

May 31, 1960

E. R. VORENKAMP

2,938,353

SUBMERSIBLE DRILLING BARGE

Filed Dec. 27, 1954

4 Sheets-Sheet 1

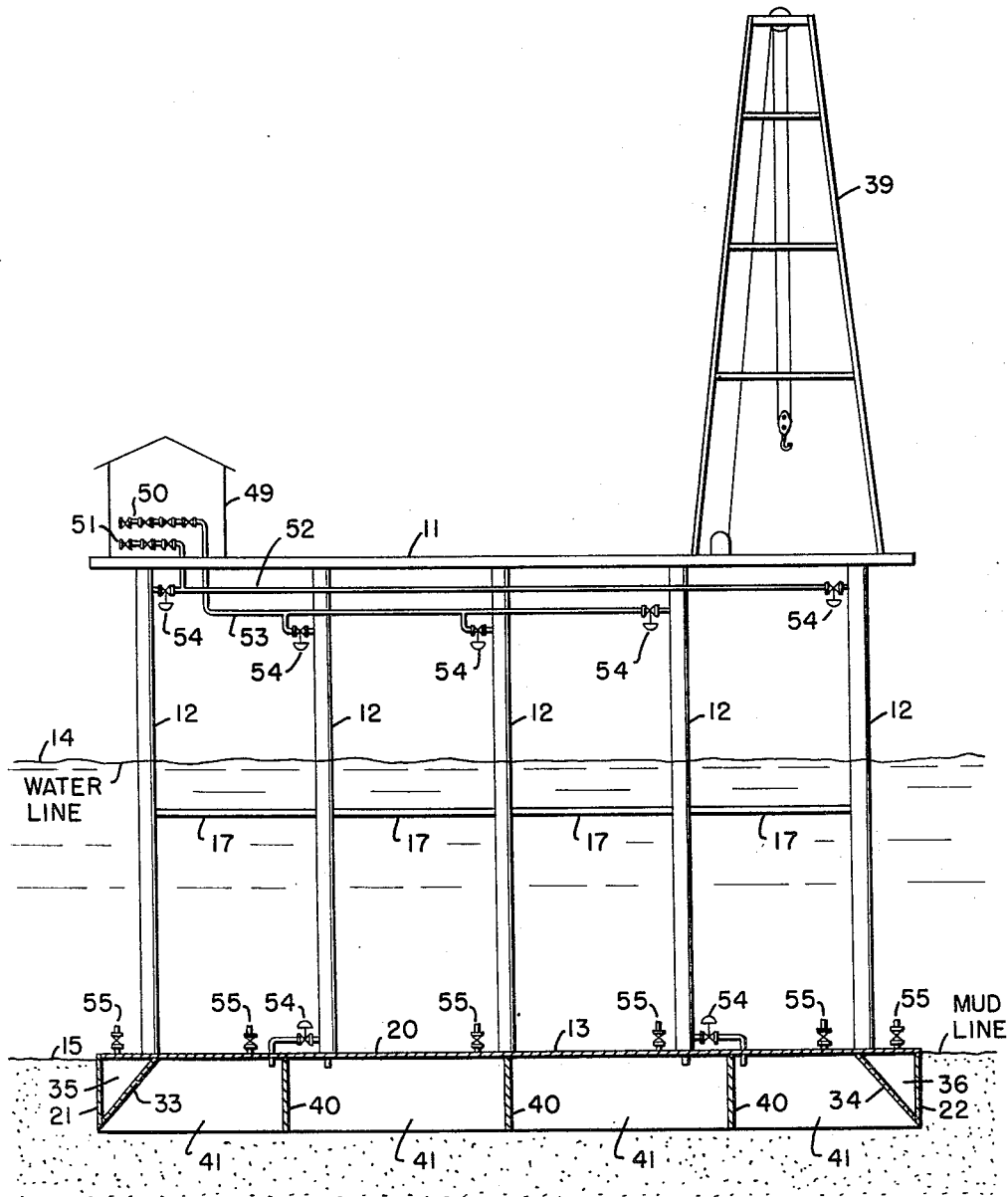


FIG. 1

INVENTOR

