Dec. 23, 1952 G. P. RICE 2,622,404

OFFSHORE DRILLING APPARATUS AND METHOD OF INSTALLING THE SAME

Filed March 24, 1949 3 Sheets-Sheet 1

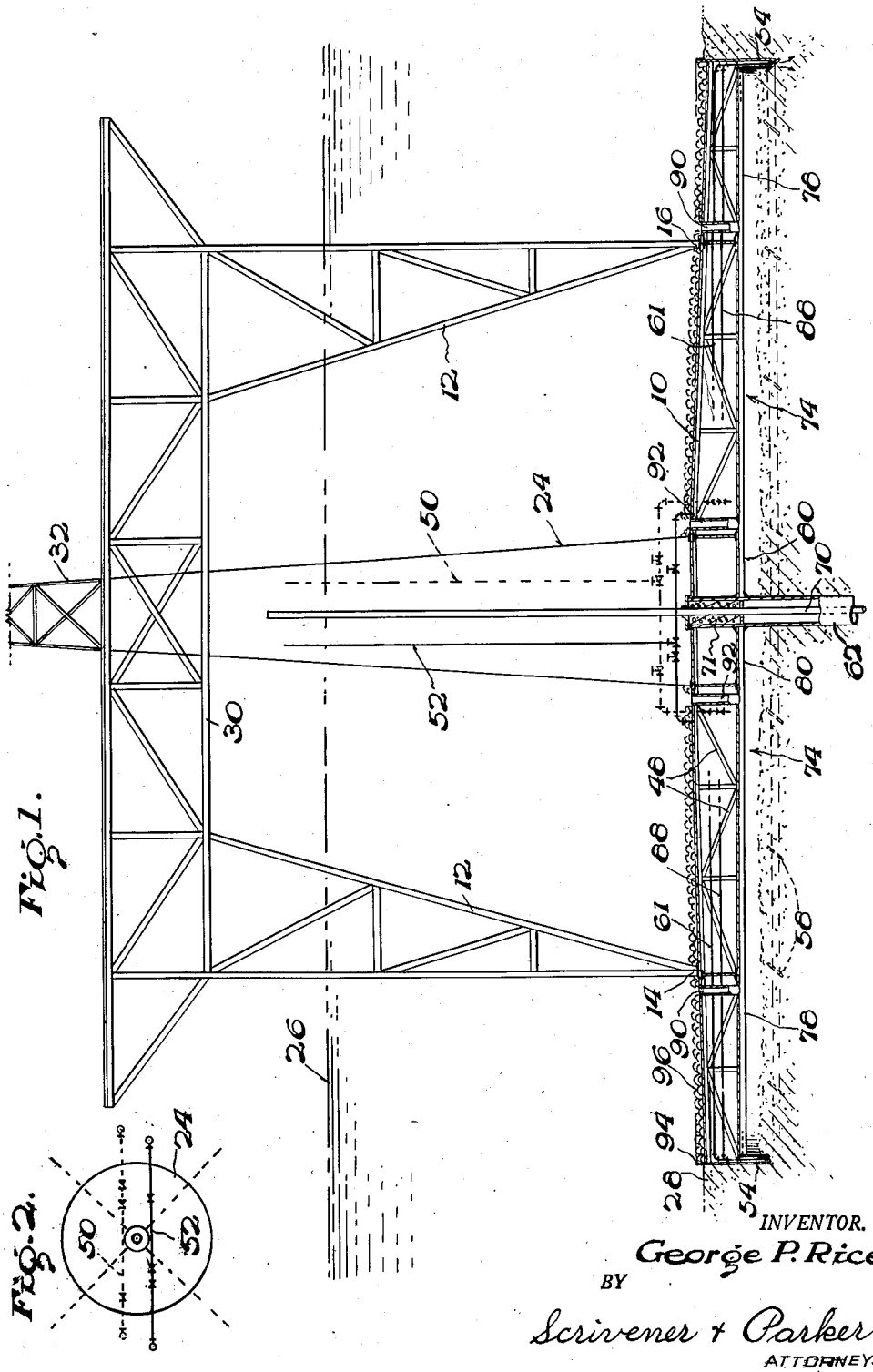

Fig. 1.

Fig. 2.

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Fig. 3.

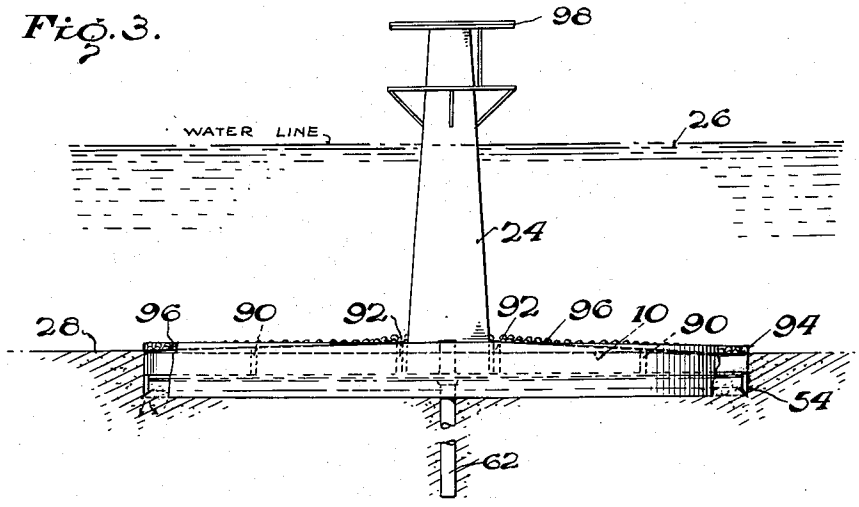


Fig. 4.

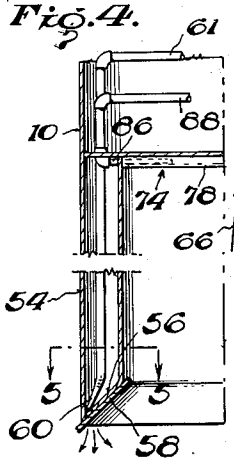


Fig. 5.

