March 24, 1970 P. W. MARSHALL 3,501,919

METHOD AND APPARATUS FOR CARRYING OUT OPERATIONS AT AN UNDERWATER INSTALLATION

Filed Feb. 28, 1968 2 Sheets-Sheet 1

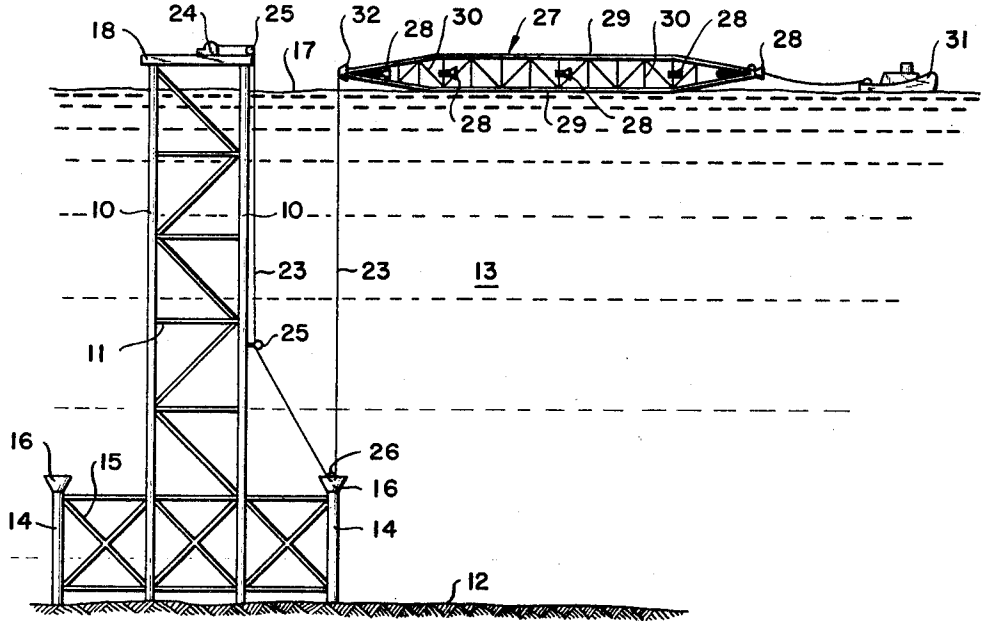


FIG. 1

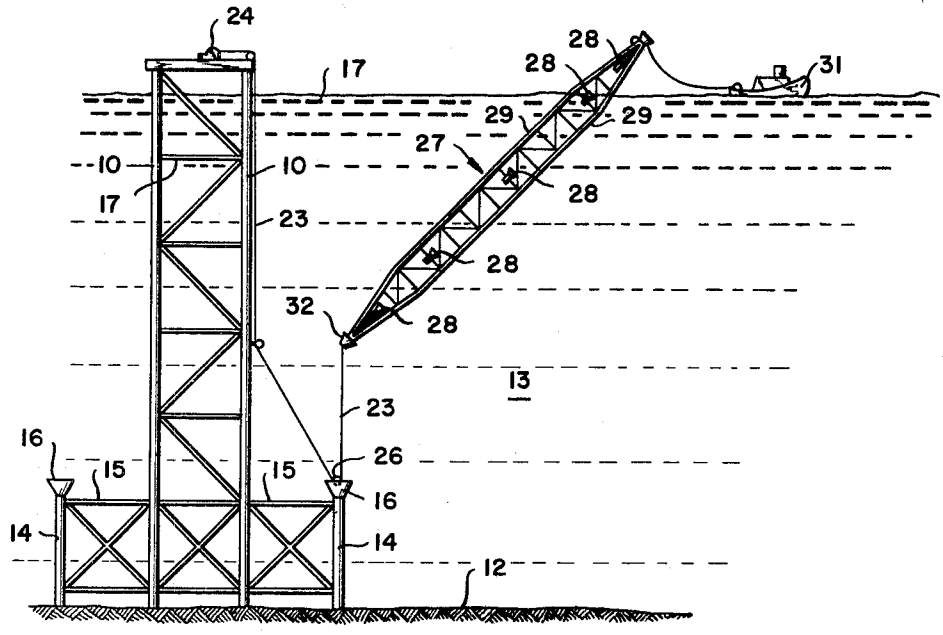


FIG. 2

INVENTOR:
P. W. MARSHAL
BY: A. H. McCarthy
HIS AGENT

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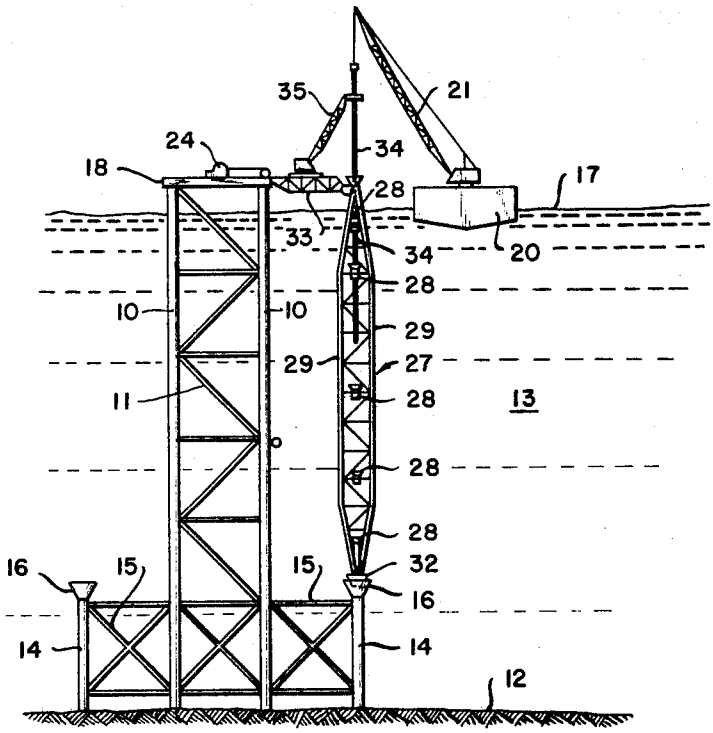


FIG. 3

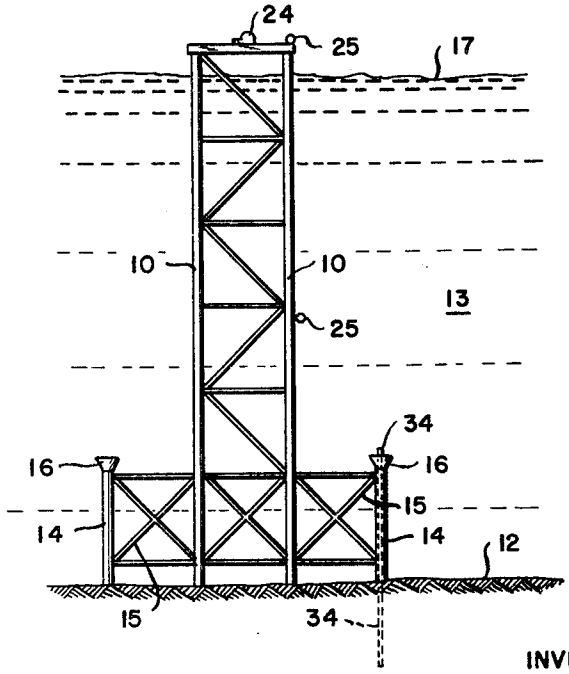


FIG. 4

INVENTOR:
P. W. MARSHALL
BY: A. H. McCarthy
HIS AGENT

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METHOD AND APPARATUS FOR CARRYING OUT OPERATIONS AT AN UNDERWATER INSTALLATION

Peter W. Marshall, New Orleans, La., assignor to Shell Oil Company, New York, N.Y., a corporation of Delaware

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U.S. Cl. 61—46.5 11 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for carrying out operations on an underwater installation, for example, inserting stub piles to anchor a marine structure, in which an elongated buoyant truss member is lowered from the water surface into a substantially vertical position with the lower end in registry with the underwater installation to thereby provide communication between the water surface and the underwater installation for lowering pilings and the like.

