

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO OFF-SHORE PLATFORMS FOR DRILLING AND/OR STORING OIL AND OTHER PRODUCTS

(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:-

5 This invention relates to improvements in methods of building off-shore platforms and to such off-shore platforms - that is, platforms for installing on a sea or other underwater bed for well drilling and/or storing oil or other products, the platforms being more particularly of metal construction (the following description assumes metal construction, but this is, of course, not essential). 5

10 The platforms to which this invention relates comprise, in known manner, a base adapted to be anchored to the sea or other underwater bed, *inter alia* by the weight of the whole platform and of an appropriate ballast, the base having mounted on it one or more columns or towers, mounted on top of which is a deck or the like on which the drilling or other equipment is installed. Normally, the base comprises an oil storage tank or has such a tank 10
15 mounted thereon. 15

The known platforms of the kind described suffer from a number of technical difficulties, more particularly when they are being towed from the construction site to the site where they are to be installed since the lack of stability of the platform during towing causes problems, particularly if the complete platform is to be towed in a vertical position. Usually, it is impossible to complete the platform before towing, a particular difficulty being that 20
20 the considerable weight of the equipment to be installed on the deck would impair stability. The equipment therefore has to be assembled subsequently to tow out at the installation site, with a consequent complication and prolongation of assembly operations. 20

25 In addition, if the platform is to be built at a sheltered coastal construction site, in vertical position, the construction site chosen must have sufficiently deep water and easy access for open-sea towing. Unfortunately only a few such suitable construction sites exist, since the exit channel of such a site often has shallows. 25

To obviate these disadvantages it has already been proposed to provide the platforms with an intermediate member which, at certain stages in the building operation, can be used as a 30
30 float to facilitate towing. This, however, does not in itself provide an easy method of constructing the platform superstructure, since the platform is constructed in a site which is sheltered but is relatively shallow, which means that the high parts of the structure cause difficulties as regards access during the building operation. 30

35 Furthermore, the distance between the member and the platform bed-plate is relatively small, *inter alia* less than half the total height of the platform. As a result, the platform is not very stable when floated to the immersion and anchoring site. 35

It is an object of the present invention to overcome, or at least mitigate, the aforementioned disadvantages and difficulties.

40 According to the first aspect of the present invention there is provided a method of constructing an off-shore platform for installation on a sea or other underwater bed, which platform comprises a base and one or a plurality of column(s) which supports a deck, the platform also comprising an intermediate buoyancy member and ballasting and deballasting means, which method comprises building a buoyant first structure comprising the base and 40

a lower part of the column(s), after which a buoyancy member, the upper part of the column(s) and a deck are built onto the first structure while it is still floating, the entire structure descending during the building process into water in a protected site, which is suitably chosen and has a sufficient depth, after which the structure, *inter alia* the buoyancy member, is deballasted so that the structure is raised until the buoyancy member is substantially at the water level, so that the structure can then be towed in stable manner to a site where it is to be installed and finally lowered by further reballasting, in known manner.

According to the second aspect of the present invention there is provided an off-shore platform whenever constructed by the method of the invention.

By the method of the present invention, the building operations can be carried out under essentially ideal conditions afloat, that is at a short distance above the water level. In addition, the distance between the buoyancy member and the base can be given a high value, greater than half the height of the platform (from the deck to the bottom of the base), thus giving high stability during towing.

In a preferred embodiment, the method of construction according to the invention comprises the following steps:

building a first structure comprising the base and at least a lower portion of the column(s) on land,

floating the first structure to a protected erection site, ballasting the first structure until the upper ends of the column portion(s), which if required are built up to the intended height of the buoyancy member are at a predetermined height above the water level,

building a second structure comprising the buoyancy member and upper portion(s) of the column(s) on land and floating the second structure on a pontoon to a position above the immersed first structure,

securing the second structure to the first and if necessary building up the tower(s) to the intended height to form a partially complete platform,

ballasting the partially complete platform until the upper end(s) of the column(s) are at a predetermined height above the water level,

floating out the deck at a position above the immersed, partially complete platform and then securing the deck to the column(s),

raising the platform, which is substantially complete, by deballasting until the buoyancy member is substantially at the water level, whereupon the platform is towed to the site where it is to be installed and finally lowered by further reballasting.

