

April 21, 1959

H. B. JORDAN
BUOY CONSTRUCTION

2,882,536

Filed Dec. 29, 1955

5 Sheets-Sheet 1

FIG. 8.

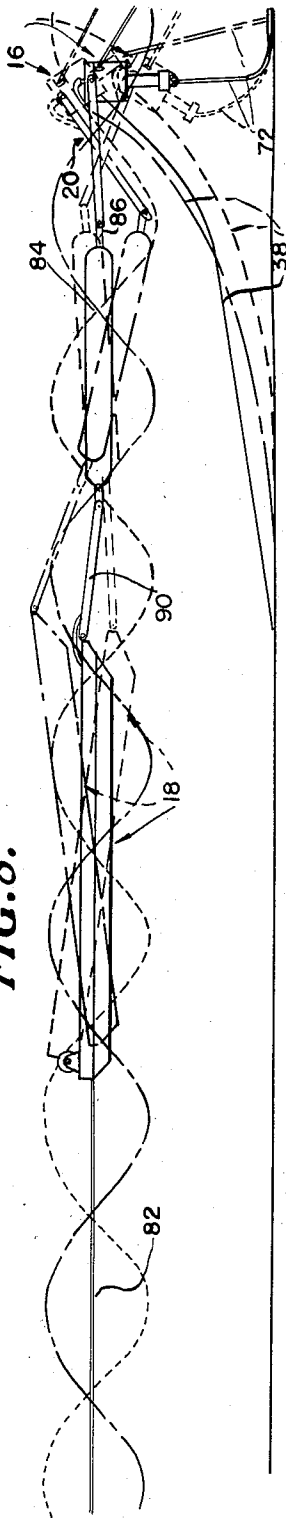


FIG. 7.

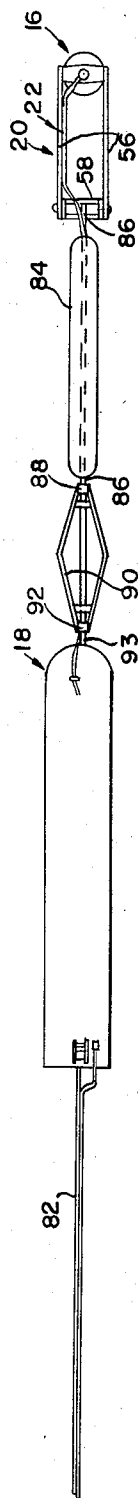


FIG. 1.

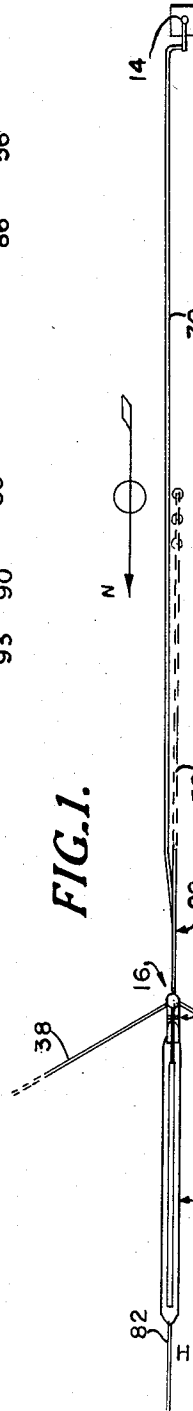
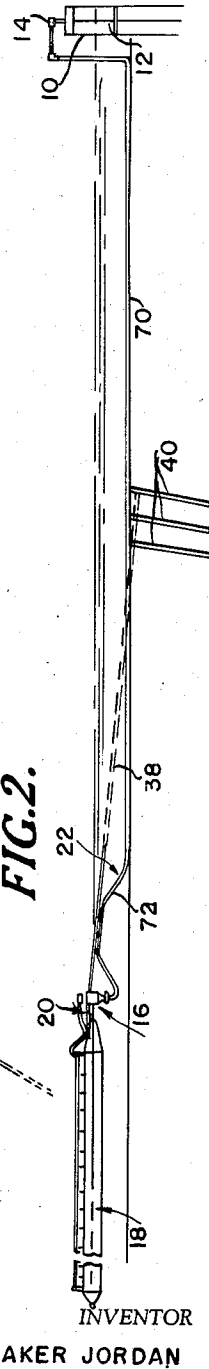


FIG. 2.



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FIG. 3.

