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Mott et al.

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[54] MARINE TERMINAL MOORING

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[52] **U.S. Cl.** **114/230**

[51] **Int. Cl.** **B63b 21/00**

[58] **Field of Search** ..... 114/230, 206; 9/8 R, 8 OP

[56] **References Cited**

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[57] **ABSTRACT**

The invention relates to a marine terminal positioned at or adjacent to an offshore body of water being adapted for anchoring barges, vessels and the like while the latter are connected with one or more sources of fluid to be transferred. Said vessels are fixedly located in the water by a plurality of anchor means disposed at discrete intervals about the floating vessel. Each anchor means includes a holding member imbedded at least partially into the ocean floor and connected to the floating vessel by an anchor rode such as a chain, cable or the like. A mooring means is likewise connected to the imbedded anchor by a stabilizing member which includes a weighted body normally supported at the ocean floor and a buoyant column pivotally connected at one end to the body buoyed whereby to maintain an upright position.

3 Claims, 4 Drawing Figures

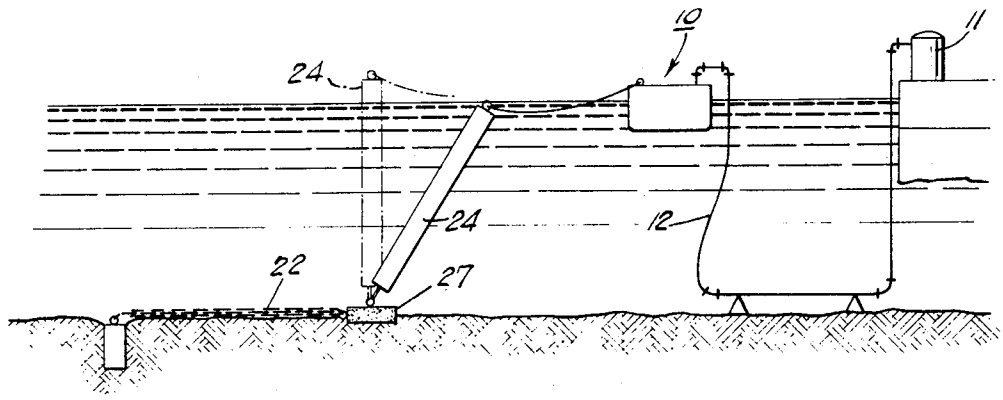


Fig. 1.

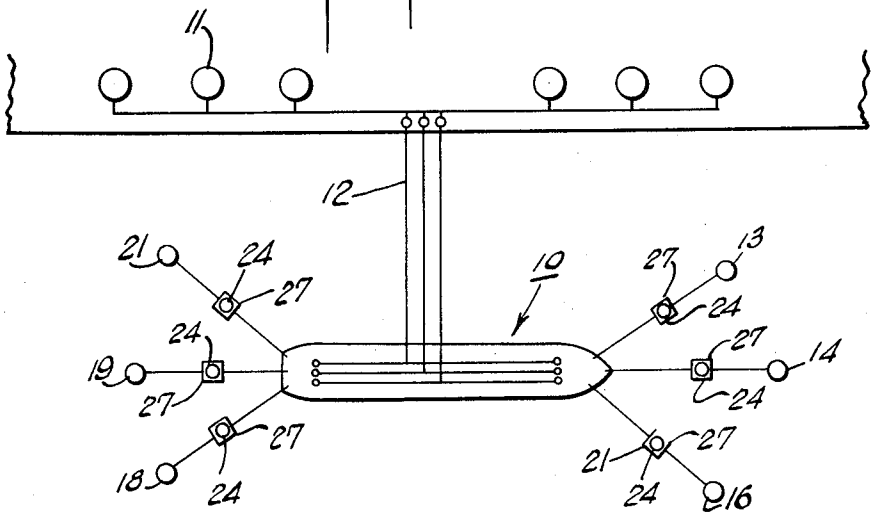


Fig. 2.

