Dec. 21, 1965 C. H. SIEBENHAUSEN 3,224,204

METHOD OF ANCHORING AN OFFSHORE STRUCTURE

Filed Aug. 15, 1963 3 Sheets-Sheet 1

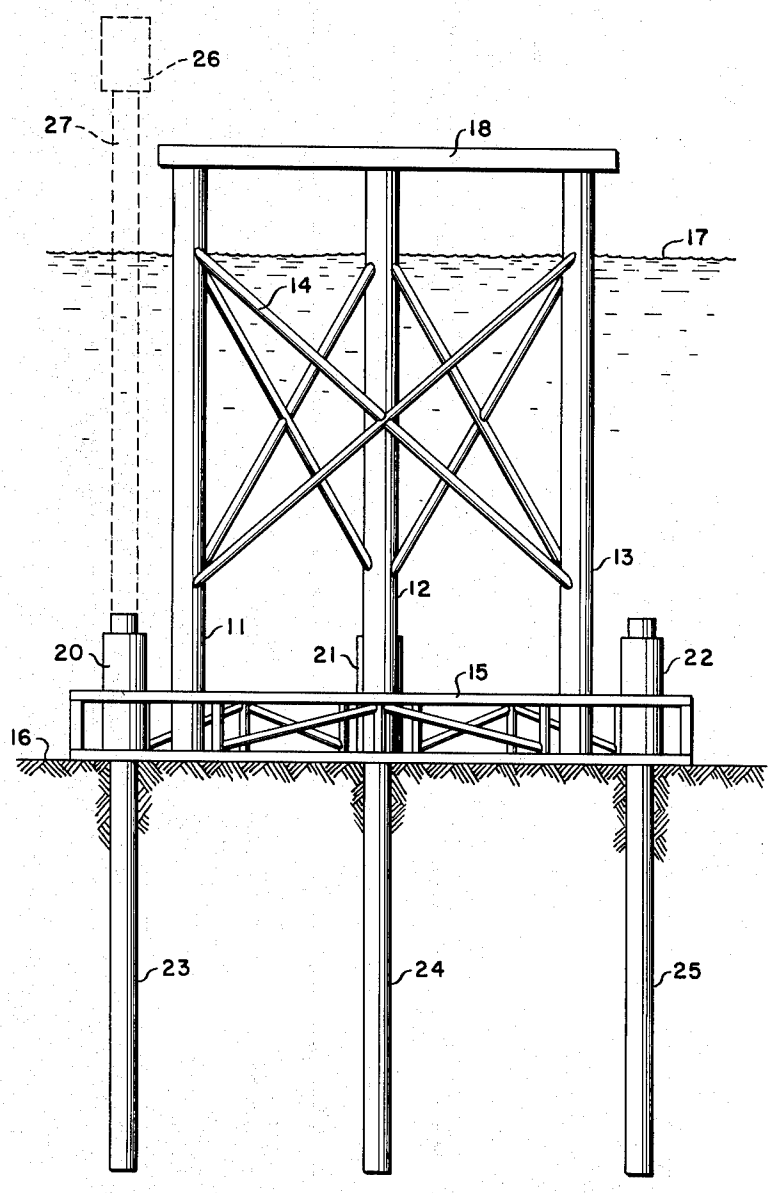

FIG. 1

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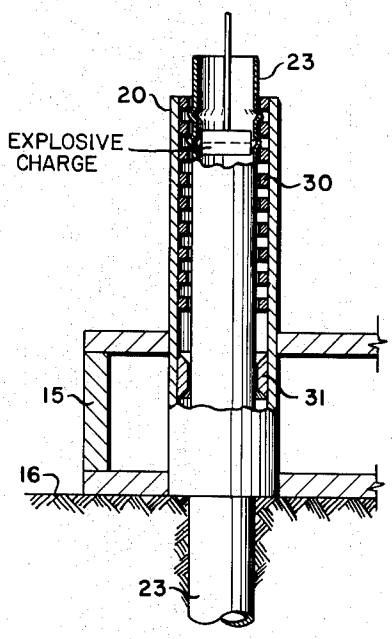