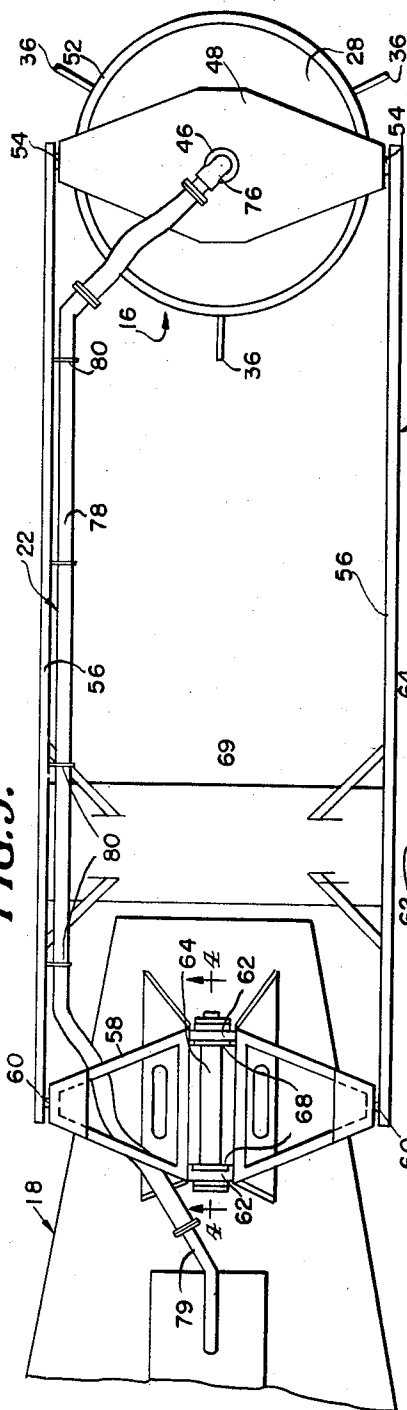


FIG. 4.

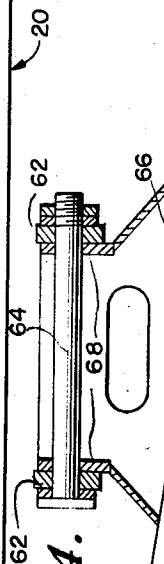
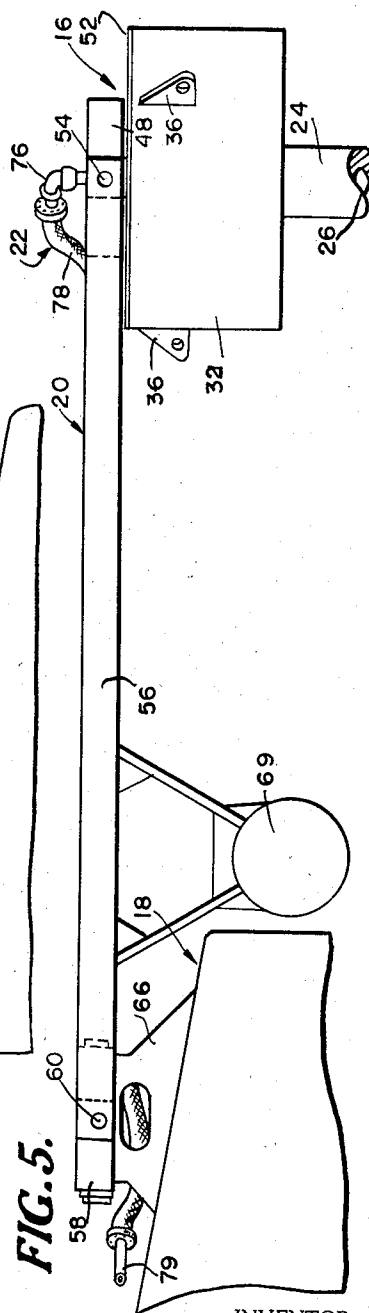


FIG. 5.



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FIG. 9.

