July 26, 1932. L. B. COLLINS 1,868,494

STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

Filed Dec. 9, 1930 5 Sheets-Sheet 1

Fig. 1.

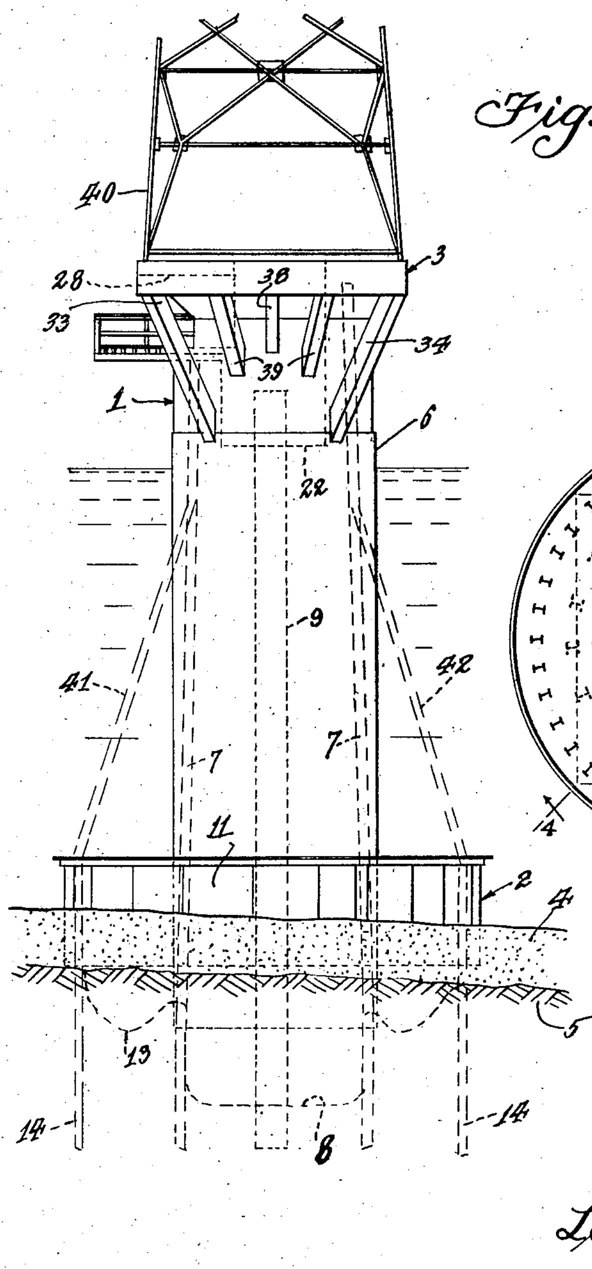
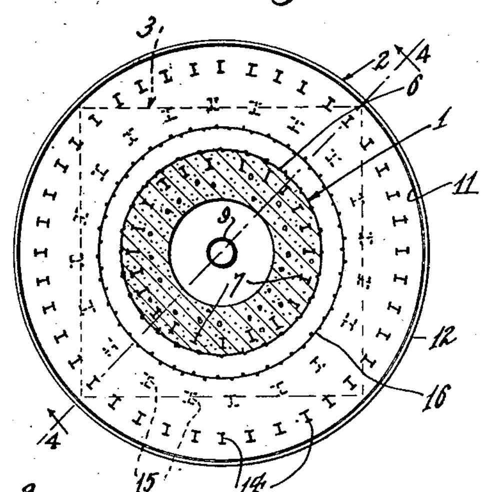


Fig. 3.



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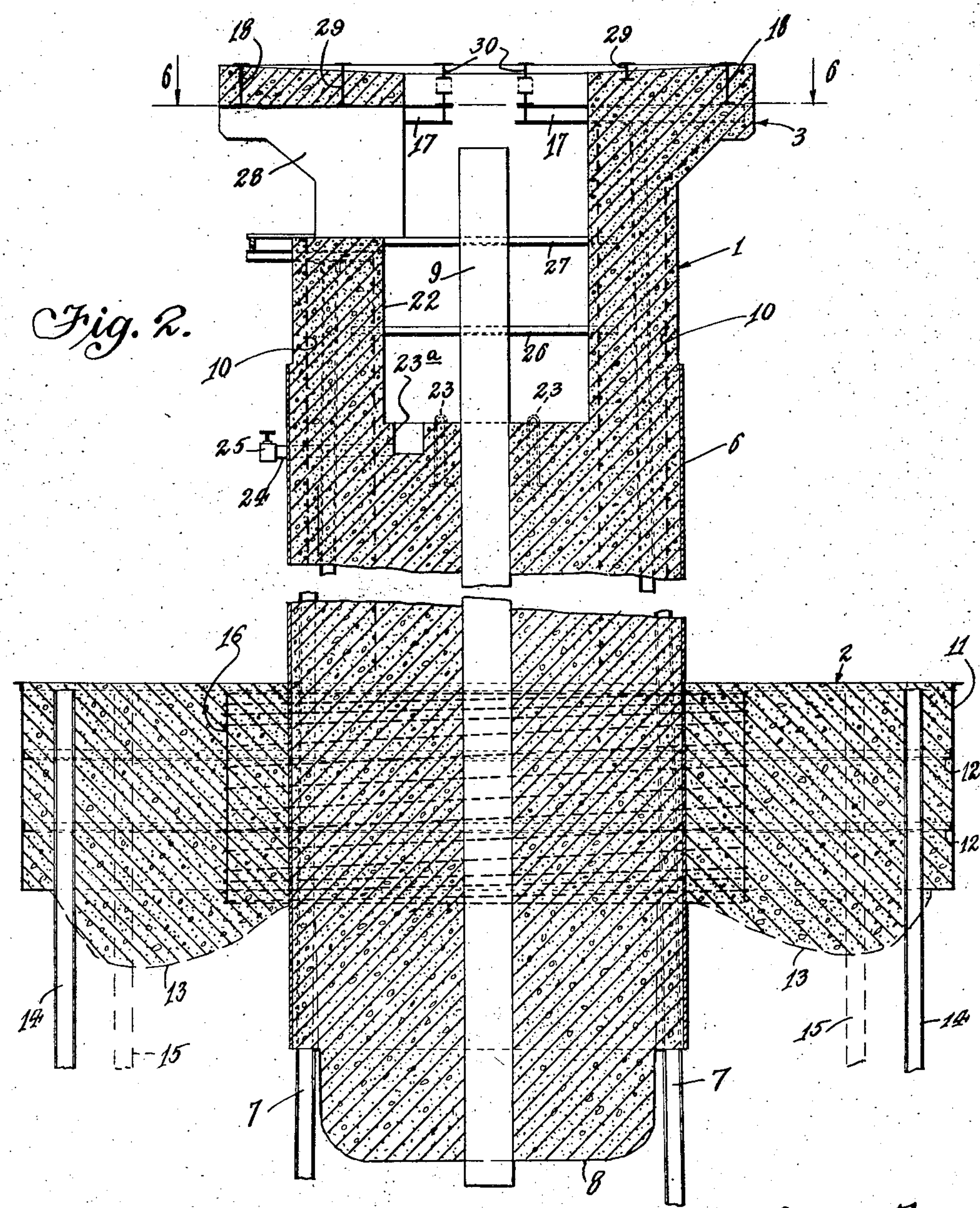
STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

