May 15, 1951 O. B. MANES 2,552,899

FLOATING DRILLING RIG

Filed May 19, 1947 2 Sheets-Sheet 1

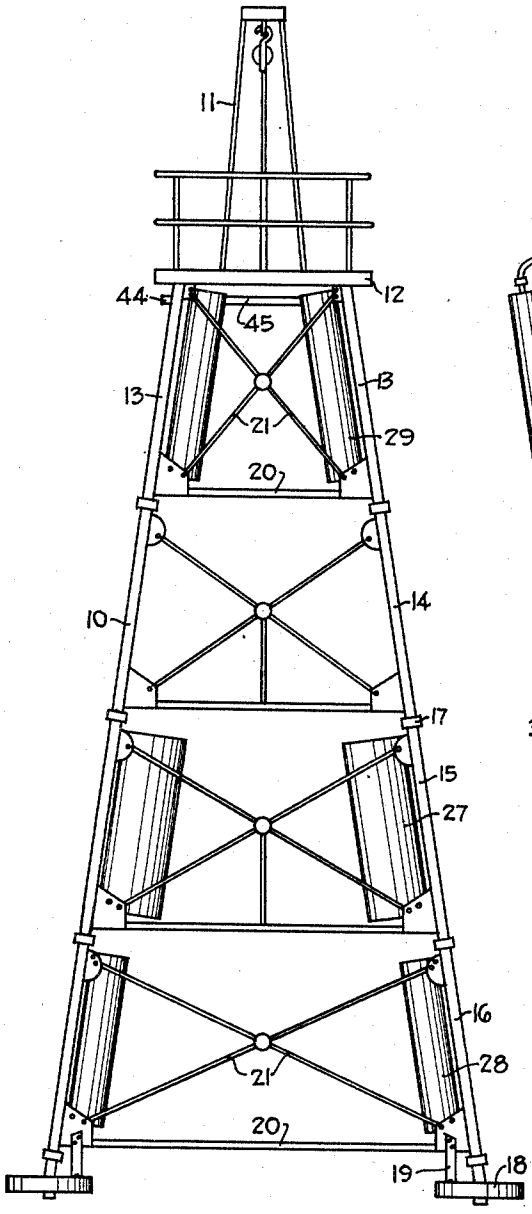

Fig. 1.

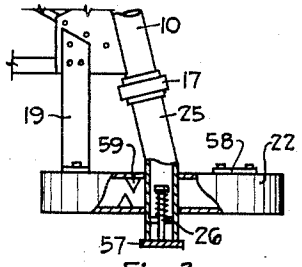

Fig. 3.

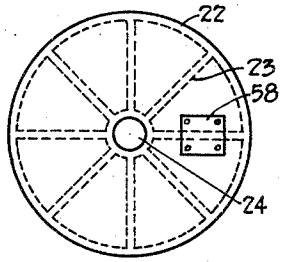

Fig. 4.

Fig. 2.

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By his Attorney: [signature]

