May 26, 1964 L. B. PARKER ETAL 3,134,235

INSTALLATION OF PILING

Original Filed Nov. 12, 1959 4 Sheets-Sheet 1

FIG. 1.

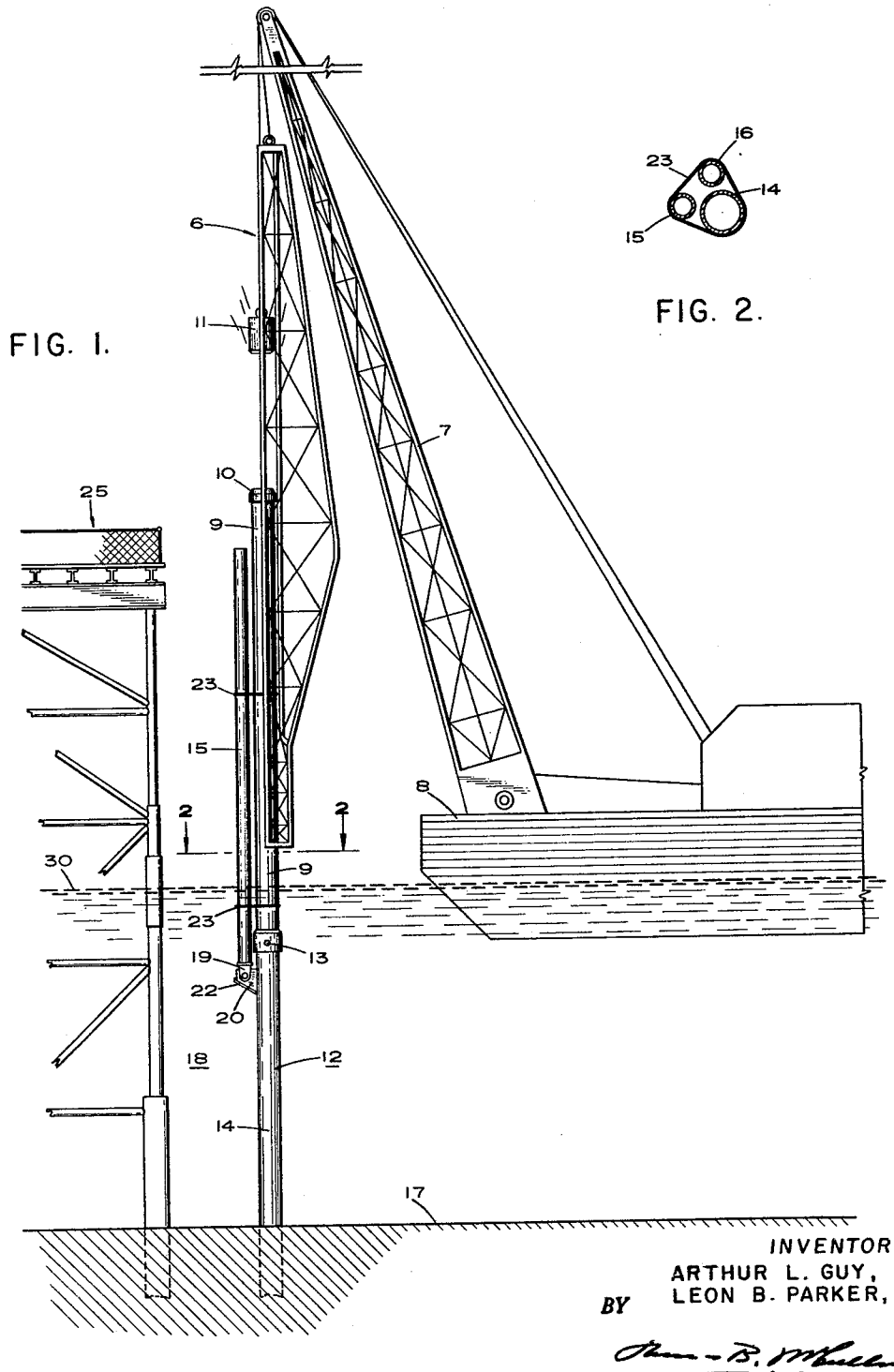


FIG. 2.