Thus, all the work is performed on land or afloat, in particularly advantageous positions giving high efficiency.

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

For a better understanding of the present 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:-

Figure 1 shows a diagrammatic elevational view of an off-shore platform in a position for towing to an installation site, after it has been built, according to the invention.

Figures 2 and 3 show a side view in the direction of the arrow II of Figure 1 and a sectional view along the line II-III of Figure 1, respectively, of the platform of Figure 1.

Figure 4 shows a diagrammatic view illustrating the various parameters which determine statical stability of a floating offshore platform.

Figure 5 shows a vertical diagrammatic elevational view of a first structure comprising the base and the lower portions of the columns or towers of the platform of Figure 1 being towed to a protected site,

Figure 6 shows a diagrammatic elevational view illustrating a second structure comprising the upper portion of the platform of Figure 1, built ashore and being transferred on a pontoon or barge,

Figure 7 shows the second structure of Figure 6 being towed to the protected site.

Figure 8 shows a diagrammatic elevational view illustrating the structures of Figures 5 and 6 being fitted together at the protected site.

Figure 9 shows a diagrammatic elevational view illustrating, at the protected site, a deck being installed on the upper ends of the columns of a platform comprising the two structures shown in Figure 8, and

Figure 10 shows a diagrammatic side view of the finished platform being towed towards an immersion site.

To give a general idea of the considerations affecting the statical stability of an offshore platform, there is shown in Figure 4 a platform which is floating and which comprises a base 1, a support structure 2, for example one or more columns or towers, and at the top a deck 3. The statical stability of the floating platform depends upon the respective positions, relative

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to the bottom K, in accordance with known hydrostatic laws, of the following points:

- The centre of Buoyancy,
- The centre of gravity G, and
- The metacentre M.

- 5 Of course, the distance CM is the metacentric height and is equal to I/V where:
 I represents the second moment of area of the water plane and
 V represents the immersed volume of the platform.

It can be shown that, for the platform to be stable, it is necessary that:

$$KM = KC + CM > KG$$

- 10 that is, the point M must be higher than the point G.

If the metacentre M is raised, it becomes possible to raise the centre of gravity G without adversely effecting the statical stability of the platform, that is, all the items of drilling and/or other equipment required can be assembled on the deck 3 before towing, and thereby the platform can be fully prefitted and towed from a protected construction site to a

15 drilling site in a ready-to-operate state.
 Figures 1 to 3 show, by way of example, an embodiment of platform built according to the method of the invention, in which the value M has been increased by increasing the parameter I of the platform, that is the waterplane area of the platform in the "tow-out" condition is increased. The platform comprises a substantially rectangular base 1 which may include one or more storage tanks 4, for example, two oblong tanks 4, four columns or towers which can be, in cross-section, round or square or of some other shape (each tower comprising a number of elements 2, 2₁, 2₂ whose cross-section decreases upwardly), and a deck 3 supported by the columns and adapted to accommodate various items of equipment

25 In this embodiment, the means for raising the metacentre is at least one buoyancy member 6 secured, possibly with provision for release or adjustment, to the towers or columns 2 at such a distance H₁ from the bottom level of the base 1 that, in relation to overall platform height H, the still water line for the platform in a "tow-out condition is slightly below top edge 7 of the member 6, although this feature is not indispensable and under certain conditions, *inter alia* when the sea bed is deep, the top of the member 6 can be partly immersed.

30 As a rule, the ratio between the height H₁ and the height H is between 0.50 and 0.65, but this range is not limitative. Of course, it is advantageous to increase the value H₁, since this increases the stability during towing.