BACKGROUND OF THE INVENTION

This invention relates generally to the anchoring of structures of various types to the floor of a body of water and more particularly to a method and apparatus of anchoring marine structures of the type having a plurality of skirt pile sleeves attached to the lower end of the structure for receiving concentric stub piles therethrough.

In drilling and producing wells at offshore locations large marine structures are employed which are positioned on the floor of the body of water and extend upwardly above the water surface. These structures or so-called platforms generally comprise a lower base element including a plurality of substantially vertical legs which extend above the surface of the water and an operating deck secured to the upper end of the legs above the water surface. If the platform is to be used for the drilling of wells, drilling equipment including a drill rig and auxiliary equipment as well as living quarters for the crew and storage facilities are usually mounted on top of the platform. If the platform is to be used for production purposes, various manifolding equipment, storage tanks, meters and treating apparatus are generally mounted on the platform deck.

After a marine structure or platform of the above-described type has been positioned on the floor of the body of water, it is the general practice to anchor the structure to the water floor by driving piles down through the vertical legs of the structure so that they penetrate up to 300 feet or more in the water floor. In general, the depth to which these piles are sunk depends on the nature of the soil on the water floor. Thus, the harder the formation beneath the structure the shorter the piles that are used. In addtion, it is also a practice at times to install stub piles through suitable sleeves or guide means attached to the lower end of the marine structure to further anchor the structure to the water floor. Stub piles are piles that do not extend to the surface of the water and usually only extend up to the top of the sleeve or a guide attached to the marine structure. They provide additional obstruction to wave action and without impairing access to the platform deck. In relatively shallow waters stub piles may be satisfactorily located in sleeves or guides attached to the lower end of the structure and driven into the floor of the body of water by employing conventional methods. However, in relatively deep water in the order of hundreds of feet in depth the problem of aligning the pile in the sleeve or guide becomes increasingly difficult, if not impossible, especially at depths exceeding deep sea diver capabilities. Furthermore, the longer the unsupported length of the pile, the more subject it is to buckling either under its own weight or due to installation forces. Accordingly, there existed a need for a method of anchoring marine structures in relatively deep water by remotely locating a stub pile in a sleeve or guide attached to the lower end of the marine structure, which method can be entirely performed from the surface without the need of employing deep sea divers and it is to this end that the subject invention is directed.

SUMMARY OF THE INVENTION

It is a primary object of this invention to provide a method for carrying out operations on an installation positioned on the floor of a body of water.

It is another object of this invention to provide an apparatus for carrying out the above method.

It is still another object of this invention to provide a method and an apparatus for installing piles to anchor a marine structure wherein a buoyant truss member for guiding a pile is employed.

A further object of this invention is to provide a method and apparatus of the subject type wherein the marine structure has a plurality of pile guide means attached to its lower end and the truss member is positioned with one end in registry with one of the guide means.

A still further object is to provide a method and apparatus for remotely positioning the truss membr wherein one end of the truss member is pulled into registry with the guide means from a point on the guide means by a drawline operated from the water surface.

These and other objects will become apparent from a reading of the detailed description of the invention which follows.

