Nov. 3, 1953 J. B. TEMPLETON 2,657,540

METHOD OF ERECTING AND POSITIONING MARINE STRUCTURES

Filed June 14, 1948 3 Sheets-Sheet 1

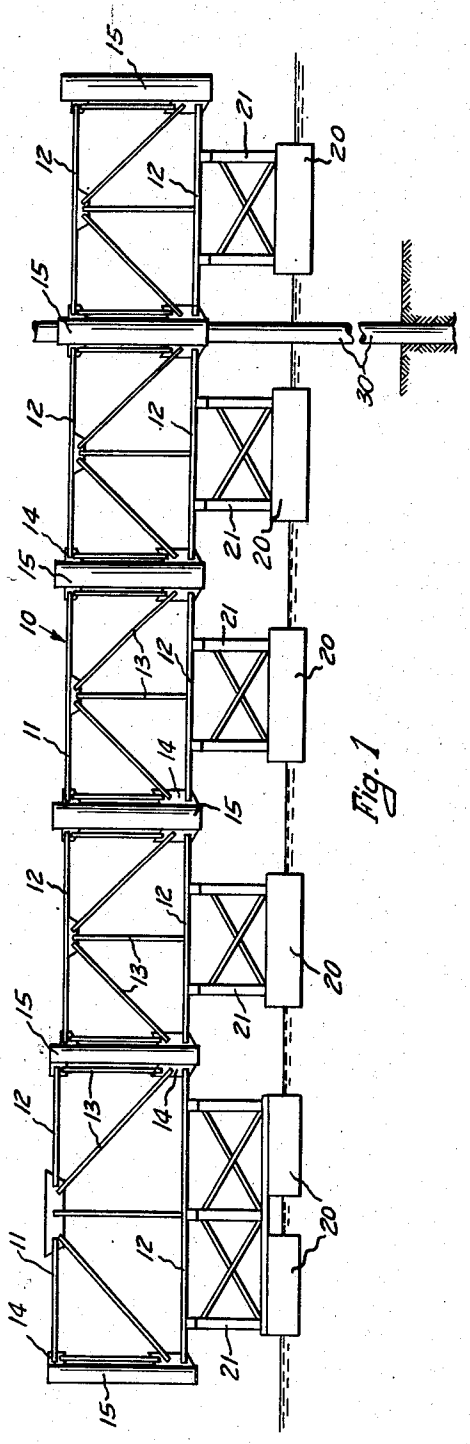

Fig. 1