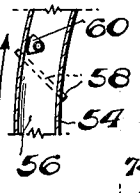


Fig. 6.

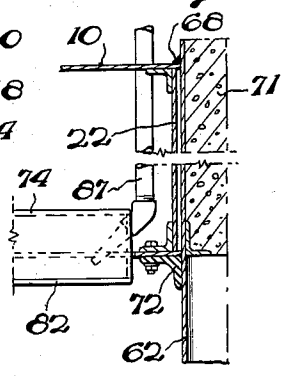
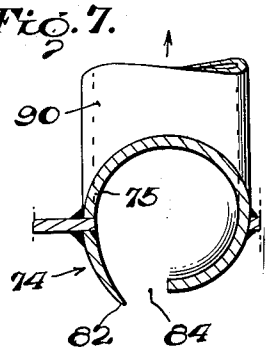


Fig. 7.



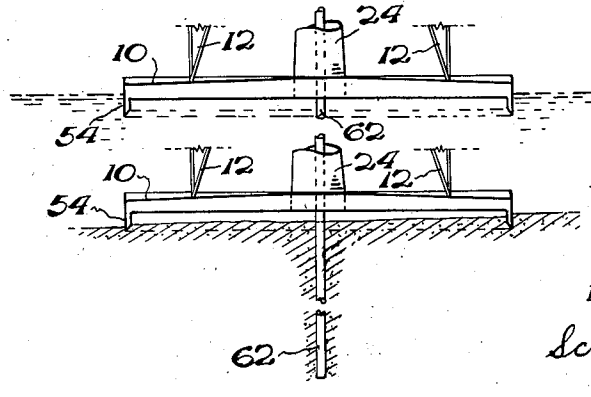


Fig. 8.

Fig. 9.

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Fig. 10.

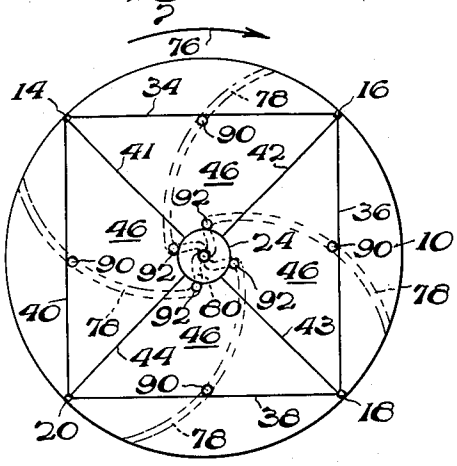

Fig. 11.

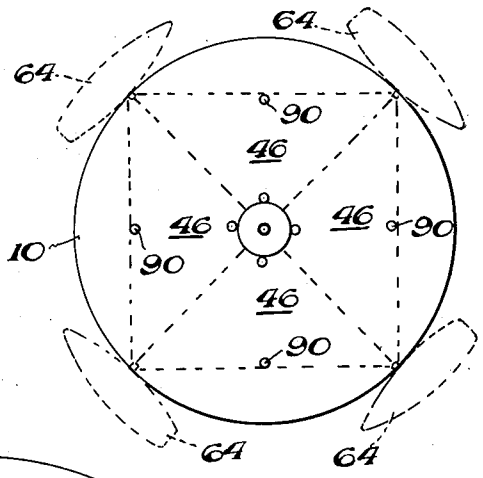

Fig. 12.

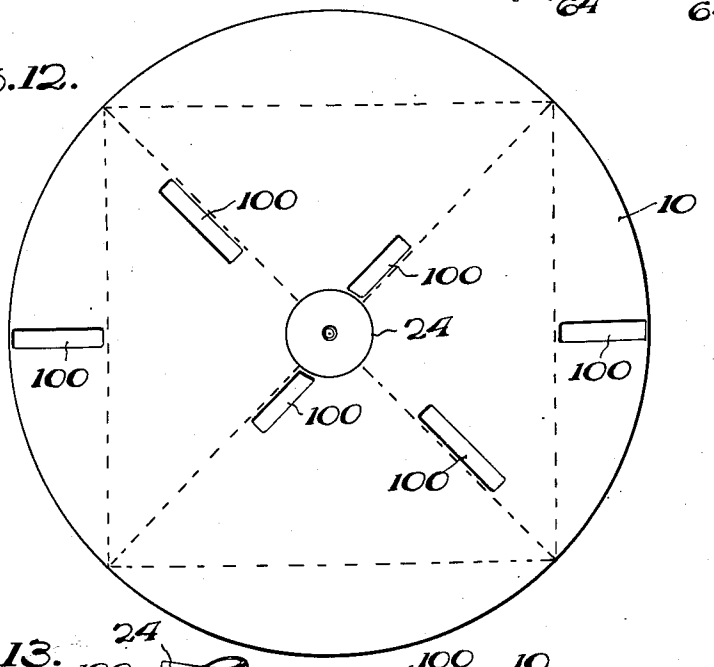

Fig. 13.

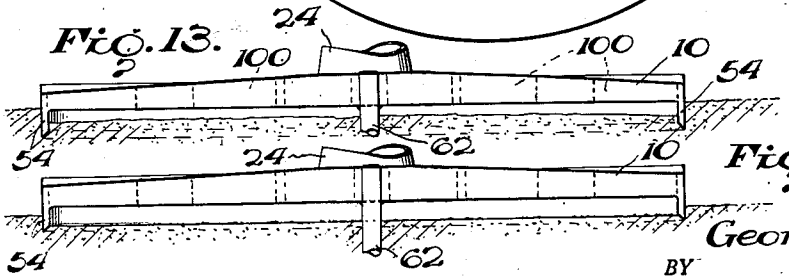

Fig. 14.

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UNITED STATES PATENT OFFICE

2,622,404

OFFSHORE DRILLING APPARATUS AND METHOD OF INSTALLING THE SAME

George P. Rice, Nashville, Tenn.