In summary, the invention broadly comprises a method and apparatus for carrying out operations from the surface of a body of water at an installation positioned on the water floor by employing an elongated truss member which is positioned with one end in registry with the installation and is long enough to extend substantially to the water surface. More specifically, the method and apparatus is adaptable to a marine structure of the type having a plurality of pile guide means attached to its lower end and carried outboard thereof for receiving anchoring piles therethrough. An elongated truss member, or stinger, for transferring the pile from the water surface to the pile guide means, is lowered into the water and one end thereof placed in registry with one of the pile guide means. Preferably the stinger is pulled into registry with the guide means by a drawline extending from the water surface, past a point on the guide means then to the end of the truss member where it is attached, so that as the guide line is pulled from the water surface the end of the truss member is pulled into contact with the guide means.

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an elevational view of a marine structure having a plurality of pile guide means attached to its lower end and carried outward thereof and also shows an elongated truss member or pile stinger floating on the water surface with a drawline extending from one end of the truss member, past a pulley on one of the guide means and back up to the surface of the marine structure;

FIGURE 2 is a similar elevational view of the structure showing the truss member being pulled into position;

FIGURE 3 is the same elevational view with the truss member moved into registry with one of the pile guide means and further showing a pile being lowered into position through the truss member;

FIGURE 4 is an elevational view of the marine structure showing the completed installation of the pile but the pile installed through the pile guide means extending into the floor of the body of water.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURE 1 of the drawing a marine structure is shown as comprising a plurality of support members or legs **10** interconnected by suitable bracing **11** and positioned on the floor **12** on the body of water **13**. It will be understood for the purposes of this invention that the structure could employ any number of legs which are usually arranged in a configuration having a closed perimeter or it could even be a single leg structure. The legs are generally tubular and constructed of a large-diameter pipe, but they may also be solid members such as I-beams. A plurality of skirt pile sleeves **14** are attached to the lower ends of the legs **10** by means of suitable bracing **15**. Each skirt pile sleeve **14** is a tubular structure open at each end with the upper end having a flared mouth portion **16** for receiving a pile. The lower end of the sleeve **14** is adapted to rest against or penetrate slightly into the floor **12** of the body of water **13**. Mounted on top of the legs **10** at a suitable distance from the surface **17** of the body of water **13** is an operating platform or deck **18** which carries suitable well-drilling or servicing equipment (not shown). For purposes of construction, this may be a temporary deck located somewhat closer to the water.

Although the skirt pile sleeves **14** are shown as continuous tubular members, it will be understood for the purposes of this invention that any form of guide means for guiding the pile may be employed. For example, vertically spaced rings of a sufficient size to allow a pile to pass therethrough may be attached to the marine structure. In this arrangement, the uppermost ring would be preferably provided with a flared mouth portion, similar to the flared mouth portion **16** described with reference to the embodiment illustrated in FIGURES 1–4. In addition, the remaining rings may be provided with flared openings to accommodate a piling being inserted therethrough.

A drawline **23** extending from a winch **24** located on the operating or temporary deck **18** passes over suitable pulleys **25** carried on the deck and leg **10**, past pulley **26** carried by the skirt pile sleeve **14** and then back to the surface of the water where it is connected to one end of an elongated buoyant truss member **27**. It is preferable for the purpose of this invention that the drawline **23** be positioned over the pulleys **25** and **26** prior to positioning the marine structure in its desired location in which case the drawline **23** would not be connected to the elongated buoyant truss member **27** as shown, but rather would extend back up to the water surface where it would be suitably tied off on the top of the marine structure. Thus, when the structure has been positioned on the water floor and it is desired to locate the elongated truss member **27** in the manner to be hereinafter described, the free end of the drawline **23** would be transferred from the structure to the truss member **27** where it would there be attached.

The truss member **27** may be of any desired construction and includes a plurality of pile guide means **28** spaced longitudinally therealong and adapted to receive a pile therethrough. For example, as shown, the truss member **27** may include main tubular frame members **29** interconnected by suitable bracing **30** which supports the pile guide means **28**.

Alternately, the guide means **28** may be a single continuous tube supported by the stinger, and the conical end portion **32** may include seals, such that drilling and grouting operations may be conducted within the guide **28** and sleeve **14** without communication with the body of water **13**.