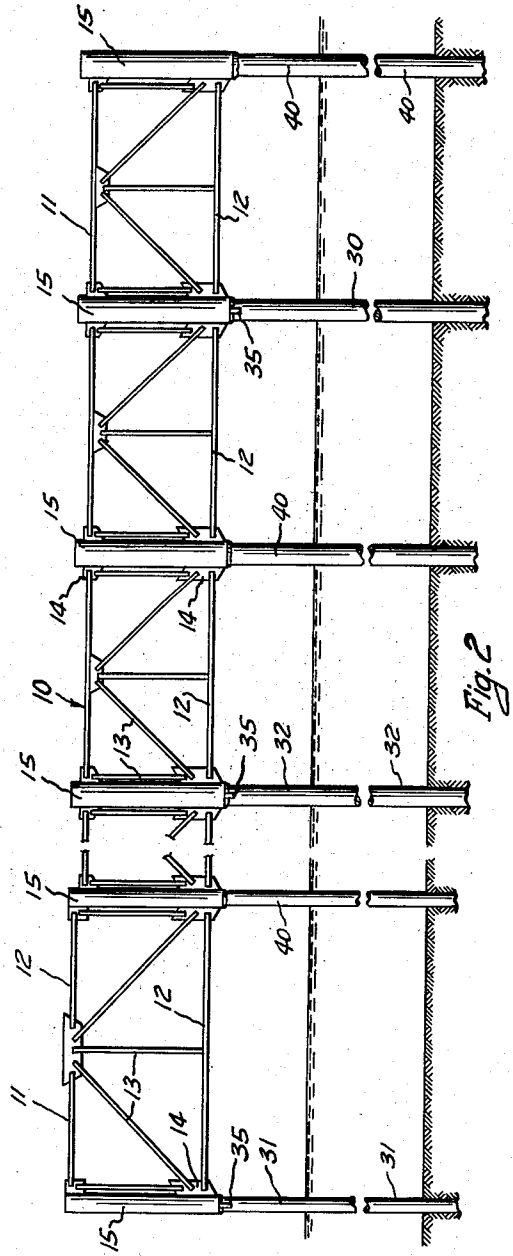

Fig. 2

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Fig. 3

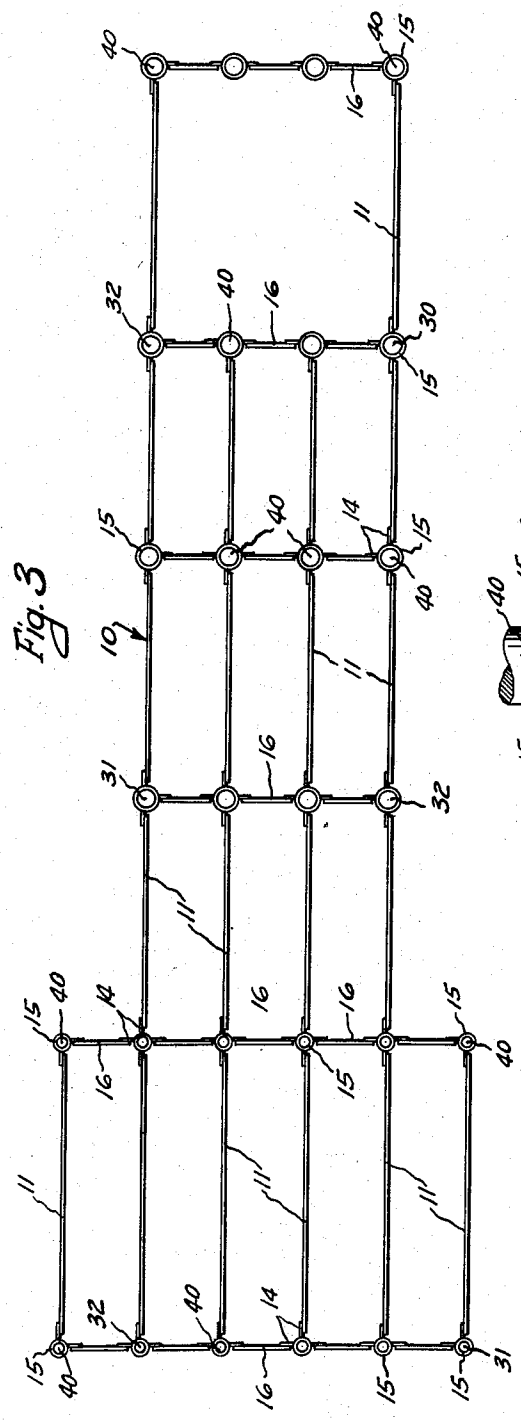
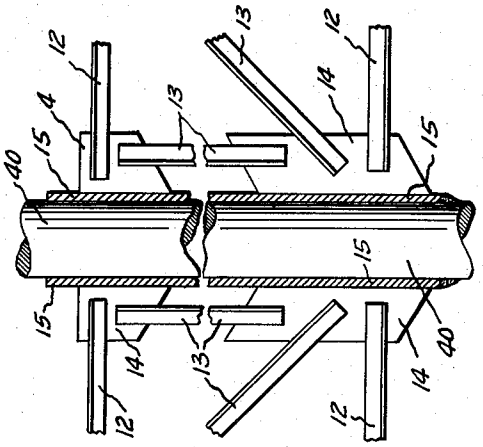


