

PATENT SPECIFICATION (11)

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(54) IMPROVEMENTS IN OR RELATING TO ANCHORING OFF-SHORE RIGS OR THE LIKE

(71) We, COMPAGNIE FRANCAISE D'ENTREPRISES METALLIQUES, a French Body Corporate, of 57, Boulevard de Montmorency, 75781 Paris Cedex 16, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to methods and devices for anchoring the base of an off-shore rig to the sea bed, the rig being of the kind used for drilling operations and/or storage of oil or other products.

15 The problem in this kind of anchorage is to secure the base in a sufficiently rigid manner for it to withstand horizontal forces (for example swell) applied to the rig assembly, and to withstand the resulting torque.

20 Hitherto, the base has been anchored and stabilized on the ground mainly by gravity; the base is heavily ballasted, *inter alia* with concrete or sand positioned after the rig has been placed on the operating site. The purpose of ballasting is to drive in props which usually form part of conventional bases and to ensure that the stresses under the base always remain positive, in spite of the aforementioned torque.

30 It has also been proposed to supplement the anchorage by piles, but the piles are usually drilled from the rig. If the anchorage is required on a deep sea bed, the distance between the rig and the ground is too great for suitable drilling under economic conditions.

35 According to the present invention there is provided a method of anchoring the base of an off-shore rig of the kind specified in which drilled piles are used for anchoring the rig, the method being such that the piles to be distributed around the base of the rig are successively drilled by means of at least one machine adapted to move, *inter alia* on rails, on the edge of the base and, if required, remote-controlled.

45 In a preferred embodiment, the piles are tubular and are each provided at the base with drilling tools rotatable with the pile

and having an external area slightly greater than the pile cross-section, and are rotated by a rotating head which is driven by the machine and is lowered at the same rate as drilling proceeds.

If the piles are given a relatively large diameter, their length can be considerably reduced, so that the drilling operation can be performed quickly.

For example, in the case of large rigs having a square base with sides from 50 to 100 m. in length, about 20 metal piles of the aforementioned kind, laid at a depth of the order to from 10 to 15 m., can be provided on each side, the piles being hollow and having a diameter for example of the order of 1.5 m.

After drilling, the outer surface of the pile has to be firmly secured to the wall drilled in the ground and to the tubular wall of the supports. The pile is secured for example by injecting concrete from its interior.

In addition to the preceding features, the invention comprises certain advantageous other features which are preferably used at the same time and will be described in detail hereinafter.

For a better understanding of the invention and to show how the same may be put into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figures 1 and 2 respectively show a very diagrammatic, partial elevation view of an off-shore rig assembly and plan view of its base having a number of drilled piles according to the invention around its periphery.

Figure 3 shows a separate, larger-scale partial elevational view of the base assembly, a pile and the drilling device.

Figure 4 shows an even larger-scale axial sectional view through the interior of a pile, showing the various pipes for discharging excavated material and supplying cement, and

Figure 5 shows a still larger-scale sectional view of an anti-return device for injected cement.

According to the invention, more par-

particularly according to the applications and partial embodiments which appear to be most promising, for example in the case of an off-shore rig essentially comprising a base 1, a shaft or tower 2 and a deck 3 for receiving equipment, the following or similar method is adopted for anchoring the base to the ground and will be described with reference to the accompanying drawings.

Anchoring is mainly by means of metal piles having a drilling head at their base and disposed for example inside tubular supports which are secured to the base and are drilled by suitable devices known in the art.

Figure 1 shows piles P and a tubular support 4. The support may for example be laterally secured to the base, although this is only a preferred embodiment.

Figure 3 shows the assembly on a larger scale, a drilling tool 5 being provided at the base of pile P. The outer diameter of the tool 5 is slightly greater than the diameter of the pile proper so as to facilitate drilling. Consequently, the cylindrical hole drilled in the ground leaves a certain space 6 between the wall 7 of the hole and the wall 8 of pile P, as shown in Figure 4. Similarly, the wall 9 of the hole formed in the tubular support 4 will be slightly larger in diameter than the pile.

The diameter and length of the piles are chosen in dependence on the nature of the ground and the desired retaining force.

By way of non-limitative example, in the case of a rig having considerable height and weight, for example, a height of the order of 150 m. and a weight of the order 60,000 tonnes, including the weight (approximately 20,000 tonnes) of the equipment supported by the deck, and a maximum horizontal thrust of the order of 25,000 tonnes, the piles can have a total height H of the order of from 20 to 25 m, a depth of penetration h of the order of from 15 to 20 m, whereas their diameter will be of the order of 1.5 m for ground having extremely poor characteristics.