E. R. VORENKAMP

BY *J. H. McCarthy*
HIS AGENT

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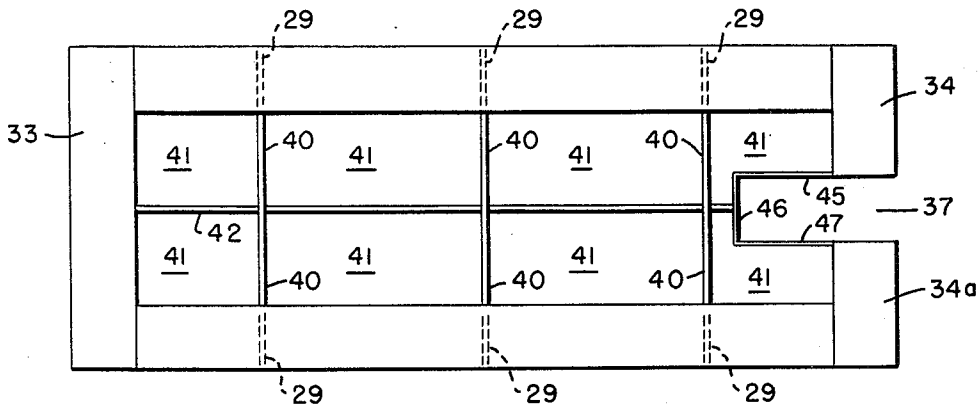
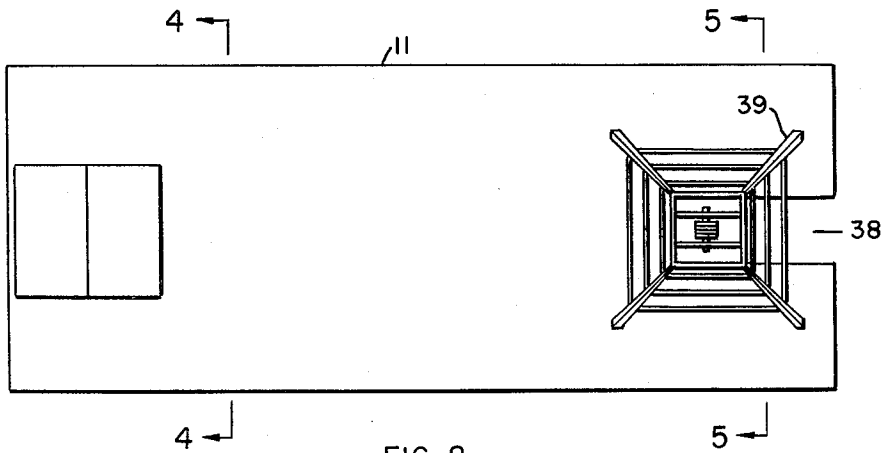