Fig. 4



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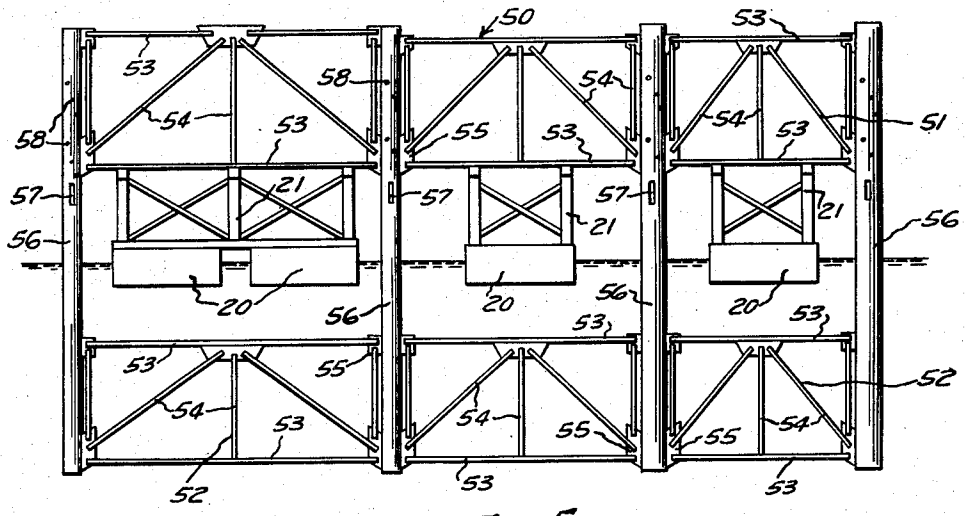

Fig. 5

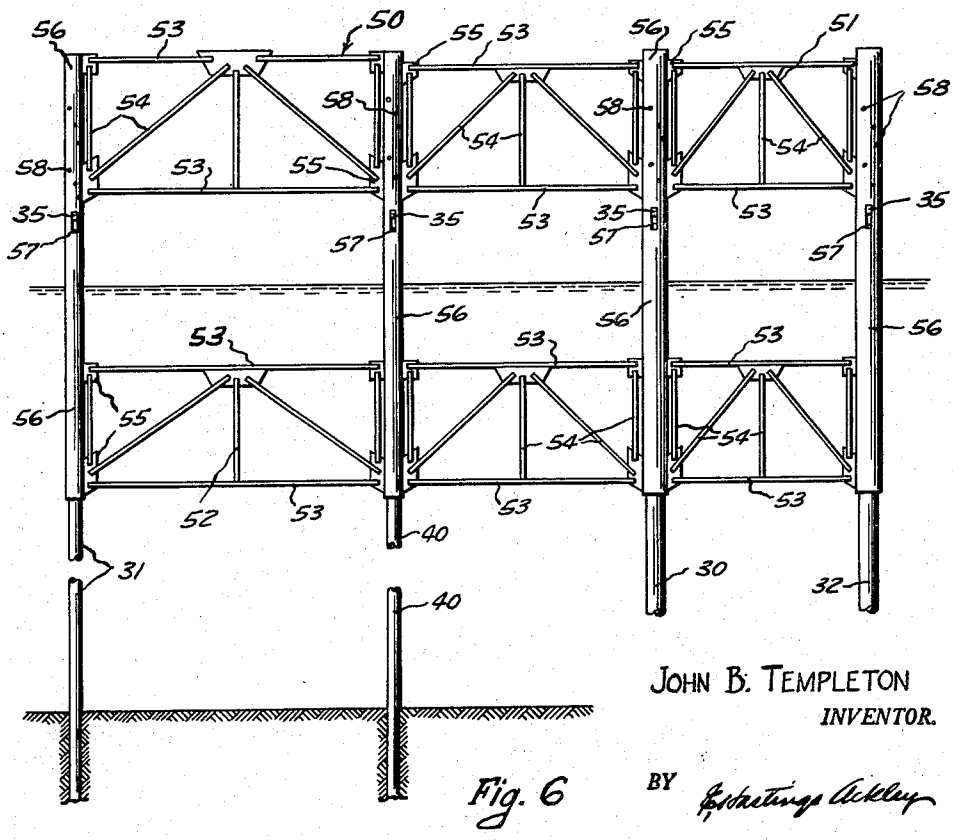

Fig. 6

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2,657,540

METHOD OF ERECTING AND POSITIONING MARINE STRUCTURES

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Application June 14, 1948, Serial No. 32,766

5 Claims. (Cl. 61—46)

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This invention relates to new and useful improvements in over-water marine drilling structures and methods of erecting and positioning the same.