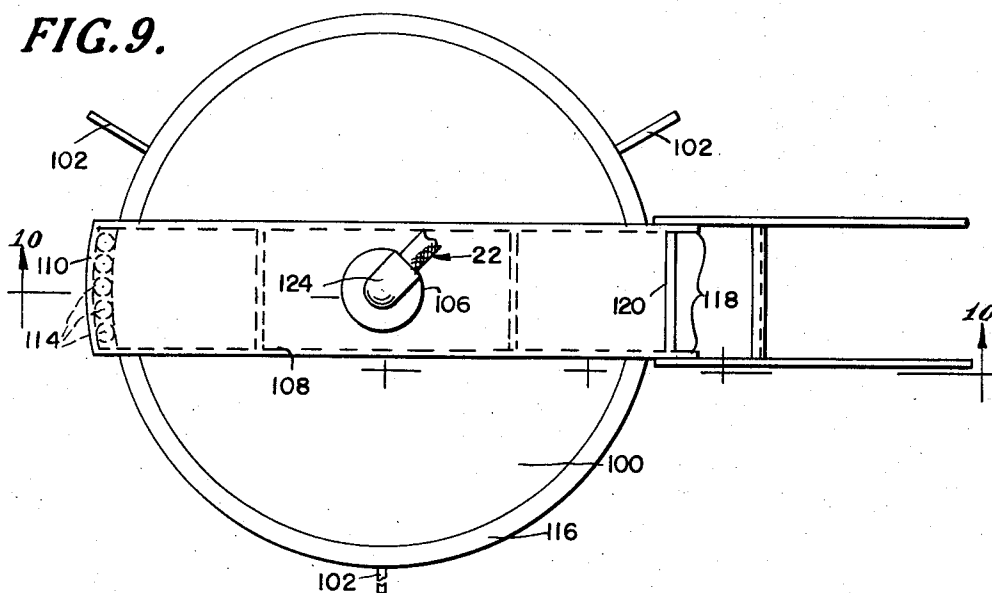
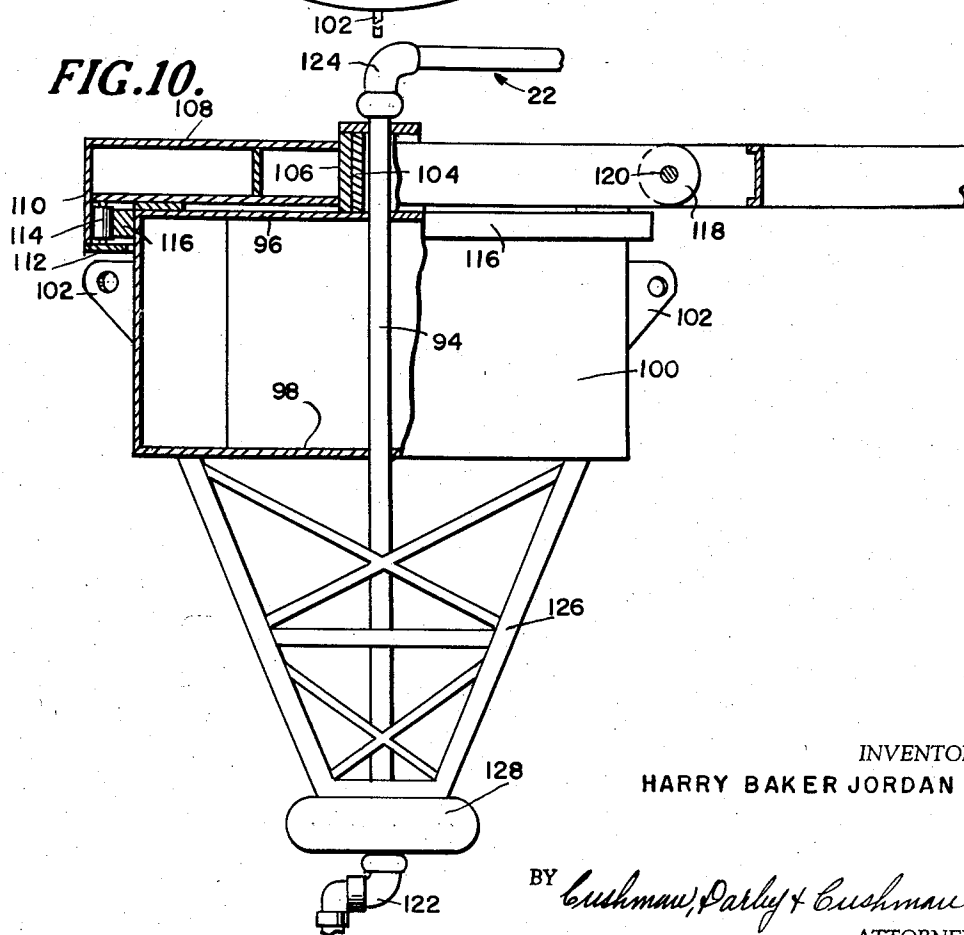


FIG. 10.



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FIG. 6.

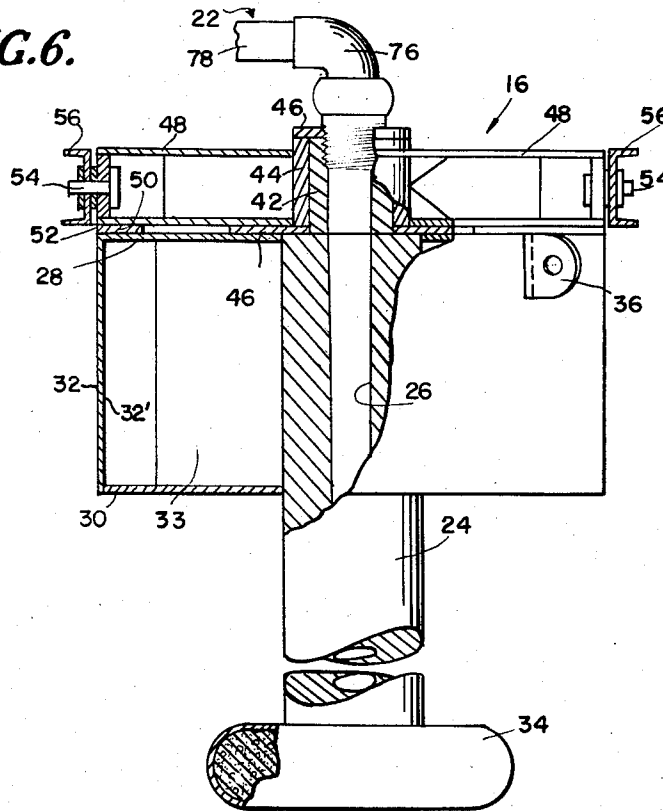


FIG. 11.