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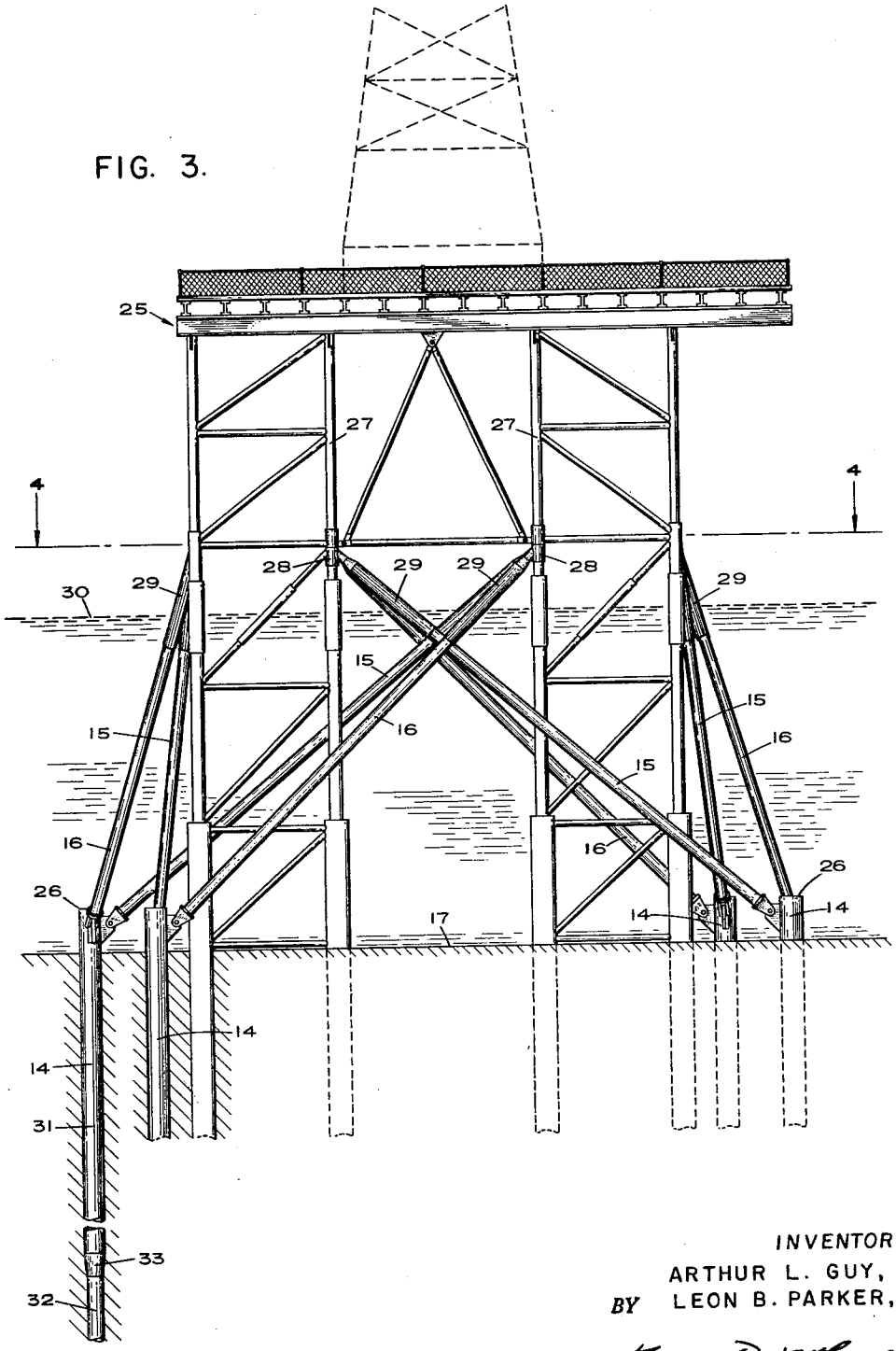
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INSTALLATION OF PILING

Original Filed Nov. 12, 1959 4 Sheets-Sheet 2

FIG. 3.