FIG. 3

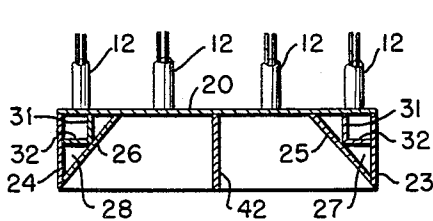


FIG. 4

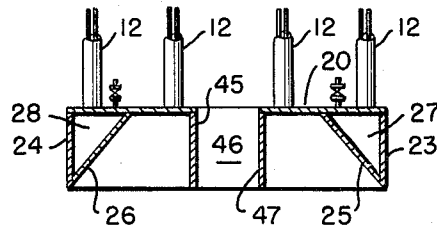


FIG. 5

INVENTOR

E. R. VORENKAMP

BY

J. H. McCarthy
HIS AGENT

May 31, 1960

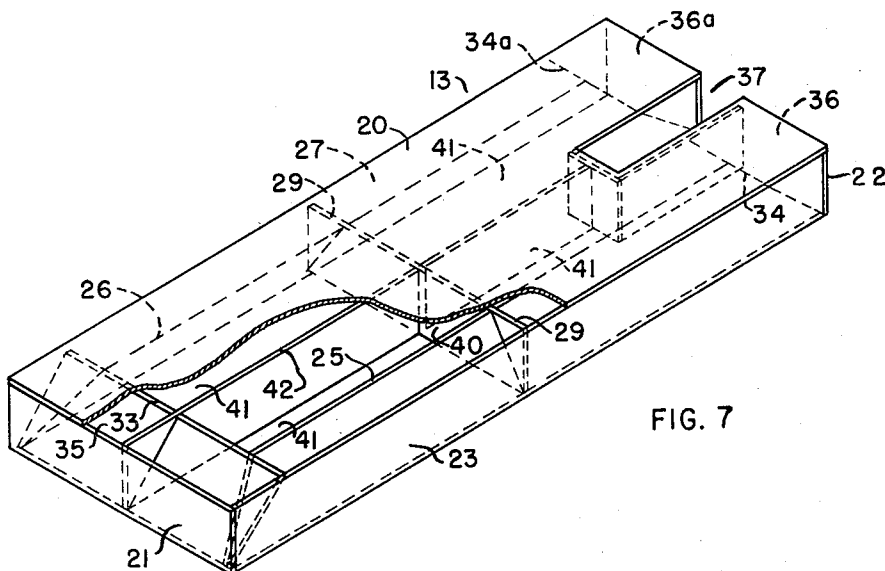
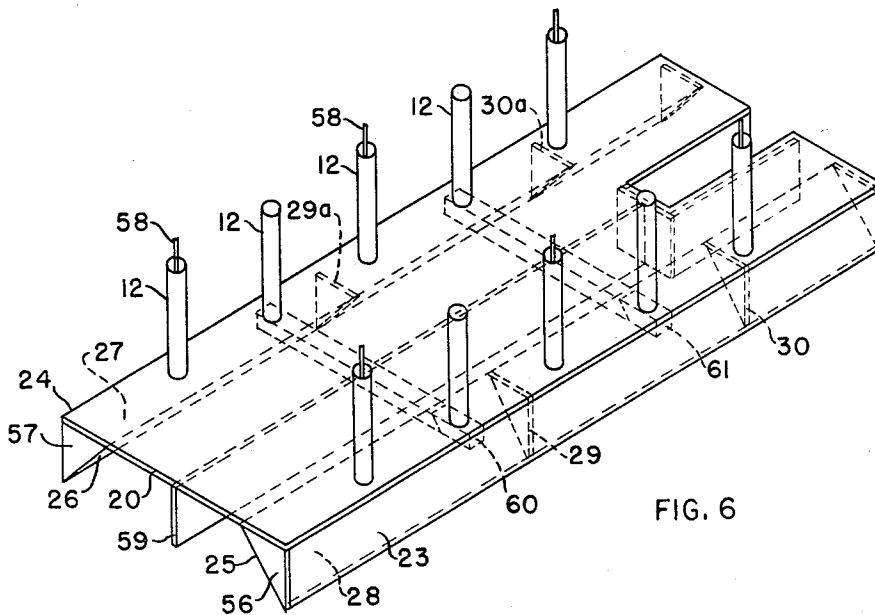
E. R. VORENKAMP

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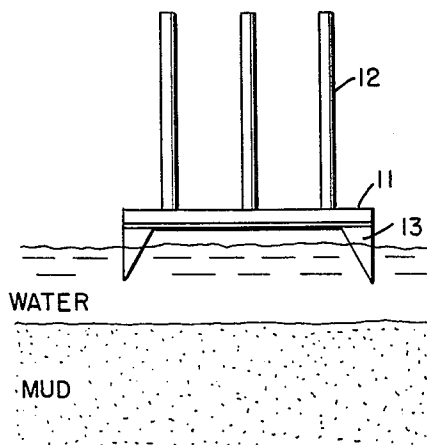