35 By way of example in the embodiment shown, the member 6, in plan, is generally angular in shape (see Figure 3) and can be circular or rectangular or of some other shape. Figure 3 shows the member 6 to comprise, by way of example, four tubular tanks or caissons secured to the columns 2. If drilling tubes 9 are disposed laterally of the platform - that is, substantially along one of its four vertical faces - whichever of the tanks, for example 6₁ is on the face concerned includes passages 8 for the tubes 9 and can be of larger cross-section than the other tanks.

40 Figure 1 also schematically shows trunking and other facilities 12 for controlling ballasting and eballasting operations and the base 1 in known manner to be divided into ballast compartments, as are, if required, the storage tanks 4 and/or the buoyancy member 6.

45 The following approximate data is given by way of example, for the platform shown in Figure 1 which is to be placed on underwater beds at a depth of 160 metres or more, and to be constructed at a site having a water depth or exit channel depth of about 120 metres:

	Metres
Overall height H	190
Length L of sides of base 1	100
50 Base height h ₁	15
Height h ₂ of tanks 4	25
Spacing e between axes of towers 2	45
Base diameter of towers	15
55 Vertical distance H ₁ between top surface of buoyancy member 6 and bottom level of base 1	110
Cross-section, assumed to be rectangular, of buoyancy member 6	9 m x 8 m
Area of deck 3	6,500 m ²

60 The platform is of steel and would be about 45,000 tons in weight including the deck. The deck could withstand installations weighing approximately 15,000 tons during towing. The weight of the platform ready for towing - that is, ballasted to a draught of 110 metres - would, therefore, be about 60,000 tons. The vertical movements of such a structure on tow would be about 0.25 m in a swell having a 3 metre trough and a 10-second period, with substantially zero pitching and rolling.

65 On the basis of these general remarks, which are given by way of example only a method

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of construction according to the invention will now be described, with reference to Figures 5 to 10 and in accordance with a preferred embodiment.

A first structure comprising the base 1 and columns 2 or at least portions of the columns are constructed in a construction yard, the work being done if required on a slipway or in a drydock. In any case, after all the columns 2 have been completed up to height H_1 at which the base of the buoyancy member 6 is to be positioned, the first structure is floated out and towed (see Figure 5) to a protected site 10 (see Figure 8) having a sufficient depth of water.

The same construction procedure is used for the assembly of a second structure comprising the buoyancy member 6 and the upper portions of the towers 2 such as 2_1 and 2_2 , but in this case a pontoon or barge 13 (see Figures 6 to 8) is used for supporting the second structure when towing to the site 10.

Figure 6 shows the second structure being launched onto the pontoon or barge 13, and Figure 7 shows the "loaded" pontoon or barge 13 being towed to the site 10 after the launch.

After the two structures, being basically the upper and lower parts of the platform, have been towed to the site 10, the first structure 1, 2 is immersed by ballasting the base 1 or lower parts of the columns 2, the towers 2 are at a predetermined height above the water (see Figure 8). Next, the second structure is brought on its barge and introduced between the emerging towers in a position (see Figure 8) such that the second structure is above the submerged first structure and in the right position for joining the two structures together.

The buoyancy member 6 is then secured to the lower parts of the columns 2, after which the pontoon or barge 13 is released, for example by momentarily deballasting the assembly 1, 2. To mount the deck 3 on top of the column sections 2_2 , the structure is additionally ballasted until the top towers 2_2 are just above the water level, as shown in Figure 9.

The deck 3 has in turn been constructed in a construction yard and brought on another pontoon or barge 14 (see Figure 9), after which deck 3 is secured to columns 2_2 .

After the entire platform has thus been constructed, it is ready to be towed to the installation site.

For the purpose of towing the platform is (see Figure 10) ballasted to float at a level with the buoyancy member 6 being intersected by the water line whereat the structure can pass readily over possible shallows in the protected site exit channel which yet provides satisfactory stability in towing.

