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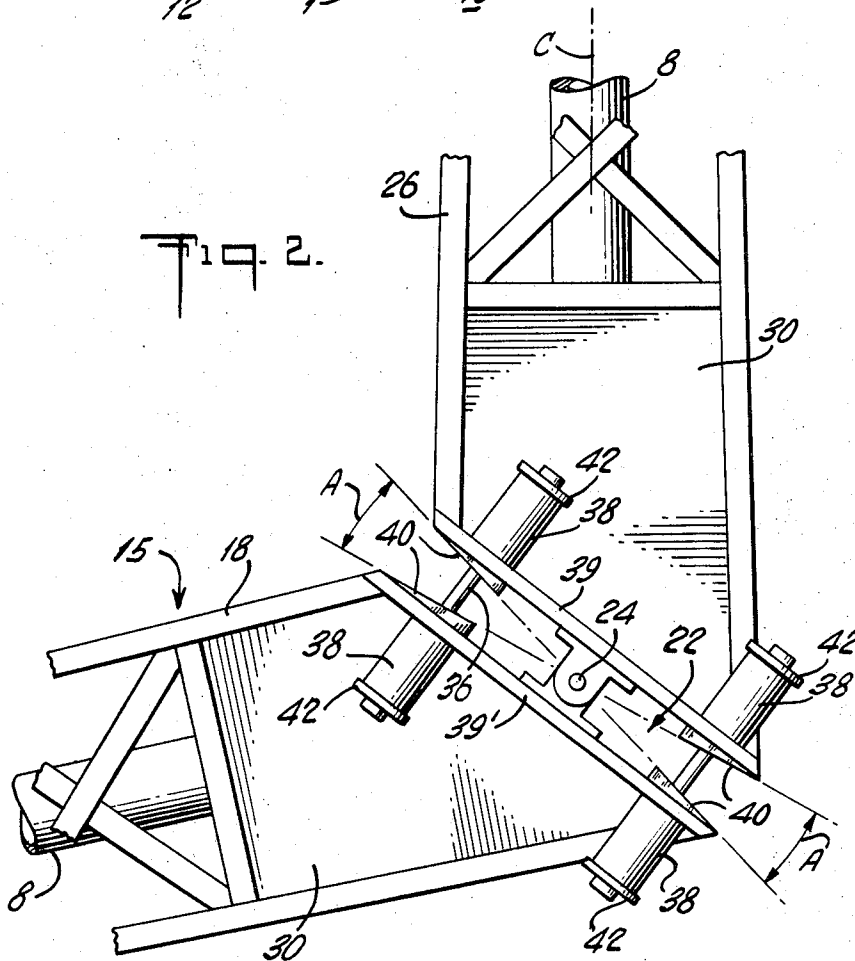
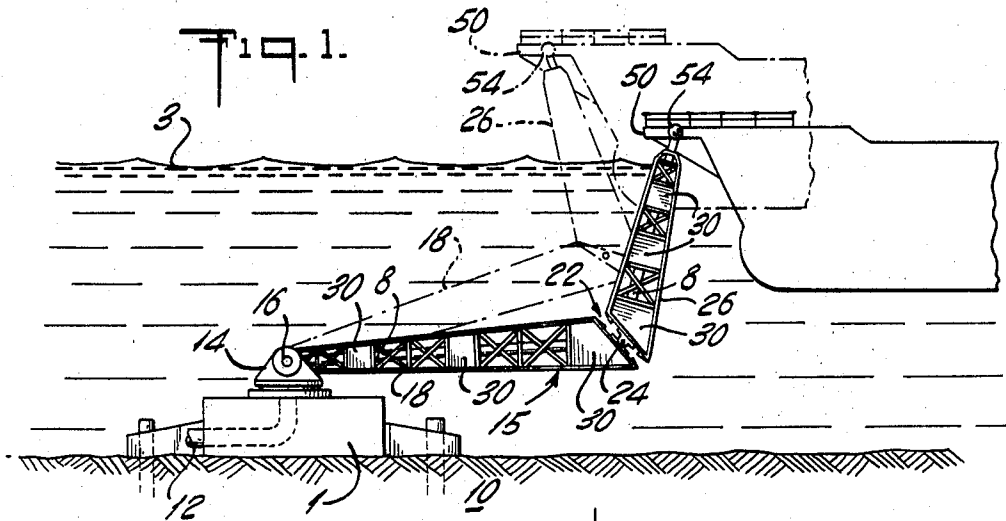
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3,572,408

