# United States Patent [19]

**Bartels**

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[54] **OFFSHORE MARINE STATION**


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[52] **U.S. Cl.** ..... **114/230**; 9/8 P

[51] **Int. Cl.**[2] ..... **B63B 21/00**

[58] **Field of Search** ..... 114/230, 5 BD; 9/8 P



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[57] **ABSTRACT**

An offshore marine station has a floating mooring unit for marine vessels, and can be connected with shore-terminating conduit lines. It is coupled with an ocean-bottom anchor by a coupling arrangement permitting it several freedoms of movement relative to the anchor, and a buoyant damping arrangement is pivotally interposed between the coupling arrangement and the mooring unit in order to damp the transmission of stresses from the latter to the anchor.


**4 Claims, 6 Drawing Figures**

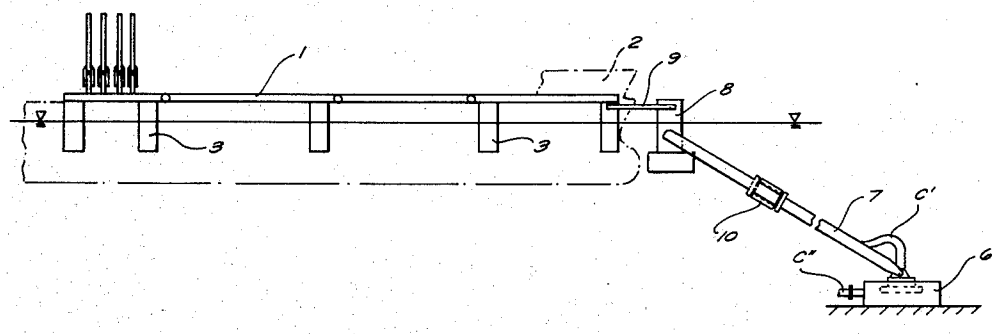


FIG. 1

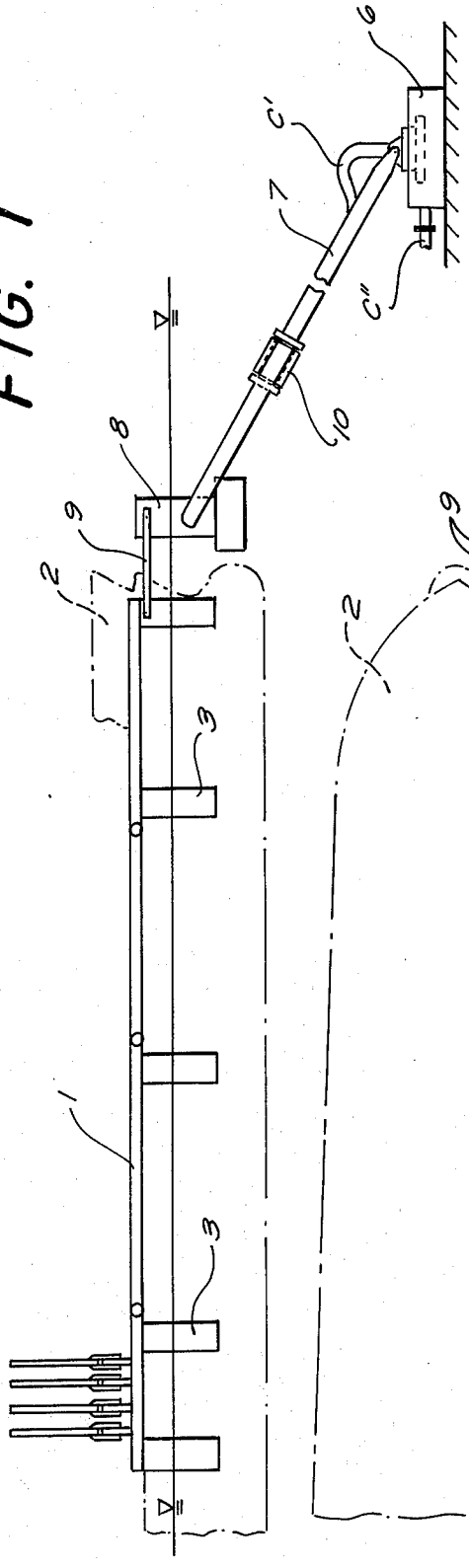
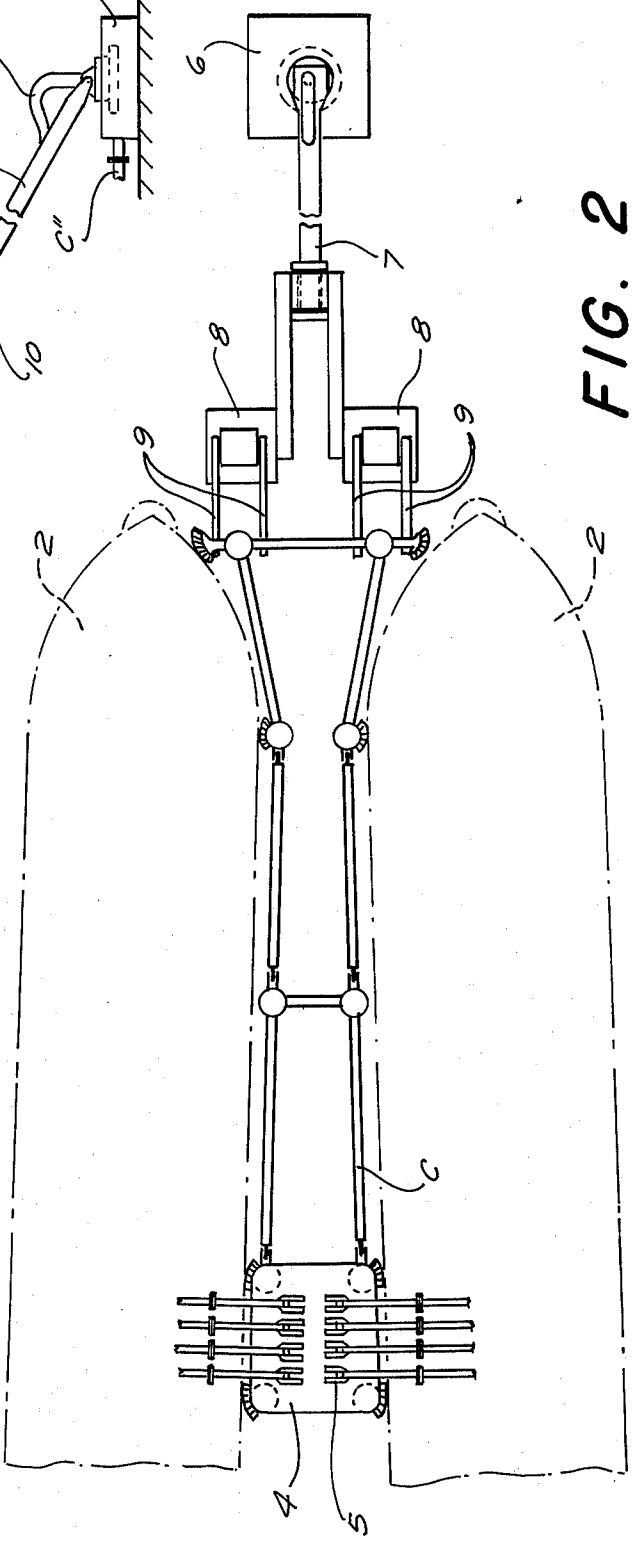