An increasing number of wells, particularly oil wells, are being drilled under bodies of water, such as lakes, bays, or oceans. Wells in shallow inland waters have been drilled with equipment mounted upon and supported by a barge or barges which have been floated to the desired location and then sunk to position on the bottom of the body of water so that the deck or super-structure of the barge remains above the water line and the drilling equipment is therefore supported above the water level. Such a sunken barge foundation is not suitable, however, when the water is deep, or in rough water, or where the tide fluctuates greatly so that the level of the water rises and falls substantial distances. It is difficult and expensive, especially where the water is deep, and waves and the tide cause fluctuations in the water level, to construct the foundation structure for a working platform and superstructure in the usual manner by driving piles or making concrete piers and then erecting the foundation and superstructure on the driven piling or piers. Furthermore, it is difficult to correctly position the piles and dangerous to undertake the construction and erection of the superstructure on the piles after the same have been sunk or driven into place in the bed of the body of water.

It is, therefore, one of the objects of this invention to provide an improved over-water marine drilling foundation structure and an improved method of transporting the foundation structure to the drilling site and positioning and erecting the same in place for the drilling operation.

A particular object of the invention is to provide an improved method of constructing and installing an over-water marine drilling foundation structure which may be floated to the location to be drilled, properly positioned at such location and then secured in position for supporting the drilling apparatus.

It is also an object of this invention to provide a method of erecting a marine drilling foundation structure for drilling apparatus over a body of water which can be carried out readily and satisfactorily in spite of rough or deep water and which is relatively simple and inexpensive to practice.

An important object of the invention is to provide an improved method of erecting an over-

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water marine drilling foundation structure over a body of water which includes the steps of erecting the foundation structure on barges in smooth protected water, floating the foundation structure on barges at the desired elevation above the water level to the location to be drilled, sinking a first pile through a sleeve in the structure, positioning the structure laterally relative to such first pile, sinking additional initial piles through other sleeves in the structure, fixing the foundation structure to the initial piles, removing the barges from supporting position with respect to the foundation structure, sinking additional piles through other sleeves in the structure, and then securing the foundation structure to all the piles whereby the foundation structure is firmly and positively secured in operative supporting position at the desired elevation above the water level.

A further object of the invention is to provide an over-water marine drilling foundation structure which is supported at a sufficient elevation above the water level to prevent waves or other changes or fluctuations in the level of the water above which the foundation structure is erected from acting upon and damaging such foundation structure; the foundation structure being supported upon piles which offer relatively small resistance to the passage or flow of waters through and past such structure.

A still further object of the invention is to provide an over-water marine drilling foundation structure of the character described which may be reflected and removed from the drilling location after the drilling operation has been completed.

Another object of the invention is to provide an improved over-water marine drilling foundation structure which may be completely fabricated in the desired form on barges in smooth or protected water near a dock or shore and transported to the desired drilling location and positioned and secured in supporting position at such location; whereby proper fitting and shape of the structure is assured, costs of erection are reduced, completion of the over-water work is facilitated, the foundation structure is positively secured in supporting position with minimum effort and expense, and the danger of damage because of storms, high waves and the like is minimized.

Additional objects and advantages of the invention will readily be apparent from the reading of the following description of a foundation structure constructed and erected in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

Figure 1 is a side elevation of a foundation structure constructed in accordance with the invention and showing the same supported by barges in position for being secured at drilling location,

Figure 2 is a side elevation of the foundation structure secured in place at the drilling location and with the barges removed,

Figure 3 is a plan view of the foundation structure,

Figure 4 is an enlarged vertical cross-sectional view of one of the cylindrical sleeves of the structure,

Figure 5 is a side elevation of a modified form of foundation structure showing the same supported on barges, and

Figure 6 is a side elevation of the modified foundation structure secured in place with the barges removed.

