

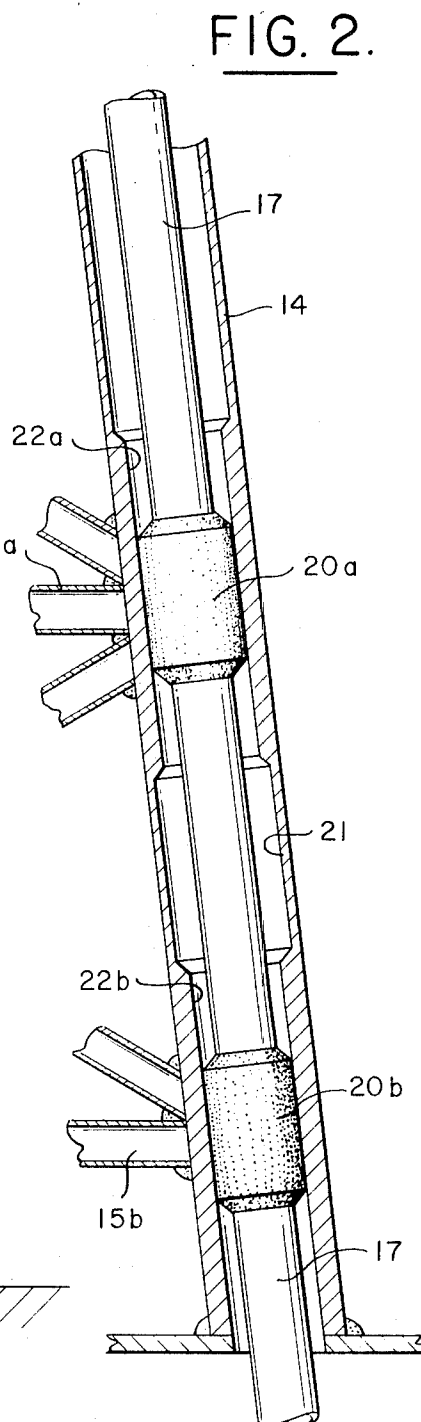
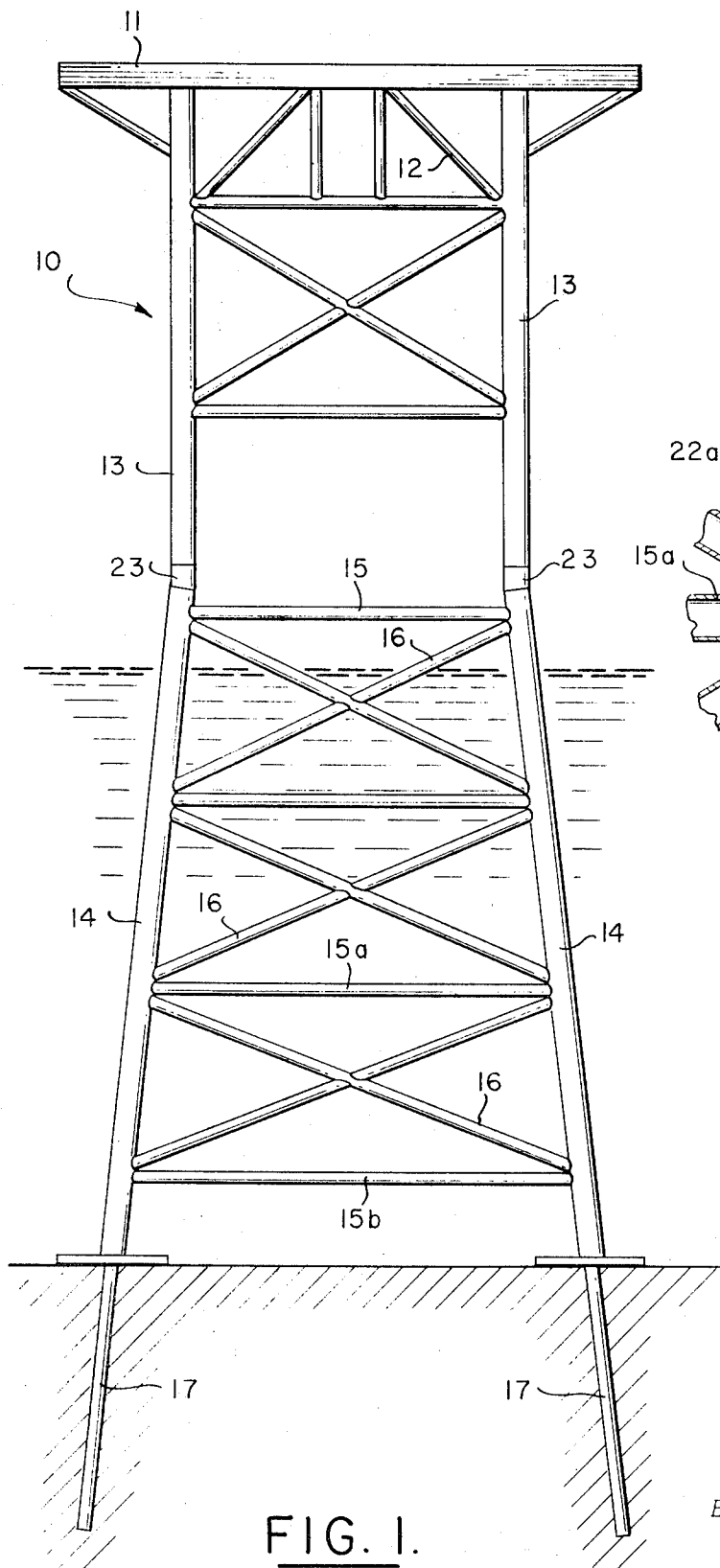
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J. J. BARDGETTE ET AL

