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MARINE OIL WELL DERRICK

Filed Sept. 2, 1930 9 Sheets-Sheet 1

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This invention is directed to a marine oil well derrick to be used in drilling and producing oil from submarine floors at great distances from shore and in great depths of water. In the previous application, I have described foundation structures suitable for this purpose. This invention is an improvement thereon.

The drilling in deep water, especially in the Pacific Ocean where the major submarine oil formations are found, involves peculiar problems not heretofore encountered.

Well locations are now being discovered at depths in the neighborhood of 50 feet of water and as far as 2000 feet from shore. The necessity of practical operation requires that the derrick floors be elevated 25 or 30 feet above the high tide line. The ordinary derrick used employed is 122 feet in height. The structure thus has a height of about 300 feet. It must be recognized that such derricks cannot be guyed and the over-turning moment, due to wind pressure, is enormous. In addition, the wave action creates a tremendous force tending to upset the staunchest derricks. Additionally, the derrick is subject to eccentric loads of tremendous amounts.

In the previous applications, I have designed a derrick which is particularly directed to resist these conditions by employing a peculiar arrangement of concrete piers and caissons. I have employed, in actual constructions, concrete piers 7 feet in diameter and center caissons 10 and 12 feet in diameter. The present invention is directed to an improvement upon the above construction whereby the cost of the construction is reduced and particularly whereby the wave resistance of the structure is diminished materially. I employ a foundation made up of entirely structural steel members presenting a minimum surface to wave action.

Drilling in the ocean has developed an additional problem. Laws are now enforced in California making it illegal to contaminate the ocean by either the oil or drilling fluid. This, while easily avoided on shore, is a serious problem when drilling at distances of 2000 feet or more at sea. In the previous applications, I have designed a construction that obviates any such difficulties. This invention is an improvement upon that construction.

It is, therefore, an object of this invention to design a foundation for a submarine oil well derrick which will withstand the tremendous wave and wind action and high eccentric loads at a minimum cost and which, at the same time, would present a minimum of surface to the wave action.

It is another object of this invention to provide for means for segregating drilling fluid and oil to prevent contamination of the water.

In general, the structure consists of a foundation made up of structural members formed into piers and a central structural member to give a five point pier construction of great rigidity and strength. More specifically, it is constructed of a plurality of vertical H-beams driven into shales to refusal and cross-connected by structural members to form four compound columns which act as piers. These piers are interconnected by other structural members which act as tie rods. Centrally disposed of these four piers is a ring of vertical H-columns all tied together in a ring and cross-braced to the corner piers. This central ring thus constructed has as one of its functions to act as a vertical compound column. Centrally disposed of this ring of H-columns is a pot suspended and carried by both the central ring of H columns and the corner piers. This pot has a double function. It acts as a sump to collect drilling fluid and oil and also acts as the cellar of the oil well. On top of the corner piers is positioned the derrick and the derrick floor. Beneath the floor and registering with the central pot is a scupper or drain pan or sub-floor. This pan has the additional function of acting as a guard for the floor in such cases as where the seas run high.
to the great strength of this pan, it prevents the uplifting of the floor by the running seas, breaking the force of the waves. Passing centrally through the pot is a caisson in which a conductor pipe is cemented both above and below water. In order to function efficiently, this pan or sub-floor must have sufficient structural strength, be adequately supported by the structure and cover the whole of the floor area. Through this pipe passes the drill tube. The rotary table is supported on certain of the H-beams of the central ring. The construction above water level is preferably welded and below water line, clamped and bolted.

The construction will be more specifically described by reference to the accompanying figures.

Fig. 1 is a vertical elevation of the front of the structure.

Fig. 2 is a vertical elevation of one of the sides.

Fig. 3 is a vertical section taken on the line 3–3 of Figs. 5, 6, 7 and 8.

Fig. 4 is a vertical section taken on the line 4–4 of Figs. 5, 6, 7 and 8.

Fig. 5 is a plan view of the structure taken on line 5–5 of Figs. 1, 2, 3 and 4.

Fig. 6 is a plan section taken on line 6–6 of Figs. 1, 2, 3 and 4.

Fig. 7 is a plan section taken on line 7–7 of Figs. 1, 2, 3 and 4.