Filed Dec. 9, 1930 5 Sheets-Sheet 2



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STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

Filed Dec. 9, 1930 5 Sheets-Sheet 3

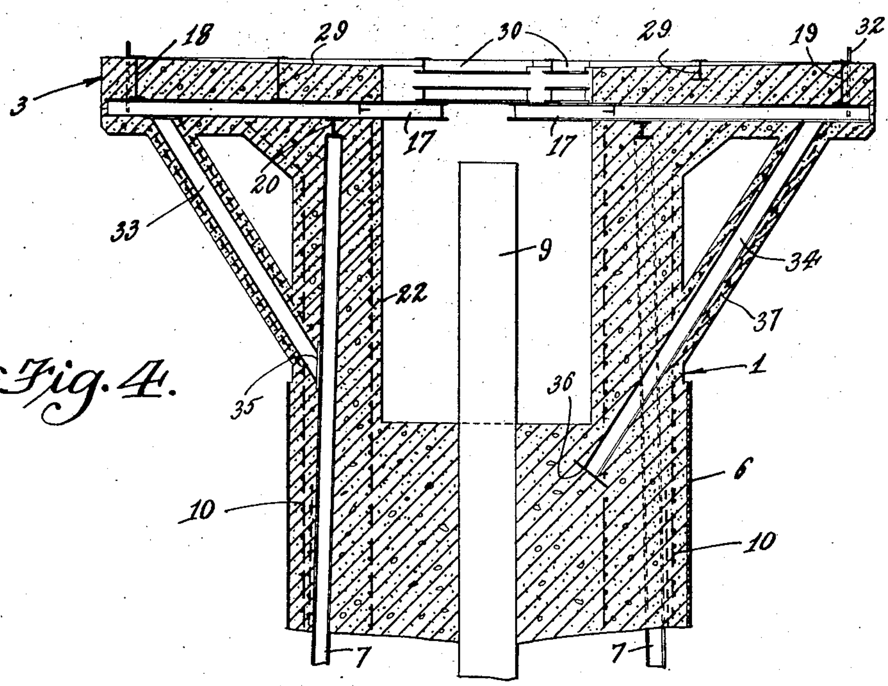


Fig. 4.

Fig. 9.

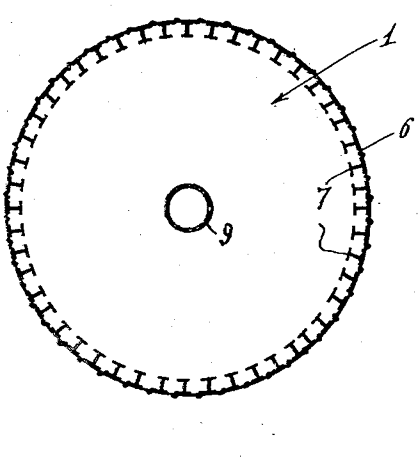
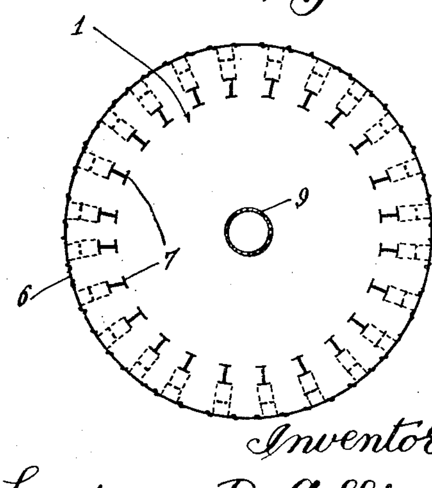


Fig. 10.



