# United States Patent [19]

**Reynolds**

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[45] **Apr. 17, 1973**


[54] **SUBMERGED TANKER MOORING AND CARGO TRANSFERRING SYSTEM**


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[52] **U.S. Cl.** .....**141/387,** 285/13, 285/275

[51] **Int. Cl.**.....**B65b 1/04,** B65b 3/04

[58] **Field of Search**.....9/8 P; 61/.5, 1 R, 61/1 F, 46, 69; 114/230; 137/236, 236 OS, 312; 141/86, 284, 387, 388; 166/.5, .6; 210/242; 285/13, 14, 272, 275



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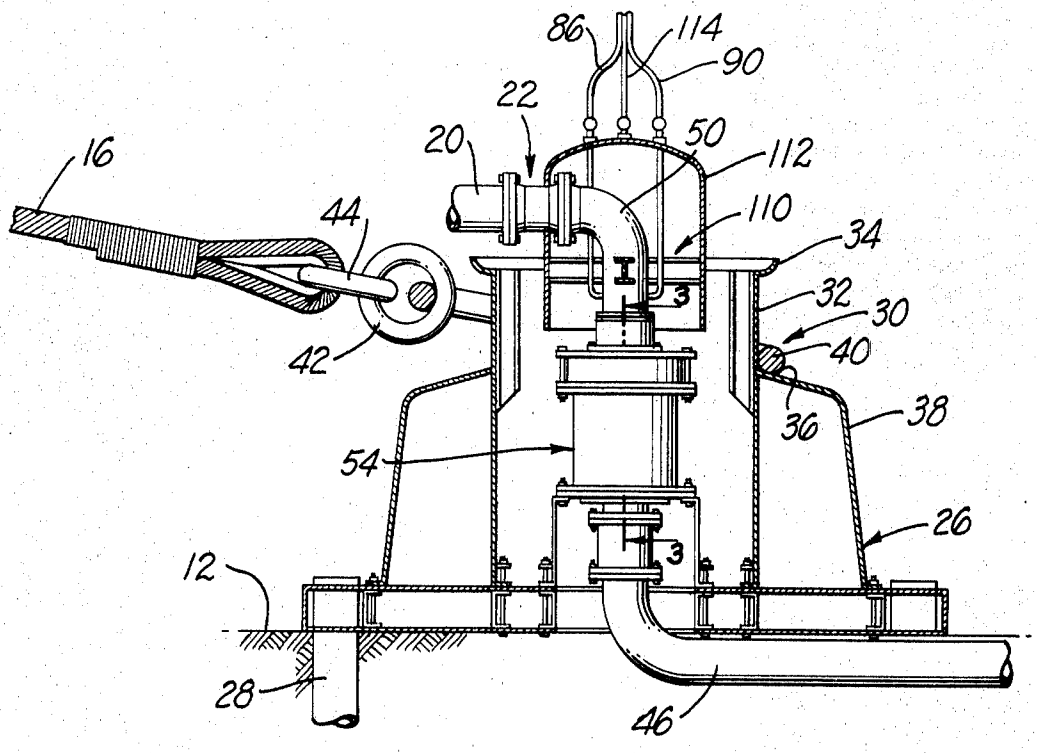
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[57] **ABSTRACT**

A submerged tanker mooring and cargo transferring system including a base anchored to the sea floor, swiveling mooring means for mooring a tanker to the base, a stationary conduit connected to the base, movable conduit swingable about a vertical axis and connectible to the tanker and aligned with the stationary conduit, swivel means interconnecting the movable and stationary conduits, a sealed chamber at least partially enclosing the swivel means, means for pressurizing the sealed chamber with a gas and for draining liquid therefrom into one of the conduits, a bell movable with the movable conduit above the swivel means, and means extending from the bell to the surface for sampling the liquid in the bell to detect leakage of fluid from the swivel means.


**5 Claims, 3 Drawing Figures**



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SHEET 1 OF 2

FIG. 2.