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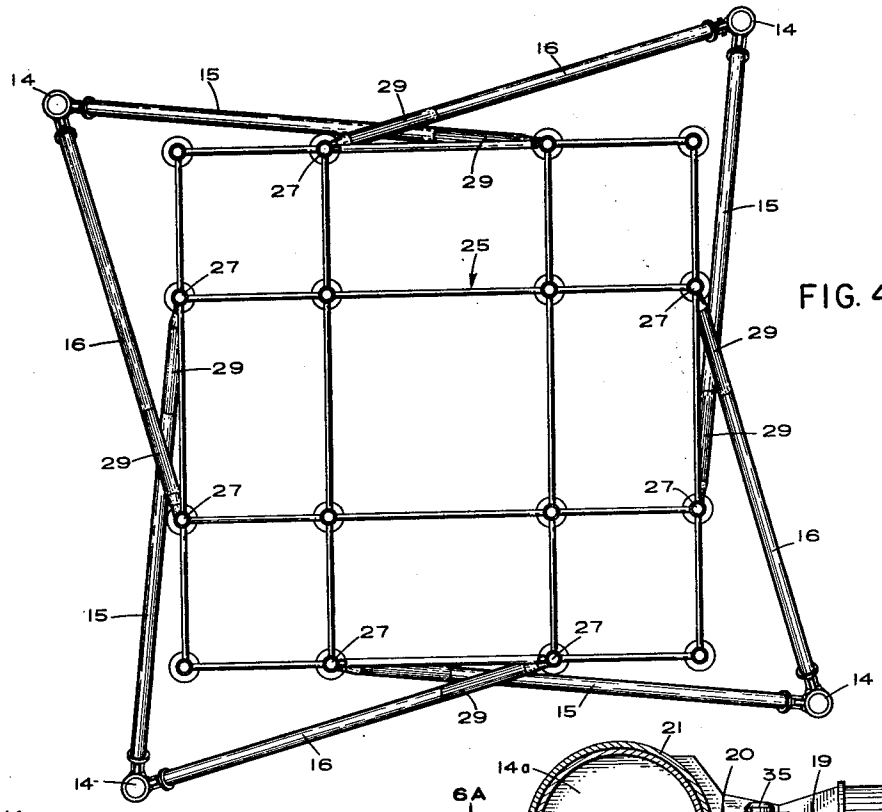


FIG. 4.

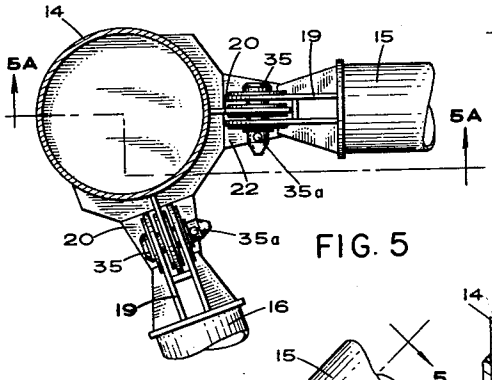


FIG. 5

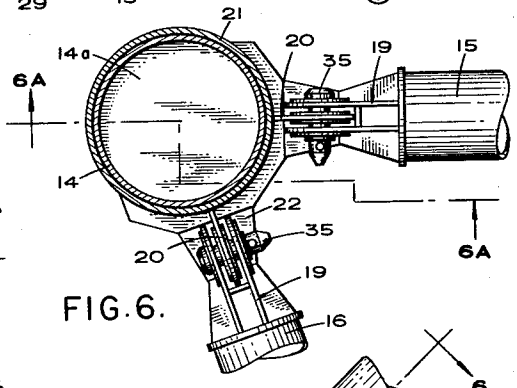


FIG. 6.

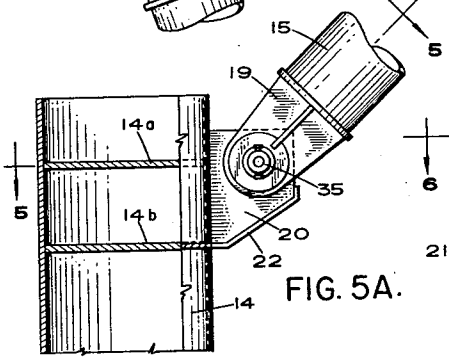


FIG. 5A.

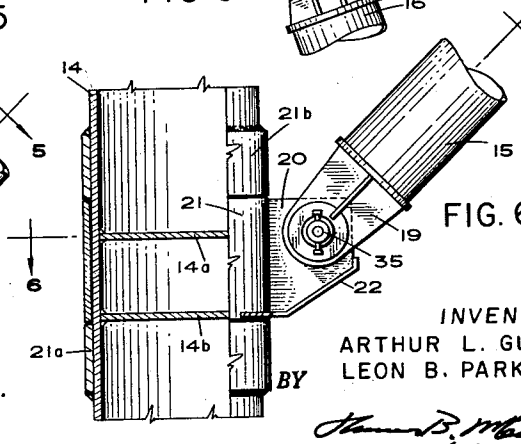


FIG. 6A.