FIG. 2



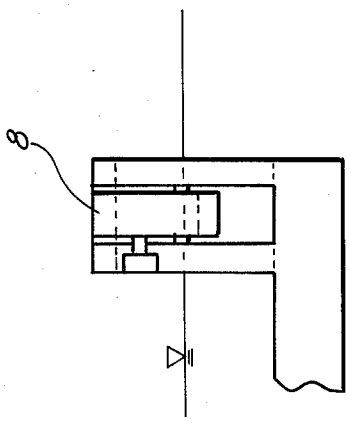



FIG. 5

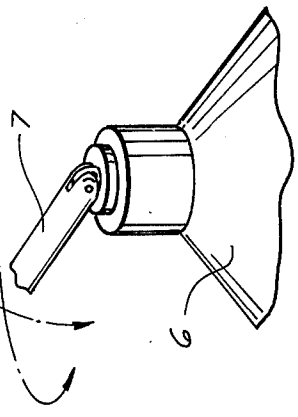



FIG. 6

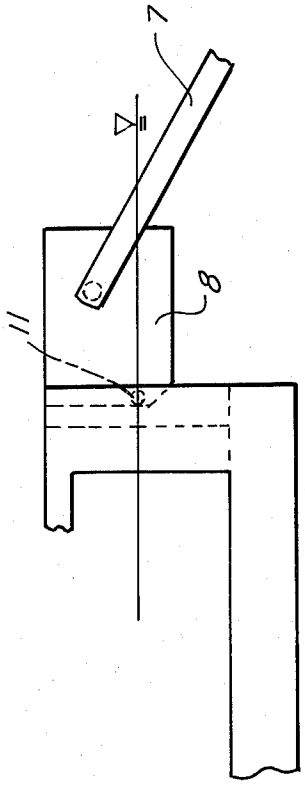



FIG. 3

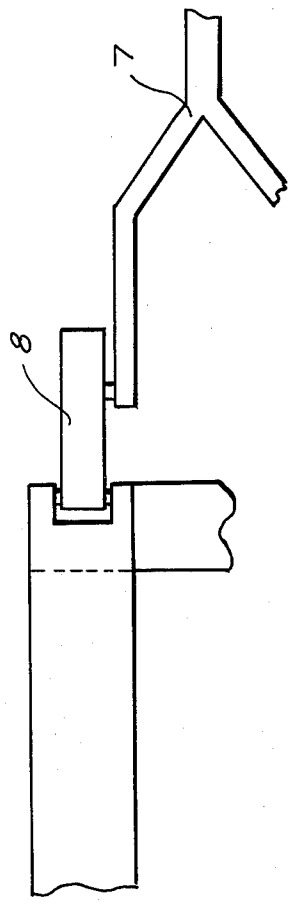



FIG. 4

# OFFSHORE MARINE STATION

## BACKGROUND OF THE INVENTION

The present invention relates generally to a marine structure, and more particularly to a floating marine structure. Still more specifically, the invention relates to an offshore marine station which floats and at which marine vessels can be loaded and/or unloaded.

Offshore marine stations in themselves are already known. They are floating docks or similar units which are anchored offshore in deep water in order to make it possible for large marine vessels to take on or deliver goods in areas where conventional harbors either do not exist or are inadequate. Such goods may be oil or other flowable materials or the like which can be piped to and from the mooring unit by means of conduits, that is pipe-lines which terminate on shore.

It is known to provide some such marine stations in form of fixedly anchored docks, that is docks which do not float and are anchored on the ocean bottom. It is also known to provide such stations in form of floating buoys or the like. The disadvantages of this prior art is that in order to anchor the marine vessels to such units it is necessary to provide relatively long anchor lines, and similarly to provide long hose connections between the vessel and the mooring unit. The reason for the length of the anchor lines and the consequently necessary length of the hose connections is to permit the marine vessel itself to perform rolling and other movements independently of its anchoring basis, and to enable it to pivot about the anchoring basis —i.e. the mooring unit— through or even beyond 360°.

Another type of offshore marine station, with an improvement of which the present invention is in particular concerned, uses a floating mooring unit to which one or more marine vessels may be anchored. The mooring unit is so connected with an ocean-bottom anchor that it can perform pivotal movements about the anchor through 360° or more, and can also perform rolling and other movements with reference to the anchor. The anchor is in form of one or more strong ocean-bottom anchors, in form of flooded buoys which are deposited on the ocean bottom, or in form of other elements which are fixed on or in the ocean bottom. This type of offshore marine station has several advantages, including the fact that the connecting arrangements for connecting the mooring unit with shore-terminating conduit or pipelines can be fixedly mounted on the mooring unit itself which in effect serves as a platform to which personnel may have access and to which the marine vessel or vessels may be anchored. This greatly facilitates the anchoring —that is the making-fast of the marine vessel to the marine unit— and the connection between the vessel and the conduit lines on the mooring unit.

This latter type of offshore marine station is connected with the ocean-bottom anchor either by means of wire cables or the like, by means of chains or by means of a rigid connecting arrangement which is pivoted to the mooring unit at one end and with its other end is pivoted to the ocean bottom anchor and assumes a position at which it is inclined at approximately 45° to the horizontal. This latter type of connecting arrangement can transmit both tensile and pressure forces and prevents undesired swinging movements of the mooring unit which are the result of wind and wave action. However, this arrangement does have the disadvantage that forces which act longitudinally of the coupling arrangement upon the ocean-bottom anchor, particularly tensile forces, are transmitted more or less directly to the anchor and can either shift or loosen the same from the ocean bottom. This of course permits the mooring unit to shift beyond its permissible location and can cause breaks in the conduit lines which extend from the mooring unit to the shore and which are usually rigidly and fixedly mounted.