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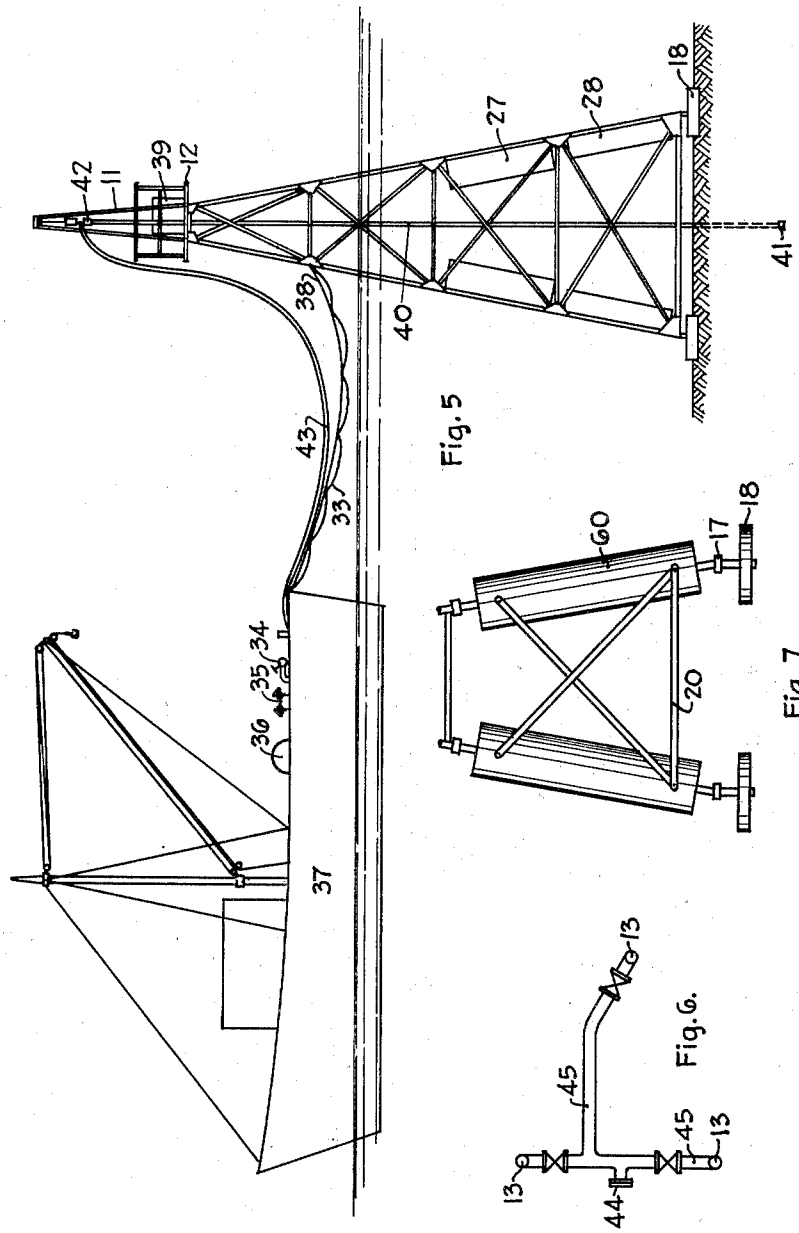

Fig. 5

Fig. 7

Fig. 6.

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UNITED STATES PATENT OFFICE

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FLOATING DRILLING RIG

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6 Claims. (Cl. 61—46)

1

The present invention relates to methods and apparatus for drilling wells or boreholes into ground submerged under water bodies, such as into formations beneath lakes, shallow coastal waters, etc., and pertains more particularly to improvements in the construction and use of floating drilling rigs.

Previously, several methods for handling equipment while drilling into formations submerged by water have been employed. One method consists of mounting the drilling equipment, such as drawworks, derrick, pump, etc., on large self-propelled barges or boats equipped and designed for drilling operations. On such boats or barges the derrick is usually mounted at one end over an open bay or well in the boat which permits the passage of the drill or casing string therethrough. This supplies a floating base from which drilling operations are conducted, but considerable difficulty is experienced due to the rocking action of such a base caused by wave action.

Another method consists of mounting the drilling equipment on the superstructure of a barge capable of supporting such a load. The barge is towed to the selected location at which the well is to be drilled, and, by flooding the watertight compartments, is then firmly grounded into position on the bottom so that the deck on the superstructure, upon which drilling equipment is mounted, remains above water. Such barges are also formed with a bay or open slot in one side to permit the passage of the drill or casing string therethrough, so that when the ballast tanks are emptied and the hull raised, the barge may be floated away from the well head to another location. This method is subject to considerable limitations as to the depth of the waters in which it may find application.

It is the primary object of the present invention to obviate the use of large and expensive boats or barges in transporting the drilling rig and other equipment to the location at which the borehole is to be drilled by providing a floating drilling rig, adapted to be towed and sunk into position for drilling, and later refloated in order to be moved to another location.

It is also an object of this invention to provide a lightweight floating drilling rig of simple and sturdy design that is capable of being positioned and used for drilling operations in any reasonable depth of water where the wave and swell actions are of such nature as to preclude the use of a floating boat or barge as a drilling platform.