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STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

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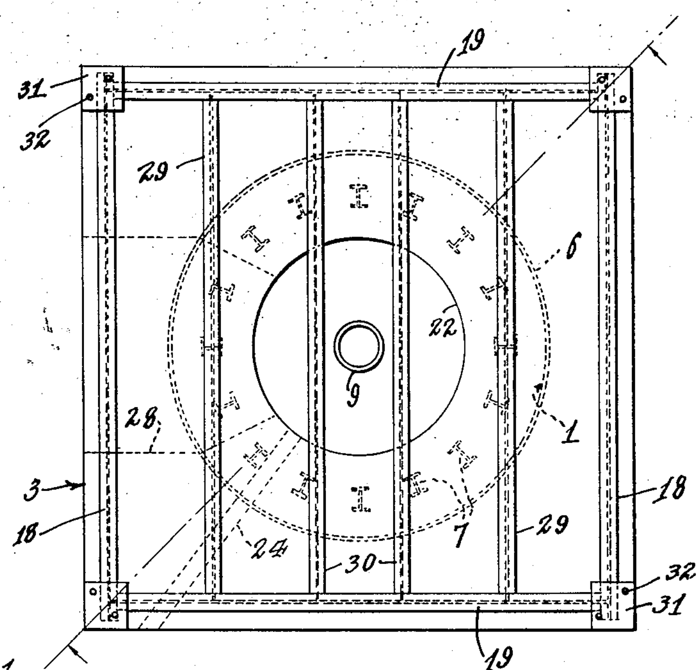
Fig. 5.



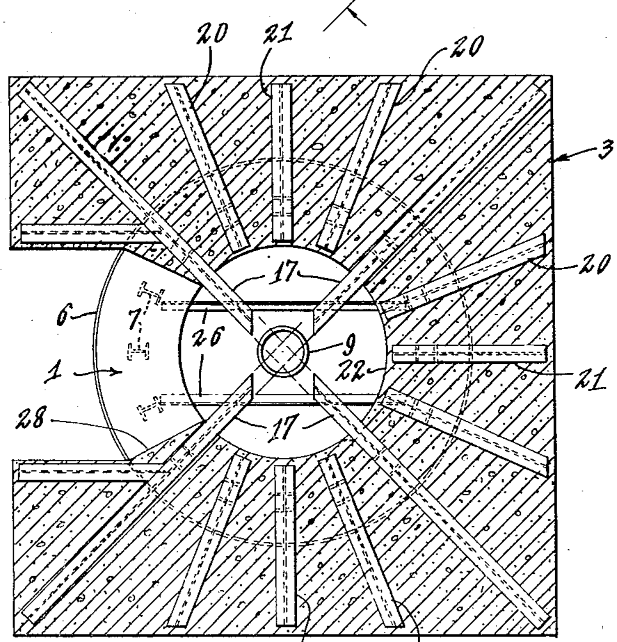


Fig. 6.

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STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

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Fig. 7.

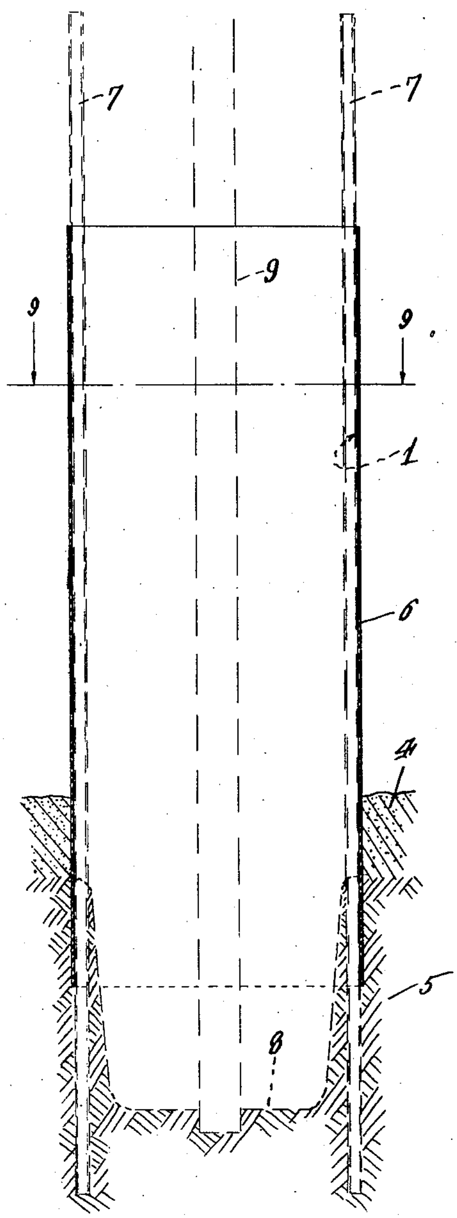
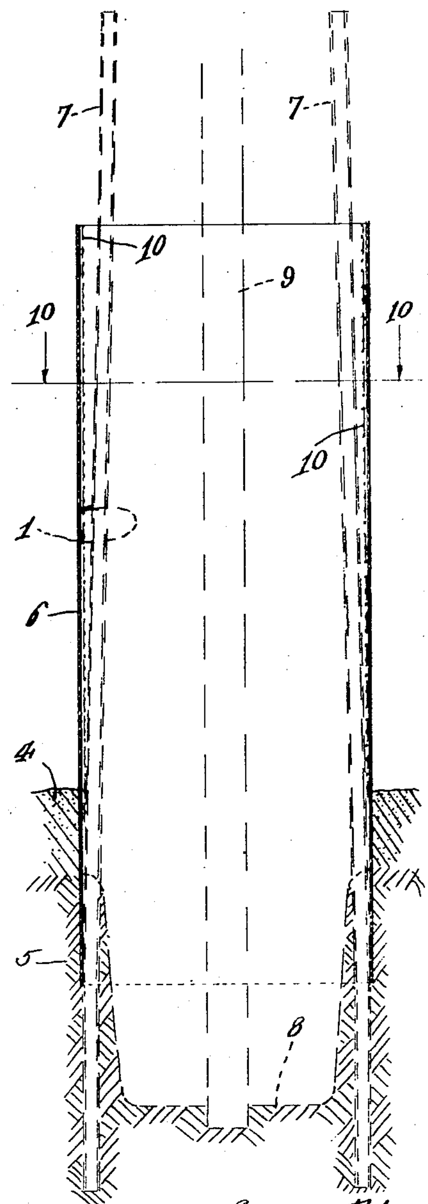