In operation, the truss member **27**, which is buoyant by virtue of the hollow tubular frame members **29**, or if desired, auxiliary buoyancy means may be added to the truss member **27**, is towed into the approximately position as shown in FIGURE 1 by means of a tug boat **31** or other suitable vessel. The drawline **23** is connected to the generally conical end portion **32** of the truss member **27** which is so shaped to fit into the flared mouth portion **16** of one of the skirt pile sleeves **14**. After the truss member is positioned the drawline **23** is tensioned by means of the winch **24** thus pulling the end **32** of the truss **27** down into the water as shown in FIGURE 2. The pulley **26** may be attached to the skirt pile sleeve **14** in any suitable manner, for example, as shown in my copending application Ser. No. 694,243, filed Dec. 28, 1967. Continued tensioning of the drawline **23** serves to pull the end **32** into register with the flared mouth portion **16** as shown in FIGURE 3. Due to its buoyancy the truss member **27** will assume a substantially vertical position as shown in FIGURE 3. The phrase "substantially vertical position" as used herein is intended to include the possibility of having a slight amount of batter or inclination of the stinger or truss member **27** with respect to the skirt pile sleeve **14**. The truss member **27** is held in position by a temporary platform extension **33** carried outboard of the deck **18**. The extension **33** is connected to the upper end of the truss member **27**. If desired, suitable cooperating latching means may be provided on the end **32** and the flared mouth portion **16** to secure the truss member **27** in place or if desired the tubular frame members **29** of the truss member **27** may be flooded to provide negative buoyancy. Negative buoyancy means as used herein is intended broadly to cover any means capable of producing a force to submerge the truss member, for example, the drawline **23** of the tubular members **29** which may be flooded.

After the truss member **27** is in place as shown in FIGURE 3 a barge **20** equipped with a derrick **21** is moved into position adjacent the truss member **27**. A pile **34** is then lowered by means of the derrick **21** through the guides **28** in the truss member **27** and the skirt pile sleeve **14**. The pile **34** may be fabricated by adding lengths to the upper end of the pile and successively lowering it through the guides **28** and the skirt pile sleeve **14**. An alternative arrangement which may be used when lowering the pile **34** is to employ a "follower pile" or section of pile which extends from the top of the pile **34** up to the water surface. The so-called follower is employed until the pile **34** has been lowered and driven into its final position in the floor **12** of the body of water after which the follower is removed and brought to the surface.

After the pile has reached the floor **12** of the body of water the pile is introduced into the floor **12** of the body of water by suitable means well known in the art, for example, by driving the pile with a steam or sonic pile driver until it reaches a desired depth, typically in the order of seven hundred feet. Alternately, a small drilling rig **35** positioned on the frame **33** may drill a hole to aid pile installation (see FIGURE 3). The pile **34** is generally secured to the skirt pile sleeve **14** in a suitable manner for example, by filling the annulus between the pile **34** and the skirt pile sleeve **14** with cement. After the pile **34** has been installed the truss member **27** is removed as shown in FIGURE 4, and the pile is cut off by divers or by remote cutting equipment just above the skirt pile sleeve **14**. In the event a "follower" pile is employed as discussed above, the necessity of cutting off the pile is eliminated since the follower would be employed until the pile **34** reaches the position shown in FIGURE 4 after which it is removed to the surface.

Thus, it will be seen that the subject invention provides an attractive method and apparatus for remotely carrying out operations on an underwater installation. The invention accurately and efficiently provides commuunication between the water surface and an underwater installation, for example, when locating and driving a pile in a skirt pile sleeve as described above. The invention is

particularly beneficial in deep water since a long unsupported length of pile is subject to buckling due to the effect of current forces, forces imposed by the weight of the pile and the dynamic forces introduced in the pile when it is being driven.