In the drawings, the numeral **10** designates generally a foundation structure or framework which is made up of various longitudinal and transverse structural members. The longitudinal structural members or trusses **11** are formed of beams **12** and braces **13** secured together in the usual manner.

The longitudinal trusses are spaced apart and extend parallel to each other, and are joined at each end by means of gusset plates **14** to upright cylindrical sleeves or tubes **15**. The transverse trusses **16** are similar in construction to the longitudinal trusses **11**, and likewise have their ends secured by means of gusset plates to the sleeves **15**, as clearly shown in Figure 3, to form the foundation structure or framework **10**.

It is to be expressly understood that, while one particular form of foundation structure or framework is illustrated in the drawings, any desired suitable structure may be employed, so long as the upright cylindrical sleeves **15** are provided at suitably spaced intervals therein. Furthermore, the length of the trusses may vary, and the size of the cylindrical sleeves may likewise differ to meet varying conditions of use.

The foundation structure or framework **10** is assembled on barges in smooth or protected water adjoining a dock or near shore, where correct fitting and alignment of all parts may be definitely assured. After the foundation structure has been completed and is positioned upon and supported by a plurality of barges **20**, being spaced at a desired elevation above water level by means of supporting structures **21** carried by the barges and engaging the lowermost beams **12** of the truss members of the foundation structure, the framework or foundation structure carried by the barges is floated thereupon to the desired drilling location. The height of the support members **21** is preferably such that the foundation structure will be supported by the barges at an elevation slightly higher above the water level than the elevation at which it is desired to secure the foundation structure at the drilling location.

When the foundation structure has been floated on the barges to the desired drilling location, an initial pile **30** is inserted through one of the sleeves **15** of the foundation structure and dropped or driven into the ocean bed a sufficient distance to restrain the barges and foundation structure against displacement from the desired location. The foundation structure is not secured to the pile, and as a result the structure may pivot about the pile as a center. Thus, the foundation structure may be swung in position laterally about the initial pile **30**, until it has been moved to the desired position with respect to prevailing wind and wave movements and the like, whereupon a second pile **31** is inserted through one of the upright cylindrical sleeves **15**, spaced from the initial pile, and is likewise dropped or driven into the bed of the ocean a sufficient distance to restrain further lateral movement of the structure and barges. Additional initial piles **32** are inserted at spaced positions through a plurality of the spaced cylindrical sleeves **15** and are driven to the desired depth in the ocean bed to obtain the necessary or desired footing for use in supporting the foundation structure. The first initial pile **30** and second initial pile **31** are lifted slightly, freed and straightened in their sleeves **15** and are then driven to the desired depth. After the initial piles **30**, **31**, and **32** have all been driven into place in the ocean bed, stop members or rings **35** are secured to such piles by welding, or by bolts or any other suitable means (not shown), at a point on the piles at which the stops will be engaged by the sleeves **15** to support the foundation structure at the desired elevation above the water level. The number of initial piles so driven is sufficient to initially support the foundation structure and permit removal of the barges from their supporting position with respect to the foundation structure.

When the desired number of initial piles have been sunk into place in the ocean bed and the stops **35** have been secured to such piles by welding or otherwise, as hereinbefore set out, the barges **20** may be partially sunk to lower the foundation structure until the sleeves **15** engage the stops and the foundation structure is supported on such stops. Continued partial sinking of the barges will then lower the supporting structures **21** from supporting engagement with the lowermost beams **12** of the truss members **11**, whereupon the barges and supporting structures may be floated from under the foundation structure and moved ashore or elsewhere.

When the barges have been so removed, additional piles **40** are inserted through each of the remaining sleeves **15** and driven to a depth in the ocean bed suitable to obtain footing sufficient to support the desired weight on the foundation structure, and after the piles have been driven into place in the ocean bed, they may each be welded or otherwise suitably secured to the cylindrical sleeves through which they extend.