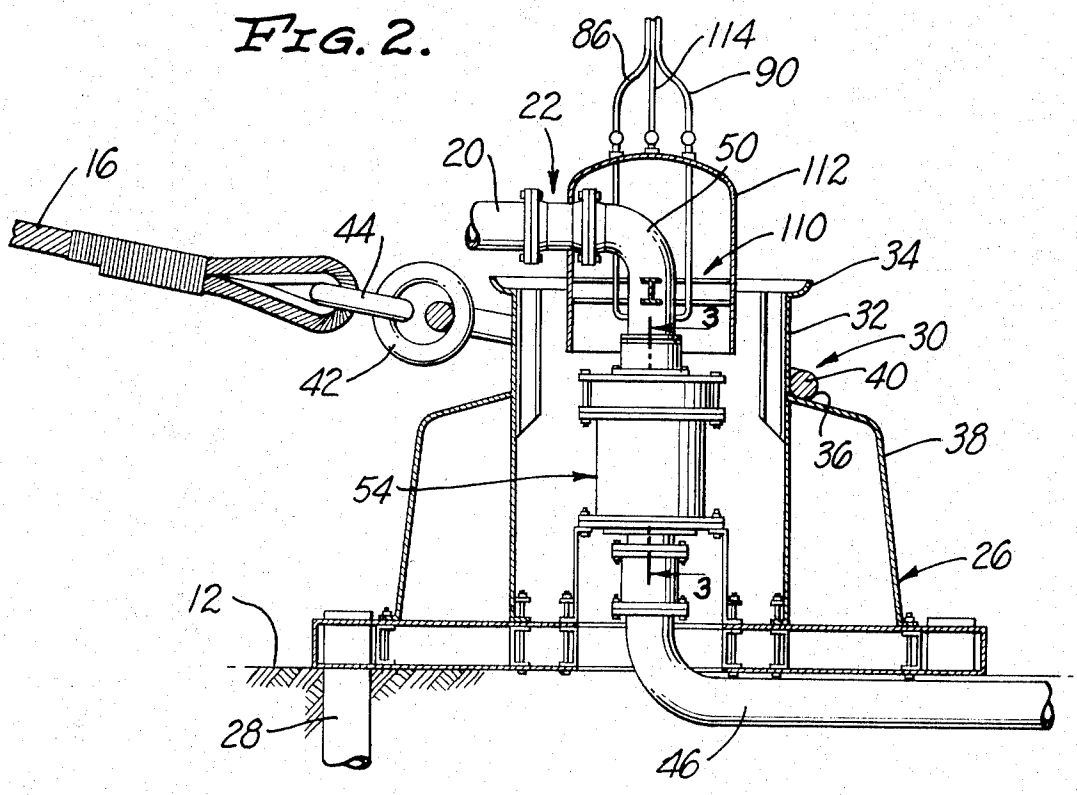
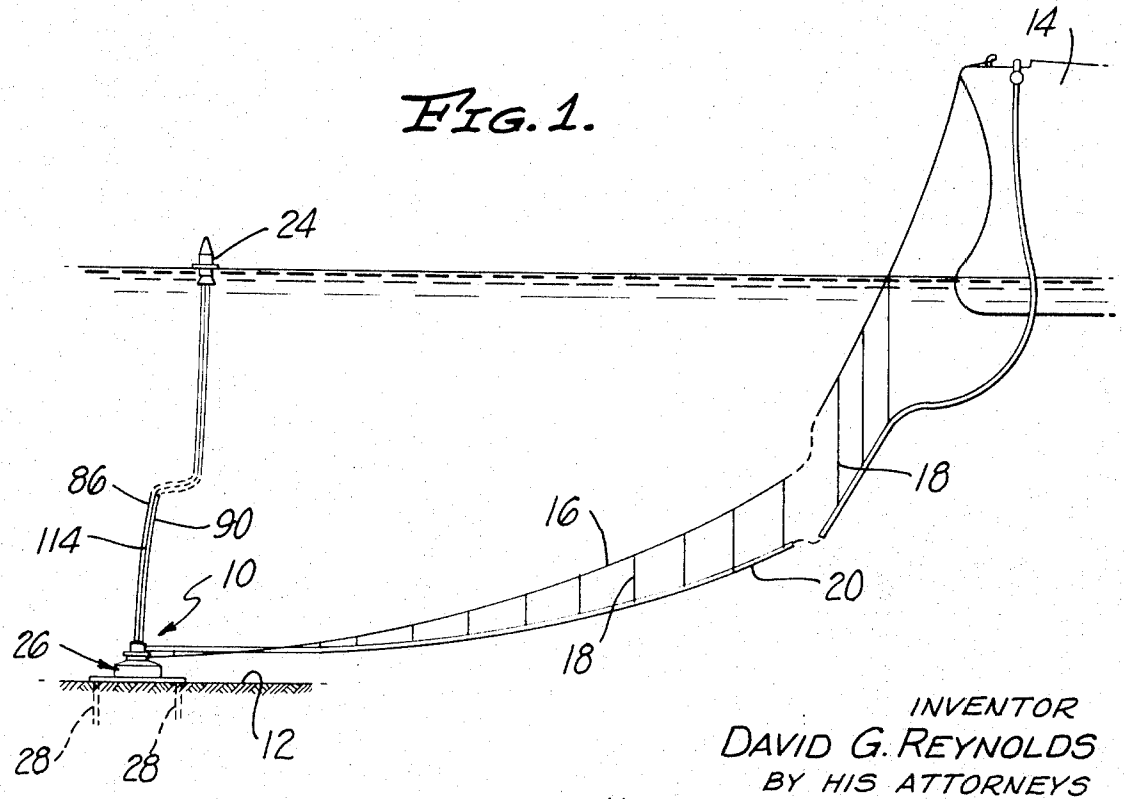