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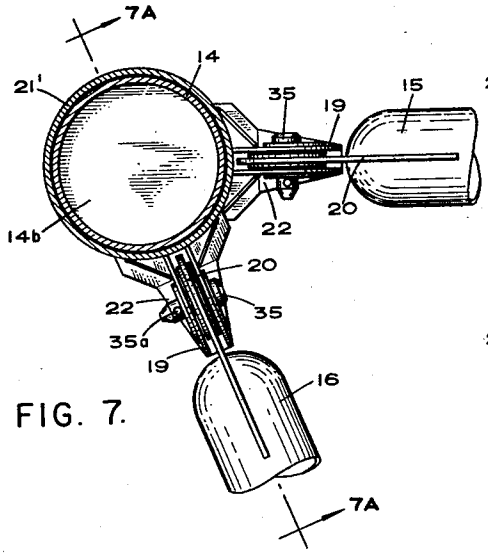


FIG. 7.

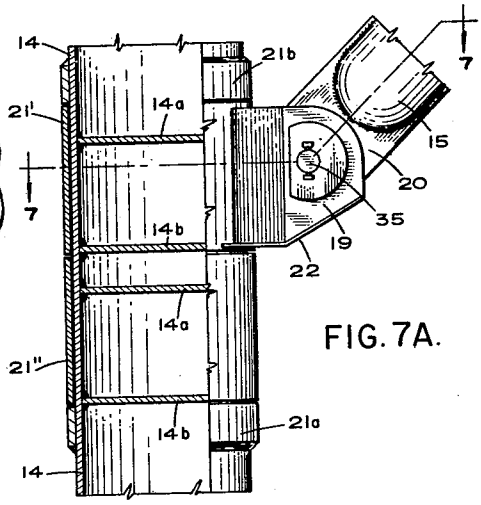


FIG. 7A.

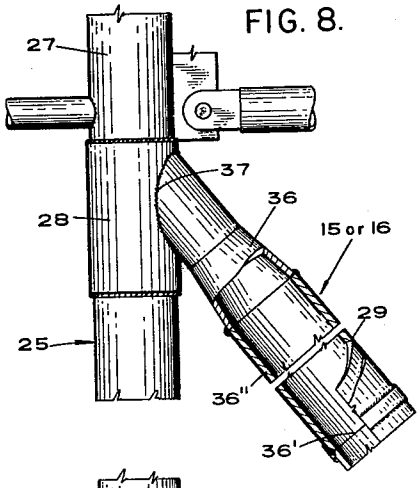


FIG. 8.

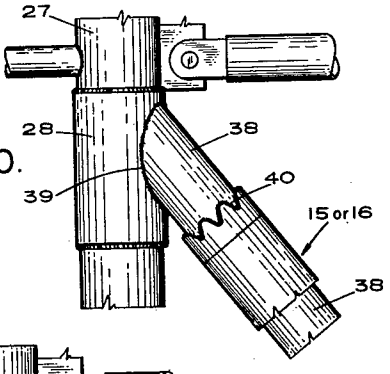


FIG. 10.

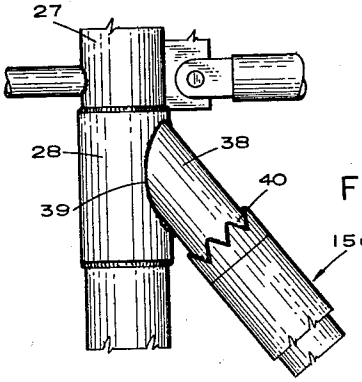


FIG. 11.

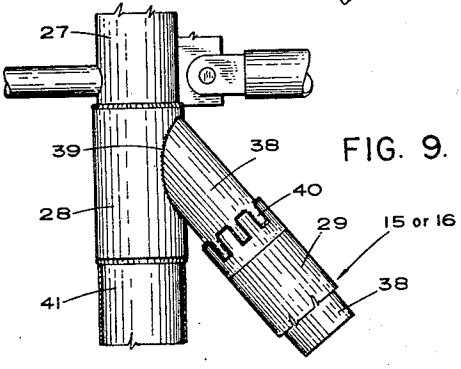


FIG. 9.