Other objects and advantages of the present invention will be apparent from the following

2

description taken in reference to the drawings, wherein:

Fig. 1 is a side elevation of the drilling rig showing one possible location of the flotation tanks.

Fig. 2 is a schematic diagram of an air supply system connected to one leg of the drilling rig having tanks attached thereto.

Fig. 3 is a side view, partly in cross section, of a foot assembly attached to the base of the drilling rig.

Fig. 4 is a bottom view of a foot assembly.

Fig. 5 is a perspective view showing the drilling rig in position for drilling in shallow water with the accompanying towing boat.

Fig. 6 is a top view of a fluid distribution manifold and valve assembly located on the drilling tower.

Fig. 7 is a side elevation of another embodiment of the drilling rig.

Briefly, the present invention comprises a drilling tower having at least three tubular legs and adapted to be dismantled into a number of vertical sections, a top working platform, said tower having attached to each leg an extending foot assembly, and at least one vertical flotation tank having an air port and a water port, said tanks being adapted to be filled with air, thereby causing the tower to float, or to be filled with water, thereby causing the tower to sink.

Referring to Fig. 1 of the drawings, showing a side view of the floating drilling rig or tower of the present invention, a preferred form of the tower comprises a suitable number, preferably three or four, of sloping legs 10, so that the structure has the shape of a truncated pyramid having a removable pipe-pulling tripod 11 and working platform 12 at the top of the legs 10. Each leg 10 comprises several pipe sections such as 13, 14, 15 and 16 which are connected by any suitable means as, for example, by pipe unions 17. A foot assembly 18 is attached to each leg 10 in a similar manner and is reinforced by a brace 19. The corresponding sections (for example 13) are fastened together in a rigid manner by transverse braces 20 and diagonal braces 21. The braced and connected sections of the legs thus form removable sections of the drilling tower. The individual sections of the tower are constructed to any size that is easily transported and assembled. When the desired height of the drilling tower has been determined, the proper number of sections is connected together and the foot assemblies 18 are attached to the bottom of the legs of the lowermost section.

A supporting foot assembly 18 is shown in Figs. 3 and 4 as comprising a flat plate member or drum of preferably circular shape. The drum 22 may be constructed of any plate or sheet metal of suitable strength which is reinforced by a plurality of radial braces 23. An opening 24 in the center of the drum permits the passage therethrough of a short tubular member or jet-pipe 25 adapted to be connected to the lower section 16 of the tubular leg by means of a union 17. Located within the short tubular member 25 is a downwardly opening check valve 26 which prevents mud and sand from entering the tubular leg, at the same time permitting fluid which is forced under pressure down said tubular leg to open the check valve 26. As the check valve 26 opens, the closure plate 57 is forced downward by the fluid stream which impinges on the inner surface of said plate 57 and jets radially into the formation adjacent the foot assembly 18.

Although the foot assembly 18 is shown as a drum-like cylinder, it is understood that it may be of any other shape, such as square, hexagonal, octagonal, etc., being of sufficient size to prevent the lower end of the leg from sinking to any substantial depth into the bottom. Besides acting as a solid base for the drill rig the foot assemblies also serve as counterweights, since a floatable structure such as the drilling rig of the present invention should be counterweighted, preferably at the bottom end, in order to lower the center of gravity below the center of buoyancy. When it is desired to float the rig from one position to another in an upright position, the working platform 12 may be securely fixed to the top of the rig and the foot assemblies, preferably of the hollow drum type, may be filled with a weighting material. As shown in Fig. 3, a foot assembly drum 22 may be equipped with one or more openings in the top thereof, covered by removable plate means 58, through which weighting materials may be added. Radial braces 23 may be equipped with one or more openings 59 which allow an even distribution of the weighting material in the foot assembly. In order to be able to vary the weights of the foot assemblies for changing operating conditions the drums of the foot assemblies may be removably filled with substances such as lead shot, small pieces of scrap metal, sand, concrete, crushed stone, etc. In some cases the foot assemblies 18 on the present drilling rig can be eliminated so that the entire base of the rig, comprising the legs and the lower cross supports 20, could rest on the bottom and support the rig. It can be easily seen, however, that any unevenness of the bottom, when encountered by one of the cross supports 20, would cause a tilting of the tower. Such a tilting of the tower is eliminated or greatly minimized by the use of a three or four-legged tower having legs equipped with the foot assemblies above-described.