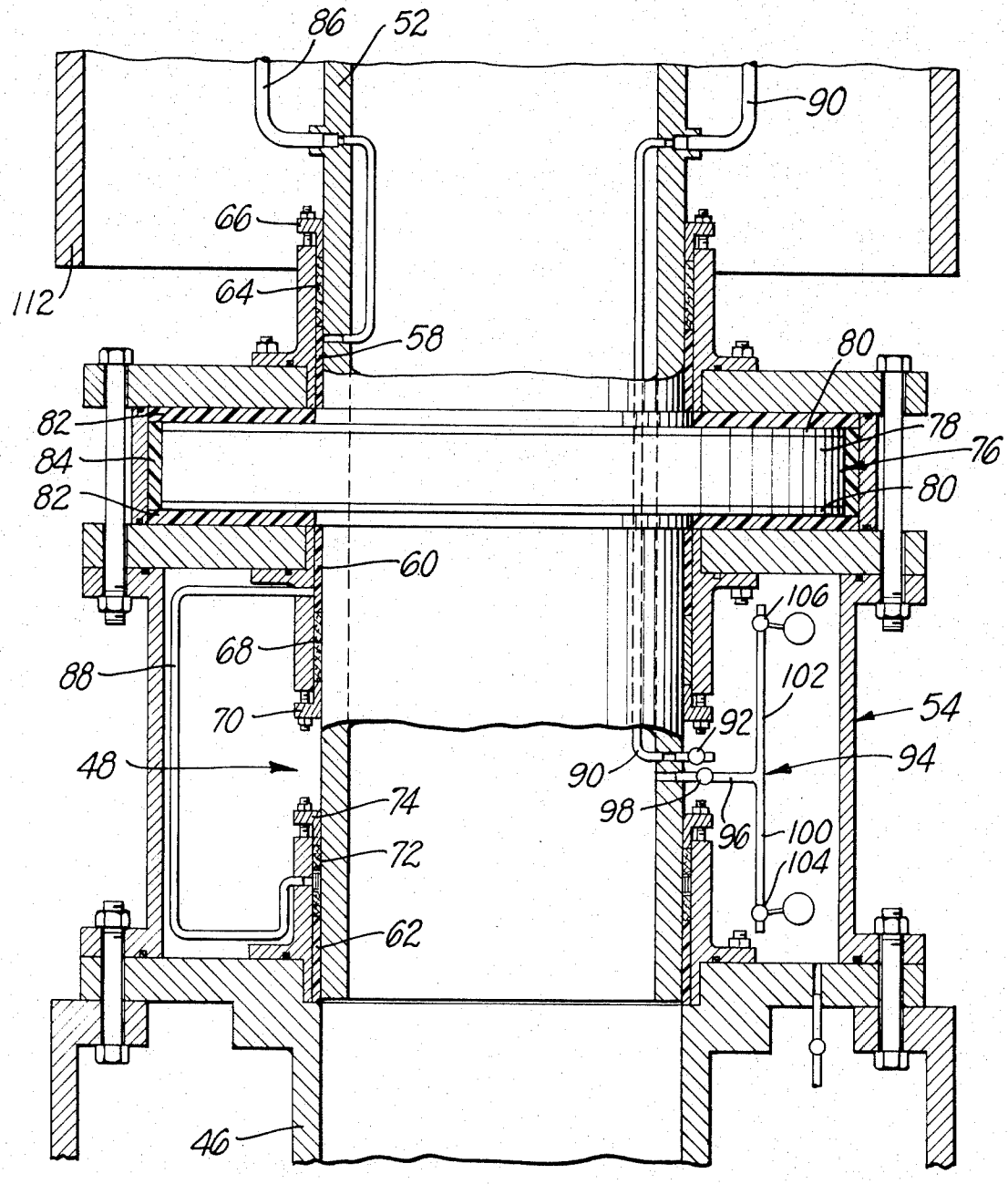