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United States Patent Office 3,134,235 Patented May 26, 1964

3,134,235

INSTALLATION OF PILING

Leon B. Parker and Arthur L. Guy, Houston, Tex., assignors, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware

Original application Nov. 12, 1959, Ser. No. 852,303. Divided and this application Aug. 17, 1960, Ser. No. 50,191

10 Claims. (Cl. 61—46)

The present invention is directed to a method for installing a piling assembly adjacent a marine structure. More particularly, the invention is concerned with the installation of auxiliary piling relative to a marine structure for bracing the structure. In its more specific aspects, the invention is concerned with a piling and strut assembly for strengthening a marine structure.

This application is a division of Serial No. 852,303, entitled "Method and Apparatus for Installing Piling," filed November 12, 1959, for Leon B. Parker and Arthur L. Guy, Jr.

The present invention may be briefly described as a method for placing and installing auxiliary piling relative to a marine structure for bracing the structure in which a piling and strut assembly is employed. The strut of the assembly is hingedly connected to the piling adjacent one end with the strut assembly folded upwardly substantially parallel to the longitudinal axis of the piling in driving position. The piling of the assembly has releasably connected to it at one end a driving mandrel and the piling is then spudded and driven into the marine bottom until the one end is adjacent the marine bottom and the free end of the strut is above water level. The mandrel is released and removed and the strut is unfolded and connected at its free end to the structure. The assembly is located and oriented in plan relative to the structure and the orienting of the strut may be performed before, after, or during spudding the piling into the marine bottom.

The invention also involves an assembly for strengthening a marine structure which comprises a piling having a ring arranged thereon adjacent one end. The ring may be fixedly arranged on the piling or it may be rotatably arranged on the piling. A strut is attached to the ring by a clevis means on one end of the strut and a pin means whereby the strut is hingeable and foldable to a position substantially parallel to the longitudinal axis of the piling, the free end of the strut being adapted for connection to the structure. The free end of the strut may be telescoped with one section movable relative to another section for connection to the structure or it may be formed into one member on connection to the structure.

The clevis means on the strut is adapted to matingly receive a plate member which is attached to the ring, and the clevis means and the plate member are each provided with a port through which the pin means is arranged for hingedly attaching the strut to the ring. The clevis and plate member for matingly attaching the strut to the ring may be reversed; i.e., the clevis may be on the ring and the plate member may be on the strut. Likewise, the clevis means may be adapted to receiving more than one plate on the mating part.

The piling is suitably tapered for lateral strength and for driving into marine bottom and the strut may also be tapered on its free end.

The marine structure may suitably be a platform, tower, caisson, piling or other offshore marine structures suitable for supporting drilling offshore well production structures and the like but not limited thereto. The marine structure may suitably be supported by upright members on which means are arranged which are vertically adjustable thereon. By attaching the free end of the strut to the vertically adjustable means, it is possible to adjust the

arrangement of the bracing structure for best utilization of the present invention.

It is contemplated that the struts may be partially or completely filled with concrete to provide strength and weight for the structure, and it is further contemplated that the struts of the present invention may be provided with a sleeve or jacket adjacent water level for protection against corrosion.

In the present invention a pile-founded bracing system for marine structures is provided which is installed without the use of divers. The bracing system of the present invention is suitably driven under water adjacent to an offshore drilling platform, for example, and then connected to the structure above water to provide structural integrity and to impart lateral strength. This is quite important in that wave forces encountered, for example in the Gulf of Mexico during a hurricane, are sometimes destructive to offshore drilling platforms. The present invention also provides for a complete preassembly of the bracing structures with the piles before installation and provides for the struts to remain affixed to the pile while driving. The present invention also provides a bracing system which affords a minimum projected area to wave forces.

In the practice of the present invention, the piles are located exteriorly to the corners and sides of a rectangular platform. Each pile and strut assembly comprises a pile with one or more struts hingedly attached by pins at their lower ends to plates which, in turn, are welded to the head of the pile or attached by pins to plates welded to a rotatable ring or rings. The rings in turn are affixed on the upper end of the pile but are prevented from moving along the pile by means of stop rings and other stop means. In the case of pile and strut assemblies located externally to the corners of a structure, the struts on each pile are inclined to intersect and connect to main vertical members of the structure, the vertical members lying in planes 90° apart. The upper or free end of the struts may suitably be connected to the vertical members above water by welding. The piles on each of the four corners are located in plan such that the struts on the same side of the platform cross over and pass each other with clearance. The struts may either be uniform in size or tapered at one or both ends, but preferably the free ends, while the piles may also be uniform in size or tapered toward the lower end.

