnecting said buoy and said foundation about a common main axis and capable of carrying a mooring load, said anchor leg means comprising:
      i. said lower portion including a nonrotating rigid fluid conduit flexibly connected to said foundation and to said buoy,
      ii. said upper portion including flexible means for connecting said lower portion to said buoy, swivel means for allowing said buoy to rotate with respect to said lower portion, and restraint means directly connected between said swivel means and said buoy, said restraint means comprising at least one spreader arm pivotally attached to said swivel means and extending outwardly therefrom, and flexible tension means connecting the outer ends of said spreader arm with said buoy, said flexible tension means being of predetermined length so as to remain slack while said flexible means is tensioned by a mooring load, whereby said swivel means rotates in unison with said buoy, and
      d. means in operable communication with said rigid fluid conduit for transferring cargo to and from said rigid fluid conduit.

11. The system of claim 10 wherein the connection between said rigid fluid conduit and said foundation includes restraint means comprising at least one spreader arm pivotally mounted with said rigid fluid conduit and extending outwardly therefrom, and flexible tension means connecting the outer ends of said restraint means to said foundation to prevent relative rotation between said rigid fluid conduit and said foundation.