It is to be understood, however, that the barges need not be removed from supporting position until all the piles have been driven into place and the stop members or rings **35** secured to the piles in proper position to be engaged by the sleeves of the foundation structure to support said structure in a level position. Also, the sleeves **15** may be welded directly to the piles, if desired, to securely affix the foundation structure in place on the piles. Any desired structure may then be erected upon the foundation structure or frame **10** for carrying a drilling apparatus, or any other desired apparatus or structure.

The piles are preferably tubular, and formed of large, heavy wall pipe, which may be built up in length by welding additional joints to the upper end of the pile. Also, the tubular piles may be filled with concrete or the like if desired.

It will be seen, therefore, that the foundation structure or frame **10** is thus firmly, positively and permanently affixed in place at the drilling location, being supported by the piles at the desired elevation above the water level. It is preferable that the lowermost beam **12** of the trusses

be spaced sufficiently above water level to prevent damage or other undesired action from the waves or tide upon the flooring, platform, or apparatus or material, or other structure, carried by the foundation structure or framework. Obviously, the height of the frame members above the water level may be selected as desired to meet various conditions of use.

Manifestly, if desired, screw jacks (not shown) may be used to raise or lower the various supporting structures **21** carried by the barges **20** to positively assure the frame or foundation structure **10** being positioned in a substantially horizontal or level plane when the sleeves **15** are supported upon the stops **35** or otherwise secured to the initial piles. Also, such screw jacks or other adjusting means may be used to set or alter the elevation of the foundation structure or frame to the desired distance above the water level prior to welding or otherwise securing the sleeves to the piles.

It is preferable, however, that the foundation structure be initially supported by the barges and supports **21** at an elevation slightly higher than the final desired elevation at which the foundation structure is supported by the piles. The initial piles, or all the piles, may then be inserted through the sleeves **15** and driven into place in the sea bed and the stop rings **35** may be secured to such piles, by welding or otherwise, in position to support the foundation structure in a level plane. After the stop rings have been secured to the piles, the barges may be partially sunk to lower the foundation structure to position on the stops, whereupon the barges are sunk further and removed from beneath the structure.

After the drilling operation has been completed, the foundation structure may be removed by partially sinking and repositioning barges beneath the truss members in a position similar to that which the barges were positioned for floating the foundation structure to the drilling location. The barges may then be emptied of water and permitted to rise until the supporting structures **21** are re-engaged with the truss members **11**. When the barges have been so raised and the supporting members are engaged under the trusses, the piles may be cut off just below the sleeves **15**, or at a point adjacent the sea bed by explosives, or otherwise in any desired suitable manner, whereupon the entire structure is freed from the piles and is supported by the barges. The foundation structure may then be floated to shore, or may be repositioned in the manner already described at a new location, if desired.

As has already been pointed out, the foundation structure may take a form differing substantially from that just described. A modified form of the invention is shown in Figures 5 and 6, wherein the foundation structure or framework **50** includes an upper truss section **51** and a lower truss section **52**, spaced vertically from each other. Each of the truss sections is made up of various longitudinal and transverse structural members formed of beams **53** and braces **54** secured together in the usual manner and joined by means of gusset plates **55** to elongate upright cylindrical sleeves or tubes **56**.

The elongate cylindrical sleeves extend vertically from a point slightly above the uppermost member of the upper truss section to a point slightly below the lowermost member of the lower truss section. The vertical spacing between the upper and lower truss sections is preferably sufficient to permit the lower truss section to be completely submerged for all normal water movement conditions, while the upper truss section is spaced above the water level in the same manner as the truss framework of the previous form. It will be seen, therefore, that the truss sections are spaced from each other and are held securely and rigidly together by means of the vertical cylindrical sleeve.

The foundation structure **50** is fabricated and erected upon barges in protected or smooth water near land or a dock, in the same manner as the foundation structure of the form previously described. However, the barges **20** and support members **21** are positioned between the upper and lower truss sections, so that the support members engage against the lowermost beams **53** of the upper truss sections, and the lower truss section is disposed in the water beneath or below the barges.