In order to enable the drilling tower to float in a body of water when being conveyed to a drilling location, the tower is equipped with a number of watertight compartments or flotation tanks. One embodiment of the tower of the present invention is shown in Fig. 1 as having a set of main flotation tanks 27, lower flotation tanks 28 and upper flotation tanks 29, with one section of the tower shown as having no tanks attached thereto. The tanks are fastened to the leg sections 13, 15 and 16 in any suitable manner as by ring clamps 30 which readily permit the removal of any tank or group of tanks for repairs or when not needed. The tanks

may be of any shape having a horizontal cross section that is circular, triangular, square, square with rounded corners, etc. Tanks having the shape of elongated cylinders are, however, preferred as being easy to fabricate while furnishing a maximum volume with a minimum cross section, thus possessing the maximum strength to handle the pressures involved. Each tank is equipped with air inlet and outlet means 31 and a water inlet and outlet means 32, the air port 31 being coupled, preferably by means of a flexible conduit 33, to a suitable air supply system usually located on a towing boat or barge 37 which also carries a water pump 36 (Fig. 5). An air supply system, as schematically shown in Fig. 2, comprises an air compressor 35, driven by a motor 46 and connecting drive belt 47, which maintains a supply of compressed air in a supply or storage tank 48. A conduit 49, having a valve 50 located therein, is in communication with an air distributing manifold 34 having valved outlets 50, 51 and 52 which communicate through conduits 33 with the main 27, lower 28, or upper 29 flotation tanks respectively. Thus any amount of air necessary to float or level the tower may be admitted to the flotation tanks by opening valves 53, 54 and 55 in the outlets 50, 51 and 52. Closing the valves 53, 54 and 55 traps the air in the tanks preventing water from entering outlet ports on the tanks.

With such a manifold and valve assembly 34, it will be seen that each tank can be filled individually, or all the tanks in any section can be filled at once, or all the tanks on the entire drilling rig can be filled at once. Since the tanks have individual conduits and connections to the valve manifold, the volume of air or water in the flotation tanks can be adjusted to trim the tower so that it floats in a vertical position. The flexible fluid conduits 33 between the control manifold 34 and the flotation tanks should be of sufficient length to allow free movement of the towing boat 37.

In practice a drilling tower of a predetermined size is assembled and equipped with the necessary number of flotation tanks and foot assemblies. The removable working platform 12, tripod 11 and drilling equipment (as schematically represented at 39, Fig. 5) may be either securely attached to the top of the tower at this time or they may be attached after the drilling tower has been sunk into position. The drilling tower is then lowered into the water and attached to a towing barge 37 by means of a towing cable 38. The fluid conduits 33 leading from the valve manifold 34 to the flotation tanks 27 and 28 are grouped and bound together to form a single cable which in turn is suspended from the towing cable 38. With the valve manifold 34 set to deliver air to the flotation tanks, the air compressor 35 is operated so that all of the flotation tanks are filled with air causing the drilling rig to float. The air valves in the manifold 34 are then closed trapping the air in the flotation tanks and giving the desired buoyancy to the tower.

With the tanks filled with air to provide buoyancy, the floating tower is towed to the desired location. The air compressor 35 is shut off, or the outlet valve 50 from the air supply tank 48 is closed, and the air-exhaust valve 56 in the manifold is opened, thus venting it to the atmosphere. Air valves 53, 54 and 55 in the manifold system 34 are opened permitting the air to escape from the flotation tanks or to be forced therefrom through air ports 31 by water which enters

the water ports 32, flooding the tanks and thereby causing the tower to sink to the bottom. An operator controls the air valves of the manifold 34 in a manner which permits a controlled flooding of the flotation tanks so that the tower is sunk in a vertical position, as shown in Fig. 5. Drilling of the borehole is accomplished by use of a suitable pipe 40, bit 41 and water-circulating system which includes a water-hose swivel 42, a water pump 36 and a connecting flexible fluid conduit 43, said water pump being located normally on the towing boat 37. (After drilling, the shot hole is then loaded and shot or the shooting may be delayed until after the tower has been moved.)