Fig. 8.



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Patented July 26, 1932 1,868,494

UNITED STATES PATENT OFFICE

LAWRENCE B. COLLINS, OF SANTA BARBARA, CALIFORNIA

STABILIZED FOUNDATION CONSTRUCTION AND METHOD OF ERECTING THE SAME

Application filed December 9, 1930. Serial No. 501,033.

This invention relates to a foundation construction adapted for use under varied conditions, but particularly adapted for underwater foundation structures intended to support heavy static and live loads, and subject during construction and thereafter to lateral stresses such as are developed by wave action, swift stream currents, earthquake shocks or wind pressure upon the superstructure which the foundation is caused to carry.

The invention also relates to a method of erecting stabilized foundations whereby the sheathing and other temporary structures are supported and reinforced during construction so as to minimize danger from lateral stresses such as wave action, etc.

The stabilized foundation construction embodied in this invention may be applied to foundations for many different purposes. For example the construction may be utilized in bridges, lighthouses, radio beacons, electric transmission towers, piers, intakes and oil well foundations. For purposes of simplicity, the invention will be described in detail hereinafter in its adaptation to oil well foundations located in bodies of water where sudden violent wave action may occur at any moment during or after the construction of the foundation.

For some time geologists have recognized that oil bodies are located at considerable distances from shore, particularly along the Pacific coast of the United States. About 1900, oil wells were drilled at Summerland, California at a distance of about 100 feet from shore but these wells were extremely shallow sand being struck at a depth of only about 200 to 300 feet. In effect the wells were drilled on wooden piers extending from shore. Since that time, very little maritime drilling has been accomplished, two factors exerting a restraining influence on such drilling, namely, weights of tubing, casing and drill rods when wells of any appreciable depth are being drilled, and the problem of keeping oil, mud and other contaminating substances out of the water in accordance with statutory regulations. In addition, the problem of erecting structures capable of supporting the loads when said structures are exposed to wave action, has baffled the engineering profession.

This invention relates to a mode of construction whereby foundations adapted to support derrick structures as well as the weight of tubing, drill stem and casing, in tide waters, are provided. The stabilized foundation construction of this invention has proved to be adequate, simple and economical under the conditions encountered in drilling operation upon tide lines of the California coast.

An object of this invention is to disclose and provide a novel and preferred foundation construction adapted to be successfully completed and safely stand after completion, in locations where storm waves or stream currents or other forces would prevent the safe use of construction known hitherto.

Another object is to provide and disclose a construction which while furnishing adequate strength for the super-structure it is designed to support, still offers a greatly reduced area to the lateral forces of the classes above indicated, such forces tending to sway, overturn or break off the foundation.

A further object of this invention is to disclose and provide a method of operation whereby such construction may be rapidly and safely erected at a much lower cost than heretofore incurred for comparable structures.

It is an object of this invention to disclose and provide a structure of simple configuration, low surface area and high stability, said structure being particularly adapted for use in tide waters.

Another object is to disclose and provide a foundation structure which is thoroughly reinforced and in which the reinforcing is completely protected from the action of sea water by a cementitious casing.

Another object is to disclose and provide a cylindrical foundation adapted to be erected in tide waters, said foundation being particularly resistant to wave action by reason of a stabilizing ring surrounding the cylindrical foundation near the bottom thereof.

Another object is to disclose and provide a substantially cylindrical foundation for oil well derricks in tide waters in which a metal-to-metal contact and connection is established from the derrick to solid foundation on the ocean bottom.

Another object of this invention is to disclose and provide a marine foundation particularly adapted for oil well derricks which is of unitary character and particularly resistant to damage by earthquake or ground movement.

A still further object is to disclose and provide a maritime foundation in which the vital steel members are incased and thus protected from corrosion and fire.

A still further object is to disclose and provide a marine foundation for oil well derricks which is of a unitary character and free from braces and other members which increase the area at wave impact points and provide havens for sea growth and thus increase the resistance of the structure to wave action.

An object of this invention is to disclose and provide a method of constructing marine foundations in a rapid and economical manner.

These and other objects, uses and advantages of the invention will become apparent to those skilled in the art from the following detailed description of one preferred form which the invention may assume. It is to be understood that the subsequent detailed description does not limit the invention to the specific embodiment being described in detail merely for purposes of illustration and facility of understanding.

In describing the invention, reference will be had to the appended drawings, in which:

Fig. 1 is a side elevation of a foundation made in accordance with this invention and particularly adapted for use as a foundation for oil well derricks.

Fig. 2 is an enlarged vertical section of the foundation shown in Fig. 1.