FIG. 8

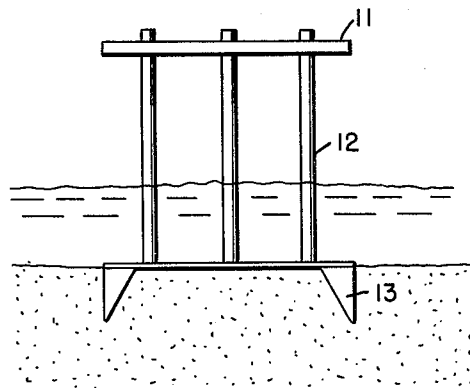


FIG. 8a

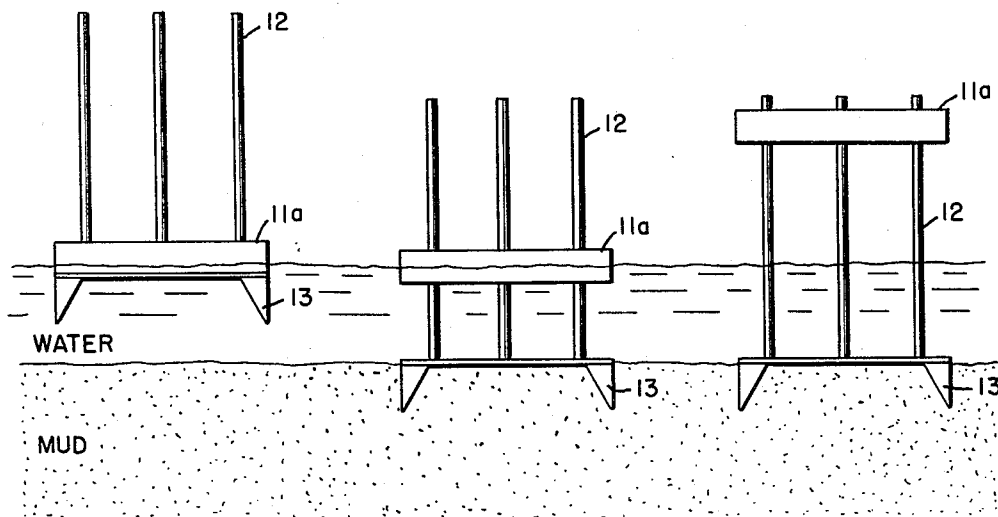


FIG. 9

FIG. 9a

FIG. 9b

INVENTOR

E. R. VORENKAMP

BY *J. H. McCarthy*
HIS AGENT

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2,938,353

SUBMERSIBLE DRILLING BARGE

Egbert R. Vorenkamp, New Orleans, La., assignor to Shell Oil Company, a corporation of Delaware

Filed Dec. 27, 1954, Ser. No. 477,743

2 Claims. (Cl. 61—46.5)

The present invention relates to marine vessels such as floating barges for use in subaqueous drilling operations and pertains more particularly to a new type of a submersible barge for supporting the necessary well drilling equipment firmly in place above the surface of the water during drilling operations at off-shore locations.

During the past several years considerable interest has been shown in drilling oil wells in off-shore locations, particularly in the Continental Shelf off the shores of Texas and Louisiana. Drilling off-shore oil wells is a difficult and expensive operation necessitating the use of suitable apparatus for positioning the required drilling equipment at a safe level above the surface of the waters in which drilling operations are being carried out. Heretofore, various types of apparatuses have been proposed for use in off-shore drilling operations. These apparatuses fall into two main classes: (1) fixed platforms positioned on piling which is driven into the ocean floor and (2) floatable drilling barges which are generally submersible and can be sunk onto the ocean floor at the drilling location.

Since drilling platforms are very expensive and cannot be readily recovered after drilling operations have been completed, many drilling contractors and oil well companies prefer to use submersible drilling barges. The ideal drilling barge should have a hull or pontoon sufficient in size to impart stability to the barge either when the barge is being floated to the drilling location, or after it has been sunk to the ocean floor at said location. In designing a pontoon adapted to be positioned on an ocean floor, it is important that the pontoon be no higher than necessary so as to reduce the area against which wind and ocean waves or currents would act to move the barge.