## SUMMARY OF THE INVENTION

It is, accordingly, a general object of the present invention to provide an improved offshore marine station of the type lastly described above.

More particularly, it is an object of the present invention to provide such an improved offshore marine station which avoids the disadvantages of the prior art.

Another object of the invention is to provide such an offshore marine station which assures that forces which act in longitudinal direction of the mooring unit, for instance inertial forces of a ship which is being anchored to the mooring unit, can be transmitted only in dampened condition to the ocean-bottom anchor.

In keeping with the above objects, and with others which will become apprent hereafter, one feature of the invention resides in an offshore marine station which, briefly stated, comprises a floating mooring unit for marine vessels, and connecting means for connecting the mooring unit with shore-terminating conduit lines. An ocean-bottom anchor is provided, and coupling means couples the mooring unit with this anchor with freedom of movement relative to the latter in a plurality of directions. Buoyant damping means is pivotally interposed between the coupling means and the mooring unit for damping the transmission of stresses from the latter to the anchor.

Advantageously, the damping means is a so-called semi-submersible element, in form of an elongated vertically oriented body of displacement which is submerged to approximately half of its length in the water, and which under all circumstances extends out of the water with a substantial portion of its length. The mooring unit and the coupling means are both pivoted to the body of displacement, at vertically spaced locations for movement about parallel pivot axes.

With this arrangement, any tensile forces which are transmitted to the body of displacement, will cause the body to heel over, that is to tilt about the two parallel pivot axes. This acts counter to the buoyancy forces of the body of displacement, and thus the tensile forces are either fully or at least to a substantial extent compensated. It is advantageous if the body of displacement is connected with the mooring unit itself by means of joint plates or the like, or if the body of displacement is movably connected with the mooring unit by means of a vertical guide arrangement. Particularly if the forces which are expected to be transmitted will be substantial, two or more bodies of displacement can be arranged laterally adjacent one another and connected with the ocean-bottom anchor via a single or several coupling means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following de-

scription of specific embodiments when read in connection with the accompanying drawing.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic side view illustrating an offshore marine station according to the present invention;

FIG. 2 is a top-plan view of FIG. 1; and

FIGS. 3, 4, 5 and 6 are respective diagrammatic fragmentary detail views, illustrating further embodiments of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing the drawing in detail, and referring firstly to the exemplary embodiment shown in FIGS. 1 and 2, it is pointed out that reference numeral 1 identifies a floating mooring unit of an offshore marine station at which vessels such as the ones identified with reference numeral 2 in FIG. 2, can unload or load. For the sake of convenience, no water has been illustrated, but a waterline is shown in FIG. 1 and indicated by the two arrowheads.

The mooring unit is provided with a plurality of bodies of displacement 3 which maintain it floating and are in form of elongated vertically oriented pontoons or the like which extend only approximately halfway into the water, that is below the level of the indicated waterline, to assure that the mooring unit 1 will provide a relatively stable and calm anchoring base for connection of the marine vessels 2.

For such connection, appropriate connecting elements are formed or provided on the mooring unit 1; since these are well enough known not to require a detailed discussion, they have been neither illustrated nor are they being described in detail.

One end of the mooring unit 1 is provided with a platform 4 on which there are provided connecting elements 5 which can be connected with non-illustrated conduit lines that extend to shore, that is that terminate on shore. Such conduit lines are usually rigidly mounted. In particular, it is the usual practice that such conduit lines have a portion C which extends from the platform 4 (where it is connected with the connecting elements 5) longitudinally of the mooring unit 1, to be connected via a flexible portion (e.g. the portion C' in FIG. 1) with the oceanbottom anchor 6, where they are in turn connected with rigid conduits (one of which is fragmentarily shown at C'' in FIG. 1) which extend to shore.

The ocean-bottom anchor may be in form of a tank or the like that is flooded and thus rests on the ocean-bottom floor, under the influence of its own weight and under the pressure of the water above it. Of course, a different anchor could be utilized.

In any case, an inclined coupling element 7 is provided which, as shown in FIG. 2, may be bifurcated and is so connected with the anchors that it can turn about an upright axis and can also pivot about a horizontal axis. According to the present invention, the bifurcated portion of the element 7 is pivoted to buoyant damping means which here is in form of two buoyant bodies of displacement 8 which are vertically oriented and in part are located below and in part above the waterline. Each of the two bifurcated portions of the element 7 is pivoted to one of the bodies 8 which act due to their buoyancy. The bodies 8 are enlarged at their lower ends to increase the buoyancy forces, but it must be assured under all circumstances that the enlarged portion (visible clearly in FIG. 1) will always be immersed below the level of the water.