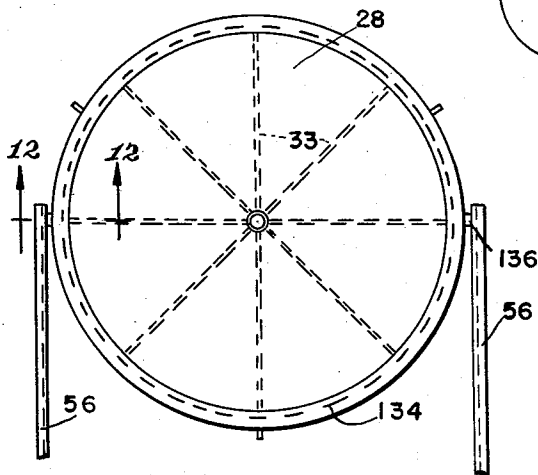
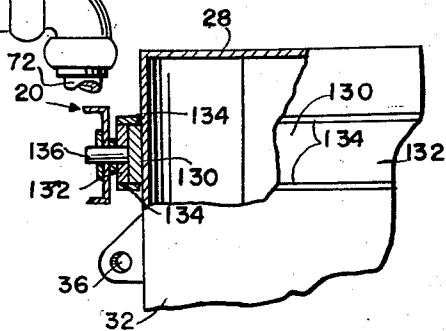


FIG. 12.



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FIG.13.

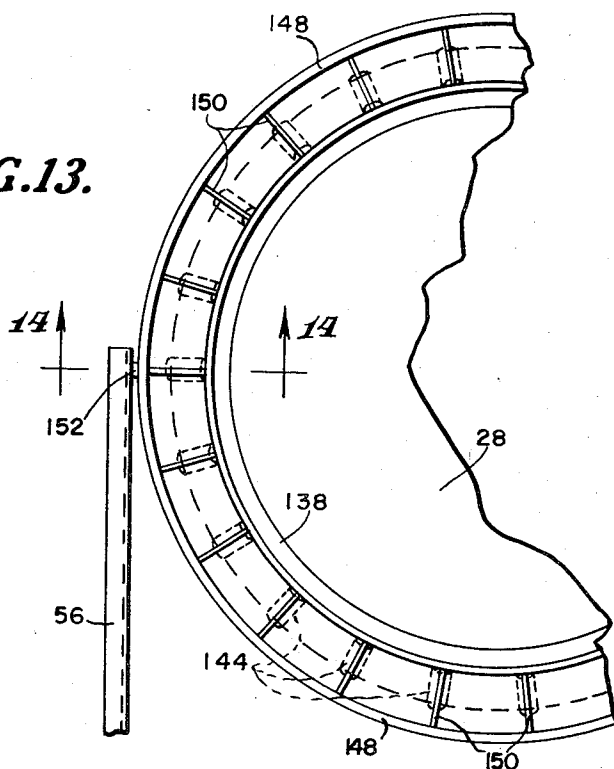
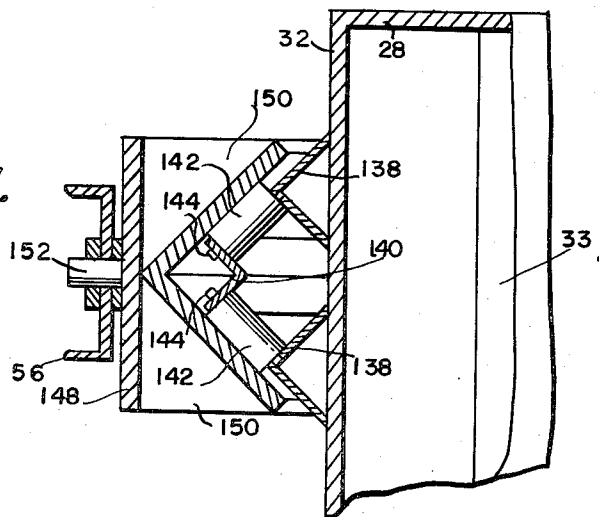


FIG.14.



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Application December 29, 1955, Serial No. 556,345

8 Claims. (Cl. 9—8)

This invention relates to off-shore well installations and, more particularly, to a system for transferring and storing the fluid from such an installation.

Heretofore, the practice utilized to transfer the fluid from off-shore fluid well installations entailed the construction of permanent platforms which must be firmly embedded in the water bed and extend above the water level. A fluid transporting vessel is then anchored to the platform while fluid is flowed from the installation to the vessel.

This system has many inherent disadvantages. Primarily, the building of permanent stationary platforms is a time-consuming and extremely expensive job. In addition, the securing of the transporting vessel to the platform is hazardous, particularly in rough weather where the effect of turbulent seas can cause damage both to the vessel and to the platform.

It is, therefore, an object of the present invention to provide an improved buoy construction for use in a fluid transfer and storage system for an off-shore fluid well installation which will substantially overcome the disadvantages mentioned above.

Another object of the present invention is the provision of an improved conduit carrying buoy construction which is highly stable and well-balanced in operation so as to minimize the possibility of damage either to the buoy, the conduit or a floating vessel secured thereto, which may result from the action of the water under extreme inclement conditions.

A further object of the invention is provision of an improved buoy construction for permanently securing a floating vessel thereto having means for rigidly maintaining the vessel in spaced relation thereto, but yet permitting unlimited movement of the vessel in a horizontal plane about the buoy and relative vertical movement with respect thereto.

These and other objects of the present invention will become more apparent during the course of the following detailed description and appended claims.

The invention may best be understood with reference to the drawings wherein an illustrative embodiment of the invention is shown.