Fig. 3 is a plan view of the foundation shown in Fig. 1, this figure diagrammatically illustrating the relative proportions of the column, stabilizing ring and head, as well as the location and arrangement of pile members.

Fig. 4 is an enlarged vertical section through the head and upper portion of the column, said vertical section being generally taken along plane indicated at 4—4 of Fig. 3.

Fig. 5 is a plan view of the floor or head carried by the foundations shown in Figs. 1 and 2 and 4 this figure particularly disclosing the location and arrangement of steel reinforcing members in said floor.

Fig. 6 diagrammatically illustrates the location of knee braces extending from the column and adapted to support the floor, said figure representing the arrangement of structural elements at and below a plane indicated at 6—6 in Fig. 2.

Fig. 7 is a diagrammatic representation of a vertical section taken through the column during construction thereof, this figure illustrating the arrangement of sheathing and piles before placement in concrete.

Fig. 8 is a vertical section diagrammatically illustrating the relative positions of sheathing and piles immediately prior to and during the placement of concrete within the sheathing.

Fig. 9 is a horizontal section taken along the plane indicated at 9—9 in Fig. 7.

Fig. 10 is a horizontal section taken along the plane 10—10 indicated in Fig. 8.

For purposes of simplification, the drawings appended hereto do not disclose a wharf structure leading out to the foundations to which this invention is particularly directed. Any suitable wharf structure extending into the ocean or other tide water may be employed.

However, it is to be understood that in accordance with this invention, the wharf structure is preferably not connected to the foundations of this invention. Instead, the wharf structure is preferably spaced away from the foundation a distance of 3 to 12 inches so as to permit the wharf structure to weave and sway under the action of waves and elements without transmitting stresses to the foundation proper. In other words, the foundation structure of this invention is a separate entity having no operative relation to the wharf with the exception of the necessity of having either a wharf or other means of communication with the foundation structure.

The principal elements of the foundations stabilized in accordance with this invention comprise a vertical columnar member generally indicated at 1, a stabilizer member surrounding the lower portion of the column and generally indicated at 2, and a top or head 3 adapted to permit the column 1 to support the desired super-structure in a required manner, as for example where the super-structure requires support over an area exceeding that of the columnar member.

In general, the vertical column 1 utilized in the stabilized foundation is a vertical column of substantially circular horizontal section and of substantially uniform diameter throughout its length. Said column is preferably made of concrete and may be steel incased up to about mean low water level. The top 3 of the column may include a suitable floor. Preferably the floor is of greater area than the horizontal cross section through the column so that the floor extends beyond the column. The column is preferably provided with the required number of vertical steel piles, which may take the form of H-beams, these piles being driven to refusal in a solid bearing foundation. The piles, as well as the sections of sheathing, if sectional steel sheathing is employed, may be buttwelded to each other so as to permit the piling, as well as the sheathing to be driven to depths of 50 feet and more into the bottom of the body of water in which the structure is erected.

Preferably the vertical piles extend upwardly and are intimately connected to the structural members in the head, top or floor 3. Portions of the floor or top extending beyond the column are supported by means of knee braces connected to the horizontal members in the floor and to the vertical piles.

The column 1 is designed with the required area of cross section and resistance to lateral bending to insure safe support for the intended load even when subjected to the lateral forces which may occur. The foundation, as a whole, derives its unusual steadiness against side sway and overturning from the stabilizer constructed about its lower portion in the manner shown in the drawings and hereafter described in greater detail. It has been found that the structures constructed in accordance with this invention are particularly resistant to wave action and will not sway or weave even when erected in depths of 60 to 70 feet on exposed sea-coasts, where the bottom for a distance of 20 or 30 feet is composed of clay and loose gravel underlaid with shale.

As shown in Fig. 1 the column 1 is erected in a body of water having on its bottom a layer 4 of clay, sand or other unstable material, and an underlying layer 5 of sound bearing foundation such as shale, rock or the like. In constructing the column 1, the mode of operation preferably followed is that diagrammatically illustrated in Figs. 7 to 10 inclusive. Sheet piling indicated at 6 is first driven into the sound foundation material 5 to a desired depth. The sheet piling 6 is preferably of interlocking character. In this manner the ring of sheet piling is formed. Vertical steel piles 7 are then driven into the solid foundation 5 to a greater depth than the depth to which the sheet piling 6 have been driven.

Furthermore, the steel piles 7 are driven in within the ring and adjacent the inner surfaces thereof as indicated in Fig. 7, the steel piles 7 thus reinforcing the ring made from the sheathing 6 and maintaining such ring in position. The number and size of the steel piles 7 are, of course, dependent upon the location in which the columns are being constructed and the conditions encountered. By driving the piling 7 within the ring 6 and adjoining the inner surfaces thereof, the ring 6 is not subject to destruction by storms or wave currents which normally would retard construction to a very great extent.

It is to be remembered that the column 1 and the space within the sheathing 6 is to be filled with concrete, but before the placement of concrete the structure is subject to movement by even minor wave actions and the piling 7 steadies the column against sway under the action of horizontal forces until such time as the stabilizing member 2 (Fig. 1) has been formed around the column. Furthermore, the piling 7 affords convenient and effective means for supporting the elements used in forming the head or top member 3.

After the piling 7 has been driven in as described hereinabove, the foundation material within the coffer-dam or sheathing ring 6 is removed as by means of a clam shell or orange peel. Such excavation may be carried to below the lower edge of the sheathing 6 the depth of such excavation being diagrammatically shown at 8.