Fig. 8 is a plan section taken on line 8–8 of Figs. 1, 2, 3 and 4.

Fig. 9 is a plan section taken on line 9–9 of Figs. 1, 2, 3 and 4.

Fig. 10 is a bottom view of the cellar or pot.

Fig. 11 is a detail plan view of the clamp ring.

Fig. 12 is a side view of the plan shown in Fig. 11.

Fig. 13 is a detail showing the method of securing the lower end of the turn buckle rod.

Fig. 14 is a fragmentary detail showing the matter of attaching a turn buckle rod.

The substructure for the marine oil well derrick in this case is substantially entirely of metallic construction made up of standard structural shapes assembled into a unitary structure of great rigidity and presenting a minimum surface to wave impact.

It will be observed that the structure is substantially completely symmetrical. It is substantially identical on all four sides except in minor details hereinafter more specifically specified.

The functional elements of this structure are four corner piers, tied together in a number of bays 6, 7, 8 and 9 by means of internal and external trusses of tension and compression members. Above the water line, the construction may be welded. Below the water line, it is preferably clamped and bolted. These are thus formed into compound columns.

Centrally disposed of the four corner piers is a ring of vertical structure members, such as H-beams, all tied together by means of structural shapes, such as angles, gussets and plates. This forms a compound column of substantial diameter. The H-beams of this ring are connected to the corner piers by connecting members. Positioned on the center ring of H-beams is a cellar or pot. In turn, this pot is connected by means of supporting angle braces to the corner H-beams. Through the center of the pot runs the conductor pipe surrounded with a concentric caisson whose function is to seal this pipe above and below the water line. This caisson is supported by means of tension members from the corner piers. The derrick is supported upon the pier by means of plates. The floor is, in turn, supported by these piers and also the center ring of the H-beams. The rotary table is carried upon certain others of the central ring of H-beams. A scupper is positioned beneath the floor and is preferably rigidly connected to the corner piers and to the central ring of H-beams. This scupper is made of sheet steel. The center of the scupper is provided with a hole which registers with the pot.

Describing the structure in detail and referring to the figures:

The piers 1 are composed of four vertical H-beams 2, 3, 4 and 5, each driven into the submarine floor through the water 191, sand 150 and into the shale 149, until the beam can be driven no further, i.e. to refusal. Sixteen H-beams are thus driven appropriately spaced. The connection and cross-bracing of these vertical H-beams will depend upon the particular conditions to be met and the illustration herein given is merely a description and is not to be taken as limiting. As illustrated, H-beams 2, 3, 4 and 5 of the four piers thus constructed are connected in four bays 6, 7, 8 and 9.

In bay 6 they are connected by two angles 10 on the front and back of the structure, and two angles 11 on the two sides of the structure. The two angles 11 are longer than the two angles 10. At the bottom of bay 6, the columns 2 and 5 are connected by I-beams 13 attached at their upper side to 2 and 3 by means of angle 14 and on their underside by means of angle 21. 5 and 6 are similarly connected by means of a beam 15 and angles 16. 3 and 4 are similarly connected by beams 17 and angles 18. 2 and 3 are similarly connected by beam 19 and angles 20.

In bay 7 the beams 2, 3, 4 and 5 are connected by the four I-beams 22 connected to their respective H-beams by angles 23 and 25. Between the sides in bay 7 are the angle braces 24.

Bay 8 is of substantially the same construction as bay 7 and is composed of horizontal braces 26 formed by I-beams and con.
The under water construction in bay 9 is composed of clamps and cross-tension turn buckle rods. The clamps are composed of an upper clamp bar composed of inner clamp plates 30 and 31 and outer clamp plates 32 and 33. These are clamped to the vertical H-beams by means of outer clamp bolts 34 and inner clamp bolts 41. These are rigidly clamped to the vertical H-beams by means of nuts 53. The inner nuts have the function of both clamping the plates and also limiting the amount of pull on the vertical H-beams. On the elevation of the structure are provided turn buckle rods 40 which are connected between the clamp plates 30 and 37 and 31 and 34 and clamped by means of nuts 35 on bolts 34. In the side elevation will be seen the cross-connecting members 42 which are cross-connected between the bolts 41 on the outer face of the clamp plates 33.

The cross-connection between the piers thus constructed will be next described.