COMBINED SHIP MOORING AND LOADING-UNLOADING DEVICE

Filed April 29, 1968

2 Sheets-Sheet 1



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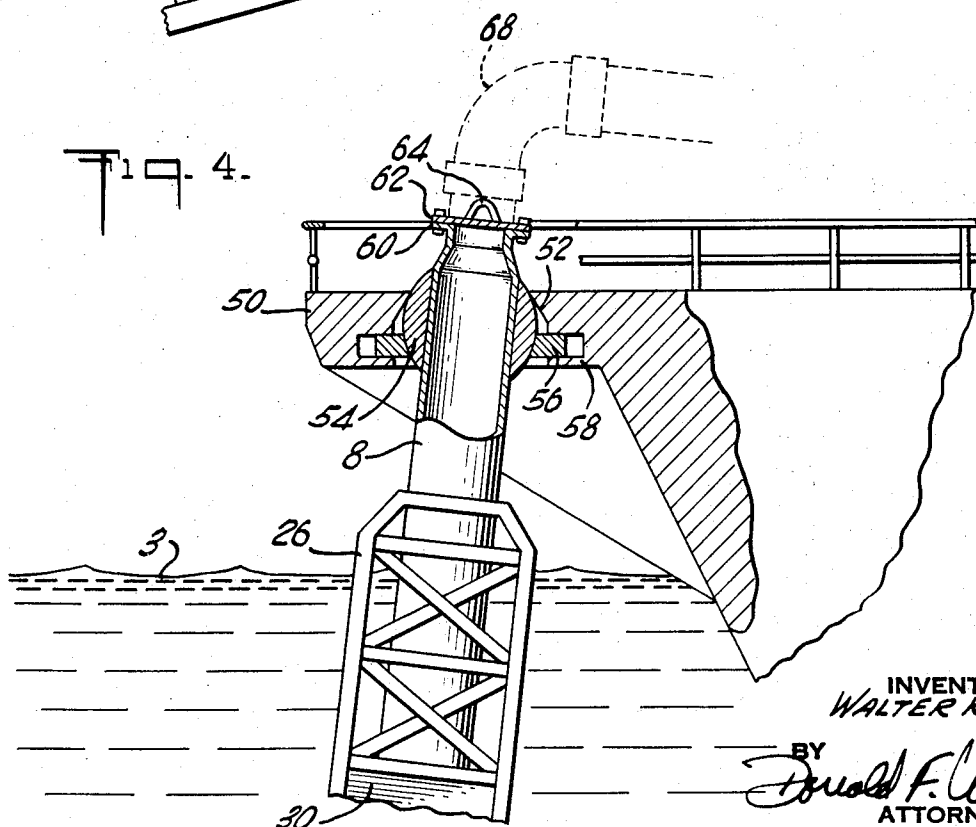
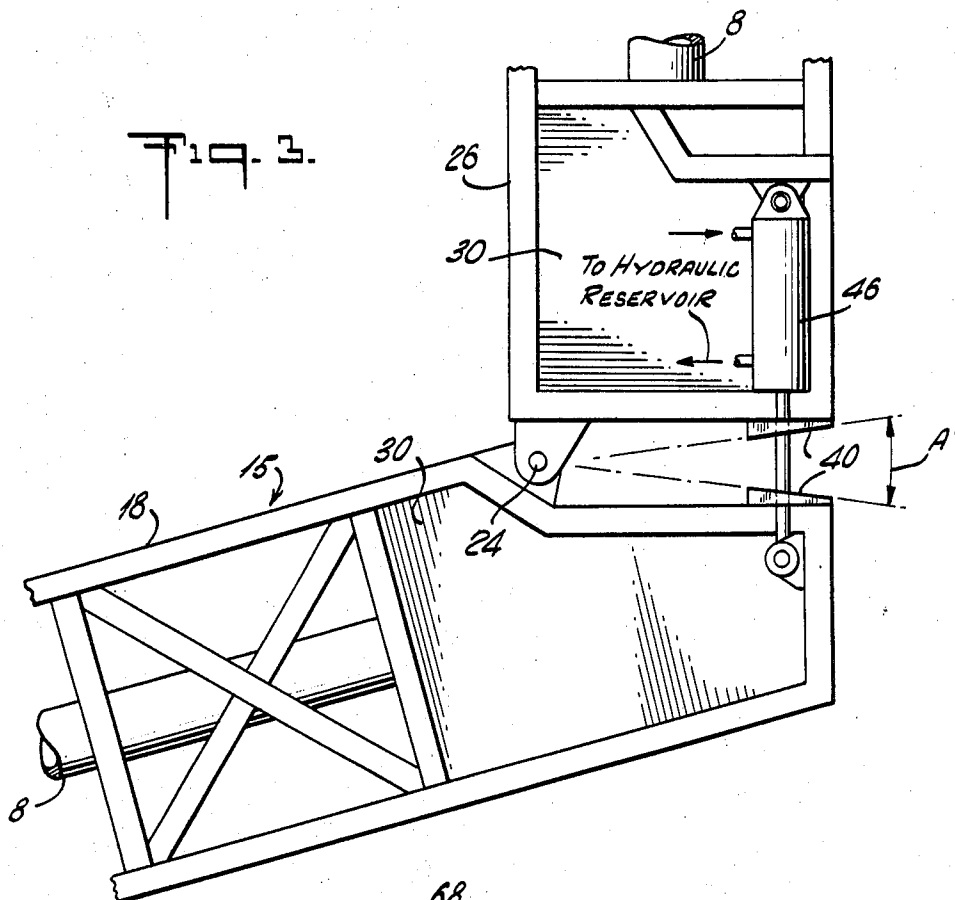
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2 Sheets-Sheet 2