If the foundation is to be employed to support an oil well derrick, a conductor pipe 9 may then be placed centrally of the sheathing ring 6 and after the seepage water has been pumped out of the ring, the upper portions of the piles 7 are bent toward the center as indicated in Fig. 8 and reinforcing members in the form of a spiral or a plurality of rings introduced between the vertical piles 7 and the sheathing ring 6. Such reinforcing is generally indicated at 10. Concrete is then poured into the sheathing ring, preferably such pouring being continuous until low water level is reached.

The depth from which the column 1 may rise and still possess great stability without an unduly large diameter is much increased by the stabilizer member which in preferred form is constructed by lowering a circular steel plate shell 11 having the diameter appreciably greater than the diameter of column 1. The ringlike shell 11 may be made of bolted sections provided with internally extending ribs 12 formed of angle iron. The ring 11 is lowered onto the bottom and hammered or driven into place. The depth to which the ring 11 is driven depends upon the character of the upper layer 4 on the bottom of the body of water. Preferably the shell 11 is driven until it contacts with the firmer foundation 5.

The material within the ring 11 is then excavated, preferably such excavation indicated at 13 extending into the more solid foundation ground. Stub piles 14 and 15 may then be driven within the ring 11, such stub piles 14 and 15 being arranged peripherally near the outer portions of the ring 11. A cage of reinforcing bars 16 may then be suspended within the ring 11 at a point between the column 1 and the median of the ring 11, and such ring is then filled with concrete.

The effect of such a stabilizer is to prevent swaying of the column 1, the concrete as well as the piles 14 and 15 furnishing a key into the foundation, thereby absorbing any jar produced by the movement of the center column 1.

The concrete within the ring 11 contracts upon setting causing the entire ring to freeze onto the column 1 and hold it tightly.

Furthermore, the stabilizing ring 2 increases the bearing area to a certain extent. It is to be understood that a stabilizer such as has been described hereinabove may be applied to each of a number of columnar members, or may be of a size sufficient to include more than one column.

As has been stated hereinabove, the column 1 carries a top or head which includes a floor. During construction diagonal I-beams 17 are attached to vertical piles 7 either by the use of fishplates or by welding. These diagonal members 17 assist in holding the vertical piles 7 together. Upon these diagonals a flooring is constructed, said flooring preferably consisting of large peripherally arranged I-beams 18 and 19 which rest upon the diagonal girders 17 and are welded thereto. Additional radially extending members such as the members 20 and 21 are connected to the tops of the piles 7 and also to the lower sides of the girder members 18 and 19. This steel work in effect holds the piles in position during the pouring of the concrete in the column 1.

A well or cavity 22 is formed in the upper end of the column 1, the conductor pipe 9 extending into and terminating within the cavity 22. This well or cavity 22 provides a suitable chamber for the collection of drilling mud, overflow oil, drippings, and Schaffer or Oklahoma type safety valves. The well 22 is made of circular cross sections but similar wells or cellars have been used under derricks erected on land permitting the safety valves to be erected beneath the derrick floor. The well 22 on the foundation column 1 not only permits the safety valves to be installed beneath the derrick floor 3 but in addition the well 22 is made of sufficient depth so as to act as a mud tank.

In addition anchor bolts 23 may be embedded in the floor of the well 22 so as to provide means to which the Christmas tree and valve structure may be subsequently connected or anchored.

Means for draining the well 22 may be provided, including for example a sump 23ª and a downwardly inclined, outwardly directed conduit 24 provided with a valve 25. Transverse rods or channel irons 26 and 27 may be provided within the well 22, these channel irons or bars forming holds for workmen within the well.

An entry or opening may be formed beneath the floor 3 through the wall of the column 1 so as to permit communication with the well 22. Such an opening or entry is indicated at 28. For purposes of convenience the entry 28 may face the shore side of the structure.

A plurality of girders 29 and 30 may be carried within the peripherally disposed frame girders 18 and 19. The members 18, 19, 29 and 30 rest upon the diagonally and laterally extending members 17, 20 and 21, these latter members being in turn firmly connected to the tops of the vertical piles 7. All of these members are suitably encased in concrete thereby forming a roof extending over the entry 28 and protecting the steel work from the effect of fire.

Corner plates 31, as well as J-bolts 32 may be embedded near the corners of the floor 3 so as to provide a ready means of attaching the derrick to the floor.

The outer ends of the diagonal floor members 17 may be supported by means of knee braces, for example knee braces 33 and 34, said knee braces being connected to the horizontally disposed girders 17 by welding, by means of fishplates, or in any suitable manner and then connected to the vertical piles 7 in a similar manner as indicated at 35. Instead of connecting the lower ends of the knee braces, as for example the knee brace 33, to the pile 7, the lower end of the knee brace, as for example the knee brace 34, may be provided with a dead man or bearing plate 36, such bearing plate being buried in the mass of concrete constituting the center of the column 1.

It is to be understood that the corner knee braces, as the knee braces 33 and 34, may be encased in concrete, suitable reinforcing being employed around the knee braces as indicated at 37. Additional knee braces may connect the ends of the shorter radial members 20 and 21 with other vertical steel piles, such other knee braces being shown in Fig. 1 at 38 and 39. The shorter knee braces, and particularly the knee brace 38, may not necessarily be separately encased in the concrete but may merely be embedded in a concrete fin extending from the main cylinder 1. As shown in Fig. 1 the knee braces 34, 38 and 39 are of varying lengths, the angularity of such knee braces with respect to the vertical being substantially constant. In this manner only the knee braces 33 and 34 which connect the corners of the floor with the column are within the reach of the waves, whereas the majority of the knee braces are above the zone of the wave action.