FIG. 1.




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FIG. 3.




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# SUBMERGED TANKER MOORING AND CARGO TRANSFERRING SYSTEM

## CROSS REFERENCE TO RELATED APPLICATION

The present application discloses subject matter which is disclosed and claimed in my copending patent application Ser. No. 74,293, filed Sept. 22, 1970, now U.S. Pat. No. 3,670,686.

## BACKGROUND OF THE INVENTION

The present invention relates in general to mooring and cargo transferring systems for ships, or the like, and, more particularly, to a submerged tanker mooring and cargo transferring system which permits the tanker to weathervane with the wind and/or current so that its bow always faces the anchor point while the tanker is being loaded or unloaded. The invention is particularly applicable to loading or unloading an oil tanker, although other uses therefor are also possible.

The submerged tanker mooring and cargo transferring system to which the invention relates incorporates mooring means which is swivelable above a vertical axis and to which a bow mooring line extending to the tanker is connected, the mooring means permitting the mooring line to swing about a vertical axis as the heading of the tanker changes with variations in the wind and/or current. Also located at the anchor point is a swivel means interconnecting a stationary conduit and a movable conduit comprising a hose swingable with the mooring line about the same vertical axis, the movable conduit being connected to the stationary conduit by a conduit swivel or swivel means. A protective bell or dome rotatable with the swingable conduit may at least partially enclose the mooring and cargo transferring installation at the anchor point.

## RELATED PRIOR ART

A submerged tanker mooring and cargo transferring system of the general type to which the present invention relates is disclosed in Mascenik et al. U.S. Pat. No. 3,455,270, issued July 15, 1969.

## SUMMARY AND OBJECTS OF INVENTION

With the foregoing background in mind, one of the primary objects of the present invention is to provide a submerged tanker mooring and cargo transferring system wherein the conduit swivel is at least partially enclosed by a sealed chamber or chamber means for receiving any leakage from the conduit swivel of the fluid flowing through the conduits, thereby preventing the escape of such leakage into the surrounding water.

Another object in connection with the foregoing is to provide means for pressurizing the sealed chamber with air or other gas, to minimize leakage into such chamber from the conduit swivel.

Still another object is to provide float controlled means for draining liquid from the sealed chamber into one of the conduits of the cargo transferring system.

Yet another object is to provide a submerged tanker mooring and cargo transferring system wherein the conduit swivel includes vertically spaced radial bearings and a thrust bearing between two of the radial bearings.

An additional object is to provide seals associated with the radial bearings for minimizing leakage from the conduit swivel, two of such seals bounding the sealed chamber mentioned.



A further object is to provide means for lubricating the bearings of the conduit swivel with a lubricant under pressure, any excess lubricant leaking past the seals bounding the sealed chamber being trapped in such chamber to prevent contamination of the surrounding water.

Another primary object of the present invention is to provide a flooded bell carried by the movable conduit above the conduit swivel, and to provide means extending from the bell to the surface for sampling the liquid in the bell. With this construction, any leakage from the conduit swivel, either of the fluid being transferred, or of lubricant, is trapped in the bell and the presence thereof may be detected by the sampling means before sufficient leakage occurs to fill the bell and escape under the periphery thereof. Thus, the possibility of contamination of the surrounding water is virtually completely eliminated, which is an important feature.

Still another object is to space the bell from and to make it independent of the mooring means for the tanker. Consequently, nothing associated with the bell and conduit swivel is required to sustain mooring leads, which is an important feature.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in the art to which the invention relates in the light of this disclosure, may be achieved with the exemplary embodiment of the invention described in detail hereinafter and illustrated in the accompanying drawings.

## DESCRIPTION OF DRAWINGS

In the drawings:

FIG. **1** is a semidiagrammatic view illustrating a submerged tanker mooring and cargo transferring system of the invention in use to load or unload a tanker;

FIG. **2** is a vertical sectional view of the submerged tanker mooring and cargo transferring system; and

FIG. **3** is an enlarged vertical sectional view taken as indicated by the arrowed line **3—3** of FIG. **2** of the drawings.

## DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT OF INVENTION

Referring initially to FIG. **1** of the drawings, the submerged tanker mooring and cargo transferring system of the invention is designated generally therein by the numeral **10** and is shown as anchored to the sea floor **12**. A tanker **14** is shown secured to the submerged system **10** by a bow mooring line **16**, which is preferably formed of a synthetic material such as nylon, or the like, but which may also be a cable, chain, or the like. Illustrated as connected to the mooring line **16** by ties **18** is a bow hose **20** which forms part of a movable conduit **22** swingable about a vertical axis in a manner to be described hereinafter. A buoy **24** connected to the submerged system **10** marks the location thereof, and performs other functions to be described.

Considering the submerged system **10** in more detail, it includes a base **26** which is suitably anchored to the sea floor **12**, as by being connected to piles **28** driven thereinto. The mooring line **16** is connected to the base

26 by a mooring means 30, FIG. 2, capable of swiveling about a vertical axis with the hose 20, whereby the tanker may weathervane with variations in the wind and/or current.

The mooring means 30 is completely disclosed and is claimed in the aforementioned copending application, reference to which is hereby made. Consequently, the mooring means 30 does not need to be described in detail herein. Briefly, it comprises a cylindrical, tubular vertical column 32 forming part of the base 26. The column 32 is provided at its upper end with external annular flange 34 and spaced below this flange is an external annular shoulder 36 formed by the top of a housing 38 encompassing the lower portion of the column 32 and constituting part of the base 26.

Encircling the column 32 between the flange 34 and the shoulder 36 is a circular mooring ring 40 having linked therewith a slip ring 42 which is slidable circumferentially of the mooring ring. The slip ring 42 is connected to the mooring line 16 by a link 44.

With the foregoing construction, as the tanker 14 drifts with the wind and/or current, it always remains bow-on to the submerged system 10, and the mooring means 30 permits swinging of the mooring line 16 about the vertical axis of the mooring means. As the tanker swings, the mooring ring 40 slides circumferentially around the column 32, or the slip ring 42 slides circumferentially along the mooring ring, or both. This provides a very flexible arrangement which insures the desired swiveling action about a vertical axis with no possibility of binding.

It should be noted that the mooring means 30 is connected solely to the stationary base 26, and not to any movable components of the submerged system 10. The significance of this will be discussed in detail hereinafter.

The cargo transferring portion of the submerged system 10 includes the movable conduit 22 and a stationary conduit 46 which are interconnected within the base 26 by a conduit swivel or swivel means 48 permitting swinging movement of the movable conduit 22 about the same vertical axis as the mooring line 16. Thus, as hereinbefore indicated, the mooring line 16 and the hose 20 can swing in unison about the same vertical axis as the tanker 14 responds to changes in wind and/or current direction.

More particularly, the movable conduit 22 comprises an elbow 50 which the hose 20 is suitably connected and which includes a depending tube 52 coaxial with the mooring means 30 and the conduit swivel 48 and forming part of the latter. As shown near the bottom of FIG. 3, the lower end of the tube 52 registers and communicates with the adjacent end of the stationary conduit 46. The lower portion of the tube 52 and the registering end of the stationary conduit 46 are enclosed by a sealed chamber 54 suitably connected to the base 26.

The tube 52 rotates or swivels in three vertically spaced radial bearings 58, 60 and 62. The upper bearing 58 is sealed relative to the structure of the chamber 54 by packing 64 thereabove, the pressure of this packing being adjustable by a packing gland 66. Similarly, the intermediate bearing 60 is sealed relative to the structure of the chamber 54 by packing 68 below this bearing, the pressure on the packing 68 being adjustable by a packing gland 70. The lower bearing 62 is sealed relative to the structure of the chamber 54 and to the stationary conduit 46 by packing 72 thereabove, the pressure on the packing 72 being adjustable by a packing gland 74. It is important to note that any fluid leaking past the packing 68 and the packing 72 can escape only into the sealed chamber 54, which is an important feature of the invention.

Interposed between the upper and intermediate radial bearings 58 and 60 is a thrust bearing assembly 76 which resists any tendency of lateral forces applied by the hose 20 to cock the rotatable tube 52. The thrust bearing assembly 76 comprises an external collar 78 suitably fixed on the tube 52 and equipped on its upper and lower sides with annular wear plates 80. These plates engage annular thrust bearings 82 suitably mounted in the upper wall of the sealed chamber 54. A radial bearing 84 encircles the collar 78.

All of the bearings 58, 60, 62, 82 and 84 are preferably made of a synthetic material impregnated with a permanent lubricant. For example, these bearings may be made of Teflon reinforced with fiber glass, and impregnated with a suitable dry lubricant. However, other materials may be used.