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LATERAL RESTRAINT OF PILE WITHIN JACKET LEG

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INVENTORS.
JOHN J. BARDGETTE,
WILLIAM J. RUEZ, III,
BY *John S. Schneider*
ATTORNEY.

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LATERAL RESTRAINT OF PILE WITHIN JACKET LEG

John J. Bardgette, Orleans Parish, La., and William J. Ruez III, Houston, Tex., assignors to Esso Production Research Company

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10 Claims

ABSTRACT OF THE DISCLOSURE

Ring members are attached to the outer surface of piles which are positioned in the lower jacket legs (hollow tubular members) used in foundations for offshore platforms. The ring members bridge the annular space between the outer surfaces of the piles and the inner surfaces of the lower jacket legs.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention generally concerns offshore platforms of the jacket-type commonly used by the Oil Industry in the Gulf of Mexico. More particularly, it concerns method and apparatus for restraining piling within the lower jacket legs of such offshore platforms. In the construction of offshore platforms of this type, a tubular pile is normally driven through each lower jacket leg and connected only to the top ends of the jacket leg. Thus, each pile is relatively free to move laterally within the annular space between the pile and the jacket leg.

Piling for offshore structures serves two purposes: (1) the piles convey axial forces resulting from dead loads, live loads, storm loads and seismic loads to the soil underneath the body of water in which the offshore structure is located; and (2) the piles convey horizontal forces resulting from storm or seismic loads to such soil. The resistance mechanism developed by the soil to convey these two loading situations is different. Of the two, the second is generally the most difficult to handle analytically and physically.

The total horizontal force applied to an offshore platform is fixed by the magnitude of the storm wave or the earthquake. This force must be transmitted by the piling to the soil. The ability of a pile-soil system to resist horizontal forces is a function of the soil strength, the pile strength and the lateral restraint of the pile within the structure. Of these three factors, only the latter two can be influenced. To increase resistance to horizontal force, one, or a combination, of the following alternates are available: (1) increase pile diameter; (2) increase pile wall thickness; (3) increase the number of piles in the platform; or (4) increase the lateral restraint of the piles within the jacket legs. Of these four alternates, the fourth is the simplest to analyze and the least expensive to implement.