Advantageously, the piles are threaded into their supports 4 (or other means) before the rig is positioned over the sea bed. Advantageously, the piles are positioned by at least one device which can move on the edge of the base and is remote-controlled and acts on piles P in succession.

A device 10 of this kind is shown in Figure 3. It can move on rails 11 extending all the way along a lateral platform 12 of base 1. It mainly comprises a head 13 adapted to be rotated and to rotate the pile, and held by a support 14 which can be vertically moved by a suitable device 15 at the same rate as the drilling carried out by the tool 5. The material removed by

drilling is evacuated through an internal duct 16.

Preferably, use is made of a system of the kind known commercially as "Hydrofond System". The word "Hydrofond" is a Trade Name. This system comprises the following:

a hydraulic, immersed, powered reduction gear unit adapted to rotate the pile head 13, a pump for sucking away material removed by the drilling tool, and, if required, means for driving a jet of high-pressure water down the interior of the pile.

When the piles have been positioned, or during the positioning process, the spaces 6 between the ground 7 and the piles and the clearances between the piles and the walls 9 of the holes in supports 4 are filled by a suitable binder such as cement.

To this end, the piles have internal pipes for supplying cement, diagrammatically illustrated at 17 in Figure 4 and terminating at various places 18 on the wall 8 of the pile. Figure 5 shows a more detailed view of the passage through wall 8, an anti-return ball 19 being inserted so as to prevent sludge and other debris from penetrating into the pipes during drilling and possibly clogging them. The pipes are supplied on the rig via suitable connections and ducts, some of which are flexible.

Accordingly, whatever embodiment is adopted, rigs of the kind in question can be anchored under conditions having numerous advantages over the prior art, *inter alia* the following:

the anchoring can be very accurate, since the behaviour of the piles in the ground can be calculated in a known, reliable manner, so that if the penetration depth is calculated the result is completely reliable, whereas in existing methods it is never certain whether the props will penetrate to the desired depth;

ballast can be eliminated from the structure or at least reduced to a minimum value allowing for summer storms which may occur during the positioning of the piles;

a considerable reduction (for example 50%) can be made in the length L (see Figure 2) that is the dimensions of the base;

the props under the base can be eliminated; and

owing to the rigidity of the piles, the structure is substantially prevented from moving horizontally under the effect of strong swell.

WHAT WE CLAIM IS:—

1. A method of anchoring the base of an off-shore rig of the kind specified in which an anchorage is provided by drilling piles distributed around the base, wherein

(3)

particularly according to the applications and partial embodiments which appear to be most promising, for example in the case of an off-shore rig essentially comprising a base 1, a shaft or tower 2 and a deck 3 for receiving equipment, the following or similar method is adopted for anchoring the base to the ground and will be described with reference to the accompanying drawings.

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Advantageously, the piles are threaded into their supports 4 (or other means) before the rig is positioned over the sea bed. Advantageously, the piles are positioned by at least one device which can move on the edge of the base and is remote-controlled and acts on piles P in succession.

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Accordingly, whatever embodiment is adopted, rigs of the kind in question can be anchored under conditions having numerous advantages over the prior art, *inter alia* the following:

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WHAT WE CLAIM IS:—

1. A method of anchoring the base of an off-shore rig of the kind specified in which an anchorage is provided by drilling piles distributed around the base, wherein



the piles are successively drilled by means of at least one machine adapted to move, *inter alia* on rails, on the edge of the base and remote-controlled if required.

- 5 2. A method according to Claim 1, wherein the piles are tubular and are each provided at the base with drilling tools rotatable with the pile and having an external area slightly greater than the pile cross-section, and are rotated by a rotating head which is driven by the machine and is lowered at the same rate as drilling proceeds.

- 10 3. A method according to Claim 2, wherein each pile also comprises ducts terminating at its surface and adapted to supply cement for filling the gap left owing to the difference between the dimensions of the tool and the pile cross-section.

- 15 4. A method according to Claim 2 or 3, wherein the tubular piles also have at least one internal duct for discharging the material removed by drilling.

- 20 5. A method according to any one of Claims 1 to 4, wherein the tubular piles

are guided *via* brackets laterally supported by the base. 25

6. A method of anchoring, substantially as hereinbefore described with reference to the accompanying drawings.

7. An off-shore rig of the kind specified whenever anchored by the method of any one of the preceding Claims. 30

FORRESTER, KETLEY & CO.,
Chartered Patent Agents,
Forrester House,
52 Bounds Green Road,
London, N11 2EY,
and also at
Rutland House,
148 Edmund Street,
Birmingham, B3 2LD,
and
Scottish Provident Building,
29 St. Vincent Place,
Glasgow, G1 2DT.
Agents for the Applicants.

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