The present invention will be further illustrated by reference to the drawing in which:

FIGS. 1 and 2 illustrate a pile driver located on a barge and in the process of driving a piling assembly;

FIG. 3 is an elevational view of an off-shore platform structure braced in accordance with the present invention;

FIG. 4 is a view taken along the line 4—4 of FIG. 3;

FIGS. 5 and 5*a* are views illustrating one modification of the attachment of the struts to the piling;

FIGS. 6 and 6*a* illustrate another modification of a strut attachment;

FIGS. 7 and 7*a* illustrate still another modification of a strut attachment.

FIGS. 8, 9, 10 and 11 illustrate various means for attaching the upper ends of the struts to the platform structure.

Referring now to the drawings and particularly to FIGS. 1 and 2, numeral **6** generally designates a pile driver assembly suspended from a boom arm **7** which is arranged on an offshore barge **8**. The driving assembly is provided with a driving mandrel **9** which has arranged in the upper end thereof an anvil head **10** which is contacted by a reciprocating hammer **11**.

The assembly **6** is shown in the process of driving a piling assembly **12** which is connected into the lower end of the driving mandrel **9** and held in place by a frangible

pin 13. The assembly 12 is comprised of a piling 14 and struts 15 and 16. The piling assembly 12 is being driven into the bottom 17 of a marine location 18. The struts 15 and 16 are connected to the piling 14 by a clevis 19 which matingly receives a plate 20 attached to piling 14. The plate 20 is provided with a strengthening flange 22. The struts 15 and 16 are suitably lashed into position by suitable lines 23. The lashing or line 23 is secured to the driving mandrel 9 to maintain the struts 15 and 16 in position for driving the piling 14 at the marine location 18 and to water bottom 17.

Referring now to FIGS. 3 and 4, piling such as 14 have been driven adjacent an offshore marine structure 25 until the upper ends 26 of the piling 14 are aligned adjacent the marine bottom 17, the struts 15 and 16 being attached by way of reinforcing sleeve 28 to the vertical supporting members 27 which are driven into the marine bottom 17. The struts 15 and 16 are suitably attached by welding directly to vertical supporting members 27 or by way of sleeves 28, which may be slidably or fixedly arranged on the supporting means 27. The free ends of the struts 15 and 16 are formed to be received matingly by the cylindrical surfaces of member 27 or the sleeves 28 and are suitably welded thereto. The struts 15 and 16 are also provided with jackets or sleeves 29 of corrosion-resistant material such as Monel for protection against corrosion since the sleeves are arranged above and below the water level 30 of the marine location 18. The struts may suitably be filled with concrete or other cementitious material and the like to provide mass to the structure and to provide the struts with greater resistance to damage resulting from both internally and externally applied forces such as stresses generated in the strut itself and from floating objects such as boats and debris.

As shown in FIG. 3, the pilings 14 is suitably constructed of an upper section 31, which is of constant diameter, and a lower section 32, which is of reduced diameter, connected by a conical section 33. In short, the piling 14 may taper downwardly and may be of several sections of different diameter but may have its outer wall tapering continuously downwardly.

Referring now to FIGS. 5 and 5A, the piling 14 has attached thereto by welding plate member 20 which is supported by flange supporting member 22, the struts 15 and 16 being supplied with clevis 19 which matingly receives the plate 20. Cooperating bores are provided in the clevis 19 and plate 20, respectively, and adapted to receive a pin member 35 which is inserted through the clevis member 19 and the plate 20 to hingedly connect the struts 15 and 16 to the piling 14. The pin member 35 is retained in place by a key member 35*a*. It is to be noted that the piling 14 is internally strengthened adjacent the point of attachment of the struts 15 and 16 by stiffening plates 14*a* and 14*b*.