When the drilling tower is ready to be moved to another nearby location the valve manifold 34 is set so that the air compressor 35 delivers air through the air line 33 and air ports 31 to the main flotation tanks 27. These main tanks 27, when blown free or nearly free of water provide sufficient buoyancy to cause the tower assembly to rise and float in a substantially vertical position if the foot assemblies 18 do not adhere to the bottom. If settling of the foot assemblies 18 into the bottom has occurred and adherence thereto prevents the tower from rising immediately when sufficient buoyancy is provided, the water-circulating system comprising the pump 36 and hose 43 is connected at an auxiliary connection 44 of a control manifold-valve assembly having valved conduits 45 leading from said connection 44 to each tubular leg of the drilling rig, as shown in Fig. 6. Such a control manifold assembly is located preferably near the top of the upper section of the tower. Fluid is then pumped through said conduits 43 and 45 and circulated through the tubular tower legs (or other suitable conduits) leading to the jet-pipes 25 opening at the bottom of the foot assemblies 18. The discharge of water through the check valve 26 results in a radial jetting or washing action beneath the foot assemblies 18, and this jetting is continued until the adherence of the foot assemblies to the bottom is broken, at which time the tower will rise off the bottom. Such jetting action is very effective in breaking the footing loose from the bottom in all except the most unfavorable bottom conditions.

If the drilling tower does not float in a vertical position, it may be trimmed by adjusting the volume of air in the main flotation tanks 27 and the auxiliary tanks 28, entry of air into all of these tanks being individually controlled by the manifold and valve system 34. The drilling tower, now being afloat again and in proper trim, is towed by the service-boat 37 to the next location and the cycle of operations described above is repeated.

By a proper disposition of the flotation tanks on the drilling tower structure the tower floats in a vertical position and also possesses the necessary degree of stability for being towed through the water in that position, as diagrammatically shown in Fig. 5, without the removal of the working platform, tripod, etc., from the top of the tower. The substantially vertical positioning of the elongated flotation tanks on the drilling tower is an important feature of this invention as it has been found that with the tanks in this position the drilling structure has much more stability afloat and while anchored on the bottom, particularly in offshore waters where wave and swell actions are of such height and violence as to tend to upset the tower. Vertically disposed elongated tanks have a minimum reaction to wave and swell action. With vertical disposition of elongated tanks, it is also possible to secure the greatest variability of, and control over, the center of buoyancy of the flotation system, which results in the best control over the stability of the tower when it is afloat. Simplicity of design and construction are also achieved by the vertical positioning of the buoyancy tanks. Attachment of the tanks to the tower structure longitudinally with the legs places them as far as possible from the vertical axis of symmetry of the structure and also provides for maximum differential buoyancy between tanks, thus providing for best control of this differential buoyancy in adjusting the "trim" of the tower afloat. Good trim control over a floatable tower may also be secured when the buoyancy tanks surround the legs or form the legs or part of the legs 60 themselves, as shown in Fig. 7 on another embodiment of a drilling tower of the present invention. When the buoyancy tanks surround or are formed around the leg members, they may be attached to said leg members by any suitable means, as by flanging, welding, riveting or the like.

When drilling operations are conducted in waters that are too shallow to float the drilling tower in a vertical position, a tower having both upper 29 and lower auxiliary tanks 28 is used, as shown in Fig. 1, so that the tower may be floated and towed in a horizontal position. On reaching the desired drilling location the tower is either sunk in the manner described above or it is elevated into position by a cable and winch (not shown) located on the towing boat.

I claim as my invention:

1. For use in offshore drilling in combination with fluid pumping means mounted on a floating platform, a floating drilling tower adapted to be connected with said pumping means by flexible fluid conduits, said tower comprising a plurality of braced legs, separate elongated flotation tank members attached to each leg longitudinally therewith and at substantially the same distance from the ends thereof, each tank member being arranged to be selectively flooded when said drilling tower is erected off-shore for operation, port means in each tank member open to the medium surrounding said tank member, port means in each tank member connectable with said flexible conduit means, whereby the buoyancy of the tower can be controlled by supplying to said tank members a fluid from said pumping means, and a drilling platform mounted on the top of said tower.