Application March 24, 1949, Serial No. 83,188

20 Claims. (Cl. 61—46)

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This invention relates to an apparatus for facilitating the drilling of oil wells over bodies of water, and more particularly to a novel integrated structural framework and foundation supporting tank therefor together with a novel method for securely anchoring the tank to a water-bed, the arrangement being such that the apparatus may be readily floated to the desired location and anchored, and may thereafter be readily removed for use elsewhere, after it has served its purpose.

Various types of marine towers and offshore supporting structures have heretofore been provided for the purpose of enabling the drilling of oil wells in bodies of water at substantial depths. In one type of construction which has been proposed, a buoyant barge or pontoon is utilized to support the necessary framework and platform for the well drilling equipment and may be floated to the desired position by the aid of barges or tugs. Thereafter, the barge is flooded in order to submerge and sink the same to a position to rest upon the water-bed, thus forming a foundation for the superstructure and the necessary loads supported thereby. Such an arrangement offers the advantage that the entire apparatus may be re-floated for use elsewhere in the event that the well drilling operations are unsuccessful. On the other hand, the submersible barge arrangement heretofore considered offers several disadvantages which render its use impracticable except in cases where wind or wave action and subsurface eddies are substantially negligible, the water-bed is substantially soft and practically flat, and more usually where the depth of water is shallow. In many other cases, it has been the practice to drive piling into the water-bed and to build the necessary framework, platforms and other facilities required for the well drilling operations, directly on such piling. Constructions of this latter type, performed at the well drilling site, are extremely difficult, hazardous, excessively time-consuming, costly and practically worthless from a salvage point of view in the event the well is or becomes unproductive.

In addition to the foregoing, all of the prior devices at deep water offshore locations have required separate and independent oil storage facilities of substantial capacity to store the oil between barge servicing operations. Such facilities have included moored barges or large tanks positioned on the structural framework of the drilling platforms. Needless to say, the initial and maintenance costs of such oil storage facilities is considerable and the latter type also increases greatly, the cost of the drilling platform supporting framework and foundation.

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The principal object of the present invention is accordingly to provide a novel offshore well drilling apparatus and method for anchoring the same, which is so arranged and constituted as to avoid the objections and disadvantages referred to above.

Another object of the invention is to provide a novel offshore drilling apparatus or tower which may be readily floated to the desired site and which may be thereafter securely anchored to the water bed in a relatively short period of time without the necessity of utilizing costly auxiliary mechanism.

A further object resides in the provision of a novel foundation tank for apparatus of the above character, which not only serves to adequately support the apparatus on, and to securely anchor it to the water-bed, but also functions as a storage reservoir for the oil produced by the well.

Another object is to provide in a construction of the above type, a novel foundation tank which, to accomplish the foregoing, presents a large bearing area in contact with the water-bed, and which is so arranged as to be capable of being efficiently completely embedded and anchored into water-beds which possess irregular and sloping surfaces.

Still another object includes the provision of a novel peripheral apron structure for the tank which projects downwardly from the bottom thereof, and which may be readily penetrated into the water-bed, such apron confining the soil within its reach, for the full bearing area of the tank, whereby the depth to plane of load transfer is increased and an exceptionally high load supporting capacity, even under conditions where the ground is soft and mucky, is thus obtainable.

A still further object is to provide a novel foundation tank construction and method of anchoring the same so that the tank may be penetrated into the water-bed to a position where the top of the tank is substantially flush with the ground surface, such an arrangement achieving a firm and secure anchorage for the tank, frame work and superstructure, and avoiding any tendency for the foundation tank to shift due to subsurface eddies and wave action.

Another object is to provide in an arrangement of the foregoing character, a novel system of cutters arranged at the rim of the peripheral apron and at the under surface of the tank, together with a central spud anchor for supporting the tank and framework for pivotal move-

ment, the construction being such that upon rotation of the apparatus about the spud anchor, while controlling the flooding of the tank, the latter may cut its way into the water-bed and become firmly embedded therein and anchored thereto.

Still another object comprehends the use of a spud anchor which is of hollow construction in order to enable well drilling operations to be conducted therethrough, and to which the tank is secured after the latter has been submerged in the water-bed to the desired depth.

A further object includes the provision of a series of water jets beneath the bottom of the tank and at the rim of the peripheral apron to assist in the submerging of the tank during its rotation and to break the suction between the water-bed and the bottom of the tank as the buoyancy of the tank is controlled, for the purpose of re-floating the structure to utilize it elsewhere.

Still another object is to provide a hollow drilling stack secured to the top of the foundation tank at the central portion thereof, such stack extending above the surface of the water and serving as a housing for well drilling equipment, supplies, etc., while permitting a material reduction in the height of drilling derricks and other necessary superstructure.

A still further object resides in a novel arrangement of parts which mutually contribute to provide a highly efficient and portable drilling apparatus, which may be constructed on shore and installed in a body of water in a relatively short period of time and at a relatively low cost.

Other objects and novel features of the invention will appear more fully hereinafter from a consideration of the following detailed description when taken in connection with the accompanying drawings which illustrate certain preferred forms of the invention. It is to be expressly understood however, that the drawings are employed for purposes of illustration only and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein similar reference characters refer to similar parts throughout the several views;

Fig. 1 is a side view partly in section of an offshore drilling apparatus constructed in accordance with the present invention;

Fig. 2 is a diagrammatic plan view illustrating a portion of the water and oil piping systems;

Fig. 3 is a side view partly in section illustrating the apparatus in operating condition with the derrick, platform and framework removed;

Fig. 4 is an enlarged sectional view of a portion of the edge of the foundation tank illustrating the depending peripheral apron, and the jets associated with the rim cutters and the bottom cutters;

Fig. 5 is a sectional view taken along line 5—5 of Fig. 4;

Fig. 6 is an enlarged view showing the seal between the tank and the spud anchor;

Fig. 7 is an enlarged transverse sectional view of one of the bottom cutters;

Fig. 8 is a partial side view illustrating the apparatus in floating position;

Fig. 9 is a view similar to Fig. 8 but illustrating the apparatus in a sinking position;

Fig. 10 is a diagrammatic plan view of the foundation tank;

Fig. 11 is a view similar to Fig. 10 and illustrating diagrammatically one method of rotating the tank;

Fig. 12 is a diagrammatic plan view of a modified form of foundation tank provided with a plurality of dredging wells;

Fig. 13 is a diagrammatic view of the tank of Fig. 12 wherein the peripheral apron is submerged prior to dredging beneath the tank bottom, and

Fig. 14 is a side view similar to Fig. 13 but illustrating the apparatus with simultaneous dredging beneath the tank and submerging of the apron.