In the drawings:

Figure 1 is a top plan view of an off-shore fluid well installation embodying one form of the fluid transfer and storage system of the present invention;

Figure 2 is a side elevation of the installation shown in Figure 1;

Figure 3 is an enlarged top plan view of the system;

Figure 4 is a sectional view taken along the line 4—4 of Figure 3;

Figure 5 is a side elevational view of the system;

Figure 6 is a cross-sectional view of the buoy of the system;

Figure 7 is a top plan view showing a system of modified form;

Figure 8 is a side elevational view of the system shown in Figure 7;

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Figure 9 is a fragmentary top plan view showing a modified form of the buoy and the manner in which it is connected in the system;

Figure 10 is a sectional view taken along the line 10—10 of Figure 9;

Figure 11 is a fragmentary top plan view showing another modified form of the buoy;

Figure 12 is a fragmentary sectional view taken along the line 12—12 of Figure 11;

Figure 13 is a fragmentary top plan view showing still another modified form of the buoy; and

Figure 14 is a fragmentary sectional view taken on the line 14—14 of Figure 13.

Referring now more particularly to the drawings, there is shown in Figures 1 and 2 an off-shore fluid well installation which includes a permanent platform 10 having a casing pipe 12 extending upwardly therefrom and a christmas tree 14 secured to its upper end. The casing 12 may receive fluid from as many as five beds extending radially outwardly therefrom as is the usual practice.

In order to illustrate a preferred use of the present invention there is disclosed in Figures 1 and 2 a system which generally comprises a buoy 16 arranged to be anchored to the water bed at a position remote from the well installation, a permanent floating storage vessel or barge 18 for receiving the fluid from the installation, rigid arm means 20 securing the vessel 18 to the buoy for unlimited movement in a horizontal plane about the buoy and for vertical movement with respect thereto, and conduit means 22 for directing the fluid from the well installation to the storage vessel through the buoy.

Referring now to Figures 3—6, the present invention is more particularly concerned with the buoy 16 which comprises a centrally disposed, vertical, cylindrical member or rigid structure 24 of substantial thickness having a bore 26 extending therethrough. Secured to the cylindrical member at the upper end thereof is a circular wall 28 and a second circular wall 30 is rigidly secured to the member 24 in spaced relation therefrom. A cylindrical wall 32 is secured between the outer peripheral edge of the walls 28 and 30 and forms therewith water-tight compartment means, indicated at 32', which render the buoy buoyant. If desired, internal ribs 33 may be rigidly secured within the compartment to add strength thereto.

Secured to the lower end of the cylindrical member is a container 34 for receiving suitable ballast, such as concrete or the like. As shown in Figures 5 and 6, the ballast container 34 is spaced substantially below the compartment means and serves to maintain the buoy in an upright position. It will be understood that the length of the cylindrical member 24 may be varied so as to dispose the ballast in varying vertical positions with respect to the compartment means to accommodate different conditions relative to the marine bottom and contemplated weather.

Extending radially outwardly from the upper end of the cylindrical wall 32 is a plurality of circumferentially spaced lugs or trunnions 36, which are apertured to receive one end of a plurality of cables or chains 38 for anchoring the buoy to the water bed. The lower ends of the chains 38 may be rigidly secured to caissons or pilings 40 driven into the water bed in the usual manner.

Means is provided between the upper ends of the buoy 16 and the inner end of the rigid arm means 20 which is operable to secure the latter to the former for unlimited movement in a horizontal plane and for swinging movement in a vertical plane. To this end, a hollow bearing 42 is rigidly secured to the upper end of cylindrical member 24 so that its hollow interior communicates with the bore 26 of the member. Journaled on the bearing is a sleeve 44 which is maintained in a vertical position thereon by a retainer ring 46. Extending radial-

ly outwardly in opposite directions from the sleeve 44 is a rigid yoke 48 which has its central portion suitably secured to the sleeve, as by welding or the like. The outer peripheral ends of the yoke are provided with lower horizontal surfaces 50 which are disposed in sliding engagement with a bearing ring 52 secured to the upper surface of the circular wall 28 adjacent its periphery. Each end of the yoke is apertured to receive a pivot pin 54 which is arranged to extend through the rigid arm means 20.

As best shown in Figures 3 and 4, the rigid arm means 20 includes a pair of horizontally spaced parallel arms 56, which may be of channel construction or the like. The inner ends of the arms are pivotally secured to the pins 54, respectively, and the outer ends thereof are provided with means for securing the same to the vessel 18. This means comprises a swiveling frame 58, of diamond shape in plan, extending between the ends of the arms. Pivot pins 60 disposed on a common axis extend between each arm 56 and the adjacent end of frame 58. The central portion of the swiveling frame 60 includes a pair of longitudinally spaced, apertured plates 62 through which a removable swivel pin 64 is arranged to extend. The pin 64 is mounted on the vessel 18 by means of a base 66 of inverted V-shaped construction having a pair of longitudinally spaced, apertured, pin-receiving plates 68 disposed adjacent the plates 62. Base 66 has its lower end rigidly secured to the vessel 18 in any suitable manner, such as by welding or the like. It can thus be seen that the means for removably connecting the rigid arm means to the vessel provides for both vertical swinging movement of the arms with respect to the vessel and for tilting movement of the arms with respect to the vessel.