Each of the bodies 8 is in turn pivoted to connecting elements 9, such as joint plates or the like, and the latter are in turn connected to the mooring unit 1, for instance again pivotally. The pivotal connections between the element 7 and the bodies 8 on the one hand, and between the bodies 8 and the plates 9 on the other hand, provides for tilting of the bodies 8 about two vertically spaced but parallel pivot axes. A component 10 is interposed in the element 7, permitting a threaded adjustment between the bifurcated portion and the single portion of the element 7, so that adjustments can be made if for instance the bifurcated portions need to be turned with reference to the single portion.

Any forces acting longitudinally of the mooring unit 1 will cause the bodies 8 to tilt in the water. If, for instance in FIG. 1 a force acts towards the left upon the mooring unit 1, then the bodies 8 will tilt in counterclockwise direction and the force will be dampened before it is transmitted to the ocean-bottom anchor 6.

FIGS. 3, 4 and 5 show a modification according to which the mooring unit 1 is provided with a vertical cutout into which one end of a box-shaped body of displacement 8 extends, and where this one end is pivotally connected with the mooring unit 1 for pivotal displacement about a horizontal pivot axis 11. The water level is again indicated in FIGS. 3–5 by the arrowhead. Horizontal forces acting upon the mooring unit 1 cause heeling of the body 8, which movement is counteracted by the buoyancy of the body 8 so that the horizontal forces are fully or at least to a substantial extent compensated.

FIG. 6, finally, shows how the element 7 can be connected with the ocean-bottom anchor 6 so that it can turn through 360° or more with reference to the ocean-bottom anchor 6, about an upright axis. This connection should permit freedom of movement in all directions. FIG. 6 shows also that the anchor 6 can be in form of an underwater tank, the upper end portion of which is shown in FIG. 6 and which may be filled with liquids to be stored, for instance with oil which is either transferred from a ship into the tank 6 and not yet ready to be pumped on shore, or which has been pumped from shore into the tank 6 and is waiting to be transferred into a ship.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in an offshore marine station, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. An offshore marine station, comprising a floating mooring unit for marine vessels; an ocean-bottom anchor for said mooring unit; rigid elongated coupling means having one end jointed to said ocean-bottom anchor with freedom of movement in a plurality of directions, and a free end spaced from said one end, and extending from said ocean-bottom anchor upwardly toward said mooring unit at an acute angle to the horizontal; and buoyant damping means including a body of displacement floating partially immersed in water, first pivot means connecting said body with said coupling means for pivotal displacement about one horizontal axis, and second pivot means connecting said body with said mooring unit for pivotal displacement about another horizontal axis which is located at a vertically spaced level from but parallels said one axis, so that a horizontal displacement of said mooring unit with respect to said coupling means results in pivoting of said buoyant damping means about said axes against a force tending to establish the equilibrium of said buoyant damping means, whereby forces transmitted between said mooring unit and said coupling means are damped.

2. An offshore marine station as defined in claim 1, wherein said second pivot means comprises pivot arms pivoted to said body and connecting with said mooring unit.

3. An offshore marine station as defined in claim 1, wherein said damping means comprises a plurality of additional buoyant bodies of displacement which are arranged laterally adjacent one another and said body, said coupling means being pivotally coupled with all of said bodies.

4. An offshore marine station, comprising a floating mooring unit for tankers and supporting the terminals of a pipeline leading to the shore; an ocean-bottom anchor for said mooring unit; rigid elongated coupling means having one end jointed to said ocean-bottom anchor with freedom of movement in a plurality of directions, and a free end spaced from said one end, and extending from said ocean-bottom anchor upwardly toward said mooring unit at an acute angle to the horizontal; buoyant damping means interposed between and pivoted to said free end of said coupling means and said mooring unit, respectively, for angular displacement about two horizontal axes located at vertically spaced levels, so that a horizontal displacement of said mooring unit with respect to said coupling means results in pivoting of said buoyant damping means about said axes against a force tending to establish the equilibrium of said buoyant damping means, whereby forces transmitted between said mooring unit and said coupling means are damped; and connecting elements on said mooring unit for tying the tankers thereto so as to substantially eliminate relative displacement of said tankers with respect to said mooring unit, whereby conduits may be connected to said terminals to establish communication of the latter with the holds of the tankers.

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