Referring more particularly to Figs. 1 and 10 of the drawings, a novel offshore drilling apparatus embodying the principles of the present invention is illustrated therein as including a buoyant water-tight foundation tank 10 having a circular plan and adapted to support an upwardly extending open framework 12 upon the top surface thereof at points 14, 16, 18 and 20 positioned adjacent the outer edge of the tank, as shown in Fig. 10. The tank 10 is provided with a central opening 22, see Fig. 6, and a hollow, water-tight drilling stack 24 is firmly secured to the top of the tank around the opening, the said stack extending above the surface 26 of the water where the drilling operation is to be performed when the tank 10 is anchored to the water bed 28, in a manner which will appear more fully hereinafter. The framework 12 is provided above the water line with a superstructure 30 on which a suitable platform may be installed to support conventional equipment and apparatus for conducting well drilling operations through the hollow drilling stack 24, such apparatus including a derrick 32 of well-known construction.

One of the features of the invention resides in providing a foundation tank which is so constituted as to be capable of floating the framework 12 and superstructure 30 to the desired drilling site and to be thereafter submerged and firmly anchored to the water bed 28. To this end, the tank 10 is hollow and water-tight and is provided with a plurality of bulkheads or partitions 34, 36, 38, 40, 41, 42, 43 and 44 which divide the tank into a plurality of compartments, some of which are shown at 46. A suitable number of trusses 48 serve to materially strengthen the hollow tank and as diagrammatically indicated in Fig. 1, a water system 50, including conventional pumping equipment, valving devices, and sea cocks, is provided for controllably flooding and emptying the tank compartments in order to control the buoyancy of the tank. After the apparatus has been securely anchored in position and the well drilling operation has proved successful, the compartments of the foundation tank 10 are employed for the storage of oil. For such purpose, an oil system 52 is adapted to receive the oil produced by the well and to conduct such oil to the water filled compartments in order to displace the water through the system 50. When it is desired to transfer the oil to a suitable barge or tanker, it is only necessary to admit or pump water into the bottom of the tank through the system 50 whereupon the oil will be displaced through the system 52 and to the tanker by means of suitable conduit connections, not shown. Preferably the top of the tank 10 slopes upwardly toward the center in order to facilitate the delivery of the oil from the compartments.

A further feature of the invention relates to the portability of the apparatus which enables the structure to be readily constructed on shore

and to be thereafter floated to a desired location. More particularly, the tank 10, framework 12, superstructure 30, drilling stack 24 and the necessary water and oil systems 50 and 52, are all assembled on shore and towed by means of tugs or the like, to the site where the drilling operation is to be conducted, see Fig. 8. After the apparatus has been securely anchored and occupies the position illustrated in Fig. 1, any suitable platform may be assembled on the superstructure 30 along with all necessary well drilling equipment including the derrick 32. Thereafter, the well drilling operation may be carried out through the hollow drilling stack 24 in a manner which will appear more fully hereinafter.

A novel arrangement is provided by the present invention for enabling the circular foundation tank to be submerged in the water-bed 28 to such an extent that the top of the tank may be substantially flush with the ground level as indicated in Fig. 1. Such construction secures a firm anchorage for the tank regardless of the action of subsurface eddies or wave action. More particularly, the tank 10 is provided with a hollow peripheral apron 54 which extends below the bottom of the tank and which is provided with an outwardly beveled rim 56 forming a cutting edge and to which a plurality of angularly disposed cutters 58 are secured. With rotation of the tank, such cutters materially assist the sinking and the embedment of the apron 54 in the water-bed 28. Preferably, the cutter action may be supplemented by hydraulic jetting, and as shown, such jetting includes the use of a plurality of jets 60 having open nozzles in the rim or cutting edge 56 and respectively arranged adjacent to the cutters 58, the jets being suitably connected with a source of pressurized water by means of a conduit system 61.

In order to obtain efficient submergence of the apron 54, the present invention provides a novel arrangement whereby the foundation tank 10 may be rotated as the buoyancy of the tank is controlled. As shown such means includes the provision of a hollow spud anchor 62, which not only serves as a pivot about which the foundation tank may be rotated, but also functions first, as a means for temporarily mooring the tank, and finally as a fixed anchorage for the tank and as a hollow casing through which the well drilling operation may be conducted. More particularly, the spud anchor 62 is projected through the central opening 22 and forced into the water-bed 28, in any suitable manner, as by jetting, jacking, or driving, etc., after the tank 10 has been flooded to an extent sufficient to partially submerge the same. Thereafter, the tank 10 may be rotated about the spud anchor 62 while further controlling the flooding of the tank and the hydraulic jetting through the jets 60, in order to scour a seat in the water-bed into which the apron 54 may readily sink. Preferably the tank may be rotated by means of one or more tugs which may be secured to the framework sections 12, as diagrammatically illustrated at 64 in Fig. 11. It will be understood however, that such rotational means is by way of example only, as any convenient means may be utilized to secure the rotational movement of the tank. Whatever means or devices are employed to secure such rotation it will be seen from Fig. 5 that the jets 60 are preferably located in advance of the cutters 58, as determined by the direction of rotation denoted by the arrow 66, and that the cutters 58 are arranged angularly with respect to the tank radii and in such a manner that the cuttings are directed inwardly beneath the bottom of the tank. In this manner the apron 54 may be quickly and efficiently submerged in the water-bed to a point where the bottom of the tank begins to contact the ground. Such anchoring of the apron may be effected while maintaining the horizontal stability of the tank regardless of any surface irregularities or sloping conditions of the water-bed, as shown in Fig. 9, for example.