Lateral restraint within the jacket leg can be increased substantially by locking the pile to the jacket leg at several points above the mud line or by filling the annulus between the pile and jacket leg for a short distance above the mud line with a material which will restrict or prevent movement of the pile within the jacket leg. At the present time, only the latter method is commonly used. For several years, the annulus between the pile and the jacket leg has been filled with a cement slurry or grout. This is an excellent method of lateral restraint of piling within jacket legs, but it causes serious problems when the platform is salvaged.

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SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, lateral restraint of piles within jacket legs used in supporting offshore platforms is provided by attaching at least one annular member or ring to each pile prior to insertion of the pile within the jacket leg so that when the pile is inserted through the jacket leg a portion of the annular space between the outer surface of the pile and the inner surface of the jacket leg is completely bridged. The ring is attached to the outer surface of the pile at a predetermined location so that when the pile is driven to its predetermined depth the ring will be positioned in a reduced internal diameter section of the jacket leg. Two or more rings are preferred. When more than one ring is used, each succeeding ring diameter from the uppermost ring is slightly smaller than the ring next above it and accordingly, each succeeding reduced diameter section of a jacket leg from top to bottom is formed slightly smaller than the reduced diameter section next above it to allow the lower rings attached to the pile to pass through the upper jacket leg restrictions without undue contact pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and other objects and advantages of the invention will be apparent from a more detailed description thereof when taken with drawings wherein:

FIG. 1 is a side view of an offshore platform of the jacket-type; and

FIG. 2 is a view of one portion of a jacket leg showing the arrangement of the pile, rings and jacket leg in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in greater detail, in FIG. 1 is shown an offshore platform generally designated 10. Platform 10 includes a deck member 11 provided with supporting cross-bracing 12. Deck legs 13 are connected to deck 11 at their upper ends and to tops of piling at their lower ends. The piles are connected by welding to the tops of jacket legs at 23. The lower jacket legs 14 are connected together by horizontal braces 15 and angular braces 16. Piles 17 extend through the lower jacket legs 14.

As seen in FIG. 2, each lower jacket leg 14 has arranged within it a pile member 17 to which are bonded two spaced-apart rings 20a and 20b of resilient material (e.g., rubber). These locations are opposite the lowest two horizontal jacket braces 15a, 15b. To prevent excessive wear of the resilient material 20 during pile-driving operations, ample clearance is provided between the outer surface of rings 20a, b and the inner surface 21 of jacket leg 14 until the pile has nearly reached its predetermined depth. The internal diameter of jacket leg 14 is reduced as at 22a, b adjacent the two lowest horizontal braces 15a, 15b so that at these locations, the internal diameter of jacket leg 14 is equal to or slightly less than the outside diameter of rings 20a, b. The inside diameter 22a opposite the horizontal jacket brace 15a is slightly larger than the inside diameter of jacket leg 22b opposite the bottom horizontal jacket leg brace 15b and the outside diameter of the lower ring 20b on pile 17 is slightly smaller than the outside diameter of upper ring 20a. This arrangement allows lower ring 20b to pass through the upper jacket leg restriction formed by the reduced diameter 22a without undue contact pressure.

The purpose of the rings is to restrain the lateral movement of the pile within the jacket leg so that the jacket leg and the pile deflect together when the platform is moved by an external lateral force, such as by wave and wind or

seismic loads. The rotational movement of the pile is fixed relative to the position of the jacket leg in which it is arranged. It is desirable to have rings of nonyielding and thus nonenergy absorbing material; however, because of construction considerations, a yielding or resilient material is desirable so that if the ring or the receiving socket is out of round or if dimensions, as manufactured, are slightly different from planned, then the ring can be forced into the receiving socket without damage to the pile or the jacket leg. When only two rings are used, as described above with reference to the preferred embodiment, the deflected shape of that portion of the jacket leg between the two lowest horizontal braces connecting the lower jacket legs to each other is approximately the same as the deflected shape of that portion of the pile between the two rings.