At some locations off the coast of Louisiana, there is no solid bottom on which a submersible barge may be set. This is especially true at locations off the mouth of the Mississippi River where the water may be only 30 ft. deep while the soft, fluid or unconsolidated mud underlying the water may be several hundred feet deep. This mud often consists of from 60 to 90% solids and has to serve as the base for drilling barges, which must be constructed with sufficient bearing areas to rest on this mud.

However, even a barge of considerable weight does not sink into this mud far enough to be safe from currents or wave forces tending to move the barge. While at most locations on the Continental Shelf there generally no underwater currents, a storm of considerable duration will cause a constant movement of the water against a sunken barge tending to move it. Thus, in some cases a storm may cause the water to move against a sunken hull at a constant speed of 1 knot or more during the duration of the storm, and to move a hull. In one storm, a submersible drilling barge, which was over 200 ft. long and weighed about 4500 tons, was moved 8 ft. in one direction and 10 ft. in another direction while on drilling location.

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It is therefore a primary object of the present invention to provide a floatable drilling barge adapted to be submerged on an unconsolidated muddy bottom, said barge having sufficient bearing area to support a drilling platform and associated drilling equipment at a predetermined height above the surface of the water.

A further object of this invention is to provide a floatable drilling barge adapted to be submerged on a muddy bottom in such a manner that the entire submerged pontoon of the barge sinks into the mud with the top deck of the pontoon substantially level with the mud-water interface at the drilling location.

Another object of this invention is to provide a floatable drilling barge adapted to be submerged in a manner such that there is substantially no area on the ends of the submerged pontoon against which the force of the water currents may act.

It is a further object of this invention to provide a floatable drilling barge having a submersible pontoon of a design adapted to cut into a muddy bottom to prevent lateral movement of the pontoon by underwater currents.

Another object of this invention is to provide a floatable drilling barge having a submersible pontoon of a suitable design to allow it to sink into a muddy ocean bottom in such a manner as to prevent any erosion of material from beneath the pontoon by currents or the impact of waves.

These and other objects of the invention will be understood from the following description taken with reference to the drawing, wherein:

Figure 1 is a view of the present drilling barge, shown with its pontoon, taken in cross-section, positioned in the mud below the surface of the water.

Figure 2 is a plan view of the drilling barge of Figure 1.

Figure 3 is a bottom view of the barge of Figure 1, showing the drilling slot or bay through which drilling operations are carried on.

Figure 4 is a cross-sectional view of the pontoon taken along the line 4—4 of Figure 2.

Figure 5 is a cross-sectional view of the pontoon taken along the line 5—5 of Figure 2.

Figures 6 and 7 are isometric projection views of other types of pontoons of the present invention.

Figures 8, 8a and 9, 9a, 9b are schematic views illustrating barges of the present invention while floating and while sunk at a selected drilling location.

Referring to Figure 1 of the drawing, the present drilling barge comprises an operating platform 11 fixedly secured to and supported by a plurality of vertical legs or columns 12 which are in turn affixed to the top of a pontoon 13 which has substantially the same dimensions as the operating or drilling platform 11. The vertical legs 12 are of a length sufficient for the drilling platform 11 to be positioned 20 or 30 ft. above the water line 14 while the pontoon 13 is sunk flush with the mud level or line 15. The legs 12 may be constructed as tubular columns, I-beams or the like, having a diameter or size sufficient to give the necessary strength while being as small as possible to reduce the area against which current or wave forces might act when the barge is in its submerged position. Cross bracing members 17 may be employed to impart added rigidity to the structure.

As shown in Figures 1 and 7 of the drawing, the pontoon 13 comprises a top plate 20, end plates 21 and 22 and side plates 23 and 24 with the bottom of the pontoon open. As shown in Figures 4 and 5 of the drawing, a pair of sloping longitudinal bulkheads 25 and 26 are provided and securely welded in a fluidtight manner to the top plate 20 and the side plates 23 and 24, respectively, to form longitudinal fluidtight ballast tanks the length of the barge along each side thereof.