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3,572,408 COMBINED SHIP MOORING AND LOADING- UNLOADING DEVICE

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9 Claims

ABSTRACT OF THE DISCLOSURE

An improved offshore ship mooring and ship loading-unloading structure comprising an arm having a first portion mounted for universal rotation at one extremity and having hingedly secured at its other extremity for limited pivotal movement, a second portion. A cargo carrying conduit located within said first and second portions and having at its free end means for securement to a ship whereby the mooring and cargo transfer structure are contained within a unitary structure.

BACKGROUND OF THE INVENTION

The efficient mooring of a vessel and the rapid loading of the marine equipment with liquid products, as, for example, hydrocarbons and the like, has always presented a complicated problem due to the continuous shifting of the marine equipment or ship being loaded. This shifting of marine equipment is due, of course, to such factors as tidal variations, changes in the ship's draft during the loading operations and wave and wind action. Thus, there exists the problem of continuously adjusting the position of loading hoses to compensate for these changes. Any appreciable change in the relative position of the loading hoses, unless corrected, will cause a severe strain on the tanker connections and in many instances cause them to break, thereby putting the tanker out of operations until repairs are effected. Other difficulties are encountered when attempting to moor ships in various areas due to wave, current and ocean bottom conditions. In order to overcome many of these difficulties, it is known in the art to load ships such as oil tankers and the like at piers either in protected waters or at marine anchorages which are located offshore.

In the case of tankers at piers, the manifolds of tankers are connected to the pier piping by multiple hoses or flexible arms. In the case of marine anchorages, the tanker manifolds are connected to hoses attached to submarine lines. The number of hoses is limited by the necessity of laying them out on the ocean bottom so that they are not tangled. Furthermore, the hoses must be long, usually 200 feet or more, and the weight and hence the diameter is limited by the capacity of the gear of the ship. Thus, marine anchorages are generally limited to one or two hose connections of 12 inch diameter or smaller.

The above problems are becoming increasingly magnified with the steadily increasing size of today's modern tanker. With tankers of 500,000 deadweight tonnage predicted for the near future, the limitation of a 12 inch diameter or smaller hose connection would be totally impractical. Such tankers will need unloading hoses of about 36 to 48 inches in diameter and mooring lines will also have to be increased in diameter and number.

SUMMARY OF THE INVENTION

The present invention as hereinabove indicated is concerned with an improved offshore ship mooring and ship unloading device which alleviates the necessity of mooring

lines or hawsers by utilizing the unloading line structure as the mooring device itself. The invention also makes possible easy utilization of large diameter unloading lines particularly suitable for tankers in the 500,000 DWT classification. The unloading line structure itself, or arm, is provided with upper and lower portions having an arm, forearm and an elbow joint there between and is attached to a sunken base or anchorage with the arm being free to rotate a full 360°. The upper and lower portions are provided with suitable buoyancy chambers so that the coupling end of the upper portion will float above the surface of the water.

Tankers utilizing the instant apparatus are provided with a special mooring bow so that the coupling end of the upper portion may be readily secured to the tanker. The invention may be more readily understood by reference to the following detailed description taken in conjunction with the drawings wherein:

FIG. 1 is a schematic side view of the mooring apparatus of the present invention;

FIG. 2 is an enlarged view of the elbow joint between the upper and lower portions of the arm structure shown in FIG. 1;

FIG. 3 is an alternate design for the joint shown in FIG. 2; and

FIG. 4 shows a cross-sectional schematic view of the coupling end of the upper arm portion engaged in the tanker bow.