I claim as my invention:

1. An apparatus for installing a pile to anchor a marine structure to the floor of a body of water, said structure being of the type having a plurality of upstanding underwater pile sleeves attached to the lower end of said structure and carried outboard thereof for receiving piles therethrough, said apparatus comprising:

an elongated buoyant pile stinger of a length sufficient to extent at least substantially between the upper end of one of said pile sleeves and the surface of said body of water;

pile guide means carried by said stinger and extending longitudinally therealong to provide means for centering a pile in said buoyant pile stinger substantially along the length thereof; and,

pulling means attached to one end of said stinger and in operable association with said sleeve for pulling said end of said stinger into contact with the upper end of said sleeve to thereby place said guide means into substantial axial alignment with said pile sleeve of said underwater installation.

2. An apparatus as defined in claim 1 wherein said guide means comprise a plurality of annular ring members spaced along said stinger.

3. An apparatus as defined in claim 1 wherein said pulling means include a cable attached to said stinger and passing over pulley means carried by said sleeve.

4. An apparatus as defined in claim 1 including means carried by said stinger to selectively add ballast to said stinger to cause at least said one end of said stinger to submerge.

5. An apparatus for anchoring a marine structure on the floor of a body of water, said apparatus comprising:

a marine structure positioned on the ocean floor;

a plurality of pile guide sleeves attached to the lower end of said structure;

elongated buoyant pile stinger having pile guide means extending longitudinally therealong, said stinger having one end adapted to be positioned on the upper end of one of said sleeves with said guide means in substantial axial alignment with said sleeve and said stinger being of a sufficient length so that said stinger extends at least substantially to the water surface;

pulling means in operable contact with said sleeve and connected to said one end of said stinger for pulling said one end into contact with the upper end of said guide;

a stub pile adapted to be lowered through said guide means on said stinger, through said pile guide sleeve and into the floor of said body of water; and,

attaching means carried between said pile and said pile guide sleeve for attaching said pile to said pile sleeve of said underwater installation.

6. A method for installing equipment for carrying out operations at an installation positioned on the floor of a body of water and having a plurality of upstanding, underwater pile sleeves attached to the lower end thereof, said method comprising:

floating an elongated unitary buoyant truss member on the surface of said body of water to a position substantially above said installation;

at least partially submerging said truss member;

selectively moving said truss member into a substantially vertical position over one of said pile sleeves;

positioning the lower end of said truss member into registered contact with said one of said pile sleeves;

driving a pile through said one sleeve into the floor of said body of water; and

moving said truss member into registered contact with another of said truss pile sleeves for repeating pile driving operations through another of said sleeves.

7. A method of installing at an offshore location a marine structure having a plurality of pile guide means attached to the lower end of said structure and outboard thereof for receiving concentric pile therethrough, said method comprising:

positioning said marine structure on the floor of a body of water;

floating an elongated unitary buoyant truss member on the surface of said body of water to a position substantially above one of said pile guide means, said truss member having longitudinally disposed pile support means therealong for laterally supporting a pile when said truss member is in a vertical position;

at least partially submerging said truss member;

moving said truss member into a substantially vertical position;

positioning one end of said truss member in registry with the upper end of said one pile guide means so that said pile support means on said truss member are substantially axially aligned with said one pile guide means;

lowering a pile through said truss member and said one pile guide means;

extending said pile into the floor of said body of water; and,

securing said pile to said one pile guide means.

8. A method as defined in claim 7 wherein the step of positioning said truss member in registry with said one pile guide means is performed by pulling one end of said truss member from a point on said one pile guide means.

9. A method as defined in claim 7 wherein the steps of submerging said truss member and moving it into a substantially vertical position are performed concomitantly.

10. A method as defined in claim 7 wherein said pile is extended into the floor of the body of water by driving the pile.

11. A method as defined in claim 7 wherein said pile is extended into the floor of the body of water by first drilling a hole in said floor for receiving said pile.

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JACOB SHAPIRO, Primary Examiner

U.S. Cl. X.R.

61—53.5, 63; 166—.6; 175—7