In FIGS. 6 and 6A, a preferred form or embodiment is shown for attaching the struts 15 and 16 to the piling 14. In this embodiment, a ring 21 is rotatably arranged on piling 14 and is maintained in places by stop members or rings 21*a* and 21*b* which are welded or otherwise attached to piling 14. In this particular embodiment, the clevis 19 is attached to struts 15 and 16 and the plate members 20 is attached to the ring 21. Flange supporting member 22 is likewise attached to ring 21. By virtue of the embodiment of FIGS. 6 and 6A, orienting of the piling 14, before or during spudding, may not be required. However, it may be desirable to orient the piling 14 relative to the structure 25 so that the struts 15 and 16 are properly positioned and related thereto.

Referring to FIGS. 7 and 7A, rings 21′ and 21″ are rotatably provided on piling 14 and maintained thereon with stop rings or collars 21*a* and 21*b*. In this embodiment, the strut 15 is hingedly attached to ring 21′ while the strut 16 is hingedly attached to ring 21″. Also, in this emobdiment, the clevis 19 and plate 20 are reversed, a clevis 19 being attached to each of the rings 21′ and 21″ and strengthened with flange supporting member 22. The plate member 20 is attached to struts 15 or 16 and the plate member 20 and clevis 19 are provided with cooperating bores to receive pin member 35 which is held in place by key member 35*a*. It is to be emphasized that the clevis 19 and plate 20 may be used on either member, or in effect, clevises may be used on both members to provide additional strength at the point of hinged attachment.

In the several embodiments of FIGS. 5, 5A, 6, 6A, and 7 and 7A, strengthening plates 14*a* and 14*b* are provided. Plate 14*a* is located adjacent the pin 31 and plate 14*b* is adjacent the supporting flange member 22.

Referring now to FIG. 8, the strut 15 or 16 may be attached to the structure 25 as described hereinafter. In this embodiment, the tapered weldment member 36 with matingly formed end 37 is oriented, inclined and welded to member 28, arranged on the supporting member 27 such as to be in alignment with the strut 15 or 16 in final position. The strut 15 or 16 is then unfolded or moved and its free end 36′ cut away such as by a cutting torch to provide for rotation into alignment with the free end of member 36. A joining or splice member 36″ is then fitted into the space between members 36 and 36′ and the abutting ends of members 36 and 36′ welded to splice member 36″ to form an integral strut 15 or 16 braced and joined to structure 25. A Monel sleeve or jacket 29 is then placed about the upper end of the strut as shown.

Referring now to FIG. 9, which illustrates a preferred embodiment, the strut 15 or 16 is provided with a jacket 29 of Monel metal to protect the strut 15 or 16 from corrosion. Arranged in the upper end of the strut 15 or 16 is a telescopic member 38 which is movable relative to the strut 15 or 16 with the telescopic member 38 being formed at its free end 39 to receive matingly the sleeve 28, which may be vertically adjustable on the supporting member 27. After the strut 15 or 16 has been adjusted for attachment to the supporting member 27, the telescopic member 38 may be welded at points 40 to the struts 15 or 16 and the free end 39, in turn, welded to the sleeve 28 supporting member 27. It is to be noted that the points 40 provided a large surface for welding attachment by virtue of the toothed-shaped edge. It is contemplated that a saw-toothed or scalloped pattern may also be used.

FIGS. 10 and 11 illustrate various patterns of the welding points 40 which may be formed in the upper end of the struts 15 and 16 where they are connected to the telescopic member 38.

It is to be noted that the supporting members 27 are provided with sleeves or jackets 41 likewise constructed of Monel metal for protection of the structure against corrosion in the area above and below the water level 30.

The present invention is of considerable importance and utility in that it is possible to provide increased strength to existing marine structures or to reinforce newly constructed marine equipment. For example, it sometimes is desirable to drill additional wells from an offshore platform such as 25; but because of inadequate lateral strength, this cannot be done although adequate floor area for drilling such wells might be available. Also, the structure might not be sufficiently strong to withstand increased hurricane forces, including wind and water action, which are encountered in the Gulf of Mexico. The present invention provides a method and means for strengthening an existing structure or providing any structure with additional strength.