Referring specifically to FIG. 1, a foundation structure 1 or equivalent means is securely positioned on the ocean bottom 10 at the desired offshore location. Suitable conduit means 12 extend from shore tankage (not shown) along the bottom of the sea to a universal swivel 14 mounted for rotation on foundation 1. This conventional swivel permits feeding over 360° rotation. The loading/unloading and mooring arm of the instant invention indicated generally at 15 is in communication with swivel 14 and is pivotally attached thereto at 16. Arm 15 is composed of a lower portion 18 and an upper portion 26 which are connected by the hinge assembly 24 of elbow joint 22. Both portions 18 and 26 are of grid-type construction so as to minimize their resistance, and hence reaction, to currents and wave motions. To further minimize stresses and/or strains due to wave and wind action, the greater part of the arm 15 is submerged below the surface of the water. To insure proper positioning of both the lower and upper portions of the arm, however, suitable buoyancy chambers indicated schematically at 30 are provided at intervals along both of portions 18 and 26. These chambers insure that the end of upper portion 26 will float out of the water. A large diameter loading and unloading conduit 8 is provided within the upper and lower portions of arm 15. This conduit, which may be 60 inches or larger in diameter, includes conventional swivel or flexible joints (not shown) at its ends which serve to convey fluid through the regions of hinge 24 and pivot 16 and allow conduit 8 to conform to the various positions of the upper and lower portions of arm 15 and rotational position of swivel 14.

It will be appreciated from the foregoing description that the configuration of the instant apparatus allows all movements of the tanker to be readily accommodated. Thus, for example, should there be changes in the level of the sea 3 or should a tanker rise as it unloads, arm 15 will accommodate these changes by assuming the position indicated in phantom line. Furthermore, should wind direction change and the tanker shift around in response thereto, the swivel joint at 14 will accommodate this movement.

It is also to be appreciated that while changes in the ship's position must be accommodated, it is often desirable

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ble to limit and dampen these movements so as to prevent rapid and large movements. To this end, elbow joint 22 is provided with a controlled degree of damping and flexibility, which can both be varied depending on the particular location at which the apparatus of the instant invention is to be employed.

To more fully understand the operation of joint 22, reference will now be had to FIG. 2. As hereinbefore indicated, upper portion 26 and lower portion 18 of loading arm 15 are pivotally connected by a hinge 24. The ends of hinge 24 are rigidly attached to bearing plates 39 and 39', which are affixed to the respective ends of portion 26 and portion 18. To control the resistance to motion (i.e. the damping effect exhibited by elbow 22) a plurality of rubber bearing pads 38 are provided. These pads, along with their associated connecting rods 36 and bearing caps 42, prevent the sudden movements which would normally accompany sudden changes in tidal and wind factors.

It will be readily appreciated that the damping effect may be easily controlled by modifying the configuration and/or stiffness of the particular rubber pads employed. The flexibility, i.e. the degree of movement allowed between upper portion 26 and lower portion 18, is readily controlled by bearing surfaces 40. These surfaces define an angle indicated at "A," which in turn sets the amount of flexibility allowed. Thus, for example, with the lower portion having a length of 240 feet and the upper portion 26 having a length of 140 feet and the angle "A" set at 15°, the flexibility of elbow joint 22 will allow the upper extremity of portion 26 to move a distance of approximately 37 feet (each way) from the normal position as indicated by line "C" in FIG. 2.

Referring now to FIG. 3, an alternative design for elbow joint 22 is presented. In the embodiment therein illustrated a hydraulic damper 46 is provided in lieu of the rubber pads 38 shown in FIG. 2. Damper 46 may be readily and remotely controlled so as to achieve any desired degree of damping.

Reference will now be had to FIG. 4 in discussing the unique method of tanker mooring which may be employed using the apparatus of the instant invention. The upper extremity of conduit 8 is provided with a ball joint 54. This joint is designed to be fitted into a joint socket 52, which is integral with the bow 50 of the tanker being moored. The tanker bow is also provided with suitable quick closing latches 56 which are slidably engaged with in housing 58. As hereinbefore indicated, the upper extremity of the loading arm is designed to float above the level 3 of the sea. Thus, in operation, as a tanker approaches the floating upper end of the arm, a line may be readily connected to a lifting hook 64 provided in a flange 62 designed to be secured to another flange 60 located at the uppermost extremity of conduit 8. With the line secured, the arm may be lifted out of the water and the ball joint 54 fitted into the socket 52 on the tanker bow. The quick closing latching mechanism 56 completes the mooring. The tanker crew can then remove flange 62 and connect the tanker loading line 68 shown in phantom line.