Additionally, the various bearings 58, 60, 62, 82 and 84 are preferably lubricated with oil to minimize friction. For this purpose, the buoy 24 may contain a lubricating oil storage tank, not shown, and suitable means for delivering lubricating oil therefrom under pressure to the conduit swivel 48 through a lubricating oil line 86. As shown in FIG. 3, the line 86 delivers lubricating oil to the upper radial bearing 58. From this point, the lubricating oil makes its way past and lubricates the radial bearing 58, the upper thrust bearing 82, the radial bearing 84, the lower thrust bearing 82 and the radial bearing 60. An oil line 88 conveys lubricating oil from the intermediate radial bearing 60 to the lower radial bearing 62. Thus, all of the bearings involved in the conduit swivel 48 are lubricated from a common source.

The buoy 24 also contains a suitable source, not shown, of compressed air, or other gas, which is delivered to the sealed chamber 54 through a line 90. The latter is equipped with a check valve 92 preventing reverse flow. With this construction, the sealed chamber 54 can be pressurized, preferably to a valve of the same order of magnitude as the oil or other fluid flowing through the conduits 22 and 46, so as to minimize leakage into the chamber past the packing 72, and incidentally the packing 68.

The invention also provides float controlled means 94 for draining liquid from the sealed chamber 54 into the tube 52 whenever the pressure in the tube falls below the pressure maintained in the sealed chamber. This occurs, for example, whenever delivery of oil, or other liquid, from the stationary conduit 46 to the movable conduit 22 is terminated. The draining means 94 includes a drain line 96 equipped with a check valve 98 preventing reverse flow, the drain line being carried by and rotatable with the tube 52. The drain line 96 preferably includes downwardly extending and upwardly extending branches 100 and 102 equipped with float controlled valves 104 and 106. The lower valve 104 responds to the level of any oil-water interface in the chamber 54, withdrawing the water to the tube 52,

while the upper valve **106** opens whenever the liquid level reaches the float thereof.

Carried by the tube **52** on a spider **110**, FIG. **2**, is a dome or bell **112** above and coaxial with the swivel means **48**. Any leakage past the upper packing **64**, or any other leakage escaping from the swivel means **48**, is trapped within the bell **112**, which is an important feature.

Preferably, the bell **112** is filled with water so that any lubricating oil leakage, or transferred oil leakage, rises to the top of the bell. Connected to the top of the bell **112** at its highest point is a sampling line **114** which extends upwardly to the buoy **24**. By withdrawing a sample of liquid from the sampling line **114** periodically, the presence of oil leakage within the bell **112** can be detected. If the leakage becomes severe, the installation can be shut down and the necessary repairs made before there is any contamination of the surrounding water, which is an important feature.

It will be noted that, as previously mentioned, the mooring means **30** is connected directly to the base **26** and that the movable conduit **22** and the bell **112** are spaced from and independent of the mooring means. Consequently, the swivel means **48** is not required to withstand any mooring loads, being required to withstand loads imposed by the hose **20** only. In other words, the swiveling of the hose **20** and the swiveling of the mooring line **16** are totally divorced from each other so that there is no connection whatsoever between mooring loads and the swivel means **48**, which is an important feature.

Although an exemplary embodiment of the invention has been disclosed for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims which follow.

I claim as my invention:

**1**. In a submerged tanker mooring and cargo transferring system, the combination of:

a. a base anchored to the sea floor;

b. mooring means swivelable about a vertical axis for mooring a tanker to said base;

c. a stationary conduit terminating within the lateral confines of said base;

d. a movable conduit swingable about a vertical axis and connectible to the tanker and terminating within the lateral confines of said base;

e. swivel means interconnecting said movable and stationary conduits;

f. sealed chamber means at least partially enclosing said swivel means;

g. means for draining liquid from said chamber means into one of said conduits; and

h. a bell carried by said movable conduit above said swivel means and spaced from and independent of said mooring means.

**2**. A submerged tanker mooring and cargo transferring system as set forth in claim **1** including means for lubricating said swivel means with a lubricant under pressure.

**3**. A submerged tanker mooring and cargo transferring system according to claim **1** including means for pressurizing said chamber means with air or other gas.

**4**. A submerged tanker mooring and cargo transferring system as set forth in claim **1** wherein said draining means includes float controlled valve means.

**5**. A submerged tanker mooring and cargo transferring system according to claim **1** wherein said swivel means includes vertically spaced radial bearings and a thrust bearing between two of said radial bearings.

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