2. For use in offshore drilling in combination with fluid pumping means mounted on a floating platform, a floating drilling tower adapted to be connected with said pumping means by flexible fluid conduits, said tower comprising a plurality of braced legs, each of said legs being at least partially formed of an elongated cylindrical tank member, port means in each tank member open to the medium surrounding said tank member, port means in each tank member connectable with said flexible conduit means, whereby the buoyancy of the tower can be controlled by supplying to said tank members a fluid from said pumping means, and a drilling platform mounted on the top of said tower.

3. For use in offshore drilling in combination with a floating platform having air and liquid

pumping means mounted thereon, a floating tower adapted to be connected with said air and said liquid pumping means by flexible conduits, said tower comprising a plurality of braced tubular legs, separate elongated flotation tank members attached to each leg longitudinally therewith and at substantially the same distance from the ends thereof, each tank member being arranged to be selectively flooded when said drilling tower is erected off-shore for operation, a flat support member affixed around the foot of each leg transversely thereto, valve means in the foot of each of said tubular legs opening outwardly to the space below said flat support member, port means in each floating tank member opening to the medium surrounding said tank, port means in each tank member connectable to the flexible conduit means to the air pumping means, whereby the buoyancy of the tower can be controlled by supplying air to said tank members from said pumping means, port means in each leg connectable to the flexible conduit means to the liquid pumping means, whereby a liquid may be forced through said legs and jetted through said foot valve means, and a drilling platform mounted on the top of said tower.

4. For use in offshore drilling in combination with fluid pumping means mounted on a floating platform, a floating drilling tower adapted to be connected with said pumping means by flexible fluid conduits, said tower comprising a plurality of braced legs, a separate elongated floatation tank member carried longitudinally by each of at least three legs, said tank members being arranged at each of said legs at substantially the same distance from the ends thereof, each tank member being arranged to be selectively flooded when said drilling tower is erected off-shore for operation, port means in each tank member open to the medium surrounding said tank member, port means in each tank member connectable with said flexible conduit means, whereby the buoyancy of the tower can be controlled by supplying to said tank members a fluid from said pumping means, and a platform mounted on said tower.

5. For use in offshore drilling in combination with fluid pumping means mounted on a floating platform, a floating drilling tower adapted to be connected with said pumping means by flexible fluid conduits, said tower comprising a plurality of braced legs, at least two elongated floatation tank members carried longitudinally of each other by each of at least three legs, one of said tank members being positioned on the upper and one on the lower halves of each leg, all of said upper and all of said lower tanks being spaced substantially equally from the lower ends of said legs, each tank member being arranged to be selectively flooded when said drilling tower is erected off-shore for operation, port means in each tank member opening to the medium surrounding said tank member, port means in each tank member connectable with said flexible conduit means, whereby the buoyancy of the tower can be controlled by supplying to said tank members a fluid from said pumping means, and a platform mounted on the upper half of said tower.

6. For use in offshore drilling in combination with fluid pumping means mounted on a floating platform, a floating drilling tower adapted to be connected with said pumping means by flexible fluid conduits, said tower comprising a plurality of braced legs, at least two elongated floatation tank members carried longitudinally of each other by each of at least three legs, one of said tank members being positioned on the upper and one on the lower halves of each leg, all of said upper and all of said lower tanks being spaced substantially equally from the lower ends of said legs, said tanks on the lower halves of said legs being of greater capactiy than the tanks on the upper halves of said legs, each tank member being arranged to be selectively flooded when said drilling tower is erected off-shore for operation, port means in each tank member opening to the medium surrounding said tank member, port means in each tank member connectable with said flexible conduit means, whereby the buoyancy of the tower can be controlled by supplying to said tank members a fluid from said pumping means, and a platform mounted on the upper half of said tower.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,210,408	Henry	Aug. 6, 1940
2,422,168	Kirby	June 10, 1947