In the practice of the present invention, the apparatus such as illustrated in the drawing, including a pile and strut assembly, is fabricated on shore with the two struts folded and lashed together alongside the pile in the final upward direction. The assembly is accurately located in plan with relation to a corner of the platform or structure and is spudded into the ground. Previous to lifting

the pile and strut assembly 12 from a barge 8, shown in FIG. 1, a pipe-driving mandrel of appropriate length is inserted into the top of the pile and lashed to support the weight of the assembly while lifting it. The temporary connection between the mandrel and the pile may be frangible such that when the head of the pile is driven to below or adjacent mud level, a pull on the mandrel will shear the connection and allow retrieval of the mandrel without using divers. Before, after or during spudding, the pile is oriented accurately such that the struts will lie in the proper plane in the unfolded position. When rotatable rings are not used, orienting must be quite accurate, but when rotatable rings are employed, extreme accuracy of orientation is not required excepting that the struts be arranged on the side adjacent the structure. Thereafter, using a pile driver, the pile driving hammer is placed on top of the mandrel and the pile is driven under water until the strut connection is approximately located even with the soil or the marine bottom. The struts are unlashed from the mandrel and folded outwardly by virtue of the hinged pin at their lower ends and connected to the appropriate location on the marine structure such as by welding or by other means as may be desired. The mandrel is then removed from the top of the pile and the steps may then be repeated for the remaining pile and strut assemblies for the remaining corners of the platform or along its sides.

Piling driven in accordance with the present invention have withstood the enormous forces encountered during driving without endangering the connection. For example, accelerations which may be as much as 100 times gravity and forces ranging upwardly to 1,200,000 pounds have been withstood satisfactorily in driving and installing the present invention, as illustrated in the drawing.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and secure by Letters Patent is:

1. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling adjacent the upper end and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting a driving mandrel to said assembly, spudding and driving said assembly into marine bottom until said upper end of said piling of said assembly is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, releasing and removing said mandrel, and connecting said unfolded strut at its free end to said structure, said assembly being located and oriented relative to said structure.

2. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling adjacent the upper end and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting a driving mandrel to said assembly, spudding and driving said assembly into marine bottom until said upper end of said piling of said assembly is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, connecting said unfolded strut at its free end to said structure, and releasing and removing said mandrel, said assembly being located and oriented relative to said structure.

3. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling adjacent the upper end and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting to said upper end of said piling of said assembly a driving mandrel, locating said assembly in plan relative to said structure with the lower end of said piling on marine bottom, spudding and driving said piling of said assembly into marine bottom until said upper end is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, and connecting said unfolded strut at its free end to said structure, said assembly also being oriented relative to said structure.

4. A method in accordance with claim 3 wherein said mandrel is released and removed.

5. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting to said upper end of the piling of said assembly a driving mandrel, locating said assembly in plan relative to said structure with the lower end of said piling on marine bottom, orienting said assembly, driving said piling of said assembly into marine bottom until said upper end of said piling is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, and connecting said unfolded strut at its free end to said structure.

6. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, said assembly being provided with two spaced struts, the struts of said assembly being hingedly and rotatably connected to said piling and laterally offset thereof and the struts of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting to the upper end of the piling of said assembly a driving mandrel, locating said assembly in plan relative to said structure with the lower end of said piling on marine bottom, spudding and driving said piling of said assembly into marine bottom until said upper end of said piling is adjacent marine bottom and the free ends of said struts are above water level, unfolding and orienting said struts, and fixably connecting said unfolded struts at their free ends to said structure.

7. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling adjacent the upper end and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises releasably connecting to said upper end of the piling of said assembly a driving mandrel, orienting and spudding said assembly relative to said structure with the lower end of said piling on marine bottom, driving said piling of said assembly into marine bottom until said upper end is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, and connecting said unfolded strut at its free end to said structure.

8. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly connected to said piling and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises locating said assembly in plan relative to said structure, spudding and driving said piling of said assembly into marine bottom until the connection of the strut and the piling is adjacent marine bottom and the free end of said strut is above water level, unfolding said strut, and connecting said unfolded strut at its free end to said structure, said assembly also being oriented relative to said structure.

9. A method in accordance with claim 8 in which the

assembly is oriented during spudding of said piling into marine bottom.

10. A method for placing and installing a piling and strut assembly relative to a marine structure for bracing said structure, the strut of said assembly being hingedly and rotatably connected to said piling and laterally offset thereof with the strut of said assembly folded upwardly substantially parallel to the longitudinal axis of said piling in driving position, which comprises locating said assembly in plan relative to said structure, spudding and driving said piling of said assembly into marine bottom until the connection of the strut and the piling is adjacent marine bottom and the free end of said strut is above water level, unfolding and orienting said strut, and connecting said unfolded strut at its free end to said structure.

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