FIG. 2

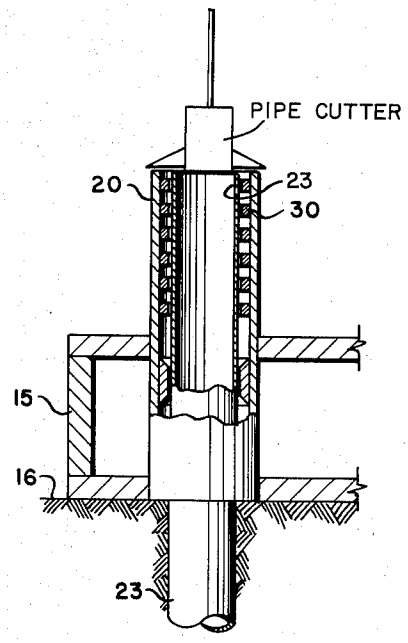

FIG. 3

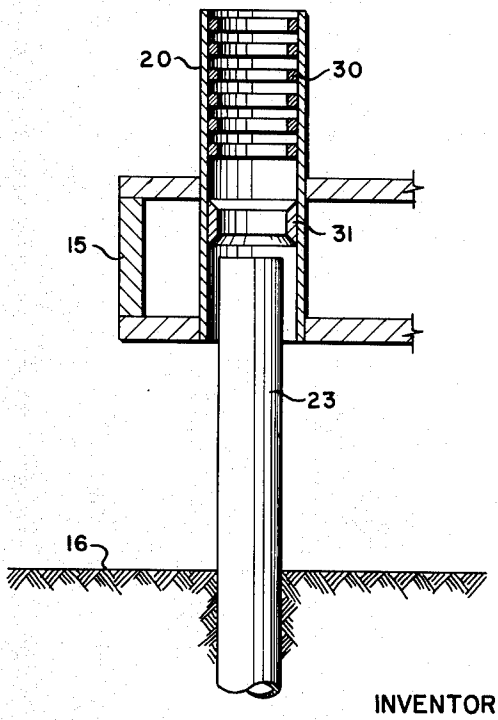

FIG. 4

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Filed Aug. 15, 1963 3 Sheets-Sheet 3

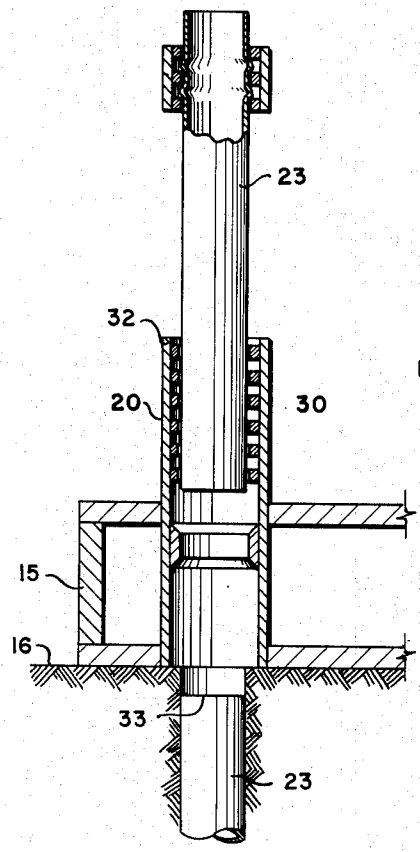

FIG. 5

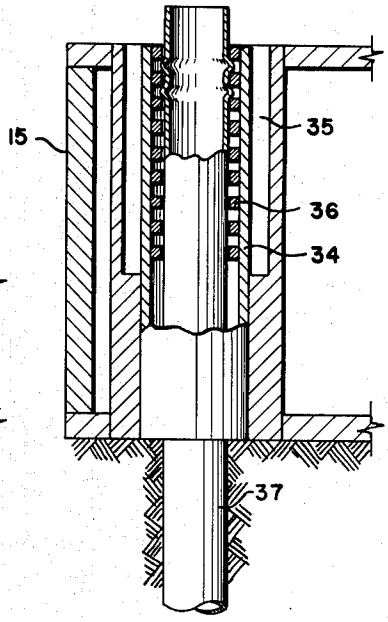

FIG. 6

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METHOD OF ANCHORING AN OFFSHORE STRUCTURE

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Filed Aug. 15, 1963, Ser. No. 302,418
7 Claims. (Cl. 61—46.5)

The present application is a continuation-in-part of copending application, Serial No. 65,308, filed October 27, 1960.

This invention relates to offshore structures of various types adapted to be anchored to the ocean floor for use in offshore operations. More particularly, the invention is directed to a structure such as an oil well drilling platform or production platform which may be secured to the ocean floor in a relatively simple and inexpensive manner which permits the structure to be subsequently readily moved and anchored at another location.