Thus, the present invention permits the loading and unloading of ships under sea conditions which make the use of conventional equipment dangerous or impractical. It also permits large tankers to moor without the utilization of tugs. Also by utilization of the present invention, large tankers can moor and transfer cargo without the necessity of line handling launches normally necessary for marine anchorages. The device also permits vessels to readily change position so as to lie in the most favorable direction while loading or unloading cargo. The apparatus of the present invention also permits the handling of fluids to or from the vessels without practical limitations on hose diameter without the need for long floating hoses.

Although for purposes of illustration the apparatus of the instant invention has been described in considerable

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detail, it will be appreciated that changes in the various components may be made without departing from the spirit of the invention. Thus, for example, in the embodiment depicted in FIG. 2, the rubber bearing pads 38 could be replaced by a series of springs of proper stiffness to achieve the desired damping effect. Therefore, in determining the full scope of the invention, reference should be had to the appended claims.

What is claimed is:

1. In a combined offshore mooring and cargo transfer system adapted for mooring a vessel at sea, improved combined integral mooring and loading-unloading means including an arm and a base secured to the bottom of the sea, said arm comprising a first rigid portion and a second rigid portion, first means for pivotally connecting one end of said first portion to said base for universal movement, said second portion being hingedly connected to the other end of said first portion, flotation chambers integral with said first and second portions for maintaining said first portion entirely beneath the surface of the sea while allowing the free end of said second portion to float continuously above the surface of the sea, conduit means integral with said first and second portions of said arm for transferring cargo to and from said vessel, and second means connected at the floating end of said second portion to said conduit means mooring said vessel to said base via said arm while fluid communication between said conduit means and said vessel is effected and maintained.

2. The arm of claim 1 including damping means located at the hinged connection between said first and second portions for restricting the movement of said second portion with respect to said first portion a predetermined amount.

3. The arm of claim 1 wherein said conduit means comprise a cargo loading and unloading conduit positioned within said first and second portions and adapted to move therewith, the end of said conduit having said second means connected thereto extending beyond the floating end of said second portion allowing said second means universal rotary motion of said conduit means and said arm relative to said vessel, whereby the connection between said conduit and said vessel via said second means comprises the sole mooring for said vessel.

4. An improved apparatus for providing combined mooring, loading and unloading of a vessel at offshore sites at sea, which comprises in combination, a foundation secured to the sea bottom, an arm, means for pivotally connecting said arm for universal movement to said foundation, said arm comprising a lower portion positioned below the surface of the sea and extending from said foundation and an upper portion, means for pivotally connecting said upper portion to said lower portion for limited relative movement, flotation chambers integral with said lower and upper portions for maintaining the free extremity of said upper portion above the surface of the sea, conduit means positioned within said arm, and means operably connected at said extremity for releasably mooring said vessel to said foundation via said arm to permit universal rotary movement therebetween, while fluid communication between said conduit means and said vessel is effected and maintained.

5. The apparatus of claim 4 wherein said means for pivotally connecting said upper portion to said lower portion includes damping means operably connected with said lower and upper portions for limiting the movements of said upper portion with respect to said lower portion.

6. The apparatus of claim 4 wherein said means connected at said extremity includes a ball-like structure and a lift up hook.

7. The structure of claim 6 wherein said vessel is provided with a socket integral with its bow portion, said socket designed to engage said ball-like structure.

8. In an offshore mooring system for the mooring and loading and unloading of a marine vessel, an improved mooring which comprises, a base rigidly positioned on the

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sea bottom, an arm having a lower portion and an upper portion, said lower portion being pivotally connected for universal movement to said base, and said upper portion being pivotally connected to said lower portion, flotation means for maintaining the free end of said upper portion above the surface of the water, conduit means positioned within said arm, said conduit means having one end extending above said free end of said upper portion, and means mounted at said one end of said conduit means mooring said vessel to said base via said arm while fluid communication between said conduit means and said vessel is effected and maintained.

9. The system of claim 8 wherein said means mounted at said one end of said conduit means includes a ball-like member and said vessel is provided with socket means for engaging said ball-like member to permit universal rotary movement of said conduit means relative to said vessel, whereby said vessel is moored at its offshore location.

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