For towing, for instance, the top edge 7 of the member 6 in the example just mentioned can be from 1 to 3 metres above waterline (see Figure 1). It is generally preferred that the float line is at about $4/5$ ths of the total height of the buoyancy member. This is not indispensable, however, and when the sea bed is sufficiently deep, the water level may be slightly above the top surface of the buoyancy member 6.

Upon arrival at the installation site the platform is lowered by further ballasting and anchored to the sea bed. To increase the weight of the platform, heavy ballast, for example sand, is used; in the example mentioned, the weight of such heavy ballast would be approximately 70,000 tons.

By use of the present invention, it is possible under appropriate conditions to obtain the following advantages:-

Since the buoyancy member intermediate the deck and the base raises the metacentre M, it is possible to raise the centre of gravity too, that is all items of equipment can normally be installed on the platform deck before the structure is towed to the installation site;

Because of the increased hydrostatic buoyancy force from the buoyancy member, stability is improved during towing and during construction and immersion;

The platform can be constructed at a site where only a reduced draught is possible due to the presence of shallows

The main advantage is that the building and assembly operations can be considerably speeded up, since they can be carried out on land or in the deep protected site as appropriate, simultaneously with immersion in the site, without the need for extensive scaffolding;

The heave period of the complete platform can be reduced to a very low value;

The buoyancy member can, if required, be used as a supplementary oil tank, so that a considerable total storage capacity can be made available.

In the example hereinbefore described, the storage capacity of the base 1 would be about 160 000 m^3 plus the storage capacity of the buoyancy member 6, if required.

Of course, the example hereinbefore described is given only by way of explanation and the invention is of use with platforms of any size.

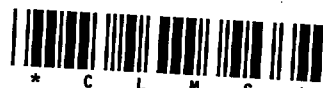
It should be noted that the method of assembling while afloat on a protected site, which is described hereinbefore for the structure comprising the buoyancy member 6 and the associated columns and also for deck 3, all of which are brought on pontoons or barges, may be applied if necessary or desirable to the final assembly of certain parts of the columns 2 or 2_1 , 2_2 which have not been constructed on land. These parts would then be towed on a pontoon or barge to the protected site and secured while afloat to those portions of the columns

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which are already secured on the base 1 or the buoyancy member 6.

WHAT WE CLAIM IS:-

1. A method of constructing an off-shore platform for installation on a sea or other underwater bed, which platform comprises a base and one or a plurality of column(s) which supports a deck, the platform also comprising an intermediate buoyancy member and ballasting and deballasting means, which method comprises building a buoyant first structure comprising the base and a lower part of the column(s), after which a buoyancy member, the upper part of the column(s) and a deck are built onto the first structure while it is still floating, the entire structure descending during the building process into water in a protected site, which is suitably chosen and has a sufficient depth, after which the structure, *inter alia* the buoyancy member, is deballasted so that the structure is raised until the buoyancy member is substantially at the water level, so that the structure can then be towed in stable manner to a site where it is to be installed and finally lowered by further reballasting, in known manner.
2. A method according to Claim 1, wherein, for towing, the structure is brought, through the agency of appropriate ballastings or deballastings, into a position such that the buoyancy member can act as a hull whose float line is substantially flush with the top part of the member.
3. A method according to Claim 1 or 2, wherein the ratio between the distance between the top of the buoyancy member and the bottom of the base and the overall platform height is in the range of from 0.50 to 0.65.
4. A method according to Claim 1, 2 or 3, wherein the buoyancy member has bores or passages through which drilling tubes extend.
5. A method according to any one of the preceding claims, which comprises the following steps:-
 - building a first structure comprising the base and at least a lower portion of the column(s) on land,
 - floating the first structure to a protected erection site, ballasting the first structure until the upper ends of the column portion(s), which if required are built up to the intended height of the buoyancy member, are at a predetermined height above the water level.
 - building a second structure comprising the buoyancy member and upper portion(s) of the column(s) on land and floating the second structure on a pontoon to a position above the immersed first structure,
 - securing the second structure to the first and if necessary building up the tower(s) to the intended height to form a partially complete platform.
 - ballasting the partially complete platform until the upper end(s) of the column(s) are at a predetermined height above the water level.
 - floating out the deck to a position above the immersed, partially complete platform and then securing the deck to the column(s).
 - raising the platform, which is substantially complete, by deballasting until the buoyancy member is substantially at the water level, whereupon the platform is towed to the site where it is to be installed and finally lowered by further reballasting.
6. A method according to Claim 5, wherein the base provides the buoyancy during towing of the first structure to the protected site.
7. A method according to any one of Claims 1 to 4, which further includes towing the completed platform structure, after deballasting, to a work site and reballasting to lower the platform structure onto a sea bed.
8. A method according to any one of Claims 5, 6 and 7, wherein, during towing, the buoyancy member is partly immersed, the float line being *inter alia* at about 4/5ths of the total height of the buoyancy member.
9. A method according to any one of Claims 5 to 7, wherein, during the operation of towing to the work site and the final immersion, the buoyancy member is slightly below the water level.
10. A method of constructing an off-shore platform, substantially as hereinbefore described with reference to the accompanying drawings.
11. An off-shore platform whenever constructed by the method of any one of the preceding claims.