In drilling and producing wells at offshore locations, large structures are employed which are positioned in the ocean floor and extended upwardly above the surface of the water generally to a distance equal to the maximum wave height to be encountered in that area. An offshore structure generally comprises a footing or base element, which may be in the form of a framework or a pontoon which rests on the ocean floor, with a plurality of vertical legs extending upwardly above the surface of the water where an operating platform is secured thereto for supporting various pieces of equipment. If the platform is to be used for 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. Platforms of this type are relatively large in size and may range up to 300 feet in length. A typical platform for use in the drilling of wells may have a footing or pontoon that is 80 feet wide, 140 feet long and 15 feet high.

After an offshort structure of the above-described type has been positioned on the ocean floor at a selected location, it is the general practice to anchor the structure to the floor by driving piles down through the vertical legs of the structure so that they penetrate up to 300 feet or more in the ocean floor. In general, the depth to which the piles are sunk depends on the nature of the soil on the ocean floor. Thus, the harder the formation beneath the structure the shorter the piles that are used. While some of the piles that are driven through the legs of the structure are cut off at the level of the top of the legs of the structure and then welded or otherwise connected to the leg, it is also a practice at times to install stub piles in the bottoms of the legs and through the footing of the structure. Stub piles are piles that do not extend to the surface of the water. Usually they only extend up to the top of the footing of the offshore structure, thereby providing support for the structure without causing an obstruction to the wave action.

In shallow water, piles may be satisfactorily driven into the ocean floor with conventional tools employed, such as with a pile driver. However, in deep water, as the mass and the unsupported length of a pile increases, the efficiency of a driving hammer is reduced. In driving a stub pile into the ocean floor it is necessary to install a follower pipe or section of pile which extends from the top of the stub pile to above the surface of the water so that it can be contacted by a driving hammer. When

a stub pile has been driven to the desired depth, the follower pile is removed together with the driving mechanism and the stub pile is then usually cemented in place with the top of the stub pile being cemented to the footing of the offshore structure. If it is later desired to remove the offshore structure, for example in the case of a dry (non-productive) well, the stub piles can be cut off at a point below the footing of the structure in any conventional manner and the offshore structure may then be used at another location. However, prior to using the offshore structure at another location, it is necessary to remove the top of the stub pile which is still cemented in the footing or leg of the structure. In order to carry out this operation it is often necessary to tow the structure back to a harbor or dry dock.

It is, therefore, a primary object of the present invention to provide an offshore structure which may be readily anchored to the ocean floor by means of stub pile and later disconnected readily from the stub piles and moved to another location where it is again readily anchored to a second set of stub piles without the necessity of carrying out any major construction or repair work on the offshore structure.

A further object of the present invention is to provide a method and apparatus whereby an offshore structure may be readily connected and disconnected from stub piles at a series of offshore locations.

Another object of the present invention is to provide a method whereby an offshore structure having a plurality of legs may be anchored to the ocean floor without installing piles in the legs, so that the legs may be employed more efficiently, such as to form fluidtight chambers which aid in floating the structure to its location, or serve as housing means for various service lines or pipes for flooding or evacuating a floatable base secured to the bottom of the substructure.

These and other objects of this invention will be understood from the following description taken with reference to the drawing, wherein:

FIGURE 1 is a diagrammatic view illustrating a platform structure positioned on the ocean floor and anchored thereto by means of piles extending through anchor jackets;

FIGURE 2 is a diagrammatic view taken in partial longitudinal cross-section of one stub pile shown as anchored to an anchor jacket;

FIGURE 3 is a diagrammatic view taken in partial longitudinal cross-section of the stub pile and anchor jacket of FIGURE 2 after they have been disconnected from each other but while they still remain positioned together;

FIGURE 4 is a diagrammatic view taken in partial longitudinal cross-section of the anchor jacket of FIGURE 3 after it has been partially raised off the stub pile which remains in the ocean floor;

FIGURE 5 is a diagrammatic view taken in partial longitudinal cross-section of a portion of a stub pile after it has been cut off and partially raised out of the anchoring jacket in the footing of the offshore structure; and

FIGURE 6 is a view taken in partial longitudinal cross-section of another form of a well jacket and its position in a footing of an offshore structure.

