

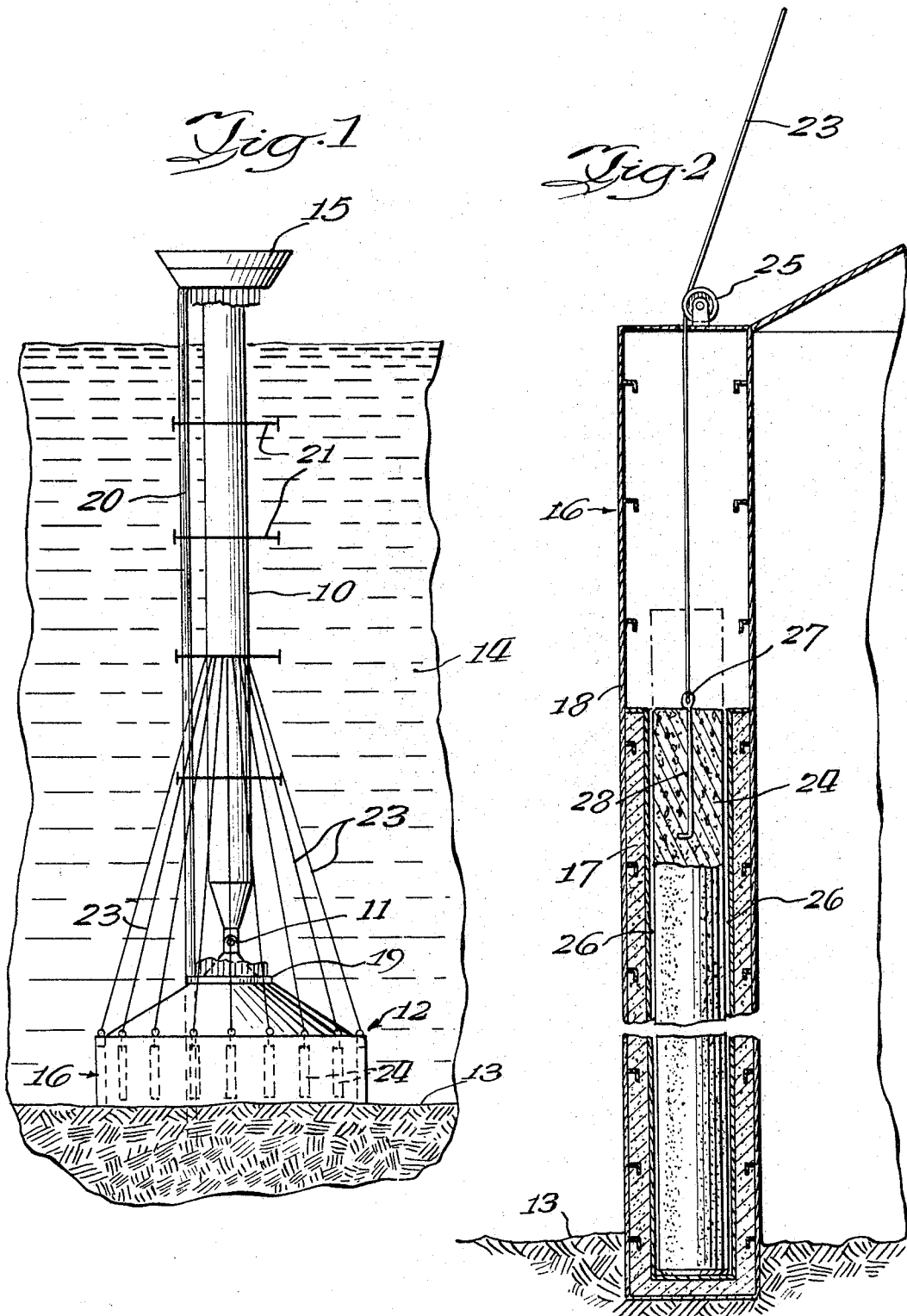
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OFFSHORE STORAGE TANK WITH SELF-CONTAINED GUY SYSTEM

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OFFSHORE STORAGE TANK WITH SELF-CONTAINED GUY SYSTEM

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4 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed is a structure for offshore exploration and production of oil. The structure has an elongated shaft positioned upright in water, a roofed tank, a pivotal connection joining the lower end of the shaft to a top portion of the tank, and a plurality of guy lines joined at their upper end to the shaft and at their lower end to a plurality of weight means radially arranged from the shaft and supported by the tank for vertical displacement upwardly upon tilting of the shaft beyond a predetermined tilt, said weights being substantially unsupported by the guy lines when the shaft is vertical.