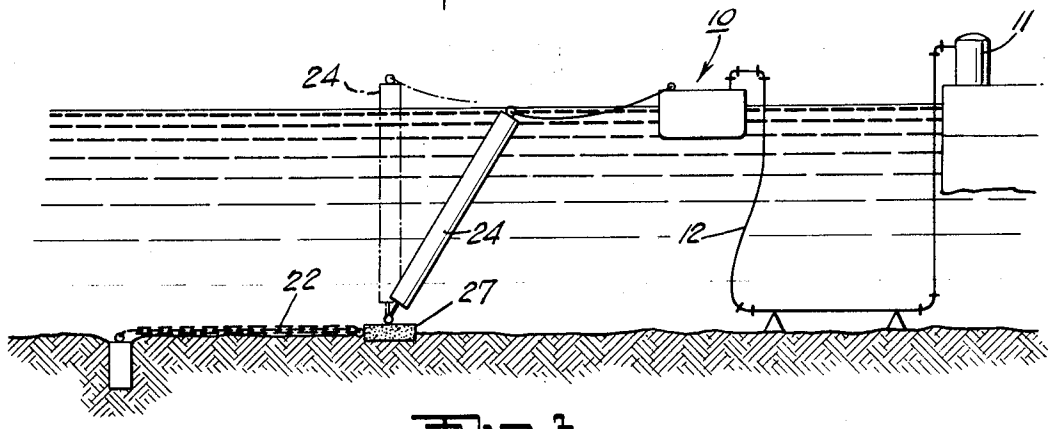


Fig. 3.