The cross-connection at the top of bay 6 has been described. The cross-connection at the bottom of bay 6 and top of bay 7 is best illustrated in Fig. 6 and in the vertical sections and elevations 1 to 4, inclusive. Between the beams 2 is a cross-connection I-beam 43 and a similar I-beam 44. Connecting the beam 19 and the beam 43 is a gusset plate 45. The four inside beams 44 are connected by a gusset plate 46. Cross-connecting beams 43 and 44 are connected by means of a beam 47 and gusset plates 48 and 49. Between the gusset plates 45 and 49 are angle braces 50. The beams 44 and 43 are connected with the H-beams 2 and 3 by means of the angles 51. The beams 43 and 44 are connected to the H-beams 2 and 3 on the underside of beams 43 and 44 by means of angles 52.

The bottom of bay 7 is connected in the fashion more specifically shown in plan of Fig. 7 and front and side elevation and section in Figs. 1 to 4. The cross-connections are composed of I-beams 53 connected by angles 54 and 55. I-beams 56 are connected by angle 57. Cross-connecting beams 58 are connected to 56 by gusset 56 and to beam 53 by gusset 59. Between the beams 43 and 53 are the external cross-connecting angles 61 and internal cross-connecting angles 62.

The bottom of bay 8 is shown more clearly in Fig. 8 and on Figs. 1 to 4. This bay resembles Fig. 6 more nearly than it does Fig. 7. The outside cross-connecting I-beam 63 and the inside I-beam 66 connect the vertical H-beams 2, 3 and 4. The beams 63 are connected by means of angles 64 to H-beams and the beams 66 are connected to the H-beams by angle 67. The beams 63 and 66 are connected by gusset plate 65 and the beams 66 are connected by gusset plates 106. The beams 63 and 66 are cross-connected by beam 68 to beam 63 by gusset 69 and to beam 66 by gusset 70 and angularly cross-braced by beam 71 connected to gussets 65 and 70.

The under water construction is more clearly shown in Figs. 9, 1 and 4, inclusive.

On front elevation, the H-beams are connected by angle 73 clamped onto the plates 75 and on the side elevation by means of an angle 77 clamped to the plates 33 by means of bolts 34. Between the beam 63 and the angle 73 are two tension members composed of turn buckle rods 75. To the underside of beam 63 are attached brackets 76 and clamped between plates 38 and angle 73 are two additional brackets 74. Between these brackets are braced the turn buckle rods 75. In a like manner, on the side elevation are turn buckles 78 connected to brackets 79 and to bolts 34.

The internal construction of the structure will be described next.

As stated before, eight H-beams are driven into the shale to refusal in the form of a ring centrally disposed of piers 1. These beams are numbered 80. Their inter-connection and integral construction will be described by reference to Figs. 6, 7, 8 and 9, as previously mentioned. At the bottom of bay 6 (see Fig. 6) the H-beams 80 are connected by means of H-beams 81 connected and held by angles 82. These angles are in turn connected by means of gussets 83 forming a rigid eight-sided figure. Angular I-beams 87 are provided between the gussets 86 and 83. The H-beams 80 are connected to the beams 44 by means of beams 84 tied to the beams 80 by means of angles 85 and to the beams 44 by means of gusset plates 86.

At the bottom of bay 7, that is, at the top of bay 8, the H-beams 80 are connected by the channel members 86 and are held by U-clamps 92. These members are in turn connected to each other by means of angle 90 and channel braces 91. The channels 88 are connected to the beams 56 in firm fashion by the angles 89. Between the channels 88 and the I-beam 81 are the cross-angular braces 88'.

At the bottom of bay 8, that is, at the top of bay 9, (see Fig. 8), the internal ring is connected in the following fashion:

The H-beams 80 are connected by means of angles 93 which are, in turn, connected by gussets 94. The beams 80 are cross-braced by means of braces 95. In bay 9 the central ring is interconnected by the deformed channels 96 held to the beams 80 by means of U-bolts 96 and to the clamp bars 92 by through bolts 97.