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The longitudinal ballast tanks 27 and 28 are of triangular cross section, as shown in the drawing, with one angle of the triangle formed between the vertical side plates 23 and 24 and the sloping longitudinal bulkheads 25 and 26. Each of the longitudinal ballast tanks 27 and 28 may be divided into a plurality of compartments as shown in Figures 3, 6 and 7 by inserting transverse bulkheads 29 at suitable locations. Additionally, if desired, cross bracing members 31 and 32 may be provided in the ballast tanks 27 and 28 to reinforce them (Figure 4).

In Figures 1, 3 and 4, the pontoon member 13 of the barge is shown as being provided additionally with transverse sloping bulkheads 33, 34 and 34a which are secured to the end plates 21 and 22 and to the top plate 20 of the pontoon to form ballast tanks 35, 36 and 36a at opposite ends of the barge pontoon. The end ballast tanks 36 and 36a (Figure 7) are formed in the end of the barge on opposite sides of the bay or elongated slot 37 provided in the pontoon, said bay being substantially equal in size to the bay 38 formed in the drilling platform 11 (Figure 2). As shown in Figure 2, a well derrick or drilling mast is mounted over the slot 38 so that drill pipe (not shown) supported by said derrick passes down through the bay 38 in the drilling platform 11 and thence down through the bay 37 in the pontoon.

A plurality of vertical plate members or transverse bulkheads 40 are preferably welded into the pontoon 11 to divide the open space in the bottom of the pontoon, which is surrounded by the ballast tanks 27, 28, 35 and 36, into a plurality of open-bottomed cells as shown in Figures 1, 3 and 7. Additionally, one or more longitudinal bulkheads 42 may be welded into the bottom of the pontoon in a fluidtight manner to divide the cells into smaller units. Vertical plate members 45, 46 and 47 surround the bay 37 in the pontoon 11 thus forming cells 41 between these plate members and the transverse bulkhead 40 adjacent thereto.

Referring to Figure 1, suitable housing means 49 are provided on the drilling platform 11 for housing the necessary air compressors, pumps and storage tanks (not shown) for supplying air or water, selectively, through manifolds 50 and 51, and conduits 52 and 53 which may pass down through or alongside of the vertical legs 12 of the drilling barge, whereby air or water may be pumped into or discharged from any and all of the ballast tanks 27, 28, 35, 36 and 36a or from any subdivided portion of any ballast tank. The manifolds 50 and 51 may also be used for pumping air in or out of the air tanks or cells 41 which are open at the bottom. Suitable valve means are provided in said conduits 52 and 53 and in the manifolds 50 and 51 for controlling remotely a flow of fluid in either direction through said conduits. Each of the ballast tanks and each of the open bottom air tanks may be preferably provided with a safety exhaust valve 55, but normally the intake valves on the upper deck will suffice.

Another design of the pontoon 13 of the present drilling barge is shown in Figure 6 of the drawing. In this design the side plates 23 and 24 of the barge and the sloping longitudinal bulkheads 25 and 26 extend the entire length of the barge and are closed at the ends by triangular shaped ended plates 56 and 57 to form the longitudinal ballast tanks 27 and 28. The ballast tanks 27 and 28 are divided into several compartments by transverse bulkheads 29 and 30. Each of the sections of the ballast tanks 27 and 28 may be filled or emptied independently with air or water through conduits 58 which pass down the legs 12 of the barge from the compressors and pumps carried on the operating floor of the barge. If desired a vertical reinforcing plate 59 may extend longitudinally the length of the pontoon between the ballast tanks 27 and 28, said plate being affixed to the bottom of the top plate 20 of the pontoon as by welding. If additional strengthening members are needed, one or more transverse reinforcing members 60 and 61 may

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be provided, which are of as small a cross-section as possible to offer a minimum of resistance to underwater currents.