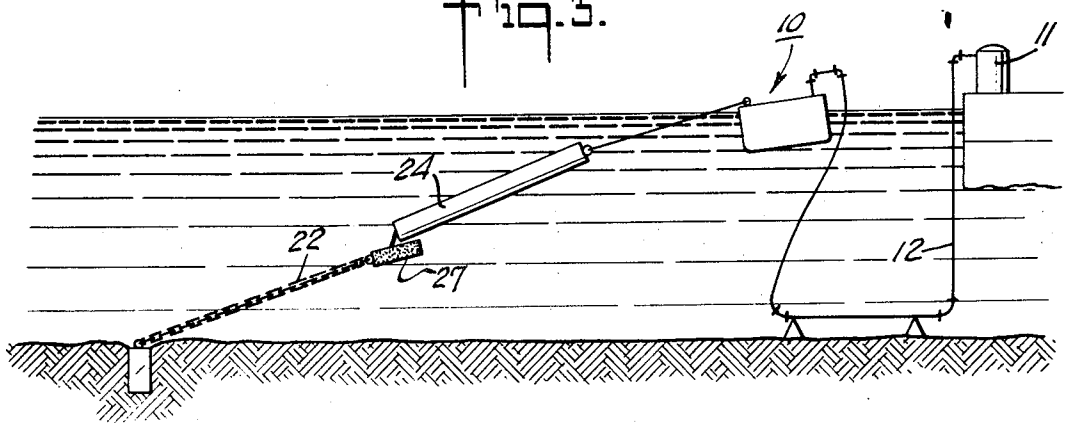
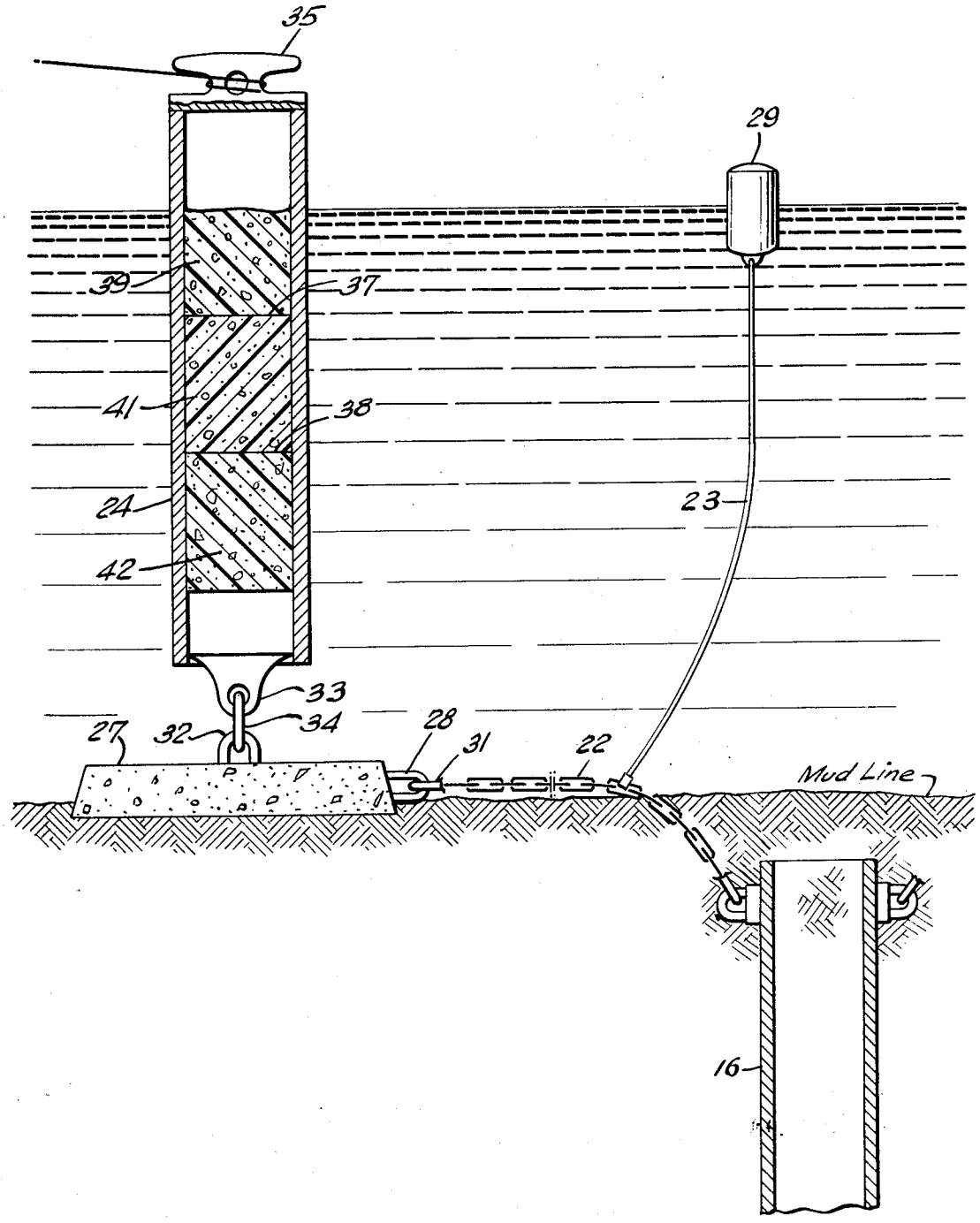


Fig. 4.



MARINE TERMINAL MOORING

BACKGROUND OF THE INVENTION

With the advent of larger ocean-going tankers, barges and other liquid carrying vessels, it has become necessary to provide means for such vessels to load and unload at a distance from the shore. This is true, particularly in the instance of super tankers and barges having overly large hulls.

A ready expedient for accommodating such vessels has been through the use of marine terminals positioned offshore from a refinery of fluid storage area. In one arrangement found to be practical, the terminal facility includes at least one shore based storage tank or floating means such as a vessel or large tanker for holding an amount of the fluid to be transferred. In the instance of the petroleum industry, the fluid would be in the form of crude or refined liquid petroleum, or the various component thereof after full or partial refining of the crude material. Thus, the marine facility quite often is adapted to accommodate a number of tankers adapted to separately carry the respective refined products.