I will next describe the positioning of the sump, pot or cellar 98. It is the function of this pot to act as a reservoir for the drainage from the scupper 117 and also to act as a...
supporting means for the Christmas tree and other arrangements used in completing the oil well and to provide for the manipulation of the valves and in general to function as the cellar for the oil well. This pot is shown in bottom view of Fig. 10 and in section on Fig. 4. It has a flange 99 of size to register with the opening and supporting structure of the beams 81 (see Fig. 6). At the bottom of the pot is a hub 100 to receive the conductor pipe and caisson 45° lugs 101 and I-beam pads 102 containing tapered holes 103. The pot is positioned on the inside of the opening so that the flange 99 rests upon the I-beams 81 and gussets 85 and 83' to which it is attached by appropriate means. The pot is preferably of cast iron. To the lugs 101 are connected angular braces 105 which are, in turn, connected to gussets 106, (see Fig. 8).

Referring to Fig. 7, the horizontal bracing I-beams 104 connect the pads 102 to the beams 56 by means of gusset 60. In this manner, the pot is permanently and rigidly attached. Registering with the opening of the pot 98 is an inclined scupper 117 (see Fig. 4 and also Fig. 5). This is made of sheet steel and is permanently and rigidly affixed to the beams 2, 3, 4, 5 and 80, and preferably rigidly affixed to the pot 98. Through the hub 100 and forming a snug fit therewith is driven an outer pipe 107 and by means of a drive point into the shale. It is welded or otherwise permanently and tightly attached to the pot 98. Through this outer pipe or caisson 107 is driven an inner conductor pipe 132 after sand and some of the shale had been excavated from the inside of pipe 107. The pipe 132 is then cemented within the pipe 107 from shale to pot. The caisson is supported from the corner piers in the following fashion: At the level of the top of bay 9 is positioned a concentric flange ring 109, (see Figs. 11 and 12). It is composed of two parts and has a flange 109 and a hub 108 and 45° lugs 110. It is clamped to the pipe 107. Between the lugs 110 and the beam 3 is a tension turn buckle rod 112. At its upper end the rod is connected by means of through bolts to lugs 110 and is connected at its lower end to beam 5 by means of an angle 113 formed at the end of the clamp bar 38, (see Fig. 19). The pin and cotter 114 near the bottom of bay 9 is a like ring 109 which is connected to the top of bay 9 by means of tension turn buckle rods 115. These are connected to the 45° lugs 110 and to the H-beams 3 by means of a bracket 116, (see Fig. 14).

The floor construction will be next described by reference to Figs. 1 to 4 and particularly to Fig. 5. The piers are capped by means of cap 119 held to the beams 2, 3, 4, and 5 by means of angles 11 and 120. The caps are interconnected by means of I-beams 121 and 122 held by means of the U-bolt clamps 123. To the underside of beams 121 are connected the cross-beams 124 by means of gussets 125. Between the beams 122 and passing over the beams 124 are cross-beams 128 connected to the beams 122 by means of gussets 129 to channels 124 by gussets 125 and to the H-beams 80 by means of angles 130. In a similar manner, channels 124 are connected by means of angles to the H-beams 80. Between the inside four beams 80 are laid cross-beams 127 connected to the beams 80 by means of angles 126. Across beams 127 is laid the supporting structure 131 upon which is to be positioned rotary table 134.

The drill pipe 140 passes through the casing 134 through the conductor pipe 132. At the end of the drill pipe is a bit 141 of conventional design. The derrick 135 is positioned on the caps 119 and carries, as is usual, a crown block 136, a swivel block 137, swivel hook 138 and swivel 139. The pier 118 surrounds the whole structure and on the pier is positioned a mud trough 145 and a mud pump 142 which is connected to the mud trough 145 and by means of flexible hose 143 to the swivel 139. The mud is pumped by means of pump 142 through the hose 143 through the swivel 139, the drill pipe 140, the drill 141, up the conductor pipe 132 through the overflow 144 back to the mud trough 145. Any drilling fluid collecting on the floor 148, which floor is positioned on the beams 128 and 121, drops on the scupper 117, is directed into the pot 98 and is removed by pipe 146 and pump 147.