The direct structure indicated at 40 rests upon the girders and joists 18, 19, 29 and 30, and is connected thereto by spot-welding and by means of the J-bolts 32. Attention is called to the fact that certain of the joists. such as for example the joists 30, extend over the well 22 thereby providing supports for the rotary table of the derrick.

After the structure described hereinabove has been suitably encased in concrete, the main diagonal girders 17 are cut away at their point of intersection above the well 22, such cut away portion being indicated in dotted lines in Fig. 6. This gives room for the casing, drill stem and other drilling tools which are used during drilling operations.

It will thus be seen that the derrick structure is comprised of a vertical column 1, a stabilizing ring 2 near the lower portion thereof, the stabilizing ring thereof being of appreciable greater diameter than the diameter of the column and having a depth of about ¼ to ⅓ of its diameter, and a head or floor. All the steel members are encased in concrete so that in case of fire the danger from buckling in said steel members is substantially eliminated.

Furthermore, the floor above the opening 28 in the side of the column 1 provides a safe working place for operators even though the well is on fire, thus greatly facilitating operations in cutting off or shutting down the well.

Furthermore, it is to be noted that substantially steel-to-steel contact exists throughout the entire structure from the derrick to the bottom of the piles thereby producing a unitary structure which is extremely resistant to side sway or lateral forces.

It is to be understood that in addition to the major steel members described hereinabove, additional reinforcing in the form of wire, deformed bars or gratings may be employed at various parts of the structure, but such reinforcing has been left out so as not to unduly complicate the drawings.

Again although certain piling has been described in detail, it is to be understood that the number, location and weight of the piling will vary the terrain in which the structure is being erected. When structures are being erected in tide waters, it is preferable that a greater number of piles be driven on the sea side of the structure than on the shore side.

Under certain conditions instead of employing the stub piles 14 and 15 in the stabilizing member 2 certain of the piles may be of much greater length, and these long piles may be bent as indicated at 41 and 42.

Those skilled in the art will appreciate that a mode of construction has been described which greatly facilitates the erection of supporting structures of great stability in exposed bodies of water where wave action hampers ordinary construction work. The sequence of operations described hereinabove has been found to greatly facilitate construction and as a matter of fact make it possible to erect structures under conditions which prevent the erection of foundations of the prior art.

Although the detailed description given hereinabove particularly relates to a stabilized foundation for use as a support for oil well derricks, it is to be understood that similar constructions embodying the invention may be employed for various other purposes. The invention is not limited to a construction precisely following that shown in the drawings but instead embraces all such changes and modifications which come within the scope of the appended claims.

I claim:

1. In a foundation construction the combination of a vertical concrete column provided with a well at its upper end, said column extending from above water level to below normal ground surface, steel piles in said column, said piles extending into sound foundation bearing beneath said column, a concrete floor carried by the top of said column and extending horizontally beyond said column, horizontally disposed girder members in said floor and connected to steel piles in said column, and a vertical conduit in said column communicating with said well.

2. In a foundation construction the combination of a vertical concrete column provided with a well at its upper end, said column extending from above water level to below normal ground surface, steel piles in said column, said piles extending into sound foundation bearing beneath said column, a concrete floor carried by the top of said column and extending horizontally therebeyond, a conduit extending substantially axially through said column and in communication with the well, and a port in the side of said column beneath said floor and in communication with said well.

3. In a foundation construction adapted for use in tide waters the combination of a vertical concrete column provided with a well at its upper end, said column extending from above high water level to below the normal ground surface below the water, steel piles in said column, said piles extending into sound foundation ground beneath said column, a vertical conduit in said column and in communication with the well, a concrete floor carried by the top of said column and extending horizontally therebeyond, horizontally disposed steel members in said floor, said horizontal members being connected to said vertical steel piles, and steel knee braces connected to peripherally positioned steel members in said floor and to vertical piles in said column.

4. In a foundation construction adapted for use in tide waters the combination of a vertical concrete column provided with a well at its upper end, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending horizontally therebeyond, horizontally disposed steel members in said floor, said horizontal members being connected to said vertical steel piles, and a concrete stabilizing ring surrounding said col-

umn adjacent to the lower end thereof, said stabilizing ring resting on the ground and extending thereinto.

5. In a foundation construction adapted to support oil well derricks in tide waters the combination of a vertical concrete column of substantially circular cross section and uniform diameter provided with a well at its upper end, said column extending from above high water level to beneath the normal ground surface, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending horizontally therebeyond, horizontally disposed steel members in said floor, said horizontal members being connected to said vertical steel piles, steel knee braces connected to peripherally positioned horizontal members in said floor and to vertical piles in said column, a vertical conduit in said column and in communication with the well, a port in the side of said column beneath the floor and in communication with said well, a sump formed in the bottom of said well, and a valved conduit extending from said sump to the exterior of said column.

6. In a foundation construction the combination of a vertical concrete column of substantially circular cross section and uniform diameter provided with a well at its upper end, said column extending from above water level to below normal ground surface, steel piles in said column, said piles extending into sound foundation bearing beneath said column, a concrete floor carried by the top of said column and extending horizontally therebeyond, horizontally disposed steel girders in said floor said horizontal girders being connected to said vertical steel piles, a vertical conduit in said column in communication with the well, a port in the side of said column adjacent said floor and in communication with said well, and a steel incased stabilizing concrete ring surrounding said column adjacent the lower end thereof, said concrete ring extending to below the normal ground surface and provided with vertical steel piles extending into solid bearing beneath said ring.