Disposed below the arms 56 adjacent the outer ends thereof is a transversely extending float 69 of cylindrical shape having its ends rigidly attached to the undersurface of the arms by any suitable means. Float 69 serves, under certain conditions, hereinafter to be more fully explained, to maintain the rigid arm means 20 in an outwardly extending position.

The conduit means 22 may include a length of pipe 70 connected at one end of the christmas tree 14 and extending toward the buoy. The opposite end of the pipe has a flexible hose or conduit 72 secured thereto which communicates with the lower end of the buoy. To effect this communication, the free end of the hose 72 is connected to one end of a swivel fitting 74 rigidly secured in communication with the bore 26 of the cylindrical member 24. The fitting 74 may be of any well-known construction and, preferably, provides for swiveling movement between the buoy 16 and the hose 72 in three perpendicular planes. The bore 26 which communicates at its lower end with the fitting 74, defines a passage which constitutes a portion of the conduit means and has a second swivel fitting 76 communicating with the upper end thereof. The fitting 76 may also be of conventional construction, although it need only provide relative swiveling movement in a horizontal plane. One embodiment of the type of fittings that may be utilized as the fitting 74 and the fitting 76 is manufactured by the Chiksan Company, the construction being illustrated, for example, in Warren Patent No. 2,501,638, issued March 21, 1950. A transfer flexible hose or conduit 78 has one end secured to the fitting 76 and its other end extending toward the storage vessel for detachable connection with suitable conduit 79 mounted thereon for directing the flow of fluid into the fluid containing compartments of the vessel. Preferably, the conduit 78 is fixedly secured to the rigid arm means, by any suitable means, such as clips 80, so that it will move therewith and be thereby protected against damage and fouling. The storage vessel may have a discharge conduit 82 extending from its remote end for connection with a transporting vessel. This discharge conduit may be of light-weight construction so that the same will

float even when filled with oil or other relatively light fluid.

Referring now to Figures 7 and 8, there is shown a modified system wherein the rigid arm means 20 is connectible to the storage vessel by means of a dampening tank 84. In this embodiment swivel frame 58 has connected therewith, for rotation about a longitudinal axis, one end of an elongated pipe or rod 86 in a manner similar to the pin 64. Rod 86 extends through the central axis of the dampening tank 84 and has its opposite end rotatably mounted in a sleeve 88 pivoted, as by trunnions or the like, about a transverse axis between adjacent ends of a pair of interconnected V-shaped arms 90. The opposite ends of the arms 90 pivotally receive, as by trunnions or the like, another sleeve 92 which, in turn, rotatably receives a rigid pin 93 extending from the storage vessel. It can be seen that the dampening tank 84 will float on the surface of the water and when extreme conditions are encountered, will act to stabilize the relative movements between the buoy and the vessel by virtue of its weight and movement in the water.

In Figures 9 and 10, there is shown a modified form of the buoy and the manner in which the same is connected with the rigid arm means 20. The buoy includes a central pipe 94 which constitutes part of the conduit means 22. Secured to the upper end of the pipe 94 is a watertight compartment means comprising a pair of vertically spaced circular plates or walls 96 and 98 and a cylindrical wall 100 secured between the outer peripheries of the same. The upper end of the cylindrical wall 100 has a plurality of circumferentially spaced radially extending lugs 102 secured thereto, which are similar to the lugs 36, previously described, and perform the same function. Rigidly mounted on the wall 96 and extending upwardly therefrom is a bearing 104, similar to the bearing 42, which has a sleeve 106 journaled thereon. A yoke 108 is rigidly secured to the sleeve at its mid-portion for rotation therewith. The yoke 108 is of box-like construction and includes at one end a vertical end plate 110 extending downwardly below the lower surface thereof. A horizontal plate 112 extends inwardly from the lower end of the plate 110 and a plurality of rollers 114 are rotatably mounted between the plate 112 and the adjacent lower surface of the yoke. These rollers are arranged to engage the outer cylindrical surface of a bearing ring 116 which is rigidly secured to the upper end of the cylindrical wall 100. The opposite end of the yoke terminates in a pair of transversely spaced apertured ears 118 through which a pivot pin 120 is arranged to extend. Pivot pin 120 connects to the rigid arm means in the manner previously indicated.

The pipe 94 of the buoy is provided with fittings 122 and 124, respectively, at its lower and upper ends, which are similar to the fittings 74 and 76 previously described, and perform the same function. Secured to the circular wall 98 and extending downwardly therefrom is a skeletonized rigid framework 126, of any suitable construction, which serves to maintain the pipe in proper alignment and to protect the same against damage. The lower end of the framework 126 has a ballast container 128 rigidly secured thereto, in the same manner as previously indicated in connection with Figures 1 through 7.

In Figures 11 and 12, there is shown a further modified form of the means for securing the rigid arm means 20 to the buoy 16. As shown, the cylindrical wall 32 has rigidly secured thereto adjacent its upper end, a bearing ring 130. A yoke or sleeve 132 is journaled on the bearing ring and has an interior cylindrical surface which slidably engages the exterior cylindrical surface of the bearing ring. The sleeve 132 may be retained in vertical position on the bearing ring by means of upper and lower retainer rings 134. A pair of pivot pins 136 are rigidly secured to and extend outwardly from the sleeve 132 at diametrically opposed positions

thereon for connection with the rigid arm means as previously indicated.