In certain cases, as where installation is made in shallow water with little or no wave action or subsurface eddies or current flow, and the water-bed is firm and non-shifting, the sinking or embedment of the apron 54, as above pointed out may be sufficient to provide a firm support and anchorage for the apparatus. In such case, after the foundation tank has been set, as indicated, the spud anchor 62 is welded at 68 to the top of the tank 10, in order to increase the stability and anchorage of the apparatus, and the interior of the spud anchor filled with concrete 71 in a well-known manner. After the concrete has set, the projecting upper portion of the spud anchor is burned off at a distance of the order of 10 to 15 feet above the weld, this being desirable to avoid interference with the well drilling operations. Such drilling operations may thereafter be readily conducted through the hollow drilling stack 24 and the hollow spud anchor 62. After the well is in, the spud anchor 62 may be further cut off as indicated in Figs. 1 and 6. In this connection, it will be observed from Fig. 6, that the bottom of the tank carries an annular sealing member 72 which bears against the spud anchor 62 in order to effectively seal the interior of the drilling stack 24 against the entrance of water during installation operations.

Where, however, a firmer anchorage is required, the present invention provides a novel construction whereby the foundation tank may be submerged in the water-bed to such a depth that the top of the tank may be installed in position substantially flush with the ground surface, as indicated in Fig. 1. More particularly, and referring to Figs. 1, 4, 7 and 10, such construction includes the provision of a plurality of cutters 74 positioned at the underside or bottom of the tank 10 and which serve to cut away the water-bed as the rotation of the tank is continued and the sinking thereof progresses. As shown, Figs. 4 and 10, the cutters 74 extend from the apron 54 inwardly toward the center of the tank, and are preferably curved in the direction of rotation of the tank, see the arrow 76, to a point approximately beneath the drilling stack 24. For the rest of their length, the cutters 74 may be generally curved in an opposite direction. Thus the cutters present two connected and curved sections 78 and 80 which function in a novel manner to be more fully described hereinafter.

In order to efficiently dispose of the cuttings beneath the tank, as the latter is submerged in the water-bed, conduits 75 having a cutting edge 82 and an open mouth 84, both of which extend throughout the length of each cutter, are provided at the bottom of the tank. By the use of this construction, the cuttings are swept into the hollow cutters as the tank is rotated. A novel arrangement is also employed for positively flowing the cuttings through the hollow cutters 74 and depositing them on the top of the tank where they may be retained for ballast. More particularly, a water jet 86 projects into each hollow cutter 74, at the outer end thereof, see Fig. 4,

and such jets may be readily controlled through suitable conduits 88 associated with the water system 50. Similar water jets 87 project into each cutter at the inner ends thereof, see Fig. 6. Due to the jet actions provided by the aforementioned water jets 86 the cuttings accumulated in the sections 78 of the hollow cutters 74 are positively flowed inwardly and are conducted through the tank to the top thereof, by means of a plurality of open relief conduits which communicate with the cutters 74 and which define relief ports 90 and 92. In like manner the cuttings in the sections 80 are positively flowed outwardly to the relief ports 90 and 92. It will be understood that while the ports 90 and 92 offer unobstructed passages between the cutters 74 and the top of the tank 10, they are nevertheless so arranged in the tank as to maintain the water-tightness thereof.

With respect to the action of the cutter sections 80, since these are preferably curved in a direction opposite to the direction of rotation of the tank 10, it will be readily seen that the cuttings accumulated thereby will be directed outwardly from the central portion of the tank and to the relief ports 92, through which they will flow to the top of the tank. As heretofore stated, this action is aided by the water jets 87. Preferably a peripheral upstanding curb 94 is provided at the top of the tank which serves as an effective means for retaining the cuttings on the tank, and which consequently act as a ballast 96. It will be understood that such ballast may be supplemented by any suitable material, if desired.

After the foundation tank 10 has been submerged to the desired depth in the water-bed, the top of the tank 10 is securely welded to the spud anchor 62 and the conduits 90 and 92 are filled with a suitable material such as drilling mud, concrete or the like. This serves to close all openings through the tank and maintains the suction between the bottom of the tank and the water-bed. The closing of such openings moreover enables the building up of hydraulic pressure beneath the tank 10 through the jets 86 in the event it is desired to re-float the apparatus for use at another site. In such event, it will be understood that the tank is first disconnected from the spud anchor 62.

Following the installation of the apparatus as above described, the well drilling operation may be readily conducted, in the usual manner, through the hollow drilling stack 24 and the hollow spud anchor 62. In case the operation is unsuccessful, the well casing is cut and sealed off, the tank 10 is disconnected from the spud anchor 62, and the entire apparatus is re-floated by pumping the water from the tank 10 and by the use of hydraulic pressure built up beneath the tank through the jets 87 and 86 as previously described. On the other hand, should the drilling operation be successful, the framework 12 and parts supported thereby may be detached from the foundation tank 10, leaving the tank 10, the drilling stack and any suitable platform 98 which may desirably be secured to the stack 24, as illustrated in Fig. 3. The framework 12 and load supported thereby may be readily removed, as by pontoons or other suitable means, and associated with another foundation tank for subsequent use. The structure retained at the drilling site for field operations includes all the essential elements which are required, it being recalled that the foundation tank is employed for the storage and delivery of oil by the hydraulic method, and that the hollow drilling stack forms a protective housing for containing all necessary pumping and other equipment incidental to the performance of all necessary operations.