This invention relates to apparatus and equipment used in the production of oil. More particularly, this invention is concerned with devices and structures useful for offshore exploration for oil, the drilling, of wells, the storage of oil produced from such wells, and the mooring of vessels offshore.

To meet the ever increasing need for petroleum products, exploration and production of oil has been extended from land to offshore locations. While well drilling can be effected from floating platforms, it is generally more efficient to support the drilling platform above the water surface on members which rest on the floor of the body of water, which is normally the ocean floor. Offshore drilling platforms supported by the ocean floor are in extensive use around the world. However, most such structures are employed where the water is comparatively shallow, such as up to about 100 to 150 feet in depth.

In order to effect drilling in comparatively deep water, such as up to 600 feet or more in depth, there has recently been developed a structure characterized by an elongated shaft, advisably a hollow tube, positioned upright in a body of water, an anchoring weight placed on the floor of the body of water and a pivotal connection joining the lower end of the shaft to the anchoring weight. The pivotal connection is advisably a universal joint of sufficient strength to withstand the weight applied thereto by the shaft, such as an elongated hollow tube, while still permitting pivotable movement of the shaft. The anchoring weight resting on the floor of the body of water can be in the form of a pile driven into the floor, a simple weight of sufficient size to securely hold the lower end of the shaft is pivotable but otherwise stationary position, or the anchoring weight can comprise a tank, joined at a suitable location thereon, to the universal joint. When a tank is used as the anchoring weight to which the shaft is joined by means of the universal joint, the tank can be used for the storage of oil produced from offshore wells. The pending patent application of Chamberlin, Davis and Stevens, Ser. No. 786,281, filed Dec. 23, 1968 disclosing such a structure is fully incorporated herein by reference.

To hold the elongated shaft in vertical position and restrict its excursion or tilting, it was contemplated to employ a plurality of taut guy lines joined at one end to the shaft and at the other end to anchor means in the floor of the body of water. Restricting excursion is desirable

for a number of reasons, including the provision of a more stationary platform on the top of the shaft and thus a more suitable environment for humans to work. In addition, it is essential to restrict excursion when the shaft and tank support conductor pipes which penetrate into the ocean floor for well drilling and oil production. However, because of the large taut guy line loads and their effect on the natural period of vibration of the shaft it is not generally suitable to use simple taut guy lines. Taut guy lines can shorten the natural period until it is less than that of even modest-sized waves so that resonance and wave force reinforcement become major problems. Furthermore, to make a taut guy line system, large size very expensive cables and special fittings are needed.

There is provided by the subject invention a novel structure for use offshore having, as an integral part thereof, a soft guy line system for restricting excursion or tilting of an elongated vertical shaft pivotally connected at the bottom to the top of a tank resting on the floor of a body of water.

More specifically, there is provided an offshore structure comprising an elongated shaft positioned upright in a body of water, a roofed tank defining a volume therein, a pivotal connection joining the lower end of the shaft to a top portion of the tank roof and a plurality of guy lines extending from the shaft to a plurality of weight means, radially arranged from the shaft, adapted for vertical displacement by the tank. Tension on the guy lines increases with tilting of the shaft through resistance of the weights, which normally rest stationary on a support. Once tension on the guy line reaches the force exerted by the weight unsupported in water, no further increase in tension is obtained.

The invention will now be described further in conjunction with the attached drawings in which:

FIG. 1 is an elevational view of one embodiment of the invention and shows an elongated vertical tube joined by a pivotal connection to the roof of a conical tank, circular in horizontal cross section, having vertical walls and with guy lines joined at one end to the tube and at the other end to vertically displaceable weights guided by slide channels associated with the tank; and

FIG. 2 is a vertical cross-sectional view of the walls of the tank in the structure of FIG. 1 and shows the vertically displaceable weight at the end of the guy line.