When the structure has been completely erected on the barges, it is floated thereupon to the desired drilling location. The initial piles are then inserted through the sleeves **56**, the foundation structure correctly positioned laterally with respect to the prevailing wind and wave movement, and the piles then sunk to proper depths for obtaining the necessary or desired footing for supporting the foundation structure. Stop members **35** are then secured by welding or otherwise to the piles through elongate slots **57** formed in the sleeves **56** and the sleeves are permitted to slide downwardly to engage said stops whereby the foundation structure will be supported thereby in a level position when the barges are partially sunk. The barges may then be removed from supporting position and transported to shore or any other desired location.

Additional openings or slots **58** are provided in the sleeves **56** at spaced points to permit the sleeves to be further welded directly to the piles, and the upper ends of the sleeves may also be welded to the piles, to obtain a more positive connection between the sleeves and the piles.

A foundation structure of the character just described is particularly advantageous where the structure is erected in deep water and the piles are rather long. The elongate sleeves will rigidify and strengthen the piles and the entire foundation structure. Since the lower truss section is positioned below the surface of the water a distance at which the normal surface movement will not affect the structure, it will be seen that the lower portion of the structure provides a supplemental strengthening structure for the upper truss section of the foundation structure upon which the flooring, housing or other drilling equipment or structures are erected and supported.

The erection and positioning and securing of the foundation structure in proper operative position is carried out in the same manner and using the same method as that of the form previously described, and all the advantages of such previously described form of the invention are present in and applicable to this form of the invention.

From the foregoing, it will be seen that the foundation structure or framework may be completely fabricated and erected upon barges near a dock or near land in protected or smooth water. The foundation structure, so mounted upon barges at a desired elevation above water level, is transported by means of such barges to the de-

sired drilling location in the ocean or other body of water. After the foundation structure has been transported to the desired drilling location, a first initial pile is dropped or sunk through one of the cylindrical sleeves to provide a pivot for positioning the foundation structure at the drilling location, and when the foundation structure has been swung into the desired position laterally with respect to such first pile, a second initial pile may be dropped or sunk through another of the cylindrical sleeves spaced from the first to maintain the foundation structure in the desired lateral position, whereupon additional initial piles may be inserted through a plurality of the sleeves spaced sufficiently apart to permit the entire foundation structure to be supported by such initial piles when the barges are removed from supporting position. After the initial piles have been inserted through the sleeves and driven into the sea bed a sufficient distance, the stop members or rings are secured to the piles by welding or otherwise, whereupon the barges may be partially sunk so that the sleeves engage the stops to support the foundation structure to permit removal of such barges from supporting position with respect to such foundation structure. After the barges have been removed, additional piles are inserted through all the remaining cylindrical sleeves and driven to the desired depth in the ocean bed, and the sleeves are affixed or secured to each of the piles extending therethrough. Or, all the piles may be driven and stop members secured thereto prior to removal of the barges, if desired.

Therefore, the foundation is positively and securely and permanently fixed in place on the piles at the desired elevation above water level, and in the desired position with respect to the drilling location.

It will further be seen that the foregoing structure and method permits fabrication and erection of the framework on barges in smooth or protected water near a dock or dry land, where fabrication may proceed rapidly in the usual manner and without the hazards incident to rough water construction. After the foundation structure has been erected on the barges in protected water near land and transported to the drilling location, it is only necessary to sink piles through the spaced cylindrical sleeves to positively securely affix the foundation structure in supporting position at the drilling location. It is obvious that the sleeves serve as guides for the piles, and the sinking of the piles through the sleeves is performed with greater ease and economy than would be the case if the piles were sunk initially and the foundation were then constructed or erected on the piles. Furthermore, it is more economical and quicker to fabricate and erect the foundation structure in protected smooth water near land than it would be to fabricate and erect the same structure on piles over rough or unprotected water.

It is also believed manifest that once the initial piles have been sunk, there is no danger of damage to the structure from waves or squalls or the like, the foundation structure being rigidly secured together and held in place by the initial piles.

Furthermore, construction and erection of a foundation structure of the character set forth herein in rough and unprotected water is a costly and hazardous operation, whereas the method just described permits fabrication and erection of the foundation structure in protected smooth water near land or a dock and eliminates the most substantial part of the rough water work.