It is believed that the construction and method of operation of the invention is clearly set forth in the foregoing. For example it is seen that after assembly of the apparatus on shore, the same may be readily floated to a desired position and readily installed within a relatively short time interval. As the buoyancy of the foundation tank 10 is gradually decreased, through the controlled flooding of one or more of the compartments 46, the tank 10 may be gradually submerged to a point where the spud anchor 62 is driven through the central opening 22 in the tank. Thereafter, the buoyancy of the tank is further decreased and as the lower rim or cutting edge 58 of the apron 54 comes in contact with the water-bed, the entire apparatus is rotated about the spud anchor 62. During such rotation, accompanied by a further decrease in the tank buoyancy, the water system 50 is operated in order to render the jets 60 operative. In this manner, the action of the jets 60, in combination with the cutters 58, effectively scours a seat in the water-bed into which the apron 54 becomes submerged. As the rotation of the tank 10 is continued, the jets 86 cooperating with the hollow bottom cutters 74 are energized and positively flow all cuttings from beneath the tank to the top thereof by way of the tubular conduits 75 and the relief ports 90 and 92 through the tank. Due to the curvature of the cutter sections 78, it will be readily perceived that the cuttings will be directed inwardly toward the central portion of the tank. At the same time, the cuttings immediately adjacent the spud anchor 62 will be directed outwardly toward the relief conduits 92, due to the curvature of the cutter sections 80. This action insures ready removal of the cuttings and enables the foundation tank 10 to be submerged in the water-bed without danger of tilting due to an uneven support beneath the tank bottom. Moreover by the arrangement proposed, together with the curb 94, the tank may be completely embedded if desired, and the cuttings utilized for ballast purposes. After embedment of the tank, it is only necessary to secure the same to the spud anchor and to seal the relief conduits 90 and 92 as pointed out hereinbefore. Since the drilling stack 24 is water tight, it will be readily understood that the same may be controllably flooded to assist in the sinking of the apparatus, if desired. It may also be used to advantage in re-floating the apparatus.

Figs. 12 to 14 illustrate a slightly modified form of the invention where the foundation tank 10 is provided with a plurality of open dredging wells 100 and through which suitable dredging operations may be conducted for the purpose of removing the soil from beneath the tank 10 as the latter is submerged in the water-bed. In Fig. 13, the apron 54 has been illustrated as being sunk in the water-bed prior to dredging operations through the wells 100. Fig. 14 illustrates the action where the apron 54 is sunk progressively and accompanied by dredging operations. In this form of the invention, the tank 10 may be embedded in the water-bed entirely by dredging the soil through the wells 100. If desired, however, such wells may be used to supplement the action of the cutters and jets in the form of the invention of Fig. 1. It will be understood that drilling operations may be conducted through the dredging wells as well as through the relief

ports 90 and 92 in the case of that form of the invention shown in Fig. 1.

As shown in Fig. 12, the location of the dredging wells 100 is preferably such that the entire area of the soil beneath the foundation tank may be exposed to the dredging operations as the tank is rotated through a distance less than one complete revolution. This may be readily accomplished by locating the wells in pairs which are diametrically opposed and positioned at different radial distances from the center of the tank. Any number of opposed pairs may be utilized in order to obtain access to the entire soil area for any desired degree of rotation of the tank less than 360 degrees. It is manifest that the wells 100 extend through the tank 10 and are open at their tops and bottoms only.

It will be understood that in certain instances it may be desirable to dispense with the oil storage feature of the foundation unit 10. In such event, the upper surface of the unit 10 may be left open and uncovered while retaining the other desirable features heretofore set forth.

From the foregoing, it will be readily appreciated that the present invention provides a novel offshore well drilling apparatus and method of installing the same which secures many important advantages, some of which may be summarized as follows.

1. The apparatus may be completely assembled, ready for installation, at an on-shore location and thereafter floated to the well-drilling site and lowered in a relatively short interval of time.

2. Installation may be effectively made in water-beds composed of sand, clay or shell-reef, composition.

3. The large bearing area of the fundation tank, in combination with the peripheral apron which confines the underlying soil and augments the depth of load transfer, provides substantial load supporting capacity even under conditions where the ground is soft or mucky.

4. By submerging the foundation tank to a depth where the top is substantially flush with the surface of the water-bed, scour caused by superstructure obstruction to sub-surface eddies is practically eliminated. Moreover, because of the open framework form of the superstructure proposed by the invention, the extent of surface subjected to wave and wind action is reduced to a minimum.

5. A further important factor resides in the suction obtained beneath the foundation tank which materially contributes to the stability of the apparatus and provides substantial resistance against uplift or dislodgement by buoyancy, impact or force of any kind.

6. The hollow tank form of foundation proposed together with its inherent resistance to uplift, permit ready use of the tank for the convenient storage of oil. Where oil storage is not needed or desired, the tank feature of the invention may be excluded while retaining the remaining construction.

7. Should drilling operations not prove productive, the invention provides a novel method for re-floating the entire apparatus so that it may be towed for use elsewhere.

8. The apparatus may be installed in irregular or sloping water-beds, while being capable of maintenance in a plumb and level position without the necessity of employing auxiliary devices.

9. In the event that the drilling site proves productive, only the foundation tank with the drilling stack and spud anchor need be left in place for field operations, the storage of oil and barge servicing purposes. Under these conditions, the invention is such that the superstructure portion of the apparatus may be lifted by pontoons and floated away for use in connection with another foundation tank.

10. The novel spud anchor construction employed herein is capable of ready installation and provides an immediate and convenient means for mooring the apparatus, preparatory to installation. The spud anchor moreover, provides a secure pivot about which the apparatus may be rotated and provides a high load supporting capacity in addition to a high resistance to uplift. When the foundation tank is submerged, and secured to the spud anchor, the tank is effectively anchored to the water-bed.

11. The cutters 58 associated with the apron 54 provide a positive means of loosening the ground into fragments which are capable of ready removal by water issuing from the jets 69. The arrangement of the cutters 58 as shown herein, is moreover such that the cuttings are directed inwardly beneath the bottom of the tank so as to be capable of being removed and passed through the top of the tank through the relief ports 90 and 92.

12. The arrangement of jets 86 and 87 and the bottom cutters 74 is such as to accomplish a highly effective removal of the cuttings from beneath the tank, and in combination with the relief ports 90 and 92, such cuttings are readily conducted to the top of the tank where they are retained by the peripheral curb 94 to serve as ballast.

13. By sealing all openings through the tank with drilling mud, concrete or other means following final installation of the foundation tank, maximum suction between the tank bottom and the water-bed is assured. The sealing thus afforded is highly advantageous in developing the required hydraulic pressure beneath the tank in the event that it is desired to re-float the same.