FIG. 1 illustrates a structure according to the invention in which the shaft is an elongated hollow tube 10 joined by a pivotal connection such as universal joint 11 to tank 12, resting on the floor of the body of water 14. The elongated hollow tube 10 can be open or closed at the bottom depending on the use to which the structure is to be put. To avoid the necessity of using heavy metal walls for tube 10 it is generally advisable to always have the inside space of tube 10 filled with a liquid when subjected to substantial water pressures. The liquid can be either water from the surrounding sea or oil produced from wells in the area. However, the tube 10 can be pressurized with air provided suitable bulkheads and/or end closures are used to prevent the pressurized air from escaping. Pressurizing the tube in this manner, or filling it with oil or water, serves to counteract the hydraulic pressure exerted on the tube by the sea and thereby permits construction of the tube of thinner walled metal than would otherwise be necessary.

If advisable, any suitable platform 15 can be mounted on top of tube 10. The type of platform used, if any, will depend on the operation to be performed at the offshore site. If a platform is used it generally will be mounted sufficiently high on tube 10 so that it is not affected by waves, whether the tide is high or low. The structure of FIG. 1, while shown as a tube, can be an open bridged shaft if desired. A tube is much more satisfactory,

however, since it aids in submerging the structure and can be used for oil storage.

The internal space of hollow tube 10 can be used, if desired, for the storage of oil produced by wells associated with the structure or from other nearby wells.

The tank 12, which is circular in horizontal cross-section, is provided with vertical weighted circular wall 16 such as concrete 17 covered with steel plate 18. The bottom of the tank can be open or closed. Ring 19 reinforces the roof of tank 12 and is provided with holes for supporting conductor pipes 20 which extend from platform 15 through the tank and into the ocean body. The brackets 21 on the tube 10 also support the conductor pipes. The conductor pipes can be used for well drilling and oil production. Of course, they need not be used at all if the structure is only to be used as a mooring station for ships.

As shown in FIGS. 1 and 2, guy lines 23 are connected at their lower ends 27 to vertically displaceable weights 24 by rods 28. Each guy line 23 passes over a sheave 25 on top of circular wall 16. A plurality of weights 24 are placed intermittently around vertical circular wall 16 of tank 12 in suitably sized vertically positioned slide channels, holes or guides 26. The number of weights and guy lines used will depend on many factors, all of which are within the design capacity of an engineer. It is expected that, because of the size of a structure needed for offshore use, that not less than twelve weights and guy lines will be used. Regardless of the number of weights used, they are advisably equally spaced in a circle. The channels 26 are larger than weights 24 to permit vertical displacement of the weights without binding. Guy lines 23 extend upwardly at an angle and come into contact with tube 10 approximately midway up the height thereof, from which point they extend through suitable guides, such as pipes or eyelets, to platform 15 where they are adjustably secured. In this way tension on any one or all of guy lines 23 can be effected without going underwater to do this. It will be readily apparent that all of weights 24 can be put into position and guy lines 23 secured where intended while the structure is being built on shore or in a graving dock near shore. By maintaining the guy lines loose but still positioned in control mechanism located in platform 15 the entire structure can be subsequently submerged at a site offshore. Following submergence the upper ends of guy lines 23 can be tightly secured with

the appropriate tension to put into effect the action of the tilt-opposing weights 24. Weights 24 will normally rest on the bottom of channels or holes 26 and will only lift therefrom after the tension on the guy lines 23 equals the effective force of the weight in water. The weights thus are substantially unsupported by the guy lines and apply a minimum of tension thereto when the shaft is vertical. This guying system avoids the laborious and expensive installation of guy lines after the structure has been submerged in position.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. An offshore structure comprising:

an elongated shaft to be positioned upright in a body of water,

a roofed tank defining a volume therein,

a pivotal connection joining the lower end of the shaft to a top portion of the tank, and

a plurality of guy lines joined at their upper end of the shaft and at their lower end to a plurality of weight means radially arranged from the shaft and supported by the tank for vertical displacement upwardly upon tilting of the shaft beyond a predetermined tilt, said weights being substantially unsupported by the guy lines when the shaft is vertical.

2. An offshore structure according to claim 1 in which the tank has a vertical circular wall and each weight is positioned in a slide channel located in the wall.

3. An offshore structure according to claim 1 in which the weights are equally spaced in a circle.

4. An offshore structure according to claim 1 in which tension on the guy lines is adjustable from the shaft above the water level.

References Cited

UNITED STATES PATENTS

3,154,039	10/1964	Knapp	61—46.5
3,355,899	12/1967	Koonce et al.	61—46.5

FOREIGN PATENTS

Ad. 86,230	11/1965	France.
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