In Figures 13 and 14 there is shown a still further modified form of the means for securing the rigid arm means 20 to the buoy 16. This means comprises a pair of vertically spaced circular members 138 of V-shaped configuration in cross section having the free ends of their legs rigidly secured to the outer periphery of the cylindrical wall 32. Disposed in concentric relation between the members 138 is a circular member 140 also of V-shaped configuration in cross section and a series of circumferentially spaced pairs of angularly related rollers 142 are mounted on suitable pins 144 extending, respectively, between one flange of the member 140 and the associated member 138. Rotatably mounted in concentric relation with the rollers 142 is an annular track of V-shaped configuration in cross section having interior angularly related surfaces which engage the rollers 142. A yoke or sleeve 148 is rigidly secured adjacent the apex of the track 146 in concentric relation thereto by means of a plurality of triangular ribs or plates 150 suitably mounted therebetween, as by welding or the like. Rigidly secured to and extending outwardly from the sleeve at diametrically opposed positions thereon is a pair of pivot pins 152 arranged to enter in suitable apertures formed in the rigid arm means in the manner previously described.

In operation, the system disclosed in connection with the present invention is arranged so as to permanently maintain the storage vessel 18 in a position remote from the fluid well installation so as to receive the fluid flowing therefrom. In order to permanently maintain the floating storage vessel 18 in such a position, the buoy 16 and rigid arm means 20 cooperate to effectively accomplish this purpose so that the vessel may have unlimited movement in a horizontal plane about the buoy and limited relative vertical movement while still being rigidly maintained in spaced relation to the buoy. It has been found that such a relationship is essential in permanently maintaining a floating vessel where the same is subjected to the worst weather conditions including those of hurricane force. The rigid arm means serves, first of all, to prevent direct contact between the buoy and the vessel which, it will be appreciated, can cause considerable damage in extreme conditions. The provision of unlimited movement in the horizontal plane permits the vessel to track the buoy in response to wind and current conditions without danger that the conduit means 22 will become fouled. Moreover, since the connection between the vessel and buoy is maintained through the rigid arm means, there is no chance that the connecting means itself will become fouled with either of the elements.

The arrangement of the anchoring connection and the rigid arm means connection with the buoy is also of primary importance in permanently maintaining the vessel in position. It will be understood that with the rigid arm means connection at the upper end of the buoy, the forces of the vessel acting therethrough will tend to tip the buoy out of its upright position. By disposing the lugs closely adjacent the arm connection to the buoy, this tendency is substantially reduced. Since the point of attachment of the anchoring means is closely adjacent the point of attachment of the rigid arm means to the buoy, the lever arm through which the forces of the rigid arm means act to tilt the buoy about its attachment to the anchoring means is relatively small. To counteract any further tendency of the buoy to tilt, the ballast container disposed on the lower end of the buoy acts to constantly maintain the same in its upright position. Thus, if the forces acting through the rigid arm means tend to tilt the buoy, the ballast means will be displaced from the center of gravity of the buoy and tend to move the same back into its upright position. As was mentioned above, the vertical distance between the

compartment means and ballast can be varied so that different counterbalancing effects of the ballast can be obtained to off-set different conditions. It will be understood that the greater the amount of tilting movement which the buoy is subjected to, the greater the amount of influence the ballast has to return the buoy to its upright position. Stated differently, the greater the amount of tilt which occurs in the buoy, the greater will be the lever arm through which the weight of the ballast acts to return the buoy to its upright position. It has been found that the present invention provides an extremely stable arrangement for maintaining the buoy in an upright position and results in less strain to the conduit means connected therewith as well as less strain to the rigid arm means and to the vessel.

With respect to the conduit means, the lower fitting 74 enables the flexible conduit 72 to swivel in any plane as the buoy is tilted and moved in a vertical direction by the action of the water. Consequently, the likelihood of the same fouling or becoming damaged due to relative movement is considerably reduced, if not eliminated entirely. With respect to the transfer conduit 78, the latter is fixedly carried on the rigid arm means 22 and consequently moves therewith. The upper fitting 76 permits the same to swivel in a horizontal plane with the arm means without danger of fouling.

The present system in which a permanent floating storage vessel of substantial capacity is maintained in a position remote from the fluid well installation effects many advantages in the transfer and storage of the fluid from the installation. Primarily, the present system permits the construction of a platform for the well installation which is less costly. Heretofore, such platforms have been constructed with the view that transporting vessels would be secured thereto. Consequently, they must be built to withstand tremendous forces due to possible contact by the vessel, whereas with the present invention, they need only be constructed to have strength sufficient to maintain the Christmas tree above the water level. This saving in the cost of the construction of the platforms is considerably greater than the entire cost of the present system. In addition, the system provides a much greater flexibility in the handling of the fluid from the well installation. The storage vessel is such that a transporting vessel can be quickly loaded therefrom by means of pumps operated from the transporting vessel. The amount of fluid that can be transferred in this manner per unit time is considerably greater than the amount of fluid which can be transferred through the operation of the well installation. Accordingly, the present system effects a substantial saving in the amount of time necessary to load the transporting vessels. This saving in loading time makes possible the operation of the present system in a manner which brings about further advantages. The operations heretofore practiced entail the docking or securing of the transporting vessel to the heavy platform while loading takes place. Because of the restrictions on the pumping of wells and other limitations, heretofore the loading operation consumed considerable time, so much so, that it became established practice to leave the transporting vessels, usually barges, tied to the platform during loading while the propelling vessel was being used to move barges at other installations. Of course, this operation was hazardous in that sometimes storms developed when the barges alone were tied to the platforms and damage resulted.