Referring to FIGURE 1 of the drawing, an offshore structure is shown as comprising a plurality of support members or legs **11**, **12** and **13** interconnected by means or bracing members **14** and fixedly secured to a base member **15** which rests on the ocean floor **16**. While a three-legged structure is shown from ease of illustration, it is to be understood that the structure could employ any number of legs which are usually arranged to outline a geometrical figure having a closed perimeter. Also, in some cases, instead of employing a plurality of legs extending upwardly from the base member or footing **15**,

there may be a single large diameter leg or caisson extending upwardly from the base member or footing **15** to support a deck thereon. The legs **11**, **12** and **13** are generally tubular, being legs formed of large diameter pipe. However, in some circumstances they may be solid members, such as I-beams. The base member **15** is shown as being a unitary structure comprising a series of interconnecting members which serve to reinforce it. In some structure the base member **15** may be covered with sheet metal or other material to form a buoyancy tank adapted to be flooded or evacuated so as to form a float by which the entire structure may be raised or lowered in the water. Mounted on top of the legs **11**, **12** and **13**, at a suitable distance above the surface of the water **17**, is an operating platform or deck **18**.

Fixedly secured to the base member or footing, preferably near the outer edge thereof, are a series of anchor jackets **20**, **21** and **22** which may take the form of short sections of tubular pipe having an upper portion that preferably extends above the base member or footing **15** while the lower portion of the jacket is fixedly secured, as by welding, within the base member or footing **15** or on the outer edge thereof. The anchor jackets **20**, **21** and **22** are shown as containing stub piles **23**, **24** and **25** which have been driven into the ocean floor **16** in any conventional manner. Elements **26** represents any suitable pile driver or drilling mechanism for driving or drilling the piles into the ocean floor. During this drilling or driving operation a follower pile **27** may have been employed to get the top of the stub pile **23** down to the desired depth. Alternatively, the stub pile **23** could be cut off at the top when it had reached the desired depth with the upper cut off portion of the pile being withdrawn to the platform or drilling barge again.

In FIGURE 2 the anchor jacket **20** is shown as being provided on the inner surface thereof with anchoring means in the form of a series of anchoring rings **30** which may be secured to the inner wall of the anchor jacket **20** in any suitable manner, as by welding or bolting. Although anchoring elements **30** in the form of rings are preferred, the anchoring elements may take the form of partial rings or merely blocks of metal secured to the inner wall of the anchor jacket **20** in axial spaced relationship. Preferably the space between each two metal rings is at least equal to the height of the ring element itself. The number of anchoring rings to be employed depends upon the number of times it is desired to connect the anchor jacket **20** to the pile **23** and subsequently to other piles. Preferably a pipe guide or collar **31** is securely anchored within the lower part of the anchor jacket **20**. In installing a pipe **23** within the anchor jacket **20**, a pile **23** is selected having a diameter only slightly smaller than the internal diameter of the anchoring rings **30**.

In order to connect the top of the pile **23** to the anchor jacket **20**, an expander tool of any suitable type, which may take the form of a mechanically or hydraulically actuated device or one containing an explosive charge, is lowered into the top of the pile **23** until it is positioned opposite the upper anchoring rings **30**. Upon actuation of the expander device the pipe wall of the stub pile **23** near the top thereof is deformed and expanded into the space between the anchor rings at the top of the anchor jacket **20**, as shown in FIGURE 2. It is preferred that the wall of the stub pile be expanded between as few of the anchor rings as possible and yet obtain their rigid connection. Thus the lower rings may be utilized at subsequent installations. Various types of expander tools may be used. One example would be a tool employing expanding dogs as in the hydraulic tool manufactured by Daily Oil Tools (see p.1552 of 1960–1961 Composite Catalog of Oil Field Equipment, Gulf Publishing Company). Controlled explosive charges to expand the pipe could be used as they are in daily use in oilfields for setting production tubing packers on a wire line (see 1960–1961 Composite Catalog, p. 546 and 586).

In the event that a well was drilled from the platform and it was found to be a dry hole, the platform structure of the present invention could be readily moved to another offshore location in the following manner. A pipe cutter of any well known design can be lowered into the top of the pile **23** or, alternatively, outside the upper portion of the anchor jacket **20** to cut off the top of the pile **23** and the anchor jacket **20** as shown in FIGURE 3 of the drawing. With the stub pile **23** and its anchoring jacket **20** now disconnected as shown in FIGURE 3, the base member or footing **15** and its anchor jacket **20** can be removed from the stub pile **23** by raising or floating the base member **15** upwardly in a conventional manner, leaving the stub pile **23** in the ocean floor as illustrated in FIGURE 4. The entire offshore structure is then moved to another location where new stub piles are driven through the portion of the anchor jacket **20** (FIGURE 3) which remains secured to the footing **15**. The second stub pile would then be attached to the upper two or three anchoring rings of the anchor jacket **20** in a manner similar to that described with regard to FIGURE 2. The anchor jacket and pile could subsequently be disconnected for a second time when desired and the entire offshore structure moved to a third location where it would be anchored and disconnected in a similar manner. One type of an inside pipe cutter manufactured by Hunt Tool Company is illustrated in the 1960–61 Composite Catalog p. 2744. Available outside pipe cutters are described on pages 776–7, 928 and 2742 of the 1960–61 Composite Catalog.