7. In a marine foundation construction the combination of a vertical concrete column provided with a well at its upper end, said column extending from above high water level into sound foundation ground, steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, a square girder framework in said floor, a plurality of parallel steel members connecting opposite sides of said framework in said floor, radially extending steel members surrounding said well in said floor, said radially extending steel members being connected to said vertical piles and to said framework in said floor, and means connected to said framework in said floor adapted to be connected to a derrick structure carried by said foundation.

8. In a maritime foundation construction for oil well derricks the combination of a vertical concrete column of substantially circular cross section and uniform diameter provided with a well at its upper end, said column being incased in sheet piling to above mean water level, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, a square framework of horizontally disposed girders embedded in said floor, a vertical conduit in said column in communication with the well, horizontally disposed radially extending members in said floor, said radially extending members resting on and connected to vertical steel piles and supporting and connected to said girder framework in said floor, steel knee braces connecting outer ends of said radially extending members to said vertical piles, and transverse girders connecting the opposite sides of said framework in said floor, said transverse girders extending over said well.

9. In a foundation construction adapted for use in tide waters the combination of a vertical concrete column extending from above high water level to below normal ground surface, said column being of substantially circular cross section and of uniform diameter and provided with a well at its upper end, said column being incased in sheet piling to above mean water level, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, radially extending horizontally disposed members surrounding said well in said floor, said horizontally disposed radially extending members being welded to the tops of said vertical piles, steel knee braces connecting the outer ends of said radial members with said steel piles below said floor, said knee braces being incased in concrete, a girder framework supported by said radially extending members connected thereto in said floor, and cage reinforcing in said column between said sheet piling and said vertical piles.

10. In a foundation construction adapted for use in tide waters the combination of a vertical concrete column extending from above high water level to below normal ground surface, said column being of substantially circular cross section and of uniform diameter and provided with a well at its upper end, said column being incased in sheet piling to above mean water level, ver-

tical steel piles in said column said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, radially extending horizontally disposed members surrounding said well in said floor, said horizontally disposed radially extending members being welded to the tops of said vertical piles, steel knee braces connecting the outer ends of said radial members with said steel piles below said floor, said knee braces being incased in concrete, a girder framework supported by said radially extending members connected thereto in said floor, cage reinforcing in said column between said sheet piling and said vertical piles, and a port in the side of said column and beneath said floor in communication with said well.

11. In a foundation construction adapted for use in tide waters, the combination of a vertical concrete column extending from above high water level to below normal ground surface, said column being of substantially circular cross section and of uniform diameter and provided with a well at its upper end, said column being incased in sheet piling to above mean water level, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, radially extending horizontally disposed members surrounding said well in said floor, said horizontally disposed radially extending members being welded to the tops of said vertical piles, steel knee braces connecting the outer ends of said radial members with said steel piles below said floor, said knee braces being incased in concrete, a girder framework supported by said radially extending members connected thereto in said floor, cage reinforcing in said column between said sheet piling and said vertical piles, and a stabilizing steel incased concrete ring supported on the ground surface adjacent the lower end of said column and surrounding said column, said concrete ring being keyed into solid foundation ground therebeneath.

12. In a foundation construction adapted for use in tide waters the combination of a vertical concrete column extending from above high water level to below normal ground surface, said column being of substantially circular cross section and of uniform diameter and provided with a well at its upper end, said column being incased in sheet piling to above mean water level, vertical steel piles in said column said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending therebeyond, radially extending horizontally disposed members surrounding said well in said floor, said horizontally disposed radially extending members being welded to the tops of said vertical piles, steel knee braces connecting the outer ends of said radial members with said steel piles below said floor, said knee braces being incased in concrete, a girder framework supported by said radially extending members connected thereto in said floor, a cage reinforcing in said column between said sheet piling and said vertical piles, a port in the side of said column and beneath said floor in communication with said well, and a steel incased concrete ring surrounding said column and adjoining the lower end thereof, said concrete ring being provided with vertical piles extending into sound foundation ground therebeneath.

13. A method of constructing stabilized foundations in bodies of water comprising driving a ring of sheathing into solid bearing foundation then driving steel piles within said ring and adjacent the inner surface thereof into solid bearing foundation, excavating material from within the ring of sheathing, bending the upper portion of said piles toward the center of the ring and then pouring concrete into said ring to fill the same and maintain said piles in bent position.

14. A method of constructing stabilized foundations in bodies of water comprising driving a ring of sheathing into solid bearing foundation then driving steel piles within said ring and adjacent the inner surfaces thereof into solid bearing foundation to reinforce and maintain said sheathing ring in position, excavating material from within the ring of sheathing, bending the upper portions of said steel piles toward the center of the ring, inserting reinforcing between said bent piles and ring of sheathing, and finally pouring concrete into said ring to fill the same and maintain said piles in bent position.

15. In a foundation construction adapted for use in bodies of water, the combination of a vertical concrete column provided with a well at its upper end, vertical steel piles in said column, said piles extending into sound foundation ground beneath said column, a concrete floor carried by the top of said column and extending horizontally therebeyond, horizontally disposed steel members in said floor, said horizontal members being connected to said vertical steel piles, a port in the side of said column beneath the floor and in communication with said well, and a concrete stabilizing ring surrounding said column adjacent to the lower end thereof, said stabilizing ring resting on the ground and extending thereinto.

Signed at Los Angeles, Cal. this 28th day of November, 1930.

LAWRENCE B. COLLINS.