The normal means for fixedly positioning such marine terminals is by anchoring the same to the floor of the offshore body of water. To avoid undue movement of the floating vessel, which would tend to disrupt the normal liquid flow by breaking or tangling subsea conduits, the vessel is held in place by a plurality of peripherally disposed anchors.

This form of anchoring method embodies the disadvantage of rendering the storage or transport facility relatively immovable in response to wind and water forces. It is nonetheless considered desirable and among the most efficient for transferring liquid petroleum products since it avoids the problems associated with the vessel swinging about a mooring.

The usual procedure for receiving or discharging a cargo from the marine terminal, is by mooring the tanker or other cargo carrying vessel a distance from the storage facility. Submarine lines connected to the facility are then communicated with the tanker whereby the liquid can be controllably pumped into or from the latter.

One drawback to the herein described marine facility is the continuous relative movement between the storage means and the tanker. Such movement, both horizontal and vertical, tends to drag the anchoring chains, which lie at the floor of the body of water and are partially imbedded by their own weight in the same. In the instance of a rocky or sandy ocean bottom, excessive losses have been realized due to downtime on the facility, and in repair costs as a result of the continuous abrasive action of the chains as they undergo horizontal and vertical displacement.

Such movement is realized whether or not a vessel is moored. It is understandable, that so long as the chain is exposed to an abrasive material at the ocean floor whether sand, mud, or other, the latter will provide a continuous source of abrasive wear between links. Further, the wear will persist so long as the chain is subject to even the ordinary and restricted movement of the moored or the storage vessel even under relatively calm conditions.

It is therefore one of the objects of the invention to provide a marine terminal adapted for accommodating

one or more cargo carrying tankers at an offshore position. A further object is to provide anchoring means for a vessel during the transfer of fluid to or from the latter from a storage facility. A still further object is to provide a buoyant mooring system connected to a fixedly positioned anchor, and having means in the system to resist harmful abrasion to moving chains at the ocean floor.

DESCRIPTION OF THE DRAWINGS

In the drawings, FIG. **1** illustrates a marine facility of the type contemplated including an oil storage means located adjacent to an offshore mooring site. FIG. **2** illustrates the disclosed facility having a tanker moored thereto. FIG. **3** is similar to FIG. **2** illustrating the position of a vessel mooring column when subjected to excessive strain by a moored vessel. FIG. **4** is an elevation view in cross-section showing the mooring column.

In overcoming the herein mentioned problems, and in achieving the foregoing objectives, there is presently provided a marine liquid storing terminal including mooring means adapted to accommodate one or more floating vessels. The shown embodiment includes a shore based facility such as a refinery, tank farm, or the like. A moored vessel is held in place at the offshore location by anchors surrounding said vessel and imbedded in the ocean floor. The mooring means is provided with a partially flexible anchor rode, including rigid and nonrigid portions extending to each of the previously mentioned anchors. Each rode further incorporates a stabilizing member embodying an elongated, buoyant column extending upwardly from a heavy base member at the ocean floor, to a position above the ocean's surface.

As the floating ship is moored to the upper end of the buoyant arm or column, the latter, being pivotally connected to the submerged stabilizing or base member, will be laterally displaceable. Thus, in response to movement of the moored vessel, the column will assume a submerged, canted position. In the event excessive strain is applied by the moored vessel as by turbulent water or extremely stormy conditions, the excessive loading will cause the mooring column including the heavy base member, to be lifted in its entirety from the ocean floor although still exerting a continuous downward force.

In either instance, mooring chains connected to the imbedded anchor securing both the mooring column and the vessel, will be subjected to a minimum amount of chain displacement. The effect will be to minimize or preclude wear on the chains as a result of abrasive action normally prompted by the presence of said or other gritty materials around and between the chain links. Further, any displacing force applied to the anchor will be minimized since the force is laterally applied so long as the chain remains at the ocean floor.