With the present system, the permanent storage vessel can be loaded at the relatively low feed rate of the well installation without the hazard of damage due to flash storms or other inclement weather conditions because the system is constructed to withstand such conditions. Loading from the storage vessel by pumps or the like can be accomplished in such a relatively short period of time that the propelling vessel can remain with the

transporting barge during the entire loading operation without serious loss of time or efficiency. In this manner, there is no danger that the transporting barge will be left alone to ride out a storm with the possibility of breaking loose and being tossed about without motive power.

Another advantage of the present system is that the fluid from several well installations can be transferred to a central storage position. Preferably, the storage vessel is of substantial capacity and it is contemplated that well installations as far as two miles or more from the storage vessel can be efficiently handled with the present system. In each case, the necessity of providing an expensive and rugged platform is eliminated and only such platform as is necessary to support the Christmas tree above the water level is required.

While the arrangement illustrated in Figures 1 and 2 is contemplated to be sufficient in most locations under extreme weather conditions, in locales where hurricanes and other highly unusual weather conditions are contemplated, the utilization of the dampening tank 84, illustrated in Figures 7 and 8, may be employed to insure the permanent securement of the vessel to the buoy.

It will be understood that in order to provide a fluid storage vessel which is permanently maintained off-shore, it is essential that the securing means maintain the same in position under all conditions. The value of the present system would be almost entirely negated, if, during storm conditions, the storage vessel should break loose causing damage to the equipment as well as loss of the fluid contained therein. It has been found that the present arrangement is more than adequate to permanently maintain such a storage vessel under any condition and hence makes possible a method of transferring and storing the fluid from an off-shore well installation, which heretofore could not be successfully carried out.

It has been proposed to anchor a buoy to the off-shore water bed at a position remote from a fluid well installation and to connect a conduit from the well installation to the buoy for subsequent connection to a transporting vessel which may be lashed to the buoy while transfer takes place. Such an arrangement is temporary in nature and does not obtain the advantageous results of the present system which are brought about by the permanent securement of a permanent storage vessel to the anchored buoy. Of course, as is usual with any marine vessel, the same must be periodically repaired and maintained and the meaning of the term "permanent" in connection with the present invention must be broadly construed to this extent. Another feature of the invention in connection with the attaching and detaching of the storage vessel with the rigid arm means for maintenance and repair is that the latter includes float means 69 which maintains the same in an outwardly extending position for convenient pickup when reattachment is to be effected. In this regard, it will be noted that the transfer conduit 78 carried by the rigid arm means is also conveniently maintained in an outwardly extending position so that the same cannot become fouled.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing specific embodiment has been shown and described only for the purpose of illustrating the principles of this invention and is subject to extensive change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. A buoy construction comprising a water-tight compartment having a central axis maintained substantially vertical in use; a rigid yoke disposed adjacent the upper end of said compartment; means mounting said yoke on said compartment for rotary movement through at least 360° about the vertical axis thereof; means connected to said yoke for pivotal movement about a transverse axis for mooring a floating vessel to said buoy; a rigid structure fixed to said compartment and extending downwardly therefrom in general alignment with said vertical axis; ballast means on the lower end of said structure in general alignment with said vertical axis; an upper swivel fitting mounted on the upper end of said compartment for connection with a fluid line whereby the line is capable of movement of at least 360° about the vertical axis of the compartment; a lower fitting for connection with a flexible fluid pipe line, said lower fitting being positioned to maintain the flexible line out of contact with the compartment, rigid structure, and ballast means; means defining a fluid passage between said upper and lower fittings, and anchoring means connected to said compartment for anchoring the buoy to the marine bottom.

2. A buoy construction as defined in claim 1 wherein said yoke mounting means includes a bearing rigidly secured to the upper end of said compartment and extending upwardly therefrom, said yoke having a sleeve journaled on said bearing.

3. A buoy construction as defined in claim 2 wherein said bearing includes a central bore defining a portion of said fluid passage.

4. A buoy construction as defined in claim 2 wherein said yoke extends radially across the upper end of said compartment and said sleeve is fixed to the central portion thereof, the outer ends of said yoke including lower bearing surfaces engaging a horizontally disposed bearing ring fixed to the upper end of said compartment adjacent the periphery thereof.

5. A buoy construction as defined in claim 2 wherein one end of said yoke extends radially outwardly from said sleeve, the outwardly extending end of said yoke operatively engaging a bearing ring on the upper periphery of said compartment.

6. A buoy construction as defined in claim 1 wherein said yoke comprises a circular member journaled on the upper periphery of said compartment.

7. A buoy construction as defined in claim 1 wherein said mooring means comprises rigid arm means pivotally connected to said yoke for movement about said transverse axis.

8. A buoy construction as defined in claim 1 wherein said anchoring means is connected to said compartment in closely spaced vertical relation with respect to the pivotal connection of said mooring means with said yoke.

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