While the terms sea, ocean and the like, have been used herein, it is to be clearly understood that the invention is applicable to any body of water, such as rivers, gulfs, bays, etc. Also, while the term cylindrical sleeve has been used herein, it is to be understood that the sleeves may be other than solid circular cylindrical in shape, so long as such sleeves serve the purpose outlined.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated or of the methods described may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. The method of erecting an over-water marine foundation structure over a body of water which includes, supporting the foundation structure on float means, floating the foundation structure on the float means to the desired location, sinking an initial pile through the foundation structure and into the earth below the body of water while the structure is supported by the float means, orienting the foundation structure with respect to said initial pile to a desired position, sinking additional piles through the foundation structure into the earth below the body of water while the structure is supported on the float means, securing the foundation structure on the piles above the bed of the body of water, and removing the float means from position supporting the foundation structure.

2. The method of erecting an over-water marine foundation structure over a body of water which includes, supporting the foundation structure on float means, floating the foundation structure on the float means to the desired drilling location, sinking an initial pile through the foundation structure into the earth below the body of water while the structure is supported on the float means, orienting the foundation structure relative to such first pile, sinking additional piles through the foundation structure spaced from the initial pile, fixing supporting stops on the piles at predetermined elevations, lowering the foundation structure to engage the supporting stops to support the structure on the piles at a desired elevation above the water level, and removing the float means from position supporting the foundation structure.

3. The method of erecting an over-water marine foundation structure over a body of water which includes, supporting the foundation structure on float means, floating the foundation structure on the float means to the desired location, sinking a first initial pile through the foundation structure into the earth below the body of water while the structure is supported on the float means, orienting the foundation structure about such first pile to a desired position, sinking additional initial piles through the foundation structure into the earth below the body of water spaced from the first initial pile, fixing supporting stops on the initial piles at predetermined elevations, lowering the foundation structure to supporting engagement with the supporting stops to position the structure on the initial piles at a desired elevation above water level, removing the float means from position supporting the foundation structure, sinking additional piles through the foundation structure at points spaced from the initial piles

in the foundation structure into the earth beneath the body of water, and securing the foundation structure on such additional piles above the earth bed of the body of water to complete the support between the earth and the foundation structure for supporting the ultimate working load for which the structure is designed.

4. The method of erecting an over-water marine drilling foundation structure which includes, constructing a foundation structure having a plurality of spaced vertical sleeves therein, supporting said foundation structure on float means, floating the foundation structure on said float means to the desired location in the body of water, sinking a first initial pile through one of the vertical sleeves in the foundation structure into the earth below the body of water while the structure is supported on the float means, positioning the foundation structure by orienting it about said first initial pile, sinking additional initial piles through selected sleeves spaced from said first initial pile into the earth beneath the body of water while the structure is still supported on the float means, fixing supporting stops on the initial piles at a predetermined elevation, lowering the foundation structure to bring the sleeves of the foundation structure into engagement with the supporting stops on said initial piles for initially supporting the structure at a desired elevation above water level, removing the float means from position supporting the foundation structure, sinking additional piles through the remaining sleeves in the foundation structure to support the ultimate working load for which the structure is designed, and securing the sleeves to said additional piles to complete the support between the earth and the foundation structure.

5. The method of erecting an over-water marine foundation structure over a body of water which includes, fabricating a foundation structure with a plurality of spaced vertical sleeves formed therein, supporting the foundation structure on float means with the sleeves spaced laterally from said float means, floating the foundation structure on the float means to the desired location, sinking an initial pile through one of the sleeves of the foundation structure and into the earth below the body of water while the structure is supported on the float means, orienting the foundation structure about said initial pile to a desired position, sinking additional piles through the sleeves in the foundation structure and into the earth below the body of water while the foundation structure is still supported on the float means, fixing stop supports at predetermined elevations on selected piles spaced from the initial pile, lowering the foundation structure to move the sleeves surrounding such selected piles into supporting engagement with the stop supports on said selected piles for supporting the foundation structure at a desired elevation above the bed of the body of water, removing the float means from position supporting the foundation structure, and securing the supporting sleeves to the piles to complete the supporting structure.

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