Referring to FIG. **1**, a marine terminal of the type contemplated is herein shown as comprising a floating transport vessel **10** moored in an offshore body of water. The latter is generally adjacent to, or remote from a land based storage area **11** such as refinery or a tank field. Vessel **10** can be connected as well to a plurality of subsea well heads or remote fields to receive flows of crude oil therefrom.

Usually the floating vessel **10** is communicated with one or more sources of crude or refined petroleum products by a subsea conduit system **12**. The latter is generally of a permanent nature formed of rigid pipe and/or flexible hose and positioned at the ocean floor being at least partially imbedded in the latter.

To simplify the conduit distribution system **12** and its connection to vessel **10**, the latter is positioned as rigidly as is feasible by a plurality of anchors **13, 14, 16, 18, 19** and **21**. The latter are disposed about vessel **10** at discrete, peripheral intervals and spaced from the vessel a suitable distance to provide maximum mooring ability with minimum strain on the mooring rodes or cables.

Since the anchored transport vessel is relatively stationary with respect to direction, it is preferably aligned on installation to the most favorable position with regard to prevailing wind and water movement. However, it is appreciated that neither of these elements of nature are constant and consequently the vessel will be subjected on occasion to excessive displacing forces.

Referring to FIGS. **2** and **3**, each anchoring connection as for example anchor **16**, includes a relatively heavy anchor chain **22**. One end of said chain connects to an outer wall of anchor **16** by means of a shackle or other appropriate connection. Anchor **16** can be of the pile type which is imbedded by driving the same into the substratum a sufficient distance to afford necessary holding power. Said anchor can also be of the more conventional type adapted to establish a holding grip in the ocean floor. It is appreciated however that the type and number of anchors used about the vessel **10** will be determinable in accordance with the composition of the substratum into which the latter are imbedded. At least a portion of the chain **22** will be supported by the ocean floor and in most instances the chain will be of such a weight as to become imbedded in the soft soil. A float **29** is connected to anchor chain **22** by a line **23** a sufficient distance from pile **16** to permit the chain to be raised to the surface for locating the anchor and replacing the chain.

Mooring column or buoy **24** to which floating vessel such as a tanker or barge **10** is temporarily connected for transferring cargo to the latter, includes basically a weighted foundation pad or base **27** to which the elongated column or arm is pivotally connected. Foundation pad **27** is spaced remote from anchor **16** and in one form can consist of a relatively heavy concrete block. Other forms of foundation members can be utilized to position column **24** as will be herein noted. As shown particularly in FIG. **4**, foundation pad **27** is provided with one or more external rings or staples **28** to which the other end of anchor chain **22** is connected by a shackle **31** or similar means.

In the normal ship mooring arrangement, the anchoring chain or rode would extend directly from anchor **16**, upwardly to the tanker **10** and be fastened to the latter. Thus, and as previously noted, continuous movement of the vessel in response to water forces would result in said chain being shifted continuously about the ocean floor. Eventually, connecting links in contact with the bottom would gradually reach the point of breakage as a result of abrasive material becoming imbedded between the contacting surfaces of the respective connecting links.

Referring again to FIG. **4**, column or arm **24** is formed of a relatively elongated, rigid connector which functions in one respect as a buoy in that it normally assumes an upright position in the body of water. In one embodiment said column **24** comprises an elongated, heavy walled tubular member having a pivotal connection at the lower end which operably engages a corresponding fitting at foundation pad **27**. A number of such flexible or universal connections are well known and widely used. However, for the purpose of exemplifying the instant description, a ring **32** is imbedded in foundation pad **27**, preferably projecting from the upper side thereof. Said ring **32** is connected in turn to an end fitting **33** depending from the lower end of column **24** by an intermediate link **34** which permits free pivotal movement of said column **24** about its connecting point to base **27**.