The present drilling barge is preferably floated into position without the derrick 39 or other drilling equipment (not shown) mounted on the drilling platform 11. The present barge assumes a floating position in the water when all of the ballast tanks 27 and 28, 35, 36 and 36a are filled with air. Preferably, the capacity of the ballast tanks is sufficient for the barge to remain afloat in the event that one of the ballast tanks or cells thereof is ruptured by accident, as by collision. With additional drilling equipment carried on the drilling platform 11 of the barge, it may be necessary to pump air into the air tanks or cells 41 also. As a safety precaution and to give added buoyancy to the barge, the cells 41 are normally filled with air as the barge is being towed to its drilling location.

Upon arriving at the drilling location, air is first discharged from all of the cells 41 and thereafter from all of the ballast tanks 27, 28, 35, 36 and 36a. With the air being released simultaneously in a predetermined sequence from all ballast tanks and/or sections thereof, the pontoon slowly settles in the water until it rests on the mud. Due to its design, the pontoon 13 settles into the mud under its own weight until the mud level rises in the air cells 41 and contacts the underside of the top plate 20 of the pontoon 13, so that no part, or at most a very small part of the pontoon extends above the level of the mud line where it could be subjected to the forces due to underwater currents and wave action. On drilling location the present barge is preferably securely anchored, at least on the seaward side, as an added precaution against movement of the barge during a violent storm. A suitable anchor for securing drilling barges in muddy locations is disclosed in my copending application Serial No. 354,567, filed May 12, 1953, now Patent No. 2,721,530.

With the pontoon of the barge sunk in the mud as shown in Figure 1 of the drawing, the only portion of the barge that is exposed to the forces of wave action and currents are the thin vertical legs 12, hence, the present barge has little tendency to be moved by either wave action or currents. However, after a violent storm of several days duration, the top layer of the mud stratum has been known to move in some cases, said movement being caused by underwater currents built up by the storm. If it can be previously ascertained that such a condition may be encountered in drilling operations, the pontoon of the design shown in Figure 6 is preferably used, said pontoon being sunk into the top of the mud layer, and oriented so that one end of the barge faces seaward or in the direction in which the currents are moving. The only areas against which the currents can act in such case are the triangular end plates 56 and 57 of the longitudinal pontoons 27 and 28.

After a well has been drilled and it is desired to move the present barge to another drilling location, the ballast tanks of 27, 28, 35, 36 and 36a of the barge shown in Figures 1 and 7 are flooded with air to refloat the barge. To facilitate the refloating of the barge off a muddy bottom, it may be advisable to pump sufficient air into the air cells 41 to break the suction effect that the mud layer has on the underface of the top plate 20 of the pontoon. As a precautionary measure, all of the air cells 41 are filled with air again as the barge is towed to its new location.

When the present drilling barge has been sunk into position on a muddy bottom at a drilling location, the downwardly pointing ballast tanks, which extend down into and are submerged in the mud layer of the ocean floor, prevent wave action or currents from undercutting the mud from beneath either side of the hull of the pontoon, which would partially tend to destroy its stability. The downwardly pointing solid angle formed at

the intersection of two side plates 23 and 25 (Figure 6) of a pontoon ballast tank may have any suitable value, the controlling factor being the consistency of the mud bottom on which the pontoon 13 is to be positioned. Thus, in very soft bottoms, the downwardly pointing angle of the ballast tanks may have a value such as sixty degrees or more between the sides of the ballast tanks. On the other hand, when a barge of the present invention is to be sunk on an ocean floor that is more firm, the downwardly pointed angle of the ballast tanks may be as little as 30° or less, in order to permit the tanks to be thin and sharp enough to be forced completely into the soft bottoms so that the top plate 20 of the pontoon rests upon the bottom and supports the weight of the drilling platform positioned thereabove.

The base pontoon 13 of the present invention may be employed also on barges as shown in Figures 8 and 9 having operating platforms 11 that normally carried on the pontoons 13 when the barge is floated into position to increase the stability of the barge during movement to the drilling location. On arrival at the location, the platform 11 is raised up the legs 12 of the barge by suitable winches, hoists, air-jacks, etc., in a manner well known to the art until the platform is at the desired height.