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1. A method of constructing an off-shore platform for installation on a sea or other underwater bed, which platform comprises a base and one or a plurality of column(s) which supports a deck, the platform also comprising an intermediate buoyancy member and ballasting and deballasting means, which method comprises building a buoyant first structure comprising the base and a lower part of the column(s), after which a buoyancy member, the upper part of the column(s) and a deck are built onto the first structure while it is still floating, the entire structure descending during the building process into water in a protected site, which is suitably chosen and has a sufficient depth, after which the structure, *inter alia* the buoyancy member, is deballasted so that the structure is raised until the buoyancy member is substantially at the water level, so that the structure can then be towed in stable manner to a site where it is to be installed and finally lowered by further reballasting, in known manner.
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4. A method according to Claim 1, 2 or 3, wherein the buoyancy member has bores or passages through which drilling tubes extend.
5. A method according to any one of the preceding claims, which comprises the following steps:-
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 - floating the first structure to a protected erection site, ballasting the first structure until the upper ends of the column portion(s), which if required are built up to the intended height of the buoyancy member, are at a predetermined height above the water level,
 - building a second structure comprising the buoyancy member and upper portion(s) of the column(s) on land and floating the second structure on a pontoon to a position above the immersed first structure,
 - securing the second structure to the first and if necessary building up the tower(s) to the intended height to form a partially complete platform,
 - ballasting the partially complete platform until the upper end(s) of the column(s) are at a predetermined height above the water level,
 - floating out the deck to a position above the immersed, partially complete platform and then securing the deck to the column(s),
 - raising the platform, which is substantially complete, by deballasting until the buoyancy member is substantially at the water level, whereupon the platform is towed to the site where it is to be installed and finally lowered by further reballasting.
6. A method according to Claim 5, wherein the base provides the buoyancy during towing of the first structure to the protected site.
7. A method according to any one of Claims 1 to 4, which further includes towing the completed platform structure, after deballasting, to a work site and reballasting to lower the platform structure onto a sea bed.
8. A method according to any one of Claims 5, 6 and 7, wherein, during towing, the buoyancy member is partly immersed, the float line being *inter alia* at about 4/5ths of the total height of the buoyancy member.
9. A method according to any one of Claims 5 to 7, wherein, during the operation of towing to the work site and the final immersion, the buoyancy member is slightly below the water level.
10. A method of constructing an off-shore platform, substantially as hereinbefore described with reference to the accompanying drawings.
11. An off-shore platform whenever constructed by the method of any one of the preceding claims.

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