Column **24** is formed of a relatively heavy walled steel tubing which is equal to or exceeds the tensile strength of the anchor cable **36**. Column **24** is further provided with a plurality of transverse water tight bulkheads **37** and **38** whereby to form individual longitudinal compartments **39, 41** and **42**. The latter in turn are filled with a light buoyant material such as expanded foam thereby assuring the column a degree of buoyancy even though accidentally fractured whereby the wall of the column would be broken to permit inleak of water. While not entirely necessary, arm **24** can be provided with a ballast medium in one or more of the lower compartments.

The upper end of the column **24** is provided with one or more mooring staples exemplified by a cleat **35** shown, or one or more peripherally spaced staples, depending from the column sides and which are adapted to receive mooring lines **36** from vessel **10**.

As shown in FIG. **4**, under normal conditions and when not being utilized as a mooring, column **24** assumes a generally upright, buoyed disposition in the body of water. Its position would of course be contingent on the tide and water turbulence. In such position upper cleat **35** is disposed sufficiently beyond the water's surface when the latter is at its highest point to facilitate connection to bow line **36**. After the latter has been connected and as shown in FIG. **3**, tanker **10** will be positioned by varying the bow line length to cause the column to be canted to an offset position. Simultaneously, tanker **10** will be further limited in movement by similar lines extending outwardly from the vessel to anchors **13, 14, 16, 18, 19** and **21** whereby the vessel will be restrained in all directions.

Referring to FIG. **3**, under extraordinary conditions, tanker **10** will be subjected to excessive displacing forces from one side such as high waves or strong winds to the extent of moving the tanker whereby to apply a dislodging force to the mooring columns **24** on one side of the ship. Under such circumstances, the tensional stress along respective connecting lines, through the columns **24** and their pivotal connections will cause the heavy foundation member **27** to be raised from its normally partially imbedded position. The function of said member **27** then is to in effect apply a temporary damping force to counter the displacing force against the vessel. The said damping force will be maintained by foundation **27** so long as the vertical component of the tension within the mooring lines **36** remains greater

than the downward component exerted by the suspended foundation pads **27**. Further, by maintaining chain **22** in a generally horizontal disposition, the disloding force against imbedded anchor **16** will be least effective toward mooring the anchor.

In the event the foundation pads **27** are displaced by a severe storm or the like, they can readily be repositioned merely by raising the same from the ocean floor and transporting to a desired location.

Obviously, many modifications and variations of the invention, as hereinafter set forth, may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A floatable mooring for a vessel positioned in a body of water, said mooring being adapted to movably adjust when subjected to excessive loading by said vessel at such time as the latter is connected to the mooring upper end, said floatable mooring comprising,

1. an elongated buoyant column, being normally urged to a substantially upright disposition in said body of water when said column is not subjected to a mooring load due to said vessel being connected at the upper end thereof,
2. said buoyant column having a length exceeding the depth of said body of water and including opposed upper and lower ends,
3. the said column upper end normally extending beyond the water's surface for engagement with a mooring line from said vessel,
4. a weighted foundation pad operably connected to the lower end of said elongated column by means of an upper ring embedded in said foundation pad and being of sufficient weight to overcome the buoyant force of the latter whereby to maintain the column in said upright disposition, said foundation pad being supported at the floor of said body of water and a lower ring embedded in and extending from a side of said foundation pad below said upper ring,
5. a fixed anchor means positioned remote from said foundation pad, and being firmly embedded into said ocean floor,
6. and a flexible connector member having one end thereof engaged to said fixed anchor means, the other end of said flexible connector being connected to said lower ring, whereby said connector member will normally rest at the ocean floor,
7. said buoyant column being pivotally displaceable when subjected to an excessive mooring force at the upper end, whereby to exert a tensional force on said flexible connector and said column respectively to thereby raise said foundation member from its resting place at said floor.

2. In a mooring device as defined in claim **1** wherein said flexible connector member comprises an anchor chain.

3. In a mooring device as defined in claim **1** wherein said elongated buoyant column includes a plurality of longitudinally disposed transverse panels forming said column into a plurality of buoyant compartments.

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