In the barge shown in Figure 9, the platform 11a is also a pontoon member adapted to aid in floating the barge when it is desired to carry loads of heavy equipment (not shown) on the operating platform when the barge is being moved. On arrival at the drilling location the base pontoon 13 is evacuated and sunk in the mud (Fig. 9a) in a manner previously described. Subsequently the platform 11a is jacked or hoisted on the legs 12 to a desired height above the water level (Fig. 9b).

In addition to the downwardly pointing ballast tanks sinking in a soft or muddy sea bottoms, the vertical plate members 40 and 42 (Figs. 1 and 3) secured to the bottom of the barge and extending downwardly therefrom into the mud also tend to prevent horizontal movement of the barge in mud due to ocean currents. Similar vertical plate members 40 and 42, either fixed or movable, could be secured to the bottom or sides of other types of pontoons, submersible drilling barges or platforms well known to the art to prevent their movement on a muddy bottom. If necessary the vertical plate members 40 and 42 of the present pontoon 13 could be made longer so as to extend deeper into the mud to give greater holding power.

Instead of employing a single large submersible pontoon 13 as illustrated in Figure 1 of the drawing, it may be more desirable in certain instances, such as on soft uneven ocean floors, to employ several small pontoons of the present design to support one or more operating platforms, or to use a single large sectional pontoon to conform to uneven bottom conditions. The pontoon of the present barge is also found to be of considerable use by itself when used as a breakwater unit for other types of drilling barges or platforms positioned in offshore locations. As a breakwater unit the pontoon may be constructed 40 or more feet high, without a drilling slot in one end, and is sunk in the bottom only a sufficient depth to prevent its being moved by wave action.

I claim as my invention:

1. A drilling barge for drilling wells on offshore locations in bodies of water covering soft muddy bottoms, said barge comprising a floatable pontoon member adapted to be sunk to form a base for the barge on the muddy bot-

tom, vertical leg members secured to the pontoon member and extending upwardly above the surface of the water when the pontoon member is positioned in the mud, an operating platform carried by said leg members, said pontoon member and said operating platform each being provided with an opening of a size to permit well drilling tools to pass therethrough, said openings being in vertical alignment with each other, said pontoon member comprising rigid top plate means having at least two longitudinal ballast tanks affixed to the underside in spaced relationship and along two opposite edges thereof, said ballast tanks having a height substantially greater than the thickness of said top plate means and being triangular in cross-section with one side of the triangle being formed by the top plate means and one angle of the triangle pointing downwardly, said triangular ballast tanks having a buoyancy sufficient to float the barge, and means for flooding said ballast tanks, thereby causing the downwardly-pointed ballast tanks to penetrate and become submerged in the muddy ocean bottom until the top plate means of the pontoon member substantially rests level with and on top of the mud to support the barge during drilling operations.

2. A drilling barge for drilling wells on offshore locations in bodies of water covering soft muddy bottoms, said barge comprising a floatable pontoon member adapted to be sunk to form a base for the barge on the muddy bottom, vertical leg members secured to the pontoon member and extending upwardly above the surface of the water when the pontoon member is positioned in the mud, an operating platform carried by said leg members, said pontoon member and said operating platform each being provided with an opening of a size to permit well drilling tools to pass therethrough, said openings being in vertical alignment with each other, said pontoon member comprising a rigid top plate member having at least two longitudinal, triangular in cross-section ballast tanks affixed to the underside in spaced relationship and along the longitudinal edges thereof, said triangle being formed by the top plate member and one angle of the triangle pointing downwardly, said triangular ballast tanks having a buoyancy sufficient to float the barge, vertically-positioned transverse plate members extending between said ballast tanks and being secured to said tanks and to said rigid top plate member to form a plurality of open-bottom cells adapted to be filled with air, and means for flooding said ballast tanks and cells, thereby causing the downwardly-pointed ballast tanks to penetrate and become submerged in the muddy ocean bottom until the top plate member of the pontoon member substantially rests level with and on top of the mud to support the barge during drilling operations.

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