Various modifications may be made in the preferred embodiment of the invention which has been described without departing from the spirit and scope thereof. As mentioned previously, for example, the rings are preferably made of resilient material, such as rubber. However, other materials, including steel, could be used by maintaining appropriate dimensional control. When a single ring is used, it should extend along the lengths of the jacket leg and pile a sufficient distance to be effective in restraining lateral movement of the pile relative to the jacket leg. Although the preferred construction places the rings adjacent the lowermost horizontal braces, the rings do not have to be so located. Further, the rings need not be solid segments. They may be otherwise configured, e.g., ribbed or corrugated, so long as the annular space between the outer surface of the pile and the inner surface of the jacket leg is completely bridged.

Having fully described the objects, advantages, apparatus and method of our invention, we claim:

1. An improved offshore structure foundation which includes a plurality of hollow jacket legs extending from the ocean floor to above the surface of water in which the foundation is arranged comprising:

a pile member arranged in each jacket leg and extending from the upper end thereof into the soil underlying said water, said pile member having at least one ring member attached thereto, said ring member bridging the annular space between the outer surface of said pile member and the inner surface of said jacket leg, and being of sufficient length to extend along lengths of said pile member and said jacket leg a sufficient distance to be effective in restraining lateral movement of said pile member relative to said jacket leg and being arranged on said pile member such that said pile member and said ring member are completely removable together from said jacket leg and salvageable without use of mechanical disconnect devices or destruction of bridging material.

2. An improved offshore structure foundation which includes a plurality of hollow jacket legs extending from the ocean floor to above the surface of water in which the foundation is arranged comprising:

a pile member arranged in each jacket leg and extending from the upper end thereof into the soil underlying said water, said pile member having at least one ring member attached thereto, said ring member bridging the annular space between the outer surface of said pile member and the inner surface of said jacket leg, said jacket leg being provided with a reduced diameter section along the length thereof

and said ring being positioned in said reduced diameter section.

3. An offshore structure foundation as recited in claim 2 including vertically spaced-apart, horizontally extending bracing members connecting said jacket legs to each other, at least two of said bracing members being connected to said jacket legs at reduced diameter sections of said jacket legs.

4. An offshore structure foundation as recited in claim 3 including two reduced diameter sections of said jacket legs located adjacent said lowermost and next lowermost horizontally extending bracing above the mud line.

5. An offshore structure foundation as recited in claim 4 in which said upper and lower reduced diameter portions of said jacket legs are of different sizes, said upper reduced diameter portion being larger than said lower reduced diameter portion.

6. An offshore structure foundation as recited in claim 5 in which said rings are formed of resilient material.

7. An offshore structure foundation as recited in claim 6 in which said upper resilient ring is larger in diameter than said lower resilient ring.

8. An offshore structure foundation as recited in claim 7 in which said rings are formed of rubber.

9. A method for constructing an improved offshore structure comprising the steps of:

arranging a plurality of jacket legs in a body of water to extend from the floor of the body of water to above the surface of the water, each jacket leg having at least one reduced diameter section;

driving a smaller diameter pile member through each of said jacket legs into the soil underlying the water, each pile member having at least one ring member attached thereto and said ring member being of smaller diameter than said jacket leg other than at the reduced diameter section thereof; positioning said ring member in said reduced diameter section of said jacket leg, said ring member when so positioned bridging a portion of the annular space between the outer surface of said pile and the inner surface of said jacket leg whereby removal of said pile member and said ring member from said jacket leg and salvaging thereof is permitted without the use of mechanical disconnect devices or destruction of bridging material.

10. A method as recited in claim 9 in which two spaced-apart rings are bonded to each pile member, the uppermost of said rings being larger in diameter than said lowermost of said rings and said upper reduced diameter section of each jacket leg being larger than the lower portion thereof.

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J. KARL BELL, Primary Examiner

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