14. A further feature resides in the rotation of the tank about the spud anchor 62 as a pivot. Once the apparatus is put into rotary motion, the momentum thereof, including that incident to the water in the foundation tank admitted for sinking the same, will prove highly advantageous in maintaining balance, alignment, and overcoming spotted resistance that might develop, especially at the commencement of the sinking of the tank into irregular sloping ground.

While several forms of the invention have been disclosed and described herein with considerable particularity, it will be readily understood by those skilled in the art that various modifications may be resorted to without departing from the spirit of the invention. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a top, a bottom, a peripheral side wall and a central opening extending through the bottom and top and said wall being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, means for flooding the tank to bring the cutting edge of the apron into contact with the water-bed, and an elongated spud anchor inserted into the

water-bed through said opening and forming a pivot about which the tank is rotated to sink the apron in the water-bed, said tank having a plurality of wells extending through the bottom and top through which dredging of the water-bed may be effected during rotation of the tank to aid in sinking the apron and tank in the water-bed, and said wells being arranged in diametrically opposed pairs with respect to said opening and with the wells of the respective pairs being positioned at different radial distances from said opening.

2. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank to be anchored to a water-bed and provided with a central opening, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, a hollow water-tight drilling stack secured to the top of said tank about the opening and extending upwardly above the surface of the water when the tank is anchored, means for admitting water to the tank and drilling stack to bring the tank into contact with the water-bed, an elongated spud anchor passing through said stack and opening and being driven into the water-bed and forming a pivot about which the tank is rotated, a plurality of hollow, open mouthed cutters carried by the bottom of the tank to cut away and receive portions of the water-bed beneath the tank bottom as the tank is rotated, means to conduct said cut-away portions from said cutters through the tank to the top thereof during rotation of the tank to facilitate anchoring of the tank in the water-bed, and means for securing the tank to the spud anchor.

3. A drilling apparatus as set forth in claim 2 which comprises in addition, a water jet positioned at the outer end of each hollow cutter for directing water under pressure through each cutter to conduct said cut-away portions from the cutters through the conducting means to the top of the tank.

4. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, a plurality of spaced-apart cutters carried by said cutting edge and being angularly arranged with respect to the radii of the tank, open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron and said cutters into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, and means to secure the spud anchor to the tank after the apron has been so submerged in order to anchor the foundation tank.

5. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, a plurality of spaced-apart cutters carried by said cutting edge and being angularly arranged with respect to the radii of the tank, framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron and said cutters into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, said spud anchor being hollow so that a well drilling operation may be conducted therethrough, and means to secure the spud anchor to the tank after the apron has been sunk in order to anchor the foundation tank.

6. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, a plurality of spaced-apart cutters carried by said cutting edge and being angularly arranged with respect to the radii of the tank, framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, a hollow water-tight drilling stack secured to the top of said tank around the opening and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron and the cutters carried thereby into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, said spud anchor being hollow so that a well drilling operation may be conducted through said stack and spud anchor, and means to secure the spud anchor to the tank after the apron has been sunk in order to anchor the foundation tank.

7. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, a plurality of spaced-apart cutters carried by the cutting edge of the tank, said cutters being directed downwardly and inwardly of the cutting edge and being angularly arranged with respect to the radii of the tank, said cutting edge being provided with a plurality of water jets adjacent the cutters, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, said spud anchor being hollow so that a well drilling operation may be conducted therethrough, and means to secure the spud anchor to the tank after the apron has been sunk in order to anchor the foundation tank.

8. An offshore drilling apparatus for conducting drilling operations in a body of water, com-

prising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, a plurality of cutters beneath the bottom of the tank to cut away the water-bed beneath said bottom as the tank is rotated about said spud anchor pivot, means for conducting the cuttings from said cutters through the tank to the top thereof so that during rotation of the tank, the entire tank will become substantially embedded in the water-bed, and means to secure the spud anchor to the tank after the latter has been so embedded in order to anchor the foundation tank.

9. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, a plurality of cutters carried by the bottom of the tank and extending outwardly from the central portion thereof to cut away the water-bed beneath said bottom as the tank is rotated about said spud anchor pivot, means for conducting the cuttings from said cutters through the tank to the top thereof so that during rotation of the tank, the entire tank will become substantially embedded in the water-bed, a peripheral curb formed around the top of the tank and extending upwardly from said top for retaining said cuttings on the top of the tank to constitute ballast therefor, and means to secure the spud anchor to the tank after the latter has been so embedded in order to anchor the foundation tank.

10. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the rim cutting edge of the apron into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, a plurality of cutters carried by the bottom of the tank and extending inwardly from said apron to the central portion of the tank, said cutters being curved in the direction of rotation of the tank to cut away the water-bed beneath said bottom and to direct the cuttings inwardly toward the central portion of the tank as the latter is rotated, means for conducting the cuttings from said cutters through the tank to the top thereof so that during rotation of the tank, the entire tank will become substantially embedded in the water-bed, and means to secure the spud anchor to the tank after the latter has been so embedded in order to anchor the foundation tank.

11. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotateed to sink the apron in the water-bed, a plurality of cutters carried by the bottom of the tank and extending inwardly from said apron to the central portion of the tank, each of said cutters being hollow and provided with an open mouth throughout its length to receive the cuttings from the water-bed beneath the tank bottom as the tank is rotated, means for conducting the cuttings from said hollow cutters through the tank to the top thereof so that during rotation of the tank, the entire tank will become substantially embedded in the water-bed, a peripheral curb formed around the top of the tank and extending upwardly from said top for retaining said cuttings on the top of the tank to constitute ballast therefor, and means to secure the spud anchor to the tank after the latter has been so embedded in order to anchor the foundation tank.

12. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a central opening and being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, an open framework secured to the top of the tank and extending upwardly above the surface of the water when the tank is anchored, means for flooding the tank to bring the cutting edge of the apron into contact with the water-bed, an elongated spud anchor driven into the water-bed through said opening to constitute a stationary pivot about which the framework and tank may be rotated to sink the apron in the water-bed, a plurality of cutters carried by the bottom of the tank and extending inwardly from said apron to the central portion of the tank, each of said cutters being hollow and provided with an open mouth throughout its length to receive the cuttings from the water-bed beneath the tank bottom as the tank is rotated, each of said cutters also being curved in the direction of rotation of the tank to direct the cuttings inwardly toward the central portion of the tank, means for conducting the cuttings from said hollow cutters through the

tank to the top thereof so that during rotation of the tank, the entire tank will become substantially embedded in the water-bed, a peripheral curb formed around the top of the tank and extending upwardly from said top for retaining said cuttings on the top of the tank to constitute ballast therefor, and means to secure the spud anchor to the tank after the latter has been so embedded in order to anchor the foundation tank.

13. An offshore drilling apparatus as set forth in claim 12 which comprises in addition, a water jet positioned at the outer end of each hollow cutter for directing water under pressure through each cutter to flow the cuttings from the cutters through the conducting means to the top of the tank.

14. An offshore drilling apparatus as set forth in claim 13 wherein the conducting means comprise a plurality of conduits spaced along the length of each hollow cutter and connecting each cutter with the top of the tank.

15. The method of anchoring an offshore drilling apparatus to a water-bed, said apparatus including an open framework and a circular, buoyant foundation supporting tank, the latter having a central opening and a peripheral apron extending downwardly below the bottom of the tank, which comprises, floating the apparatus in a vertical position to the desired location, then flooding the foundation tank to submerge the latter, then inserting an elongated spud anchor into the water-bed through said opening to form a pivot about which the tank and framework may be rotated, then further flooding said tank to bring the rim of said apron into contact with the water-bed, then rotating the framework and tank to embed the apron in the water-bed, and finally securing the tank to said spud anchor to firmly anchor the apparatus.

16. The method of anchoring an offshore drilling apparatus to a water-bed, said apparatus including an open framework and a circular, buoyant foundation supporting tank, the latter having a central opening and a peripheral apron extending downwardly below the bottom of the tank and provided with a cutting edge, which comprises, floating the apparatus in a vertical position to the desired location, then flooding the foundation tank to submerge the latter, then inserting an elongated spud anchor into the water-bed through said opening to form a pivot about which the tank and framework may be rotated, then further flooding said tank to bring the cutting edge of said apron into contact with the water-bed, then rotating the framework and tank while directing a plurality of water jets tangentially of the cutting edge to submerge the apron in the water-bed, and finally securing the tank to said spud anchor to firmly anchor the apparatus.

17. The method of anchoring an offshore drilling apparatus to a water-bed, said apparatus including an open framework and a circular, buoyant foundation supporting tank, the latter having a central opening and a peripheral apron extending downwardly below the bottom of the tank and provided with a cutting edge, which comprises, floating the apparatus in a vertical position to the desired location, then flooding the foundation tank to submerge the latter, then inserting an elongated spud anchor into the water-bed through said opening to form a pivot about which the tank and framework may be rotated, then further flooding said tank to bring the cutting edge of said apron into contact with the water-bed, then rotating the framework and ank to seat the apron in the water-bed, thereafter deepening said seat and cutting away the water-bed beneath the tank bottom while continuing the rotation of the tank in order to substantially embed the entire tank in the water-bed, and finally securing the tank to said spud anchor to firmly anchor the apparatus.

18. The method of anchoring an offshore drilling apparatus to a water-bed, said apparatus including an open framework and a circular, buoyant foundation supporting tank, the latter having a central opening and a peripheral apron extending downwardly below the bottom of the tank and provided with a cutting edge, which comprises, floating the apparatus in a vertical position to the desired location, then flooding the foundation tank to submerge the latter, then inserting an elongated spud anchor into the water-bed through said opening to form a pivot about which the tank and framework may be rotated, then further flooding said tank to bring the cutting edge of said apron into contact with the water-bed, then rotating the framework and tank to seat the apron in the water-bed, thereafter deepening said seat and cutting away the water-bed beneath the tank bottom while continuing the rotation of the tank in order to substantially embed the entire tank in the water-bed, directing the cuttings beneath the tank toward the central portion thereof and conducting the same through the tank to the top thereof, and finally securing the tank to said spud anchor to firmly anchor the apparatus.

19. The method of anchoring an offshore drilling apparatus to a water-bed, said apparatus including an open framework and a circular, buoyant foundation supporting tank, the latter having a central opening and a peripheral apron extending downwardly below the bottom of the tank and provided with a cutting edge, which comprises, floating the apparatus in a vertical position to the desired location, then flooding the foundation tank to submerge the latter, then inserting an elongated spud anchor into the water-bed through said opening to form a pivot about which the tank and framework may be rotated, then further flooding said tank to bring the cutting of said apron into contact with the water-bed, then rotating the framework and tank to seat the apron in the water-bed, thereafter deepening said seat and cutting away the water-bed beneath the tank bottom while continuing the rotation of the tank in order to substantially embed the entire tank in the water-bed, directing the cuttings beneath the tank toward the central portion thereof and conducting the same through the tank to the top thereof, retaining the cuttings on the top of the tank to form ballast for the tank, and finally securing the tank to said spud anchor to firmly anchor the apparatus.

20. An offshore drilling apparatus for conducting drilling operations in a body of water, comprising a buoyant, water-tight foundation tank of circular form adapted to be flooded to form a foundation for the apparatus, said tank having a top, a bottom, a peripheral side wall and a central opening extending from the bottom to the top and said wall being provided with a peripheral apron extending below the bottom of the tank and having a cutting edge, a plurality of spaced-apart cutters carried by said cutting edge and being angularly arranged with respect to the radii of the tank, means for flooding

the tank to bring the cutting edge of the apron and said cutters into contact with the water-bed, an elongated spud anchor inserted into the water-bed through said opening to constitute a stationary pivot about which the tank may be rotated to sink the apron in the water-bed, said tank having a plurality of wells extending from the bottom of the tank to the top thereof and through which dredging of the water-bed may be effected during rotation of the tank to aid in sinking the apron and tank in the water-bed, and means to secure the spud anchor to the tank after the latter has been so submerged in order to anchor the foundation tank.

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