It will be observed that this device provides a rigid foundation for the derrick, capable of carrying the tremendous loads incident to drilling operations. It will be observed that the loads are transmitted via the legs of the derrick to the corner piers. The load on the rotary table, especially at such times as when the drill string hangs in the slips of the rotary table, is carried by certain of the H-beams of the central ring. During drilling, the load is on the corner piers. It will be further observed that the drilling fluid and oil is carefully segregated. For this purpose a scupper 117 and a pot 98 is provided. As stated before, the scupper has the additional function of acting as a buffer to prevent the uplift of the floor and the inundation of the floor by the running seas. The cementing of the conductor pipe, both above and below water line, prevents seepage of water into the well bore and during drilling it avoids the passage of drilling fluid through the conductor pipe and seepage into the ocean and resultant solution.

The above description is not to be taken as limiting but as merely illustrative of the invention. Many modifications will suggest themselves to the man skilled in the art within the scope of my invention which I claim to be:
1. A marine oil well derrick comprising a plurality of vertical beams extending into the ocean bottom, structural shapes for tying said beams into a plurality of compound columns to act as piers, a derrick mounted on said piers, means to interconnect said piers to form a rigid foundation, a plurality of vertical structural shapes extending into the ocean bottom tied together in a compound column disposed centrally of said piers, means for interconnecting said center column with said piers, a metallic pot centrally disposed of center compound column and carried thereby, a caisson concentric with said pot and carried by said piers, and a conductor pipe cemented within said caisson above and below water line.

2. A marine oil well derrick comprising a plurality of piers extending into the ocean bottom, a derrick mounted on said piers, a plurality of structural shapes driven into the marine bottom in a ring centrally disposed of said piers, means for interconnecting said ring and said piers, a metallic pot centrally disposed of said ring and carried thereby, a caisson concentric with said pot and a conductor pipe cemented in said caisson above and below water line.

3. A marine oil well derrick comprising a plurality of vertical beams extending into the ocean bottom, structural shapes for tying said beams into a plurality of compound columns to act as piers, a derrick mounted on said piers, means to interconnect said piers to form a rigid foundation, a plurality of vertical structural shapes extending into the ocean bottom tied together in a compound column disposed centrally of said piers, means for interconnecting said center column with said piers, a metallic pot centrally disposed of said center compound column and carried thereby, a floor for said derrick supported by said piers, a sub-floor for said derrick supported by said piers and an opening in said sub-floor registering with the opening in said pot.

4. A marine oil well derrick comprising a plurality of piers, a derrick mounted on said piers, a plurality of structural shapes driven into the marine bottom in a ring centrally disposed of said piers, means for interconnecting said ring and said piers, a metallic pot centrally disposed of said ring and carried thereby, a caisson concentric with said pot, a conductor pipe cemented in said caisson above and below water line, a floor for said derrick supported by said piers, a sub-floor for said derrick supported by said piers and an opening in said sub-floor registering with the opening in said pot.

5. A marine oil well derrick comprising a plurality of piers, a derrick mounted on said piers, a plurality of structural shapes driven into the marine bottom in a ring centrally disposed of said columns, means for interconnecting said ring and said piers, a metallic pot centrally disposed of said ring and carried thereby, a caisson concentric with said pot, a conductor pipe cemented in said caisson above and below water line, a floor for said derrick supported by said piers, a sub-floor for said derrick supported by said piers and an opening in said sub-floor registering with the opening in said pot.

6. In a marine oil well derrick, in combination, a plurality of piers consisting of one or more vertical beams driven into the ocean bottom, a plurality of structural elements positioned within the ocean bottom and contained within said first mentioned piers, structural elements connecting said first mentioned structural elements to said piers, a metallic pot carried by said first mentioned plurality of structural elements, a caisson carried within said first mentioned plurality of structural elements and connected to said metallic pot, a conductor pipe within the caisson and a derrick disposed upon said piers.

7. In a marine oil well derrick, in combination, a plurality of piers consisting of one or more vertical beams driven into the ocean bottom, a plurality of structural elements positioned within the ocean bottom and contained within said first mentioned piers, structural elements connecting said first mentioned structural elements to said piers, a metallic pot carried by said first mentioned plurality of structural elements, a caisson carried within said first mentioned plurality of structural elements and connected to said metallic pot, a conductor pipe within the caisson and a derrick disposed upon said piers.

Signed at Los Angeles, in the county of Los Angeles, and State of California, this 28th day of August, A. D. 1930.

CHARLES L. ROBERTS.