Rather than cut off the top of both the pile **23** and its anchor jacket **20** as shown in FIGURE 3 and leave the top of the stub pile **23** protruding above the ocean floor **16** as shown in FIGURE 4, it may be desired to cut off the stub pile **23** below the ocean floor. This could be accomplished by inserting an inside pipe cutter into the stub pile **23** of FIGURE 3 and cutting it below the ocean floor. Thus, when the offshore structure and footing **15** were raised in a manner shown in FIGURE 4, the short section of stub piles still within the anchor jecket **20** would drop out of the jacket and onto the ocean floor **16**. Alternatively, as illustrated in FIGURE 5, an outside pipe cutter could be employed to cut the anchor jacket **20** at a point represented by numeral **32** in FIGURE 5, while an inside pipe cutter culd be run down through the stub pile **23** and cut it at a point represented by numeral **33**. Subsequently tool fishing would be lowered to pull out the top section of the stub pile **23** to which the upper cut off part of the anchor jacket **20** is illustrated as attached.

In the previously described arrangements of a stub pile and an anchor jacket, the anchor jacket **20** has been shown as extending upwardly above the base member or footing **15** of the platform structure so that an outside pipe cutter could be lowered down over the anchor jacket to cut it at a desired level. In FIGURE 6 another arrangement of an anchor jacket **34** is shown as being entirely contained within the base member or footing **15** of an offshore platform structure. In this arrangement an annular space **35** is provided around the upper portion of the anchor jacket **30** for containing the anchoring rings **36**. By providing an annular space **35**, an outside pipe cutter can be lowered at any time around the upper end of the anchor jacket **34** to cut it off while an inside pipe cutter may be lowered at any time through the stub pile **37** to cut it at the desired height.

Thus, it may be seen that the present invention provides a method and apparatus for installing and anchoring stub pile to the base or footing of an offshore platform at successive locations to which the platform is moved, without returning the platform to dry dock to have other anchoring means provided or to remove old portions of stub pile.

I claim as my invention:

1. A method of installing at an offshore location a

marine structure having a base with a plurality of pile jackets for receiving concentric stub piles therethrough and a plurality of vertically-displaced anchoring means on each jacket for each of said piles, said method comprising:

positioning said marine structure with its base on the ocean floor;

driving piles through the pile jackets of said base structure, said piles being arranged so that their upper ends are below the water surface;

connecting each of said piles to said base by at least one but less than all of said plurality of anchoring means for each pile contained within an anchoring jacket;

subsequently serving each of said piles and said jacket with said anchoring means connected thereto at a point below the connection between the pile and the anchoring means;

raising said marine structure and moving it to another location;

again lowering said marine structure to the ocean floor;

again driving a second series of piles through said jackets of said base structure; and,

connecting said second series of piles to said base structure by at least some of the remaining anchoring means in each of said jackets.

2. The method of claim **1** wherein said piles are connected to said anchoring means of said base by the step of expanding each of said piles against cooperating anchoring means.

3. The method of claim **2** including the steps of lowering a pile expanding tool down through each of said piles to a position opposite the uppermost anchoring means and actuating said tool to expand said piles against said anchoring means.

4. The method of claim **2** including the steps of lowering an explosive charge into each of said piles to a position opposite the uppermost anchoring means and detonating said explosive charge to expand said piles into locked engagement with said anchoring means.

5. The method of claim **1** wherein said piles and engaged anchoring means are severed by lowering a cutting tool to a point below the engagement of said pile with said anchoring means and cutting off said pile and said anchoring means at a level below said anchored point.

6. The method of claim **5** including the steps of lowering a pile severing device through said pile to a point below said marine structure base and severing said pile at this point also.

7. The method of claim **1** wherein said marine structure is floated when it is moved from one location to another.

References Cited by the Examiner

UNITED STATES PATENTS

2,772,539 12/1956 Sandberg ---------- 61—46.5

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